Canadian Telecommunications Policy and The National Disaster Mitigation Strategy: Observing Wireless Enhanced 9-1-1

by

Gordon A. Gow
M.A. University of Calgary, 1997
B.A. Simon Fraser University, 1995

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NAME GORDON ALBERT GOW
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TITLE CANADIAN TELECOMMUNICATIONS POLICY AND THE NATIONAL DISASTER MITIGATION STRATEGY: OBSERVING WIRELESS E9-1-1

EXAMINING COMMITTEE:
CHAIR Prof. Catherine Murray

Prof. Peter Anderson
Senior Supervisor,
School of Communication, SFU

Dr. Richard Smith
Supervisor,
School of Communication, SFU

Prof. David Mitchell
Supervisor,
Director of Graduate Programs,
Faculty of Communication and Culture, University of Calgary

Prof. Adam Holbrook
Internal Examiner
Adjunct Professor, School of Communication, SFU

Prof. Robin Mansell
External Examiner,
Dixons Chair in New Media and Internet Media,
London School of Economics and Political Science

Date:

ABSTRACT

This study weaves together telecommunications policy with theoretical and applied literature from science and technology studies in order to provide a set of general observations and specific recommendations for Canada's National Disaster Mitigation Strategy (NDMS). I argue that telecommunications are a vital aspect of Canada's National Disaster Mitigation Strategy, yet remain largely unaddressed in public proceedings to date. The NDMS may have significant implications for current and future telecom policy. Conversely, telecom policy initiatives may be capable of making a contribution to the NDMS by stimulating innovation in new products and services. This dual set of claims informs my overall thesis that we must understand in detail how growth and change happens in Canada's telecommunications infrastructure if we are to effectively intervene in that process to better coordinate it within the objectives and constraints presented by the National Disaster Mitigation Strategy.

The primary method is a case study of the development of a new telecommunications service—the introduction of Wireless Enhanced (E9-1-1) emergency telephone service in Canada. In order to generate useful results from the observations made, I introduce an analytic framework based on Constructive Technology Assessment to categorize technology projects into a number of dimensions related to standardization, innovation, and stakeholder participation. Constructive Technology Assessment is adopted for its emphasis on the early design phase of technology development. I also draw upon actor network theory and the social construction of technology for an understanding of technology dynamics. The study is operationalized through specific issues and concerns presented within the literature on telecom reform, as well as conceptual work previously undertaken in the history of technology and the study of large technical systems.

Results from the Wireless E9-1-1 case study are used to inform a general set of findings and considerations about growth and change in Canada's telecommunications infrastructure. These are then distilled into a series of specific policy recommendations for the National Disaster Mitigation Strategy. The recommendations are intended to inform a set of related intervention strategies for actively influencing growth and change in Canada's telecommunications infrastructure to contribute to the objectives of the National Disaster Mitigation Strategy while respecting the limits of current policy arrangements and established organizations and processes.

DEDICATION

To Sulya Anne

Upon Cassini's wings-
We dance,
And Saturn smiles.

Deo volente

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I wish to acknowledge the Government of Canada's Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) for seeing fit to provide financial support for this research with two Stuart Nesbitt White Fellowships between 2000-2002. I also wish to acknowledge the Social Sciences and Humanities Research Council of Canada (SSHRC) for providing financial support for this research with a Doctoral Fellowship awarded for 2001/2002. During the early phase of this project in 2001, the Canadian Scandinavian Foundation awarded me with a small travel grant to partially fund a research sojourn in Finland, where I spent time in Helsinki, Tampere, and Finnish Lapland exploring the possibility of doing a case study on that country's emergency telecommunications system in light of the impact of mobile telephones. While the results of that particular trip are not directly evident in this dissertation, the experience provided many insights that have been formative to my academic interests.

This kind of undertaking is only possible with much support from family and friends. Thank you for having been so kind and so patient throughout the past five years.

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FREQUENTLY USED ACRONYMS

AEAA	Alberta E9-1-1 Advisory Association
ANI/ALI	Automatic Number Identification/Automatic Location Identification
ANT	Actor Network Theory
BC SPA	British Columbia 9-1-1 Service Providers Association
CISC	CRTC Interconnection Steering Committee
CLEC	Competitive Local Exchange Carrier
CTA	Constructive Technology Assessment
CWTA	Canadian Wireless Telecommunications Association
ESRD	Emergency Services Routing Digits
ESWG	CISC Emergency Services Working Group
ILEC	Incumbent Local Exchange Carrier
LTS	Large Technical Systems
MIN	Mobile Identification Number
MSAG	Master Street Address Guide
MUC/UMQ	Montreal Urban Community/Union des municipalities du Quebec
NDMS	National Disaster Mitigation Strategy
NENA	National Emergency Numbering Association
OAB	Ontario 9-1-1 Advisory Board
OCIPEP	Office of Critical Infrastructure Protection and Emergency Preparedness
POTS	Plain Old Telephone Service
PSAP	Public Safety Answering Point
PSTN	Public Switched Telephone Network
RWI	Rogers AT&T Wireless Inc.
SCOT	Social Construction of Technology
TIF	Task Information Form
VAS	Value-added Services
W-CLEC	Wireless Competitive Local Exchange Carrier
WEWG	CWTA Wireless E9-1-1 Working Group
WSP	Wireless Service Provider

Chapter 1: Introduction

Not to draw smoke from the brightness of light, but to bring out light from smokey murk.
-Horace, *Ars Poetica*

At an early point during my research for this study, I stumbled upon two statements that have since had a lasting impression on me. Both are to be found in the following chapters but I think they are worthy of repetition here. The first of these statements comes from the field of urban studies, where Graham and Marvin in their book *Cities in the Telecommunications Age*, offer a rather remarkable statistic: a single flight of a 747 jumbo jet generates upwards of "50,000 electronic exchanges in booking, maintenance, airport management, and so on." For me at least, the very idea of a single flight of about three to four hundred passengers generating so many electronic transactions is astounding, let alone how this is magnified when I consider the thousands of flights scheduled everyday from the world's airports and *then* include the countless other forms of daily electronic transactions knitting the world into a global economy.

The second impressive statement is in the title of Karlsson's and Sturesson's book *The World's Largest Machine: Global Telecommunications and the Human Condition.* Here, probably for the first time in my life, it occurred to me that indeed the global telecommunications infrastructure is very likely the world's largest machine, hugging the entire planet in an embrace of electricity. To the best of my knowledge, at no other time in history have human beings attempted such a massive technological undertaking—and a largely successful one at that, if we are to measure it by the relative simplicity of placing a call to practically any city in the world.

Perhaps it is the outstanding success of the world's largest machine that has resulted in the apparent banality of placing a telephone call or using a debit card. Banality may simply be the experience of such a relentlessly pervasive system as the Public Switched Telephone Network. Nevertheless, we risk much by failing to remind ourselves of the growing enormity of modern telecommunications and its role in safeguarding and enriching the activities that constitute everyday life. The evolution of modern telecom networks is not an ordinary business in any sense, but one in need of constant public scrutiny and long-range visions. Such visions *must* include and work to support important public policy initiatives such as the National Disaster Mitigation Strategy.

Overview of this study

This study represents an effort to weave together three distinct fields of investigation: Canadian telecommunications policy, technology assessment, and Canada's National Disaster Mitigation Strategy. My principle objective has been to better understand the process of growth and change in Canada's telecommunications infrastructure in order to identify and assess intervention strategies capable of influencing the future design of the public network. Such an assessment is intended to provide general observations and recommendation for the National Disaster Mitigation Strategy, with a view to creating conditions for improved coordination of efforts across domains.

The method employed has been a case study of the processes and players involved in developing a new telecommunications service; in this case, that of Wireless Enhanced (E9-1-1) emergency telephone service. In order to generate useful results from the observations made during the case study, I have developed an analytic framework that categorizes technology projects into a number of critical dimensions. This analytic framework may be applicable to other areas of technology policy research.

My research began with a general inquiry into the role of telecommunications within the context of the National Disaster Mitigation Strategy (NDMS), a major federal government policy initiative intended to reform Canada's strategic approach to emergency management. As my inquiry progressed, two important research questions surfaced: what would be the impact of the NDMS on Canadian telecommunications policy and regulation? And, conversely, how might telecom policy and regulation be drawn upon to actively promote the objectives of the NDMS? In the process of exploring these two questions I began to realize that "mitigation" itself was a problematic concept and that conventional approaches in emergency telecommunications and business continuity planning did not seem to conform to what I felt to be the more fundamental concerns implied in an ambitious mitigation strategy.

This realization led me to conclude that mitigation, despite the volumes written on it previously, remains an ambitious but *ambiguous* idea that needs to be more clearly understood so it can stand apart from other activities in disaster management. In order to achieve this clarity I found it helpful to look beyond the typical descriptive model of disaster management based on a four-fold cycle of events and to adopt an explanatory model of disasters that could more clearly account for the root causes of vulnerability and unsafe conditions in society. Application of the Pressure and Release Model (Chapter 2) to emergency telecommunications suggests that policy research for mitigation should be directed at the early processes and influences on network development.

Having achieved this insight, the focus of my research was directed to the fundamental forces that are involved in shaping the evolution of telecommunications infrastructure in Canada—the "root causes" and "dynamic pressures" of growth and change in large technical systems. This shift in perspective unto itself makes an important contribution to emergency telecommunications planning in Canada, which in my view has been held back by an ambiguous and sometimes contradictory notion of mitigation. This contribution extends along theoretical, methodological, and empirical dimensions. Theoretically, it contributes to a growing body of literature in disaster management that recognizes risk and vulnerability as socially constructed conditions intimately linked with community development including the ongoing evolution of communications infrastructure. Methodologically, this shift in perspective led me to bring together constructivist approaches from science and technology studies and technology assessment, with those from the traditional telecom policy literature in order to create (and apply) an intervention matrix for studying the root causes and dynamic pressures in telecommunications. The intervention matrix is an original contribution to the study of infrastructure development, providing an analytic tool for identifying and assessing opportunities for intervention in the complex and dynamic processes of a technology project in progress.

Empirically, this study contributes a detailed analysis of the development of one instance of growth and change in Canada's telecommunications infrastructure, drawing on a contemporary case study for insights that may be relevant to the National Disaster Mitigation Strategy. It steps outside the bounds of traditional thinking on "emergency telecommunications" to establish a unique, empirically grounded perspective on the process of critical infrastructure development in Canada. The final chapter in the dissertation sets out a number of specific recommendations for the NDMS based on an analysis of a case study in the development and deployment of a new value-added telecom service. Complimentary to these recommendations, this study also identifies corresponding exemplars of actual programs from other parts of the world that might be used as models for reconsidering Canadian telecom policy and processes vis-à-vis the objectives of the National Disaster Mitigation Strategy.

The study begins by establishing the background, rationale, and focus for the research undertaking. In this chapter I argue that telecommunications are a vital aspect of Canada's National Disaster Mitigation Strategy yet remain largely unaddressed in public proceedings. Mitigation is defined as an ongoing program of long-term risk reduction integral to the sustainable growth of communities and further clarified through the application of the Pressure and Release Model. I discuss the implications this model has for telecommunications policy, while reviewing the current areas of research in emergency telecommunications, and stressing the need for an expanded conception of the field of investigation.

A secondary aim in chapter two is to demonstrate that telecommunications provides a critical service environment behind a wide range of activities affecting the National Disaster Mitigation Strategy. Here I return to my original two questions, and examine how the NDMS may, on the one hand, have implications for current telecom policy and regulation while, on the other hand, policy and regulation may be capable of making an active contribution to the NDMS by stimulating research and development in new products and services that support risk reduction activities. This dual set of claims is taken up in the context of the Pressure and Release Model of disasters to inform my overall thesis: *we must understand in detail how growth and change happens in Canada's telecommunications infrastructure if we are to effectively intervene in that process to better coordinate it within the objectives and constraints presented by the National Disaster Mitigation Strategy*.

Chapter three presents the theoretical and methodological ground for studying growth and change in Canada's telecommunications infrastructure. Here I adopt Constructive Technology Assessment as the primary approach because of its emphasis on the early design phase of technology development. I look to actor network theory and social construction of technology to provide a compatible theory of technology dynamics. I then bring together elements from each of these fields to establish a basic method and analytic framework for studying technology projects in the form of an intervention matrix. The intervention matrix serves as the principle analytic tool used throughout the remainder of the study.

Chapter four draws on literature from the field of Large Technical Systems (LTS) to establish operational parameters for my research. Among these, I deal with the problem of setting boundaries on the telecommunications infrastructure as a subject of study, establishing "interconnection" as the central focus for research. I then add a third dimension to the intervention matrix using the concept of interconnection space adopted from published work in the field of telecom policy. The telecom policy literature also provides a basis for identifying specific issues related to interconnection: technical standardization and the political economy of network design. I then return briefly to the literature on LTS and social construction of technology to look at challenges associated with stakeholder participation when dealing with growth and change in large systems.

Chapter five is a single case study of growth and change in Canada's telecommunications infrastructure. For this case I followed the development and deployment of Wireless E9-1-1 in Canada. Wireless E9-1-1 is a new service concept for mobile phones that has significant impacts throughout the network in terms of design and service reconfiguration. Much of the development process was available in public documents thereby permitting a detailed and comprehensive study dating back to the first official meeting of industry representatives on the issue back in 1997.

Chapter six provides analysis of the Wireless E9-1-1 case study. This analysis is undertaken in three steps. First I present a socio-technical mapping of key actors and issues and then discuss predominant intervention strategies evident in the case study. Second, I present detailed observations and findings based on specific interconnection issues and boundary crossing concerns identified in chapter four. Third, I conclude the chapter by looking for overall patterns within the development of Wireless E9-1-1 in light of current policy arrangements and organizations.

Chapter seven adapts the findings from the Wireless E9-1-1 case study to a general set of findings and considerations about growth and change in Canada's telecommunications infrastructure. These general considerations are then distilled into a series of specific policy recommendations for the National Disaster Mitigation Strategy. These policy recommendations are intended to provide a set of related intervention strategies for actively influencing growth and change in Canada's telecommunications infrastructure to better accommodate the objectives of the National Disaster Mitigation Strategy while respecting the limits of current policy arrangements and established organizations and processes.

This dissertation covers a lot of ground and may appeal to a wide range of scholars and other professionals. For those readers interested in the National Disaster Mitigation Strategy and emergency telecommunications, I suggest that chapters two and seven are most relevant. For readers interested in science and technology studies, chapter three deals in some detail with Constructive Technology Assessment and includes a brief theoretical treatment of Bijker's SCOT as well as Actor Network Theory. The intervention matrix developed in this chapter may be of particular interest to those researchers looking for analytic tools to examine technology dynamics.

Chapter four addresses a number of issues of possible interest to those scholars in the field of Large Technical Systems, particularly in the matter of defining the boundaries of these systems for analytic purposes. Chapter four also includes a discussion of matters relevant to telecom policy research including technical standards, interconnection, and stakeholder participation. Many readers will find the details of the Wireless E9-1-1 case study rather tedious; however, in composing the description the Wireless E9-1-1, it became clear to me that this account might have historical value. As such, I decided to capture as much detail as possible even where this detail was not directly related to my overall objective in this study.

Chapter 2: Telecommunications and the National Disaster Mitigation Strategy

Introduction

The function of this chapter is to create a context for including telecommunications within the scope of the Canada's National Disaster Mitigation Strategy. The National Disaster Mitigation Strategy is an ongoing initiative prompted in part by the alarming economic costs to Canada's insurance industry following the 1998 Quebec Ice Storm. The Ice Storm provided the catalyst for action that saw the Insurance Bureau of Canada and Emergency Preparedness Canada embark on a series of workshops across Canada to look at the current and future role of disaster mitigation within the Canadian emergency preparedness framework. In 1999, a Senate subcommittee was struck to examine the state of emergency and disaster preparedness in Canada and, in subsequent years, the Government of Canada established an interdepartmental task force to look into ways of implementing a national disaster mitigation policy and sponsored a series of regional roundtable workshops to bring together community stakeholders and planners around this issue.

Major events such as the Y2K crisis and the terrorist attacks of September 11, 2001 have led to a reassessment of priorities and the redirection of resources within the Government of Canada but it nevertheless reaffirmed its commitment to a National Mitigation Strategy in December 2002, stating "The Government of Canada, in cooperation with provincial-territorial partners and other stakeholders, is continuing to advance the development of options and recommendations for a NDMS with a view to finalizing proposals during 2003" (Canada. Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP), 2002).

Given this ongoing commitment by the federal government to the National Disaster Mitigation Strategy (NDMS), this study begins with the assumption that mitigation is poised to become an increasingly important aspect of emergency preparedness policy in Canada. As a result, one might expect that it will also come to play an increasing role in public infrastructure development, including telecommunications networks and services. However, telecommunications has been largely absent from the discussion of infrastructure within the NDMS. This is indeed curious, especially given the ascendancy of "critical infrastructure protection" in the federal policy for emergency management that happened to coincide with the advent of the Y2K threat. Yet even with this turn toward critical infrastructure protection, almost no discussion of substance has been given over to telecommunications within any documentation so far produced by the National Disaster Mitigation Strategy or, for that matter, the extensive Senate subcommittee hearings on emergency preparedness.

This is an incredible oversight when one considers that a robust telecommunications infrastructure is central to Canadian social welfare and economic competitiveness in the 21st century. The public telecommunications infrastructure is, after all, arguably the most critical of all forms of infrastructure because it has evolved (and continues so) into a conduit for applications that today extend far beyond "plain old telephone service" to include data networks in support of a staggering diversity of organizations and processes.[1] To the extent that the future social and economic fabric of Canadian society will be held together with the telecommunications infrastructure, it must be taken up as a fundamental concern within the National Disaster Mitigation Strategy.

This dissertation represents an initial effort to take up the matter of telecommunications within the NDMS. In this chapter I will first discuss and critique the concept of mitigation as it applies to disaster management generally. My objective here is to clearly distinguish "mitigation" from other phases of the emergency management cycle. The promise of mitigation as a strategy is usually associated with an ambitiously pro-active and sustained approach to risk reduction. However, I argue that the concept tends to remain ambiguous and hard to differentiate from other aspects of emergency management when it is put into practice. To address this problem of ambiguity, I adopt an explanatory model of disasters to claim that mitigation is an activity properly situated within everyday processes of community development—processes often

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[1] Graham and Marvin offer an example of the scale and scope of modern telecommunications when they point out that a single flight of a 747 jumbo jet generates upwards of "50,000 electronic exchanges in booking, maintenance, airport management, and so on" (2000, p.75).

far removed from what many would consider "disaster management" but which are nevertheless deeply implicated in the production of risk and vulnerability in society. In other words, in this study mitigation is taken to be concerned with fundamental forces of social and technological change rather than events more directly associated with a hazard or disaster.

The next section of this chapter describes the origins, guiding principles, and major objectives for the National Disaster Mitigation Strategy. My intent with this background is twofold: first, to demonstrate a correspondence between the formal rhetoric of the NDMS and the concept of mitigation that I have proposed for this study; second, to establish a set of principles and guidelines drawn from the NDMS to establish some parameters to begin framing my inquiry into telecommunications policy and regulation.

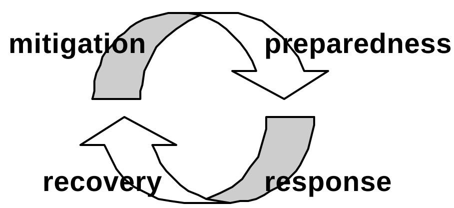
Having reviewed the National Disaster Mitigation Strategy, I then turn to making my case for including telecommunications within the initiative. My case is established on the importance of modern telecommunications as a kind of meta-infrastructure—*the infrastructure of infrastructures*—and, therefore, its vital supporting role to many of the other activities that the NDMS will seek to address. This is described as a growing interdependency problem, where vulnerability in the telecommunications infrastructure creates cascading risks in other areas of society. While detailing various aspects of the interdependency problem, I also weave together a constructive critique of the traditional realm of emergency telecommunications research and practice. My intent here is to argue for an expanded conception for the field of emergency telecommunications that more closely corresponds to the concept of mitigation embodied within the NDMS. Such an expansion would include a substantial focus on the forces of growth and change influencing the development of telecommunications infrastructure. It is here where I situate my research within the wider field of emergency telecommunications and set the stage for the rest of the study.

Understanding Mitigation as Social Process

The generally accepted model for emergency and disaster management is based on a four-phase, iterative cycle that includes *mitigation*, *preparedness*, *response*, and *recovery*. Much ink has been spilled in the effort to determine how these phases are best defined and delineated, with little consensus emerging across the disciplines and among practitioners. Today we continue to find the terms being used inconsistently by practitioners and researchers alike, which leads to a problem of determining the functional role and value of a National Disaster Mitigation Strategy. This situation requires that I clearly define mitigation as it applies in this study. For the sake of overall coherence and relevancy, the definition I adopt for this study should correspond closely to that notion of mitigation embodied within the NDMS.

Mitigation is typically defined as "pre-meditated action leading to a reduced risk of a loss occurring" or, more formally as in the case of the U.S. Federal Emergency Management Agency (FEMA), "sustained action taken to reduce or eliminate long-term risk to people and their property from hazards and their effects" (Newton, 2001). The formative terms in most definitions of mitigation are almost always the same: "pre-meditated, sustained, long-term." Whereas preparedness, response, and recovery represent actions taken in close proximity to an event, mitigation is regarded as a proactive approach to managing risks.[2] In terms of the four-phase emergency management cycle, it is usually depicted as a bridge between recovery and preparedness, which suggests that it is applied after a disaster occurs as a part of social learning, or may be undertaken in advance of a disaster occurring as a means of reducing anticipated risk. Figure 1 depicts this model of emergency management.

Figure 1: The Four Phase Model of Emergency Management



Despite the apparent simplicity of this disaster management model, it leads to considerable ambiguity when we attempt to put the concept of "mitigation" into practice. Does mitigation mean a long-term effort at improving preparedness or response measures, say through research to improve weather forecasting or by building new weather alert systems? Or does it mean a sustained program aimed at improved recovery procedures, for example through new forms of insurance and loss coverage? In practical terms this is often how mitigation is interpreted—as a proactive extension to one or more of the other three phases of disaster

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[2] "Recovery," however, is unique because it may involve a long term process of community re-building––sometimes lasting years, as in the case of residents of Kobe, Japan, where recovery efforts stretched to five years after a major earthquake struck the region in 1995 (City of Kobe. Post-Quake Citizen Support Services Head Office, 2000).

management, depending on the discussants involved.[3] Perhaps this is a logical interpretation of the concept. My sense, however, is that "mitigation" within the context of a National Disaster Mitigation Strategy ought to be more ambitious in principle; that it ought to address a deeper set of questions related to risk and society, and that it should therefore lead to practical action that is distinct from the other three phases of disaster management. For instance, Newton (2001, p. 2) has considered the meaning of mitigation and concluded that

> [t]he hallmark of an approach to loss reduction based on a mitigative attitude or approach is the presence of *integrated thinking*—the capability to deal with situations from human, technical and organizational perspectives at various scales of detail. …
>
> Part of this attitude requires that we clearly see that natural disasters are not arbitrary occurrences, but rather the interaction of changes in physical systems with existent social conditions. As such, natural disasters can be said to be social phenomena. For without property and casualty losses, concern is much reduced, if we set aside for the moment disruptions to nature, non-human deaths, and the loss of natural resources. [emphasis in original]. (Newton, 2001, p. 2)

If the hallmark of mitigation is integrated thinking wrapped around an interactionist conception of disasters, as Newton would have us think, then it suggests to me that we must move beyond the descriptive model presented above and adopt an explanatory model of disasters. Whereas the four-phase model tells us *what* happens in relation to a disaster, an explanatory model of disasters can help us to better grasp *why* these events happen by explaining *how* social conditions are related to risk and vulnerability. Understanding the social processes that create vulnerability may then lead us further down the road to unearth the deep social roots of disasters. Here we may find some clues to the practical meaning of "pre-meditated action" and its role in long-term risk reduction.

Disasters as Social Phenomena

An explanatory model addresses the question "what is a disaster?" by establishing a causal sequence based on certain assumptions. Early in the modern history of disaster management, those assumptions were drawn from a military metaphor, or what Gilbert (1998) has labelled a "patterns of war approach" to natural hazards. Gilbert observes the historical

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[3] This claim is based on observations I made while participating in a "Regional Stakeholders Meeting" for Canada's National Disaster Mitigation Strategy. This meeting was held in Vancouver on May 30, 2002 and included participants from all facets of the disaster management community.

context of this approach, noting its origins in the United States at the height of the Cold War, when

> … US government institutions provided research funds at that time primarily for studies relevant to understanding the reactions of people to possible air raids. Disasters were viewed as situations likely to elicit reactions of human beings to aggressions and to allow an adequate test of them. … Bombs fitted easily with the notion of an *external agent*, while people harmed by floods, hurricanes, or earthquakes bore an extraordinary resemblance to victims of air raids. [emphasis in original] (1998, p. 12)

The "patterns of war approach" assumes natural hazards to be external, aggressive forces against which communities have to be fortified in order to defend themselves. The military metaphor, which played a formative role in disaster management in countries outside the United States including Canada,[4] leads to a causal sequence that tends to bracket-out the social pre-conditions that create vulnerabilities in the face of natural hazards. In terms of action to mitigate disasters, it has been criticized for overemphasizing the natural hazard (as an aggressor against society) at the expense of examining more deeply rooted social origins of vulnerability and risk (Gilbert, 1998, p. 13). In other words, it leaves little room for social accountability for disasters other than to suggest that not enough effort was given over to plan for, or respond to, a *force majeure*. Within this approach, mitigation tends to be viewed as a form of advanced planning (i.e., additional effort) for preparedness, response, and recovery. An explanatory model built on assumptions characteristic of the patterns of war approach, leads to a concept of "mitigation" that tends toward ambiguity and does not easily stand apart from the other three phases of disaster management. For this reason, we must look for another set of assumptions to inform our explanatory model.

Today the "patterns of war approach" has been eclipsed, at least in the social sciences, by a more socially aware conception of disasters (Gilbert, 1998, p. 14). This alternative view, which emerged from critiques levelled against the military metaphors of a previous era, argues for a turn toward societal structures and processes when considering the question "what is a disaster?" Researchers adopting this approach acknowledge that *force majeure* is a reality, yet contend that natural hazards are more appropriately understood as disaster-precipitating events intimately connected with social phenomena. With this alternative approach, the causal sequence seeks to

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[4] The early history of civil defense in Canada is steeped in the wars (both hot and cold) of the last century. See, for example, Emergency Preparedness Canada (1999). It is no coincidence that an "aggressor" metaphor has been used in the past to characterize natural hazards, when disaster management has been so closely associated with civil defence.

bracket-in social pre-conditions rather than ignore them. As a result, practical action to mitigate disasters is predicated on understanding the fundamental forces that produce risk and vulnerability within society:

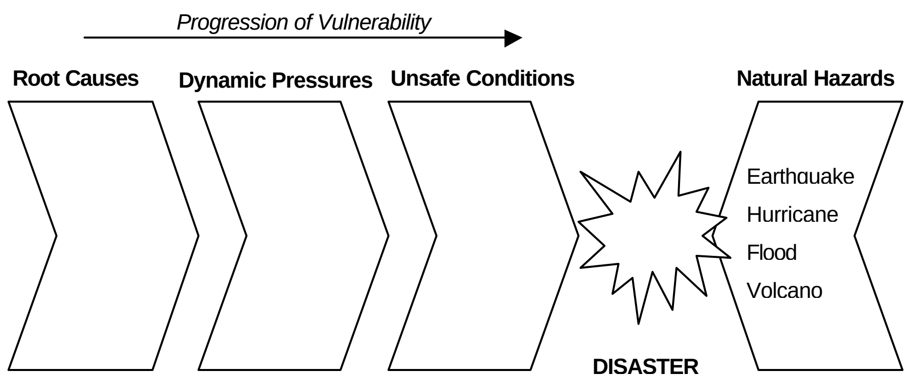
> The crucial point about understanding why disasters occur is that it is not only natural events that cause them. They are also the products of the social, political, and economic environment (as distinct from the natural environment) because of the way it structures the lives of different groups of people. There is a danger in treating disasters as something peculiar, as events which deserve their own special focus. By being separated from the social frameworks that influence how hazards affect people, too much emphasis in doing something about disaster is put on the natural hazards themselves, and not nearly enough on the social environment and its processes. (Blaikie, Cannon, Davis, & Wisner, 1994, p. 3)

If we include the deep social dimension within our assumptions about disasters then we must also deal with a much longer, and more complicated, causal chain. An explanatory model of disasters based on these assumptions must therefore account for a wide range of influential factors within the social environment and its processes. Blaikie, *et al.* offer a “Pressure and Release” (PAR) model that reflects this extended causal chain. The Pressure and Release model is based on the view that disasters occur when natural hazards affect vulnerable parts of a community, and that “vulnerability is rooted in social processes and underlying causes which may ultimately be quite removed from the disaster event itself” (Blaikie et al., 1994, p. 22). I believe that this is an important consideration for this study because it can inform a conceptualization of “mitigation” that does indeed stand apart from the other three phases of disaster management.

The Pressure and Release Model of Disasters

The causal chain in the Pressure and Release (PAR) model is established in three primary social links. These links are described as a “progression of vulnerability” that creates mounting pressure for a disaster starting with *root causes*, translated into *dynamic pressures*, and resulting in the creation of *unsafe conditions*. Within the PAR model a disaster event is conceived of as the product of unsafe conditions confronting the effects of a natural hazard. The “Release” aspect of the model is meant to emphasize that by considering root causes and making certain changes, the dynamic pressures that were once translated into risk and vulnerability can also be directed toward the creation of safe conditions, resiliency, and sustainable community development (Blaikie et al., 1994, p. 219).[5]

Figure 2: Pressure and Release Model of Disasters



The value of this explanatory model for conceptualizing mitigation is that it encourages integrated thinking because it includes a wide range of influences that are typically quite remote from actual disaster events. In effect, it extends the sphere of influence backwards in time to focus on distant events that have initiated a momentum or trajectory leading up to unsafe conditions. For instance, the most distant link in the social chain of the PAR model is the "root causes" of vulnerability, which Blaikie *et al.* (p. 24) cite as economic, demographic, and political processes reflecting "the distribution of power in a society" or the prevailing "ideological order." "Dynamic pressures" represent the next link where the effects of root causes are "translated into the vulnerability of unsafe conditions." Dynamic pressures could be budget allocations, purchasing decisions, resource distribution, or other forms of action that are influenced by root causes. The last link in the social chain describes "the specific forms in which the vulnerability of a population is expressed in time and space in conjunction with a hazard." Unsafe conditions include poorly built or maintained infrastructure, unacceptable exposure to natural hazards (e.g., flooding or landslides), insufficient ability to recover losses suffered as a result of a natural hazard, poor health, and lack of awareness and education about natural hazards.

If we are to establish a socially oriented concept of mitigation based on the hallmark of integrated thinking linked to "pre-meditated action" and "long term risk reduction", the Pressure and Release model suggests it is appropriately situated among root causes and the dynamic

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[5] Blaikie *et al*. (p. 9) define vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard."

pressures that translate them into unsafe conditions. I would argue that once we reach the state of "unsafe conditions" the domain of mitigation more properly yields to that of preparedness, response, or recovery, where effort is directed at reducing the consequences of pre-existing conditions.

If we accept that mitigation is situated conceptually within the domain of root causes, then how does this translate into action? When viewed in light of the Pressure and Release model, mitigation is perhaps best conceived of within the sustainable development movement in which the community planning process itself is opened up to scrutiny as a means of including a wide range of social and environmental factors (Darlington & Simpson, 2001; Geis, 2000; Robinson, Francis, Lerner, & Legge, 1996). As such, we can assume "that [if] actual loss reduction occurs through mitigation at [this] community level, then considering how *communities evolve* represents an important step toward a fuller appreciation of mitigation, as a integral contributor to the *safer growth* of Canadian society" [emphasis added] (Newton, 2001, p. 6).

Mitigation is therefore part of other constructive social processes, intimately bound to the evolution of communities and directed toward creating safe and sustainable conditions. For the purpose of this study "mitigation" will be distinguished in this manner in order to make a distinction between it and the other three phases of disaster management. I will, however, move beyond the notion of communities as simple geographical entities to consider them as associations of similar interests, such as those involved in shaping the evolution of Canada's telecommunications infrastructure. I also believe this interpretation of "mitigation" is also the meaning of the term implied in Canada's Disaster Mitigation Strategy, despite the ongoing ambiguity that often surfaces in both policy discussions and related documents.

Canada's National Disaster Mitigation Strategy

Canada's overall approach to disaster management was scrutinized at length following an unprecedented string of natural disasters between 1996 and 1998, including the Saguenay River and Red River Floods in 1996 and 1997 respectively, and the Eastern Canada Ice Storm in 1998. Alarmed at the growing cost of insurance payments arising from these recent severe weather events—and spurred on by the looming earthquake threats on both the West and East coasts—the Insurance Bureau of Canada in partnership with the University of Western Ontario and others established the Institute for Catastrophic Loss Reduction (ICLR). The ICLR serves as a research body mandated to examine ways of mitigating the cost of natural disasters in Canada. In the autumn of 1998, the ICLR partnered with Emergency Preparedness Canada (EPC)[6] to consider a national approach to reducing the impact of natural disasters. The primary objective of the strategy is to modify Canada's approach to disaster management by placing a greater emphasis on sustained efforts at long-term risk reduction. This represents an important shift in strategy, away from response-oriented policy toward a proactive policy aimed at building what the ICLR has termed "resilient communities."

In due course, the National Disaster Mitigation Strategy was formed out of a series of workshops held across the country with a diverse group of participants. The strategy was also aided indirectly by a Senate subcommittee on Canada's emergency and disaster preparedness that held hearings in 1999 to provide recommendations on reducing the impact of disasters on Canada's economy (Canada. Parliament. Senate. Standing Committee on National Finance, 2000). By contrast, the United States Federal Emergency Management Agency (FEMA) has been promoting its own national mitigation strategy since the mid-1990s, and offers a model for Canadians to build upon (Federal Emergency Management Agency, 1996). A number of other countries in the world, including France and Australia, have also been identified as having introduced mitigation-oriented policies and programs in recent years.

The subject of mitigation was also central to the United Nations International Decade for Natural Disaster Reduction (IDNDR), which concluded in 1999 and had as its aim the objective "to reduce the loss of life, property damage, and social and economic disruption caused by natural disasters …" (Jeggle, 1999). The IDNDR has been criticized elsewhere for focussing too much attention on natural hazards at the expense of dealing with the root social causes of vulnerability (see Blaikie et al., 1994), but despite these accusations it did enrich international debate about natural hazards and vulnerability, and made important connections between disaster management and sustainable development (Bruce, 1999). If anything, the UN's role in this effort raised the profile of mitigation among the world community and provided a backdrop for the Canadian initiative, which was supported by members of Canada's participating committee at the IDNDR.

To date, Canada's National Disaster Mitigation Strategy initiative has produced a small number of official documents that I have drawn upon to develop a framework for my study. More specifically, I have taken a number of features of these documents including recommendations, themes, and objectives and applied them as a set of principles and conditions for considering telecommunications within the scope of the NDMS. An appropriate fit for

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6 EPC is now called the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP).

telecommunications within the NDMS is essential if it is to contribute in a synergistic and coordinated manner with other projects intended to foster a sustained program of long-term risk reduction in Canada.

As noted above, the initial motivation for a National Disaster Mitigation Strategy stemmed directly from the losses suffered as a result of the 1998 Ice Storm and indirectly from international influences such as the United States and the UN's International Decade for Natural Disaster Reduction. In many respects, the events of the Ice Storm fuelled a discourse that had been simmering in Canada throughout 1990s (Newton, 1997). What emerged from the early workshops was a clear sense that a national mitigation policy is going to be necessary if Canada is to avoid the burden of heavy social and economic losses caused by future severe weather events and earthquakes. The cost of weather-related disasters in Canada has risen sharply in the past two decades and four factors are seen to be contributing to the increased vulnerability of Canadian society. It is important to note that public telecommunications are relevant to three of these four factors:

- Economic prosperity (i.e., greater prospects for losses to occur)
- Densification in urban centres
- Aging infrastructure
- Climate Change

Potential future losses resulting from natural disasters include loss of life and destruction of property, but also and perhaps more significantly include secondary impacts related to lost production and industrial competitiveness; restorative costs associated with disaster recovery; unanticipated personal hardship; and negative effects on public (and market) confidence. Central to a mitigation strategy is the view that these kinds of losses can be significantly curtailed in advance through a sustained program of risk reduction. Above all, what we find in the Canadian discourse is that the key to a successful mitigation strategy is to blend it into everyday practice as seamlessly as possible. Mitigation, as the Institute for Catastrophic Loss Reduction (ICLR) has pointed out, needs to be grounded in a set of cultural norms––a "culture of mitigation"––that views risk reduction as a necessary component of civil society (Institute for Catastrophic Loss Reduction, 1998). Mitigation-oriented social policy is regarded as an enlightened approach to building and maintaining civil society and this is where it bears close correspondence with the Pressure and Release model. This view is clearly reflected in several of the key themes that emerged from the early round of consultations that took place in 1998.

Among the ten key themes, several echoed the view that a mitigation strategy needs to be built into current activities and organizations. For instance, it became clear that participants felt that mitigation should be seen not as a one-time cost but rather an ongoing investment in long-term safety and economic security. Partnerships between government and the private sector are deemed necessary for such investment, and the local community is considered the most appropriate site for mitigation projects to be undertaken. A number of other principles surfaced during the consultations. Flexibility in approaches was considered essential in order to address the wide variety of regional conditions across Canada. Education and awareness of risk along with applied research to identify and better understand risk were seen as equally important principles behind the culture of mitigation that would ultimately provide sustained support for a national strategy. Further, and perhaps most important for telecommunications, was the assertion that "mitigation measures must be compatible with other important public policy objectives" (Institute for Catastrophic Loss Reduction, 1998).

The consultations also produced a set of specific guidelines, or "mechanisms for action" as they were termed in the report. Funding formulas represented the underpinning of these guidelines, essentially following along four types of support. Funding opportunities are considered in both pre-impact and post-impact stages. Pre-impact funding would be guided by applied research to identify priorities within Canadian communities. Post-impact funding would be guided by assessments made during the recovery phase following a disaster. With respect to pre-impact funding, the ICLR has recommended that a disaster mitigation fund of $100 to $150 million per annum be established with contributions from the federal and provincial governments. Money from this fund would be used to support ongoing mitigation projects modeled on previous public works programs. The ICLR has also recommended that Canada adopt a model similar to the United States and expand the current post-impact disaster financial assistance by fifteen percent to prevent future reoccurrence through specific mitigation projects (Insurance Bureau of Canada, 1999).

The strategy would also require the private sector to become a major participant in mitigation programs and would seek ways to encourage the business community to initiate and fund mitigation projects in conjunction with government projects. Coordination and leadership for the strategy would come from three sources: governments and the private sector committing resources toward mitigation, the creation of a national mitigation secretariat, and the formation of a national mitigation partnership.

The question remains whether or not the National Disaster Mitigation Strategy will evolve to become a national mitigation policy, and how such a policy might translate into legislative reform (if at all). In June 2001, the Government of Canada announced that it would begin consultations on the development of a National Disaster Mitigation Strategy involving all levels of government, non-governmental stakeholders and the private sector (Canada. Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP), 2001). Based on the outcome from these consultations, it is likely that the current national policy for emergencies will be revised to reflect, at least in part, the mitigation framework developed by the ICLR and EPC (now OCIPEP).

Implications for Telecommunications Policy and Regulation

If Canada continues to travel down this road of a mitigation-oriented policy for emergencies, what might it mean for telecommunications policy and regulation? Table 1 summarizes the ICLR/EPC framework developed for a National Disaster Mitigation Strategy. It is useful to the extent that it highlights key principles and guidelines that define the initiative and establishes parameters for considering telecommunications within the Strategy.

Table 1: Principles and Guidelines of the National Disaster Mitigation Strategy

Major Objective	Associated Principle	Mechanism for Action
Sustained program of action	Investment oriented thinking	Ongoing resource commitments
Consistency in method and application	Partnership-based approach	National mitigation partnership ; standards
Expansion of expertise through interdisciplinary exchange	Flexibility and local orientation	Innovation and leadership in many fields
Dissemination of best practices	Promotion of education and awareness	National Mitigation Secretariat; industry forums
Framework for rational allocation of resources	Alignment with current policy frameworks	Policy review

The first major objective is described as a “sustained program of action” based on investment-oriented thinking, requiring resource commitments. In telecommunications policy terms this means contributing an incentive for stakeholders to build mitigation programs into practice. One conceivable way to do this is to include risk reduction as a design consideration within Canada’s telecommunications infrastructure. This approach is not unlike the ongoing investment in other public works programs such as the Winnipeg Floodway, and it will be a central focus of this study. In policy terms this could mean ensuring processes are in place so that the telecommunications infrastructure evolves with risk reduction taken into account. By introducing a process to guide infrastructure development, a sustained program of action is more likely to be feasibly maintained over time.

The second objective of “consistency in method and application” suggests that a national approach is needed to ensure the development and application of baseline standards to support mitigation-oriented activities. Flexibility and local orientation, however, will remain paramount considerations and a combination of consistency adapted to local conditions will depend on good working partnerships between government and the private sector. In this light, telecommunications policy and regulation might be applied to ensure that processes are designed to cultivate a level playing field through nationally recognized baseline requirements that, in turn, are flexible enough to meet local needs. Perhaps most significantly, telecommunications policy instruments could be used to create a forum for the dissemination of best practices among users and service developers, in order to enable partnerships and innovative ideas to bloom. Finally, all of these objectives must align with the current telecommunications policy framework in Canada.

Taken together, this set of implications suggests that a mitigation strategy should seek to influence growth and change in Canada’s telecommunications infrastructure while working within the upper-tier policy framework established by legislation and regulatory decisions. Here we find a correspondence between the rhetoric of the National Disaster Mitigation Strategy and the concept of mitigation based on the Pressure and Release model—a concern with fundamental forces of social and technological change to reduce vulnerability in society. Yet, as I will argue in this chapter, current telecommunications policy in Canada does not take this approach to mitigation. Rather, emergency telecommunications policy and planning have been, according to my interpretation of the Pressure and Release model, preparedness/response/recovery oriented. While many existing programs have so far proven somewhat effective within their own field of endeavour, the ambitious objectives of the NDMS suggest to me that we must look to a wider profile if we are to address the more fundamental processes by which Canada’s telecommunications infrastructure develops.

Expanding the Conception of Emergency Telecommunications

I have emphasized the importance of clearly distinguishing mitigation from other phases of disaster management to help set my work apart from what has been traditionally subsumed under the term “emergency telecommunications.” For a number of reasons, partly historical, much of the practical work in the field of emergency telecommunications has addressed needs that arise during the response and short-term recovery phases. By this, I mean that the field of practice has been concerned primarily with restoring essential services and maintaining emergency communication channels during the immediate aftermath of a disaster. Examples include the various activities under Industry Canada's Emergency Telecommunications program (Industry Canada, 1997a) as well as the mandate of carriers' forums such as the Canadian Telecommunications Emergency Preparedness Association (CTEPA).

Likewise, research in the field of emergency telecommunications has been similarly concerned with issues other than mitigation as it is conceived in this study. This becomes evident when we examine the four main areas of investigation in the literature: critical infrastructure protection, lifeline engineering, business continuity planning (BCP), and policy studies. I will touch upon each of these areas throughout the remainder of this chapter.

Critical Infrastructure Protection

To begin, the area of critical infrastructure protection encompasses what is called in the United States "national security/emergency preparedness" and in Canada what is typically subsumed under Industry Canada's Emergency Telecommunications bureau. The focus of this area is largely with continuity of governance following a major emergency or disaster. The legacy of this approach to emergency telecommunications stems from strategic defense initiatives undertaken during the Cold War (recently renewed as a result of the so-called War on Terrorism). Hoffman's report on survivability (Hoffman, 1990), for instance, examined the vulnerability of Canada's public telecommunications networks in the context of a nuclear attack from the Soviet Union.

After the conclusion of Cold War, research into critical infrastructure protection tended to focus on the impact of emerging technologies on government preparedness and response capabilities. Thomas's doctoral dissertation (the first done in Canada on this subject) examined the impact of technological and regulatory change on government emergency telecommunications planning and programs (Thomas, 1994), and work done by Anderson has examined the challenges for the emergency management community in light of developments with the Internet (Anderson & Stephenson, 1997) and wireless technology (Anderson & Gow, 2000).

Leadership in this field has come from the United States, where a number of organizations have conducted research into emergency telecommunications in light of critical infrastructure protection issues. Of these, the United States National Communications System

(NCS) has initiated numerous projects addressing vulnerability and response readiness for the U.S. federal government (US National Communication System, 2001). The U.S. National Security Telecommunications Advisory Committee (NSTAC) is a government advisory committee consisting of industry representatives that is assigned to provide "industry-based advice and expertise to the President on issues and problems related to implementing national security and emergency preparedness (NS/EP) communications policy." NSTAC has produced a number of reports addressing ongoing developments in the U.S. public telecommunications infrastructure (US National Security Telecommunications Advisory Committee, 2001). The U.S. National Institute of Standards and Technology published a study in 1995 on national security/emergency preparedness concerns associated with Federal Communication Commission's (FCC) requirement for "Open Network Architecture" within the public switched telephone network (US National Institute of Standards and Technology, 1995).

When one examines the existing policy, programs, and research dealing with critical infrastructure protection, it becomes evident that much of it is directed toward the objective of preparedness, response and recovery rather than mitigation. In part, this focus in Canada stems from the current framework for emergency telecommunications, which is circumscribed by responsibilities set forth in the Federal Policy for Emergencies, the *Emergency Preparedness Act* and detailed at various levels of departmental policy. As witnessed in recent events, federal programs have proven somewhat effective but we must keep in mind that their *raison d'etre* is to provide a structure for governance during emergency or disaster situations and, as such, offers little by way of incentive or support for ongoing programs intended to support programs of long-term risk reduction within communities or private industry.

Emergency telecommunications responsibilities fall within Industry Canada's lead agency role, and the Ministry's role in this regard is described in government policy documents (Emergency Preparedness Canada, 1995). Federal policy for emergency telecommunications is characterized by response-oriented approach to support continuity of government, as evident in the responsibilities of Industry Canada. These responsibilities may be summarized into three general categories:

- Offering advice and assistance to various levels of government.
- Facilitating provision of telecommunications equipment to government departments as "required in emergency response operations."
- Coordinating and managing programs to ensure availability of telecommunications to support emergency responders, issue warnings, and meet federal requirements for continuity of governance "during periods of system overload or degradation."

There is one apparent exception to the otherwise response-oriented list of Emergency Telecommunications responsibilities:

> Providing advice and assistance, as appropriate, to private or public telecommunications undertakings in *mitigating* the disruptive effects of emergencies on domestic and external telecommunications.

This statement should provoke debate about the meaning of mitigation in the context of emergency telecommunications but it has not so far. Industry Canada itself contends that programs such as Priority Access to Dialing (PAD) and High Probability of Completion (HPC) qualify as mitigation to the extent that they serve to support more effective response, thereby reducing potential losses in the face of a disaster-precipitating event.[7] The claim reflects the conceptual ambiguity that plagues mitigation when it is put into practice. I have no specific critique of Industry Canada's claim that its current programs qualify as mitigation activities except to suggest that this approach may be somewhat narrow with respect to the objectives of the National Disaster Mitigation Strategy.

There is no doubt that programs such as PAD and HPC are important undertakings. Noting, however, that in Canada we are now seeking to build "more resilient communities" through a National Disaster Mitigation Strategy, and recognizing the fact that telecommunications are at the heart of our increasingly information intensive society, it seems imperative to me that we reconsider the scope of the field as currently defined on paper and in practice. Therefore, my study in part seeks to expand the concept of "emergency telecommunications" beyond its traditional scope on continuity of governance in the response phase and to account for wider socio-economic interdependencies now being fostered by modern communications infrastructure.

The Interdependency Problem

A shift toward recognizing wider community interdependencies appears imminent within the changing context of emergency management in Canada. For example, the newly created Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) reflects a growing concern with social interdependency linked to the public telecommunications infrastructure:

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[7] This was communicated to me by an Industry Canada official who noted that both PAD and HPC were accepted as mitigation activities by an inter-governmental committee conducting preliminary work on the National Disaster Mitigation Strategy (M. Milot, personal communication, June 19, 2001).

> In this "Information Age," critical infrastructure is a key enabler to the modern economy. It is complex, interconnected and interdependent and relies heavily on information technology. Disruptions in one infrastructure could produce cascading disruptions across a number of other infrastructures, with significant economic and social consequences to Canada and Canadians. (Canada, 2001)

The concerns posed in the OCIPEP statement are detailed to some degree by recent research into critical infrastructure protection. Masera and Wilikens (2001), for instance, have investigated dependability and complexity associated with infrastructure interdependencies. According to Masera and Wilikens, the risk of interdependency is a product of three major trends that "seem to affect all the infrastructures that compound [*sic*] modern society."[8] These trends are summarized as increasing complexity of technology, a high degree of interconnectedness at various layers (both social and technical), and a growing reliance on information and communication technologies to support and control internal and external systems. Public telecommunications enter into the picture as the means of interconnecting other infrastructures into complex networks of networks:

> The interconnections among infrastructures are facilitated by the internal use of ICT [Information and Communication Technologies], and by the availability of affordable means of establishing fast and reliable data communications. These communications means are beginning to be considered as a sort of public information infrastructure, and are increasingly employed for exchange of information and access to new value-added services such as trade tools for actors in a given market sector, and for getting connected with other infrastructures. …
>
> … the fact is that each and every infrastructure, and that means society at large, is attempting to benefit from the public information infrastructure. The end result is an overall, global dependence on a limited set of hardware and software technologies, with evolving and not yet mature interconnection and business models.

There is some discrepancy between the "public information infrastructure" that Masera and Wilikens are referring to above and the current public *telecommunications* infrastructure that we tend to think about with respect to the Canadian Radio-television and Telecommunications Commission's (CRTC) regulation of circuit-based voice services. Masera and Wilikens are addressing the information infrastructure made up of data networks (e.g., X.25, ATM, IP) that have been deployed separately from circuit-based voice networks. In other words, the

[8] The Masera and Wilikens article is a conference presentation. The document was obtained online as a Microsoft Word file and was not paginated by the authors. As a result, I have not included references to specific page numbers.

discrepancy is a result of two types of information services (voice and data) that have been established as separate infrastructures, of which the circuit-based voice network remains synonymous with public *telecommunications*. At present, we should be careful not to conflate the two infrastructures. This situation is changing rapidly, however, as voice and data services converge at trunk-side and as new voice-over-IP (VoIP) services and other digital standards are deployed at line-side. Voice service is quickly evolving into just another data application, which means that we must begin to think of public *telecommunications* as a single, interconnected network of networks.

