



Participatory Modeling Methodology: Tightening the GeoWeb Design Loop

Tim Nyerges

Department of Geography, University of Washington
Seattle, Washington USA

Piotr Jankowski

Department of Geography, San Diego State University
San Diego, California USA

Brent Hall

School of Surveying, University of Otago
Dunedin, New Zealand

ICA-ISPRS Workshops
Simon Fraser University
August 10, 2011



Outline

1. GeoWeb as convergence of three realms
 - Spatial Data Infrastructure, Online Participatory GIS, Volunteer Geographic Information
 - A Synthesis of Values for Design
2. Coupling architectures for the GeoWeb
 - Service-oriented architecture
3. Participatory Modeling Methodology
 - System development, use, and evaluation
 - Tighten the design loop
4. Conclusions and Directions
 - Results of tightening the design loop
 - A fourth realm? CyberGIS high performance computing

1. GeoWeb Realms of GIScience & Technology

- Spatial Data Infrastructure (circa 1990)
- Online Participatory GIS (circa 1999)
- Volunteer Geographic Information (circa 2005)

Look at a brief overview of these realms...

Motivation within realms

- **SDI** - increase data sharing
- **OPGIS** - broaden public governance and community voice
- **VGI** – enhance distributed information collection

All involve values, interests, and concerns, but perhaps from different perspectives...

US SDI

Spatial **D**ata **I**nfrastructure, e.g. three levels

- 12 Federal Agencies – geoplatform.gov
- 50 States (National States Geographic Information Councils)
- Regional (e.g. Washington State Geographic Data Archive)

Data.gov



<http://www.naco.org/meetings/participate/Presentations/Federal%20Geographic%20Data%20Committee%20and%20National%20Geospatial%20Advisory%20Committee.pdf>

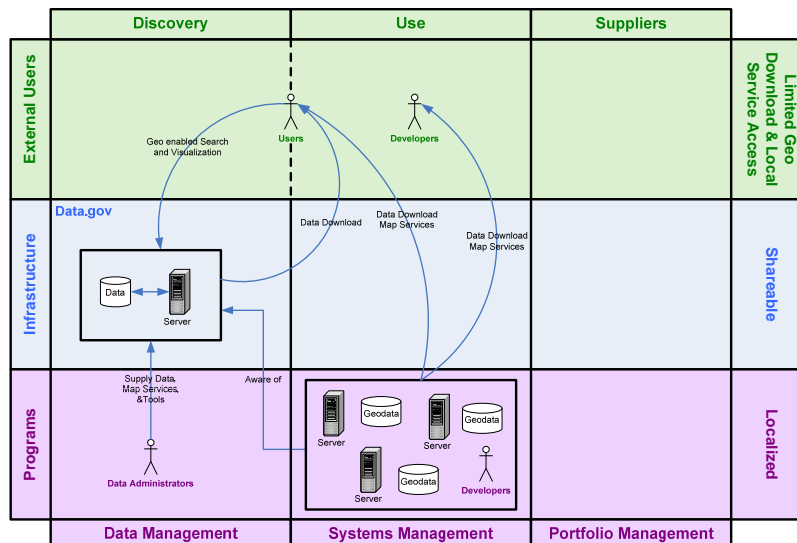
www.geoplatform.gov

Common geospatial data, services, and applications contributed and administered by authoritative sources and hosted on a shared infrastructure, for use by government agencies and partners to meet their mission needs and the broader needs of the Nation.

The screenshot displays the www.geoplatform.gov website. The top navigation bar includes the site name and a link to the National Geospatial Data Council. The main content area is divided into sections: 'CALL TO ACTION' with a quote from the President's Budget, 'ABOUT THE GEOSPATIAL PLATFORM' describing the platform's purpose, and a 'KEY FEATURE: MAPPING DEEPWATER HORIZON MC252' section. A map interface is shown on the right, displaying a map of the Gulf of Mexico with a sidebar containing various layers and tools.