In spite of the fact that this evolution to a manifold public information infrastructure is still nascent, we need not look far to see how interdependency is fostered through interconnected industries. The electricity infrastructure illustrates the interesting double-bind created by interdependency arrangements. This Catch-22 stems from the fact that commercial power is needed as a source of power to operate the technology of the communication networks and yet the very information moving over those networks is also the means by which the energy infrastructure is managed. Masera and Wilikens describe the relationship from the perspective of the commercial power industry:

> An advanced management of the generation and distribution of electricity has been made possible by the establishment of monitoring and control systems relying on complex communications systems. In addition electric companies rely on information exchanges for their connections with the energy value chain and their customers. Thus *it is now possible to speak of the electricity infrastructure as composed of the power grid and an associated information network*.
>
> … energy producers and distributors, while trying to develop their markets and enhance their efficiency, are getting strongly dependent on the public open Information Infrastructure [*sic*] on both the demand and supply sides. They have to communicate with the other energy market actors, as well as complete the energy offer with information-related services. These could be energy information services related to the energy loads, generation and consumption, or pricing and billing; or derived services that take advantage of the link established with residential or industrial customers (for instance, alarm management, heating, etc.). [my emphasis]

From this example we begin to glimpse how the public information infrastructure fosters interdependencies that are foundational for a wide range of services stretching across geographic, social, and economic landscapes.

Clear evidence of the *effects* of infrastructure interdependency has also come to light. In 1999 a fire at a Bell Canada switching office in downtown Toronto disrupted local voice services as well as a national data network supporting financial services such as credit card authorization and automated teller machines. Because of interdependency, the effects of a small, local incident were experienced across the country, as many businesses found themselves unable to process electronic transactions. The impact did not stop there: separate data services controlling traffic lights in downtown Toronto, a security system at the Ontario Art Gallery, and communication links to the emergency services were also affected by the switch fire (Blackwell, Craig, & Bell, 1999; Cheney, 1999).[9]

Increasing interdependency means that local disruptions in telecommunications service due to a major earthquake, severe weather incident, workplace accidents, or malicious intrusion could quickly propagate across Canada and throughout parts of North America to produce secondary disasters in social, economic, and even environmental terms. A minor example of this occurred in November 2000, when a contractor in a Chicago-area rail yard accidentally cut a cable providing access to the Canadian Venture Exchange (CDNX) trading system. The accident subsequently interfered with trading activities right across Canada. To make matters worse, Sprint Canada's backup provision for the system reportedly failed to work (Cattaneo, 2000). In other words, modern telecommunications systems foster interdependencies whereby a distant event in a seemingly irrelevant location can lead to serious disruptions for local business and community organizations.

Lifeline Engineering

Despite the looming possibility of widespread network outages leading to secondary disaster scenarios, until recently there have been few attempts to describe and quantify the losses that such outages might entail. Perhaps the most significant of these is a series of surveys undertaken by the Disaster Research Center (DRC) located at the University of Delaware (Nigg & Tierney, 1995; Webb, Tierney, & Dahlhamer, 2000). While these studies do not address the impact of communications networks specifically, their findings are linked to disruption in

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[9] Specifics of the incident are recorded in (Cheney, 1999): Art Gallery of Ontario security system went offline; sequencing for about 570 traffic lights was knocked out; travel agencies offline; Ontario Lottery terminals offline; 113,000 Bell phone lines disrupted; emergency services needed to resort to alternative communications systems; 911 system maintained but capacity to handle calls was impaired; some stock trading affected; almost 1/10 of nation's cash machines out of service for parts of the day; hundreds of bank branches offline; some retailers unable to process transactions; Hospital for Sick Children and several others were affected by failure of pagers and disrupted phone service, including poison and medical information hotlines; law offices unable to close real estate deals (clearing house for title searches was offline); travel agents lost a day, est. of $30,000 worth of sales by one affected; Toronto police lost phone and computer systems.

lifelines that include telecommunications, concluding that losses and business closures are often a result of disruptions to essential infrastructure than the disaster-precipitating event itself.

In contrast to the DRC studies, there are ongoing civil engineering studies into lifeline vulnerability that examine the physical impact of disasters on communications networks, yet only touching upon the wider socioeconomic fallout (Schiff & Tang, 1995). This body of research into lifeline engineering represents the second area of investigation in emergency telecommunications. While this area of investigation may be somewhat more mitigation-oriented than the critical infrastructure protection field, it deals primarily with physical infrastructure and not wider social and economic concerns. During my review of this body of research, I found only one specific study aimed at measuring the wider social costs of a telecommunications network outage, which was undertaken as a case study following a cable fire in Setagaya, Japan, in the late 1980s (Takansashi, Tanaka, Yoshi, & Wada, 1988).

Details from the Setagaya example are not relevant to this study aside from the fact that it was an early, “pre-Internet” case that merely hints at what may be the effects stemming from the terrorist attack on the World Trade Center towers in New York City. Not only did the attacks precipitate a staggering loss of life and property, they struck at the heart of North America’s modern telecommunications networks. Reports emerging from the terrorist attack of September 11, indicate that U.S. telecommunications carrier Verizon had five central offices serving some 500,000 telephone lines in the vicinity of the World Trade Center, and that more than six million private circuits and data lines pass through switching centers in or near the site of the collapsed twin towers. In addition, reports claim that AT&T and Sprint switching centers in the World Trade Center were destroyed as well as numerous cellular base stations within the vicinity (Angus Telemanagement Group, 2001). Data networks for major corporations, including AOL Time Warner, and other broadband services were also disrupted by the collapse of the towers (Ray, 2001). Within a society increasingly dominated by electronic networks, telecommunications outages ascend to major hazards with the potential for significant social repercussions.

Both the Setagaya and New York events highlight the importance of understanding the consequences of public telecommunications disruptions for the social and economic activity of local communities. Lifeline engineering remains, however, concerned primarily with physical infrastructure issues and not wider social or economic repercussions.

Business Continuity Planning

Emergency telecommunications has historically focused on maintaining communications to support government and emergency services during the immediate response phase of a disaster. Available evidence seems to suggest that to the extent that these programs have been developed and maintained, they typically meet their objectives. Commercial carriers themselves go to great lengths to plan for the coordination of network operations during crisis periods,[10] and according to published reports have worked together in previous events to share traffic and offer additional manpower and equipment support in the field (Industry Canada, 1997b; Industry Canada, 1998; Industry Canada, 1999).

Emergency telecommunications support for the private sector, however, has tended to remain an issue for the marketplace and thus outside the domain of public policy. To the extent that this private sector arrangement has been tested by recent events (e.g., Manitoba flood in 1997, or the Quebec Ice Storm in 1998), we have no evidence of formal complaints lodged against Canadian carriers with respect to loss of telephone service or delays in restoration. In fact, the CRTC has no records whatsoever of any complaints related to record-breaking Canadian disaster events of the past five years.[11] From this evidence, or lack thereof, we may conclude that either the current arrangements are adequate given the nature of recent events or that complaints have not been reported through CRTC. I believe, however, that the former would be a premature conclusion and that further research conducted with local firms and community organizations might provide important insights into past experience with private sector arrangements for emergency telecommunications.

Taking what evidence we do have, let us assume that Canadian carriers have demonstrated a proven capability to meet the demands of responding to disaster scenarios directly affecting their networks. Infrastructure failure is a main issue of concern with respect to emergency telecommunications policy and its private market equivalent known as *business continuity planning,* or *business resumption planning.* The literature on business continuity planning has taken up the challenge of telecommunications failures, most notably reflected in the work by Leo A. Wrobel who has written extensively in this area (Wrobel, 1993; Wrobel, 1997). Wrobel's work is commendable to the extent that he recognizes the needs and issues facing

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[10] I make this claim having examined guidelines developed by Canada's major carriers to deal with network failures, extended outages and congestion (see CRTC Interconnection Steering Committee. Network Interconnection Group, 2000).

[11] I undertook a search for these kinds of complaints with the help of CRTC staff in Vancouver.

business and community organizations in the face of telecommunications disasters, and has created detailed planning guidelines to support business continuity planning. The thrust of Wrobel's message is that private organizations must prepare themselves by being well informed and by establishing good working relationships with their telecommunications carriers. In fact, the field of business continuity planning is important for this study because it demonstrates a concern with the mitigation phase, as expressed through the concept of advanced planning for continuity of operations. Continuity refers not only to the capability of a private firm or community organization to quickly respond to a disaster but, more importantly, draws attention to the notion that long range planning for successful recovery is a means of mitigating disasters. In reviewing the literature in this field, however, I have discovered that the focus tends to be placed on existing solutions rather than developing new services to accommodate the needs of unique groups of users not adequately serviced by the major carriers.

Policy Research for Mitigation

Despite the commendable work done in emergency telecommunications programs, lifeline engineering, and business continuity planning there still remains a significant oversight; namely, that most policy research has been confined to the critical infrastructure protection domain. Recently there has been some mitigation-oriented research done to examine the regulatory dimensions of disaster preparedness for telecommunications in developing nations (Samarjiva, 2001; Srivastava & Samarajiva, 2001) but while important it is preliminary work that lacks comprehensive data and analysis.

While the literature on business continuity planning presents recovery solutions based on the available menu of services offered by telecommunications carriers it ignores the processes by which those services are actually developed and introduced in the marketplace. By contrast and as evident in programs such as Priority Access to Dialing, Industry Canada has demonstrated a concern with service development to support emergency telecommunications for continuity of governance. Lifeline engineering and business continuity planning (BCP) adopt somewhat more of a mitigative attitude but do not deal specifically with processes that shape the evolution of telecommunications products and services. We can also see from Table 2 that public sector organizations remain the focal point for critical infrastructure protection, while BCP is predominantly addressed to private sector firms and organizations. Policy research has tended to support critical infrastructure protection activities rather than addressing issues related to new service development. Table 2 presents the traditional realm of emergency telecommunications research for comparison.

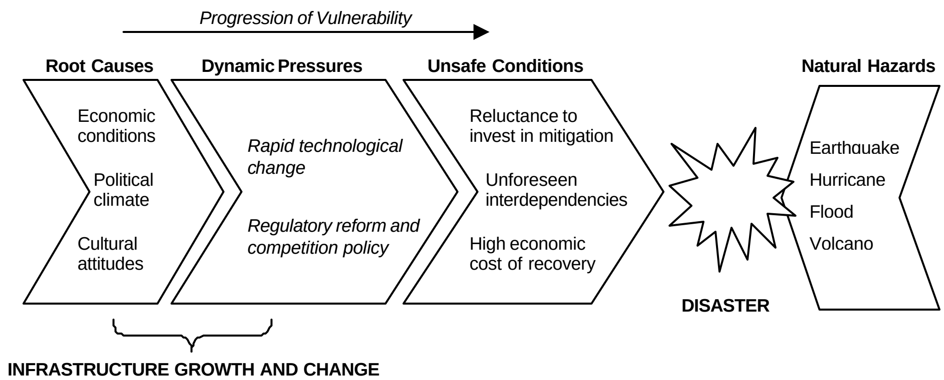
Table 2: Traditional Realm of Emergency Telecommunications Research

	Critical Infrastructure Protection	Lifeline Engineering	Business Continuity Planning	Policy Research
Mitigation oriented?	No	Somewhat	Somewhat	No
Includes private sector?	No	Yes	Yes	Minor role
Service development?	Yes	No	No	No

When we compare these four areas of investigation it is evident that the research community has largely ignored the *process* by which growth and change occurs in telecommunications infrastructure. This is a significant oversight to the extent that a considerable number of dynamic pressures are now surfacing with the rapid deployment of new technologies within Canada's competitive telecom environment. On the one hand, new opportunities include the enabling of new flexible, cost effective telecommunications services to support emergency planning. Hidden threats, on the other hand, stem from rapid technological developments confronting uncoordinated investment and design decisions taken by various stakeholders in the telecommunications sector. Making the most of these opportunities and reducing the long-term risks associated with this evolving infrastructure means investigating the processes involved in the design of the telecommunications infrastructure. I believe that such an investigation can make an important contribution to the National Disaster Mitigation Strategy but it will require an expanded—perhaps radically expanded—conception of emergency telecommunications.

Figure 3 illustrates where mitigation-oriented policy research, as it has been conceived for this study, properly resides within the Pressure and Release Model. Understanding the fundamental processes of infrastructure growth and change are necessary to anticipate and avoid the development of unsafe conditions. As such, policy research for mitigation resides at the interval between root causes and dynamic pressures. This interval as it relates to telecommunications in Canada will be explored further at a later point in this study, but the illustration provides a basic set of considerations.

Figure 3: Mitigation-oriented Policy Research



While respecting the real limitations to anticipating future conditions, the objective of telecom policy research for the National Disaster Mitigation Strategy should be (1) to understand the processes by which growth and change occur in Canada's telecommunications infrastructure, and then (2) to assess the various means by which to intervene in those processes in order to ensure that long-term risk reduction is given high priority, especially at critical decision points.

This study is partly about developing this proposition more fully while evaluating its feasibility as a policy research methodology. This study is also about applying this methodology to an empirical case in order to derive a set of practical recommendations for the NDMS.

Some Background and a Set of Questions for this Study

Telecommunications falls under Federal jurisdiction in Canada and is therefore within the scope of the National Disaster Mitigation Strategy. Industry Canada has the primary oversight role for telecommunications policy including spectrum management. The Canadian Radio-television and Telecommunications Commission (CRTC) is an arms-length regulator for the telecom sector. Today, Canada's telecommunications infrastructure consists of a small number of regional incumbent wireline telephone companies (ILECs), numerous independent telephone companies (most in Ontario and Quebec), four national wireless service providers, and number of competitive long distance and local exchange carriers. The passage of the 1993 Telecommunications Act has made reliance on market forces a principal policy objective for the telecommunications regulator; however, the regulatory environment is something of a patchwork as the CRTC continues to regulate facilities-based carriers (those owning or operating transmission faciltities), while non-dominant carriers may be forborne from regulation (e.g., wireless service providers), as are re-sellers and other competitive service providers (see Grieve, 2000).

Section 7 of the *Telecommunications Act*, which establishes the overall policy objectives for Canada's telecommunications infrastructure, provides a starting point for mitigation-oriented policy research:

> It is hereby affirmed that telecommunications performs an essential role in the maintenance of Canada's identity and sovereignty and that the Canadian telecommunications policy has as its objectives
>
> (a) to facilitate the orderly development through Canada of a telecommunications system that serves to safeguard, enrich and strengthen the social and economic fabric of Canada and its regions; …
>
> (f) to foster increased reliance on market forces for the provision of telecommunications services and to ensure that regulation, where required, is efficient and effective; …
>
> (i) to respond to the economic and social requirements of users of telecommunications services; (Canada. Department of Justice, 2001)

The wording of the legislation suggests a set of three observations relevant to the National Disaster Mitigation Strategy. I have used these to develop an initial series of questions that have been formative to this study.

First, section 7 (a) implies the need to ensure an "orderly development" of the telecommunications infrastructure to the extent that it is capable of supporting the broader objectives of the NDMS (i.e., "safeguarding"). In the face of rapid technological change this suggests to me that some kind of direct oversight or regulatory action may be required to ensure that Canada's telecommunications infrastructure will evolve in a coordinated way along the lines of established best practices that embody a vision of long-term risk reduction. Is such oversight necessary? Is this oversight currently in place? If so, can it be improved? If not, what are the best means to implement it given current policy and regulatory considerations?

Second, section 7 (f) calls for increased reliance of market forces for service provision, implying that initiatives taken up within the NDMS should be fostered by competition wherever feasible. In terms of infrastructure development, this might mean looking for policy instruments to promote research and development and encourage technology transfer for disaster management. It might also mean ensuring access to certain strategic network elements and services that enable innovative services in support of mitigation-related activities. What policy instruments are available to support research, development, and technology transfer for disaster management? What are the key bottlenecks and strategic network elements that might influence the deployment of new services?

Third, section 7 (i) requires that the social and economic requirements of user communities be considered in the development of Canada's telecommunications infrastructure. In terms of the NDMS, this suggests a need to ensure stakeholder consultation is undertaken at critical stages of infrastructure development. Current stakeholder development may need to be expanded, or new processes may need to be introduced in order to better facilitate participation in critical decisions. What are the important issues, challenges, and opportunities for expanding stakeholder participation in telecommunications infrastructure planning and development?

Together this set of observations and questions forms the basis for inquiry that will guide the rest of this study. To these I will return at the end of the study, after having developed my methodology in more detail and after undertaking a detailed case study and assessment of a new service development in Canada's telecommunications infrastructure.

Summary

In this chapter I have introduced Canada's National Disaster Mitigation Strategy as a major policy initiative now being undertaken by the Office of Critical Infrastructure Protection and Emergency Preparedness (OCIPEP) in conjunction with other Federal departments and industry associations. I have argued that telecommunications are a vital aspect of this initiative, particularly in light of growing interdependency concerns, yet this sector has been largely overlooked to date in proceedings on the NDMS. I then discuss how the major principles and guidelines derived from the may have implications for telecommunications policy and regulation in Canada.

The chapter also included a critique of traditional approaches to "emergency telecommunications," where I argued that they do not address "mitigation" as it is interpreted through the Pressure and Release Model. This explanatory model of disasters places emphasis on understanding root causes as precursors to vulnerability in society and offers a less ambiguous approach to conceptualizing mitigation. I have adopted this perspective on mitigation, which suggests to me that the objective of telecom policy research for the NDMS should be (1) to understand the processes of growth and change in telecom infrastructure development and (2) to assess the various means by which to intervene in those processes to ensure that long-term risk reduction is given high priority. Finally, I introduce a set of questions that form the basis for the inquiry that will guide the rest of this study.

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Chapter 3: Technology Assessment and Intervention Analysis

> The effect of CTA [is] not to bring technology under control so that it plays a less dominant role in society. What changes is the form of control and how technology development is played out. … The goal is to anticipate earlier and more frequently, to set up design processes to stimulate reflexivity and learning, and thus to create greater space for experimentation. (Schot, 1998)

Introduction

The previous chapter was principally concerned with describing the context for this study and then positioning it within the existing field of research and practice, thereby defining a specific scope of inquiry. The contextual space of this study is characterized by a focus on the National Disaster Mitigation Strategy, with the intention of investigating growth and change in telecommunications infrastructure as it relates to the objectives of this initiative.

I have positioned by my research within the existing field by demonstrating how this study addresses a lacuna that currently exists within the fourfold field of emergency telecommunications. To do this, I provided a constructive critique of current emergency telecommunications policy and planning for critical infrastructure protection, pointing out that it has largely emphasized public sector preparedness/response/recovery initiatives. Lifeline engineering has undertaken mitigation-oriented research into communication infrastructure but not addressed wider social and economic impacts associated with lifeline vulnerability. Business continuity planning (BCP), on the other hand, has placed greater emphasis on recovery aspects for the private sector but has largely ignored the process of telecommunic ations service development. Existing policy research in the area of emergency telecommunications has been an extension of conventional disaster management activities and has yet to adopt a wider scope of investigation within the full scope of mitigation. I see my contribution falling within the realm of policy research, applying an expanded conception of emergency telecommunications to the National Disaster Mitigation Strategy.

My general contention is that this study will provide useful input to current policy processes by highlighting telecommunications infrastructure development as a risk reduction initiative unto itself. As such, this study is an exploratory investigation, located at the intersection between disaster mitigation, public policy, and the social shaping of Canada's telecommunications infrastructure.

A major challenge for this study has been to adopt a theoretical framework and methodology suited to this intersection of interests. In order to investigate the observations and questions I set forth in the previous chapter, I decided to undertake this research as a technology assessment. Foremost among the reasons for deciding on technology assessment is my personal interest in the complex interplay between technology development and social policy on the design of large technical systems. Admittedly, this is a very general statement of interest but it applies to this specific study in two ways. On the one hand, I wanted to explore the influence of telecommunications policy and other regulatory instruments as a way of managing growth and change in Canada's public telecom infrastructure. On the other hand, I wanted to understand from an empirical vantage point a large technical system like the telecommunications network evolves and how or where intervention might take place to influence the process of design to address wider social objectives. Technology assessment is an approach well suited to these kinds of inquiries and, in my view, is therefore appropriate for mitigation-oriented policy research in the field of telecommunications.

Technology Assessment and the Design Nexus

Technology assessment is a research strategy prompted by a desire to understand—and to anticipate—the interaction of technology and social forces in order to produce better policy decisions within government and industry (Herdman & Jensen, 1997; Hill, 1997; La Porte, 1997). At least two prominent technology assessments have been undertaken in the North American telecom sector, although they are now somewhat out of date and simply report on the potential impact of forthcoming technologies (Office of Technology Assessment, 1989; Office of Technology Assessment, 1995). Neither study is principally concerned with understanding the dynamics of technological change. As such I have decided not to present a review of either report but instead to focus on other areas of technology assessment that I feel are more directly suited to my investigation.

As an approach to research, technology assessment is best viewed as a pragmatic arrangement of theory and method emphasizing one of three concerns: a particular technology project, a technology related problem, or the introduction of a new technology into society (Porter, 1980, p. 51). In this study we are concerned with a particular technology project; namely, the introduction of a new service into the Canadian telecommunications infrastructure. I call it a “pragmatic arrangement” because specific technology assessments will take many operational forms depending on the requirements and constraints of a given study (Armstrong & Harman, 1980; Nguyen, Lobet-Maris, Berleur, & Kusters, 1996; Porter, 1980). This reflects the applied, qualitative character of technology assessment where “the (applied) researcher is faced with ‘fuzzy’ issues underneath which lie multiple, often broad research questions, and he or she is asked to address them in a rather ‘messy’ or uncontrolled environment” (Hedrick, Bickman, & Rog, 1993, p. 3). Technology assessment is conducted not in the laboratory but in the wilderness of the world and must reflect this in the flexibility of approaches and iterative processes required for meaningful results. This is not to suggest, however, that a technology assessment can simply disregard matters of utility and validity; indeed, these concerns remain a foremost challenge to research design (Porter, 1980, p. 44).

In the mid-1990s a number of books and articles were issued to address various methodological aspects of technology assessment, often contrasting the particular historical circumstances of its development and evolution between North America and Europe, where a growing emphasis on technology design began to flourish around that time (Bereano, 1997; Berloznik & van Langenhove, 1998; Herdman & Jensen, 1997; Hill, 1997; La Porte, 1997; Van Den Ende, Mulder, Knot, Moors, & Vergragt, 1998; Wood, 1997). While forward thinking proponents of technology assessment in Europe appear to be the first to view design as the critical nexus between technology development and social policy, the idea was also gradually taking root within North American technology studies. Influential American academics soon began to write about design as the active process of embedding social norms and political economic motives into technological systems, a process which Langdon Winner labelled as “political ergonomics” (Winner, 1995). Philosopher Andrew Feenberg pointed to design as the foundation for a political critique of modern technology (Feenberg, 1999) Mansell’s political economic research has also drawn attention to the design of telecommunications networks as a pivotal enabling and constraining factor in both European and American settings (Mansell, 1993; Mansell &

Silverstone, 1996). Much earlier, Innis's historical research in political economy and, more recently, Hughes' analysis of large-scale technological deployment all suggest that materiality and design are critical variables in shaping the "bias" (Innis) or "momentum" (Hughes) of large technical systems (Hughes, 1987; Innis, 1951; Innis, 1986).

Design and Telecommunications Infrastructure

Design becomes an operational concept for telecom policy research when we remove it from the narrow definition of industrial arts or aesthetic ornamentation to embrace its wider significance in large technical systems. Put simply, the public telecommunications infrastructure is *designed* through the interactions of a large number of interested parties to be an interconnected, interoperable network of technologies and services. It is, moreover, a designed system that spans the entire planet as one writer has observed in suggesting that the public switched telephone network (PSTN) may very well be the largest integrated technical system that our species has ever created (Karlsson & Sturesson, 1995). However, in contrast to many consumer artifacts such as wristwatches or lawn furniture the public telecommunication infrastructure is a highly diffuse system, which makes it difficult to say at the outset where or by whom it is "designed," or whether we can talk about it as a single infrastructure at all.

I suggest therefore that it may be helpful to think of the telecommunications infrastructure as the outcome of *a distributed design process,* involving coordinated set of interactions between quasi-independent organizations such as the International Telecommunications Union (ITU), national regulatory agencies, national standards bodies, telecommunications carriers, equipment manufacturers, and any number of other interested parties including (potentially) the diverse community of users. While each of these organizations is principally concerned with its own mandate and agenda, their collective action has led to the present design of the world's telecommunications infrastructure. In this study I will explore certain aspects this distributed design process in the Canadian context by adopting an approach to technology assessment specifically concerned with the design nexus.

Constructive Technology Assessment

Linking public policy to the design nexus is a matter for Constructive Technology Assessment (CTA), an approach spawned by research done through the Dutch Science Dynamics program into the question of technology dynamics. CTA presents an important contrast with the so-called "early warning" approach of technology assessment as it developed in North America during the middle of the twentieth century. Whereas proponents of early warning TA such as the United States Office of Technology Assessment (OTA) tended to adopt an *exogenous* model of technology development for its research projects, the CTA program was conceived within a participatory *endogenous* model of technology development (Eijndhoven, 1997). An exogenous model anticipates a finished technology that enters into and creates effects in a society (Edge, 1995). Endogenous models, by contrast, recognize that a technology and its effects are not necessarily dropped "stork-like" into a society but are produced, womb-like, by various interested parties within society. Therefore, CTA practitioners view technology projects as highly contingent undertakings open to a range of alternative possibilities, especially in the early stages of development.

A Dutch government policy memorandum of 1984 is credited with formulating the overall goal for CTA, although it never referred to CTA as such. "The Memorandum," write Schot and Rip, "argued that the function of TA studies should be to let societal aspects become additional *design criteria*" [emphasis added] (Schot & Rip, 1996, p. 252). In the tradition of constructivist approaches, CTA redefines technology assessment as an active contribution to the process of design as opposed to an independent program of technology impact analysis. The Dutch policy memorandum established the Netherlands Organization of Technology Assessment (NOTA), later known as the Rathenau Institute. NOTA developed the new TA approach along two major paths: (1) by introducing public participation in the TA process and (2) by funding of several key studies looking at the value of TA at the design stage of technology development (Schot & Rip, 1996, p. 253).

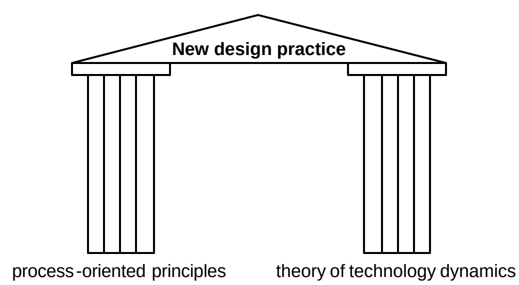
Since the Memorandum was issued, the Constructive Technology Assessment approach has been adopted by numerous organizations across Europe including TA groups in Denmark, Germany, and Norway. The Organization for Economic Cooperation and Development (OECD) has also paid heed to the CTA concept (Schot & Rip, 1996, p. 254). In addition, various EU programmes in the R&D field have recognized the ideas within CTA as contributing to improved technology policy and development (Berloznik & van Langenhove, 1998). It is therefore reasonable to argue that CTA has become a recognized approach in the technology assessment field, particularly in the European community. In North America its presence is less evident and likely a result of the US Office of Technology Assessment (OTA) dominating the field until the mid 1990s, when it was disbanded. Recently, however, the philosophy behind CTA has begun to gain prominence in a number of selected areas of science and technology policy research in both Canada and the United States (see, for instance, Loka Institute, 2002).

In its most general formulation, CTA is taken to be an input to technology design with an emphasis on iterative and contingent processes, or "societal learning" as a major outcome (Eijndhoven, 1997, p. 280). In effect, the endogenous model of technology development and process-oriented principles establish twin foundations for CTA practitioners and make an innovative contribution to technology policy research:

> CTA can be seen as a new design practice … in which impacts are anticipated, users and other impacted communities are involved from the start and in an interactive way, and which contains an element of societal learning. (Schot & Rip, 1996, p. 255)

Schot and Rip summarize the strategic view of CTA practitioners when they claim it is an approach that "attempt[s] to improve our chances to arrive at better path dependencies by broadening technological design and development" (Schot & Rip, 1996, p. 258). In other words, Constructive Technology Assessment practitioners seek to open the design process to scrutiny in order to explore the potential effects of technology projects well before they are become entrenched or "locked-in" to socio-economic frameworks (see Figure 4).

Figure 4: Twin Pillars of CTA as a form of Design Practice



The Collingridge Dilemma: An Obstacle to CTA?

Problems experienced with the North American early-warning approach to technology assessment, typified by projects done within the US Office of Technology Assessment, suggest that future *effects of* and *influences on* technology are not easy to determine and pose a challenge to the objectives of Constructive Technology Assessment, which must grapple with anticipation of effects at the early design phase of a technology project.[12] Any effort to anticipate future effects of a technology project must address what has come to be known as the Collingridge Dilemma. This describes the inherent paradox that confounds attempts at technology forecasting and efforts at social shaping:

> The Collingridge Dilemma is often used to refer to the fact that forecasting future effects of technology is difficult, whereas well-developed technology is difficult to direct, because it has become embedded in society ... The Collingridge Dilemma points to the fact that the early warning function of technology assessment has severe limitations, because either the knowledge or the power are missing to change the direction of technological development, leaving quick adaptation to new technology as the only way society can react. (Eijndhoven, 1997, p. 279)

Another view on the matter describes the Collingridge Dilemma in more succinct terms:

> First, [there is] an information problem: impacts cannot be easily predicted until the technology is extensively developed and widely used. Second, a power problem: control or change is difficult when the technology has become entrenched. (Rip, Misa, & Schot, 1995, p. 7)

The Collingridge Dilemma is a double-bind problem related to path dependency: effects are difficult to anticipate until a technology is deployed, yet once deployed it may be impossible to affect substantial change to it because of investments made in its development and deployment. Collingridge himself suggested that a solution to his dilemma could be found in developing highly flexible technology designs capable of multiple configurations. In other words, he advocated building technology so that it is easily adaptable to a variety of social settings and different user needs. CTA proponents argue that this is a conceptually flawed strategy because some degree of "entrenchment is necessary to implement a technology" (Rip et al., 1995, p. 7). In other words, the notion of full flexibility is problematic in practice because it overlooks the inherently value-laden and goal-oriented processes within each phase of a technology project. Rip, *et al.*, for instance, note that decisions *must be made* at numerous points in the design process in order *to affect closure* on any technology, and this is where the entrenchment, or embedding, of values and path dependency begins.[13] Without minimum degrees of closure along

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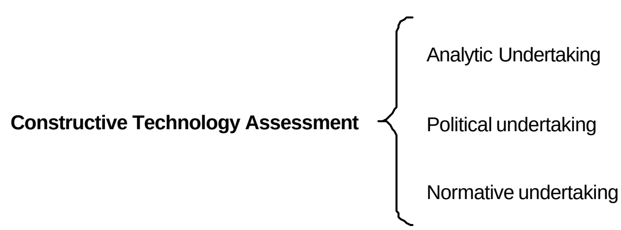
[12] This challenge speaks to a larger theoretical problem integral to technology studies. For instance, if one rejects technological determinism outright when dealing with the problem of anticipating future effects, then one is obliged to assume either the totality of the social as an influence, or the hybrid possibility that technology and society are somehow co-constitutive. The former amounts to a radical position of social determinism that critics have argued as untenable (Sismondo, 1996).

[13] Path dependency and network evolution is taken up in David (1993).

the way there can be no movement toward a functional technological artifact. CTA proponents accept this inevitability as integral to technology design but assert that path dependency can be positively directed to the extent that society understands the implications of and participates in choosing a pathway from among a range of alternatives (which might include outright cancellation of a technology project).

Facing the methodological challenge presented by the Collingridge Dilemma, CTA practitioners must first adopt a perspective on technology dynamics in order to *identify where* and to *conceptualize the means and motivations* by which closure and entrenchment happen amidst the otherwise complex ambiguities of technology design. This is an *analytic undertaking*, which has been studied under the labels of Social Construction of Technology (SCOT) and Actor Network Theory (ANT). In conjunction with the analytic project, however, there is also a *political undertaking* that needs to be addressed within CTA. This undertaking deals with questions of stakeholder composition, involvement, and intervention to ensure that "appropriate" technology pathways are taken into consideration. And this leads logically to a *normative undertaking*, which is necessary to address questions of social values and cultural practice in deciding the criteria of "appropriateness" for society. Each of these three undertakings (see Figure 5) is a response to the methodological challenge posed by the Collingridge Dilemma and is reflected in the achievements and limitations of CTA (Schot & Rip, 1996, p.258).

Figure 5: Three Undertakings of CTA



Analytic undertaking: generalized principle of symmetry

"From the beginning," writes Arie Rip (1994), "CTA emphasized the necessity of insight into, and analysis of, the dynamics of technological development and how technology gets embedded in society." This emphasis has drawn CTA practitioners to constructivist science and technology studies (S&TS) for a model of technology dynamics. The constructivist model suggests the anticipatory problems of the Collingridge Dilemma can be resolved to some extent and that it is possible—indeed that it is essential—to learn about and shape technology effects in the early design phase of development.

CTA takes from S&TS the generalized principle of symmetry as a foundation for its model of technology dynamics (Rip, 1994). In its original form established by SCOT (Pinch & Bilker, 1987) the principle of symmetry meant that within a study all relevant social influences on a technology project are to receive equal accounting in an analysis—not just those involved in the "success" of a technology project, as had been commonplace in earlier histories of technology (see, for instance,Cutcliffe, 2000). Actor Network Theory developed a more radical position, arguing for a *generalized* principle of symmetry, where it is claimed that the very categories of technical and social should not even be assumed *a priori* but should be considered a process of classification or "purification" that is synonymous with technology projects considered "successful" (Callon & Latour, 1981; Latour, 1993). Callon, for instance, has argued "the distinction between the technical and the social is the result, not the cause, of the stabilization of socio-technical ensembles" (see Bijker, 1995, p. 275). For this reason the approach of actor network theory is called "relational materiality" by Law, who has described it as "a ruthless application of semiotics … [that claims] entities take their form and acquire their attributes as a result of their relations with other entities" (Law, 1999, p. 3). In this formulation, the distinction between "technical" and "social" is taken to be a relational effect, uncertain and reversible, derived out of contingent relations among actor networks within a specific technology project.

In operational terms the generalized principal of symmetry suggests that analysis should focus on the most nascent stage of a technology project—the initial design phase, where the construction of relational entities can be observed in action. To some extent this circumvents the Collingridge Dilemma because it pre-empts the bi-polar model of "technological" and "social" and recognizes that design deals with "quasi-subject matter" of heterogeneous and often indeterminate elements out of which specific artifacts come to be stabilized. Scholars in the field of design studies express similar sentiments in this regard:

> In actual practice, the designer begins with what should be called a *quasi-subject matter*, tenuously existing within the problems and issues of specific circumstances. Out of the specific possibilities of a concrete situation, the designer must conceive a design that will lead to *this* or *that* particular product. A *quasi-subject matter* is not an undetermined subject waiting to be made determinate. It is an indeterminate subject waiting to be made specific and concrete. (Buchanan, 1996, p. 16)

Buchanan refers to this as the "wicked problem" of design. The wickedness derives from the fact that designers are not discovering but *inventing*, and often within an indeterminate field of possibilities. Design is therefore an integrative, constructive, discipline that draws from a wide range of sources including "signs, things, action, and thoughts" to organize experience and develop design solutions (Buchanan, 1996, p. 8). The process of design is an act of "heterogeneous engineering" (Callon & Law, 1997) in which both human and non-human actors come to play an active role in the creation of a new technological achievement. The term "quasi-subject matter" describes the imbroglio of indeterminacy that precedes the translation of interests into specific forms of technological artifacts. It is here, in this domain of the imbroglio, where the generalized principle of symmetry is located as a principle of analysis.

Drawing on the generalized principle of symmetry, CTA practitioners therefore consider design to be a site of negotiation wherein future effects are sought after by means of an intentional process of heterogeneous engineering that is observable as a discursive process between interested parties. I will expand on this theoretical position further in the chapter, but this notion of "sought after" effects introduces a related question of *unintended* effects created by otherwise intentional actor network constructs. CTA practitioners are interested in such unintended effects, as they represent a major challenge to traditional forms of technology assessment and become key issues in debates about new technologies. This moves our discussion to the next methodological challenge of identifying appropriate stakeholders and strategies for intervention.

Political undertaking: participatory TA

CTA is an offspring of parliamentary TA in which technology development has come to been seen as political activity worthy of public reflection and debate (Eijndhoven, 1997, p. 270). Moreover, CTA contributes to technology policy a strong emphasis on "societal learning," which involves iterative assessments by numerous stakeholders from across a wide range of interests. With this ambitious objective in mind, CTA practitioners are faced with a two-fold problem of stakeholder representation and stakeholder congruency.

Stakeholder representation is the matter of deciding the constituency of participants that should be invited into a technology assessment project. The representation problem stems from the meaning of participation in a given setting. For some CTA practitioners the idea of participation means public or "citizen" participation, which "encompasses a group of procedures designed to consult, involve, and inform the public to allow those affected by a decision to have an impact into that decision" (Rowe & Frewer, 2000, p. 6). There are two operative terms in this statement: "those affected" and "have an impact". Recalling a central problem of the Collingridge Dilemma, how are we to determine those who are likely to be affected if we take into account the inherent ambiguity of a technology project in its conception phase? Moreover, what does it mean to talk of having an "impact" when, as Rowe and Frewer (2000, p. 6) have noted, participation can range from one-way public information campaigns to extensive dialogue, to forceful intervention?

The ideal CTA situation seems to be one characteristic of the consensus conference, which is also a European invention developed co-extensively with the birth of CTA. The consensus conference "is a structured education, discussion, and decision-making process designed to inform citizens about a subject in question, and then to elicit their informed judgments about it" (La Porte, 1997, p. 208). Richard Sclove, an American advocate for the consensus conference, describes it as an extended commitment of time that involves selected members of the public undergoing extensive preparation and intimately involved in the assessment process (Sclove, 1999).

The consensus conference may address the problem of participants "having an impact" but the basic question of stakeholder representation remains and may need to be addressed in each unique set of circumstances. Again, this is complicated by the double-bind raised by the Collingridge Dilemma. In theory, CTA practitioners address this challenge through a process-oriented approach, whereby successive assessments are adjusted to new conditions as learning progresses. As such, the problem of "those affected" can be dealt with through iterative sessions where new conditions and higher or more specific levels of learning in an assessment project lead to an evolving mix of stakeholders. This evolving mix could include previously overlooked stakeholders or it could shed those stakeholders with decreasing relevance in the project. Of course, this would require among stakeholders and organizers alike some form of ongoing commitment to and coordination of such iterative learning.

Stakeholder congruency, on the other hand, is the matter of establishing minimum conditions of shared understanding among participants who may otherwise have widely divergent expertise, backgrounds, and interests (Grin & Graaf, 1996, p. 77). It is also the vital foundation for the learning objectives of CTA. How can congruent terms of reference be reached as an integral step in the assessment process? Following the prescriptions of CTA, a number of approaches have been developed to address the problem of stakeholder congruency (Grin & Graaf, 1996), including metaphor assessment (Mambrey & Tepper, 2000). These approaches are generally directed at a three-step process for achieving "congruent frames of meaning" among stakeholders that involves articulation, reflection, and consensus building. In the field of science and technology studies this problem of stakeholder congruency is related to Bijker's concept of the technological frame (introduced later in this study).

Normative undertaking: directed incrementalism

While CTA's kindred field of research (science and technology studies) has been criticized for failing to take a normative stance on technology development (Winner, 1993), CTA practitioners have adopted at least an implicit normative position on the matter, "embrac[ing] values such as being anticipatory, reflexive, and oriented toward learning" (Schot & Rip, 1996, p. 265). Radder (1996) has argued that this kind of normative stance borders on an empty value system, but its proponents reply that it should be recognized for an explicit aim of achieving open-ended learning that avoids imposing prescribed values on stakeholders and their positions. While this hardly seems a solid basis for fulfilling long-range societal objectives such as sustainable development or disaster mitigation, it is central to the principles of CTA.

To counter charges of relativism in such a "meta-level" value system, Grunwald (2000) has proposed that open-ended learning could be reconciled with long-range objectives by shifting criteria of acceptance in technology assessments from substantive to procedural measures. In effect, this would mean working toward consensus not on the content of particular technologies per se, but rather on the *criteria of acceptability* for technology development. In effect, this might take the form of something similar to the development process for technical standards where specifications and not specific products are discussed. In the case of CTA these procedural criteria would be applied to a wider set of societal considerations including, for example in our case, the question of making mitigation a component of critical infrastructure development.

For Grunwald, criteria of acceptability are established on the basis of pragmatic rationality, which is a theoretical concept beyond the scope of this study. However, a cursory understanding of the concept suggests it is an attempt to establish criteria of acceptability based on what Grunwald terms "the social contract", or "the medium of society [that enables] continuity, stability, and identity beyond the individual level" (p. 120), which he translates into an operational model based on "directed incrementalism."[14] This strategy of directed

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[14] Grunwald's concept is linked to the work of Habermas and Ulrich Beck, both of whom have dealt with the question of rethinking modernity in the face of the postmodern challenge. Beck in particular has examined the concept of risk within modernity.

incrementalism yields some insight on the normative dimensions of CTA and the associated challenges posed by the Collingridge Dilemma.

Contrasting long-range strategic planning with short-range tactical planning, Grunwald argues that both are unacceptable models for reconciling flexibility with long-term objectives. Detailed technocratic models, for instance, posit a stable future objective and establish a pre-defined trajectory to reach that objective. In effect, they presume "the plannability [*sic*] of large areas of society at the macro-level" and ignore the possibility that societal conditions themselves may change and, as a result, that the original objective may become obsolete or problematic in the future (p. 128). On the other hand, incrementalist models posit no long-term objective, "staggering through history like a drunk putting one disjointed incremental foot after another" (p. 109). In the incremental model, long-term objectives such as those associated with disaster mitigation are simply out of the question because there is no means of establishing distant targets on which to guide long-range technology development.

Directed incrementalism is the middle road. Using this approach, Grunwald suggests long-range targets should be established as a second-order set of criteria. This allows for incremental changes in specific targets but draws on these changes to feedback into the assessment and revision of long-term objectives:

> Permanent reflection on the goals and the means to attain them leads to incremental changes of direction in the development of the goals as well as of the measures to reach the goals. The change, however, does not show an erratic behaviour. This kind of development allows [us] to get closer to the envisaged area of goals and to take into account the short-ranged flexibility requirements (which are leading to the incremental changes of direction). (p. 129)

This is a systems-theoretic idea similar to homeostasis (i.e., self-regulation of a system) but is actually based on a second-order cybernetic model. Second-order cybernetics addresses the problem of evolving systems (Leydesdorff, 1996). With directed incrementalism, long-range targets are taken to be second-order criteria, meaning that the short-range feedback process is used in part to help the system regulate itself (homeostasis) but it is also used to help the system reflect upon and learn from its current state, formulate new long-term objectives, and make changes directed toward those new objectives.

This notion of second-order reflection appears to be at least an implicit idea behind societal learning as it is conceived within CTA. Grunwald's model is helpful for understanding the so-called *broad* and *deep* learning that CTA proponents refer to in the literature (Schot, 1998). Broad learning describes a wide sweeping exploration of possible links between design, user demands, and issues of social and political acceptability. This is typified by a group of stakeholders sharing ideas and increasing awareness of each other's positions on a matter. Deep learning, on the other hand, has a first and second order component. First order learning improves the ability to deal with tasks at hand, such as coming to terms with a specific design problem. This might be compared to the idea of *technique*, whereby stakeholders learn to develop methods of addressing commonly faced issues or challenges. Second-order learning "requires clarifying values and ways of relating values to each other" (Schot & Rip, 1996, p. 257). Simply put, it refers to self-reflection that may lead to significant adjustments in held ideas, beliefs, and practices.

CTA and the National Disaster Mitigation Strategy

It is interesting to compare the principles and objective of Constructive Technology Assessment with those embodied in Canada's National Disaster Mitigation Strategy. Such a comparison suggests, for instance, that the NDMS shares key features of CTA's analytic, political, and normative undertakings. In the analytic domain, the NDMS interpretation of "mitigation" shares a similar concern with CTA for the basic processes of growth in social and technical systems. Both seek to bring an endogenous perspective to systems undergoing growth and change.

Likewise, both the NDMS and CTA share a participatory politics that respects and seeks to cultivate wide stakeholder representation in program development. In the case of the NDMS this is reflected in its aim to create a National Mitigation Partnership.

Finally, the normative undertaking of CTA with its emphasis on societal learning is evident in the NDMS principle of promoting education and reflexive dialogue among a wide range of stakeholders through a National Mitigation Secretariat and industry forums. While it is important to maintain a distinction between CTA as an approach to technology policy research and the NDMS as a policy initiative, my point here is simply that their principles and aims display a high degree of resonance.

Exploring the Sociotechnical Landscape: Theorizing Technology Dynamics

Among CTA's three related undertakings, this study will concentrate on the analytic domain both theoretically and empirically. While I will of necessity consider both the political and normative aspects of CTA throughout the study, I will not deal with them in depth, as they are worthy of separate research projects. Results from this exploratory study, however, could contribute to a more extensive CTA dealing with political and normative aspects in the field of emergency telecommunications.

As I have noted, a central concept in CTA is that of “path dependency” or “lock-in,” which results when a commitment of resources is made to a technology project. Path dependency represents a kind of momentum or soft determinism in technological systems that CTA practitioners seek to understand and influence at the early stage of design. Before exploring the roots of path dependency within the Canadian telecommunications infrastructure, I will turn to the work of Bijker as well as Actor Network Theory for a theoretical account of technology dynamics.

Bijker’s work (Bijker, 1995) has been particularly influential in this study because it purports to offer a coherent theory of “socio-technical” change based on constructivist principles. Bijker’s work is also helpful from an operational standpoint because it provides a set of guideposts and criteria for doing constructivist analysis—what he has termed as well as offering a “sociological deconstruction.” In each of these two respects, Bijker has synthesized a great deal of the work undertaken in science and technology studies in order to provide a model that can be applied to empirical research. My adaptation of Bijker includes some further theoretical development, as I have found it helpful to augment his model with additional concepts from Actor Network Theory (ANT).

How to Study Technology Projects

While Bijker in his writings tends to refer to technical artifacts, his approach is applicable to any effort that seeks symmetrical analysis as a method to reveal the multiple possibilities and contingent evolutionary forces that shape technological development. Because of a semantic issue of referring to technical “artifacts” when dealing with large technical systems I have adopted the term “technology projects” instead. Within this study, the term *technology projects* refers to open-ended, contingent, and indeterminate efforts that embody the motivations of numerous interested parties to establish a working technical artifact or system.

Bijker’s method of studying technology projects is structured in two stages. In the primary stage, the researcher begins with a “sociological deconstruction” by identifying “relevant social groups” and their relationship to a technology project. In this study I use the term *interested parties* as a substitute term for relevant social groups because it corresponds with conventions found in the case study.

In the second stage of deconstruction, the researcher then investigates the interested parties to unearth the multiple meanings that each ascribes to the technology project as instances of “interpretative flexibility” (Bijker, 1995 p. 45, 73). I have adapted this second stage by referring to specific interpretations as *problem formulations*. Problem formulations consist of a number of related elements: first, a set of actors (human and non-human) as identified and described by the interested parties themselves; second, a set of unresolved issues that the interested parties have expressed as relevant to the technology project.

In the case of historically finished technology projects sociological deconstruction is the process by which the researcher traces the development of a technology artifact through its potential manifestations and subsequent closure or stabilization into what Bijker calls a “socio-technical ensemble” (p. 49, 84). In my case I am dealing with an unfinished technology project, where attempts by interested parties to affect closure are referred to as *design propositions*. Design propositions emerge from problem formulations and represent attempts by interested parties to establish a specific socio-technical ensemble. It can thus be proposed that when several interested parties have different problem formulations a number of alternative design propositions will be put forward.

In Bijker's original method, the investigator begins with a finished artifact and works backward to provide a detailed account of the technology project from which it emerged. For a constructivist analysis it is critical that the account of the technology project is symmetrical, meaning that it includes both successes and failures and does not adopt an *a priori* evaluation of the capacity of human and non-human actors to influence action. In its original formulation, however, Bijker’s method presents an obvious problem for Constructive Technology Assessment because it is based on a deconstruction that requires an existing artifact as basic source material. For example, Bijker’s own work examines artifacts such as the safety bicycle and fluorescent lighting, both of which achieved closure several decades previous to his analysis. How then does one undertake a study situated in the conceptual design phase of a technology project, as CTA would have us do? In a CTA situation the investigator likely has no stabilized artifact as a starting point for analysis. Is it possible to use Bijker’s method if one *begins with unfinished technology projects*? We must be able to, for this is the means by which CTA proponents claim that it can support alternative trajectories of development. The question raises once again the problem of stakeholder representation.

Bijker has recognized “that no principally prioritized group can exist in society” when it comes to assessing technology projects and he accepts such a limitation, with the proviso that "this is not a matter of postmodern relativism but of recognizing that there will always be other actors who contribute to the construction of society and technology, actors that cannot be controlled" (p. 288-289). Given this pronouncement, how is the investigator to identify interested parties and know when all relevant social groups have been accounted for? Bijker himself suggests that the researcher ought to adopt a "snowball" approach to identifying relevant social groups. However, this approach has been criticized on the grounds that it "is inadequate for identifying unrecognized and missing participants, while its emphasis on groups overlooks social structures that might account for such absences" (Klein & Kleinman, 2002, p. 32).

In light of this critique of Bijker's method, we might examine social structures in which technology projects typically come to be articulated. Granted this does not guarantee that all social groups will be represented but it does provide a starting point for identifying a core set of interested parties at the conceptual stage of development. Even without a stabilized socio-technical ensemble at hand, a technology project will serve as the basis for Bijker's method provided the project is defined well enough to attract interested parties to a space/process of interaction. Here the investigator can look to existing structural loci for such spaces/processes of interaction. Examples of this include government-sponsored public forums, industry working groups, and regulatory hearings. Within these loci, the investigator can begin to seek out parties that have expressed interest or are likely to express interest in a technology project. Instances of this can be interpreted as *demand articulation* and this provides the basis on which to establish the grounds that a technology project does indeed exist (seeVan Den Ende et al., 1998, 11). While Bijker makes no mention of this concept, the notion of demand articulation does appear throughout the CTA literature and is used within this study.