US Federal SDI – current architecture

Data.gov Geospatial Capability – Without Geo Platform

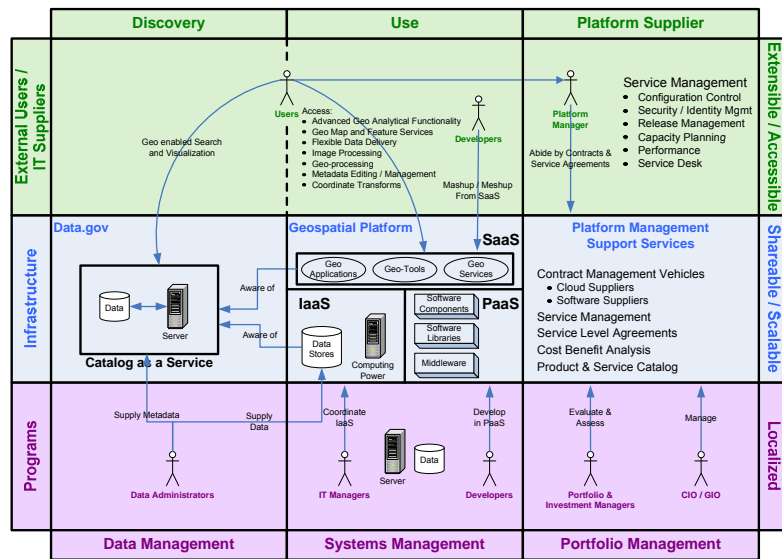


Jerry Johnston, US EPA, presentation to NGAC "Status Update: Geospatial Platform"

<http://www.fgdc.gov/ngac/meetings/march-2011/intergovernmental-subcommittee-update.pptx>

US Federal SDI – next architecture

Data.gov Geospatial Capability – With Geo Platform



Jerry Johnston, US EPA, presentation to NGAC "Status Update: Geospatial Platform"

<http://www.fgdc.gov/ngac/meetings/march-2011/intergovernmental-subcommittee-update.pptx>

US – States Level

(National State Geographic Information Councils)

- GeoSpatial One-Stop Nodes
- Metadata only

Regional SDI Washington State Geospatial Data Archive (WAGDA) 1.0

WAGDA

Washington State Geospatial Data Archive
[Site Index](#)

W UNIVERSITY LIBRARIES
UNIVERSITY of WASHINGTON

| HOME | DATA | GIS HELP | GIS LAB | METADATA | CONTACT US |
|--------------|--------------------------------------|----------------------------------|--------------------------------------|-------------------------------|------------|
| Quick Links: | City of Seattle Data | King County Data | Digital Ortho Photos | Census GeoDBs | |

Welcome to the Washington State Geospatial Data Archive

The Washington State Geospatial Data Archive (WAGDA) is a space to locate geospatial data for the state of Washington. Maintained by The Map Collection & Cartographic Information Services, University of Washington Libraries, this site also contains selected non-Washington geospatial data sets that have been created by students and researchers at the University of Washington.

Some of the datasets located here are restricted by license agreement and are available only to UW faculty, staff, and students. Other datasets are in the public domain.

This site does not provide digital maps. We offer access to digital geospatial data that can be used to make maps when used with GIS software. Our [service policy](#) is available online. Questions about data formats can be sent to gis@lib.washington.edu.

WAGDA NEWS:

- ArcGIS Desktop and Workstation 10.0 installation disks are now available for circulation in [Map Collection](#).
- [GIS Lab](#) open all [building hours](#) - GIS assistance available 15 hours/week during Fall Quarter October 13 - December 14, 2010.
- King County** data on WAGDA updated to December 2009 release. **Pierce County** data updated to August 2008.
- ArcGIS 9.3.1 now available through ESRI Site License for installation on UW-owned computers. Contact gis@lib.washington.edu for additional information.
- [US Census Bureau makes available TIGER/Line Shapefiles](#)

Acquiring Data – Data Access

- Data Access
 - Multiple Services (currently in development)

| Function | Direct Connection | Geodata Service | Image Service | Web Feature Service/Web Coverage Service | Web Mapping Service | Geoportal |
|------------------------------|-------------------|-----------------|---------------|--|---------------------|-----------|
| Fast data view | • | ○ | ○ | | | |
| Remote data analysis | • | • | • | • | | |
| Complete and ready metadata | • | • | • | | | • |
| Geodatabase versions | • | ○ | ○ | | | ○ |
| Exportable data | • | • | • | • | | • |
| Interoperability | | | • | • | • | • |
| Modifiable access permission | • | • | • | • | • | ○ |
| Replication/Editing | • | • | • | • | | |

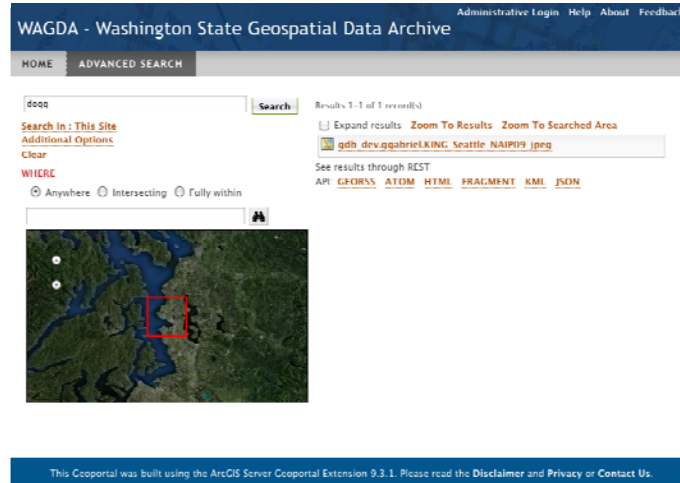
• supported - ○ unverified -

(blank) not supported - (grey) not preferred

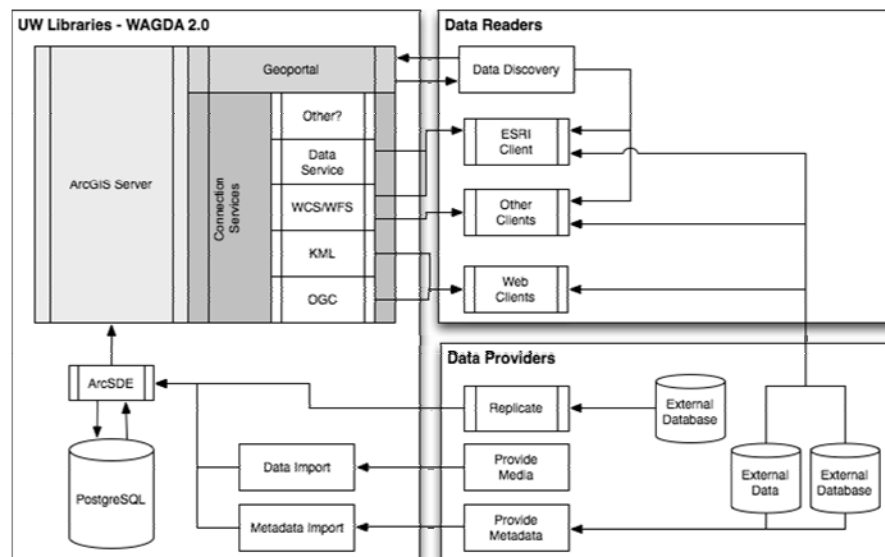
12

Regional SDI WAGDA 2.0

- GeoPortal – wagda.lib.washington.edu/geoportal



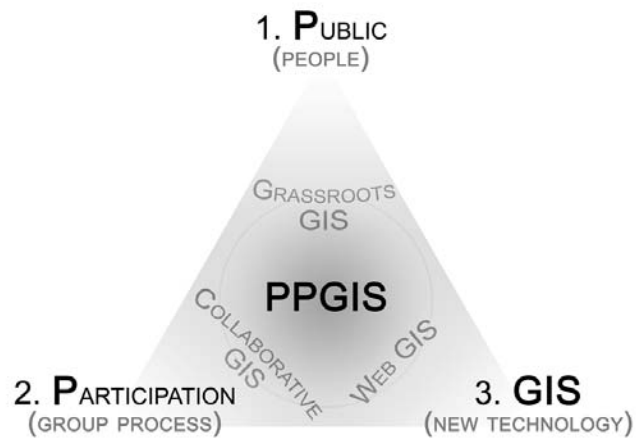
WAGDA 2.0 Architecture



OPGIS

- Online Participatory GIS
- Widespread growth since 1999

OPGIS Niches



OPGIS example

Let's Improve Transportation!

Support provided by the National Science Foundation Grant No. EIA 0325916, funded through the Information Technology Research Program, and managed in the Digital Government Program.

During the next 25 years the central Puget Sound population is expected to grow by **1.2 million people**.

How will this growth impact our already congested **transportation system**?

What **improvements** are necessary to keep our region moving?

Who gets to have a voice in this decision?

Let's Improve Transportation is an experiment in participatory democracy which was first conducted during a four-week period in October and November 2007. The study is now complete and we are no longer registering participants.

[Learn More](#) about this research study.

The [Let's Improve Transportation Final Report](#) details the outcomes of the experiment.

If you would like to review the website and Fall 2007 experiment, please log as follows:

User Name: guest
Password: guest

For contact information, please visit www.pgist.org.