Table 3: Steps in a Constructivist Analysis

Step	Objective
Demand articulation	Establish the existence of a technology project
Socio-technical mapping	Identify actors and issues using a thickly descriptive analysis of interactions
Layout of interventions	Evaluate the various strategies by which problem formulations are generated and translated into, and accepted (or rejected) as design propositions.

I have modified Bijker's method slightly in order to place demand articulation in advance of sociological deconstruction (or "socio-technical mapping"). This is a minor modification when dealing with unfinished technology projects as opposed to historical artifacts. Table 3 summarizes the steps in a constructivist analysis of a technology project. The first two steps of having now been discussed, the third step identifies various means by which interested parties come to be involved in a technology project. A theoretical account by which problem formulations are translated into design propositions serves as the basis for the "layout of interventions" (Van Den Ende et al., 1998, p. 9) I will use to structure my primary analysis. In the following section I provide an account of this step, which is adapted from Actor Network Theory.

Translating problem formulations into design propositions

Actor Network Theory (ANT) presents a model that helps us to understand how problem formulations are translated into design propositions. By understanding this process it is possible to establish a layout of intervention strategies that might be applied to influence the outcome of technology projects. From the perspective of ANT, a successful technology project is equated with a form of rhetorical achievement in the sense that it involves the successful alignment of human and non-human actors to create a stabilized socio-technical system. The process of achieving successful alignment involves *translating* problem formulations into a design proposition that then becomes a foundation for investment of resources among interested parties. CTA practitioners sometimes call this process "modulation" while ANT writers have described it as "enrolment" or "scripting" (Latour, 1995; Law, 1999). I suggest that it is a rhetorical process in view of recent work in design studies that has argued persuasively for a broad definition of rhetoric to include the design and development of technological artifacts.[15]

Concomitant with enrollment and translation, interested parties must acquire a *congruency* of interests, though not necessarily consensus on the meaning of a technology project (Leyten & Smits, 1996). To be effective, enrolment must then lead parties into commitments with one another to begin work on developing technology product or service. According to those

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[15] Buchanan (1987) has argued that design resides within the domain of invention and is thus properly associated with rhetoric as "the study of how products come to be as vehicles of argument and persuasion about the desirable qualities of private and public life" (p. 26). He presents a compelling case that claims "the pattern of rhetoric in twentieth-century design builds on distinctions which were established early in the formation of rhetorical theory and developed to meet changing circumstances" (p. 44). He then suggests that the investigation of design in theory and practice centers around four themes closely related to the traditional divisions of rhetoric: invention and communication, judgment and construction, decision making and strategic planning, evaluation and system integration (p. 45). Further study of Buchanan's work in this area could inform a more detailed study on how problem formulations are turned into effective design propositions.

who ascribe to Actor Network Theory, a successful *alignment* of interests is achieved when some form of inscription binds heterogeneous networks of human and non-human actors into a relatively obdurate system (Akrich, 1995). Akrich describes this process as one of "superposition" of user representations in the design-development phase of a technology. Success is judged by the quality of relations among actor networks:

> As … put forward in actor-network theory and shown for many cases, a new technological system will succeed only when it is able to attract a whole universe: a network of socio-technical relationships has to be put together, persuaded, and enlisted. In the final analysis, verifying the viability of the proposed combination of user representations entails determining if a system is able to relate harmoniously to appropriate networks, and ensuring that the various implications of the proposition are not conflicting and do not introduce intolerable stresses or constraints. (p. 177)

In this formula, "viability" is equated with a successful alignment of interests and is measured by a high degree of buy-in among interested parties when "various implications of the proposition" are examined in light of anticipated consequences. The inherent challenge to successful alignment in CTA is the expansion of conditions against which viability must be assessed, thereby extending the horizon of "implications" to include those not previously addressed in earlier forms of technology assessment. This horizon of implications is extended with the enrolment of new actors (human and non-human) into the design-development process. Viability, in other words, is a relative measure closely linked with the composition of stakeholders invited to participate in the design-development of a technology.

Successful alignment of interests is in some respects a quintessential moment of translation, or act of "purification" of diverse interests directed through a common point of consensus (Latour, 1997). For its achievement to occur, alignment depends on the creation of a congruent point of singularity that motivates and directs activity in the various actor networks (Bijker, 1995, p. 276). Latour refers to this process as *circulation through translation* (Latour, 1999), where interested parties come to view their interests and orient their actions through a specific technology project. In this case, the prime mover of any technology project may be compared to an autopoietic process that spawns second-order alignments among other actors and their associated networks (see, for instance, Luhmann, 1995).

Actor Network Theory offers a useful model because it suggests several discrete moments in the movement between demand articulation, problem formulation, and design proposition:

- First, the initial stage of enrolment, suggests a requirement for both a space and a process (means) of establishing legitimacy among interested parties.
- Second, congruency requires a means of establishing and maintaining a basic shared frame of meaning (not necessarily consensus) among interested parties with respect to a technology project.
- Third, successful alignment requires a vehicle (medium) of inscription; in other words, a means of firmly binding the actors together in commitment to a design proposition.

Operationalizing CTA through Actor Network Theory

Actor network theory provides an account of the design process that in turn suggests an applied analytic framework when combined with CTA. A simple example of this process in action is found in the creation of official standards for technical equipment or professional practice. The preliminary acceptance of the need for a standard is the principle step necessary to establish a fixed frame of reference for the circulation of interests among diverse actor networks. However, to achieve successful alignment around a specific standard, three key elements (as noted above) are necessary: a space or process of legitimacy for actors to come together, a means of establishing and maintaining a congruency on goal of the undertaking and the steps to be taken toward it, and a vehicle of inscription to lock parties into commitment with one another.

Similarly, making legitimate the interests of those with an interest in telecommunications infrastructure requires a space and/or process by which those interests can be expressed and pursued. Generally speaking, we can readily identify two kinds of spaces that provide for legitimization of interests: regulatory and voluntary forums. In terms of emergency telecommunications these can be further classified into government and industry directed forums. Government regulatory bodies such as the Canadian Radio-television and Telecommunications Commission (CRTC) or Industry Canada may provide a space of legitimization for the disaster management community. At present the CRTC, however, does not address disaster management concerns.[16] Industry Canada provides a number of Regional Emergency Telecommunications Committees (RETC) and a National Emergency Telecommunications Committee (NETC) but while otherwise relatively open, the RETC/NETC forums tend toward a limited constituency that does not include a wide-cross section of representatives from local community groups and organizations.

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[16] One minor exception is the CRTC's role in mandating 9-1-1 (telephone access to emergency services) for all competitive local exchange carriers. The CRTC has not otherwise considered telephone services in light of disaster management to any significant extent.

Industry-directed forums tend to be specialized in both constituency and focus. Some are exclusive to the telecommunications industry, such as the Canadian Telecommunications Emergency Preparedness Association (CTEPA). CTEPA membership includes most major national and regional telecom carriers in Canada and also includes representatives from the Federal government. Local or regional industry forums may not be exclusively focussed on telecommunications issues but provide an opportunity for a wider diversity of participants. Examples in Canada include the national Disaster Recovery Information Exchange (DRIE), a national forum that focuses primarily on business continuity planning, and the regionally-based Emergency Preparedness for Industry and Commerce Council (EPICC) which provides a forum for local organizations that is not primarily concerned with telecommunications issues.

Even from a cursory assessment, it has become evident that there is a significant gap between stakeholders in the telecom sector and those that make up the wider community of telecom users. In many respects this is simply because there is no single forum or combination of forums in which concerns and interests can be exchanged among a broad constituency of suppliers and users of telecom services. CTEPA addresses important details at the technical network level, while DRIE members speak from the user's point of view. Legitimacy of concern is usually dependent on recognition within each of these forums.

Beyond the problem of establishing a space/process of legitimacy the next concern is that of forming congruency around which to orient activities between interested parties. This is a particularly difficult problem insofar as CTA practitioners advocate an open and participatory design process. Practically speaking, this means bringing together engineers, local community emergency managers, telecom carriers, equipment vendors, government officials, and members of the general public to discuss ideas and concerns. Achieving congruency is challenged by the disparities in expertise, motivation, and vision that reside within such a diverse group of participants. Congruency is often formed around concerns such as public safety, expanded knowledge, or regulatory parity.

Finally, a vehicle of inscription is necessary to bind actors into commitment to each other. A number of methods are commonplace today within the telecommunications sector: regulations, standards, memoranda of understanding (MOU), and voluntary cooperation. While each method differs in its means of compliance, all have in common the provision of an inscribed point of consensus that serves as the basis for diversified action.

Creating an Intervention Matrix

If we apply these three conditions for technology development to three "generic intervention strategies" identified by CTA practitioners a matrix is created that presents a layout of interventions. CTA's intervention strategies are methods available to influence technological development in the early phase of design: (1) technology forcing, (2) strategic niche management, and (3) loci for reflexivity (Schot, 1998; Schot & Rip, 1996).

Technology forcing is a demand-side strategy where a social actor, often a government or regulatory agency, stipulates desired impacts and directs technology development toward those ends through regulations or other incentives (p. 258). Technology forcing is a strategy that places emphasis on a vehicle of inscription for binding actors into alignments that will better conform to certain policy objectives. A common example of this strategy is the introduction of "clean air" legislation designed to influence technology development in the automobile industry (i.e., to force the development of lower emission technologies).

Strategic niche management is a supply-side strategy where industry stakeholders orchestrate product development "through setting up a series of experimental settings (niches) in which actors learn about the design, user needs, cultural and political acceptance, and other aspects" (p. 261). Organizational learning is often emphasized with this strategy, with the objective of improved development processes and more precisely targeted technology products. This strategy places emphasis on generating congruency or shared frames of meaning among technology suppliers. An example of this strategy is the formation of a government-industry partnership to explore new market possibilities for an emerging technology project (e.g., alternative fuel systems).

Loci for reflexivity is a strategy that modulates interactions between supply and demand, attempting to "create and exploit *loci*: actual spaces, and institutionalized linkages" between actor networks. Temporary loci, such as consensus conferences or workshops provide one opportunity. Another approach is to create new loci or "regular nexuses" where productive linkages between interested parties can be forged. This strategy places emphasis on space/processes of legitimization as the means for achieving better actor network alignments.

Table 4 summarizes the basic intervention matrix. The shaded cells indicate the central driver behind to each strategy. Technology forcing, for example, turns on a vehicle of inscription, whereas Strategic Niche Management turns on congruency and Loci for reflexivity on a space/process of legitimacy. Within each cell of the table are examples of spaces/processes of legitimacy, forms of congruency, and vehicles of inscription.

Table 4: CTA Intervention Matrix

	Technology Forcing	Strategic Niche Management	Loci for reflexivity
Basis for legitimacy	Government legislation; policy; regulatory bodies.	Government research programs; private R&D investment and working groups.	Government or industry associations; public forums; congresses
Congruency	Public welfare	New markets	Improved business processes; knowledge sharing
Vehicle of Inscription	Regulations; technical standards	Partnerships and alliances; tax credits; direct government funding	Memoranda of understanding; non-disclosure agreements

While each strategy is unique unto itself, CTA practitioners advocate a pragmatic combination of all three in most cases. In this study, I will use the intervention matrix as a starting point for assessing the role and feasibility of various strategies used by interested parties to influence growth and change in the telecom infrastructure.

Summary

In this chapter I have examined Constructive Technology Assessment as a basis for this study, emphasizing the analytic rather than political or normative aspects of technology development. CTA is taken to be a new design practice based on process-oriented principles and a constructivist theory of technology dynamics. Bijker's "sociological deconstruction" provides a methodology for my case research and Actor Network Theory provides an account of the design process that suggests three operational requirements for successful technology projects: a vehicle of inscription, congruency, and a space/process of legitimacy. I combined these requirements with CTA's three generic intervention strategies of technology forcing, strategic niche management, and loci for reflexivity to produce a basic intervention matrix that will be used in the analysis of results obtained from my case study.

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Chapter 4: Growth and Change in a Telecommunications Network

> [As] for the telecommunication network, its role in the economy and society is a reflection of the minimum characteristics that are available to all those who would benefit from its use. (Mansell, 1993, p. 1)

Introduction

The previous chapter established this study as form of technology assessment founded on a constructivist theory of technology dynamics. In that chapter I introduced Constructive Technology Assessment, discussed its theoretical dimensions, developed a set of related concepts, and set out an analytic framework based on three conditions of actor network alignment cross-referenced with three intervention strategies. CTA practitioners claim that by intervening early in the design phase of a technology project, interested parties may become better able to achieve closer correspondence between technology development and societal values and aspirations. In light of the National Disaster Mitigation Strategy this suggests to me a strategy for building closer linkages between public policy objectives, community interests, and the ongoing design of Canada's critical communications infrastructure.

In this chapter I will begin by addressing an outstanding issue related to CTA and its application within this study, then I will proceed to situate the CTA intervention matrix within the general field of telecom policy and regulation. My objective in this chapter is to expand the analytic framework along a third dimension of interconnection space. Interconnection space is a key concept that will draw out a set of specific issues and permit me to apply the analytic framework to the focal point for this study—namely, the matter of growth and change in a telecommunications network. At this point in the study I will not address the Canadian context specifically but rather use this chapter as a stepping-stone to the case study and a basis for its focus and analysis.

To begin, however, I will deal briefly with two outstanding matters stemming from the constructivist approach as it is generally conceived in the literature. First, constructivist studies have tended to focus on technology in the form of historical studies of discrete artifacts, whereas I am undertaking a future-oriented study of a large technological system. Constructive Technology Assessment has taken up the problem of anticipatory technology research, as I detailed in the previous chapter. However, the fact that I am dealing with the relatively indeterminate future of a large system as opposed to a single artefact raises a second matter for consideration—that of circumscribing the object of study. Whereas technological artefacts represent relatively discrete objects, when dealing with large technical systems there is a problem of identifying suitable conditions for limiting the scope of research. With respect to this matter, I have turned to research on large technical systems (LTS) and network economics. The following section will describe some of the key features of technical networks and large technical systems, considering the problem of boundary conditions as it relates to telecommunications infrastructure.

The Dynamics of Large Technical Systems

The genesis of constructivist studies of large technical systems (LTS) is generally attributed to Hughes' seminal work on the development of electricity networks in Europe and America throughout the early part of the last century (Hughes, 1983; Hughes, 1987; Mayntz & Hughes, 1988). Hughes was interested in the process of LTS development and provides a widely lauded contribution to the history of technology. His work represents much more, however, as Hughes also contributes the first systematic analysis of LTS development, introducing key concepts and a systems-based evolutionary model that has since spawned a distinct field of technology research.

The Hughes' evolutionary model is based on an historical observation that "large, modern technological systems seem to evolve in accordance with a loosely defined pattern" that follows a series of phases: invention, development, innovation, transfer, and growth, competition, and consolidation (Hughes, 1987, p. 56). Hughes' cautions us that these are not strictly sequential phases but tend to overlap and backtrack; yet a pattern is often discernible "because of one or several of these activities predominating during the sequence of phases" (p. 57). The model is important because it establishes the baseline on which the wider field of LTS has been developed and against which I will consider the development of the Canadian telecommunications infrastructure. Hughes' model is typically associated with a triumvirate of science and technology studies that also includes Pinch and Bijker's SCOT and Callon, Law, and Latour's ANT (Cutcliffe, 2000, p. 30). Each phase of Hughes' model (see Table 5) exhibits certain characteristics, including a characteristic "system builder who is most active as a maker of critical decisions" (Hughes, p. 57).

Table 5: Hughes' Phase Model of LTS Development

Phase	System-builder
Invention	Inventor-entrepreneur
Development	Inventor-entrepreneur
Innovation	Manager-entrepreneur
Transfer	Manager-entrepreneur
Growth	Manager-entrepreneur
Competition and Consolidation	Financier-entrepreneur Consulting engineer

In one of the first subsequent collections of work in the field of large technical systems, Joerges (1988) reviewed Hughes' influence on the field, characterizing it as historical research that has introduced a systems perspective "linking technical apparatus to the engineering systems, and in turn these to manifold organizational, economic and political actors and structures" (p. 11). Joerges refers to Hughes' contribution as the "phase model" (p. 15) of system development, arguing that the pedigree of this model lies within the historical approach to technology studies and therefore may present challenges when it is applied to studies of contemporary technical systems. Following this line of argument, Joerges poses three related questions for consideration:

- Is the phase model compatible with evidence about the same systems when produced by disciplinary approaches other than history (e.g., political economy)?
- Can the model be generalized to the development of other types of LTS beyond the scope of Hughes' original study of electricity systems (e.g., transportation, communications)?
- Can the model be generalized to post-maturity stages in LTS development (e.g., expansion, upgrading, de-regulation)?

Joerges (p. 15) answers in the affirmative for the first question, with the proviso that technology remains the distinct object of study as opposed to it being a proxy through which to study other matters. In other words, he claims that the phase model can be used to make sense of technological systems using not only historical evidence but also data generated by other disciplinary approaches. On the second question, however, Joerges is of the view that empirical case evidence suggests Hughes' model may not be applicable to other LTS, especially "in the case of implantation of new subsystems in old, 'mature' LTS" (p. 15).[17] This is an important distinction to which I will return momentarily. The third question implicitly asks about the completeness of Hughes' model, which ends with the consolidation phase for LTS underpinned with his concept of *momentum* (see Hughes, 1987, p. 76). Curiously, Joerges does not appear to provide a direct response to this question. Nonetheless, we might clarify it somewhat in order to seek answers from others in the LTS field. As I interpret it, Joerges is asking if we can superimpose (i.e., "generalize") the phase model on latter periods of growth and change in an LTS once it begins to exhibit new developments to its previously mature stage. This question might also be restated in the obverse: what kinds of events in the latter, mature phase of LTS development might disrupt previously established stability and momentum, leading to renewed efforts at system building? And how might this subsequent round of system building compare with Hughes' phase model? These are relevant questions especially in light of advent of the Internet and various international efforts at telecom reform over the past decade.

More generally for this study, Hughes' phase model introduces two considerations with respect to telecommunications infrastructure: one, the notion of phase (or stage) of development and, two, the idea that we can expect to find predominant stakeholders, activities, and strategies associated with each phase. Phase of development is a temporal variable describing a qualitative state of an LTS at some point in its ongoing development, and in my case this refers to the current state of Canada's telecommunications infrastructure. Based on an assessment of historical developments and current activities in Canada, we should be able to establish its current phase of development within Hughes' model by identifying predominant systems-builders and activities.

Difficulties in Applying Hughes' Phase Model

For the purpose of this study the results of such an analysis, while perhaps interesting, are less important than the methodological problems it raises at the very outset. In attempting this historical positioning exercise, I am immediately faced with difficulties on at least three related fronts. First, I need to account for cases of uneven development within a large technical system. Second, I will need to establish boundaries of the Canadian telecommunications infrastructure.

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[17] For instance, embedding a communication control system within a large transportation system.

Third, I will need to account for the influence of new technology and other disruptive forces beyond the control of dominant systems-builders.

With respect to the first difficulty, can I realistically claim that a large technical system such as the public switched telephone network (PSTN) in Canada is at an equal stage of development across the country? With current growth and change are we witnessing a single, unified pattern of development in Canada's PSTN or do current events represent something more akin to a set of related but uneven developments across regionally related subsystems? On the one hand, I might view Canada's PSTN as a single large technical system itself undergoing significant holistic growth and change. On the other hand, I might argue that Canada's PSTN is in fact a mature LTS and that current developments simply represent modifications to its various sub-networks or components with little significance for a more widespread and essentially mature infrastructure.

Hughes' concept of "reverse salients" may be applicable here, while also serving as a bridge to the second challenge. Simply put, I can solve the problem of uneven development by conceptualizing less developed parts of a telecommunications network as reverse salients, which Joerges (following Hughes original formulation) defines as "technical or organizational anomalies resulting from uneven elaboration or evolution of a system" (Joerges, 1988, p. 13). By adopting this approach, Canada's PSTN can be analyzed as a single large technical system with an advancing front in certain areas but with less developed areas conceptualized as reverse salients.

While the notion of reverse salients may solve the problem of uneven development, I must then proceed to the second (and related) challenge of establishing boundaries for my analysis. For instance, what constitutes the Canadian telecommunications infrastructure? Is it a single LTS, a composite of several national competing carriers, several regionally operating carriers, or a set of functionally distinct but physically connected networks (e.g., voice versus data)? Or, for that matter, is it more accurately defined as a subsystem within a North American or global telecommunications LTS? It seems that how I choose to define the boundaries of an LTS may have an influence on the phase of development at which I would then characterize that system. The problem is not a glass-bead game but a real methodological concern simply because the Canadian public telecommunications infrastructure is not a single homogenous system but a complicated network of networks at various stages of development across the country. In order to undertake a study of its growth and change, I am therefore obliged to specify its nature and extent as an LTS, accepting that such specification will determine in part the phase of development at which we may say the telecommunications infrastructure has reached.

A third challenge to Hughes' phase model comes from its tendency toward endowing systems-builders with considerable influence over the development of large technical systems. Some have criticized the model for romanticizing the notion of entrepreneurship and overlooking structural and outside influences on system development. These critics have raised the question as to how we might conceptualize disruptive external forces and structural influences, particularly with respect to contemporary developments that build on pre-existing LTS such as the Internet does on the telecommunications infrastructure. Werle (1998), for example, argues that Hughes' model confronts recent developments in LTS, which appear to indicate a re-configuration or "even decline" of these systems resulting from outside influences. Some characteristic changes that Werle cites include a shift from monopoly to competitive structures; a movement from centralized to de-centralized control of system elements; and a shift from tight coupling of system elements to looser federations of organizations and elements. In effect, he argues that Hughes' model may have difficulty in accounting for the current complexity of influences on developments in contemporary LTS such as telecommunications.

To illustrate his point, Werle characterizes Hughes' model as one based on a more or less hierarchical view of development based on governing power of systems-builders. This view, according to Werle, blinds analysis to a richer understanding of the multifaceted influences that shape growth and change in contemporary LTS. He claims "Looking at the development of technical networks from the angle of governance forms suggests *a one-way relation* between [system-builders] and technology" [emph. added]. "Co-evolution," he claims, is a more accurate conceptualization in that it takes into account the reciprocal influence(s) of path dependency and other variables as shaping the development of LTS.

Werle supplies evidence of such co-evolutionary dynamics in his account of the growth of the Internet, where he seeks to demonstrate how the hierarchical governance structure of the monopoly-era telco regime drove the growth of proprietary data networks in the 1970s and 1980s. The increasingly fragmented range of data networks in turn drove the development of TCP/IP and other "bearer services" in an effort toward integration. Today, the success of TCP/IP has resulted in the explosive growth of the Internet and other data-based telecom services, setting off new debates about appropriate governance structures and provoking significant changes in policy and regulation (see, for instance, Mindel & Sirbu, 2000).

In some respects the regime of monopoly-era telecom resembled Hughes' hierarchical model, with systems-builders—in this case the telco monopolies and their vertical control over equipment and services—at the top of the pyramid acting as key influences on the development of large technical systems. Yet, as Werle illustrates, this form of governance created a situation in which independent developers of data networks were excluded from interconnecting with the telcos' infrastructure, ensuring that voice and data "would [not] be integrated into one encompassing network." As a result, these competing independent firms found themselves in a world of increasingly proprietary and fragmented data networks. In time this forced the development of new technologies and services that provided a "soft" integration of proprietary networks through protocols like TCP/IP, which in turn drove an increased demand for new data services. Soon the monopoly telcos found themselves confronted by forces that had evolved beyond their control and they could no longer ignore data services.

Werle's critique offers an insightful example of a reversal, where an existing regime of control provokes outside developments that later come back to challenge (and bring down) that same regime structure. His point is that contemporary developments in the telecom sector must be appreciated as a product of co-evolving forces and not under the sheer willpower of systems-builders, as Hughes' model might lead us to believe. I should add that Werle's point also applies to the case of mobile telecommunications and location-based services, which have thrown Canada's regulatory regime into new light, as we will see later with the case of Wireless E911 in Canada. In sum, Werle's critique tells us that the evolution of a large technical system is a complex co-evolutionary process that Hughes' model may oversimplify.

Defining a Large Technical System

Given the challenges I have just outlined, how is it possible to delimit and effectively analyze a rapidly changing technical system such as the public switched telephone network (PSTN)? What in fact *is* a large technical system? In his attempt to define an LTS as an object of study, Joerges (p. 21) offers three approaches, each of which I contend is rather problematic when applied to telecommunications. First he says we might look at the size of the organizations that make up a particular LTS. A *large* technical system is one that *large* corporations control. On these terms, the Canadian PSTN might be considered several interconnected systems operated by a number of large regional carriers (e.g., TELUS, Bell, Aliant, etc.). Using this definition also creates the problem of considering dominant equipment suppliers and their role with respect to a technical system. For instance, should we include wireless local area networks (Wireless LANs) within our LTS definition if they assembled with equipment manufactured by large firms? While we might have an economic or supply chain connection in this case it seems odd to classify a wireless LAN as a *large* technical system.

A second approach to defining an LTS, according to Joerges, might focus on the "externalities" produced by or under the influence of a technical system. Here the emphasis is on social or ecological effects of the system, where *large* is often equated with *high risk* as in the case of an LTS that produces and distributes nuclear energy. This approach suggests extending or perhaps erasing the boundaries of the technical system itself and integrating it into a wider social and ecological web of effects and interdependencies.

The problem with both approaches, notes Joerges (p. 22), is the confusion or blurring of systems with their operating environments. Analytically these two approaches lose sight of those "features of large-scale technical systems which should be kept separate [from their environment] in order to explain their [unique] dynamics" (p. 22). This is an important consideration because I am specifically interested in the process of infrastructure evolution and do not want to be distracted by *unnecessary* contextual analysis.[18] In response, Joerges advises that we maintain "close(r) reference to the scale of the technical core—both materially and otherwise—of LTS [to] give room to inquiries about the conditions and consequences of LTS' momentum" (p. 22). In other words, if we do not distinguish between a large technical system and those forces that support it or are impacted by it we reduce our ability to analytically distinguish those attributes explainable by the significant properties of the system itself.

Joerges (p. 23) therefore proposes a third approach that combines elements of the first two and provides for the "preliminary delineation" of a large technical system in view of the fact that he claims a more systematic, empirically-grounded definition is still wanting. His definition begins from an engineering standpoint, identifying technical systems with "...systems of machineries and freestanding structures performing, more or less reliably and predictably, complex standardized operations by virtue of being integrated with other social processes, governed and legitimated by formal, knowledge-intensive, impersonal rationalities" (p. 24). He refers to this as a "formal rationality" that captures the essence of a technical system (p. 19) and advises that we might then draw the measure of scale (large or small) based on the quantity of activities "materialized in such systems" as well as the scale of other social processes (e.g.,

[18] Although I do want to ensure that contextual analysis is taken into account when it is relevant to understanding infrastructure evolution. Making this determination is part of the problem I am working out in this section.

financing, regulation, etc.) necessitated by these activities in order for the system to function (p. 24). First we have a technical system based on "formal rationality," then it is defined as big on quantitative terms. Of course this formulation is equally unsatisfactory because it leaves us with the problem of making arbitrary distinctions between small, medium, and large. It also leaves the boundary problem unresolved. Joerges acknowledges these difficulties, noting that ultimately such an approach requires an empirical knowledge of engineering and, admittedly, "much preliminary and arbitrary classification of qualitatively different technical systems." (p. 24). Yet, he claims this approach provides some guidelines to distinguish certain types of technical systems that "can be singled out as indisputably large" (p. 24), such as

- Those that are materially integrated or "coupled" over large spans of space and time.
- Those that provide support for the functioning of very large numbers of other technical systems, "whose organizations they thereby link."

Based on these two characteristics, typical large technical systems according to Joerges (p. 24-25) would include integrated transport systems, telecom systems, water supply systems, and some energy systems. While some appliances may be connected to one or more systems (e.g., a washing machine connects with the hydro grid and municipal water systems), they do not "qualify" as large technical systems. It seems that we may have a potential boundary condition drawn on a distinction between a core network and the terminal equipment that is attached to it. Yet, as Joerges himself admits, this kind of boundary setting becomes especially fuzzy when we think about connecting devices to a communications network, such as a personal computer, a PBX, or for that matter, a wireless local loop. Does a peripheral device, or sub-network, become part of the LTS when it is connected to others by a communications link? Is a communications link qualitatively different from other material couplings like that of water or electricity? According to Joerges (p. 25) it is, which means that the type of coupling used to define a large technical system is a significant consideration when setting boundaries; however, nowhere in the LTS literature does this concept appear to be further elaborated. In consequence, and en-route to solving my boundary-setting problem, I turned to the field of network economics to examine the notion of "network externalities" for its relevance to coupling to consider how it might better account for differences between communication systems and other types of large technical systems.

Boundary Setting: Network Externalities and Complementarity

The field of network economics provides a useful distinction between standalone artefacts and networks that further clarifies the notion of coupling as it applies to Joerges' definition of a large technical system. Shy (2001) has observed that many goods can be consumed alone but some goods must be consumed in conjunction with other products or services. A loaf of bread, for example, can be "consumed" by itself even though a wide range of support systems is required to get it to your dinner table. A computer or CD player, however, requires a body of software to provide it with value in the marketplace. Similarly, a telecommunications network requires voice or data connections to provide it with value. In fact, the more potential connections available the more the service is valued by its users. This is the notion of *network externalities* and marks a qualitative difference between technical artifacts and certain kinds of technical systems. Moreover, though, it establishes a qualitative difference between the large technical systems that support washing machines and those that support networked PCs or telephones.[19]

Network externalities are achieved through *complementarity*, which is a concept also found in the network economics literature (Shy, p. 2) and, as it turns out, is closely related to Joerges' claim that large technical systems are "materially integrated … over large spans of space and time." In order to produce network externalities, each of the nodes and links in a technical system must operate together to provide efficient connections between the various end-points. Complementarity describes this arrangement and is taken to be a function of two related operations—one technical, the other social. The first of these operations is *compatibility*, which refers to coordination of design specifications based on mutually accepted standards. Compatibility, or "interoperability" as it is sometimes called, is the technical dimension of coupling needed to achieve network externalities. The second operation is *interconnection*, which refers to the regulatory, business, or other arrangements needed to achieve a flow of services across a network. Interconnection requires compatibility as a prerequisite and provides the social dimension of integration needed to achieve network externalities.

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[19] While the *cost* of some services such as electricity or water supply may drop in proportion to the number of users of the system, the functional value of the service to each customer does not necessarily improve and may in fact decrease with loading. With communications networks, however, larger numbers of connections means an increase in the functional value of the network because more potential points of contact are made available to all customers simultaneously.

According to one of the leading scholars in the field, the “crucial relationship” in network economics is the compatibility of components, which tends to be grounded in technical standards as the vehicle of inscription:

> ... for many complex products, actual complementarity can be achieved only through the adherence to specific technical compatibility standards. Thus, many providers of network or vertically-related goods have the option of making their products partially or fully incompatible with components produced by other firms. This can be done through the creation of proprietary designs or the outright exclusion or refusal to interconnect with some firms. (Economides, 1996, p. 4)

In conjunction with the fundamental importance of compatibility at the technical level, the ongoing process of telecom reform around the world has also provoked an intense interest in the socioeconomic dimension of interconnection. This interest has inspired a number of studies into growth and change in telecommunications networks that examine compatibility as a strategic socio-economic matter. Among these, several approach compatibility from within the LTS framework (see articles in Mayntz & Hughes, 1988; Summerton, 1994a). Other studies have explicitly identified with design as a political economic force behind interconnection arrangements (Mansell, 1993; Mansell & Silverstone, 1996). Connecting these various studies is a similar concern among contemporary telecom regulators and flagged in the network economics literature:

> In a network where complementarity as well as substitute links are owned by different firms, the questions of interconnection, compatibility, interoperability, and coordination of quality of services become of paramount importance. (Economides, 1996, p. 6)

Indeed, this statement has been borne out by historical developments in the telecom reform process underway in Canada and around much of the world, as regulators wrestle with difficult issues raised in the process of liberalizing markets.

International telecom reform initiatives ongoing today suggest that modern telecommunications systems may have indeed entered a new phase of development. Drawing on Hughes’ model it is reasonable to argue that many of these systems achieved a mature phase in the development of analog technology under monopoly regimes. General consensus in the literature on telecom reform points to the advent of digital technologies, convergence, and a concomitant push on several fronts from business users, computer industry, and regional economic development organizations alike as part of a co-evolving impetus to liberalize entry and promote innovation and greater efficiency in telecommunications systems around the world

(Davies, 1994; Melody, 1999; Winseck, 1998). Together these forces have encouraged Canadian regulators and policymakers to shift away from direct intervention and toward a greater emphasis on what I will call *complementarity oversight* in the ongoing evolution of Canada's telecommunications infrastructure (Doern, 1998).

With this understanding of complementarity as a key feature of large communication systems I will now propose a means to resolve the boundary-setting problem for this study. If communication networks are a unique form of LTS because of network externalities then the functional boundary of a telecom system is linked to complementarity, in both its technical and social dimensions. Where complementarity ends so does the network. I therefore submit that the Canadian PSTN is logically bounded by the extent (potential or actual) to which complementarity can be influenced and enforced by a recognized authority in Canada. In effect, this implies two levels for consideration: one, the extent to which Canadian authorities can exercise influence over technical compatibility and, two, the extent to which Canadian authorities can exercise influence over socio-economic matters of interconnection. Of note here is that the boundary of the Canadian telecom system is not necessarily at the physical edges of the system (where we might typically understand a boundary to be) but rather in the extent of control over complementarity that enables a large technical system to produce network externalities. The boundary conditions of the Canadian PSTN are therefore in many respects political boundaries stemming from jurisdictional influence over the design of the infrastructure.

Complementarity and the Evolution of Telecom Infrastructure

Network externalities are a unique feature of telecommunications systems, providing value to users of these systems by providing symmetrical access to other users of the system. Complementarity, in both technical and social dimensions, is necessary to achieve network externalities. While network economists use the term complementarity, those writing about telecom reform tend to use the term “interconnection” to embody the same idea. To respect convention in the field of telecom policy research, I will use the term interconnection where it is found with the same essential meaning as complementarity in the literature.

Interconnection is regarded by telecom analysts as the fundamental enabler of the future “network of networks” (Noam, 2001) or the “cornerstone of competition” as Melody (1997, p. 53) has put it:

> Interconnection is fundamentally important because the telecom system must function as a single system. Users desire end-to-end services within an

> apparently ‘seamless’ communication network. They want connectedness and connectability. They do not usually care who own what facilities in the overall system, or how the communication links are established. As traditional telecom networks have grown from national to global dimensions and have been expanded to include competitive suppliers and new services, interconnection has become the key to defining the limits of telecom service networks and the structure of competition that can prevail in supplying them.

Interconnection has thus served historically as a regulatory instrument directly linked to telecom policy objectives, as both Melody and Noam have argued. Noam (2001, p. 257), for instance, writes of three phases of interconnection policy that have guided the history of telecom development for much of the past century. Interconnection policy has undergone significant changes in three phases as political and economic interests shifted from “pro-incumbent” to “pro-competition” to “market control” strategies. The first phase was dominant in the previous era of regulated or state-owned monopoly telecommunications where interconnection to the network infrastructure was highly restricted and open to only a few privileged operators and suppliers. In the second phase, interconnection policy was aimed at prying open these networks to permit competitive entrants, while in the third phase it has focussed on actively promoting competition by facilitating innovation and entry through favourable interconnection arrangements. But what exactly is interconnection and what role does it play in the design of telecom network infrastructure? What force does it hold as a regulatory instrument to influence the development of telecom networks?

Arnbak’s Functional Systems Model

The emphasis on the importance of interconnection as a regulatory instrument is evident in the telecom policy literature by Arnbak (1997, p. 68), who shares a view with those in the LTS field that public policy initiatives cannot afford to ignore “the empirical evidence of modern [information and communication technology] as a radical and permanent change agent inside telecom—and in the society to be served by telecom”. Working from within a policy and regulatory standpoint, Arnbak (p. 75) offers an analytic “functional systems model” to differentiate between various forms of interconnection arrangements. The model is based loosely on the Open System Interconnection (OSI) reference model, which was originally created to provide a standardized basis on which to design layered communication systems. Arnbak's model consists of four layers arranged hierarchically from predominantly physical systems based on hardware elements to more logical systems based on software elements. The primary layer is that of “ physical infrastructure,” which includes the provision of transmission capacity and basic physical interfaces. The second layer is that of “network services,” which includes the provision of routing and gateway services. At the third layer is “value-added services” that provide access to information content. Finally, at the fourth layer is “information services” where content is created and supplied as a market good (p. 76). Table 6 summarizes Arnbak’s Functional Systems Model.

Table 6: Arnbak’s Functional Systems Model

Layer 4	Information Services
Layer 3	Value-added Service
Layer 2	Network Services
Layer 1	Physical Infrastructure

A simple example of Arnbak’s functional systems model in action is the hypothetical delivery of a weather bulletin to a mobile phone through short message service (SMS). A combination of wireline and wireless infrastructure (layer one) must enable end-to-end connectivity between a content provider and a handheld wireless device; network services (layer two) then enable the correct routing (and perhaps billing) for the data from the content provider's network, perhaps through a series of gateways, on to an intermediary public network and eventually to the appropriate wireless service provider and the correct cell-site location (i.e., the “local loop”) for radio transmission to the wireless terminal that has requested the information.

In this scenario a variety of suppliers is required to support this simple service. At layer one, a physical infrastructure operator is required to provide end-to-end connectivity. In some cases where large distances or organizational boundaries are crossed, several layer one operators may be involved in the physical delivery of the data through routers and other software elements (layer two). The wireless carrier, or perhaps a third party service provider, must operate an SMS portal (layer three) that enables access to weather bulletins for its customers by creating a special user profile account. Finally, a content provider (e.g., Environment Canada) must supply weather data either in a raw or customized form (layer four). All the layers must be interconnected in order to affect a telecommunications service.

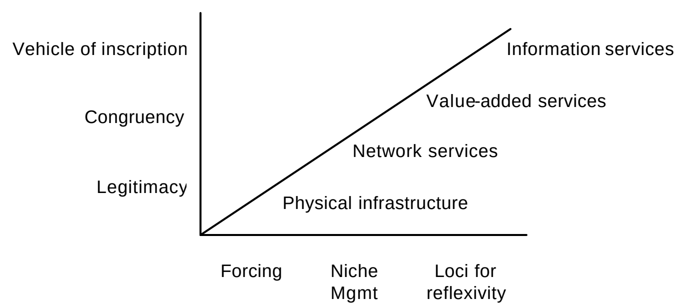
Interconnection Space

Undertaking policy and regulatory analysis under these conditions can be extremely complicated, as numerous stakeholders may be involved at one or more layers of the functional model. Moreover, some of these functions may be regulated (e.g., physical transport) while others remain unregulated (e.g., content provision). Arnbak thus draws on his functional systems model to introduce the concept of "interconnection space" as a way of modeling a multidimensional competitive domain of contemporary telecommunications networks. He claims it is a useful framework for charting the alternative paths of interconnection between layers when undertaking analysis of design options for telecommunications services:

> The policy issues facing a regulator are to decide to what extent the costs and benefits of a particular path through the interconnection space can be discovered—and allocated—by a free market, or if regulations are required to enforce desirable interconnection paths. (p. 79)

Interconnection space provides a third axis and a further operational dimension to the CTA layout of interventions developed in the previous chapter. Figure 6 depicts this three-dimensional version of the intervention matrix.

Figure 6: CTA intervention matrix with interconnection space



Trends and Developments in Telecom Reform

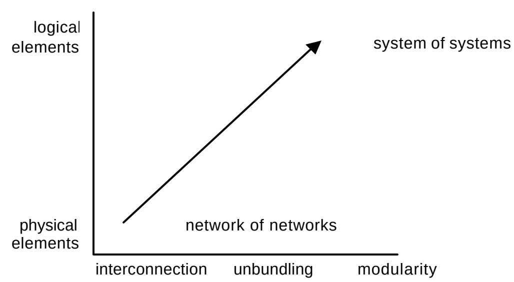
The next step in adapting Arnbak's interconnection space to this study is to examine it in light of contemporary trends/developments and related policy issues. Melody's (1997, p. 58-60) discussion of interconnection is helpful in this regard, as he makes an important observation on developments in competitive interconnection and provides a set of general issues for our attention. To begin, Melody has observed that interconnection can be of two essential types: at the end of a network or at the point between networks. In other words, we should distinguish between interconnection at the periphery or at the core of a network infrastructure. He notes further that in telecommunications history, competition has tended to first emerge at the periphery of the network with the deregulation of customer premises equipment and has gradually moved toward the core elements, with liberalization of transmission and switching markets. This means that interconnection issues have also tended to parallel this inward migration. Furthermore, Melody predicts that "the more significant interconnection issues for the longer term relate to VAS [value-added services], resale and network management" because opportunities in these markets "are essential to unleashing the new services … that will provide a foundation for the development of [future] information societies" (p. 62). Combining Melody's two observations leads to the proposition that telecom reform in the wide view of things is moving inward toward the core of the network while simultaneously upward along Arnbak's functional systems model (toward layer four concerns), where competitive interests come to supply value-added and information services over lower-layer facilities.

In addition to contributing these observations about contemporary developments in telecom reform, Melody (p. 59-60) also lists four "substantive issues" that tend to surface in conjunction with negotiations around interconnection arrangements. The first is the technical matter of standardization and interoperability that Melody claims is relatively easy to solve, although I will demonstrate that this may remain a critical point of intervention in network evolution. Second is the issue of defining terms and conditions for services that interconnection will support. Third is the competitive issue of access to markets and services, which includes establishing points of interconnection, levels and grades of service, and prices. Finally, the fourth substantive issue is that of regulation and the incorporation of broad social and economic policy into interconnection negotiations. Traditional examples here include universal service provisions, information society objectives, privacy and security. In this study I am exploring the case for exploring disaster mitigation within interconnection arrangements.

Noam (2001), who has written extensively on interconnection in the context of telecom reform, writes of three phases of telecom reform that involve a gradual evolution of interconnection paradigms. In the so-called pro-incumbent phase, Noam notes that networks were tightly integrated in vertical structures under limited control but that telecom reform and market-oriented interconnection policies have since permitted horizontal linkages. These new linkages have increased emphasis on interconnection arrangements between competitors to support peer-to-peer network services. Following this first phase of reform, new demands for competitive interconnection then encouraged the unbundling of network and service elements to support competitive access requirements. Later, this process of unbundling is expected to yield to what Noam has termed "modularity" of network design where "service providers connect several modules together, or replace some network modules and interact with others" (p. 249).

Noam's "modularity model" posits a trend with significance for emergency telecommunications; namely, the emergence of third party value-added service organizations or "system integrators" that seek out and combine physical and logical network elements to create customized telecom packages for clients. This scenario is predicated on two developments that Noam (p. 251) believes characterize the current evolutionary direction of telecommunications network design. The first of these is a shift away from physical, or hardware defined, network elements to more logical, or software-defined, network elements. The second reflects the gradual movement away from simple interconnection of networks to services based on a modularity paradigm that is expected to coincide with the mature phase of telecom reform. In summarizing these trends, Noam writes of a fundamental shift away from "network of networks" to more modular designs based on "system of systems." Figure 7 depicts my interpretation of Noam's model of network evolution.

Figure 7: Noam's model of network evolution



The implication of this trend is that competitive interests will move to higher levels and toward value-added service layers in the form of software defined network elements. Noam claims that traditional carriers will then enter "uncharted waters" as other service providers' expertise—such as those in the data networking field—becomes increasingly prevalent in the telecom sector (Noam, 2001, p. 252). Accordingly, it also suggests to Noam (p. 252) that corporate re-organization will tend to occur along lines of service provisioning that will lead to further competition in the upper layers of the telecom service chain.

Noam looks askance at the regulator's role in the future of network evolution, which may account for his failure to note that certain network elements will require special treatment to ensure that public policy objectives can be accommodated as Melody and other have noted. Among those that have advocated the need for regulatory oversight in interconnection matters is Mansell who has considered the interests of parties who might seek to maintain or establish strategic control over core network elements in a future system of systems. Similarly, Hawkins has considered these interests in the context of technical standards and their influence on network evolution at the core versus periphery. Both Mansell and Hawkins, discussed forthwith, serve to add some counter-balance to Noam's views and suggest an important need for continued regulatory action to ensure that important social policy objectives will be addressed within a competitive telecom sector.

Technology Forcing and Technical Standards

Hawkins (1997, p. 200) argues that advocates for telecom reform have adopted a philosophy that promotes competition in equipment and service markets, yet raises questions about desirable R&D structures, technical standards, and the role of the regulator vis-à-vis technology design. In particular, as deregulation has led to an increase in the range and complexity of standardization efforts, the direct involvement of national regulatory agencies in standards development is now more limited in scope than ever before. Despite this situation, Hawkins contends that there remains a need to ensure "standards are produced and implemented in a way that is compatible with regulatory objectives as set out in national policy" (p. 200). An important question for Hawkins (p. 201) and relevant to my study is thus: how should regulatory agencies interact with the standards-making process to ensure that telecom networks will evolve along lines that conform to national policy objectives?

In addressing this question, Hawkins explores the contemporary notion of standards development and its changing meaning in the telecom sector, as it shifts from tactical matters of technical interoperability to become a strategic influence on market positioning. In most basic terms, technical standards represent the compatibility dimension of interconnection and are therefore an important means by which the wider development of network infrastructure can be influenced. Standards represent "a consensus of views in the industry concerning the kinds of technical issues that should be approached and resolved in a common way, and the technical solutions that should be adopted" (p. 198). Hawkins (p. 204) claims that the opening of the equipment market through telecom reform has resulted in a burgeoning need for standardization that has, in turn, created "problems of standards planning, evaluation and coordination".

One important development in standardization since the advent of telecom reform is a shift toward strategic development of standards along a business-interests dimension rather than a predominantly technical dimension. Hawkins (p. 201) identifies five "key types of standardization rationale" that are active within a competitive telecom sector: variety reduction, harmonization, intelligence, design, market positioning. Whereas variety reduction and harmonization are largely matters of technical interoperability, the latter three rationales are more closely aligned with strategic business activities intended to better position equipment and service suppliers in a highly dynamic marketplace. Industry players may seek to participate in standards development to gain valuable intelligence on trends and issues, influence "pre-competitive" technologies in the early stage of development, or to directly link their marketing and R&D activities with standards development to improve market positioning with respect to new technologies and services (p. 204).

Along with the expanding range of rationales for industry to participate in standards making, is an expanded rationale for regulatory involvement through monitoring or direct intervention. At the tactical, technical levels regulatory involvement is based on the need to ensure equitable access for those wishing to access network services at both the periphery and core nodes—rationales of variety reduction and harmonization. Moving to the strategic rationales for influencing standards development, regulatory involvement is often justified by a need to control market power of incumbents and other large players. At the very highest level of influence, Hawkins (p. 205) suggests that regulatory oversight is needed to ensure that standardization, within the wider context of infrastructure development, meets with national policy objectives.

Such a wide range of rationale requires that instruments of technical regulation must be appropriate to the context of regulation. Hawkins (p. 205) notes, for instance, that technical regulation in contemporary telecom context is classified into three primary methods: voluntary standards (proprietary and open), "virtually mandatory" standards that are *de facto* employed in a market, and mandatory standards set by a regulatory agency. When considering these three instruments, however, Hawkins (p. 206) points out that regulatory agencies must balance their need to influence certain aspects of network evolution, especially those regarding broad general policy objectives, without imposing undue constraints on standards-development that might counteract incentives to innovate and efficiency gains.

At the heart of this matter is this tension between voluntary and mandatory instruments. Typically, voluntary instruments are preferred in the telecom industry under the rationale that industry knows its business best and is motivated to work toward optimization of results. Under these conditions Hawkins (p. 198) points out that optimal results are not guaranteed and could very well lead to problematic path dependencies as dominant stakeholders seek to preserve competitive advantage in the market through proprietary designs. Without regulatory incentive, moreover, uncertainty in the standardization process can result in delays in their development and pose subsequent barriers to investment and innovation in network infrastructure. For regulatory agencies this tension amounts to a need to balance between direct involvement and arms-length oversight in standards development. Hawkins (p. 204) notes, however, that with the emerging complexity in telecom technology any form of broad scale influence is likely confined to a few international equipment manufacturers, vendors, and service providers. For Canada this suggests that domestic influence over standards-development may be seriously constrained by trends in the international setting, and especially those set by the United States. This is clearly evident in the Wireless E911 case, as we shall see, where American organizations have set the research agenda and have predefined certain technical standards available for application in Canada.

In effect, standards development is a form of technology forcing that can be imposed by industry on itself, by a large supplier through its overwhelming influence on a market (*de facto*), by a regulatory agency, or by some combination of these influences. As previously described, technology forcing is a CTA strategy that turns on a vehicle of inscription—one of which can be a technical standard. In fact, as Hawkins points out, in the realm of technical regulation, standards are a means of inscribing acceptable terms and conditions on technology design.

Hawkins also observes that the impetus for technical standards ranges from relatively narrow efforts to ensure interoperability, through much wider efforts at influencing markets for new technology and supporting corporate R&D initiatives. We should therefore not assume technology forcing to be a simple matter of ensuring technical interoperability among suppliers but rather as a multifaceted strategy that may be implemented at one or more layers of the interconnection space. In some cases these might be more or less toward physical infrastructure, as with Industry Canada's Terminal Attachment Program to ensure customers premises equipment (CPE) for sale in Canada is interoperable with telecom networks (Industry Canada, 2002). Or, in other cases, technology forcing may be applied at the value added service layer to promote innovation and support broader social and economic policy initiatives, as with the CRTC's requirement for certain regulated carriers to provide an "enhanced" 9-1-1 emergency service to their customers (Canada. Canadian Radio-television and Telecommunications Commission, 1997, par. 286).[20]

Given the contending forces between mandatory and voluntary standards in light of the continuing importance of regulatory oversight, Hawkins suggests that regulatory agencies should aim their efforts at "keystone standardization initiatives that have implications for those broad

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[20] This requirement will be discussed in the Wireless E9-1-1 case study.

areas of technological development that relate directly to specific policy goals for the national telecom system" (p. 206). It is here that Hawkins sees an appropriate point of interaction for regulatory bodies that strikes a balance between oversight and flexibility in standards making, suggesting further questions about wider stakeholder participation in the standardization process.