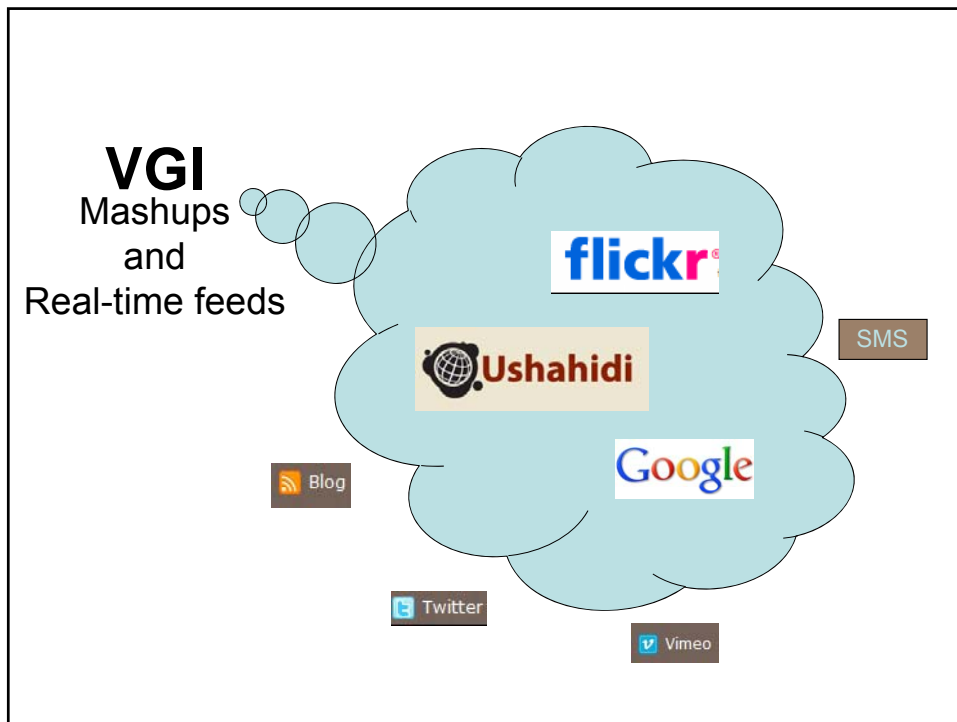
User Name

Password

Login

VGI

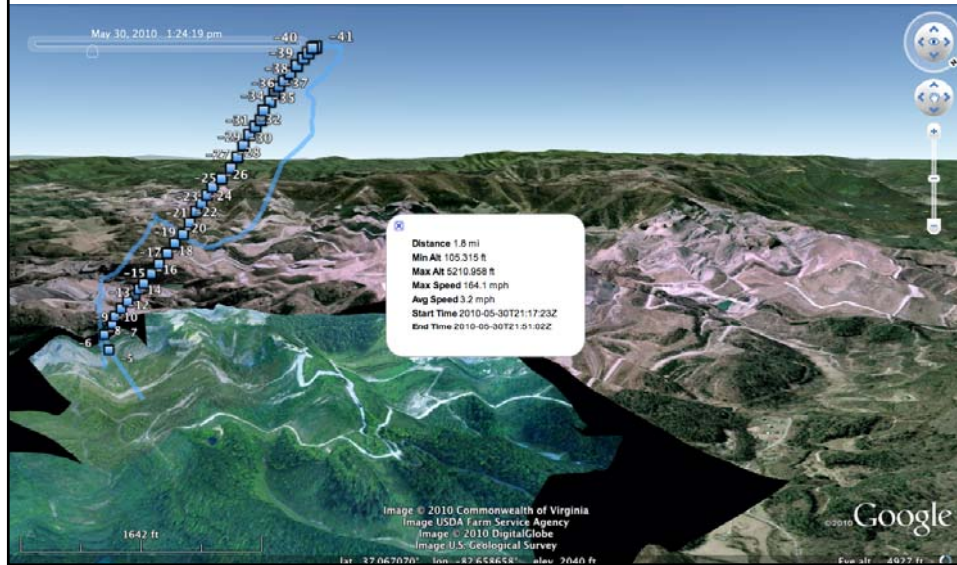
- Volunteer Geographic Information
- Wide array of developments since 2005



VGI - balloon sensor launch



Balloon trajectory



Volunteer Geographic Information accuracy comparison of geocoded addresses



Synthesis across SDI-OPGIS-VGI

What is being valued?