Expanded Stakeholder Involvement in Standards Making

I have now argued that technology forcing is a CTA strategy that draws on standards as one instrument by which it can influence path dependency. Yet in the case of standards making it is a complex strategy that may be enacted in one or more layers of the interconnection space. Moreover, CTA's emphasis on reflexive learning among stakeholders further complicates the strategy of technology forcing by pressing for the inclusion of a wider constituency of participants in the standards-setting process, thereby opening up the further problem of expanded stakeholder involvement in standardization.

Hawkins (1995) has also explored the question of user involvement in standards-making, drawing on empirical research into the development of European standards for digital wireless telephony for evidence. In his view, technical standards represent an important opportunity for including a wider constituency in shaping network design, particularly in the context of telecom reform:

> Standardization is becoming a crucial node through which the technical design of network services will be self-regulated with the industry. ... the standardization phase is the only open point of access at which users can inject their collective needs and perspectives into the process of network and service design such that they might actually influence its outcome. (p. 34)

Despite this opportunity, Hawkins (p. 23) identifies a number of conceptual difficulties to realizing user participation in standards-making process. First among these is an analytical problem of sorting out suppliers from users in a competitive telecom market, especially where third party service providers and nested systems may be prevalent. To address this difficulty Hawkins (p. 24) establishes a distinction between *end-users* and *intermediate users*, based on the distinction that intermediaries extend the functionality of the basic public network facilities, while end-users are typically a point of termination that adopts one or more service profiles provided by a carrier.

The related notion of a "user group" is equally difficult to establish given the fractious nature of the telecommunications user community that includes large and small enterprises, public institutions, and private subscribers. Hawkins (p. 25) thus defines the user group as a collective set of entities whose interests are represented in institutional structures separate from those of telecommunications service and equipment suppliers. One example in the field of emergency telecommunications could be the distinction between CTEPA and DRIE or EPICC.[21] The former group represents the telecom industry while the latter two groups represent the wider business community that uses telecom services. DRIE and EPICC would therefore fall within Hawkins' definition of user groups and CTEPA would represent the supplier community.

Having established these distinctions, Hawkins then describes some of the major obstacles to user participation in standards making. Among these he has observed that a fragmented user community and different problem formulations among suppliers and user groups rank highest in most cases (p. 28). According to his findings, suppliers tend toward a focus on upstream standards processes at the network core, while user groups concern themselves with downstream standards such as services and terms of network access. Even with this simple division of interests between users and suppliers, there is often little by way of a unified front within the user community. This may lead to further fragmentation in the user community, splitting resources and creating impediments for participation in standards-making fora. The fragmentation problem, according to Hawkins (p. 28), stems from a number of sources including the lack of intra-community communication, antagonistic and unresolved issues among users, and the general inability to support participation across the required range of contemporary standards proceedings. As a result of these obstacles, standards making remains a typically supplier-led process "without much active reference to service requirements as perceived by the users" (p. 33).

Given the obstacles of fragmentation within the user community as well as its adversarial relations with suppliers, Hawkins notes two risks associated when wider stakeholder involvement does occur in standardization. The first is capture by the suppliers where user groups become little more than puppets to help promulgate standards in the market. The second risk is that of simply being ignored by the supplier community, leading to further alienation and wasted time and effort among user groups. And while subsidies might increase the presence of user groups in standards-making, Hawkins (p. 35) points out that it does not guarantee that the input of additional stakeholders will be coherently formed or taken into account during the standardization process.

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[21] CTEPA (Canadian Telecommunications Emergency Preparedness Association); DRIE (Disaster Recovery Information Exchange); EPICC (Emergency Preparedness for Industry and Commerce Council).

Hawkins (p. 35) offers two "plausible" alternatives to facilitate closer involvement of user community in standards making. First he suggests the notion of an "honest broker", or third party external to both supplier and user communities. The second alternative is that of "the filter", which is a body set up by a standards institution to allow the user community to participate in standards projects at various stages of development. Selective intervention is the key to these alternatives and some kind of "coercive mechanism" should be considered to ensure the establishment of "user-administered requirements studies as constituent parts of the standardization process" (p. 36). Hawkins suggests that oversight in this regard is appropriate to public regulatory function.

I would add one other dimension to Hawkins observations, which stems from his comments on the fractured nature of the user community and its problems with forming coherent positions on standards projects. In order to work toward the goal of coherency within the user community (which may be relatively impossible), a pre-requisite stage of demand articulation should be undertaken to assist the user community in better understanding the issues and forming its views on any standards-related matters.

In summary, Hawkins (p. 22) points to "structural impediments" in the user community and "institutional barriers" in the standards-making mechanism itself are key factors in preventing users from becoming "conventional participants" in the process and in shaping the evolution of telecommunications network infrastructure. I have added the further view that demand articulation is a pre-requisite to facilitating coherency within the user community vis-à-vis its participation in standards-making.

Application to this Study

The creation of technical standards is a fundamental design activity that influences interconnection arrangements and may assume a prominent role as a vehicle of inscription in a regulatory strategy of technology forcing. Hawkins' work in this area describes the challenges and importance of maintaining regulatory oversight in standardization, while identifying major obstacles to achieving wider stakeholder involvement in the process. Furthermore, his views evoke the societal learning aspect of CTA when he states that, at minimum, the telecom industry "will have to begin at least to 'learn to learn' from its users" (1995, p. 36). This statement suggests the need for a complimentary intervention strategy to technology forcing that includes the creation (or improved utilization) of loci for reflexivity within the standards community in order to expand stakeholder participation.

In sum, I have argued that technical standards may serve as a powerful intervention strategy of technology forcing. Following this line of argument, one stream of inquiry for my case study will be the role of technical standards as an intervention strategy of technology forcing in the development of a new telecom service in Canada. Considering Hawkins' arguments and using the CTA-informed analytic framework developed in the previous chapter, my case study will in part examine the role of standardization in the development and deployment of a new telecom service in Canada.[22] I will then extend the case study findings to a set of wider questions that may be applied to technology forcing in the context of the National Disaster Mitigation Strategy:

- What are the current spaces/processes of legitimization for "keystone standardization initiatives" in telecom service development?
- What is the basis for stakeholder participation (the principle of congruency) in these spaces/processes? Is there a basis for regulatory intervention/oversight in these spaces/processes?
- What forms of "structural impediments" or "institutional barriers" might constrain wider stakeholder involvement in standardization? What forms of regulatory instruments or other means might be drawn upon to address these barriers?
- How could an intervention strategy based on loci for reflexivity contribute to current standardization processes, and how might an "honest broker" or "filter" fit within such a strategy?

Strategic Niche Management, Unbundling, and Network Design

Research undertaken by Mansell into early efforts at network unbundling (Mansell, 1990; Mansell, 1993) addressed certain political economic aspects of interconnection and presents a case in support of strategic niche management. Two central principles guided her research. First is the notion that network evolution is a process open to discussion and debate:

> Insofar as the telecommunications networks and services of the future will underpin the organization and use of information, the coordination and management of production systems, and new ways of gaining competitive advantage, it seems vitally important that the full implications of alternative telecommunications development trajectories be explored. (Mansell, 1990, p. 501)

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[22] It is important to make a distinction between the development of standards and their subsequent adoption within a technology project. The former is a first order undertaking that may create a set of alternative options that can later be selectively adopted during second-order undertakings. When I use the term "standardization" I am referring collectively to both development and subsequent adoption activities.

Mansell's second principle is reflected in the view that policy and regulation also have a role in supporting new entrants as an active contribution to network evolution:

> Today's communication networks and services enable increasing opportunities for innovation and experimentation by smaller firms and consumers. Experimental initiatives by smaller firms and by public organizations contribute to the total stock of knowledge and competence available within each country. In a market characterized by the dominant player scenario, the independent initiatives of public organizations and smaller firms must be candidates for public financial support to encourage experimentation on a broad scale. (Mansell, 1999, p. 96)

The first principle is clearly a constructivist view of technology development while the second principle ascribes to the societal learning objectives of Constructive Technology Assessment. In contrast to Hawkins, however, Mansell presents a case for strategic niche management rather than technology forcing. Her view is to encourage experimental initiatives through the public support of new entrants, arguing that they serve as positive risk takers contributing to new markets and promoting a true diversity of services in the future telecom sector.

In light of this study, Mansell's views suggest that telecom policy and regulation might serve the National Disaster Mitigation Strategy through strategic niche management, by stimulating experimentation and innovation in telecom services for disaster management. Given the long-term trends of network evolution purported by Melody and Noam, Canadian emergency telecom policy might—in an extension of its current focus on physical and network layer issues—consider means to encourage the development of value-added disaster services among third-party service providers or seek to lure new entrants into the field of emergency telecommunications.

Idealist Versus Strategic Scenarios of Network Evolution

Mansell's research has demonstrated the "non-neutrality of technical design" (Mansell, 1993, p. 207), meaning that interconnection arrangements are not simply a matter of technical decisions but a distribution of control among suppliers in the market, each seeking an advantage in design, operation, and use of network elements and services (Mansell, 1999, p. 87). She characterizes this non-neutrality in terms of idealist versus strategic scenarios, the former being one in which full competition is expected to prevail and the latter "in which an oligopolistic market structure emerges where a few dominant players vie for success in the market" (p. 85). The latter situation represents the "dominant player scenario" mentioned in the excerpt above.

Based on a series of case studies into the development of so-called "intelligent network" initiatives in Europe and North America during the late 1980s, Mansell has concluded that the strategic scenario is acted out through a variety of design parameters affecting growth and change in telecom networks. As a result, policymakers and regulators "need to evaluate the impact on social and economic goals of the uneven distribution of network control among a few oligopolistic players in the market" (p. 92).

From the point of view of path dependency, and perhaps especially within Noam's "system of systems" paradigm, the ongoing presence of a strategic scenario suggests a need for regulators to assess interconnection arrangements to assure careful balance between tendencies toward centralized control versus decentralized control of network elements and interfaces. This translates into three related tasks for policy/regulatory initiatives: one, constraining market power where dominant players are seeking anti-competitive or exclusionary arrangements; two, creating incentives for new market entry to promote diversity and competition; three, ensuring coordination among multiple actors in supply of complex information and communication services to meet social and economic objectives (Mansell, 1999, p. 92).

The value of the two scenarios for my study is that they establish a critical counterpoint to Noam's idealist view on interconnection. Mansell (1999, p. 88) draws upon the strategic scenario to identify interconnection as a political economic issue, noting that it is not simply a commercial or technical matter, but a "major bottleneck" that presents strategic opportunities for both incumbents and new entrants alike to consolidate or extend control over network infrastructure. This suggests that certain network elements may never be open to full competition without regulatory intervention or that access to critical network elements may require regulatory oversight to ensure fair terms and conditions for all parties in exchange for meeting security standards.[23]

Mansell identified two major areas in which control can be exercised through the design of interconnection arrangements: access to underlying infrastructure and access to customers. Following Melody's model we can classify these as control issues at the core and at the periphery of a network. According to Mansell (1999, p. 88), attempts to gain strategic control over networks have gradually shifted to the periphery, in the form of "conditional access systems", as open systems standards have become increasingly accepted (and mandated) for core

[23] For instance, opening critical network elements within a competitive setting may hinge on the coercive power of government to ensure that all parties will conform to certain security standards (e.g., Federal privacy legislation).

infrastructure. She notes also that control over access to market information is a further strategy that may confer advantages in the market. In some cases this mode of control is directly related to proprietary information generated by transactions at both the core and periphery of a network through interconnection arrangements.

In terms of Arnbak's interconnection space, and considering Melody and Noam's views on the matter, Mansell's analysis reveals a subtle distinction related to interconnection design: while regulatory reform may be moving toward core infrastructure, efforts at strategic positioning are migrating up interconnection space toward network elements supporting value-added and information services layers. These upward layers remain a last bastion where dominant players can retain proprietary control over service design and deployment. One example of this upward movement is evident in the Canadian setting in the unbundling directives from the CRTC that have gradually opened the network core up to competitive interconnection. Discretionary control continues in value-added areas such as voicemail and other services at the upper layers of interconnection space.[24]

If the idealist scenario represents a baseline in which conditions of supply are closely correlated with demand then the strategic scenario is one in which dominant suppliers and major customers effectively control key aspects of network design to ensure a strategic advantage in the market. According to Mansell, the role of policymakers and regulators in a competitive environment is to limit this control where it inhibits public policy objectives and to use interconnection arrangements to promote new entrants and encourage improved coordination of supply and demand, bringing it closer to the idealist vision while recognizing the limits of competition for achieving certain social objectives. Yet demand may remain uncertain in many sectors where possibilities of new value-added services have yet to be explored hence the need to encourage experimentation among a wide range of interests.

Application to this Study

Mansell's perspective on network evolution with its idealist and strategic scenarios is helpful to my study because it proposes that certain parties will resist access to network elements where they serve as strategic control points over infrastructure design or customer access. As a result, I should expect to see attempts by certain parties to deny access to these elements or

[24] Voicemail systems do not interconnect between service providers and provide a form of conditional access system. Regulatory directives do not mandate interconnection of such value-added services at the periphery of the network.

otherwise attempt to influence the development of a new service to conform to their wider strategic objectives. This suggests that where parties call into question alternative problem formulations or when they reject design propositions, the question of motivation should be carefully considered beyond technical arguments. To aid in this consideration Mansell's research also offers a set of indicators that may give evidence of strategic positioning through manipulation of specific interconnection arrangements (Mansell, 1993, p. 209). Table 7 summarizes these indicators.

Table 7: Indicators of Strategic Positioning through Network Design

Design Parameter	Indicators
Network interface standards	Attempts to maintain proprietary interface standards, network management software, and some aspects of service applications
Unbundled intelligence	Resistance to requests from new entrants to provide access to intelligent network elements (i.e., SS7 elements); non-transparent pricing strategies; lack of responsiveness to small user requirements
Product differentiation	Superficial variations in equipment design; strong differentiation in certain submarkets where competition is strongest, where cross-subsidies can be introduced, or where costs of innovation are highest.
Service competition	Strong among services where majority of users are large network corporations; weak competition in maintenance, billing, use of network resources and service applications; cross-subsidization between strong and weak competitive services; disparities in network access for majority of users.
Network access	Closed and uneven geographically distributed network access; restrictions on the use of public network resources; increasingly difficult negotiations over terms and conditions of interconnection.
Network control	Disparities in degree of network control available to service suppliers and different types of users.

To look for evidence of efforts at strategic positioning, my case study will draw a socio-technical map of key network elements as introduced by the parties themselves in the process of designing a new service. Then those elements implicated in contested problem formulations or design propositions will be identified and analyzed, guided by the indicators above. The analysis contributes to a Constructive Technology Assessment by identifying current interconnection arrangements that may constrain future efforts at strategic niche management.

Loci for Reflexivity: the Challenge of Boundary Crossing

In light of the wide trends toward competition in software defined network and service elements and the possible advent of systems integrators in Noam's modularity model, we might do well to look for emergent issues at the leading edges of network evolution. At the lower layers of the growing interconnection space is likely to be increasing encounters between traditional telecom sector and data networking providers, while at the higher layers we will likely find heretofore unseen encounters between content providers, value-added service enablers, and other old and new stakeholders. How might we characterize these encounters and what should we expect in terms of challenges to policy and regulatory processes with relevance to the National Disaster Mitigation Strategy? These questions return us to the literature on Large Technical Systems in order to conceptualize the process of establishing new loci for reflexivity within expanded domains of network design.

Summerton's (1994b, p. 6) notion of *boundary crossing* as a metaphor for changes in large technical systems is useful to enhance an interpretation of challenges faced in expanding stakeholder participation in network design. Summerton has concluded from her analysis of empirical studies that changes in large technical systems often involve boundary crossing activity that embodies functional, territorial, and cultural dimensions.

Functional boundary crossing describes situations in which fundamentally different systems are interconnected, such as that between railways and communications (p. 8). Territorial boundary crossing describes situations in which interconnection has jurisdictional implications either of a political or organizational nature. Summerton cites the merging the East and West German telecommunications networks as a case of territorial boundary crossing and has observed that it often begins with the *disintegration* of standing institutions and practices as a pre-requisite for integration of separate systems. In telecommunications we see such an instance, as Noam has indicated, with the requirement to *unbundle* network access services in order to provide the functional integration needed to support a competitive telecommunications system.

Finally, Summerton considers cultural boundary crossing to be those situations in which interconnection has implications for normative values or practices among the interested parties (p. 10).[25] Where boundary crossing involves interconnection of one or more large technical system, normative values tend to serve as a backdrop for all manner of decision-making and debate. I

[25] To simplify matters and to avoid unnecessary semantic trappings, I have opted to employ term *normative* instead of cultural when referring to this dimension of boundary crossing.

suggest therefore that we consider both functional and territorial boundary crossing as contained within this wider frame of reference. In other words, boundary crossing in large technical systems is a process that foregrounds normative values of the stakeholders, wherein we can identify functional and territorial aspects.

This view is supported by Abbate's (1994) research into the debates in the early 1980s about the merits of data networking protocols TCP/IP and X.25. Abbate's findings provide an insightful perspective on the evolution of internetworking standards and support the view that challenges to boundary crossing may be principally a matter of normative debate, in some instances with territorial concerns expressed through functional claims. She demonstrates, for instance, that conflict over competing design propositions may be only partly about technical matters and a good deal about group interests and "fundamental differences in [stakeholder] perceptions of the technology" within a wider social setting (p. 194).

Normative Boundary Crossing: the Case of Data Networking Protocols

Abbate examined the historical development of the data networking protocols TCP/IP (datagram based) and X.25 (virtual circuit based) in early internetworking initiatives between 1976 and the late 1980s. According to her account, the internetworking debate was expressed as functional claims that disguised normative perspectives on network design. Datagram-based networks (using TCP/IP) by design place greater control at the edge of the network, in the host computers, whereas virtual circuit based designs (using X.25) place control at the subnet level, among the nodes and transmission media at the core of the network. Both standards represented independent networking efforts and each initiative represented a distinct constituency of participants and interests. TCP/IP was a product of the US Department of Defense ARPANET Internet program, while X.25 emerged out of international consensus with the CCITT (Consultative Committee on International Telegraphy and Telephony) of the International Telecommunications Union (ITU).

Abbate uses this case to illustrate how different normative expectations between stakeholders reveal themselves in debates about data networking standards where "Arguments tend[ed] to be framed as the evaluation of trade-offs between different technical costs and benefits, yet the assessment of these trade-offs *depend[ed] on tacit assumptions about the goals and operating environment of the networks*" [emph. added] (p. 199). Abbate's choice of the term "tacit assumptions" suggests to me that within a technology project, problem formulations have extensive normative dimensions that may be a significant yet unrecognized influence in debates over technical merits.

In the case of internetworking standards, these assumptions were articulated, on the one hand, through debates about the merits of TCP/IP and X.25 as technical standards. Positions taken by participants in the debate, on the other hand, tended to reflect different views on network design that stemmed directly from their regional experiences. For example, European participants viewed network design from within a PTT-dominated setting, which envisioned public networks as a hierarchical structure dominated by state monopolies. As a result, network design and transactions were to be administered by a central body with control over nodes and transmission, and using gateways circumscribed by political boundaries. The American participants, however, viewed network design from within a rapidly changing telecom environment characterized by the dismantling of AT&T and the rise of competing network providers. From their perspective, growing heterogeneity in data networks appeared to be the normal course of development and thus control was best left to the edges at the host computers (p. 201-202). Abbate summarized the problem: “At the heart of the arguments over [technical standards] are two contrasting assumptions about the environment in which large networks will operate” (p. 204). Each of the data networking standards emerged out of and tended to support regionally defined normative perspectives. Abbate concludes with the recommendation that researchers ought to consider normative reference points when seeking “to identify where the gulfs lie between competing technologies and to understand the strategies of those who attempt to cross them” (p. 208).

Technological Frame and the Configuration Model

What is the relationship between normative boundary crossing and the functional and territorial dimensions that it embodies? How is it that these dimensions can become associated with normative perspectives and, in turn, how might these come to be expressed in debates over design propositions? I will demonstrate that such questions are relevant when applying the notion of boundary crossing to an empirical study. To address them I will draw upon Bijker’s notion of a *technological frame* and its role in his so-called “configuration model” of socio-technical change (Bijker, 1995, p. 122).

Bijker developed the concept of the technological frame as a means to describe the basis for interaction between and among relevant social groups, prescribing it to be “used by the analyst to order data and to facilitate the interpretation of the interactions within a relevant social group" (p. 124). The technological frame is akin to a shared point of view among a group of people and, in Bijker's view, is typically manifested as commonly held goals, problems and problem solving strategies, theories, tacit knowledge, and practices. It provides a context that actively influences demand articulation, problem formulation and design propositions, thereby enabling and constraining criteria of acceptability. Bijker, is careful to define a technological frame as the result of *situated interaction* and not an *a priori* property of individuals or social groups per se:[26]

> A technological frame structures the interactions among the actors of a relevant social group. Thus it is not an individual's characteristic, nor a characteristic of systems or institutions; technological frames are located between actors, not in actors or above actors. A technological frame is built up when interaction 'around' an artifact begins. Existing practice does guide future practice, through without logical determination. If existing interactions move members of an emerging relevant social group in the same direction, a technological frame will build up; if not, there will be no frame, no relevant social group, no future interaction. (Bijker, 1995, p. 123)

Others have found Bijker's concept useful to interpret the effects of technological change within organizational settings. Orlikowski and Gash, for instance, take the idea of a technological frame to be a subset within a wider field dealing with social cognition. More specifically, they consider Bijker's concept as a "contextual dimension" of social cognition, defining it as

> … the understanding that members of a social group come to have of particular technological artifacts, and they include not only knowledge about the particular technology but also local understanding of specific uses in a given setting. …
>
> Technological frames have powerful effects in that people's assumptions, expectations, and knowledge about the purpose, context, importance, and role of technology will strongly influence the choices made regarding the design and use of those technologies. (Orlikowski & Gash, 1994, p. 178)

In my view, Bijker's concept describes a normative marker that demarcates various social groups and lends character to their perspectives on a technology project. He says, for instance, "a technological frame comprises all the elements that influence the interactions within relevant social groups and lead to the attribution of meanings to technical artifacts" (p. 123). The following table is Bijker's "tentative list" of elements in a technological frame. Based on Bijker's

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[26] Admittedly this remains to be further examined from a theoretical standpoint. In my view Bijker's formulation is similar to that of actor network theory, especially with its similarities to semiotics and symbolic interactionism. See, for instance, Law (1999). For this study, however, it nevertheless provides a good foundation (as Bijker himself notes) for ordering raw data and enhancing an interpretation of contextual factors that influence a technology project.

empirical examples, I have added two corresponding columns as an aid in structuring my own study.[27] (See Table 8).

Table 8: Elements of Bijker's Technological Frame

Element	Activity	Analyst's question(s)
Goals	Demand articulation	What motivates the technology project?
Key problems	Demand articulation	What issues are being addressed by the technology project?
Problem-solving strategies	Problem formulation	What are the identified general principles to solving the problem?
Requirements to be met by solutions	Problem formulation	What are the standards by which design propositions to be measured?
Current theories	Problem formulation	How is the problem conceptualized?
Tacit knowledge	Problem formulation	What are the taken-for-granted assumptions?
Testing procedures	Design proposition	What is an acceptable means for evaluating a design proposition?
Design methods and criteria	Design proposition	What existing practices are drawn upon to establish a design proposition?
Users' practice	Problem formulation/Design proposition	What are the views on users' needs and behaviours with respect to a design proposition?
Perceived substitution function	Design proposition	What are the relevant alternatives to a design proposition?
Exemplary artifacts	Problem formluation/Design proposition	What previously established artifacts or systems lie at the heart of a design proposition?

Having introduced the concept, Bijker (1995, p. 276-279) then argues that in a technology project there may be several configurations among relevant social groups: an absence of a technological frame, one dominant frame, or competing technological frames. He has described these situations within a "configuration model" that establishes a set of generalized (and hypothetical) expectations resulting from each situation.

Where we find an absence of a technological frame, we should typically find a wide variety of design propositions being introduced into the technology project. Bijker notes, that "where there is no dominant technological frame, the range of variants that can be put forward to solve a problem is relatively unconstrained" (p. 277).

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[27] Bijker does not offer such an aid to the analyst. I have derived these questions based on his findings from a case study into celluloid chemists involved in the creation of Bakelite. See Bijker (1995, p. 126).

Where we find a single dominant frame and a set of vested interests, Bijker suggests we will see much more conservative approach to problem formulation, typically dominated by a single group, and thus greater conformity in design propositions. In these instances, Bijker introduces the notion of "inclusion" to describe the variations between relevant social groups that are more or less within the dominant frame and those that are outside of it. Those within the frame ("high inclusion actors") are likely to draw on standard problem-solving strategies based on an exemplary artifact or system because …

> [t]he relevant social groups have, in building up the technological frame, invested so much in the artifact that its meaning has become quite fixed—it cannot be changed easily, and it forms part of a hardened network of practices, theories, and social institutions. From this time on it may indeed happen that, naively spoken, an artifact 'determines' social development. (Bijker, 1995, p. 282)

Those actors with "low inclusion" may offer alternative approaches by disregarding or otherwise questioning the exemplary artifact/system within the dominant technological frame, or perhaps complying with them as "obligatory passage points" towards a desired objective (p. 285).

In the case of multiple and equally dominant frames, the configuration model proposes "arguments, criteria, and considerations that are valid in one technological frame will not carry much weight in the other [competing] frames" (p. 279). As a result, criteria *external to all* technological frames will come to play a major role in problem formulation and evaluation of design propositions. Bijker suggests that in these instances, alternative rhetorical strategies and an "amalgamation of vested interests" (p. 279) may come to play a significant role in proceedings.

The concept of the technological frame taken as a normative marker will embody territorial and functional dimensions because it establishes boundaries by which various social groups are granted legitimacy within a technology project and can thus act as a position from which to attack or defend competing problem formulations or design propositions. Bijker's configuration model sets out expectations for those situations in which territorial boundaries come into conflict—that is, when a dominant or competing technological frames are at play. For example, in Abbate's case of internetworking standards I suggest that the data networking protocols TCP/IP and X.25 might be usefully interpreted as exemplary artifacts within two competing technological frames comprised of more extensive normative positions.

Application to this Study

The notion of boundary crossing emphasizes the point that shifts in large technical systems introduce new alignments and that the process of change is laden with normative values. In Summerton's words, " ... the rhetoric of defining the new system (what is possible, what will work) can be as important as actual system design" (Summerton, 1994b, p. 16). A CTA intervention strategy based on loci for reflexivity seeks to expand the range of "rhetoric" in which network design will occur and thus brings with it the prospects for new forms of boundary crossing and concomitant challenges for achieving viable outcomes. For my study, the question remains as to what challenges an expanded domain of network design might pose in the context of a National Disaster Mitigation Strategy.

My case study will consider the idea of boundary crossing to assess how normative perspectives may be drawn into a technology project. More specifically I will look for the presence of one or more technological frames and apply the findings to the generalized expectations stated in Bijker's configuration model. By adopting the technological frame analysis I will expand my assessment to include contextual explanations for conflict situations that may not be adequately explained by Mansell's political economic perspective. In addition, the configuration model may offer some insight as to the strategies that parties use when seeking to promote design propositions within a technology project. Such findings may help to anticipate difficulties associated with the expansion of stakeholder involvement in the process of network evolution.

Summary

This chapter began by addressing the challenge of undertaking a technology assessment involving an evolving large technical system and with the problem of identifying suitable boundary conditions for limiting the scope of research. With respect to this matter, I discussed some of the key features of technical networks and large technical systems, considering the problem of boundary conditions as it relates to telecommunications infrastructure. My objective in this chapter has been to expand the analytic framework along a third dimension of interconnection space, while introducing a number of operational issues related to growth and change in a telecom system.

Interconnection space is an important extension to the intervention matrix that draws out a set of specific issues in the areas of technical standards, interconnection arrangements, and expanded stakeholder participation. In this chapter I discussed each of these areas and their specific application to the study of growth and change in telecommunications infrastructure. In particular, the telecom policy literature introduces specific lines of inquiry that will be applied to examine Wireless E9-1-1: technical standards and the standards process, interconnection arrangements, and Bijker's technological frame. Analysis of these operational concepts was structured thematically through Constructive Technology Assessment's three generic intervention strategies of technology forcing, strategic niche management, and loci for reflexivity. A theoretical account of the movement from demand articulation, through problem formulation, and design proposition was based on a constructivist theory of technology dynamics drawn from science and technology studies. Together these dimensions combined to form the tri-dimensional intervention matrix to be used in analyzing the Wireless E9-1-1 case, which will provide a baseline assessment against which to measure current arrangements in light of the wider objectives of the National Disaster Mitigation Strategy.

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Chapter 5: Observing Wireless Enhanced 9-1-1 in Canada

Introduction

In chapter one of this dissertation I put forth the general thesis that a successful implementation of a National Disaster Mitigation Strategy in Canada, particularly as it is linked to an integrated program of critical infrastructure protection, will hinge on the arrangements to support cost-effective and sustainable risk reduction activities. Chapter two opens with the observation that telecommunications has been largely overlooked in public proceedings to date, yet is probably one of the most critical areas to study in view of its potential role as a service environment to support the objectives of a National Disaster Mitigation Strategy. I then argue that a central objective for telecom policy research in this field should be to understand the process by which growth and change occurs in Canada's telecom infrastructure and to assess the various means by which to intervene in that process in order to ensure that long-term risk reduction is afforded high priority.

In chapter three I then established the analytic framework for this study based on constructive technology assessment and related theories of technology dynamics. This framework introduces an intervention matrix that will be used to organize and examine data obtained from the empirical case study. In chapter four I operationalized this intervention matrix through the literature on Large Technical Systems and telecom policy. Interconnection is taken up as an operational concept in that chapter and was discussed in both its technical and social aspects through Arnbak's functional systems model. This produced a third axis for the intervention matrix, creating a dimension referred to as "interconnection space." Drawing on literature from telecom policy I argued that interconnection remains a key variable in shaping the design of public telecommunications infrastructure, especially with respect to technical standards, strategic control over network elements, and stakeholder participation. Current trends suggest that focus on interconnection matters include value-added and information services will increasingly involve third-party systems integrators, as telecommunications networks and services are forecasted to evolve into more modular designs.

This chapter reports on a case study that examined an instance of growth and change in Canada's telecom infrastructure. It provides a detailed, empirical account of stakeholders and processes that have been influential in shaping the evolution of network infrastructure through the introduction of a new service offering.

Why Wireless Enhanced 9-1-1?

Put simply, Wireless E9-1-1 is a new service development in the Canadian telecom infrastructure. Its relevance and value to this study stems from its impact across the entire network infrastructure; its design and implementation, as we shall see, affect both core and peripheral elements and processes. It spans all four levels in Arnbak's functional systems model and may signify a looming challenge to Canada's current telecom policy framework. These considerations notwithstanding, Wireless E9-1-1 also represents a leading edge development that I felt could be feasibly studied in its entirety as a new service initiative. It offered me a unique opportunity to follow in detail a new service from its early conception through to its implementation as a commercial offering in Canada. Its development has also been controversial, thus presenting an opportunity to examine challenges to stakeholder interaction and congruency.

The purpose of this case study is to shed light on the processes and interventions by which network evolution occurs with respect to an identified public policy objective; namely, that embodied in the National Disaster Mitigation Strategy. I acknowledge at the outset that Wireless E9-1-1 may seem a matter of *public safety* as opposed to disaster mitigation but this is more a matter of degree than kind; moreover, I would contend that in any case this consideration does not diminish its relevance as a leading edge case in new service development. In fact, we might well consider Wireless E9-1-1 an innovation that contributes to the National Disaster Mitigation Strategy insofar as it lends itself to the notion of a long-term program of risk reduction where, according to the Pressure and Release Model, fundamental processes of growth and change in the Canadian telecom system are explicitly directed toward the objective of reducing unsafe conditions within society.

Encountering the Imbroglio of New Service Development

A major challenge in studying telecommunication network evolution is that of bringing limited resources to a highly distributed process. Even something as "simple" as Wireless E9-1-1 represents a complex process with thousands of potential documents and numerous organizations of interest. For example, several organizations in the United States such as the National Emergency Numbering Association (NENA) or the Association of Public-Safety Communications Officials (APCO) each host extensive Wireless E9-1-1 websites (Association of Public-Safety Communications Officials, 2002; National Emergency Numbering Association, 2002). The United States Federal Communications Commission (FCC) hosts a dedicated E9-1-1 website with hundreds of documents associated with its ongoing deployment in the wireless sector (United States. Federal Communications Commission, 2002). Industry organizations such as the Canadian Wireless Telecommunications Association (CWTA) and the Telecommunications Industry Association (TIA) also host websites with important Wireless E9-1-1 documentation (Canadian Wireless Telecommunications Association, 2001; Telecommunications Industry Association, 2002). Some U.S. telecommunications carriers, too, provide Wireless E9-1-1 information to the public (BellSouth, 2002).

The most important consideration at the outset of my study was selecting a case study that could be systematic and comprehensive.[28] While exploring various candidates for my case, I recall my first encounter with the documents on Wireless E9-1-1 at the CRTC website leaving me somewhat discouraged at the prospects of developing a robust case study of new service development. There appeared to be so many documents, so many unfamiliar acronyms and terms, so many arcane links and considerations that I understood more completely Latour's theoretical notion of the *imbroglio* that defines our initial encounters in science and technology studies. Indeed, I encountered Wireless E9-1-1 as a confusing imbroglio of technical terms, regulatory processes, industry organizations, and professional practices.

Yet on October 31, 2001 the CRTC issued Public Notice 2001-110: Conditions of service for wireless competitive local exchange carriers and for 9-1-1 services offered by wireless service providers (Canada. Canadian Radio-television and Telecommunications Commission, 2001g).

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[28] Originally, I had considered looking at the Priority Access to Dialling (PAD) program in Canada but encountered difficulty in obtaining any information of substance beyond the slim offering on Industry Canada's website. Both government and industry alike proved to be reluctant to cooperate. This kind of barrier is not uncommon for those attempting to do public policy research on critical infrastructure.

This would prove to be a skeleton key to Wireless E9-1-1 development in Canada, and the proceedings that lead into and stem from this Public Notice provide the firmament of my case study.

The value of CRTC Public Notice 2001-110 was that it provided the means to establish a systematic review of documents and processes related to a new service development, as the interested parties often mentioned of other documents in support of their submissions. At first I reviewed in detail each set of comments and reply comments submitted with respect to PN 2001-110. When reference was made to external documents I made careful note and later followed up with secondary and, again, tertiary stages of document analysis. I usually began these successive reviews with single citations where reference had been made to documents with cryptic titles such as "ESTF029" or "ESCOX155". These fragments of information served as keys to gain entry into the procedural structures within which Wireless E9-1-1 has come to reside and to begin to glimpse the processes, stakeholders, and other influences that shape new service development in the Canadian telecom sector.

Principles of Research Design

Apart from Bijker's preliminary work in this area, the constructivist literature offers little by way of formal methodology for doing studies on technology development (Klein & Kleinman, 2002, p. 32). In view of this, I consulted Yin's highly regarded work on case study research to support the design of my study (seeYin, 1984; Yin, 1993). Yin (1984, p. 6) has argued that case study research is most appropriate for those instances in which the researcher is tackling exploratory or explanatory questions and when there is limited control over the events being studied. My study is concerned with explaining how a new telecom service comes to be developed and exploring the options for intervening in that process. Clearly the events and processes involved are beyond my control. Among the critiques of case study research, Yin (1984, p. 10) addresses the problem of scientific generalization by pointing out that case study findings are "generalizable to theoretical propositions and not to populations or universes." This means that we can draw on the findings to expand our analytic understanding of technology projects but that I cannot make assertions or generalizations about probability of outcomes based on this method. The study therefore does not attempt to state the likelihood of various intervention strategies but examines their suitability within the context of Canadian telecom policy and regulation.

Using Yin's terminology (1984, p. 38, 44), I would classify my case study as a single case, embedded design. Embedded designs are those in which multiple units of analysis are examined. I am studying three units of analysis within a single case of Wireless E9-1-1. These units of analysis, introduced previously in the form of an intervention matrix (see chapter three), are technology forcing, strategic niche management, and loci for reflexivity.

Yin (1984, p. 33) also offers four tests by which we can assess the quality of case study research design, combining them with "quality control" techniques to be considered during various phases of research. I took these considerations into account for my case study (see Table 9).

Table 9: Four Tests to Assess Research Design

Test	Quality Assurance	Quality Control Techniques
Construct validity	Controlled operationalization of concepts through intervention matrix; pattern matching using empirical evidence.	Multiple sources of evidence; chain of evidence; informant-led perspectives on evidence.
Internal validity	N/A; relevant for experimental or evaluation research	Pattern-matching; explanation building; time-series analysis
External validity	Choice of case study sample based on gradient of similarity to established regulatory and industry processes.	Theoretical generalization
Reliability	Possibility of replication enabled through systematic analysis of primary and secondary source documentation.	Clear protocol to ensure systematic collection and archiving of data; potential for replication

Methodology

Data for this case study is drawn from a primary-source document analysis using an approach known as "grounded-theory" (Strauss, 1990). In identifying and gathering documents, I used a snowball strategy to produce a chain of evidence drawing on multiple sources. My objective was to produce a thick description of the events that surrounded the original demand articulation for Wireless E9-1-1, its introduction subsequent development in Canada. Research began with CRTC Public Notice 2001-110, and I initiated the case study by registering with the CRTC as an interested party to the proceedings, thereby establishing myself as a participant-observer and obtaining directly all comments filed by other interested parties. Three rounds of comments were received from ten parties. The first round of comments (December 13, 2001) was followed by reply comments (January 17, 2002) and then further reply comments (January

28, 2002). I reviewed all comments submitted by all parties in considerable depth, making extensive notes on two categories of interest in a process known in grounded-theory as "inductive" or "open" coding (Bernard, 2000, p. 444):

- Issues and arguments
- Key actors

The category of issues and arguments refers to concerns raised by interested parties during the proceeding. Some issues were given greater weight than others, evident both in the quantity and quality of effort given over to them. For instance, the matter of mobile telephone subscriber records being entered in the Automatic Location Identification (ALI) database produced the most amount of debate in terms of word count but also the most forceful and provocative language between the interested parties.

Among the key actors I included both human and non-human elements. Human actors were typically those people speaking on behalf of their organization and contributing to the proceedings. Non-human actors were those elements introduced or enrolled into the proceedings by human actors when formulating problems or asserting design propositions. These include pieces of legislation, specific regulations, technical standards, equipment, professional practices, and so forth. I consider these to be "actors" in the proceedings if they were embodied in an identifiable vehicle of inscription and if they were enrolled in a key issue and/or argument.

The vehicles of inscription on which non-human actors were established often served as the basis for subsequent rounds in my document analysis. For instance, where an interested party cited a previous CRTC decision or a published technical standard, I then would note the context and obtain the associated documents. The process continued for several iterations until the point at which the subsequent documents were not primarily concerned with Wireless E9-1-1 as their subject matter or where the influence on those documents extended beyond the influence of Canadian authorities. In some cases, I reached a "trailhead" that represented a logical point to terminate a thread. For instance, a number of interested parties cited Canada's privacy legislation. Given that the subject of this legislation is not primarily E9-1-1 it suggested a logical point of termination for that particular thread of inquiry. In other cases, references to a document issued by the U.S. National Emergency Number Association (NENA) were common in the proceedings. In these instances I would terminate the document trail with those NENA-produced documents because they represent the edge of the Canadian PSTN boundary as established in chapter four of my study.

Once the inductive coding process was completed, the intervention matrix was applied to the identified categories of interest. This analytic framework served as the basis for identifying specific themes to inform an iterative process of inductive and deductive coding for the case study analysis (see Chapter 6). The telling of the case study is derived from deductive coding based on the generic intervention strategies of technology forcing, strategic niche management, and loci for intervention. Finer points of analysis were coded using the other two dimensions of the intervention matrix. This hybrid approach of inductive/deductive coding is suited to grounded-theory studies that incorporate a general thematic framework such as that presented by the intervention matrix (Bernard, 2000, p. 445). See Appendix B for samples of the coding documents.

In all, my case study examined virtually every public document directly associated and cited in conjunction with the development of Wireless E9-1-1 in Canada, an extensive range of technical and policy documents produced by U.S. public safety organizations and industry groups, numerous Federal Communications Commission's E9-1-1 rulemaking documents and related American legislation, as well as consulting a score of secondary sources on telecommunications systems engineering (to understand terms and concepts used in the proceedings). Individuals from several organizations involved in the proceedings were contacted by email or telephone during the course of my study to clarify questions and in some cases to obtain documents that were not otherwise available.

The Genesis of Wireless E9-1-1: Technology Forcing and the FCC

The story of Wireless E9-1-1 in Canada actually begins in the United States, with the Federal Communications Commission's (FCC) *Notice of Proposed Rule-Making* under Docket 94-102, issued in October of 1994 (United States. Federal Communications Commission, 1994). Among other things, Docket 94-102 addressed a growing concern over the impact of mobile phones at the public safety answering points (PSAPs). Over the course of some thirty-five years, public safety groups across the U.S. had developed a rather advanced system for providing telephone access to PSAPs for requesting emergency services. The first stage in this history was the adoption of a simple, widely known number that people could easily remember to call during an emergency. The digits 9-1-1 were eventually selected for this purpose (National Emergency Number Association, 2002a).

The original 9-1-1 concept was to provide a simple voice path connection to an operator designated to handle emergency calls and to dispatch appropriate agencies as required. With the subsequent development of more sophisticated telecommunications services, an enhanced 9-1-1 concept was introduced whereby the voice path connection was augmented with two data elements: caller identification and location information (National Emergency Number Association, 2002b). With these data elements in hand, an emergency operator would have more information available to improve dispatch operations. With caller ID—also known as automatic number identification (ANI)—calls can be returned in the event they were disconnected, or the number can be provided to law enforcement agencies to support follow-up investigations. Furthermore, the ANI data can be used by the call-takers to dip into an automatic location identification (ALI) database that associated fixed line telephone numbers with street addresses. With this in place, emergency calls can be more easily down-streamed to appropriate jurisdictions for dispatch. In the event a caller was unable to provide their location verbally to the operator, emergency personnel can be directed to the exact spot from which the call had originated. The ANI/ALI (pronounced "Annie-Alley") combination has since become the benchmark feature of E9-1-1 across North America.

With the rapid uptake of mobile phones beginning in the mid-1990s, the well-established E9-1-1 system was quickly becoming fragmented into wireline calls with ANI/ALI capability and wireless calls with no enhanced capability whatsoever. The system had been conceived within a wireline environment in which telephone numbers were more or less permanently associated with fixed addresses. Mobile terminals undermined this design, as a wireless phone number is not associated with a fixed physical location. Moreover, existing interconnection arrangements between wireline and wireless carriers often precluded the ability to pass little more than the voice path to a Public Safety Answering Point (PSAP). This meant that emergency call-takers were not even receiving caller ID from the wireless calls, leading (or so it is claimed) to intolerable delays in dispatching emergency personnel. It began to appear as if E9-1-1 would need to be further enhanced to permit ANI data plus some kind of *dynamic assignment of location information* for mobile-originated emergency calls. For the wireless industry in North America this application represented the first widespread demand for a location-based service.

The matter was taken up in FCC's Docket 94-102 in the form of a mandate for the U.S. wireless industry and coincided with new American legislation that made 9-1-1 the universal emergency number across the country (United States. Federal Communications Commission, 2000). The FCC was determined to solve the problem of Wireless E9-1-1 by mandating a two-phase process by which wireless carriers would be required to develop ANI/ALI capability for 9-1-1 calls initiated on their networks (see Table 10). In the first phase of the process the U.S.

wireless carriers were required to implement a solution that would provide a local PSAP with mobile caller ID (ANI) plus low-resolution location information (ALI) in the form of cell-site or cell-sector address from which the call had been placed to 9-1-1.

The second phase requirements are more rigorous and demand that the wireless carriers implement a system that provides ANI plus high-resolution location information in the form of x/y coordinates of the mobile phone. High-resolution is defined according to the system that a carrier chooses to implement. For handset-based solutions the FCC has set an accuracy/reliability requirement of 50 metres for 67 percent of calls and 150 metres for 95 percent of calls. For network-based solutions, the FCC requires an accuracy of 100 metres in 67 percent of calls and 300 metres for 95 percent of calls. Phase 1 deployment was originally set at April 1998 and Phase 2 at October 2001. Revisions have since been made to the Phase 2 deployment timeline, as many of the U.S. carriers have had problems meeting the original deadline (United States. Federal Communications Commission, 2001).

Table 10: FCC Wireless E9-1-1 Requirements

FCC Phase	Requirement
0	Transmit all mobile 9-1-1 calls to a PSAP
1	Transmit ANI and cell-site/sector with all 9-1-1 calls
2	Transmit ANI and x,y location with all 9-1-1 calls

For many of those in the U.S. wireless industry, Docket 94-102 inaugurated what was believed would be a rush to deploy location-based services out of the capabilities that Wireless E9-1-1 would bring to the mobile telecom sector. Numerous third-party solutions providers appeared on the horizon with solutions contrived in conjunction with the FCC mandate, and in 2000 the Wireless Location Industry Association was formed as an industry advocacy body to promote location based services (Wireless Location Industry Association, 2001). Speculation in the trade press and much of the popular media also reflected an optimistic sense of inevitability with respect to the future of mobile positioning and location based services. In reality, however, progress has been much slower than first anticipated as many carriers have filed for waivers on the Phase 2 deadline and to date only a handful are prepared to offer high resolution Wireless E9-1-1.

In effect, the FCC mandate for Wireless E9-1-1 is a form of technology forcing intended to steer the development of wireless telecommunications along a certain trajectory in order to accomplish wider social policy objectives. As I introduced in chapter three of this study, technology forcing is one of three generic strategies identified within Constructive Technology Assessment. It relies heavily on a vehicle of inscription to stipulate desired impacts and influence technology development accordingly. As we shall see further, the U.S. experience with technology forcing was mentioned by various parties in the Canadian proceedings on Wireless E9-1-1 and may shed some light on challenges associated with this form of intervention strategy in Canada.

Strategic Niche Management: Wireless E9-1-1 Technical Development in Canada

While the FCC in the United States had initiated an ambitious effort in technology forcing to create a service environment that would support the wider objectives of the 9-1-1 Act, a similar strategy was not being contemplated in the Canadian context by the Canadian Radio-television and Telecommunications Commission (CRTC). Regulators in Canada had not adopted national emergency number legislation, nor were they making plans to do so in the foreseeable future.

The initiative to develop and deploy Wireless E9-1-1 in Canada was thus left up to the wireless industry, which turned to the matter in late spring 1997 under the auspices of the Canadian Wireless Telecommunications Association (CWTA). Achieving early functionality of wireless E9-1-1 in Canada would be done through a coordinated effort between the wireless industry, the incumbent carriers, and the Public Safety Answering Point (PSAP) representatives, working together cooperatively to sponsor a series of technical trials.

On June 17, 1997, a roundtable was held at the Airport Hilton in Toronto to affirm the wireless industry's commitment to developing wireless E9-1-1 for Canada. Previous to this event, the CWTA had conducted its E9-1-1 proceedings through an internal 9-1-1 committee, which was now to be opened to include a wider constituency of stakeholders. Participants at the roundtable included members of the wireless industry, representatives from public safety communications associations, equipment vendors, the incumbent wireline carriers, Industry Canada, and the CRTC. Agenda items at this inaugural event included a review of the U.S. FCC mandate, status of the Canadian industry, cost and cost recovery issues, consumer awareness, and a proposal for a joint CWTA/PSAP working group to further the development of Wireless E9-1-1.

From a technical standpoint, participants at the roundtable identified the problem of providing mobile caller ID (ANI) as a preliminary task to achieving full scale Wireless E9-1-1 functionality. Cost recovery was also deemed a major concern. In addition, the parties noted that consumer education was a priority, the public safety answering point (PSAP) representatives agreeing to share costs with the CWTA on developing a consumer awareness program to inform the public about wireless emergency calls. Together the parties affirmed that a working group could be formed and thus began a search for co-chairs representing both the CWTA and the Provincial PSAP associations (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1997a). For the time being, the development of Wireless E9-1-1 in Canada would not be a mandated undertaking as it was in the United States but rather (perhaps to the delight of the CRTC) it looked as if it would be the wireless industry who would work to establish congruency among stakeholders and to identify, align, and inscribe their interests in the design of a Wireless E9-1-1 solution.

Following the encouraging results of the preliminary roundtable, the CWTA formally established in July 1997 the Wireless E9-1-1 Working Group (WEWG) at a meeting of interested parties. In addition to selecting a co-chair from each of the CWTA and PSAP groups, this meeting produced a mandate for the WEWG, which served to inscribe the congruent interest among wireless service providers, ILECs, PSAPs, and others:

> The CWTA/PSAP E9-1-1 Working Group will examine the migration of E9-1-1 service in a wireless environment to give it the *equivalent capabilities of wireline E9-1-1* in locations where a PSAP is capable of receiving the information. The working group will identify, evaluate and prepare options for the migration of wireless E9-1-1 service in accordance with the priorities the working group identifies. [emphasis added] (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1997b)

In effect, the WEWG and its mandate would grow to become a foundation for strategic niche management, as it moved from identifying and evaluating options for Wireless E9-1-1 to conducting technical trials in Alberta and Ontario, and to a lesser extent in Nova Scotia. Strategic niche management is an intervention strategy defined in the field of Constructive Technology Assessment as “the orchestration of the development and introduction of new technologies through setting up a series of experimental settings (niches) in which actors learn about the design, user needs, cultural and political acceptability, and other aspects” (Schot & Rip, 1996, p. 261). While on the surface, the objective of the WEWG was less about learning (as CTA would have it) and more about developing a functional system, it closely resembled in operational terms a process of strategic niche management.[29] Reports from various technical trials dominated much of the WEWG meetings from April 1998 through to the last reported meeting in July 2001.