- **SDI** – people interested in efficient, effective, and equitable access to data
- **OPGIS** – people interested in stakeholder public values, goals, and concerns
- **VGI** – people interested in personal values, goals, concerns about what is important

Is there a convergence of “value” in light of geospatial information technology?

Shared interests?

Common values?

All realms...

- Engage participants
- Enable participants
- Structure participation

...as human-computer-human interaction

...for data, information, evidence, and knowledge production on the GeoWeb

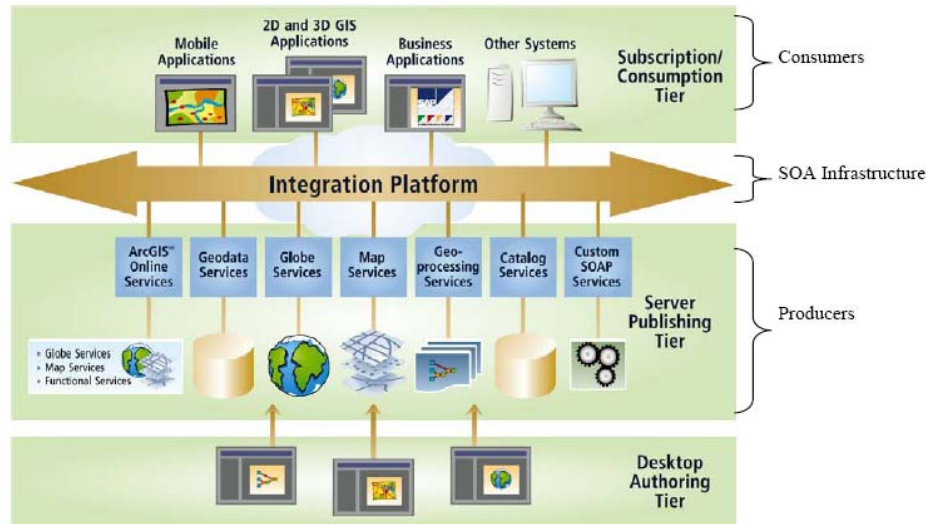
Coupling SDI-OPGIS-VGIS enables distributed and participatory GeoDesign

- GeoDesign – geography by design (Steinitz 2011)
- For example, a regional stormwater runoff monitoring network to better understand and act upon non-point source pollution
- GeoDesign can enable large-scale participatory monitoring designs using GIS
- GeoDesign as sustainability management requires SDI, OPGIS, and VGI resources configured into regional enterprise GIS also called consortium GIS

2. Coupling SDI-OPGIS-VGIS

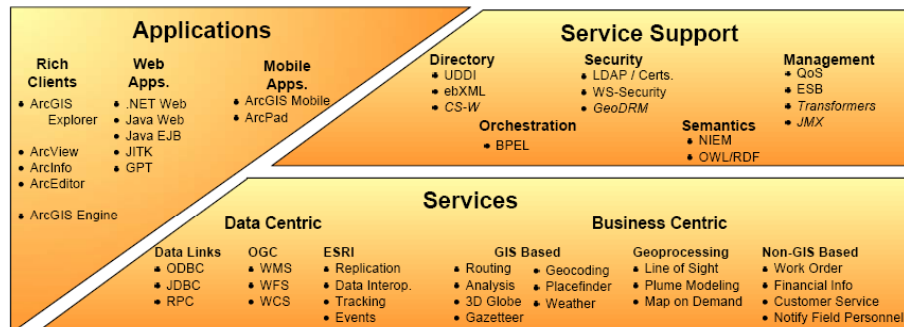
- What architecture design(s) might help us couple SDI-OPGIS-VGI resources?
- Service-oriented architecture (SOA) is an approach proposed by many
- SOA – a collection of protocols and components for integrating service resources
- SOA infrastructure connects...
 - Consumer services: User interface clients
 - Producer services: Data and software capabilities

Esri example of integration platform



<http://www.esri.com/library/whitepapers/pdfs/geospatial-soa.pdf>

Expansion of SOA Infrastructure, by example, for coupling SDI-OPGIS-VGI



<http://www.esri.com/library/whitepapers/pdfs/geospatial-soa.pdf>

What methodology Helps Guide Coupling of SDI-OPGIS-VGIS Resources?