A central task to be addressed in the Wireless E9-1-1 Working Group (WEWG), was articulating the meaning of Wireless E9-1-1. In the United States, demand articulation was central to the FCC rulemaking: Wireless E9-1-1 requirements were clearly specified by the FCC and served as critical design criteria. Without a similar framework in Canada, the first step for the WEWG was to establish a definition for Wireless E9-1-1, or at least to establish a basic problem formulation. The FCC's most demanding requirements for Phase 2 deployment went largely untouched in the WEWG meetings, but FCC Phase 1 requirements became the *de facto* model for Canadian Wireless E9-1-1. In fact by the time the WEWG had started its initiative, discussions in the United States were far enough along that the Canadian wireless industry could cherry pick from standard approaches being adopted by carriers and the National Emergency Number Association (NENA).

By this point in time, consensus had largely been achieved in the United States that Phase 1 Wireless E9-1-1 would consist of two elements delivered to a Public Safety Answering Point (PSAP): a ten digit mobile caller ID number (NPA NXX-XXXX) and a *pseudo*-ANI (Automatic Number Identification) specifying the cell site/sector from which a mobile telephone call had been placed (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1997c). In March 1998, the WEWG later adopted the term Emergency Services Routing Digit (ESRD) to replace the pseudo-ANI, or *pANI*, designation (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998c).

Following the American lead, it was clear among most stakeholders early in the WEWG meetings that the first challenge for Wireless E9-1-1 was simply that of upgrading 9-1-1

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[29] CTA proponents suggest that with strategic niche management "the learning component must take precedence over the goals of the technology actor" (Schot & Rip, 1996, p. 261). Learning is defined along two dimensions: first-order (horizontal) awareness of issues and concerns; and second-order (vertical) self-reflexive learning that modifies the process itself. There is no question that learning was an important component to the WEWG activities, as evidenced by ongoing sharing of information and contributions. An important question for this study, however, is whether the WEWG was a site of predominantly first-order learning, or whether the opportunity to move discussion into the realm of second-order learning. Evidence indicative of second-order learning would be, for example, using technical trials as experiments "to learn about possible new linkages between technology, demand requirements and issues of cultural and political acceptability … [that might be] fed back into the strategies of actors and used on future occasions" (p. 262). The key idea here is to anticipate later phases in technology development and to draw these insights into the design process. Among the issues that surfaced later in the Wireless E9-1-1 proceedings were subscriber activation process and privacy. A discussion of Phase 2 and future public safety opportunities was also a possible topic for reflection, yet it was only touched upon briefly in the WEWG proceedings.

interconnection arrangements to transit the 10-digit mobile caller ID from a Wireless subscriber through the local ILEC 9-1-1 platform and on to a designated PSAP. The ANI problem was thus given highest priority despite the fact that a number of Stentor companies expressed their opinion that a solution to this challenge was “light years away” even in view of the fact that a mobile positioning solution could be implemented “immediately” (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998b).

The difficulty seemed to reside in the fact that then-current E9-1-1 platforms supported only wireline customers (and here we have an example of a “reverse salient”). Wireline telephones are associated with a fixed address residing within a designated Number Plan Area (NPA), also referred to as an area code (i.e., NPA-NXX-XXXX). Because the fixed address and NPA are permanently associated, the record field in the 9-1-1 database for call-back number is typically designed for the seven digits that represent the customer’s local exchange and specific line (i.e., NXX-XXXX). The NPA need not be included in each record associated with that local calling area, as this is taken for granted with wireline telephones. In multiple NPA situations, an eight-digit combination that includes a single NPA digit (1-4) is often used.

Mobile terminals, however, introduce roamers into the local NPA, which in turn creates the need for a 10-digit call back number to accurately identify the calling party. For example, a visitor from Toronto carrying her mobile phone when she is roaming in Vancouver (NPA 604/778) will have a “local” number that includes NPA 416. For a Vancouver PSAP to correctly identify this caller in the event of an emergency they require access to the 10-digit number that includes NPA 416. The legacy ILEC 9-1-1 platforms had not been designed to take into account the problem of wireless roaming and the 10-digit call back number represented, for some interested parties, the first boundary object in the problem formulation for Wireless E9-1-1.

Emergency Services Routing Digit (ESRD)

Pseudo-ANI, or the Emergency Services Routing Digit (ESRD) as it has come to be known, seemed at the outset of the WEWG proceedings to be a far less complicated problem to solve as compared with mobile caller ID (which is “true” ANI). ESRD is also a 10-digit number but is associated with a cell site/sector rather than a mobile handset. ESRD provides a crude method of mobile positioning by presenting the PSAP with information about the cell-site location from where a mobile call has been placed. The ESRD is a very low resolution positioning solution that is primarily intended for routing mobile calls to the appropriate PSAP jurisdiction rather than providing a definitive location of the mobile caller.

An important technical question for design propositions based on ESRD was whether it could be passed to the ILEC 9-1-1 platform from a Wireless Service Provider's switch and subsequently linked to the ALI (automatic location identification) field in the current E9-1-1 database. This path would be necessary to use ESRD to trigger the delivery of a cell-site/sector address instead of a wireline subscriber address. In this case, the problem of Wireless E9-1-1 appears to be the need for two 10-digit fields to represent a mobile caller, as opposed to one field for a wireline caller.

In the wireline scenario, the caller's 7-digit telephone number serves as both the call back number and the trigger for the ALI database (because the number is more or less permanently assigned to a physical location). In the case of mobile calls, however, the caller ID is dynamically linked to an ESRD depending on the physical location of the caller at the time the call is placed. This dynamic link between caller ID and ESRD is then used to send cell site/sector data to the emergency call-taker at the PSAP. The question for the wireless service providers, ILECs, and PSAPs was whether current 9-1-1 platforms and display equipment were capable of being modified to meet the requirement for two 10-digit fields. Would the equipment be ESRD-compliant?

Early in the WEWG proceedings the question of ESRD seemed to be resolved. Both Bell and TELUS claimed that it could be adopted in their respective operating territories and Microcell had already conducted with Bell captive trials of ESRD in Quebec prior to the formation of the WEWG. While there were some concerns expressed among members of the WEWG as to their full understanding of ESRD concept, it was agreed in November 1997 to adopt it as a fundamental design proposition for Wireless E9-1-1, and that "the adoption of pANI [ESRD] would be a necessary first step to routing 10-digit wireless phone numbers to the appropriate PSAP using Stentor Owner Companies' 9-1-1 platforms" (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1997c). The CWTA membership as well as the PSAP representatives expressed a common desire to adopt a design that would provide a timely solution equivalent to the FCC Phase 1 requirements. The ESRD solution also met with a cost factor that was equally on the minds of the CWTA membership:

> [The] CWTA expressed concern with any proposal that would limit the speed at which a Canadian solution equivalent to the FCC's Phase I requirement can be adopted. CWTA stated that the effort required to implement the pANI option is such that *little additional effort would be required* to arrive at a FCC Phase I equivalent solution. [emph. added] (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998b)

The proposed ESRD solution met with consensus among the members of the WEWG, yet it raised the issue of numbering assignments, as each cell-site/sector would require a unique identifier that conformed to ALI database requirements. At the November 14, 2000 meeting of the WEWG, Bell Canada and TELUS indicated that they intended to propose the use of NXX 5-1-1 for the ESRD. That is, cell-site/sectors would be assigned unique four digit numbers preceded by a special prefix that would include the local NPA and the NXX 5-1-1 (i.e., 604-511-1234). This proposition required enrolling an altogether different working group in the development of Wireless E9-1-1, as NXX numbers cannot be assigned arbitrarily because they must conform to the North American Numbering Plan and other regional arrangements. Within the North American Numbering Plan (NANP), which provides the framework for a continent-wide telephone numbering system, the N11 code provides an industry standard for specific types of services. Currently N11 codes are assigned to the following services:

- 211 Public Information and Referral Services
- 311 Unassigned
- 411 Local Directory Assistance
- 511 Reserved
- 611 Carrier Repair Service
- 711 Message Relay Service (MRS)
- 811 Carrier Business Office
- 9-1-1 Emergency

Any Canadian carrier can use 411, 611, or 811, whereas other N11 codes are made available for third party services. Prior to the technical trials for Wireless E9-1-1 in Canada, the 511 code is

> held in reserve in Canada for access to Message Relay Services (MRS) by hearing persons who wish to communicate with deaf persons. Presently access to MRS by the hearing person is provided by a 1-800 number. Access to MRS by the deaf is provided by a 711 number. Consequently, in Canada, only 211 and 311 are currently available for assignment. (Canada. Canadian Radio-television and Telecommunications Commission, 2001d)

Requests for allocation and use of the remaining N11 codes are made through the CRTC, and typically handled by the CISC's Canadian Steering Committee on Numbering (CSCN). CRTC Decision 2001-475 has established principles and guidelines for the allocation of unused N11 codes in Canada.[30]

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[30] These guidelines stipulate that there must be a compelling need for three-digit access that cannot be met by other dialing arrangements; that the assignment of N11 is for a service and not a specific organization;

As it happened, the WEWG's proposal to use NXX 5-1-1 for the Emergency Services Routing Digit (ESRD) does not actually conflict with the previously reserved 511 service code for Message Relay Service (as noted above). The reason for this is based on an important distinction between the ESRD function and that of a public access service. An ESRD is a non-dialable number, which means that it is only used to populate a *pseudo NXX field* in the Wireless E9-1-1 data architecture. As such, the NXX 5-1-1 requested for ESRD is not to be confused with the public 511 service access code. A letter issued by the CRTC to the Peel Regional Police in conjunction with the Ontario Wireless E9-1-1 trial clarifies this important distinction:

> As you may be aware the Commission has recently initiated a public proceeding to examine issues relating to the assignment of the remaining N-1-1 service codes. It is noted that service code 5-1-1 is currently reserved and may be assigned in the future. It is understood however that the assignment of 5-1-1 as a service code will not conflict in any way with the use of 5-1-1 as proposed by the field trial participants, as a pseudo NXX, as ESRDs are non-dialable and do not trigger any routing.
>
> … given that the ESRD would not trigger any network routing, and that the use of NXX 5-1-1 as part of the ESRD would not impact or preclude any future use of NXX 5-1-1 as a service access code, there is nothing to preclude the use of NPA—5-1-1—XXXX as ESRDs in Canada. (Canada. Canadian Radio-television and Telecommunications Commission, 2001e)

The WEWG proposal to use NXX 5-1-1 for the ESRD was assigned a Task Identification Form (TIF 37) by the CSCN in early 2001. By July of that year the co-chair of the responsible task force at the CSCN reported to the WEWG that guidelines were being prepared for its implementation. (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2000; Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001a; Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001c; Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001d).

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assignment of N11 should be based on a need to serve broad public interest; N11 dialing should not confer a competitive advantage on service provider(s) reached by the number; services provided by N11 are to be made widely geographically available on a full-time or extended-time basis; and N11 allocation "does not conflict with NANP and is in keeping with the CSCN guidelines for N11, which state that the application of N11 should be uniform and consistent throughout the NANP area to the maximum extent practical, and the unassigned N11 codes should be designated primary for basic, or adjunct-to-basic, telecommunications services of a universal social value rather than commercial use by certain industry segments" (Canadian Numbering Administrator, 2001).

Interconnection Methods: Call-path versus Non call-path signalling

Having reached relatively early consensus on the ESRD as an acceptable mobile positioning concept for Wireless E9-1-1 in Canada, the WEWG membership turned its attention to the problem of delivering wireless call back numbers and associated ESRDs through the 9-1-1 network to public safety answering points. The basic design proposition had been approved by the WEWG, and it was now time to consider interconnection options. In the United States, Wireless E9-1-1 Phase 1 was typically classified into three basic interconnection methods: Call Path Associated Signalling (CAS), non-Call Path Associated Signalling (NCAS), and a hybrid CAS/NCAS method.

Interconnection requirements for E9-1-1 can be divided into two services with a voice component and a data component that operate in two distinct legs (see Appendix A for a schematic diagram). Voice connection proceeds from a mobile device through to mobile network switch to a 9-1-1 tandem, where it is then routed to an appropriate PSAP telephone handset. In a typical E9-1-1 system, the voice call is routed to the appropriate PSAP based on a data service using the ANI. ANI is delivered either by in-band or out-of-band signalling from a wireline end-office switch to an ILEC's 9-1-1 selective routing database, which makes up the *first leg* the E9-1-1 system architecture. The *second leg* connects the 9-1-1 tandem switch to the PSAP telephone system. The ANI provides a function in each leg of this configuration. In the first leg, it acts as a trigger for the routing of the wireline call to the appropriate PSAP. In the second leg, the ANI provides the PSAP call-taker with a visual display of the caller's telephone number (this is essentially a caller ID system), which can also be used to query an ALI database. An *ALI query* is done to obtain civic address information pertaining to the physical location of the caller. This ALI data may be linked in turn to a mapping application that will present the call-taker with a cartographic rendering of the caller's location. (See Figure 8).

Figure 8: Wireless E9-1-1 Call Flow

- First Leg (End-office to 911 tandem switch)
- Second Leg (911 tandem switch to Public Safety Answering Point)
- ALI query (PSAP equipment to ALI database)

A serious challenge for Wireless E9-1-1 interconnection stems from the fact that much of the currently installed PSAP equipment has been designed to work with a wireline ANI, often delivered in the second leg by means of call-path associated signalling (CAS). This "in-band" interconnection method places a technical limit on the amount of data that can be provided with each call—often as few as 8-digits. In the wireline environment these 8-digits are all that is required to carry a single-digit NPA signifier (a number from 1 to 4) and a seven-digit NXX-XXX call back number. Much of the installed PSAP equipment is therefore designed to accommodate ANI based on an 8-digit string that, in turn, is also used for ALI query.

In the case of interconnection arrangements for Wireless Service Providers, this 8-digit number usually represents a trunk-group and *not the specific telephone number of the handset from which the call is being made.* Moreover, this trunk-group number provides no point of geographical reference for routing the call to the appropriate PSAP or for locating the caller. In some cases where a caller was unable to report his/her location, call-takers have had to contact a Wireless Service Provider's (WSP) security desk to request a manual search of the switch records for this information.

Signalling methods established for wireline E9-1-1 thus impact on the migration to a Wireless E9-1-1 system. Each leg of the E9-1-1 system has been established with certain types of signalling technologies that will determine the kind of data that can be passed through the network. In most basic terms, signalling can be in-band or out-of-band and typically falls into several basic types. In-band signalling uses multi-frequency (MF) tones sent ahead of the voice signal to provide basic information for call set-up and billing. Standard in-band signalling systems include a range of MF services sometimes referred to as "Feature Groups". Each feature group has distinct signalling capabilities that may range from 8-digit (CAMA) to 10 or 20-digit enhanced MF (EMF).

Out-of-band signalling uses separate pathways for voice and data. With ISDN and SS7, for instance, separate logical and sometimes physical channels for voice and data are established between nodes in the E9-1-1 network (Lucent Technologies, 1999).[31] In effect, these methods differed only inasmuch as they present different means of delivering the ESRD and mobile caller ID from a Wireless Service Provider to a PSAP. Using Call-Path Associated Signaling (CAS), both voice and data follow the same pathway to the PSAP. The NCAS design, however, introduces some additional elements into the process and delivers data and a voice circuit to a PSAP via different pathways.

In the CWTA proceedings it became quickly evident that the wireless industry, PSAPs, and ILECs were of different opinion as to the best method of interconnection. Each of the

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[31] ISDN (Integrated Digital Services Network) and SS7 are both systems that permit separation of voice from data signals.

methods would have different impact on the costs for PSAPs, ILECs, and the WSPs. In autumn of 1998, the WEWG began to address in earnest the issue of CAS versus NCAS methods for Wireless E9-1-1 in Canada. The CWTA initially expressed support for a CAS solution, whereas the PSAPs in Alberta and Ontario preferred a NCAS solution, citing the cost of equipment upgrades as a major concern. Despite its position on the matter, the CWTA did recognize that a regional approach might need to be considered:

> The CWTA continues to be supportive of a CAS based solution for Wireless E9-1-1, however, the Association understands that in some areas of Canada a CAS based solution may not be feasible due to cost and/or operational impacts. Therefore, the CWTA is recommending that an evaluation of NCAS and hybrid solutions be conducted by the working group to address those regions where CAS cannot be supported. Along with this evaluation, the impact of regional solutions in comparison to the original objective of a common national approach must be identified. (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998d)

For their part in the matter, the ILECs seemed at least initially to be divided on the matter, with Stentor expressing its opinion that a hybrid solution would be most cost effective and TELUS not making any commitment at the outset of discussions. The Rogers/Cantel wireless representative of the WEWG did express concern over experience in the U.S. that seemed to indicate that the NCAS solution was proving problematic from a technical standpoint, giving some credence to the CAS method. Minutes from the September 28, 1998, meeting of the WEWG also indicate that the CAS method was being considered for trials in Nova Scotia and Manitoba (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998d). Oddly enough considering its potential implications on a number of fronts, the matter of CAS/NCAS methods was never again raised in subsequent meetings of the WEWG. In fact, it was discussed in only three meetings of the WEWG between March and September 1998.

Wireless E9-1-1 Technical Trials

Central to the WEWG activities almost since its formation was to foster a series of Wireless E9-1-1 technical trials in the Canadian Provinces of Nova Scotia, Alberta and Ontario. The earliest mention of a technical trial is a brief discussion in the November 10, 1997, minutes of a "captive" trial undertaken by Microcell and Bell in Quebec to test feasibility of using *pseudoANI* to route wireless emergency calls. It would not be until April of 1998, however, that the discussion of Wireless E9-1-1 trials would become a major pre-occupation within the WEWG. At the April 28 meeting, three ILECs made presentations outlining possible approaches to trials. Stentor expressed a negative view on call-path associated signalling (CAS), claiming that it “would not only degrade the integrity of the existing E9-1-1 network, but would also require a major network reworking in order to support a wireless E9-1-1 service that meets [FCC] Phase II requirements.” TELUS offered a presentation that introduced an NCAS approach for Alberta. A different presentation by MTS outlined a possible CAS approach for a Manitoba trial (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 1998a). Despite outstanding differences in views on interconnection methods, members of the WEWG were now clearly moving toward the implementation of technical trials for Wireless E9-1-1 in Canada.

The operational objectives of the technical trials have varied slightly according to the region in which they have been conducted (see Table 11). For instance, Nova Scotia was among the earliest Provinces to begin a Wireless E9-1-1 trial but focussed principally on a preliminary objective of simply routing MT&T wireless calls to appropriate PSAPs through the use of a pseudoANI-type arrangement. In this trial no attempt was made to actually delivery either psuedoANI or MIN data through to the PSAP call-taker’s desktop. On the other hand, the Alberta trial was far more ambitious in bringing together four wireless service providers and a Calgary PSAP to conduct a true FCC Phase 1 operation that included ESRD-based routing plus ESRD and 10-digit CBN display at the PSAP. Bell Ontario followed suit with a similar trial in the Toronto area. Of note is that at this time no discussion of FCC Phase 2 wireless trials had been reported at the WEWG, although several mobile positioning vendors had made presentations to the working group.

An important reason for the difference between Nova Scotia and Alberta may be due to the wide variation in wireless coverage between these two regions at the time. Nova Scotia was served by two wireless service providers, with limited digital PCS coverage confined to major urban centres. Alberta, on the other hand, was at the time well served by four WSPs, providing extensive analog and digital coverage across the Province. As a result, it made more sense that the Alberta trial would provide a setting for more ambitious testing of Wireless E9-1-1.

Table 11: Major Wireless E9-1-1 Technical Trials in Canada

Province	Date Launched	Lead	Enhancement
Nova Scotia	Nov/98 to May/99 (6 months)	MT&T	ESRD (routing only)
Alberta	Oct/99 to Apr/00 (7 months)	TELUS	ESRD/ANI (to the PSAP)
Ontario	Jun/01 to Dec/01 (7 months)	Bell	ESRD/ANI (to the PSAP)

Recalling my claim that the WEWG has provided a foundation for strategic niche management of Wireless E9-1-1 in Canada, the trials can be considered a prototypal design stage "in which actors learn about the design, user needs, cultural and political acceptability, and other aspects" (Schot & Rip, 1996) before committing to commercial deployment. Indeed, this was a major stated reason for undertaking the trials, which have proven to be informative from a variety of perspectives, a number of which I will address in detail using examples drawn largely from the Alberta Trial Report.

The Alberta trial officially commenced in October 1999 and was scheduled to continue until January 31, 2000, but was eventually extended to April 30. The extension was negotiated to give TELUS an opportunity to seek approval for a tariff filing with the CRTC to offer commercial trunk-side Wireless E9-1-1 interconnection. In effect, the extension was to allow the participants the option of a smooth transition from a trial to a commercial rollout of Wireless E9-1-1 by leveraging the existing trial architecture. In point of fact, however, the only WSP to adopt the service would be Microcell (Fido) who by October of 2001 had introduced Wireless E9-1-1 Province-wide in Alberta and had began testing it in the British Columbia Lower Mainland (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001b). Microcell had its reasons to move quickly to Wireless E9-1-1 but the other WSPs did not seem to share any sense of urgency following the trial's completion. Despite the apparent success of the trial and the subsequent commercial Wireless E9-1-1 tariff offering, both TELUS Mobility (which had absorbed Clearnet in early 2000) and Rogers Wireless declined to offer their customers the enhanced service and—much to the dismay of the Alberta E9-1-1 Advisory Association (AEAA) who had spearheaded the Alberta trial—have remained using line-side interconnection for basic (voice only) 9-1-1 service.

Mounting the Alberta trial for Wireless E9-1-1 was foremost an undertaking in negotiation and cooperation among the participants. Planning for what was to be a four-month long live trial took some eleven months (Nov. 1998 to Sept. 1999) to establish guidelines and, most importantly, to finalize the wording on a Memorandum of Understanding (MOU). The author of the Alberta Trial Report echoes similar sentiments to those that were expressed in WEWG meetings, when he wrote

> The single most difficult aspect of moving to the operational phase of the Trial was successfully negotiating a memorandum of understanding (MOU). … The MOU and Schedules … were an exercise in compromise that took the efforts of all participants to reach successful and amicable solutions. (Alberta E9-1-1 Advisory Association, 2000a, p. 1)

Furthermore, it is clear from related documentation that the leadership of the AEAA was paramount in the success of the trial, as it provided a coordination mechanism outside the fray of the competitive telecom carriers. The MOU provided a legally binding *vehicle of inscription* for the trial, setting out in detail the exact terms and conditions, including the following provisions:

- Trial area (geographic boundaries)
- Trial architecture (interconnection)
- Trial location data record format and presentation
- Trial call answer arrangements (PSAP equipment)
- Responsibility for costs
- Trial plan (goals, considerations, and implementation)
- Limitations of liability

The trial area was confined to a north portion of the City of Calgary, including the neighbouring rural areas but used only one E9-1-1 tandem, obviating the need for inter-tandem networking. Bell's Ontario trial, while similar in many other respects to the Alberta trial, sought to include an inter-tandem component to test the additional functional requirements of an extended configuration. The Alberta trial included only one NPA (403), although the architecture successfully passed caller ID from roaming handsets with other NPAs. A major consideration at the outset of the trial, however, was the problem of unsubscribed handsets.

In the name of promoting public safety, the wireless industry in Canada has agreed to provide 9-1-1 service to all mobile phones whether or not they are associated with an active account. The obvious problem for Wireless E9-1-1 is that unsubscribed handsets might transmit an invalid mobile identification number and it was not known if these could be prevented from being sent to the PSAP, as each of the WSPs' switches handled this situation differently. A similar problem had been raised in the WEWG meetings with respect to the availability of so-called "one button" phones that are, in effect, non-registered mobile handsets designed with a single 9-1-1 call setting and approved for sale in Canada as personal safety devices.

In dealing with this situation, one WSP decided to route these exceptional calls over its existing line-side trunks so that the invalid MIN would not be transmitted to the PSAP. For their part, the other WSPs confirmed that their switches would not transmit a dialable MIN for unsubscribed callers and therefore handled them in no special manner. However, the Report notes, "it was discovered during the Trial that … non-dialable CBNs *were* being transmitted on calls from unsubscribed callers" [emph. added] contrary to what the WSPs had claimed would happen. Despite initial confusion at the PSAP, it happened that the non-dialable MINs (e.g., NXX 111) stood out enough to be a helpful signal to trained call-takers who quickly identified the odd-looking numbers with unsubscribed handsets (Alberta E9-1-1 Advisory Association, 2000a, p. 9).

Technical design of the trial was discussed early in the planning stage, with a number of propositions placed on the table. Microcell put forth a plan to use conventional Feature Group C trunking that would permit quick implementation of 7+1 (8-digit CAMA) ESRD routing based on work previously done in the Nova Scotia trial. TELUS offered a plan based on Feature Group D trunking and 10-digit ESRD that would use existing interconnection and promised easy implementation "with [a] low risk of stranded investment." TELUS offered a second proposition, also touting a low risk of stranded investment, based on CCS7 signaling to deliver 20-digit ESRD/MIN to the PSAP by way of existing interconnection arrangements. TELUS did note, however, that this design would require upgrading their own 9-1-1 platform.

Clearnet proposed a hybrid solution based on an ISDN-PRI configuration to deliver ESRD to the PSAP. A most interesting development in the Clearnet proposal was its later revision into a more radical design that provided for "direct interconnection to PSAP's through a third party provider" and bypassed the TELUS 9-1-1 platform altogether. Trial participants agreed among themselves that a single interconnection methodology universally applied was preferred, thus ruling out the option of each WSP adopting a unique method and effectively ruling out the Clearnet third party option (Alberta 9-1-1 Advisory Association, 1998; Alberta 9-1-1 Advisory Association, 1999a).

As it happened, the TELUS proposition based on the hybrid arrangement was agreed to on March 11, 1999 and eventually implemented for the trial (Alberta 9-1-1 Advisory Association, 1999b). (A schematic diagram of this architecture is found in Appendix A.) This decision among the trial participants may be attributed in no small measure to its promise to deliver sophisticated functionality (delivery of ESRD and MIN) using existing interconnection arrangements, and which would require little by way of additional investment for the WSPs. Current PSAP equipment in Calgary was also capable of accommodating the design. Much of the risk was with TELUS who would have to upgrade their 9-1-1 platform to enable this method. In light of Clearnet's third party proposal, it is entirely conceivable that TELUS regarded this as a reasonable risk given the business opportunity in positioning itself as the sole Wireless E9-1-1 platform provider for both Alberta and BC and thus earning the revenue that would result when it issued a commercial tariff for the service.

Reported results from the trial indicate that it was a resounding success. All the objectives and considerations were rated "achieved" with the exception of cost recovery, which was to be dealt with later in the TELUS tariff application. The technical architecture proved viable and the Calgary PSAP found the enhancements improved its operations. Among the challenges and issues raised in the Report, several fall into the category of *presumptive anomalies* that Bijker refers to in light of his configuration model. In contrast to Hughes' concept of revese salients, which refers to backward-compatibility problems, the term presumptive anomalies refers to concerns that can be identified in advance of a technology deployment. The Trial Report addresses a number of these, including the problem of updating ESRD records when cell-site coverage is modified, as well as anticipated problems with invalid Mobile Identification Numbers (MINs) from unsubscribed handsets. Among the presumptive anomalies mentioned in the Report, one that would come to haunt the later development of Wireless E9-1-1 in Canada was seemingly innocuous problem of tracing the subscribers of disconnected calls:

> With the provision of MIN, wireless carriers can expect to receive a larger number of requests for subscriber information related to "trouble-not-known" calls. It is critical to ensure that 7x24 procedures between PSAPs and wireless carriers are firmly established. (Alberta E9-1-1 Advisory Association, 2000a, p. 8)

With the announcement of CRTC Public Notice 2001-110 and the regulatory crossroads that were to be reached among the WSPs and PSAPs, this issue of subscriber trace was to become a most contentious issue of debate.

If indeed the Alberta Trial was such a success, then what of the deployment of Wireless E9-1-1 in the TELUS operating territory of Alberta and British Columbia? Why is it that as of mid-2002 only one among three major WSPs operating in this territory offer enhanced 9-1-1 service to its subscribers? These questions were in fact put to both TELUS Mobility and Rogers Wireless at several WEWG meetings. Rogers Wireless has persistently objected to a number of issues in the TELUS tariff filing, noting at the time that it had only received interim approval and was thus subject to further modifications. In this regard, Rogers Wireless had filed comments on the TELUS tariff, noting problems with certain limitations of liability, which were to resurface in comments made in response to the CRTC Public Notice 2001-110.

Responding to a question at the May 8, 2001 meeting about its own Wireless E9-1-1 foot-dragging, TELUS Mobility replied “that since the Microcell Press Release six weeks ago, TELUS would not discuss their future plans for implementation in an open forum,” noting further that Microcell had “moved 9-1-1 to a commercial matter vs. a non-commercial matter” (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001d). The press release in question was issued on March 13, 2001, wherein Microcell announced its deployment of its enhanced 9-1-1 service in BC and Alberta in conjunction with a Part VII application it had filed with the CRTC requesting mandated provision of network access services for Wireless E9-1-1 (Microcell Telecommunications Inc., 2001g). Apparently the Microcell move had introduced ill will into what had previously been an open discussion among the WSPs and PSAPs. Ironically, TELUS Mobility had previously drawn on the symbolic image of a mobile phone and 9-1-1 service in order to market its products and services in Western Canada (see Figure 9).

Figure 9: Billboard advertisement (photo by author)

This was not the first time that 9-1-1 had been mentioned as a competitive service offering among the Wireless Service Providers. Clearnet had made mention of the CRTC’s local competition framework—that classifies 9-1-1 as a non-essential service, thereby including it within the realm of competitive supply—to support its bid for a third-party “Alternate Operator Services Provider” to handle Wireless E9-1-1 calls for the Ontario trial. Clearly the PSAP representatives took a dim view of the comments made by TELUS Mobility, as the record of the May WEWG meeting notes that the Ontario E9-1-1 Advisory board had “expressed disappointment that once again 9-1-1 was being discussed as a competitive service" (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001d). The Ontario Board's position was not a new development either, as it had previously submitted an appeal to the CRTC regarding the "non-essential" status the Commission had conferred upon 9-1-1 emergency services in the Local Competition Framework (Ontario 9-1-1 Advisory Board, 1997).

The Ontario trial was launched in June 2001 with an expected completion date of December. In many respects it was similar to the Alberta trial, with regional differences based on the Bell regional 9-1-1 system and the Toronto serving area and PSAPs. Bell began the trial fully intent on transitioning to a commercial rollout of Wireless E9-1-1 in Ontario. It would remain to be seen if it would prove to be a faster commercial uptake than has happened in the West. Most certainly, Microcell would move to adopt it but would Rogers Wireless remain reluctant? Bell Mobility too, had by now moved into Western Canada and had suggested to the WEWG its intention to implement Wireless E9-1-1 in BC and Alberta sometime in 2002. According to the WEWG records, Nova Scotia was the only other Province to have conducted technical trials for Wireless E9-1-1. Manitoba had announced plans for a trial in early 1998 but then put them on hold in May of that year, pending a digital upgrade and citing resource constraints resulting from then-upcoming the Pan American Games and ongoing Y2K preparations.

The record clearly shows that the wireless industry has taken the initiative to develop the technical capability for Phase 1 Wireless E9-1-1 without a regulatory mandate to prod it on. Furthermore, two of the country's largest carriers, TELUS and Bell Ontario, will likely have achieved commercial rollout to make the tariff available in most of the major population centres of Canada by year-end 2002. What remains to be seen, especially from the perspective of the PSAP representatives, is if the largely unregulated Wireless Service Providers, including TELUS Mobility, will move to adopt Wireless E9-1-1 will equal initiative.

Consensus-building in the CISC: Locus for Reflexivity?

In May 1997, a month prior to the CWTA's first roundtable on Wireless E9-1-1, the CRTC had issued Telecom Decision 97-8: Local Competition. Decision 97-8 sets forth the regulatory framework under which Competitive Local Exchange Carriers are to operate in Canada and purports to be technologically neutral and thus inclusive of wireless technology. However, the *Telecommunications Act* to some extent compelled the CRTC to forebear from regulating wireless service because mobile telephony was emerging as a competitive offering with the entry of two national PCS carriers (Microcell, Clearnet) in 1995 (Canada. Canadian Radio-television and Telecommunications Commission, 1996a). With the issuing of Public Notice 2001-110 eighteen months after the successful completion of the Alberta trial (and four months into the Ontario trial), the design of Wireless E9-1-1 in Canada was suddenly called into question. A single paragraph from Decision 97-8 had collided head-on with the CRTC's 1996 decision to forebear from regulating key aspects of the wireless sector. It seems as if Wireless E9-1-1, among other issues, has created a regulatory crossroads of sorts.

To explain the origins of this situation, I will trace out the regulatory context within which Wireless E9-1-1 has evolved and describe the series of events that have come be at the centre of Public Notice 2001-110. This overview also provides an opportunity to view the CRTC's Interconnection Steering Committee (CISC) from a CTA perspective as a locus for reflexivity, different from the strategic niche management function served by the CWTA's Wireless E9-1-1 Working Group (see Table 12). While the CWTA/WEWG was instrumental in fostering technical capabilities for Wireless E9-1-1 in Canada, the CISC by contrast has played an equally important role in transforming it into a commercially available tariff through the design of network access services. It has also been the site of an intensely heated debate between the wireless industry and the Public Safety Answering Point (PSAP) representatives on the issue of mobile telephones and customer billing records.

Let us begin this section, however, by recalling that Constructive Technology Assessment (CTA) "is an attempt to improve our chances to arrive at better path dependencies by broadening technological design and development" (Schot & Rip, 1996, p. 258). CTA practitioners have suggested three generic strategies for this process, which I am using to thematically organize the history of Wireless E9-1-1 design and development in Canada. I have so far dealt with the FCC mandate and the CWTA technical trials, and now add to this history a description of the CRTC regulatory context. Now I turn to identify the mandate of the CRTC's Interconnection Steering Committee (CISC) with the third CTA intervention strategy. I make this comparison based on the observation that the CISC emphasizes a space/process of legitimation as a primary means of achieving better path dependency within the design of the public telecommunications infrastructure in Canada. By contrast, the CWTA process emphasized stakeholder congruency through technical trials and the FCC mandate has emphasized regulation as a vehicle of inscription to intervene in technology development.

Table 12: Wireless E9-1-1 Development Compared to CTA Generic Strategies

	CTA generic strategy
FCC regulatory mandate	Technology Forcing
CWTA Wireless E9-1-1 technical trials	Strategic Niche Management
CISC W/E9-1-1 network access services	Locus for Reflexivity

Loci for reflexivity is a strategy "that attempts to create and exploit *loci*: actual spaces, forums, and institutionalized linkages between supply and demand … offering opportunities to modulate developments" (Schot & Rip, 1996, p. 262). CTA practitioners claim that it differs from strategic niche management on the basis that the alignment strategy emphasizes interventions from both the supply and demand sides rather than simply on the supply or technology side. I find this to be a murky distinction at best, given the involvement, for example, of the PSAPs (demand side) with the CWTA-fostered (supply side) technical trials. However, I think we have the makings of a clearer distinction when we recognize that a locus for reflexivity is distinct from strategic niche management (SNM) insofar as it seeks to provide legitimacy for a varied cross-section of stakeholders in the design stage. In other words, whereas SNM is an intervention strategy that turns on building *congruency* (shared frames of reference) among stakeholders, the alignment strategy turns on the creation and maintenance of *spaces/processes of legitimation* to foster a farther reaching exchange of views on technology design than might otherwise be the case. Congruency should not be confused with consensus building, as CTA practitioners have noted that the former may be sought to foster debate, rather than achieve consensus, among stakeholders (Grin & Graaf, 1996).

CTA practitioners identify three types of *loci* where alignment strategy can be implemented (Schot & Rip, 1996, p.). The first of these is "action forums" such as consensus conferences and dialogue workshops. In most cases these are temporary loci and may be quite distant from the centres where technology development is actually taking place. Under such circumstances, feedback from the forums can be very limited and its actual influence in modulating technical design equally tempered. One North American example of this strategy can be found in the consensus conferences promoted by the Loka Institute in the United States (Sclove, 1999). The second type of *loci* are those where "new platforms are created" to address emerging technologies. One example in the wireless industry might be the Wireless Location Industry Association, founded by a number of firms and related interests to further the development of location-based services through advocacy and information sharing (Wireless Location Industry Association, 2001). Typically, however, these loci are often more about removing barriers to new technology markets rather than expanding societal learning on technology issues and concerns. The third *loci* are institutional forums that have developed over time into "regular nexuses" such as technology testing labs. One example is the Canadian Standards Association, which provides test labs and certification procedures for new products (Canadian Standards Association, 2002). Such forums also come with a caveat from the CTA practitioners, who suggest that in these loci learning may drift away from substantive debates about design to issues of a comparatively benign procedural (*viz*., bureaucratic) nature:

> When a nexus has become institutionalized, learning shifts from the issue of how variation and selection can be linked, to learning how to handle specific technologies within the nexus. The institutionalization of the nexus makes it forceful, but it may also create barriers to further broaden the design and development processes. (Schot & Rip, 1996. p. 262)

I will characterize the CISC as an institutionalized locus for reflexivity based on a public-participatory and consensus-driven mandate. However, before examining Wireless E9-1-1 within the scope of the CISC we need to first determine how the largely unregulated wireless sector has over the years been engaged in a complicated and often delicate *pas de deux* with the CRTC.

Wireless Service Providers and Local Exchange Competition in Canada

As I have noted previously, the development of Wireless E9-1-1 in Canada has not been prompted by a direct regulatory mandate as in the United States. Nevertheless, the regulatory matters have had a powerful influence in shaping Wireless E9-1-1 in Canada and we need to examine these in some depth to appreciate the impetus behind this new service development. In particular, I wish to draw attention to major policy developments and regulatory decisions that have come to influence emergency services (9-1-1) deployment in the mobile wireless sector.

Telecom policy in Canada falls within the portfolio of Industry Canada, under the *Telecommunications Act* (the "Act") of 1993 (Canada. Department of Justice, 2001). Within our intervention matrix, the Act is a vehicle of inscription to support the transition to a liberalized and competition-oriented telecom sector, with a specific mandate "to foster increased reliance on market forces for the provision of telecommunications services" (sec. 7 (f)). While this mandate has set the general tone for the regulation of wireless sector in Canada, section 34 of the Act has directly influenced the CRTC's decisions regarding Wireless Service Providers in Canada.

Section 34(2) is often a touchstone in Commission decisions regarding wireless service because it establishes the terms and conditions of forbearance:

> Where the Commission finds as a question of fact that a telecommunications service or class of services provided by a Canadian carrier is or will be subject to competition sufficient to protect the interests of users, *the Commission shall make a determination to refrain*, to the extent that is considers appropriate, conditionally or unconditionally, *from the exercise of any power or the performance of any duty* under sections 24, 25, 27, 29, and 31 in relation to the service or class of services. [emph. added]

In other words, the CRTC is required to forebear from applying certain sections of the Act to carriers offering telecommunications services deemed to be within competitive markets.

Section 34 would prove to be a centrepiece for the future of the wireless sector through Telecom Decision 96-14: *Regulation of Mobile Wireless Telecommunications Services*, which established what we might call the second generation regulatory framework for Wireless Service in Canada (Canada. Canadian Radio-television and Telecommunications Commission, 1996a). While purporting to be technologically neutral, the Decision was nevertheless prompted in part by developments in wireless technology. More specifically, it followed on the heels of the appearance of digital cellular (PCS) into the Canadian market in 1995, one of a number of developments the Commission noted at the time "have cast doubt" on previous categorization of mobile wireless telecommunications services.[32] The CRTC issued its final determination in December 1996, citing section 34 of the Act and stating that it would forebear from regulating most Wireless Service Providers with respect to sections 24, 25, 29 and 31 and subsections 27(1), (5), and (6). This determination effectively de-regulated much of the wireless sector in the areas of conditions of service, tariff approval, rates and calculation methods, and inter-carrier working agreements.

At the time Decision 96-14 was issued, local exchange service in Canada remained a regulated monopoly. To this day, Wireless Service Providers, although licensed by Industry Canada, typically operate at the fringe of regulated local exchange service and as such are not required to meet certain obligations set by the CRTC. The decision to provide customer access to

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[32] Prior to Decision 96-14, the CRTC had issued a decision to forebear "unconditionally" from the wireless industry based on several assumptions steeped in technology forecasts made at the time; namely, that analog cellular and public cordless telephone services (PCTS) represented the near-term future of mobile wireless. As it turned out following the licensing of digital PCS in 1995, the CRTC changed its view on the matter, noting that PCS "will supplant PCTS services, and would appear in many respects similar to cellular services." Decision 96-14 then established a forbearance regime based on two categories of wireless services: those that interconnect with the PSTN and those that do not.

emergency services (9-1-1) is therefore not a regulatory requirement but more often than not a unilateral business decision on the part of a WSP. Providing line-side (not enhanced) access to emergency services costs little and goes a long way when marketing mobile service in the name of public safety. In some cases, as we will see, this has resulted in false expectations for customers and headaches for the public safety answering points.

From a regulatory standpoint, emergency (9-1-1) service had a somewhat unusual treatment in the framework for Local Competition (Telecom Decision 97-8) issued in May 1997 (Canada. Canadian Radio-television and Telecommunications Commission, 1997). In paragraph 113 of this decision, the Commission determined that 9-1-1 is not an "essential facility" but later in paragraph 286 of the document concludes "that it is [nevertheless] in the public interest to require CLECs to provide 9-1-1 service."[33] The determination went further to specify a quality of service requirement for CLECs:

> …With regard to 9-1-1 service, all service providers must ensure, to the extent technically feasible, that the appropriate end-user information is provided to the Automatic Location Identification database to the same extent as that provided by the ILEC. (par. 286)

In most basic terms, paragraph 286 of Decision 97-8 simply means that competitive local exchange carriers (CLECs) are required to meet certain standards for providing emergency (9-1-1) service based on those set by the Incumbent Local Exchange Carrier (ILEC) in the respective operating territory. Yet these requirements do not have any bearing upon Wireless Service Providers because they do not qualify as CLECs, under the terms of Decision 97-8. However, if a WSP chooses to apply for CLEC status, then among the obligations set forth by the framework for local competition is a requirement to provide 9-1-1 service comparable to the ILEC established standard. While this may seem a reasonable obligation in exchange for certain opportunities provided with CLEC status, a literal implementation of paragraph 286 might be problematic when considered from the point of view of a CLEC seeking to offer *mobile* wireless service.[34] This is precisely what transpired in 2000, when both Clearnet and Microcell filed

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[33] According to paragraph 74 of the Decision, to be "essential" a facility, function or service must fulfill all three of the following criteria: it is monopoly controlled; a CLEC requires it as an input to provide services; and a CLEC cannot duplicate it economically or technically. At the proceedings leading up to Decision 97-8, several parties argued that 9-1-1 should be treated as an essential facility but the Commission refused to accept these arguments in its final determination.

[34] CLEC status offers carriers certain benefits unavailable to WSPs such as local number portability (LNP) and access to contribution funds intended to offset service delivery in high cost serving areas.

applications with the CRTC to become Wireless Competitive Local Exchange Carriers (W-CLECs).

Microcell's Application for CLEC Status

In May 1999—two years after the CRTC established its local competition framework through Decision 97-8—Microcell Connexions Inc. filed a general tariff notice (TN1) with the Commission and declared its intention to become a Competitive Local Exchange Carrier (CLEC). Microcell Connexions is a Montreal-based Wireless Service Provider holding one of two national digital PCS licenses in Canada, offering mobile telephone services under the brand name Fido. At the time, the company issued a press release in conjunction with the tariff notice stating that "CLEC status is an integral part of Microcell's business plan and vision for the future of wireless" (Microcell Connexions Inc., 1998). In December, the CRTC issued Telecom Order 99-1127, denying the Microcell tariff application on the basis that is was "inconsistent with the interconnection framework that underpins local competition in Canada" and that the tariff "is significantly different from the tariffs of the incumbent local exchange carriers (ILECs) and CLECs" (Canada. Canadian Radio-television and Telecommunications Commission, 1999b).

The Order makes no mention of E9-1-1, and the Commission appeared to be concerned solely with Microcell's failure to adequately address other regulatory matters such as equal access to long distance providers and customer privacy. Microcell had tried to pre-qualify a number of these shortcomings by arguing that they stemmed directly from two factors that set its operations apart from other existing CLECs and ILECs; namely, that it was seeking to operate as a wholesaler of telecom services and that it operates a mobile wireless network that differs both in functionality and structure from conventional fixed networks. Despite the fact that local competition had been framed around the objective of technology neutrality, the matter of Microcell's proposed wholesale operation and its mobile network infrastructure were both to become technology centred issues with respect to interpreting the E9-1-1 obligations described in paragraph 286 of Decision 97-8.

Microcell filed a second general tariff application the following year in May 2000 (TN2). Its national PCS competitor Clearnet also filed for CLEC status a month later. This time Microcell's application received interim approval along with the Clearnet application in CRTC Orders 2000-830 and 2000-831, issued in September. Clearnet's application was placed in abeyance when TELUS acquired it in October 2000 and subsequently assumed its national operations under the TELUS Mobility brand.[35] Microcell continued to forge ahead with its move toward co-carrier status and it was with Decision 2000-831 that Wireless E9-1-1 entered a new phase of development. In fact, one key directive within this Decision ultimately led to a stalemate in the CRTC's Interconnection Steering Committee and the eventual issuing of Public Notice 2001-110 to examine regulatory issues concerning WSPs and their associated 9-1-1 obligations.

To grasp the full context within which Orders 2000-830/831 were issued we must consider that the Alberta wireless trial had ended a month prior to Microcell's TN2 application. The Alberta trial had proven the feasibility of Phase 1 Wireless E9-1-1 and established an accepted design for the service based on the provision of Emergency Service Routing Digits (ESRD) and 10-digit call-back number (CBN) to the Public Safety Answering Points (PSAPs). Drawing on the success of the Alberta trial, TELUS was also at the time of Decision 2000-831 preparing a tariff application for the provision of E9-1-1 network access services for its operations in Alberta and British Columbia. It was therefore to come as a surprise to many involved when the Commission in Orders 2000-830/831, issued the following orders to Microcell (and similarly to Clearnet) regarding its 9-1-1 obligations as a Wireless CLEC:

> The Commission consider that, as a CLEC, Microcell should provide the end-users of its resellers with 9-1-1 service that is better than what it currently provides them as a WSP. The Commission considers that until Wireless E9-1-1 is implemented, Microcell *should support the inclusion of the subscriber records of its resellers' end-users in the ALI [automatic location identification] databases*.
>
> The Commission [thereby] directs Microcell to update the relevant ALI databases with the subscriber records of its resellers' end-users where it operates as a CLEC. … [emphasis added] (Canada. Canadian Radio-television and Telecommunications Commission, 2000, par. 51, 52)

Much of the surprise, at least on the part of the WSPs and Microcell, stemmed from the fact that populating the ALI database with mobile subscriber records had never been discussed among members of the CWTA Wireless E9-1-1 Working Group in conjunction with Wireless E9-1-1 system design. For its part, Microcell had addressed the wording of paragraph 286 in its TN2 application, noting that a literal interpretation of the E9-1-1 obligation is not suitable for mobile wireless service providers:

[35] This was confirmed through personal correspondence (April 24, 2002 by email) with Regulatory & Public Policy at TELUS Communications Inc.

> With regard to the provision of appropriate end-user information to the Automatic Location Identification (ALI) database, we note the means by which this can or should occur is different for a mobile wireless carrier than for a fixed wireline carrier. In the case of a fixed wireline carrier, a permanent data file is entered into the ALI database for each end user, and consists of the end user's name, fixed service address and 7-digit local telephone number. However, in the case of a mobile wireless carrier, such data entry protocol clearly would be inappropriate.
>
> Mobile wireless subscribers do not remain at their fixed billing address, nor can they be uniquely identified by a 7-digit local telephone number. (A 10-digit phone number is required due to the fact that mobile wireless subscribers can roam outside their home NPA). As such it would be inappropriate and potentially confusing to enter mobile wireless end user information into the ALI database in the same manner as for fixed wireline subscribers. (Microcell Connexions Inc., 2000b)

The wording of paragraph 286 nevertheless remained a problem for Microcell and Clearnet to address in their tariff applications. Microcell dealt with it by making reference to the Alberta trial and the likelihood that TELUS was preparing to file a tariff proposal in the near future while Bell in Ontario and Quebec, and MT&T in Nova Scotia were actively working toward Wireless E9-1-1 tariffs by way of technical trials in their respective operating territories. Microcell's application intimated a congenial, progressive mood within the telecom industry, a feeling conveyed in its expressed opinion that "a migration to Wireless E9-1-1 can and should occur swiftly across Canada." However, in the meantime, Microcell admitted that wireless carriers will "have no practical choice but to continue to employ existing 9-1-1 call routing arrangements," which meant line-side interconnection with no ANI/ALI functionality. Microcell's commitment was founded on a *trial-before-tariff* argument, which advocated that technical trials be undertaken in each of the ILEC serving territories as a prerequisite to the filing of commercial Wireless E9-1-1 network access service tariffs. In sum, Microcell wanted status quo in the interim, with a pledge to adopt Wireless E9-1-1 service as it became available on a commercial basis across the country. Clearnet's tariff application presented a largely identical argument.[36]

Comments submitted to the CRTC on Microcell's tariff application came from TELUS, Bell and its affiliates, and the Alberta E9-1-1 Advisory Association (AEAA) on behalf of the

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[36] In part because of the similarities between Microcell and Clearnet applications and because of the suspended state of the Clearnet tariff I have chosen to deal in detail only with the former's tariff application in my study.

PSAPs. Bell and AEAA objected to Microcell's deployment strategy based on the view that arrangements could be made immediately available to improve the functionality of wireless 9-1-1 before the implementation of a commercial tariff. Bell stated that it was prepared to make a trunk-side interconnection arrangement available that would provide some enhanced features to Microcell. Bell was also concerned that Microcell's "hybrid" interconnection arrangement, as Bell referred to it, would establish an asymmetrical regulatory environment in which wireless CLECs could circumvent certain obligations on the basis of technical arguments (Bell Canada, 2000b). In a similar set of comments to the Clearnet tariff notice, Bell stated that "Agreeing to treat wireless CLECs differently to any other established CLECs might pose serious issues, concerns and general inequities about emerging [i.e., advanced] technology-based LECs" (Bell Canada, 2000a, par. 28).

The AEAA characterized the advent of wireless technology as an "ongoing erosion of the E9-1-1 database" and objected to Microcell's interpretation of paragraph 286 by claiming that "the inclusion of any and all information that is automatically delivered with an E9-1-1 call is vital" in order to fulfill "the PSAPs legal and moral obligation to locate callers who call 9-1-1 but can't communicate …" (Alberta E9-1-1 Advisory Association, 2000b). TELUS was largely silent on the matter of Wireless E9-1-1 design, choosing rather to criticize Microcell's reluctance to enter into 9-1-1 service contracts prior to the approval of commercial tariffs for the enhanced service (TELUS Communications Inc., 2000). All three parties to the proceeding advocated that Wireless E9-1-1 interconnection arrangements be taken up with the CISC Emergency Services Working Group rather than the CWTA's Wireless E9-1-1 Working Group, where the technical arrangements had been first developed.

Microcell's response to these comments was that its proposed approach to Wireless E9-1-1 deployment was the most effective means "to minimize disruption and confusion" among the various parties during the transitional period. In other words, it would adopt the status quo as an interim approach rather than deploying ad hoc and non-standard solutions to simply fulfill the wording of paragraph 286. Furthermore, Microcell suggested in its reply comments that Bell's offer of trunk-side interconnection was "greatly oversimplifying the effort required to implement even a partial enhancement of wireless 9-1-1," citing the findings of the Alberta trial report as an example of the extensive consultation and preparation required (Microcell Connexions Inc., 2000a, par. 47).

The AEAA recommended that Microcell be required to populate the ALI database with subscribers' records until such time as a FCC Phase 1 equivalent system was in service. Microcell dismissed this idea on the grounds that these records provided irrelevant information, that this design proposition had not formed any part of the wireless E9-1-1 discussion within the scope of industry activities and the FCC mandate. Moreover, Microcell claimed that the PSAPs were not technically capable of automatically receiving the data even if it were made available (par. 70-72), with the wry suggestion that another agenda might underlie the PSAP position on the matter:

> Microcell notes that the law enforcement community has raised the issue of the entry of wireless subscriber records into the ALI database as part of a broader effort to create a universal telecommunications subscriber information database in Canada. This effort has been met with expressions of serious concern from wireline and wireless carriers alike. Microcell suggests that if the PSAP or law enforcement communities want to pursue this issue further, it should not be in the context of a Microcell tariff notice but rather in the context of an explicit and open application to the Commission. (Microcell Connexions Inc., 2000a, par. 74)

Microcell repeated this allegation within the CISC Emergency Services Working Group in February of 2001, pointing out that nowhere in previous trials had subscriber records ever been considered as a feature of Wireless E9-1-1. The idea, according to Microcell, may have come from the CISC Network Security Working Group, "where law enforcement representatives had included it as part of an omnibus proposal to develop what could best be referred to as a universal telecommunications subscriber information database covering both wireline and wireless subscriber data." Microcell further suggested "the fact that this initial discussion took place in a law enforcement context raises questions as to the relative weight of 9-1-1 service motives and non 9-1-1 service motives behind the [ALI] proposal." (Microcell Telecommunications Inc., 2001e, sec. 2.3).

The need to minimize confusion and disruption was also cited by Microcell to defend the CWTA as an appropriate forum for developing Wireless E9-1-1, as opposed to the CISC as recommended by the ILECs and AEAA (par. 63). One possible clue to this objection may be derived from comments made by Microcell in its TN2 application, where it makes reference, on a related matter, to delays inherent in the CISC process and where, "We believe there are incentives for the ILECs, and perhaps other parties, to extend that delay" (Microcell Connexions Inc., 2000b, schedule 1,section E).

As it turned out, the CRTC ruled largely in favour of the comments submitted by the ILECs and the AEAA. Microcell and Clearnet were to implement Wireless E9-1-1 where and when it became technically feasible, but in the meantime would be required to populate the ALI database with subscriber records and adopt Bell's trunk-side routing arrangement to provide limited enhanced functionality. Furthermore and in line with the ILEC/AEAA recommendations, the CISC Emergency Services Working Group (ESWG) was directed by the CRTC to develop the necessary interconnection arrangements for Wireless E9-1-1.

By February 2001, TELUS had received interim approval from the CRTC for its Wireless E9-1-1 network access service. This tariff enabled Microcell to begin offering Wireless E9-1-1 in Alberta and parts of British Columbia in March 2001 (Microcell Telecommunications Inc., 2001g).[37] Per the CRTC's direction, the technical details of populating the ALI database with subscriber records were now being discussed in the CISC ESWG, as was a revision of the *CLEC Trunk-Side Interconnection Document* that would provide the framework for the provision of E9-1-1 network access services to wireless CLECs.

TELUS Tariff Notices 327/4120

On December 8, 2000 TELUS Communications Inc. (TCI) of Alberta and TELUS Communications British Columbia (TCBC) filed with the CRTC Tariff Notices (TN) 327 and 4120 respectively, both titled "Wireless Service Provider Enhanced Provincial 9-1-1 Network Access Service" (Telus Communications (B.C.) Inc., 2000; Telus Communications Inc., 2000). With the filing of these Tariff Notices, Wireless E9-1-1 was translated into a legal and working technical system through a set of related vehicles of inscription. The first among these was the tariff notice itself, which is a statement of intent made available for public consultation that sets out the terms and conditions of a proposed telecommunications service offering. The corresponding components to the tariff notice are the actual revisions to the ILEC's tariff page and the set of legal agreements between the ILEC, the WSP, and the local municipality or PSAP. In the case of TELUS's Wireless E9-1-1 service offering, the documentation consisted of a Tariff Notice, revisions to the Provincial E9-1-1 service offering, addition of a WSP E9-1-1 service offering in the General Tariff, as well as corresponding legal agreements. Recalling that a Wireless E9-1-1 system is designed in two legs, there is a requirement for documents that deal with the first leg (WSP to ILEC) and documents for the second leg (ILEC to PSAP and WSP to PSAP).

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[37] It is curious to note that a search among the archived press releases on the TELUS website (in April 2002) did not turn up a corresponding announcement of the interim approval for the Wireless E9-1-1 tariff. Also of note is that the Clearnet archive (available through the TELUS website) does not contain any press releases mentioning its interim approval for Wireless CLEC status.

The proceeding that followed the TELUS tariff notice included comments from the Alberta E9-1-1 Advisory Association (AEAA), the BC 9-1-1 Service Providers Association (BC SPA), and the Canadian Wireless Telecommunications Association (CWTA). Once again, the PSAP representatives raised the issue of wireless subscriber records and the ALI database. Significantly, and even though it was filed after CRTC's Orders 2000-830/831, the TELUS tariff notice made mention of neither a requirement for WSPs to submit subscriber records to the ALI database nor provided an administrative means for doing so in its service offering. In fact, when responding to PSAP comments on this issue, TELUS noted the following:

> The proposed service is the result of the findings and conclusions reached during the Alberta Enhanced 9-1-1 Wireless Trial, the scope of which was understood and agreed to by the members of the industry who participated in the trial. The trial and subsequent service development did not take into account the technical and operational issues or the costs associated with the management of such an enhancement to the proposed service. The AEAA's request [to include subscriber records in the ALI database] is therefore clearly beyond the scope of the proceeding surrounding TN 327 and TN 4120, a fact also noted by the CWTA in its comments, and should be rejected. (TELUS Communications Inc., 2001b, par. 6)

Despite the fact that directives in CRTC 2000-830/831 supported the position of the AEAA on subscriber records and the ALI database, the case seemed to be crumbling as the Wireless E9-1-1 service offering was becoming operational; the TELUS tariff simply ignored the ALI directive altogether. Furthermore, the original comments issued by the BC SPA that aligned with the AEAA's position were immediately revised to more closely align with the CWTA position, thereby placing the feasibility of the subscriber records requirement in further doubt. The BC SPA comments were not to be taken lightly, as they represented the first region in Canada prepared to deploy Phase 1 equivalent Wireless E9-1-1 (BC 9-1-1 Service Providers Association, 2001c).[38]

The AEAA also included a letter in its comments that had been sent to TELUS in June 2000, after completion of the Alberta trial, as a letter of thanks and statement of "strong support"

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[38] In their comments to the CRTC, the BC SPA first aligned directly with the AEAA in requesting that all WSPs be required to place their subscriber records in the ALI database. A revised version of the comments (issued later the same day) contained the following clarification vis-à-vis their original position: "My intention is to stress that all wireless service providers be made *to provide the service being proposed by TELUS in this Tariff application*." [emph. added] (BC 9-1-1 Service Providers Association, 2001c). Effectively, this revision advocated the design of the TELUS system without forcing an outright dismissal of the ALI directive, but the message clearly seemed to be that the ALI requirement is not of significant interest to the BC SPA in this phase of Wireless E9-1-1 deployment. Personal conversations I have had with BC SPA representatives seem to support my claim on this matter.

for the proposed tariff. Oddly enough, even though the AEAA appeared to have a firm grasp of the design being proposed, the letter made no mention of including wireless subscriber records in the ALI database. The AEAA also introduced a line of argument in its comments that would continue into other proceedings yet failed to deal with the inherent problem that mobile terminals presented to an E9-1-1 service. In its comments, the AEAA suggested that even with high resolution (i.e., FCC Phase 2) location capabilities, Wireless E9-1-1 systems "would still only get emergency services to the front door of an apartment building" and that "properly provisioned 'wireless service provider ALI records' [*sic*] in the database, delivered concurrent with the voice call will guide them to the correct apartment in precise and timely fashion (Alberta E9-1-1 Advisory Association, 2001b, par. 7).[39]

Of course the problem with this claim is that it assumes mobile calls are often made from the same address where the telephone subscriber is assumed to reside, based on the information contained in the WSP's records. However, mobile terminals—as Microcell would later go to great lengths to illustrate—do not conform in any reliable sense to the established (wireline) ALI administrative system, hence the need for an alternative design for Wireless that provides comparable functionality under profoundly different conditions. While it is conceivable that subscriber records could indeed be useful under certain circumstances, the AEAA wanted *real-time access* to subscriber records "… delivered concurrent with the voice call …", a design requirement that has been dismissed repeatedly by the CWTA and the ILECs as not feasible in either a technical or administrative aspect.

One of the appendices to the AEAA comments is interesting to consider in this respect because it sheds some insight on the organizational culture of PSAPs and the way they interpret their obligation to serve the public. The letter was written by the Deputy Fire Chief of Strathcona County in Alberta (it is undated and originally addressed to the CRTC), and is titled "Consequences Caused by the Lack of Wireless Callers Information." It describes a shooting that took place in a rural part of central Alberta in late August 1999, where the lack of a call back number and location information were attributed to a delay in emergency response. Three people died on the scene while the emergency operator was unable to provide additional assistance to the emergency services. The author admonishes TELUS for its public safety-based ("Cellular saves lives") marketing campaign at the time, claiming the practice as "dangerous" because of the false

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[39] The Ontario E9-1-1 Advisory Board also used the "apartment door" argument in a Contribution to the CISC Emergency Services Working Group in March 2001 (Ontario 9-1-1 Advisory Board & Alberta 9-1-1 Advisory Association, 2001).

expectations it creates in mobile phone subscribers. However, perhaps the most significant contribution this letter offers in the Wireless E9-1-1 case is that it introduces an otherwise overlooked human perspective on the situation when the author expresses the personal frustration that he and his staff have experienced with respect to calls originating from wireless phones. He also writes of the emotional impact the shooting incident has had on the operator who handled the call:

> The Dispatcher answering the call for help from the lady being shot has suffered through a very traumatic experience. Not having basic information gave her a sense of not being able to help the caller during her last few minutes of life. Further to this, [*sic*] talking to her husband when he knew his wife was dead and venting his frustrations over the phone. This call has had a profound impact on the Dispatcher. The County will endeavour to seek … counselling for the individual, however, I believe the Dispatcher will be scarred for life by this call. (Alberta E9-1-1 Advisory Association, 2001b, Attachment C)

Testimony given in the letter from Strathcona County reflects what appears to be fundamental difference in problem formulations between the WSPs and the PSAPs. Whereas the CWTA referred to a need to minimize costs and Microcell advocated a need to minimize confusion and disruption in the transition to Wireless E9-1-1, the PSAPs formulated the problem according to its impact on professional practice, their legal and moral obligations to serve the public, and its ultimate effect on human lives.

Other issues introduced during the Tariff Notice proceeding included concern about liability and indemnity provisions in the legal agreement. The CWTA submitted comments to the effect that the legal agreements were one-sided and provided unfavourable terms for TELUS on the matters of liability and indemnity. TELUS responded with the claim that the legal agreements were based on a previous wireline E9-1-1 agreement established through the CRTC Interconnection Steering Committee and therefore provided acceptable terms and conditions.

The TELUS tariff received interim approval by the CRTC on February 2, 2001 and Microcell (Fido) introduced Wireless E9-1-1 service to its customers in Alberta and British Columbia one month later (Canada. Canadian Radio-television and Telecommunications Commission, 2001f). As of summer 2002 no other WSP offered Wireless E9-1-1 to its customers in these Provinces.

Bell Tariff Notice 6629

At the conclusion of the Ontario Wireless Trial in November 2001, and a year after the TELUS filing, Bell filed its own Tariff Notice for Wireless E9-1-1 network access service (Bell Canada, 2001b). Bell's stated intent was to make the service available in the Toronto trial area by January 2002, with wider deployment planned for June. In this proceeding, comments from the wireless industry were not submitted by the CWTA but rather by Rogers Wireless Inc. and Microcell individually. Microcell largely applauded the tariff proposal and recommended only minor changes, but did recommend the CRTC direct Bell to produce a firm deployment schedule for the service. Microcell also requested clarification on rates and charges pertaining to its status as a W-CLEC and whether it would be required to pay the full CLEC rate for E9-1-1 service or whether the half-rate for WSP (basic) 9-1-1 network access service established in Decision CRTC 99-17 would remain in effect (Microcell Telecommunications Inc., 2001c, par. 5, 14).

Rogers Wireless Inc. (RWI) raised numerous concerns with respect to liability and indemnity provisions in the legal agreement, claiming that they were "biased in favour of Bell" (Rogers Wireless Inc., 2001a, par. 4). RWI also expressed concerns with segregated trunks, telephone number charges, termination conditions, and CCS7 facilities, most of which had been previously raised by the CWTA in the TELUS tariff proceeding. RWI characterized these concerns as a symmetry issue inasmuch as they claimed the Bell tariff places unfair terms and conditions on the WSPs. Above all, however, Rogers Wireless cites the liability and indemnity provisions as the most significant issue in both the TELUS and Bell tariffs, and its primary reason for not having yet offered Wireless E9-1-1 to its customers in Western Canada (Canadian Wireless Telecommunications Association. Wireless E9-1-1 Working Group, 2001b). Rogers Wireless cites the US Wireless Communications and Public Safety (9-1-1) Act to support its claim that WSPs are entitled to better liability protection than that afforded in the TELUS and Bell legal agreements (par. 20). This despite the fact that Bell and TELUS in their defence both highlighted that their agreements draw directly upon a consensus document produced by members of the CISC Emergency Services Working Group for wireline E9-1-1 network access service to CLECs. Here, Bell takes the opportunity to criticize Rogers Wireless for its lack of participation in the CISC activities, observing that it "has been largely absent from the ESWG and … appears to have little or no understanding of the respective risks assumed by [Bell], WSPs and municipalities in relation to the delivery of 9-1-1 service [which] is telling" (Bell Canada, 2002, par. 26).

The PSAP representatives remained absent from the comments on the Bell tariff notice. The Ontario E9-1-1 Advisory Board submitted no comments to the proceeding and not a single word was mentioned in conjunction with Bell's proposed Wireless E9-1-1 service offering with respect to the outstanding issue of entering wireless subscriber records into the ALI database. This unusual circumstance may have had something to do with the fact that the issue had by that time reached an impasse in the CISC and the CRTC had a month previous to the Bell tariff filing issued Public Notice 2001-110 to further examine the question of WSPs and E9-1-1 services. On December 21, 2001 the CRTC approved the Bell tariff on an interim basis, paving the way for the second region in Canada to make Wireless E9-1-1 network access service commercially available (Canada. Canadian Radio-television and Telecommunications Commission, 2001h).

Microcell had pledged in its comments during the TN6629 proceeding that it would seek to immediately enter into an agreement with Bell for Wireless E9-1-1 network access service and modify accordingly the Part VII application it had previously made requesting that the CRTC mandate the deployment of Wireless E9-1-1 across Canada.

Microcell's Part VII Application

On March 13, 2001 Microcell filed an application with the CRTC, seeking relief in seven Canadian Provinces from barriers to the deployment of Wireless E9-1-1. This application and request was filed under Part VII of the *CRTC Telecommunications Rules of Procedure*, which sets forth the process by which certain kinds of applications for relief can be made to the Commission.[40] Under the Rules of Procedure, a Part VII application must contain a number of elements including "a clear and concise statement of the nature of the order or decision applied for" and the title and section of the statute under which it is made; "a clear and concise statement of the facts upon which the applicant relies"; and "proposed directions on procedure where the applicant requests a particular form of proceeding or seeks to vary or supplement these rules"

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[40] The *CRTC Telecommunications Rules of Procedure* specifies several types of applications that may be made to the Commission by regulated companies and other parties. The term "Part VII" refers to a general section within the Rules of Procedure describing the procedure for a specific type of application. Part I describes the overall framework for the Rules of Procedure, but other application types are included under separate "Parts" including applications by regulated companies for approval of tariff pages (Part II), general rate increases (Part III), certain applications concerning agreements and limitations of liability (Part IV), capital stock issues (Part V). Some application types address complaints by a subscriber or potential subscriber of a regulated company (Part VI). Part VII applications are intended to capture "other applications by any person" and thus may deal with a wide variety of possible issues and concerns from an equally wide variety of parties (Canada. Canadian Radio-television and Telecommunications Commission, 2001c).

(Canada. Canadian Radio-television and Telecommunications Commission, 2001c). In other words, a party files a Part VII application with the CRTC as a means of requesting that certain specified kinds of action be taken to provide relief on a particular matter. The application may be directed against another party and a public procedure is specified to provide for interventions, reply comments, and interrogatories from the Commission and others. Part VII applications are highly structured, principally written, public proceedings on specific matters of telecom policy or regulation.

Microcell filed the Part VII to request of the CRTC "mandated provision of Wireless Enhanced 9-1-1 network access services," asking the Commission "to take action to ensure that other Incumbent Local Exchange Carriers … follow the lead of TELUS Communications Inc. … in providing network access services that permit wireless carriers to enhance their contribution to public safety in Canada" (Microcell Telecommunications Inc., 2001b). The timing of the application fell a month after the CRTC gave interim approval of the TELUS wireless E9-1-1 tariff and well before the Ontario trial had commenced. In its bid to become a wireless CLEC, Microcell was struggling with the directives given to it by the CRTC under Decision 2000-831; namely, the requirement to adopt Bell's trunk arrangements as well as to begin populating the ALI databases with subscriber information where Wireless E9-1-1 was not available. As I have noted, these decisions perplexed many in the wireless industry for their sudden and, for some parties, unfounded ascendance in the regulatory proceedings.

Microcell had opposed the Decision's directives on the grounds that the Bell arrangements were but an *ad hoc* solution and not a wise use of resources that could be better invested in testing and deploying true Phase 1 service. The ALI obligations were contested on the grounds that they were also a waste of time and money to implement, especially given the perceived irrelevance of subscriber records for *mobile* emergency calls. From Microcell's point of view, Decision 2000-831 amounted to a costly effort to implement temporary solutions while awaiting deployment of Wireless E9-1-1 service in its operating territories outside Alberta and British Columbia. The Decision specified that Bell's trunk arrangements and ALI obligations would persist until Wireless E9-1-1 became available in an operating territory, at which point Microcell would be obligated to make E9-1-1 available to its subscribers in that territory. Comments submitted by Microcell suggest that it had no objection to the E9-1-1 obligation but was opposed to the temporary arrangements imposed on it in 2000-831.

Of note is that the Part VII application did not request that other WSPs be mandated to provide E9-1-1 service, only that the ILECs be mandated to make available the requisite interconnection arrangements ("network access services"). Looked at strategically, the Part VII application appears to be a bid by Microcell to avoid implementing the temporary obligations of Decision 2000-831 by seeking a mandated offering of Wireless E9-1-1 network access services in Canada. Such a mandate would provide certain assurance that Microcell could draw upon to argue its case *against* the feasibility of deploying temporary solutions in return for a guarantee to the Commission that it would, as a Wireless CLEC, deploy Wireless E9-1-1 on a national basis within a known timeframe.

Microcell's application met each of the requirements established in the Rules of Procedure, addressing them as separate sections within its application. The document established its claim to legitimacy by citing section 32(g) of the *Telecommunications Act*;[41] it went on to describe the success of the Alberta trial, highlighting the Alberta/BC deployment as evidence for the feasibility of Wireless E9-1-1 deployment in other parts of the country; and, finally, it lists the major ILEC carriers from which it seeks relief by specifying their current and future capabilities to offer Wireless E9-1-1 service network access service (Microcell Telecommunications Inc., 2001b).

Upon considering the application, the CRTC issued a set of interrogatories intended to gather further information on matters raised in Microcell's case. Respondents to these interrogatories included the ILECs, several Wireless Service Providers, and a handful of Independent Telephone Companies in Ontario and British Columbia. None of the PSAP representatives offered comments on the Part VII application, with the notable exception of the Montreal Urban Community/Union des municipalités du Québec (MUC/UMQ). The MUC/UMQ had submitted comments in the first round of the proceeding to request that the Commission modify the definition of Wireless E9-1-1 to include the real-time transmission of subscriber record information in addition to the 10-digit call back number and ESRD/ promoting the ALI database obligations. These comments were later withdrawn in their entirety after Microcell sharply criticized the MUC/UMQ for being "impractical, unhelpful and particularly disappointing given the opportunity they have wasted to support the advancement of public safety that the Application presents …" (Microcell Telecommunications Inc., 2001a, par. 52). It is curious that the other PSAP representatives, who had been so vehement in their stance on improving wireless

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[41] According to Microcell, the basis for its Part VII application stems from section 32(g) of the Act, which sets out general powers of the CRTC with respect to rates, facilities and services. The specific wording of 32(g) is an open provision that permits the Commission to "determine any matter and make any order relating to the rates, tariffs, or telecommunications services of Canadian carriers."

9-1-1 call provisions, remained utterly silent on the Part VII application when this represented an opportunity to lobby for mandated Wireless E9-1-1 across Canada.

Microcell sought specific relief in the Part VII application, and this can be categorized into two types of remedies. In order to support its stated request "that the Commission take action to ensure that Wireless Enhanced 9-1-1 is deployed expeditiously and to the greatest extent across Canada", Microcell proposed a number of directives to this end. Building on the success of the Alberta trial and its technical design, Microcell framed its proposed directives in terms of the technical capabilities of the ILECs in each of the Provinces. The TELUS design for Wireless E9-1-1 was based on CCS7 signalling and upgrades to the Nortel DMS 9-1-1 switching platform. Where an ILEC was currently operating with a similar platform—as is the case with Bell, IslandTel, NBTel, and SaskTel—the application proposed that these ILECs file tariffs and supporting agreements within 60 days for the provision of Wireless E9-1-1 via CCS7 interconnection "on equivalent terms and conditions to those approved for TELUS." In cases where a different platform was in use, the application proposed different form of relief depending the particular circumstances.

In the case of Nova Scotia, MTT (now Aliant) was at the time operating a Rockwell 9-1-1 switch but intended to replace it with a Nortel switch in "the near future" according to Microcell. However, in the meantime, MTT was providing its mobile affiliate with simple enhanced service using Feature Group C (FGC) trunk-side interconnection.[42] Microcell proposed two directives in this case. One, "to immediately provide non-affiliated wireless carriers with a legal agreement and detailed implementation supported documentation for FGC trunk-side interconnection to its existing 9-1-1 platform"; and to "ensure" that Phase 1 interconnection arrangements "are included as an integral part of its replacement [Nortel] 9-1-1 platform" along with the required tariff and supporting agreement for commercial provision of the service to non-affiliated carriers.

In the case of Manitoba, MTS was at the time operating a CML-manufactured 9-1-1 platform that, according to Microcell, was capable of supporting Feature Group D (FGD) trunk-side interconnection. FGD is capable of transmitting the 20-digit string necessary for FCC Phase

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[42] FGC interconnection service is most likely based on CAMA (Central Automatic Message Accounting) trunks, which transmit an 8-digit number in the signalling portion of the call set-up procedure. CAMA trunking was originally developed for recording and reporting of telephone call information at tandem switches. For Wireless E9-1-1 it can be adapted to provide a single digit NPA code number plus a seven-digit ESRD suitable for *routing* of mobile calls to the correct PSAP. This functionality is what is meant by the term "simple enhanced service." It provides neither ANI functionality nor true ALI functionality because cell-site/sector data is not made available to the PSAP operator.

1 equivalent service and therefore provides a technical alternative to CCS7 interconnection. Microcell's application proposed that MTS be required by the CRTC to file within 60 days a tariff and supporting agreement for FGD-based Wireless E9-1-1 network access service in its operating territory.

The only exception in the lot was for NewTel, which serves the Province of Newfoundland. At the time of the Part VII application, NewTel offered only basic 9-1-1 service in its operating territory, thereby rendering any form of enhanced 9-1-1 service (wireline or wireless) not feasible because there was no switching platform to support it. Nevertheless, Microcell requested that the CRTC "direct NewTel to ensure that Wireless Enhanced 9-1-1 network access service is included as an integral part of any future proposal to provide enhanced 9-1-1 service in its operating territory."

As one might expect, the ILECs were unanimously opposed to a mandated approach for Wireless E9-1-1 network access services. Comments from the ILECs in the first round of the proceeding cited numerous reasons to deny the Application based on the position that Wireless E9-1-1 was a far more technically complex undertaking than portrayed by Microcell, that the PSAPs would be significantly impacted in the process, that associated costing and tariff issues would need to be closely examined, that the US FCC mandated approach to Wireless E9-1-1 had not been successful, and that Microcell's proposed relief was contrary to certain provisions in the Local Competition framework.

For instance, Bell in a joint submission with Aliant, MTS, and SaskTel, argued that Microcell was "trivializing" the efforts required for Wireless E9-1-1 interconnection by failing to properly account for different levels of software, different 9-1-1 system architecture and different equipment at the various PSAPs across the country. Bell adds that "modifications to the ALI output to the PSAPs are subject to a mandatory six to ten month terminal to network interface disclosure requirement" calling into question the sixty-day timeline proposed by Microcell. Furthermore, Bell referred to comments that Microcell had made in the TN2 proceeding testifying to the complexity of implementing even a partial enhancement of Wireless E9-1-1 service.[43] The Bell comments also claim that Microcell's proposed timeline "greatly understates" the "labour intensive process" required to map cell sites to emergency service zones and create corresponding

[43] Recall that I had previously noted Microcell's claim that Bell's offer of trunk-side interconnection was "greatly oversimplifying the effort to implement even a partial enhancement of wireless 9-1-1". These comments were made in an effort to demonstrate to the CRTC that interim E9-1-1 solutions were not a feasible approach to fulfilling paragraph 286 of Decision 97-8.

ALI database entries (Aliant Telecom Inc., Bell Canada, MTS Communications Inc., & Saskatchewan Telecommunications, 2001b, par. 14-16, 21-26).

Bell Mobility expressed the view that a mandated approach was unwise given the poor results achieved in the United States under the FCC requirements. To bolster its position it noted that "less than 15% of the US wireless market has seen deployment of Phase 1 functionality" and that "the adoption of a mandate has not produced the desired result". Furthermore, Bell Mobility pointed out that the FCC has faced an additional burden of dealing with requests for waivers and mediating disputes associated with delays in deploying Wireless E9-1-1, perhaps in an effort to give the CRTC pause for concern (Bell Mobility, 2001b, par. 9).

Despite being the first to offer a Wireless E9-1-1 tariff in Canada, TELUS also opposed the Part VII application based on experience from the United States that suggested a mandate would be counter-productive due to a lack of coordination among stakeholders and that a "joint planning approach … ensures that all interests are accounted for and all solutions are explored." Moreover, according to TELUS such an industry-led approach would "also [ensure] that the resulting service and tariffs will be consistent with the capabilities of the participants" (Telus Communications Inc., Telus Mobility, & Rogers Wireless Inc., 2001, par. 18).

TELUS also raised the matter of 9-1-1 service within the Local Competition framework established in Decision 97-8, arguing that because 9-1-1 service is not deemed an essential service under the terms of the Decision, the CRTC would be forcing ILECs to provide a competitive service. Even more problematic, TELUS claimed, was that forcing the WSPs to use an ILEC Wireless E9-1-1 service "would have the effect of remonopolizing 9-1-1 service since wireless carriers would have no other option than to subscribe to the ILEC's service" (Telus Communications Inc. et al., 2001, par. 20-21). TELUS' comments anticipate a matter raised later in Public Notice 2001-110 but overlooked the fact that Microcell did not request such direction in its Application to the CRTC, only that the ILECs make the service available to WSPs.

Microcell responded to each set of objections in turn, claiming the current tariff offering in Western Canada proved that ILECs' technical arguments were "a cover for inaction" because "the differences that exist between the TELUS 9-1-1 platforms in [Alberta and BC] are as great or greater than the differences that exist between any other two 9-1-1 platforms in Canada" (Microcell Telecommunications Inc., 2001a, par. 6). Responding to comments about the labour involved in deploying Wireless E9-1-1, Microcell cautioned the CRTC against falling for the ILEC's "new found sensitivity to the workload of the PSAPs and wireless carriers in matters of wireless E9-1-1." Microcell reminded the Commission of the way in which Bell strongly advocated FGC trunk-side routing arrangements in the Wireless CLEC tariff notice proceedings (later adopted by the CRTC as a directive in the Orders 2000-830/831). Noteworthy for Microcell is its claim that the FGC design requires “precisely the same ESRD mapping and data entry processes that the Respondent ILECs now find so burdensome for PSAPs and wireless carriers to undertake” (par. 16). With respect to the FCC mandate, Microcell replied that the “fundamental failing” of the U.S. approach was that while it required WSPs to transmit E9-1-1 data elements it offered no means of ensuring that intervening 9-1-1 service platforms would be capable of handling these data elements. In support of this claim, Microcell offered anecdotal evidence to suggest that there had been cases in the United States where incumbent local carriers had refused to provide data interfaces to their ALI databases for incoming wireless E9-1-1 data (par. 29). In contrast, Microcell’s proposed directives were “expressly designed to overcome the fundamental failing of the FCC’s approach” by ensuring that key bottlenecks to Wireless E9-1-1 service (i.e., the ILECs’ E9-1-1 platforms) would be made available to wireless service providers *in advance* of any FCC-like mandate.[44] Microcell also took the opportunity in its reply comments to highlight what was in its view MTT’s “obstinate refusal” to provide legal and technical support documentation for currently available FGC trunk-side interconnection to support simple enhanced Wireless E9-1-1 service in Nova Scotia (par. 40).

Having reviewed the Application, the first round of comments, and Microcell’s reply comments, the CRTC saw fit to issue a set of interrogatories in an effort to gather further information on the matter of technical complexity and related timeframes for deployment. Two interrogatories were issued to wireline carriers (ILECs and independent telcos) requesting information on a timeline for implementation of Wireless E9-1-1 and local E9-1-1 capability. One interrogatory was issued to the WSPs, including Microcell, and requested information on labour and a forecasted timeline for implementation (Canada. Canadian Radio-television and Telecommunications Commission, 2001a). More specifically, the CRTC wanted more information on three questions: how long would it take wireline carriers to implement Wireless E9-1-1 network access services in their respective territories? What was the current capability of

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[44] This is a subtle but important point of distinction that pertains to the design of Wireless E9-1-1 interconnection arrangements. Microcell’s position suggests that the FCC mandate addressed the edges, or periphery, of the telecommunications network infrastructure and ignored the embedded core elements needed to ensure end-to-end interconnectivity. In policy terms, such a decision may be a deliberate attempt to promote the growth of alternative networking arrangements for 9-1-1 service. Likewise, it may also have been an unfortunate oversight given the fact that, as Microcell also pointed out in its reply comments, the US situation involves “a near mind-boggling fragmentation” of 9-1-1 service platforms and associated arrangements (Microcell Telecommunications Inc., 2001a, par. 33).

local PSAPs to receive and process Wireless E9-1-1 data? How long would it take wireless carriers to implement E9-1-1 if the ILECs and PSAPs were so equipped?

Responses to the CRTC's interrogatories were hardly helpful in sorting out the details of the arguments put forth in the previous round of comments. In part because there was little direction from the CRTC in how they wished the timeframe to be reported, the carriers tailored their responses to best suit their previous claims. In sum, there was no standardized means of comparing the responses to arrive at a general consensus on the nature of the requirements and their respective timeframes. The ILECs and some of the WSPs provided highly detailed lists of tasks, with widely varying time requirements for the same kinds of tasks, while some of the independent telephone companies appeared to be poorly informed about Wireless E9-1-1.

A most dubious matter in the responses to interrogatory item 200 were claims by Bell and Rogers Wireless that data on the technical capabilities of the PSAPs fell under section 39 of the *Telecommunications Act*, arguing that "release of this information on the public record would allow existing and potential competitors to formulate more effective marketing strategies and to focus on specific market segments, thereby prejudicing [Bell's] competitive position and causing specific direct harm to [Bell]" (Aliant Telecom Inc., Bell Canada, MTS Communications Inc., & SAskatchewan Telecommunications, 2001d, ref. 102). The CRTC accepted this argument and permitted the Companies to remove any information pertaining to the technical capabilities of PSAPs in their operating territories from the public record. Such a move places a major limitation on other interested parties seeking to prepare reply comments on the proceeding, a concern raised by Microcell in its later reply comments of June 7:

> That certain ILECs have the audacity to claim that summary data related to display technologies chosen and paid for by municipalities for the general public benefit is somehow proprietary to the ILEC's, speaks volumes about the degree of openness with which these ILECs approach 9-1-1 related discussions. (Microcell Telecommunications Inc., 2001f, par. 24)

Final reply comments for Microcell's Part VII application were submitted in early June 2001. Among other things, the Application highlights the fact that consensus among the WSPs and ILECs is tenuous, despite the apparent success of the technical trial in Alberta and the cooperation that was then evident in the planning for the Ontario trial. All parties, with the exception of Microcell, recommended the Part VII application be denied because, as Bell put it, "the material filed in this proceeding by the vast majority of participants confirms that the current [industry-led] approach followed for the implementation of Wireless E9-1-1 is the most appropriate" and that Microcell's proposed mandate "would be impractical" (Aliant Telecom

Inc., Bell Canada, MTS Communications Inc., & SAskatchewan Telecommunications, 2001c, par. 3).

Clearly the ILECs and WSPs wanted to avoid a mandate and continue their work on Wireless E9-1-1 solely within the comfort of an industry setting such as the CWTA Wireless E9-1-1 Working Group. Microcell's application for Wireless CLEC status had, however, forced the regulator's hand by activating paragraph 286 of Decision 97-8. While Microcell was attempting to do an end-run on the controversial obligations set forth in Decision 2000-831, the CRTC's technical consultation body was hard at work studying the practical matters of Wireless E9-1-1 network access services.

Dispute and Stalemate: Enter the CRTC (Public Notice 2001-110)

Given the potentially complex interconnection issues stemming from paragraph 286 of Decision 97-8, the CRTC recognized that technical matters would need to be addressed in a setting that would ensure CLECs could provide E9-1-1 on a competitive basis to their customers. Over the course of a decade or more, the ILECs had built and maintained 9-1-1 systems to serve major urban centres of Canada. With the advent of local competition, each of these 9-1-1 platforms now represented a potential bottleneck that the ILECs could use to their advantage. In order for the CLECs to meet the obligations of paragraph 286, the CRTC understood the need for a corresponding service environment with which to ensure fair and equitable means of deploying or accessing facilities to support E9-1-1 service. The CRTC thereby directed its Interconnection Steering Committee (CISC) to fulfill this function by making "recommendations concerning the appropriate arrangements for the provisioning of 9-1-1 service reflecting the competitive framework established in this Decision" (par. 287).

Subsequent to Decision 97-8, the CISC had set to work to develop what is now known as the "Strawman"—a document representing high-level consensus among the ILECs and others on 9-1-1-related interconnection arrangements. The Strawman is more formally titled the *9-1-1 Trunk-side CLEC Interconnection Document*, and now serves as the template from which 9-1-1 interconnection arrangements are implemented in the first leg between ILECs and CLECs. It includes a broad range of considerations that cover the voice network, data transfer and management, service management and responsibilities, 9-1-1 service provisioning and network assurance (CRTC Interconnection Steering Committee. Business Systems Industry Working Group Emergency Services (911) Sub-Group, 2000). Both the CRTC in its framework for local competition and the CISC in its various activities anticipated the advent of Wireless CLECs.

With the interim approval of the Microcell and Clearnet tariffs in September 2000, the CISC was directed by the Commission to begin a process of reviewing and revising where necessary the Strawman to accommodate the unique aspects of Wireless CLECs that offered *mobile service* to their subscribers.[45]

The history of the CISC in fact predates Decision 97-8, beginning in August 1996 with Telecom Public Notice 96-28 *Implementation of Regulatory Framework—Development of Carrier Interfaces and Other Procedures*. The CRTC had recognized prior to this proceeding the technical complexity inherent in the transition to a liberalized telecommunications environment and, with specific reference to matters of unbundling and local number portability, moved to establish a committee to expedite decision-making and build consensus among industry stakeholders. Thus the CRTC's Interconnection Steering Committee (CISC) was born, its first meeting held in September 1996 in the National Capital Region. In most basic terms, the purpose of the CISC is "to oversee the process of identifying the requirements and developing the administrative and support systems required to facilitate local telephone competition" (Canada. Canadian Radio-television and Telecommunications Commission, 1996b; CRTC Interconnection Steering Committee. Business Systems Industry Working Group Emergency Services (911) Sub-Group, 2000).

Earlier in this section I characterized the CISC as an institutionalized locus for reflexivity based on a public-participatory and consensus-driven mandate. I also stated that the CISC process is different from strategic niche management to the extent that it acts as a space/process of legitimacy for interested parties to engage in discussions about issues affecting network design, and those specifically related to interconnection. A closer examination of the CISC, its mandate and administrative procedures reveals this distinctive role.

Activities within the CISC are either assigned by the CRTC or originated by the public and that fall within the Commission's jurisdiction.[46] Within the CISC, a steering committee is appointed to oversee and direct a number of Working Groups and Ad Hoc Committees. Tasks related to Wireless E9-1-1 fall under the mandate of the Emergency Services Working Group (ESWG), which also deals with all matters pertaining to 9-1-1 including wireline services. It is

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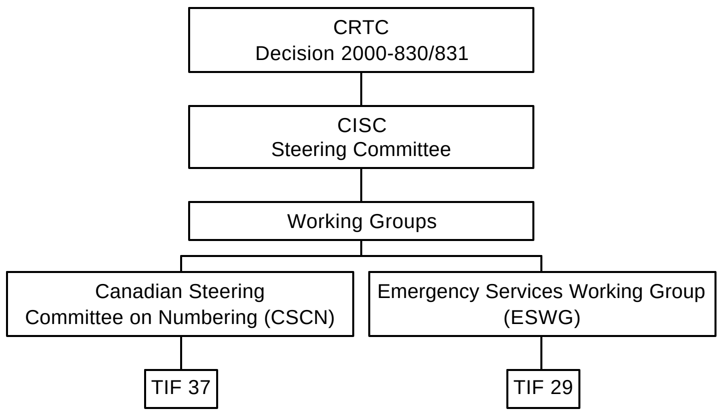
[45] There is a subtle but important distinction between wireless mobile and wireless fixed service. An example of wireless fixed service would be Local Multipoint Communication System (LMCS) that offers wireless local loop to a residence. This is a wireless service to a fixed address and does not offer the mobility that is made possible with a cellular network.

[46] My discussion of the CISC process and its organization is drawn from the CISC Administrative Guidelines (Canada. Canadian Radio-television and Telecommunications Commission, 2001b, sec. 4).

the ESWG that developed the Strawman and its various revisions to include Wireless CLECs following the interim approval of Clearnet and Microcell applications. A number of other working groups are involved indirectly with Wireless E9-1-1, including the Canadian Steering Committee on Numbering (CSCN) on the matter of NXX 5-1-1. The Network Security Working Group has also been implicated in the Wireless E9-1-1 (in conjunction with Microcell's allegations, noted above).[47] (See Figure 10).

Figure 10: Wireless E9-1-1 within the CISC



The Emergency Services Working Group (ESWG) and others undertake their assigned duties as "Tasks" which are introduced by a formal process and follow an equally formal process while under consideration. A Task may be initiated by the CRTC through the CISC Steering Committee or by a written proposal from a party directly to the Chair of a specific Working Group (Canada. Canadian Radio-television and Telecommunications Commission, 2001b, p. 4). Tasks proceed in three steps: initiation, work, impasse or consensus. At the outset, a numbered Task Identification Form (TIF) is issued according to specific guidelines that require it to be "an identifiable deliverable that is expressed in an objective manner". In effect, the TIF serves as a vehicle of inscription to bind parties into congruent action (consensus building). Work on the TIF is done through Contributions made by parties "to explain their views and propose alternatives for the completion of the task" (p. 5). Contributions are key documents and provide much of the

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[47] Personal communication with the Chair of the Network Security Working Group revealed that the issue of the ALI database was indeed taken up but "after brief discussion … participants reached agreement that CISC may not be the best place to discuss those issues" [by email 9 May 2002]. CRTC Interconnection Steering Committee. Network Security Working Group (1999) provides citation details for relevant documentation.

substance of a TIF, setting out positions, establishing facts, and proposing solutions. The Working Group maintains an Activity Diary for each TIF, which includes minutes of each meeting, action items adopted, and the status of each action item. The desired outcome of a TIF is to issue a consensus report, such as the Strawman. This report goes through an approval process and is then filed with the Chair of the Steering Committee, reviewed, and action is taken as deemed appropriate and is subject to CRTC approval (p. 6).

In the event that a dispute arises during the TIF proceeding, a Dispute Information Form (DIF) is prepared by the involved parties and reviewed by the Steering Committee to determine if further direction can be given to the Working Group to resume its activities. If this is not possible then the matter may be referred back to the CRTC (Canada. Canadian Radio-television and Telecommunications Commission, 2001b, p. 6). The Chair of the Working Group, however, is responsible for resolving issues before they escalate into disputes, and parties to the TIF are encouraged to "refrain from developing entrenched positions, and … [to] explore the viability of all reasonable options put forward at a meeting" (p. 6). Here we find an emphasis on learning within the CISC.

Membership within the CISC and its Working Groups "is open to all interested parties" with a responsibility to follow the rules of the proceedings and to be aware of issues and prepared to work toward solutions in an expeditious manner (Canada. Canadian Radio-television and Telecommunications Commission, 2001b, p. 4). Documents generated by the CISC and its Working Groups are considered part of a public process and are to be made available on the CISC website. In this respect the CISC can be taken as a public-participatory forum, however, certain limitations are recognized in the CISC Administrative Guidelines. Among its operating principles, for instance, the CISC is required to "afford all parties the right to be heard on CISC-related matters" while "recognizing the most CISC work is highly technical and therefore of limited interest to consumers …". As such, it is therefore required to "make reasonable efforts to inform consumer representatives of any consumer issues arising in the CISC", although the terms and conditions of these efforts are not specified. Due to the expeditious nature of the CISC, however, parties wishing to have their views heard on matters are expected to attend meetings and express those views "in the course of work on the tasks". Failing that, they "should not expect to be able to have items re-examined" in the CISC process (p. 1). The public nature of the

CISC is perhaps more *pro forma* than *de facto* but, given interest and resources, it nevertheless could be open to a much wider constituency than technical working groups alone.[48]

Following interim approval of Orders 2000-830/831 concerning the Clearnet and Microcell applications to become W-CLECs, the CRTC directed the CISC to address issues pertaining to interconnection arrangements. Members of the ESWG determined that the Strawman needed to be reviewed and revised in order to accommodate Wireless CLECs. As a result, TIF 29 was initiated on October 5, 2000, with Bell Canada and Microcell issuing the first Contribution in the form of proposed changes to the Strawman (CRTC Interconnection Steering Committee. Emergency Services (9-1-1) Working Group, 2001). The Activity Diary for TIF 29 indicates that a total of ten contributions were made between November 2000 and August 2001, when the last entry was made. Two months after the last entry, in October 2001, the CRTC issued Public Notice 2001-110 to address a number of disputes that had not been resolved within the ESWG. Although the ESWG had been largely successful in revising the Strawman and despite the fact that no formal disputes had been filed for TIF 29, certain members of the ESWG had reached an impasse on the recalcitrant matter of WSP subscriber records and the ALI database. With the issuing of Public Notice 2001-110, the CRTC finally stepped in to address this issue and other related matters.

Public Notice CRTC 2001-110

The CRTC issued Public Notice 2001-110 on October 31, 2001 in order to initiate public comment "on appropriate terms and conditions to govern service offered by Wireless CLECs, ILEC's associated interconnection obligations and on 9-1-1 services offered by WSP's" (Canada. Canadian Radio-television and Telecommunications Commission, 2001g). Interested parties to the proceeding were asked to address ten specific questions related to 9-1-1 services, most of which were related to the ALI obligations contained within Orders 2000-830/831.[49] These questions reflected and sought to address much of the debate that had surfaced during the tariff proceedings and within the CISC working group. Examined closely, the ten questions in the Public Notice appear to stem from four basic issues:

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[48] Criticism of the CISC's public process has come most from Canada's Public Interest Advocacy Centre (Lawson, 1998).

[49] PN 2001-110 also sought comment on "Equal Access" provisions for WSPs. Equal Access pertains to the obligation of CLECs to provide their subscribers with competitive access to alternative long distance service providers. Like the problem of Wireless E9-1-1, this obligation has also proven to be a challenge when dealing with mobile handsets.

- Should the 9-1-1 obligations established in Order 2000-831 be maintained or suspended?
- If maintained, then what are related difficulties in populating or updating ALI records with mobile subscriber records?
- If suspended, should they be replaced by additional obligations for Wireless CLECs?
- Should the 9-1-1 related obligations of Wireless CLECs be extended to WSPs? Or should the CRTC encourage WSPs to offer E9-1-1 service by other measures?

In responding to the Public Notice, the same interested parties that had, for the most part, been involved all along in Wireless E9-1-1 were those who also submitted comments and therefore few substantially new contributions entered the debate. Nevertheless, the submissions to PN 2001-110 reflect a refinement of the recurrent issues around the Wireless E9-1-1 case, which brings to high relief some of the core actors and issues at the heart of this emerging service. Issues and actors tended to be enrolled through complex and often contradictory alignments among the interested parties, especially in terms of the following concerns:

- Preserving the two track regulatory regime
- Recognizing technical standards and established business processes

Preserving the two-track regulatory regime

Among the parties to the proceeding all agreed in principle on the need to maintain firm separation between CLEC and WSP regulatory regimes, with some difference of opinion on the question of mandating E9-1-1 for Wireless Service Providers. TELUS, drawing on an academic article by Frieden (2000), argued the need to maintain "competitively neutral" rules to maintain a level playing field within each of the two regimes. On the one hand, this meant assurances that all CLECs—irrespective of outstanding technology barriers—should be required to meet the E9-1-1 obligation established in paragraph 286 of the Local Competition framework. On the other hand, "competitively neutral" rules also meant that WSPs should not be mandated to meet 9-1-1 service obligations that are intended for CLECs.

Among the wireline service providers and PSAP representatives there was concern expressed that Wireless CLECs might seek competitive advantage by using technical barriers to avoid or delay certain obligations. TELUS, for instance, stated its belief that Microcell was manipulating CLEC interconnection arrangements for strategic gain, claiming that "in the newly established competitive environment, various service providers attempt to game the regulatory process by picking and choosing from among regulatory rules in order to maximize their advantage in the marketplace" (TELUS Communications Inc., 2001a). TELUS reiterated these remarks in their first set of reply comments to PN 2001-110:

> Technological neutrality, a subset of competitive neutrality, has been defined as not discriminating in favour of a the use of a particular type of technology, but rather ensuring that the same services are regulated in the same manner … The CRTC's regulatory framework has consistently attempted to ensure that where technical and social regulations are imposed, they are imposed symmetrically. That is, firms in a particular market, offering services that are in essence substitutes for each other should be subject to the same social and technical regulatory rules. This proceeding is about the symmetrical application of equal access rules (apparently a technical requirement), and 9-1-1 rules (a social policy requirement). (TELUS Communications Inc., 2002)

From the perspective of a Wireless Service Provider, Bell Mobility in its submission made reference to a number of specific CRTC Decisions in order to argue that two classes of telecom service had been established in Canada and, as such, that an E9-1-1 mandate would be inconsistent in approach and wholly inappropriate for the wireless sector:

> Bell Mobility does not believe that regulatory mandates are appropriate in the forborne, intensely competitive wireless market. Indeed, Bell Mobility notes that the Commission itself has, despite numerous requests, consistently declined to intervene in the wireless market in the form of regulatory mandates. …
>
> In the absence of any failure on the part of WSPs to address 9-1-1 issues, … Bell Mobility submits that the spirit of the Commission's determination … to refrain from intervention in markets where competitive forces are demonstrably effective, is even more appropriate today in the wireless segment that it was in 1998. (Bell Mobility, 2001a)

The WSPs and ILECs both supported the development of Wireless E9-1-1 through an industry self-directed approach, claiming that this had been effective in the past and would be more effective than a mandate. In fact, a joint submission by TELUS and Rogers Wireless had, during the Part VII Application, called into question the FCC approach to Wireless E9-1-1 on the grounds that experience had shown it to be less effective than the industry-driven approach in Canada (Telus Communications Inc. et al., 2001). At the time Microcell responded by claiming that the FCC approach had been flawed because it offered no assurances that intervening 9-1-1 service platforms between WSPs and PSAPs would be capable of handling the required data elements (Microcell Telecommunications Inc., 2001a). Curiously, the FCC mandate was not mentioned in any submissions to PN 2001-110.

Bell Canada and its corporate affiliates, in a joint submission, suggested that the wireless sector is "extremely sensitive" to its customers and that "WSP end-customers should be the ones to determine if a wireless E91-1-1 service capability is of inherent value" given that "these customers will naturally migrate to the service provider providing the associated wireless E9-1-1 capability" (Aliant Telecom Inc., Bell Canada, MTS Communications Inc., Northwestel Inc., & Saskatchewan Telecommunications, 2001a). Bell Mobility and Rogers Wireless both capped their positions with the opinion that an E9-1-1 mandate for the WSPs would amount to a fundamental change in the two-track regulatory regime and that a separate public process would be more appropriate for an undertaking with such broad implications (Bell Mobility, 2002; Rogers Wireless Inc., 2001b).