- Coupling among three technology realms is a complex choice problem
- Need systematic approach to help guide coupling strategies
- **Participatory Modeling Methodology** brings diverse perspectives into play

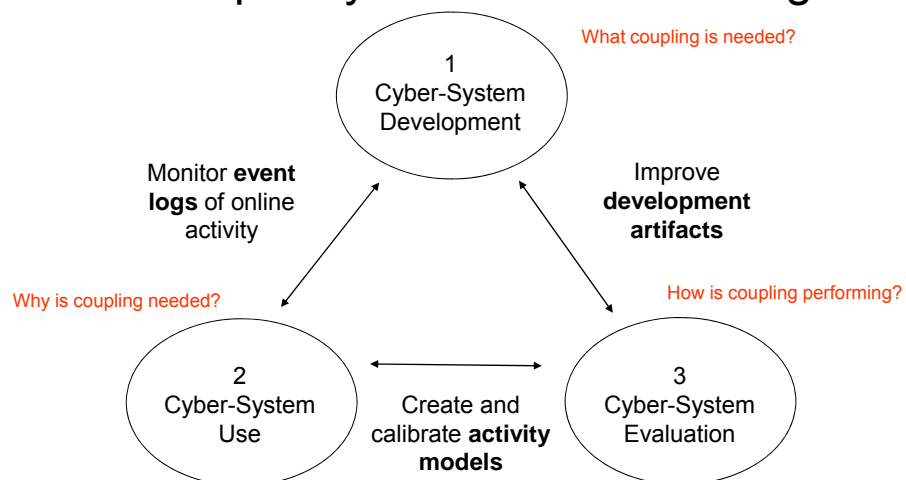
3. **Participatory Modeling Methodology (PMM)**

- Approach that links **system development (information technology)**, **system use (complex problems)**, and **system evaluation (social-behavioral science)** for improving outcomes from systems.
- One application: participatory interaction modeling explores the science of interaction design
- Participatory interaction designs are intended to structure participation, while incorporating motivation and information technology

What, Why, and How of Component Coupling?

- What resources are to be coupled?
- Why are resources to be couple?
- How are resources to be coupled?

PMM Framework for Participatory Interaction Modeling

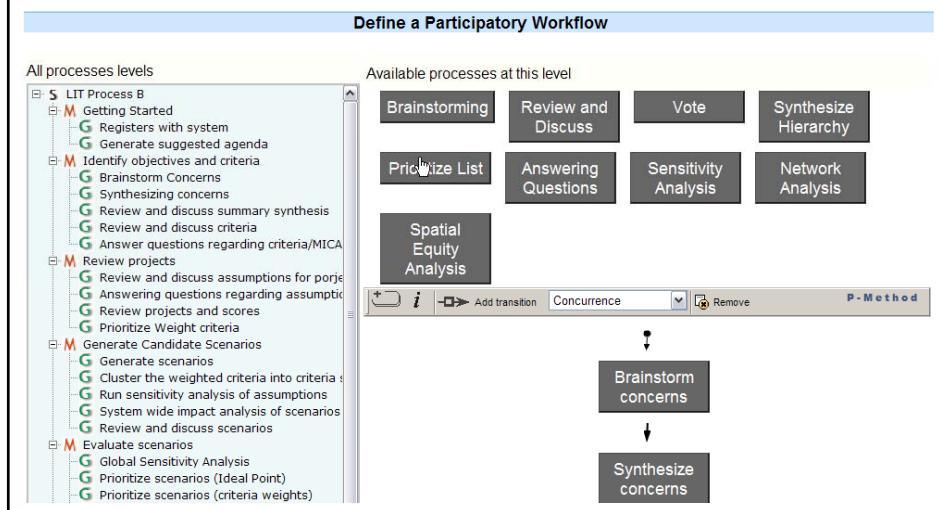


three roles in human-computer-human interaction:
(1) developer, (2) user, (3) analyst

Three domains anchor
the GeoWeb design loop

- 1) **Cyber-Systems development**
incorporate participatory technologies
- 2) **Cyber-Systems use** by participants
address pervasive complex problems
- 3) **Cyber-Systems evaluation** involve
social-behavioral studies to improve
designs

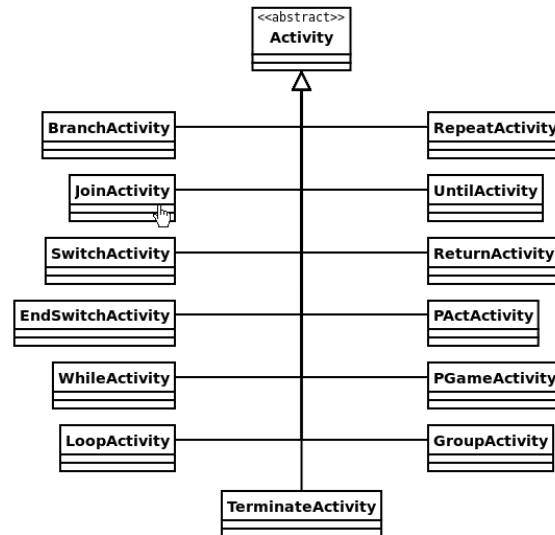
Workflow Manager System (Design) Development