While the previous success of the Alberta technical trial was paraded as an example of industry cooperation and intent, submissions made by the WSPs (with the exception of Microcell) ignored the fact that even with a commercial tariff in place, they had yet to actually offer Wireless E9-1-1 to any of their subscribers in Canada. Despite this obvious oversight, Rogers Wireless nonetheless vaunted its own voluntary efforts to deploy basic 9-1-1 service to its subscribers:

> … in all areas covered by the RWI [Rogers Wireless] network, irrespective of the extent to which 9-1-1 service has been implemented on the wireline networks. WSP subscribers do not need to determine if they must dial 9-1-1 or a 7- or 10-digit telephone number, depending on their location. This is true within or beyond the ILEC 9-1-1 serving area. Instead, WSP subscribers must only remember and dial the digits 9-1-1 when they require emergency assistance. [Rogers Wireless] notes that the voluntary provision of WSPs three-digit access to emergency services provides wireless customers with a degree of convenience and security that is unique and that is not available to ILEC customers. (Rogers Wireless Inc., 2001b)

The Ontario 9-1-1 Advisory Board (OAB) responded to this submission with the complaint that Rogers Wireless had been undertaking these efforts across the Province of Ontario unilaterally and without the input of the local PSAPs (Ontario 9-1-1 Advisory Board, 2002a). A letter from the Ontario Provincial Police (OPP) was enrolled as an example of the specific problems this practice had been causing local authorities in Ontario:

> The fact is the WSPs deliberately do not route, in many instances, 9-1-1 calls correctly through the Bell PERS E9-1-1 system, (particularly in rural Ontario—outside the golden horseshoe).
>
> In some cases the WSPs route the 9-1-1 calls to the correct Central Emergency Response Bureau (CERB) via a direct dial PSTN number. In many other cases the WSPs bypass the PERS E9-1-1 network entirely (via digit translation) and send the call to the local police service via a PSTN number. It should be noted that the local police service in NOT necessarily the CERB for the area. Such practices can and do route the 9-1-1 call to the WRONG terminating point. …

> The OPP have been utilized by the WSPs as a CERB for mobile callers in many areas where similar landline callers follow a completely different route through the PERS system. This is a competitive issue for the OPP. We contract CERB services with many municipalities and are paid accordingly. The WSPs have not made any proportionate contribution. The OPP has objected to this practice however the WSPs have persisted. The OPP is not in a position to stop such a practice, as we have no authority to do so. (Ontario 9-1-1 Advisory Board, 2002b)

The OAB used this evidence to advocate the need for "strong guidance [from the CRTC] to be provided to implement technology advancements and the additional obligations for the ever expanding WSP market" (Ontario 9-1-1 Advisory Board, 2002a). Moreover, the OAB noted that an E9-1-1 mandate would conform to the CRTC's own objectives as stated in the regulator's 2000-2003 Action Plan; in particular, the Commission's stated commitment to regulate in those areas where market forces are not achieving public interest objectives. "While we would suggest that 3 million calls to 9-1-1 across Canada is a notable market force," acknowledged the OAB in light of the delays in implementing Wireless E9-1-1, "it would [still] not seem to meet industry criteria" (Ontario 9-1-1 Advisory Board, 2002a).

It is clear from reading the submissions that both the ILECs and WSPs wish to stay the course and preserve the twin regulatory regime established by the CRTC. By contrast, the PSAPs unanimously recommended that E9-1-1 obligations be extended to all WSPs. Whereas some of the WSPs characterized their service offering as "discretionary" or an adjunct to wireline service, the BC 9-1-1 Service Providers Association (BC SPA) called this assumption into question when it linked the rapid growth in wireless handsets to emerging problems in providing public safety services:

> … with no disrespect intended, we are tired of being the victims of the success of the wireless companies. Wireless calls have grown from 8% of our total calls in 1990 to nearly 40% in 2001. It takes extra time to route a wireless 9-1-1 call to the correct dispatch centre. It is becoming more difficult to accommodate this additional work without extra resources. Operator time is at a premium. The wireless carriers do not pass on any of the 9-1-1 service fee that they collect from their subscribers to the call-answer centres [PSAPs] although the service fee exceeds the amount they are required to pay to the ILEC each month. (BC 9-1-1 Service Providers Association, 2001b)

The 9-1-1 service fee that BC SPA cites is collected on all active mobile telephone numbers and modified in CRTC Decision 99-17 "to effect cost recovery on a more equitable basis" given that WSPs do not offer ALI functionality. The modified rate structure is discounted by 50 per cent for WSPs (Canada. Canadian Radio-television and Telecommunications

Commission, 1999a). According to both the BC SPA and the OAB, the WSPs have been collecting the full fee from each of their subscribers, paying the discounted fee to the respective ILEC for basic 9-1-1-access service, and then pocketing the difference (BC 9-1-1 Service Providers Association, 2001a). In fact, the OAB calculated that in Ontario alone the WSPs were earning some $3.4-million in extra revenue annually from this discrepancy, adding that "this may be more than sufficient funding to offset WSP costs related to their ALI subscriber database concerns in Ontario" (Ontario 9-1-1 Advisory Board, 2002a).[50]

Perhaps it is this questionable source of revenue that has contributed to the reluctance of WSPs in offering Wireless E9-1-1, inasmuch as deployment would mean requiring ALI functionality and thus being obliged to remit the full 9-1-1 service fee to the ILEC. Rogers Wireless (RWI), however, has cited liability provisions in the Strawman as the key obstacle to its deployment of Wireless E9-1-1. In its submissions, Rogers Wireless repeatedly complained that liability provisions in the Strawman are biased toward the ILECs and requested the Commission consider equal limitations of liability for WSPs providing E9-1-1 service (Rogers Wireless Inc., 2001b). According to RWI's submission, selective intervention by the CRTC under section 31 of the Telecommunications Act would be an incentive for the deployment of Wireless E9-1-1 in Canada.[51] RWI also cited liability coverage in the U.S. 9-1-1 Act as a model for Canada, tempering the anti-intervention rhetoric of the other service providers by the suggestion that the Commission does indeed have some obligation to intervene in the otherwise forborne wireless sector.

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[50] The Ontario E9-1-1 Advisory Board (OAB) submission used the following calculations. The wireline 9-1-1 service access fee as of January 2002 was set at $0.22 per month per active telephone number. Bell Mobility customers are charged $0.25 per month as a 9-1-1 service fee. Only $0.11 of this fee is remitted to the ILEC as per the CRTC Decision 99-17 ruling, leaving $0.14 being collected under the guise of 9-1-1. OAB stated, "… we are unable to ascertain what those additional funds are being used toward [*sic*]." Based on 2-million active subscribers in Ontario, each contributing an extra $0.14 per month, the OAB calculated $280,000/month, or $3,360,000/year in extra revenue for the WSP (Ontario 9-1-1 Advisory Board, 2002a). It is unclear if this refers only to Bell Mobility customers or whether it includes other WSPs operating in Ontario.

[51] Section 31 of the Act states that "No limitation of a Canadian carrier's liability in respect of a telecommunications service is effective unless it has been authorized or prescribed by the Commission." Rogers Wireless was claiming that the CRTC's authorization is necessary for limiting WSP liability in this case and, moreover, would provide a vital measure of assurance to encourage the deployment of Wireless E9-1-1.

Recognizing technical standards and established business processes

Among the most contentious issues within the development of Wireless E9-1-1 in Canada has certainly been the matter of populating the ALI database with subscriber records. What makes this a most perplexing matter is that the issue appears on the record *after* the successful completion of the Alberta trial and seems to become increasingly intractable as the design parameters of Wireless E9-1-1 are inscribed in the form of a commercial tariff. In fact, the exchanges between the PSAP representatives and Microcell degenerate into antagonism within the CISC, evident in the activity diary from TIF 29 (CRTC Interconnection Steering Committee. Emergency Services (9-1-1) Working Group, 2001). Although no formal dispute process was initiated, the problems within the CISC culminated in a stalemate among parties that was to precipitate regulatory intervention in the form of Public Notice 2001-110.

Microcell's initial comments sought to deflect attention away from the ALI obligations and toward the substantive issues of their previous Part VII Application, claiming that the real barrier to Wireless E9-1-1 was "the absence of will on the part of some ILEC 9-1-1 service providers to make available the requisite access services to their 9-1-1 service platforms," especially in cases where 9-1-1 services do not yet exist and where standalone 9-1-1 services are not integrated into provincial platforms. As for the ALI obligation, Microcell dismissed it as "an ad hoc idea with a checkered past" not supported by standards or industry practice. On this point Microcell claimed even if the obligations of Order 2000-831 were met, the PSAPs themselves would not capable of viewing these mobile subscriber records in real time because the existing ALI databases were incapable of displaying a second address field.

The AEAA refuted this argument, claiming that "Microcell has provided page after page of misleading information regarding this issue" and a "total disdain for this idea". In support of their critique, the AEAA stated that the US National Emergency Number Association (NENA) was considering this as a future goal and that the Telecomunications Industry Association was undertaking standards work on handling mobile subscriber records.[52] On the matter of PSAPs capability to view subscriber records, the AEAA stated that "the only logistical concern relates to how we would display [these records] concurrent with the call to ensure that no confusion is created" and furthermore that "this is a PSAP/ILEC 9-1-1 platform issue which can be easily resolved when wireless subscriber data becomes a reality" (Alberta E9-1-1 Advisory Association, 2002). The position of the AEAA was that Order 2000-831 was an incentive that would support

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[52] The AEAA specifically cited TIA TR45.2 Subcommittee (Wireless Intersystem Technology) as the organization undertaking technical standards development.

the development of a solution to provide PSAPs with real-time access to mobile subscriber records: "If the CRTC sees fit for this to take place in the future, *we will adopt the tool available to take advantage of it, at that time*" [emphasis added]. The comments conclude with a renewed effort at demand articulation that reflects something of the original CWTA mandate but is far more ambitious in seeking to "re-build" Canada's 9-1-1 system in order to establish *functional* symmetry between wireline and wireless E9-1-1 services (Alberta E9-1-1 Advisory Association, 2002).

Microcell had previously challenged the AEAA within the CISC to produce evidence of standards work to support the entry of subscriber records into the ALI database. The AEAA's submission to PN 2001-110 was the first time that specific documents were mentioned on the public record. Microcell, however, continued to reject outright AEAA's claims in this regard, stating that "[we have] comprehensively reviewed all three of these documents and can state with certainty to the Commission that none of these standards addresses in any way whatsoever the specific issue of the display of wireless subscriber records at the PSAP" (Microcell Telecommunications Inc., 2001d). Furthermore, Microcell also dismissed as "blue sky" a NENA document cited by AEAA that was purported to contain reference to mobile subscriber records and the ALI database (Microcell Telecommunications Inc., 2001d, par. 3.2.3).

The case that Microcell was building against the ALI obligations of Order 2000-831 was not only on the grounds that technical standards were wanting, but populating the ALI database with mobile subscriber records would disrupt significantly established business processes within the Wireless sector (Microcell Telecommunications Inc., 2001d, par. 3.2.8). At the heart of the matter was the issue of providing *verifiable* subscriber records that refer to a customer's residence. Microcell had noted within the scope of Order 2000-831, and reiterated again, that this was a difficult obligation to meet because billing records did not necessarily refer to a subscriber's home residence. The common example used was the case of a customer using a non-contiguous business address for billing purposes. In many instances, Microcell argued, the billing address had no geographic correlation with the residence of the person using the mobile phone and, in some cases, might be in another province altogether (e.g., a Toronto head office might be used for billing purposes for a corporate employee operating in Calgary using a mobile phone with NPA 403).

Doubts were also raised with respect to the ALI obligation and Canada's *Personal Information Protection and Electronic Document Act*, specifically with respect to the questionable relevance of collecting subscriber information that was of little operational value in providing Wireless E9-1-1 service (par. 3.2.7). Previously within the CISC, Microcell had described their concerns:

> … one of the core principles of the new privacy legislation is that the collection, use and disclosure of personal information is subject to an organization obtaining the consent of the individual to do so. The organization must obtain the individual's consent to a specific purpose or purposes for which the personal information is to be collected, used or disclosed. And these purposes must be reasonable and not overly broad. ... Furthermore the Act expressly prevents an organization from requiring, as a condition of providing service, that an individual consent to the collection, use or disclosure of information beyond that required to fulfill the explicitly specified and legitimate purposes. (Microcell Telecommunications Inc., 2001e, sec. 10)

Microcell believes customer resistance and suspicion would follow from such an obligation because “it is by no means intuitively obvious to a reasonable member of the general public that a fixed address *must* be provided in order to receive mobile phone service” [emphasis in original] (Microcell Telecommunications Inc., 2001e, sec. 10). For its part, the OAB countered Microcell’s claim with the view that Microcell’s real concern with respect to privacy legislation “is the Principle of Accuracy (Principle 6) within this same Act. ‘Personal information shall be accurate, complete and up-to-date as is necessary for the purposes for which it is to be used’ ” (Ontario 9-1-1 Advisory Board, 2001, sec. 8).

Microcell’s comments to PN 2001-110 go to great lengths in order to detail the requirements of obtaining and verifying subscriber records during customer activation. At the heart of this process was taken to be an obdurate actor, at least from the perspective of several interested parties. The Master Street Address Guide (MSAG) pre-validates civic addresses before they are accepted by an ALI database. Microcell’s argument was that providing verifiable subscriber records would require real-time access to the MSAG and that such a proposition was fraught with problems due to the “Swiss cheese” like nature of MSAG coverage and the potential range of civic addresses that a mobile subscriber might provide when seeking service (par. 3.2.7). In fact Microcell had in the CISC asked for modification of the Strawman to include province-wide access to the MSAG in Ontario or, alternatively, to remove the requirement in Order 2000-831 to validate subscriber records. Bell Canada, who responded with a specific contribution on this matter, argued against Microcell’s request on the basis that unrestricted access to MSAGs "could assist outside suppliers in producing revenue reducing competitive products" (Bell Canada, 2001a).[53]

According to Microcell (par. 3.2.7), the MSAG challenge was further compounded by the fact that its proposed business model as a W-CLEC was based principally on being a reseller of wireless services, which meant that verification of addresses during the customer activation process would need to be undertaken by third party retailers. Among its wireless customers, Microcell also claimed about half used the prepaid service option that did not require a monthly invoice and therefore retailers placed little emphasis on obtaining subscriber addresses when activating this service.

The AEAA emphasized the need for additional obligations for WSPs to obtain and maintain valid wireless subscriber records and in particular "to address the deplorable state of Microcell's [customer] database" (Alberta E9-1-1 Advisory Association, 2001a, par. 8). Among the recommendations proposed was that of requiring prospective customers to produce valid identification when seeking to establish a wireless service subscription, an idea that Microcell characterized as "backwater" (Microcell Telecommunications Inc., 2002b, par. 3.2.7).[54]

While the issue of real-time access to subscriber records may have perplexed both the ILECs and the WSPs from a functional and feasibility standpoint, comments filed by the PSAPs in conjunction with PN 2001-110 revealed that they had experienced difficulties in obtaining the cooperation of the WSPs when attempting to follow-up emergency calls made from mobile

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[53] This matter, which is taken up in the CISC/ESWG file "ESTF029", is worthy of closer scrutiny because it involves ILEC control over municipal street address data (see CRTC Interconnection Steering Committee. Emergency Services (9-1-1) Working Group, 2001). When implementing an E9-1-1 service, local municipalities are often required to undertake a costly process of standardizing civic addresses to build an MSAG database. In many areas this database has been under the exclusive control of the ILEC operating the E9-1-1 system. Microcell's request for province-wide access to MSAGs was perhaps the first challenge to the exclusive control of this valuable resource. Subsequent to Bell Canada's determination on MSAG access, the Ontario 9-1-1 Advisory Board complained bitterly that

It is the view of the OAB and UMQ that municipal SAG information is provided to Bell Canada for their input into the 9-1-1 database to meet the needs of all municipalities with whom they have agreements for PERS 9-1-1. Municipalities entrust Bell Canada with this information solely for the purpose of timely and effective emergency response. The intent is not to give them the right to claim sole ownership and distribution rights. We do not believe it is within their purview to unilaterally decide the extent to which this addressing data should or should not be made available to Wireless CLECs. (Ontario 9-1-1 Advisory Board & Communaute urbaine de Montreal, 2001)

OAB's comments may foreshadow future debates when more advanced location-based services are being developed in Canada. The MSAG, after all, is a highly accurate and up-to-date source for locating mobile callers. It is costly to maintain and municipalities may seek to recover some of these costs by licensing access to mobile positioning firms and challenging the ILEC's exclusive control over the MSAG.

[54] Although Microcell dismissed this idea as impractical and a fundamental threat to its business, the requirement for valid identification has been considered and adopted in Australia for prepaid mobile accounts (Australia. Australian Communications Authority, 2000).

phones. The OAB, for instance, portrayed the situation as one of serious neglect on the part of the WSPs:

> In emergency response terms, immediate access to subscriber information means at the time of any 9-1-1 call on a 24 X 7 basis. WSPs continually fail to appropriately respond to telephone PSAP requests for subscriber information. Some telephone calls from our 9-1-1 Supervisors may be returned after several hours, even in the middle of a business day or not returned at all [*sic*]. Requests made during the weekend or in the middle of the night often have not been responded to until the next business day. (Ontario 9-1-1 Advisory Board, 2001, par. 8)

The BC SPA noted in their reply comments to PN 2001-110 that of all the WSPs serving in the Lower Mainland, only TELUS provides a toll-free line to their security department, the bureau where PSAP follow-up calls are typically directed. All other calls to WSPs incur long distance charge (presumably to a head office in Toronto or Montreal), which reaches paging service in some cases. In other cases, the BC SPA complained that the WSP security departments proved reluctant to provide information when it was requested by the PSAPs (BC 9-1-1 Service Providers Association, 2001b, par. 6).

Despite these charges, Microcell and Bell both accepted as an alternative design the proposition that their security departments provide high assurance and 24/7 access to mobile subscriber records as a means of avoiding the ALI obligations imposed in Order 2000-831. This position also established alignments with other PSAP representatives who had dissented on the ALI issue (Microcell Telecommunications Inc., 2002a, par. 3.2.2). PSAP representatives from Quebec and British Columbia had both chosen to shift their emphasis to advocate access to subscriber records via a telephone connection with the security departments of the WSPs rather than modify the design of the ALI database to provide real-time access. The BC SPA offered an important ally to Microcell and the WSPs because they represented the first region in Canada to have implemented Wireless E9-1-1 on a wide scale:

> Our preference is for all wireless service providers to become Wireless CLECs providing phase one enhanced service. In this case, we would not ask for the customer data to be in the 9-1-1 database. We would rather use the Wireless CLEC's security desk when we need to trace an incoming call or do any other kind of follow-up. To this end, we would ask that all wireless carriers be required to have staffed 7x24 security departments which can be accessed from the Public Safety Answering Points by toll free numbers. (BC 9-1-1 Service Providers Association, 2001a, par. 8)

Bell Canada and its affiliates also supported the telephone access solution, calling it the "most effective" solution in light of the problems associated with verifying subscriber records (Aliant Telecom Inc., Bell Canada, MTS Communications Inc., Northwestel Inc., & Saskatchewan Telecommunications, 2002, par. 33). Among the dissenters was Rogers Wireless, which argued that a directive from the CRTC to provide an assured 24/7 telephone to their security desk was "entirely unnecessary" because "any PSAP that requires such information from a given WSP [need only] submit a formal request for such information to the WSP" (Rogers Wireless Inc., 2002, par. 13).

Speculation on the Outcome of Public Notice 2001-110

While I was writing this case study in early autumn of 2002, the CRTC had yet to issue comments or a decision with respect to Public Notice 2001-110. Given the history of the matter and the substance of debate in PN 2001-110, it is conceivable that the issue of liability protection for WSPs will be taken into consideration and may call into question some aspects of the established two-track regulatory regime. It is also conceivable, given the painstaking efforts undertaken by Microcell to place the ALI obligation into disrepute, that the Commission may reconsider Order 2000-831 and vary the order to establish an alternative requirement for Wireless CLECs—prior to the deployment of FCC Phase 1 equivalent Wireless E9-1-1in a coverage area—to *either* populate the ALI database with subscriber records *or* provide PSAPs with 24/7 access to their security departments for the purpose of providing subscriber record information. Such a determination would be based on section 62 of the Telecommunications Act, which states that "The Commission may, on application or on its own motion, review and rescind or vary any decision made by it or re-hear a matter before rendering a decision" (Canada. Department of Justice, 2001).

Whether this modified determination would extend to all WSPs is another matter altogether. However, if either (or both) of the requirements were to be extended to all WSPs, the CRTC's oversight in the wireless sector would expand concomitantly and may thus require justification in light of section 34 of the *Telecommunications Act*. Section 34 (2) of the Act requires regulatory forbearance in a telecom service or class of services where "subject to competition sufficient to protect the interests of users" (Canada. Department of Justice, 2001). With Decision 96-14, the Commission determined that sections 24, 25, 29, and 31, and subsections 27(1), (5), and (6) do not apply to mobile voice services (Canada. Canadian Radio-television and Telecommunications Commission, 1996a). Of note in this regard may be section 24, which deals with conditions of service:

> The offering and provision of any telecommunications service by a Canadian carrier are subject to any conditions imposed by the Commission or included in a tariff approved by the Commission.

If the CRTC sees fit to require WSPs to provide PSAPs with subscriber records, either by populating the ALI database or by a 24/7 telephone connection, then it is possible that forebearance with respect to section 24 may need to be reconsidered. However, in light of section 34(2) of the Act, justification for such reconsideration may be needed to account for the status of 9-1-1 as a competitive service offering. Recall that under the Local Competition Framework (CRTC Decision 97-8), 9-1-1 is not considered an essential service (par. 114), which means that it does not meet the following conditions:

> The Commission concludes that to be essential, a facility, function, or service *must meet all three* of the following criteria: (1) its is *monopoly controlled*; (2) a CLEC requires it as an input to provide services; and (3) a CLEC cannot duplicate it economically or technically. [emphasis added] (Canada. Canadian Radio-television and Telecommunications Commission, 1997, par. 74)

If 9-1-1 service is not monopoly controlled then it may be deemed to be a potentially competitive service. If so, then it will be up to the Commission, subject to section 34(2), to determine if it is sufficiently competitive to protect the interests of users. If not—which may be likely given, for instance, Clearnet's experience in attempting to involve a third party 9-1-1 provider in the technical trials—the Commission may have grounds to issue a directive to the WSPs for providing PSAPs with access to their subscriber records under certain conditions.

Summary

This chapter reported on a case study that examined an instance of growth and change in Canada's telecom infrastructure. I have provided a detailed, empirical account of stakeholders and processes that have been influential in shaping the evolution of network infrastructure through the introduction of a new service offering. The purpose of this case study is to shed light on the basic processes and interventions by which network evolution occurs with respect to the current policy and regulatory framework.

Data for this case study was drawn from a primary-source document analysis, using a snowball strategy to produce a chain of evidence drawing on multiple sources. My objective was to produce a thick but systematic description of the events that surrounded the original demand articulation for Wireless E9-1-1, its introduction subsequent development in Canada.

The case study began with the U.S. Federal Communication Commission's efforts at technology forcing through a mandated approach to Wireless E9-1-1. I then described the industry-led technical trials in Canada, using strategic niche management as a guiding concept to characterize the Canadian Wireless Telecommunications Associations (CWTA's) efforts in this process. The CRTC's Interconnection Steering Committee (CISC) was introduced, and I described its efforts at consensus building and bringing forward a Wireless E9-1-1 tariff in certain parts of Canada. I characterized the CISC as a locus for reflexivity, highlighting it as a space/process of legitimacy for key stakeholders. I then turned to CRTC Public Notice 2001-110 and described how a relatively congenial idustry-led process turned into a dispute within the CISC, eventually forcing the Commission to become involved in the Wireless E9-1-1 case. Finally, I speculated on the potential outcome and implications of Public Notice 2001-110, attempting to highlight certain complexities with regard to past CRTC decisions on local competition and wireless service providers.

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Chapter 6: Analysis of Wireless E9-1-1

Introduction

The previous chapter provides a detailed account of the development of Wireless E9-1-1 in Canada from about 1997 up to the latest available proceedings in 2002. The objective of this chapter is to provide an analysis of the case study, drawing on the analytic framework developed in chapter four, with a specific focus on the operational issues identified in chapter five. I begin the analysis with a socio-technical mapping of Wireless E9-1-1 case, then proceed to a layout of interventions evident in the case. I have included these preliminary steps to establish a foundation for subsequent observations and analysis in the chapter. Having completed these preliminary steps, I then discuss in some depth the observations and findings related to operational issues of technical standards, innovation and experimentation, and boundary crossing. Finally, I apply the intervention matrix developed earlier in this study to highlight four overall patterns in the development of Wireless E9-1-1 in Canada.

A Socio-technical Mapping of Wireless E9-1-1 in Canada

In the case of Wireless E9-1-1 in Canada, we see that all dimensions of interconnection space have been important to the development and early deployment of this service. Each layer of interconnection space tends to circumscribe a specific set of actors. Recalling Arnbak's Function Systems Model introduced in chapter 4, interconnection space consists of four layers arranged hierarchically from predominantly physical systems based on hardware elements upwards toward increasingly logical systems based on software elements. Interconnection space provides a framework on which to map various actors and issues involved in the Wireless E9-1-1 case. Table 13 below charts the case study, listing key actors in each of the functional layers of interconnection space and associated issues.

Table 13: Wireless E9-1-1 and Interconnection Space

Functional Layer	Actors	Issues
Information Services	WSP customer-activation process; subscriber billing record; MSAG	Disruption of business models; control over critical information; customer privacy rights
Value-added Services	ALI database	Terms and conditions of access; database design and alternatives;
Network Services	Network access services (Strawman; E911 tariff); ILEC/PSAP contracts	Terms and conditions of interconnection, including liability; requirements for new equipment; stranded investments
Physical Infrastructure	Mobile handsets; trunking options; locating cell-sites; Province-wide E911 platforms and ILEC switches	Problem equipment (one-button phones); legacy platforms; regional differences in network equipment and design

At the physical infrastructure layer, mobile handsets undermined the standard design of the ALI (Automatic Location Identification) database, creating a problem for locating mobile callers. Trunking and signalling, switch platforms, and cell site mapping were all key actors at this lower layer, partly because of regional differences among the incumbent wireline carriers (ILECs). At the network services layer, there was a requirement to develop a Strawman document to specify interconnection arrangements between Wireless Service Providers (WSPs) and the ILEC 911 platform, as well as additional contracts specifying network services and administration details between WSPs, ILECs, and PSAPs. The ALI database represents a value-added service operated by the ILECS and providing location information from the WSPs to the PSAPs. At the functional layer of information services, the issue of customer records and the MSAG (Master Street Address Guide) featured prominently in a number of problem formulations and design propositions.

Layout of Interventions Evident in the Wireless E9-1-1 Case Study

Seven predominant intervention strategies are evident from public documents pertaining to Wireless E9-1-1 in Canada. This section first describes these strategies and then discusses them in light of their operational dimensions of inscription, congruency, and legitimacy. In terms of technology forcing, the CRTC's Local Competition Framework in 97-8 is a demand-driven strategy that has technical implications derived from the principle of symmetrical regulatory obligations between all regulated carriers. The principle of regulatory symmetry embodied in paragraph 286 of the Local Competition Framework requires all regulated carriers to provide enhanced 9-1-1 service that is functionally equivalent to local ILEC standards. This has had the effect of forcing Microcell in its application for W-CLEC status to upgrade its network to offer Wireless E9-1-1 service but has created challenges in areas where the technical capabilities to provide E9-1-1 service are not available.

Further to paragraph 286, the CRTC's Order 2000-831 forces Microcell to either deploy Wireless E9-1-1 service where available or, as a temporary stopgap, to populate the local ALI database with its customer records where E9-1-1 service is not offered by the ILEC. In some respects Order 2000-831 is simply an interpretation of the forcing strategy embodied in Decision 97-8. Conversely, Microcell's Part VII Application to the CRTC seeks relief by requesting the Commission to force the ILECs to commit to a specific upgrade path to enable future deployment of Wireless E9-1-1. As of January 2003, the CRTC had yet to respond to the Part VII Application.

In terms of strategic niche management, the wireless industry through the CWTA undertook to develop supply-side strategy to acquire a technical capability and to undertake testing of Wireless E9-1-1 under the auspices of a specific working group. Reflexivity strategies that modulated between demand-side and supply-side efforts were evident in the CISC working group that sought, under specific direction from the CRTC, to establish consensus between telcos and PSAPs on various terms and conditions of network access for Wireless E9-1-1. CRTC Public Notice 2001-110 could also be viewed as a strategy of reflexivity to the extent that it seeks to clarify, among a range of interested parties, certain outstanding disputes and questions related to Wireless E9-1-1 in Canada.

The CRTC's response to Microcell's Part VII and Public Notice 2001-110 is pending but will constitute the latest intervention in the development of Wireless E9-1-1 in Canada. Conceivably, this intervention could take the form of technology forcing if the Commission decides to mandate certain design propositions or obligations. Likewise this intervention could usher in a more ambitious strategy of reflexivity if the Commission sees fit, for example, to hold further hearings to more fully consider the status of wireless service providers and E9-1-1 obligations in Canada. Table 14 summarizes the various intervention strategies evident in the Wireless E9-1-1 case.

Table 14: Intervention Strategies Evident in Wireless E9-1-1

Actor/event	Strategy	Objective
CRTC Decision 97-8: Local Competition Framework	Technology forcing	E911 obligation forces symmetry on regulated carriers.
CWTA/Wireless E911 Working Group (WEWG)	Strategic Niche Management	Supply-side trials and system testing
CRTC Order 2000-831	Technology Forcing	Resolve gap between 97-8 requirement and current technical capabilities for wireless CLECs.
Microcell Part VII Application	Technology forcing (with reflexivity)	Demand ILEC network upgrades to support Wireless E911.
CISC/Emergency Services Working Group (ESWG)/ TIF 29	Reflexivity	Establish consensus on terms and conditions of network access services for Wireless E911
CRTC Public Notice 2001-110	Reflexivity	Clarify outstanding disputes related to Wireless E911
CRTC Decision (forthcoming)	?	Response to Microcell Part VII and/or resolution of questions in Public Notice 2001-110

Inscribing the Interventions

Each intervention strategy in the development of Wireless E9-1-1 is based on a central vehicle of inscription, which provides the point of singularity around which second-order action is enabled and directed. I have proposed in this study that technology forcing is an intervention strategy that turns on a vehicle of inscription. In the case of Wireless E9-1-1, the vehicles of inscription that support forcing strategies are a specific paragraph within a CRTC Decision (paragraph 286) and the formal Rules of Procedure that govern the interaction between the Commission and other stakeholders, including Part VII applications. The terms and conditions of these vehicles of inscription were pre-established and are largely procedural in nature. In other words, they were in force prior to the Wireless E9-1-1 case and do not address directly the specifics of individual cases. (See Table 15).

Table 15: Vehicles of inscription and Wireless E9-1-1

Actor	Strategy	Inscription
CRTC (Decision 97-8) and (Order 2000-831)	Forcing	Par. 286
CWTA (WEWG)	Strategic Niche Management	MOU
Microcell	Forcing	Rules of Procedure
CISC (ESWG)	Reflexivity	TIF 29
CRTC (PN 2001-110)	Reflexivity	Order 2000-831

In the case of the CWTA WEWG (Wireless E9-1-1 Working Group) and its strategic niche management, a Memorandum of Understanding (MOU) between participating organizations provided the necessary vehicle of inscription for the technical trials to take place. In contrast to paragraph 286 or the CRTC's Rules of Procedure, the MOU document was a limited term, project-oriented agreement that included detailed specifications in technical and administrative matters. It did not attempt to establish ongoing commitments or agreements between parties with respect to Wireless E9-1-1, but provided a basic design proposition from which interested parties could work together to undertake experimental testing.

In the strategy of reflexivity evident in the CISC ESWG (Emergency Services Working Group), the vehicle of inscription was a task identification form, also known as "TIF 29", which set out the terms and conditions for establishing network access services needed to provide Wireless E9-1-1. Like the CWTA Memorandum of Understanding (MOU), this vehicle of inscription is task-oriented and represents a certain level of acceptance for certain design propositions concerning the Wireless E9-1-1 project. Its main purpose was to establish a basis for specific negotiations toward the creation of a Strawman document. The Strawman serves as a high-level consensus document from which specific terms and conditions of implementation could then be negotiated between parties implementing technical details of Wireless E9-1-1 service.

The reflexivity strategy evident in Public Notice 2001-110 turns on the specific obligations set out in CRTC Order 2000-831 addressing the Microcell E9-1-1 issue. Of note is that the questions presented in the PN 2001-110 do not call directly into question wider 9-1-1 obligations within the Local Competition Framework but instead ask interested parties to respond to the specific design proposition for Wireless E9-1-1 established in Order 2000-831. Order 2000-831 by itself stems from the principle of symmetry established in Decision 97-8 but serves to provide specific direction for a specific case (Microcell) and is therefore limited in scope as a forcing effort but nevertheless may be precedent-setting for other Wireless Service Providers seeking CLEC status.

Establishing Congruency for Intervention

I suggested in Chapter 3 that effective strategic niche management is dependent on congruency between interested parties. Congruency refers to establishing shared frames of meaning (not necessarily consensus) between stakeholders within a technology project. In the case of Wireless E9-1-1 (see Table 16), the interested parties within the CWTA WEWG established congruency on the basis that they were engaged in technical trials. This shared orientation was reflected in the mandate of the CWTA WEWG. It is significant that activities within the CWTA WEWG dropped off sharply following the "success" of the technical trials in Alberta and Ontario, even though certain issues had yet to be resolved. This fact, combined with the antagonism that later emerged between certain parties on the ALI issue, suggests that once the trials were completed, the principle of congruency dissolved on this matter and parties disengaged from their initial efforts at strategic niche management.

Table 16: Congruency around Wireless E9-1-1

Actor	Strategy	Congruency
CRTC (Decision 97-8) and (Order 2000-831)	Forcing	Fair competition
CWTA (WEWG)	SNM	Technical trial
Microcell Part VII	Forcing	Relief
CISC (ESWG)	Reflexivity	Consensus
CRTC (PN 2001-110)	Reflexivity	Dispute resolution?

Strategies of technology forcing and reflexivity are also built on some degree of congruency, even though it is not the central element on which they turn. For example, the CRTC's role in Wireless E9-1-1 is based on a principle of regulatory symmetry to maintain fair competition, expressed in this case as a fundamental distinction between regulated carriers and the wireless service providers. Microcell's Part VII Application was initiated on the principle that it is acceptable to seek relief if the CRTC's Rules of Procedure are followed. While not all parties accepted Microcell's specific claims, the parties did appear to accept the principles of both proceedings and demonstrated congruency in their recognition of and contributions to them.

The principle of congruency on which PN 2001-110 is established remains unclear to me because the outcome of this Public Notice could be rather far reaching. I would suggest, however, that the inconsistent responses from interested parties to PN 2001-110 indicate congruency has not been clearly established with this document. Despite this apparent confusion, the intended principle of congruency behind Public Notice 2001-110 seems to be dispute resolution with respect to the obligations set forth in Order 2000-831. As we have seen in the case study, the CISC ESWG became increasingly mired in dispute over the ALI database issue and the CRTC's Public Notice is considered a formal response to this impasse.

Legitimacy and Intervention

The development of Wireless E9-1-1 in Canada has involved a number of spaces/processes of legitimacy that have, in turn, influenced to some degree the participation of certain stakeholders. I argued in Chapter 3 that a strategy based on loci for reflexivity turns on a space/process of legitimacy. In this case, the two instantiations of this strategy in the CISC and CRTC both provide a forum for a wide range of interested parties to participate in this technology project. The CISC Administrative Guidelines establish its role as a public forum open to all interested parties, despite the highly technical nature of its discussions. The CRTC Public Notice process is also open to all interested parties. Despite this, participation and reflexivity in these processes was constrained by other factors, some of which I will discuss later in the analysis.

In the other intervention strategies, legitimacy of participation was based on membership or affiliation as with the CWTA Wireless E9-1-1 Working Group, or by a specific request for information based on the interrogatory procedures established by the CRTC for handling Part VII applications. (See Table 17).

Table 17: Space/process of Legitimacy in Wireless E9-1-1

Actor	Strategy	Legitimacy
CRTC (Decision 97-8) and (Order 2000-831)	Forcing	Public Process
CWTA (WEWG)	SNM	CWTA discretion
Microcell	Forcing	Interrogatory
CISC (ESWG)	Reflexivity	Negotiated rule making
CRTC (PN 2001-110)	Reflexivity	Public Process

Discussion: Technology Forcing and Technical Standards

I argued in chapter four that standardization is a form of technology forcing that can be imposed either by an industry on itself, by a large supplier through its overwhelming influence on a market, or by a regulatory agency, or some combination of these influences. Technical standards provide a vehicle of inscription on which this intervention strategy turns, and expanded stakeholder participation in the creation of certain vehicles of inscription may be a means of shaping the ongoing development of telecommunications network infrastructure in Canada in view of the objectives of the National Disaster Mitigation Strategy.

My review of Hawkins' work raised the question as to where and how regulatory agencies and other stakeholders could most effectively participate in standardization initiatives in view of several important considerations:

- the complex tension between voluntary and mandatory instruments
- the variety of rationales for participating in standards making
- the influence of large equipment manufacturers and international bodies
- the problem of sorting suppliers from users in the telecom sector
- the challenge of fragmented user communities and competing problem formulations

In response to these considerations, Hawkins suggested that keystone standardization initiatives provide a critical site for wider stakeholder involvement, and that various structural and institutional impediments to participation may be addressed with third-party honest brokers or filter organizations, backed by coercive mechanisms. For my part, I added to this list the need for a locus of reflexivity in which demand articulation could be fostered among potential participants.

In effect, I have argued standardization is a fundamental design activity that influences interconnection arrangements and may assume a prominent role as a vehicle of inscription in a strategy of technology forcing. Drawing on the concepts and issues that Hawkins' provides, what did we discover in the Wireless E9-1-1 case study about the interaction of regulatory agencies, various stakeholders, and standardization with respect to the development of a new telecom service?

The role of technical standards within Wireless E9-1-1

Unlike the FCC in the United States, the CRTC did not directly mandate Wireless E9-1-1 in Canada and has largely remained outside the process up until the point at which Public Notice 2001-110 was issued. PN 2001-110 notwithstanding, Microcell's application to become a

Wireless CLEC invoked paragraph 286 from the Local Competition Framework that mandated a functional standard for E9-1-1 and raised substantial technical standards issues with respect network access services and the ALI database design.

Overall, the development of Wireless E9-1-1 in Canada has been characterized by mixed and often contradictory results that correspond with Hawkins' own views on the complex tension between voluntary and mandatory instruments. On the one hand, the telecom sector and the PSAPs worked together through the CWTA WEWG to develop a set of voluntary standards equivalent to FCC Phase 1 Wireless E9-1-1 service. This was undertaken in a relatively timely fashion, open to a number of key stakeholders, and proved to be effective insofar as it resulted in a commercial tariff for the service in three Canadian provinces. Throughout various proceedings with the CRTC, the industry advocated this voluntary process as the best course of action, citing problems with the FCC mandatory approach to Wireless E9-1-1 in order to support their case.

On the other hand, and despite the successful technical trials, progress on the actual deployment of Wireless E9-1-1 by Wireless Service Providers in Canada has been slow in the three provinces where it is offered and virtually nonexistent in other parts of Canada. The lack of regulatory incentive to develop Wireless E9-1-1 network access service standards seems to confirm to some extent Hawkins' claim that under these conditions "the standardization process can result in delays … and pose subsequent barriers to investment and innovation in network infrastructure." Indeed, Microcell's business plans have hinged in part on the deployment of Wireless E9-1-1 capability and network access in the regions where it is seeking to operate as a Wireless CLEC.

It seems in this case that the voluntary approach has worked best at the lower layers of interconnection space, in the physical and network services layers, where previously established technical standards now provide a relatively stable menu of signalling options and network interface arrangements. The evidence suggests that most parties to the technical trials seemed to agree upon these standards with little difficulty, perhaps meaning that variety reduction and harmonization rationales were more easily addressed than those rationales pertaining to strategic business operations. The MOU (Memorandum of Understanding) for the Alberta technical trial and TIF 29 within the CISC ESWG were largely concerned with network access services and related details, with apparent consensus on standardization at the physical infrastructure and network services layers in part because many of these standards, such as the CAS and NCAS concepts, were based on established signalling systems and adapted for Wireless E9-1-1.

Standardization at the lower layers of interconnection space was not simply confined to tactical, technical rationales, however, as it also appears in one instance to have played a major role in Microcell's business strategy. In its Part VII Application to the CRTC, Microcell requested the CRTC to force the ILECs in various provinces to commit to certain technical standards either immediately or in their upgrade paths in order to ensure the availability of network access services for Wireless E9-1-1 within a specified time frame (Microcell Telecommunications Inc., 2001a). I would suggest that this might have been a case of strategic business rationale informing a call for technical standards in the lower layers of interconnection space. After all, Microcell in its W-CLEC bid may have been looking to approach the CRTC with some assurance that it would be able to deploy Wireless E9-1-1 on a national basis within a specified time frame if standard upgrades for the ILECs were to be mandated. Such an assurance may have been seen by Microcell as a potential bargaining chip to avoid the interim obligation of populating the ALI databases with subscriber records where Wireless E9-1-1 is not available.

In the upper layers of interconnection space of value-added and information services, the issue of standards became a hotly contested matter. The debate over populating the ALI database with subscriber records involved standards related to software design, the MSAG, and even the WSP customer activation process and validating subscriber records. The debate illustrates several considerations raised by Hawkins, especially the influence of large equipment manufacturers and international bodies, the problem of sorting suppliers from users in the telecom sector, and the challenge of fragmented user communities and competing problem formulations.

The fact that a Wireless E9-1-1 system is designed in two legs is no small matter in this debate because it has been at the heart of numerous problems between the PSAPS and the WSPs, especially Microcell. In the overall process of providing Wireless E9-1-1 service, the supplier/user relationship is complicated by the two-leg design with the 9-1-1 Service Provider (usually the ILEC) serving as an intermediary actor between the WSPs and the PSAPs. Constraints imposed by the intermediary create additional complexity in the design of the telecom service. Therefore, if we consider Wireless E9-1-1 to be a keystone standardization initiative in Canada, we might do well to recognize that it consists of two nested but fundamentally distinct initiatives that have come into confrontation within the design of the ALI database: one between the WSPs and the ILECS and another between the WSPs/ILECs and the PSAPs, and even a third confrontation involving subscribers, WSPs, and the PSAPs.[55]

The debate between Microcell and the AEAA over the standardization of the ALI database software also illustrates the problem of external influences on domestic standardization initiatives and the fragmentation these influences create within the Canadian setting. For instance, during the proceedings it became clear that two standards organizations were influential to this debate, both American-based. When Microcell asked the AEAA to produce documentation on standardization that would support populating the ALI database with subscriber records, the AEAA eventually cited a specific subcommittee within the Telecommunications Industry Association (TIA) (Alberta E9-1-1 Advisory Association, 2002, par. 4). To promote its claim for including subscriber records in the ALI database, the Ontario 9-1-1 Advisory Board cited a "Future Models" document published by the U.S. National Emergency Numbering Association (NENA) (Ontario 9-1-1 Advisory Board & Alberta 9-1-1 Advisory Association, 2001, sec. 3). Microcell and others rejected the evidence as irrelevant to the ALI issue and dismissed the NENA document as "blue sky" (Microcell Telecommunications Inc., 2001b, par. 3.2.3).

Standards making for Wireless E9-1-1, in both legs of the system, has been heavily influenced by American organizations such as NENA and the TIA. These are well-resourced and influential organizations that have published extensive standards documents for suppliers and users of E9-1-1 service. While these standards making organizations have provided an important source for Canadian telcos and PSAPs, they may have also created false expectations among these parties. American technical standards are forged in working relationships found in the United States and may not be easily transplanted into Canada where PSAPs, WSPs, and ILECs have very different histories and relationships with one another.

Later in the proceedings, the ALI database issue also created fragmentation within the PSAP community itself when the BC 9-1-1 Service Providers Association, having had operational experience with Wireless E9-1-1, withdrew its call for populating the ALI database with subscriber records in order to promote the FCC Phase 1-equivalent design. Competing problem formulations among the PSAPs has resulted in fragmentation in the call for standardized design of the Wireless E9-1-1 system.

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[55] The third confrontation involving end-users, WSPs, and the PSAPs has remained largely unarticulated thus far, but could very well include the questionable public safety marketing campaigns of the WSPs, the 9-1-1 service fee issue raised by OAB, customer education about the use of one-button emergency phones, and the CRTC's general reluctance to act decisively on public safety issues such as Wireless E9-1-1.

Summary of Findings

- Industry voluntary efforts to develop basic technical standards for Wireless E9-1-1 were largely successful.
- Industry voluntary efforts to deploy Wireless E9-1-1 standards have been slow and have met with active resistance from most ILECs and WSPs.
- Microcell may have applied to the CRTC to force technical standards in lower layers of interconnection space as part of an overall strategic business rationale and not directly related to E9-1-1.
- The voluntary approach to standardization has resulted in disputes at upper layers of interconnection space, most notably with the design of the ALI database.
- American organizations have heavily influenced standardization of Wireless E9-1-1 in Canada.
- The user community (PSAPs) may have false expectations with regard to the willingness of Canadian ILECs and WSPs to recognize certain American standardization initiatives.
- The user community itself is fragmented with regard to standardization of the ALI database.

Discussion: Strategic Niche Management and the CWTA

I argued in chapter four that one possible strategy for the National Disaster Mitigation Strategy may be to adopt a policy or an initiative that encourages the development of third party, value-added services or otherwise seeks to lure new entrants into emergency telecommunications. The basis for this assertion was Mansell's two constructivist principles that advocate experimentation on a broad scale in order to explore, both widely and deeply, the potential application of emerging information infrastructures.

My review of Mansell's work suggested that certain network elements might require regulatory oversight to ensure fair terms and conditions of access, as dominant players in the telecommunications would tend to resist access to those elements as a means of protecting strategic interests in network interconnection arrangements. I then proposed that where we found contested or rejected problem formulations or design propositions among parties involved in a technology project, that we might look closely at motivating factors for incidents of strategic positioning behaviour. The point of this line of inquiry is to identify typical kinds of network elements that may require regulatory oversight to make them available to interested parties in order to encourage innovation and experimentation with new telecom services.

Innovation and Experimentation within Wireless E9-1-1

The important role that the CWTA assumed in the case of Wireless E9-1-1 suggests that innovation in this kind of industry-directed forum may tend toward conservative problem solving at the expense of permitting new entrants or high concept ideas that challenge current practices. The members of the CWTA WEWG while laudable in their willingness to conduct technical trials for Wireless E9-1-1 were clearly uninterested in Clearnet's design proposition that included a third-party 9-1-1 service provider. Strategic niche management, while a valuable strategy for experimenting with new service designs, may simply serve the interests of dominant or incumbent parties at the expense of innovative firms and new entrants seeking to develop alternative approaches to service delivery. At the heart of this dilemma are the interconnection arrangements between service providers; this is especially true with respect to certain elements that remain under the control of major stakeholders. In such cases, the cooperation (voluntary or otherwise) of these stakeholders may be essential if innovative design propositions are to be tested and refined.

Armstrong (1998, p. 545) echoes Mansell's views on the centrality of network interconnection in telecom reform: "A crucial issue for public policy is how to set the terms of access by rivals to ... monopolised inputs ('essential facilities') ...". We might refer to this as the *bottleneck problem* inherited in part from the pre-competition, or pro-incumbent (Noam), phase of interconnection policy. In the case of Wireless E9-1-1, the ILEC-owned and operated 9-1-1 platform is *not* deemed an essential facility by the CRTC but nevertheless has proven to be a *de facto* bottleneck, especially in the case of Microcell's application for national W-CLEC status. Even in the case of technical trials, the ILEC's were central to problem formulation and design propositions, as they effectively control E9-1-1 service delivery in Canada. As a case in point, Clearnet's attempt to table an alternative design proposition was dismissed outright without consideration in the CWTA WEWG. The evidence available from Wireless E9-1-1 in Canada suggests that this service conforms to what Armstrong (p. 545) calls a "one-way access" situation:

> A characteristic of one-way access situations is that, for important inputs at least, regulation in terms of access is likely to be required to ensure socially-desirable outcomes in competitive sectors since the monopolizing firm will choose to set too high a level for access charges if free to do so.

While I concur with Armstrong's first point that terms and conditions of access are required to address the bottleneck problem, his second point dealing with access charges only touches upon one barrier to interconnection. In the case of Wireless E9-1-1, for example, we see that access charges have not been a prominent issue in the deployment of the service. On the contrary, we have seen considerable cooperation among the ILECs, the WSPs, and the PSAPs in the highly valued regional markets of Canada such as Alberta, BC, and Ontario. In other regions, cooperation from the ILECs has been far less forthcoming as Microcell sought to demonstrate in its Part VII application to the Commission. In these cases, however, the issue was not over access charges but about access to technical information, existing technical capabilities in the 9-1-1 platforms, and concern over the choice and timing of equipment (i.e., switch platform) upgrade paths. For example, a major component of Microcell's Part VII was a request to the CRTC to ensure that equipment upgrades in regions with less developed E9-1-1 systems, such as Manitoba and Nova Scotia, would be done in a timely manner and would be capable of accommodating the most common E9-1-1 solutions.

In this case study, a direct application of Mansell's indicators (Chapter 4, Table 7) was not of great help to me when looking for specific attempts at strategic positioning among dominant players. This may be in part because of the high level of standardization and apparent consensus evident in lower layers of interconnection space within this case. However, two instances in the Wireless E9-1-1 case point do seem to support my proposition that attempts to gain strategic control may be shifting to the upper layers of interconnection space and Mansell's proposition that peripheral elements are now key focus for dominant players. The first example is found in Bell's refusal to provide Province-wide access to its Master Street Address Guide (MSAG) database when this was requested by Microcell as a required input to fulfill its ALI-related obligations in 2000-831. While the MSAG itself is a core element, Microcell was seeking to connect retail service points to this core network element in order to ensure that subscriber addresses could be validated in real-time. Access to the MSAG might be interpreted as an example of what Mansell noted as a "conditional access system." The MSAG is provided by Bell to other carriers and is used to filter and verify street addresses on subscriber records when populating the ALI database. By setting the terms and conditions of access to the MSAG, a dominant player like Bell can exercise control over the development of Wireless E9-1-1. In this case it may have been to encourage Microcell to adopt Bell's trunking arrangements prescribed in Order 2000-831.

The second example is the claim by the ILECs, with respect to the CRTC's Interrogatory 200 within Microcell's Part VII Application, that the release of PSAP equipment data fell under section 39 of the Telecommunications Act and would harm the competitive position of Bell and other ILECs.

The PSAPs objected to Bell's refusal to permit Province-wide access to the MSAG , while Microcell criticized the ILEC's claim that PSAP equipment data should be treated under section 39 of the Act. Looking at these concerns in terms of interconnection space, the MSAG can be viewed as part of a value-added service (ALI functionality) and the PSAP equipment lists resides at the information services layer as a form of proprietary customer data (or so it was claimed by the ILECs). The attempts by Bell and the other ILECs to protect these upper layer network elements can be interpreted as attempts to influence or otherwise delay the deployment of Wireless E9-1-1 in Canada. Both of these elements reside in the upper layers of interconnection space and at the edge of the CRTC's authority over interconnection arrangements.

Wireless E9-1-1 is a case today of a one-way access situation in which the ILEC E9-1-1 platform and support services is a *de facto* bottleneck, Noam's prediction of a modular system-of-systems scenario suggests that essential network facilities may be distributed among a number of carriers, as well as unaffiliated third-parties, requiring more complex *exchange* of services in order to create service bundles for customers. Armstrong (Armstrong, 1998, p. 547) adds a further dimension, when he notes that while the one-way access model has tended to prevail in policy analysis a two-way model may become increasingly relevant in light of competition in service development. This may be particularly important in view of a trend toward value-added services that operate at the fringes of regulation.

Had Clearnet actually developed and deployed an alternative 911 platform, we might have seen a situation like Figure 11 below, which depicts a two-way (modular) interconnection situation of the type that might become more commonplace with value-added services in Noam's "system of systems" scenario. In this alternative scenario, a carrier such as Microcell may have had to negotiate terms and conditions with more than one service provider to obtain access to all the elements it would need to meet its obligations. The modular situation may in fact become a reality if an FCC-equivalent Phase 2 service is developed in Canada, where a third party mobile positioning company independent of the carriers offers specialized location tracking services.[56]

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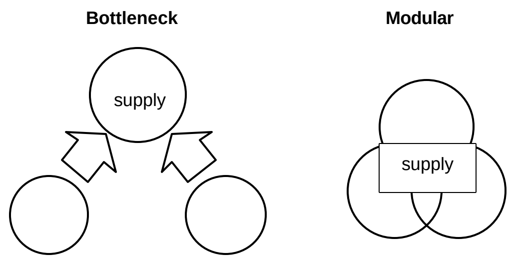
[56] A third party service model has in fact been discussed in the United States (TSI Telecommunication Services Inc., 2002).

Figure 11: Interconnection Situations



Summary of Findings

- CWTA WEWG exhibited conservative tendencies toward new service development, avoiding high concept ideas and challenges to current practices.
- ILEC-owned 9-1-1 platforms and requisite support services have proven to be *de facto* bottlenecks in the development and deployment of Wireless E9-1-1 in Canada.
- ILECs in certain regions have actively resisted efforts by Microcell to obtain data and support services for lower layer network elements relevant to Wireless E9-1-1 service deployment.
- ILECs across Canada have actively protested against mandated upgrade paths at lower layers of interconnection space.
- ILECs in certain regions have actively resisted providing access to upper layer support services requested by Microcell in order to fulfill its regulatory obligations.
- E9-1-1 design propositions based on upper layer services may complicate the traditional one-way access model that prevails in current policy analysis.

Discussion: Locus for Reflexivity and the CISC

Earlier in this study I suggested that a CTA strategy based on loci for reflexivity seeks to expand the range of discourse in which network design will occur and thus brings with it the prospects for new forms of boundary crossing and concomitant challenges for achieving viable outcomes. Boundary crossing describes the encounter between stakeholders when Large Technical Systems are undergoing moments of growth and change.

As I noted in chapter four, instances of boundary crossing within a technology project may lead to disputes because of perceived challenges in functional or territorial dimensions of problem formulations or specific design propositions. Often, however, these disputes mask more extensive normative views of stakeholders and thus prevent participants from a fuller grasp of the issues involved. I proposed that Bijker's technological frame and configuration model offer a means of investigating instances of boundary crossing. Within the scope of the case study I looked for the presence of one or more technological frames, with the intent of applying the findings to the set of expectations stated in Bijker's configuration model.

Boundary Crossing within Wireless E9-1-1

Within the case of Wireless E9-1-1 some of the controversy and disputes surrounding the design and use of ALI database can be viewed as matter of boundary crossing. Wireless E9-1-1 represents significant change to the telecommunications infrastructure both at the core and periphery because it involves the creation of new service that impacts network design throughout. It directly involves at least three major stakeholders spanning two-legs of service: the WSPs, the ILECs, and the PSAPs.[57] For all parties involved, Wireless E9-1-1 required changes in equipment and operations. It also presents an opportunity to resolve a business problem faced by Microcell (with its wireless CLEC application) and operational problems faced by the PSAPs (handling wireless emergency calls without enhanced features). The two-leg arrangement complicates the analysis to some degree but there is a pattern that emerges to suggest that the development of Wireless E9-1-1 exhibits a single dominant technological frame.

Recalling Bijker's configuration model, the presence of a single dominant technological frame tends toward a conservative approach to problem formulation, with a division between high inclusion actors operating within the frame and low inclusion actors outside the frame. Bijker proposes that high inclusion actors will draw on standard problem-solving strategies based on an exemplary artefact while low inclusion actors may offer alternative approaches that disregard or challenge the exemplary artefact.

While all parties agreed in principle to the need for Wireless E9-1-1, clear differences were evident on the matter of the ALI database. These differences tended to form along lines of WSPs/ILECs versus the PSAPs (with the later exception of the BC 9-1-1 Service Providers Association). The argument for a single dominant technological frame comes from the fact that all parties to the proceeding seem to have accepted the basic design proposition using Emergency Services Routing Digits (ESRD) and the existing ALI database system. We might say that the ALI database represents the exemplary artefact at the heart of the Wireless E9-1-1 frame. For

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[57] Of course the general public is also a stakeholder. Given the limited representation of the public so far in the Wireless E9-1-1 proceedings, I am not comfortable discussing the public in this analysis. A separate study of public perceptions related to Wireless E9-1-1 would make a critically important contribution to policy research for this emerging service.

high inclusion actors such as the WSPs and ILECs, the ALI database was an obdurate actor that presented constraints on the design of the Wireless E9-1-1 service; namely, that it has been designed with a single field for address information. As such, a decision was made that this field would be populated with cell site location information to be triggered by an ESRD.

The PSAPs appear to be low inclusion actors in this case. By low inclusion, I mean in the sense that they draw from the ALI database when handling emergency calls but otherwise have limited control over its design and implementation in the E9-1-1 system. Bijker uses the term "boundary object" to describe the relationship of low inclusion actors to an exemplary artefact. As low inclusion actors, the PSAPs proposed that the ALI database *could* be used to provide real-time access to customer records, interpreting it as a flexible artefact capable if necessary of accommodating two address fields. The exchange between Microcell and the AEAA over the very existence of technical standards is an example where this claim is being debated in functional terms with clearly territorial overtones concerning control over access to subscriber records.

Does the dispute over the ALI database lead us back to the normative reference points on which the competing positions may be founded? The theory of a single dominant technological frame helps us to interpret the normative positions from which each side in the dispute has applied to the basic problem formulations for Wireless E911. For the wireless industry the problem is formulated as a reverse salient (Hughes, 1987). In other words, the wireless industry has sought backwards compatibility and ways to provide an E9-1-1 equivalent that will fit within established practices, causing the least amount of disruption (and cost). As a result, the design proposition for Wireless E911 in Canada is drawn directly from a method developed by the U.S. telecom industry and that most closely conforms to current capabilities and standard practice. As one wireless carrier put it, adding new functions to the ALI database as proposed by the public safety agencies would

> greatly complicate the interaction between Microcell resellers and their end-user subscribers, cause Microcell and its resellers to incur substantial and unjustifiable ongoing compliance costs, raise important privacy concerns, aggravate and potentially drive away significant numbers of subscribers, and place Microcell at a distinct competitive disadvantage relative to other wireless carriers. All of this for a measure whose rationale is dubious to begin with ... (Microcell Telecommunications Inc., 2001c, p. 5-6)

The public safety agencies, however, formulated the problem quite differently. In their view, dispatch operations have suffered at the hands of the wireless carriers because of the added workload when handling emergency calls made from mobile phones:

> … we are tired of being the victims of the success of the wireless companies. Wireless calls have grown from 8% of our total calls in 1990 to nearly 40% in 2001. It takes extra time to route a wireless 9-1-1 call to the correct dispatch centre. It is becoming more difficult to accommodate this additional work without extra resources. (BC 9-1-1 Service Providers Association, 2001)

Given the new demands placed upon them by the explosive growth of wireless, the PSAPs therefore see it in their best interests to make demands for any and all information that can be provided in real-time to the PSAP and to gain some control over the real-time flow of data—hence their demand for wireless subscriber records to be included in the design of the Wireless E911 system.

Each problem formulation highlights different constellations of elements, giving credibility to some while ignoring others. At the heart of the territorial debate, however, is the ALI database and its status as a technical artifact. The PSAPs are low inclusion actors facing a dominant technology frame, and from this perspective the ALI database is viewed as a boundary object that the wireless industry is using to prevent real-time delivery of wireless subscriber records. Attempts by the wireless industry to avoid populating the ALI database with subscriber records is interpreted by PSAPs as a territorial infringement on their obligations to serve.

The result unfortunately has been a growing turf war over the ALI database at the expense of alternative solutions. In the late stages of the proceedings, for example, evidence was presented to suggest further territorial elements at play in terms of the past history the WSPs when responding to requests from PSAPs for subscriber record information by telephone. The PSAPs accused the wireless industry of not taking these requests seriously and not providing an adequate quality of service in their security departments. In the final submissions to Public Notice 2001-110 an alternative design proposition to the problem of accessing subscriber records was finally introduced. This proposition is positioned outside the dominant technological frame because it need not involve the ALI database at all. The proposal is to improve PSAP access to subscriber records by ensuring that the WSPs provide better quality of service in their security departments (i.e., easier access to staff and quicker response to calls made by PSAPs). For the PSAPs, problem formulation stems from the perceived need to gain direct access to wireless subscriber records on par with what they have come to expect with wireline based E9-1-1 service.

Had the PSAPs not been so fixated on the issue of populating the ALI database and had the CRTC not fueled this debate with its obligation in Order 2000-831 for Microcell to populate the database where Wireless E9-1-1 was unavailable, the issue may have been resolved far earlier in the proceedings. The presence of a single dominant technological frame may have contributed to parties (including the Commission) fixating debate on the ALI database at the expense of recognizing a potentially acceptable design proposition based on alternative measures.

Summary of Findings

- The case of Wireless E9-1-1 in Canada has exhibited a single dominant technological frame.
- The wireless industry and ILECs are high inclusion actors in this frame.
- The PSAPs (BC SPA excluded) are low inclusion actors in this frame.
- The ALI database is an exemplary artefact for high inclusion actors and a boundary object to low inclusion actors.
- Disputes over the ALI database contain both functional and territorial dimensions spanning competing normative frameworks.
- The presence of a dominant technological frame may have contributed to a failure to recognize viable alternative design proposition.

Considerations for New Service Development in Canada

Having identified predominant intervention strategies in the case study, I then set them against the interconnection matrix looking for larger patterns in the overall development of Wireless E9-1-1. The intervention matrix developed in Chapters 3 and 4 brings together the three operational principles, with CTA's intervention strategies, and Arnbak's interconnection space to create a three-dimensional framework for assessing a technology project.

My application of the intervention matrix to this case provides evidence to suggest that the *operational* moment of network design most open to reflexivity among all interested parties is, in fact, located at a functional systems layer in which reflexivity is most constrained.[58] Furthermore, the moment when higher level conceptual discussions about network design might take place is closed, either historically in the case of the CRTC's past public hearings, or closed to selected participants in the case of the CWTA working group. I will return to this point in a moment. Table 18 illustrates the functional systems layers that preside over each intervention strategy found in the Wireless E9-1-1 case study.

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[58] I use the term "operational" to emphasize the impact on actual design decisions rather than higher level conceptual forms of intervention, which I address later in this section.

An important pattern to observe is that each strategy tends to deal with a unique functional layer in interconnection space. In the case of the CRTC's regulatory strategy, the matter of E9-1-1 is prescribed in terms of functional requirements for a value-added service, with little regard for its technical implementation. The CISC, however, primarily deals with the point of interconnection between network services and the underlying layer of physical network infrastructure. It is therefore an open forum but restricted in its dealings to technical matters under a consensus-driven mandate.

Table 18: Comparing Wireless E9-1-1 with the Intervention Matrix

	Forcing	Niche Management	Reflexivity
Legitimacy	CRTC	CWTA WEWG	CISC ESWG
Congruency	Fair competition	CWTA technical trials	Consensus
Inscription	Decision 97-8 (par. 286); (Order 2000-831)	MOU	TIF 29
Interconnection Space	Value-added services; Information content	Network services	Physical infrastructure

The CISC Emergency Services Working Group (ESWG) operates under the auspices of the CISC, which as we have now seen is intended to be open to all interested parties as indicated in its statement of Operating Principles:

> The CISC shall … afford all parties the right to be heard … support the evaluation and acceptance of issues and development of resolutions based on their merit … make reasonable efforts to inform consumer representatives of any consumer issues arising in the CISC …

However, the task-oriented and consensus-driven mandate of CISC also limits the scope of discussion that can be practically undertaken in this space of legitimacy:

> … Recognize that broad and consistent achievement of a consensus resolution is a fundamental expectation and the reason for the existence of the CISC … that most CISC work is highly technical and therefore of limited interest to consumers … (Canada. Canadian Radio-television and Telecommunications Commission, 2001, Sect. 3)

In the case of Wireless E9-1-1, the late stage of design at which the CISC ESWG became involved placed a *de facto* limit on the range of alternative design propositions that could be tabled for discussion. In effect, TIF 29 was a second-order undertaking grounded in a first-order assumption; namely, that consensus had already been achieved on a design proposition for Wireless E9-1-1. The task for the CISC ESWG was not to debate the merits of the design proposition *per se* but to negotiate terms and conditions for network access services, despite the fact that certain PSAPs continued to criticize this design proposition. This suggests, ironically, that the forum in which technical designs are to be debated to establish “their merit” is perhaps invoked too late in the process of design, at the point when the momentum of a project tends to marginalize alternative propositions. This suggests that the role of the CISC in network infrastructure design is located at a specific functional layer of interconnection space that limits intervention to the modification of accepted design propositions rather than serving as a space/process to debate alternative concepts for value-added services.

Given this limitation of the CISC, one might posit that CRTC regulatory hearings are therefore the space/process of legitimacy that permit wide discussion of issues at higher functional layers. We have observed, for example, that technology forcing in the Wireless E9-1-1 case is located at the value-added service layer of interconnection space, where the wording of paragraph 286 of the Local Competition Framework is concerned only with functional symmetry between ILECs and CLECs.

While regulatory hearings may provide an open forum for debating alternative higher layer design propositions, these opportunities are constrained by two factors: the Commission must see fit to conduct a hearing into an issue; or an interested party must file a specific request for relief based on the CRTC Rules of Procedure (which could in turn lead to a public hearing). I would argue that these constraints place a real limit on the ability to introduce new items on the regulatory agenda and may in fact restrict public input on issues in the higher layers of interconnection space. The proceedings leading up to the CRTC’s Local Competition Framework issued in 1997 were the last occasion in Canada when the concept of E9-1-1 was open to public debate. The record indicates that fundamental debate did take place on design aspects of 9-1-1 service within local competition (Canada. Canadian Radio-television and Telecommunications Commission, 1997, par. 285). Once the Commission issued its Framework, however, the debate was closed to certain concerns about E9-1-1, restricting the range of debate that would be acceptable within a CRTC public hearing on Wireless E9-1-1. Public Notice 2001-110, for example, does not open E9-1-1 to conceptual debate but confines it within the boundaries of Order 2000-831. So while the CRTC regulatory hearing may offer a wide space of legitimacy it too, like the CISC, may be a difficult locus in which to debate new value-added service concepts or to assess alternative design propositions.

In the case of the CWTA Wireless E9-1-1 Working Group, participation was limited to specific stakeholders invited into the process. Moreover, discussions were about learning to some degree but only so far as to establish conditions needed to undertake technical trials. As we have seen, other issues and alternative design propositions were not open for discussion within the CWTA. Nor was the public invited to make contributions the proceedings.

The intervention matrix reveals an overall pattern of significant constraints on experimentation and on the potential development of innovative design propositions when Wireless E9-1-1 was being developed and deployed in Canada. A pattern can be observed where the CISC provided a locus for reflexivity open to all interested parties but was tasked with only lower layer interconnection arrangements. This precluded any substantial discussion of alternative design propositions in this forum. Conversely, the CRTC public hearing process leading to Decision 97-8 (and paragraph 286) dealt with high layer interconnection aspects of E9-1-1 but has been closed to public debate for a number of years. The Commission has not re-examined the debate at the higher conceptual level, choosing rather to issue interrogatories and a Public Notice based on the specific design proposition recognized in Orders 2000-830/831. The CWTA provided a unique setting for testing various design propositions but participation was limited to those parties acceptable to the membership of the Wireless E9-1-1 Working Group. This arrangement resulted in a conservative approach to Wireless E9-1-1 design at the expense of more experimental approaches that may have been considered.

Summary

This chapter provided an analysis of the case study on Wireless E9-1-1 in Canada. I began with a socio-technical mapping, highlighting key actors and issues in each of the functional layers of interconnection space. I presented a layout of interventions, and discussed seven predominant strategies evident in this case. Each intervention strategy was examined according to its vehicle of inscription, mode of congruency, and space/process of legitimacy. I then summarized major findings with respect to the role of technical standards, experimentation, and boundary crossing within Wireless E9-1-1. Finally, I concluded the chapter by looking for overall patterns within the development of a new telecommunications service. The intervention matrix reveals a contradictory pattern in this development with respect to early design phases and the availability of open forums for reflexive discussion of issues and concerns.

In the following chapter, I will draw on the analysis of the Wireless E9-1-1 case study to establish a set of "considerations" and "findings" that are generalizable to the wider process of growth and change in Canada's telecommunications infrastructure. These are intended to address more directly the central concern of this dissertation, which is to identify and assess intervention strategies for influencing the development of other telecommunications services in order to better coordinate overall network evolution with the objectives of the National Disaster Mitigation Strategy.

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Chapter 7: Recommendations and Conclusion

Introduction

This chapter proceeds in two sections. The first section provides a list of considerations that translate specific observations from the case study to a wider context that includes the NDMS. The next section then draws on these considerations to provide a set of specific recommendations for action. This two-step flow is intended to foreground the logical steps made between specific findings with the case study and the specific recommendations for the NDMS.

Considerations, findings, and recommendations found in this chapter are addressed to a set of three formative research questions introduced in Chapter 2. Looking to the Canadian *Telecommunications Act* ("the Act") as a source for general policy perspective on the issue of growth and change in network infrastructure, I highlighted a number of key objectives stated in Canadian legislation. First is the objective of maintaining "orderly development" of the telecommunications infrastructure and the corresponding claim that it be capable of supporting the broader objectives of the NDMS as it relates to "safeguarding" Canadians and Canadian society. In the face of rapid technological change this suggested to me that some kind of direct oversight or regulatory action may be required to ensure that Canada's telecommunications infrastructure will evolve in a coordinated way along the lines of established best practices that embody a vision of long-term risk reduction. I asked the following questions: Is such oversight necessary? Is this oversight currently in place? If so, can it be improved? If not, what are the best means to implement it given current policy and regulatory considerations?

Section 7 (f) of the Act calls for increased reliance of market forces for service provision, implying that initiatives taken up within the NDMS should be fostered by competition wherever feasible. In terms of infrastructure development, this might mean looking for policy instruments to promote research and development and encourage technology transfer for disaster management. It might also mean ensuring access to certain strategic network elements and services that enable innovative services in support of mitigation-related activities. The following questions were posed for this study: What policy instruments are available to support research, development, and technology transfer for disaster management? What are the key bottlenecks and strategic network elements that might influence the deployment of new services?

Finally, section 7 (i) of the Act requires that the social and economic requirements of user communities be considered in the development of Canada's telecommunications infrastructure. In terms of the NDMS, this suggests a need to ensure stakeholder consultation is undertaken at critical stages of infrastructure development. Current stakeholder development may need to be expanded, or new processes may need to be introduced in order to better facilitate participation in critical decisions. I asked the following question: What are the important issues, challenges, and opportunities for expanding stakeholder participation in telecommunications infrastructure planning and development?

Together this set of observations and questions formed the basis for inquiry that guided this study. I established an intervention matrix to structure my inquiry into these questions, operationalized it through the concept of "interconnection space" and specific propositions derived from the telecom policy literature. This literature introduced specific lines of inquiry that were applied to examine Wireless E9-1-1: technical standards and the standards process, interconnection arrangements, and Bijker's technological frame. Analysis of these operational concepts was structured thematically through Constructive Technology Assessment's three generic intervention strategies of technology forcing, strategic niche management, and loci for reflexivity. A theoretical account of the movement from demand articulation, through problem formulation, and design proposition was based on a constructivist theory of technology dynamics drawn from science and technology studies. Together these dimensions combined to form the intervention matrix used to analyze the Wireless E9-1-1 case, which provides a baseline assessment against which to measure current arrangements in light of the wider objectives of the National Disaster Mitigation Strategy. The objective of this chapter is to apply this baseline framework to the wider domain of objectives set forth in Canada's current telecom policy.

Considerations for the National Disaster Mitigation Strategy

The following is a list of considerations drawn from the case of Wireless E9-1-1 in Canada and then generalized to the National Disaster Mitigation Strategy.

Finding: Canada's telecommunications infrastructure varies widely by region.

Evidence from Microcell's Part VII Application indicates that Canada's telecommunications infrastructure does not conform to a single standard of performance capability. On the contrary, this capability varies widely by region and the capacity for deploying new technology and services may depend on certain provisions at the lower layers of interconnection space such as switch platform upgrades and other physical and network access service support features currently not uniformly available across Canada, particularly outside the "have" Provinces of British Columbia, Alberta, and Ontario.

Consideration: National standards for Canada's telecommunications infrastructure

Some regions are currently unable to provide minimum infrastructure required for the deployment of advanced value-added telecom services (e.g., Wireless E9-1-1). This creates a patchwork of capability across Canada, generally following, and perhaps reinforcing, patterns of economic development. If telecommunications is to provide a robust service environment to support the objectives of a National Disaster Mitigation Strategy, it may be necessary to ensure that all regions of Canada are capable of meeting certain minimum standards of infrastructure performance within a reasonable timeframe.

Finding: Standardization activities are often exogenous to the Canadian telecom sector

Evidence from the case study indicates that keystone standardization initiatives are typically undertaken outside Canada. In some cases, this situation may foster misunderstandings and false expectations among key stakeholders resulting in disputes and delays in deploying new services.

Consideration: Correspondence between standardization and user community

In the case of Wireless E9-1-1 some of the misunderstandings and enmity between parties may have been avoided had a third-party broker liaised between standardization activities with the TIA and NENA in the United States and the various interests and aspirations of stakeholders in Canada. Such a broker may have been charged with vetting detailed technical information and closely assessing technical arguments, thereby providing a balanced perspective and accurate information to all parties including the CRTC. Such a broker might have improved the efficiency of the overall process and, moreover, identified and encouraged the adoption of verifiable best practices with an eye to critical path dependency issues (such as transitioning to FCC Phase 2-equivalent deployment in Canada). In the long run such an advocate may have saved time and money for all parties involved (including customers), while ensuring a high quality of service in Canada's telecom infrastructure.

Finding: Industry voluntary efforts do not guarantee timely deployment of services

The CWTA proved that it could foster industry and other stakeholder cooperation in order to conduct successful technical trials for Wireless E9-1-1. Commercial deployment of Wireless E9-1-1 service by Wireless Service Providers has been much slower and both TELUS Mobility and Rogers Wireless have yet to issue firm public commitments to deploy the service, more than one year after becoming available in British Columbia and Alberta. Most ILECs outside BC, Alberta and Ontario have not been willing to commit to upgrading infrastructure or providing network access services necessary to enable Wireless CLECs such as Microcell to meet their regulatory obligations with respect to E9-1-1 service in these other Provinces.

Consideration: Innovation and Deployment are Intimately Linked

Industry may be willing to foster innovation in new technology and services but far less willing to let the products of these efforts be made available. This may be especially true with respect to competitive interests that challenge the efforts of dominant players to control network design through delaying or otherwise refusing to provide access to certain network elements. To foster innovation and wide experimentation, some measure of guaranteed and timely deployment of the products of such efforts must be ensured in order to provide some certainty with respect to investment.

Finding: Forcing is a problematic strategy when dealing with the wireless sector

The Wireless sector in Canada resides at the fringe of regulation in large part because of the CRTC's decision 96-14 to forebear from key sections of the Telecommunications Act for Wireless Service Providers (WSPs). In the case of Wireless E9-1-1, this situation has made it difficult in principle for the CRTC to become directly involved in the development and deployment of this new service. I would argue that this uncertainty and lack of direction from the regulator contributed to many of the delays, added costs of proceedings, and ultimate uncertainty that may have had a significant impact on Microcell's business operations (due to delays and problems in clarifying its E9-1-1 obligations across the country).

Consideration: Section 7 of the Telecommunications Act

Section 7 of the Telecommunications Act establishes the objectives of Canada's telecommunications policy. Three of these objectives are important in light of the case study and the National Disaster Mitigation Strategy:

> (a) to facilitate the orderly development throughout Canada of a telecommunications system that serves to safeguard, enrich and strengthen the social and economic fabric of Canada and its regions; …
> (f) to foster increased reliance of market forces for the provision of telecommunications services and to ensure that regulation, where required, is efficient and effective;
> (g) to stimulate research and development in Canada in the field of telecommunications and to encourage innovation in the provision of telecommunications services;

Taken together, these three subsections establish a responsibility for the CRTC and other Federal Government departments to become actively involved in key technology projects to ensure orderly development of the telecommunications infrastructure. The National Disaster Mitigation Strategy can be taken as an overarching program, one aspect of which includes infrastructure development. Infrastructure development should seek to encourage competitive supply of innovative technology projects within telecommunications that will contribute to safeguarding the social and economic fabric of Canada and its regions. Where necessary, and especially with regard to the wireless sector, the regulator should be directly accountable to these objectives.

Finding: Current arrangements do not support timely and extensive participation from the user community.

Evidence from the case study indicates that current arrangements do not support timely and extensive participation from the user community when dealing with growth and change in Canada's telecommunications infrastructure. CRTC public proceedings are one possible forum for wide stakeholder participation but the scope may be confined to narrow policy issues that the

Commission sees fit to address based on previous decisions or when parties are seeking specific relief, as with a Part VII Application. Industry arrangements with the CWTA were not open to wide stakeholder participation and the CISC is open to “all interested parties” but is a consensus-driven context, late in the design phase of a technology project, and usually concerned with very technical issues. Independent user and public advocacy groups are not well resourced to address the complex and rapid developments that characterize telecommunications.

Consideration: Demand Articulation and Loci for Reflexivity

Incremental developments in telecommunications infrastructure will often have path dependent consequences, hence the CWTA membership’s concern with “stranded investments” in the technical trials of Wireless E9-1-1. User groups are often unaware of such developments or unable to participate in proceedings around such developments. Barriers to participation include staff and financial resources but may also be related to awareness and relevance. The communities of telecommunications users in Canada need a means of being made aware of changes taking place or being proposed and, moreover, some further means of understanding how those developments may come to affect their interests in the future. Finally, these communities must be enabled in some way to discover and articulate their demands for new and/or improved telecommunications services that contribute to the objectives of the National Disaster Mitigation Strategy.

Recommendations

The following section establishes a set of recommendations using the analytic framework developed for this study. The recommendations are based on three principles advocated throughout this study and applied to the analysis of a new service development in Canada:

- Maximize learning and reflexivity through widest possible stakeholder participation in telecommunications network development.
- Encourage innovation and experimentation on a broad scale.
- Ensure a level playing field and fair opportunities for new contributions in telecommunications services.

Additional responsibility may be added to Industry Canada’s emergency telecoms role

Industry Canada could be assigned a new responsibility within its Emergency Telecommunications Bureau to facilitate the identification, dissemination, and assessment of best practices in telecommunications products and services from around the world, including technical standards, which could contribute to the objectives set forth in the NDMS. Industry Canada might, for example, sponsor a new program open to all interested parties with the express intent of fostering learning and elaborating on potential opportunities through dialogue, debate, and information sharing. The program should be distanced from existing programs to avoid confusion with these programs and to highlight its unique role within the National Disaster Mitigation Strategy.

Outcomes of the program could clarify disputes or misunderstandings among the user community, generate new opportunities for innovation within the telecom sector, and alert regulators to future items of interest or concern. A program of this type should have low barriers to entry and participation but clearly established working methods to ensure timely and effective exchanges and outcomes.

An exemplar for this program may be found in Project MESA. Project MESA (Mobile Broadband for Emergency and Safety Applications) is a technology standardization forum sponsored by the US Telecommunications Industry Association (TIA) and the European Telecommunications Standards Institute (ETSI). First established in 2000 as the Public Safety Partnership Program (PSPP), it was renamed in 2001, although its primary aim remained the same: to create specifications for “an advanced digital mobile broadband standard” to serve the public safety and emergency management communities (Project MESA, 2003). Project MESA aspires to promote constructive participation with the user community at the initial stages of technology design. Here it shares features with the approach of Constructive Technology Assessment:

> Within Project MESA, market relevance is achieved by inviting users and their organizations to play a focal role in the specification and harmonization of requirements before the technical specification efforts are introduced. MESA represents the first such international initiative within the ICT sector to “put the user in the driver seat.” (Project MESA, 2001)

The project has been designed to proceed in two general phases: first, the elaboration of a common statement of requirements (SoR) that covers “a harmonized view of applications and services” for public safety and emergency management; the second phase involves development of technical specifications in response to the common statement of requirements (SoR). Project MESA’s statement of requirements is intended to provide early specifications for telecom service design, with implications for interconnection at both lower layer physical and network protocols as well as upper layer system and service aspects. The anticipatory nature of Project MESA is emphasized in the introduction to its SoR documentation:

> The users of professional wireless telecommunications equipment within the sector of Public Protection and Disaster Relief (PPDR) have developed the MESA Statement of Requirements (SoR) document. It describes the services and applications, which a future advanced wireless telecommunications system should be able to support in order to realize the most effective operational environment for the sector.
>
> Emphasis has been placed on those applications, which current applied technology cannot carry out to the full, but which have been identified by the users and their agencies to be key requirements.
>
> The [SoR] document is unique in the sense that it represents the first trans-atlantic consolidated view expressed directly by the professional users of advanced wireless telecommunication equipment. (Project MESA, 2002)

These applications include remote patient monitoring, mobile robotics, and ad hoc networking. To facilitate user participation, MESA is organized into a service specification group (SSG) and a technical specification group, both of which act under guidance of a steering committee. The SSG deals with issues relevant to the user community such as incident scenarios, quality of service concerns, and service functionality. Results from the SSG are provided to the technical specification group to work out technical matters. Working methods are clearly established within Project MESA and much discussion is conducted through electronic means (email, website) between formal meetings of participating delegates.

Project MESA provides a model for a constructive technology assessment process that Industry Canada might consider to promote wider stakeholder participation in emergency telecommunications planning and telecom service development in light of objectives set out in the National Disaster Mitigation Strategy.

Create incentives to promote commercial innovation in disaster management services

Innovation and experimentation in telecom services may be encouraged through appropriate incentive mechanisms. For example, in the wireless sector a portion of license fees from wireless service providers and future spectrum auctions might be made available to support research and development for new value-added services that directly contribute to the objectives of the NDMS. The Canadian Wireless Telecommunications Association (CWTA) in its submission to the Federal Government's Innovation Strategy Consultation, for example, has argued for reduction in the cost of regulation "as a means to promote reinvestment [and] encouraging more continuous innovation." (Canadian Wireless Telecommunications Association, 2002). Under a designated program of innovation, such reinvestment of revenues might be allocated for research and development in value-added services for emergency management and business continuity planning. Innovation projects could be derived from an Industry Canada participatory forum much like the working relationship built into Project MESA, where a service specification group provides input to a technical specification and design group. In light of its pioneering work in developing the first phase of Wireless E9-1-1 in Canada, the CWTA might be encouraged by Industry Canada to initiate a working group to promote innovation in services identified within an Industry Canada sponsored forum recommended above.

The CRTC should make a contribution to the National Disaster Mitigation Strategy

The CRTC should recognize formally that it is committed to the NDMS through section 7 of the Telecommunications Act. In order to support innovation by creating conditions that will support the deployment of new value-added services, the Commission could direct the CISC to form a working group to address and report on interconnection issues associated with mitigation-oriented services on a case-by-case basis, giving fair and timely consideration to requests made by new entrants and third party service providers.

The specific focus should be ensuring that lower layers of interconnection space (physical infrastructure and network access services) are able to accommodate new value-added services. A primary task for this working group should be to establish baseline service capability requirements that could be reasonably extended to all regions of Canada. These requirements would provide the basis for recommended upgrade paths and timelines for ILECs and regulated facilities-based carriers. The primary objective of such a working group should be to ensure an orderly development of Canada's telecommunications infrastructure environment that does not unduly inhibit new services that support the objectives of the NDMS.

The Australian Communications Authority (ACA) has been involved in an initiative that shares features with this recommendation. In 2001, the ACA convened an industry task force to prepare a guideline "intended to materially assist in ensuring optimal communications support for emergency management situations" (Australian Communications Authority, 2001). The task force examined the problem, and opportunity, of providing a full range of services to emergency management organizations within a competitive telecom environment:

> Following the liberalisation of the telecommunications market in Australia and the advent of competition, the supply arrangements for telecommunications services has become more complex. Total reliance on Telstra [the incumbent carrier] for emergency communications management support is no longer

> appropriate. While Telstra remains the key provider for telecommunications services to ESOs this is not necessarily the case across the board. Other providers may appropriately be involved in the provision of pre-planned services where they are providing the basic telecommunications services to an ESO. *Further, it is important that in the provision of ad hoc services, ESOs have potential access (via their pre-planned provider) to the full range of telecommunications that may be potentially available to meet an emergency situation—whether or not they are directly available from the pre-planned [primary] service provider.* [emphasis added] (Australian Communications Authority, 2001, p. 2)

The task force produced a set of protocols within a guideline document to describe the process by which ad hoc services are to be arranged between secondary and primary service providers (Australian Communications Industry Forum, 2002). The guideline works within the competitive policy framework to maximize the opportunity for emergency management community to benefit from innovation and advanced services deployed in the telecommunications infrastructure. This is a not, however, a mitigation project in the strict sense adopted for my study because it does not address infrastructure development per se. It does *suggest* a mitigation project insofar as operational effectiveness of any ad hoc services will be constrained by the effective limitations of interconnection between primary and secondary service providers.[59] This may be especially critical at the higher functional layers involving access to databases and other value-added services not otherwise regulated or standardized. In order to conform to the definition with which I am concerned in this study, the ACA would need to initiate a task force into network interconnection arrangements as a pre-condition for supplying ad hoc services between primary and secondary service providers during emergency situations.

The ACA-led initiative might provide a model for Canada, where the CRTC could direct the CISC to consider developing a similar set of protocols for Canadian carriers. In the context of the National Disaster Mitigation Strategy, however, such an undertaking should be expanded to include the development of baseline service capability requirements, through the design of interconnection arrangements, to ensure optimal conditions for providing ad hoc services in emergency situations. Such a task might be assigned to a specific working group within the CISC. This would establish a decision making process for shaping growth and change in

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[59] This point should recall Mansell's words I quoted at the beginning of chapter four: "[As] for the telecommunications network, its role in the economy and society is a reflection of the minimum characteristics that are available to all those who would benefit from its use."

Canada's telecommunications network infrastructure that would make a relevant contribution to the objectives of the NDMS.

User groups should consider filing Part VII Applications with the CRTC

Business groups or others may file Part VII applications with the CRTC if specific cases for relief can be identified and developed. At present such cases may be difficult to recognize or establish in fact. A hypothetical example of one such case would be an instance where a third-party value-added service provider is seeking to introduce an ad hoc type service for business continuity planning. If this service provider were to be prevented from offering this service because an ILEC refused to provide interconnection arrangements, in a similar fashion to the Microcell Wireless E9-1-1 case, then relief could be sought by filing a Part VII application with the CRTC.

One instance that might have some relevance to business continuity planning was filed with the CRTC in January 2002. In this Part VII application, a CLEC claimed that some ILECs were providing discriminatory repair times for services provided over leased local loops (Canada. Canadian Radio-television and Telecommunications Commission, 2002). This filing is principally about competitive disadvantage related to quality of service, where ILECS apply higher standards for themselves and for their affiliates at the expense of competitors using their bottleneck facilities. In the context of innovation, such discriminatory practices related to quality of service could become major barriers to successful attempts at promoting disaster mitigation initiatives. It is conceivable that similar cases might be filed in future with respect to value-added services provided by third parties, WSPs, CLECs, or even ILECs when using bottleneck facilities. (Of note is that by implementing guidelines similar to the Australian model mentioned in the previous recommendation such cases might be circumvented.)

Recommendations as Intervention Strategies

Each of these specific recommendations can be formulated as an intervention strategy. I would stress that they are not mutually exclusive but rather should be considered as a set of related and mutually reinforcing strategies that are to be considered in combination. Table 19 summarizes my recommendations as intervention strategies.

Table 19: Recommendations as Intervention Strategies

Strategy	Lead Actor	Action
Reflexivity	Industry Canada	New responsibility; new program
Niche Management	CWTA	Working group
Technology Forcing	CRTC	CISC task force
Forcing	User group	Part VII application

Recommendations and the Intervention Matrix

My specific recommendations can be taken one step further and summarized using the intervention matrix developed for this study. Note that according to my recommendations, and in response to problems observed in the Wireless E9-1-1 case study, the flow of consultation from problem formulation to design proposition and from upper to lower layers of interconnection space is reversed.

For instance, a reflexivity strategy based on wide stakeholder consultation through an Industry Canada forum is located at the earliest point in a technology project (demand articulation) and would span all aspects of interconnection space, from lower physical layers through to value-added services and information content. Wide consultation at this early stage is intended to feed a program of strategic niche management in commercial innovation in upper layer value-added services, which in turn would drive sponsorship of tasks within the CISC working group, where lower layer (i.e., enabling) interconnection arrangements and long range network planning would be addressed.

From the perspective of Constructive Technology Assessment, the intervention matrix presents a strategy for structuring an evolving mix of stakeholders for iterative learning. It therefore also can be used to inform a political undertaking on the matter of stakeholder representation at critical decision points in infrastructure development. It suggests that an evolving mix of stakeholders might best proceed from open participatory forum within an Industry Canada supported locus of reflexivity to a more specialized form of participation as the process moves to Strategic Niche Management, then finally to task assignments within the CISC. In this arrangement, initial learning is exploratory in nature and proceeds to higher-order learning as demand articulation develops into problem formulation and then into design propositions. An evolving mix of stakeholders should accompany each phase of assessment. Stakeholder congruency is also established in distinct and logical stages, progressing from learning, to innovation, and then to enabling. (See Table 20).

Table 20: Recommendations Placed on the Intervention Matrix

	Forcing	Niche Management	Reflexivity
Legitimacy	CISC WG	CWTA WG	Industry Canada Program
Congruency	Enabling	Innovation	Learning
Inscription	CRTC Directive; Individual TIFs	Financial Incentive(s)	Participation Guidelines
Interconnection Space	Physical infrastructure; Network service	Value-added services; Information content	All layers considered

Further Avenues of Inquiry

Among the contributions I have sought to make with this study is to offer an analytic tool for future technology policy research. Others will make the final assessment as to the value that this framework provides, but I wish to comment briefly on my experience with its application in this study.

I have noted previously in this study that there is no clear and coherent methodology for doing constructivist technology research. Aside from the largely descriptive and theoretical work, there is little by way of formal techniques for studying a technology project using generalized symmetry as the central principle. Nevertheless, I found that the body of constructivist literature provided a nomenclature and basic theory of technology dynamics that permitted me to systematically study a technology project and to generate substantial insights concerning a particular case study. Moreover, the intervention matrix that I developed in this study was instrumental in refining my initial observations into concrete recommendations for the NDMS. It did so by helping me to consider three interrelated aspects of technology dynamics: three operational dimensions, four layers of interconnection space, and three generic intervention strategies. The constructivist approach to technology studies may not be a predictive tool but it has proven in this case to help explain real world events and to extrapolate from them considerations for shaping future technology projects.

While I have limited this study to an analytic undertaking within the Constructive Technology Assessment approach, I also noted in chapter three that other undertakings are possible. Additional analytical work might be done to assess the impact of international agreements such as the APEC Principles of Interconnection on telecom infrastructure development in Canada. In spring 2003, the United States launched a National Strategy to Secure Cyberspace that may have significant consequences for telecom policy in light of the National

Disaster Mitigation Strategy. Further analytical research might also attempt a more systematic study of emerging technologies and their potential to transform the process of growth and change in telecom infrastructure.

Political and normative undertakings might also be considered for further research in this area. For instance, my study did not examine specific political concerns associated with participation in planning forums nor did I attempt to identify all possible parties that might have a stake in telecom and the NDMS. Further studies might seek to identify key stakeholder groups and conduct research to better understand in detail the challenges of participation and interaction in various forums. A future study into the normative aspects of critical infrastructure development might look into the philosophy of technology or political economy to reflect more deeply on the concept of risk as it pertains to Canada's critical infrastructure. Such a study might attempt to critically reflect on fundamental assumptions that underpin current telecom policy and regulation in Canada, especially with respect to section 7 of the Telecommunications Act and the National Disaster Mitigation Strategy. Further research into the problem of path dependency, particularly in light of the progression of vulnerability in society may shed further light on technology dynamics and appropriate intervention strategies in shaping the evolution of critical infrastructure.

Conclusion

This study began with a general inquiry into the role of telecommunications within the context of the National Disaster Mitigation Strategy (NDMS). Initially I posed two basic research questions for consideration: what would be the impact of the NDMS on Canadian telecommunications policy and regulation? And, conversely, how might telecom policy and regulation be draw upon to actively promote the objectives of the NDMS? In the process of exploring these two questions it became clear that "mitigation" itself was a problematic concept and that conventional approaches in emergency telecommunications and business continuity planning did not seem to conform to what I felt to be the more fundamental concerns implied in an ambitious mitigation strategy.

This realization led me to conclude that mitigation, despite the volumes written on it previously, remains an ambitious but *ambiguous* idea that needs to be more clearly understood so it can stand apart from other activities in disaster management. In order to achieve this clarity I found it helpful to look beyond the typical descriptive model of disaster management based on a four-fold cycle of events and to adopt an explanatory model of disasters that could more clearly account for the root causes of vulnerability and unsafe conditions in society. Application of the Pressure and Release Model to emergency telecommunications suggests that policy research for mitigation should be directed at the early processes and influences on network development. This insight informs the central thesis taken up in this dissertation: *we must understand in detail how growth and change happens in Canada's telecommunications infrastructure if we are to effectively intervene in that process to better coordinate it within the objectives and constraints presented by the National Disaster Mitigation Strategy*.

Based on this formative proposition, the focus of my research was directed to the fundamental forces that are involved in shaping the evolution of telecommunications infrastructure in Canada—the "root causes" and "dynamic pressures" of growth and change in large technical systems. This shift in perspective unto itself makes an important contribution to emergency telecommunications planning in Canada, which in my view has been held back by an ambiguous and sometimes contradictory notion of mitigation. This contribution extends along theoretical, methodological, and empirical dimensions.

Theoretically, it contributes to a growing body of literature in disaster management that recognizes risk and vulnerability as socially constructed conditions intimately linked with community development including the ongoing evolution of communications infrastructure. The dissertation also demonstrates the possibility of a fruitful theoretical synthesis and empirical application across scholarly domains within the reflexive tradition of science and technology studies, particularly Bijker's theory of socio-technical change, Actor Network Theory, and historical studies in Large Technical Systems. This synthesis presents a theoretical account of technology dynamics that can be rendered through the three generic intervention strategies of Constructive Technology Assessment, resulting in a basic analytic framework for studying technology projects under development.

Methodologically, this dissertation makes an important contribution by combining the reflexive tradition of science and technology studies and technology assessment, with the more administratively-oriented traditional telecom policy literature. This combination provides a means of operationalizing and testing many of the theoretical propositions from the literature by means of a three-dimensional intervention matrix for studying the root causes and dynamic pressures in telecommunications. The intervention matrix is an original contribution to the study of infrastructure development, particularly in the application of "interconnection space" as a third dimension of analysis, and provides a useful tool for identifying and assessing opportunities for intervention in the complex and dynamic processes of a technology project in progress.

Empirically, this study contributes a detailed analysis of the development of one instance of growth and change in Canada's telecommunications infrastructure, drawing on a contemporary case study for insights that may be relevant to the National Disaster Mitigation Strategy. It steps outside the bounds of traditional thinking on "emergency telecommunications" to establish a unique, empirically grounded perspective on the process of critical infrastructure development in Canada.

Finally, the dissertation sets out a number of specific recommendations for the NDMS based on an analysis of a case study in the development and deployment of a new value-added telecom service. Complimentary to these recommendations, this study also identifies corresponding exemplars of actual programs from other parts of the world that might be used as models for reconsidering Canadian telecom policy and processes vis-à-vis the objectives of the National Disaster Mitigation Strategy.

In sum, this study has examined the development of new telecommunications service in Canada as an analytic component of a Constructive Technology Assessment. In order to undertake this research I developed an analytical framework drawn from constructivist technology studies, operationalized through issues and concepts drawn from the field of telecommunications policy and regulation. The objective of this study has been to offer insights and recommendations for the role of telecommunications in the National Disaster Mitigation Strategy. I have offered a set of considerations and specific recommendations based on generalized findings from a detailed case study into the development of Wireless E9-1-1 in Canada. I hope that my contribution will be of value to policy makers, industry stakeholders, and scholars alike for its specific recommendations and for its scholarly application to future research in technology studies.

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Appendix A: Wireless E9-1-1 Interconnection

Appendix B: Coding Documents

This appendix contains sample instruments used to code documentary evidence in the Wireless E9-1-1 case study. The methodology adopted for coding guided by grounded-theory approach that provides for both inductive and deductive coding of data in an iterative process.

Primary Coding Sample

Primary coding was done using Endnote bibliographic software. Each document reviewed in the Wireless E9-1-1 case was given a unique Endnote record. Details of the document's contents were recorded in the "notes" field of the record, with my comments and annotations in CAPITAL LETTERS. Links to other documents were also recorded in the notes field. The following sample is an excerpt taken from a typical record.

Reference Type: Generic
Record Number: 505
Author: Microcell Telecommunications Inc.
Year: 2001
Title: Comments submitted pursuant to Public Notice CRTC 2001-110
Secondary Author: Canadian Radio-television and Telecommunications Commission
Date: Dec. 14
Label: 2.1.2
Keywords: telecommunication; regulatory and policy (current); Canada; CRTC; E9-1-1
Notes: pedigree: comments submitted re: CRTC 2001-110

ISSUE: SUBSCRIBER RECORDS; STANDARDS DEVELOPMENT FOR DISPLAY AT PSAP (CHALLENGED BY MICROCELL)

(par. 3.1) barrier to w.E911 is "absence of will on the part of some ILEC 9-1-1 service providers to make available the requisite access services to their 9-1-1 service platforms." ILECs except TELUS are characterized as "generally unresponsive"; "The wireless carrier does not itself control all of the prerequisites required to launch Wireless E9-1-1 in a given location." Two cases cited as examples: where 911 does not exist, where standalone 911 services not integrated into provincial 911 platforms,

[PLAYS TO THE PART VII APPLICATION BY MICROCELL]

(par. 3.2) ALI sub recs obligation comes out of the blue, w/o any prior discussion previous to 2000-831: "Until [2000-831], the idea of entering wireless end-user subscriber data into ALI databases had never even been mentioned."

[WHAT WAS THE INTERVENTION STRATEGY OF PSAPS THAT MAY HAVE INFLUENCED CRTC IN THIS REGARD?]

Coding Index Sample

The following table is a coding index used in this study to summarize relevant actors and issues from submissions made by interested parties to CRTC Public Notice 2001-110. The coding index is a summary of notes taken during primary coding and was used to compare issues across documents and to identify common concerns among interested parties. Columns from left to right: filing party, Endnote record number (this is a database record that contains all citation details), reference to specific section or paragraph of the document, summary of actor or issue cited by the interested party in that specific section or paragraph.

Interested Party	EN rec.	Ref.	Details
AEAA	548	8	Verifiable sub recs
AEAA	558	2	CISC impasse precipitates PN
AEAA	558	3a	Growth is reason for ALI request
AEAA	558	4	M misleading on tech. Standards
AEAA	558	7	Privacy
OAB	550	7	PSAP legal obligations
OAB	550	8	WSP non response problem
OAB	550	12	Disturbing aspects of M database
OAB	550	17	Rejected records; SAG
OAB	550	27	Customer activation process
OAB	550	33	Ignoring cries for help
OAB	550	35	Apt door argument
OAB	557	app	OPP routing problems
OAB	557	app	Marketing of 911
OAB	567	2	Cultural diffs of PSAPs/WSPs
OAB	567	23	Lack of confidence in WSPs
OAB	567	30	Manual ALI access defense
OAB	567	38	RWI arbitrary 911 routing problem
OAB	567	56	$3.36 million winfall
OAB	567	57	ARC not in ESWG
OAB	567	60	Loc. info is what's really needed
OAB	567	62	CRTC Action Plan Obj. #4
BC SPA	549	2	Stats on wireless
BC SPA	549	4	WSP winfall
BC SPA	549	5	False advertising
BC SPA	549	6	Experience in BC, AB
BC SPA	549	8	P1 and 24/7 is better than ALI
BC SPA	566	2	Winfall yet PSAP victims
BC SPA	566	5	Reverse ALI too restrictive
BC SPA	566	6	WSP non-response problems
BC SPA	566	7	Tech knowledge at CISC