Workflow Manager

System Design - Class Diagram

Some major workflow engine classes



Let's Improve Transportation - Home - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Let's Improve Transportation! Home Learn More Log out

Search

LIT System Use – workflow agenda interface

Welcome, guest Your participant ID is

Agenda

Current steps are highlighted

| | |
|--|---------------|
| Review projects | 10/14 - 11/13 |
| Review proposed transportation improvement projects. | |
| Review funding options | 10/14 - 11/13 |
| Review options to pay for transportation improvements. | |
| Step 1: Discuss Concerns | |
| 1a: Map your daily travel | 10/16 - 10/18 |
| Make a map of how you use the transportation system on an average day. | |
| 1b: Brainstorm concerns | 10/16 - 10/18 |
| Brainstorm transportation concerns with other participants. | |
| 1c: Review summaries | 10/19 - 10/22 |
| Discuss and evaluate summaries of all participant concerns. | |
| Step 2: Assess Transportation Improvement Factors | |
| 2a: Review factors | 10/23 - 10/25 |
| Discuss different factors used to evaluate transportation improvements | |
| 2b: Weigh factors | 10/23 - 10/25 |
| Decide which factors are most important to you | |

Moderator announcements

Friday, October 26, 2007 Step 3 has begun! Now is the time to review and discuss proposed transportation improvement projects (3a) and funding options (3b). On Monday you can start creating your own package (3c) while we continue this discussion.


Thursday, October 25, 2007 Today is the last day to weigh the improvement factors (Step 2b)!

Wednesday, October 24, 2007

Note on Step 2: How were the improvement factors chosen?

Here is an excellent [description of how the improvement factors were chosen](#).

Keep in mind that these factors cannot change within the context of the LIT Challenge. The goal of this step is to assess the factors in their current form, and decide how relevant they are to our selection of projects in Step 3.

lets improve transportation  Overview Learn More User Settings Log out

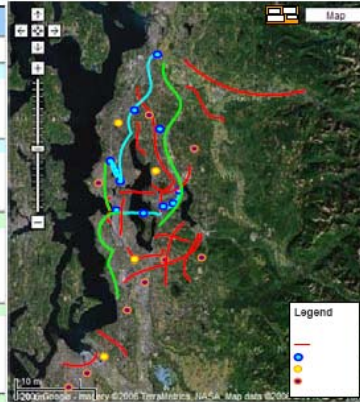
Step 3: Create Packages 3a: Review projects 3b: Review funding options 3c: Create your own package [Next Step](#)

Overview And Instructions
 Here you can review proposed projects for improving or expanding our regional transportation system. Click on a project to review information and discuss its merits or drawbacks with other participants.
 Each of the projects has been examined by a panel of specialists who assigned [Read more about the project scoring process.](#)

Select a project in the list below to display its location on the map. Jump to a project:

All Proposed Projects

| Project Name | Money Needed |
|--|-----------------|
| Road Projects | |
| Alaska Way Viaduct Options (only one option will be chosen) | |
| Expressway | \$1,090,200,000 |
| Six Lane Tunnel | \$1,470,000,000 |
| Transit - Streets | \$123,620,000 |
| Four Lane Tunnel | \$351,360,000 |
| 60th Ave Bridge Options (only one option will be chosen) | |
| 4-lane, no transit | \$78,520,000 |
| 6-lane HOV/Transit | \$537,620,000 |
| Partial Jam Lane HOV/Transit | \$400,190,000 |
| Autonomous Transit Plan | \$514,820,000 |
| I-405 Improvements | |
| Reroute to Redondo (SR 169 to I-405) | \$419,000,000 |
| 112th Ave SR to SR 169 | \$104,240,000 |
| I-5 to SR 169 | \$103,820,000 |
| NE SR 169 to SR 520 Branded Crossing | \$309,580,000 |
| 10th St. Divides | \$309,000,000 |
| SR 167 Improvements | |
| HOT Lanes Pilot Project (Auburn to Redondo) | \$813,890,000 |
| Expressway HOV 3+ Bypass (12th Street SW to 12th Street NW) | \$104,610,000 |
| I-5 Improvements at SR 167 (East of Map Triangle) | \$107,410,000 |
| Northbound Ramps to Elgin Road | \$290,000,000 |
| 15th NW to Elgin Road High Occupancy Vehicle (HOV) Extension | \$592,070,000 |
| New Highway Alternatives | |
| SR 505 Extension and I-5 Improvement | \$906,390,000 |
| I-167 New Freeway Extension Tacoma to Edgewood | \$523,680,000 |
| Cross Bay Freeway (SR 169) | \$121,900,000 |
| SR 167 Improvements | |
| Payson River Bridge | \$796,570,000 |
| Unkley Bridge for Eads | \$512,000,000 |



LIT System Use: Review project packages

System (HCI) Evaluation

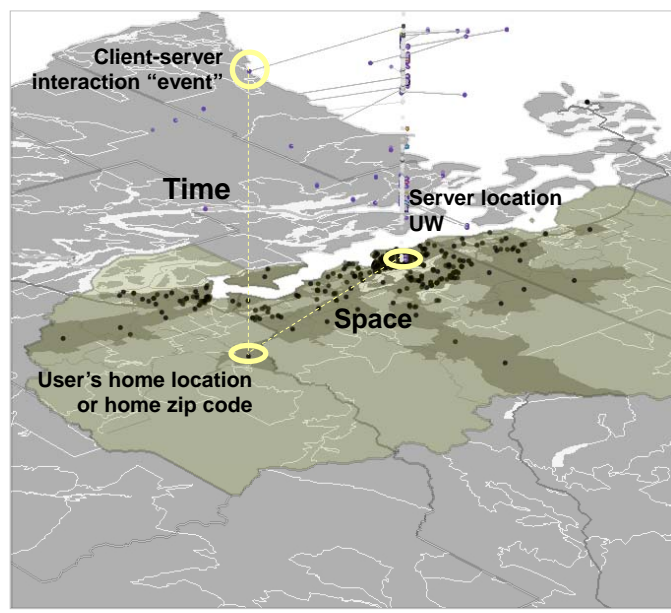
Client-server interaction "event"

Time

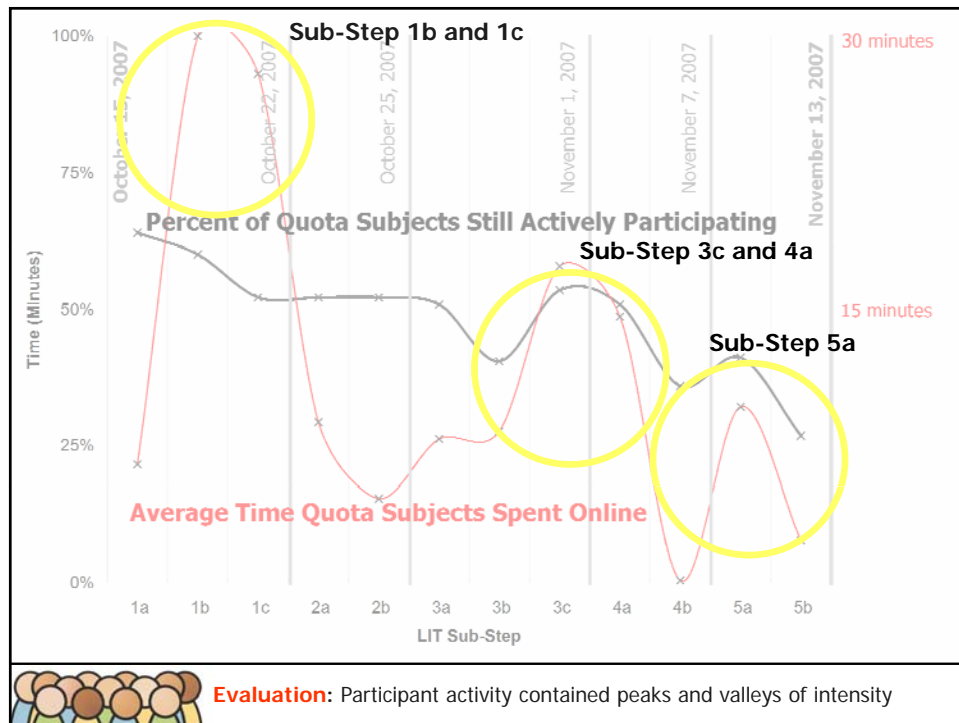
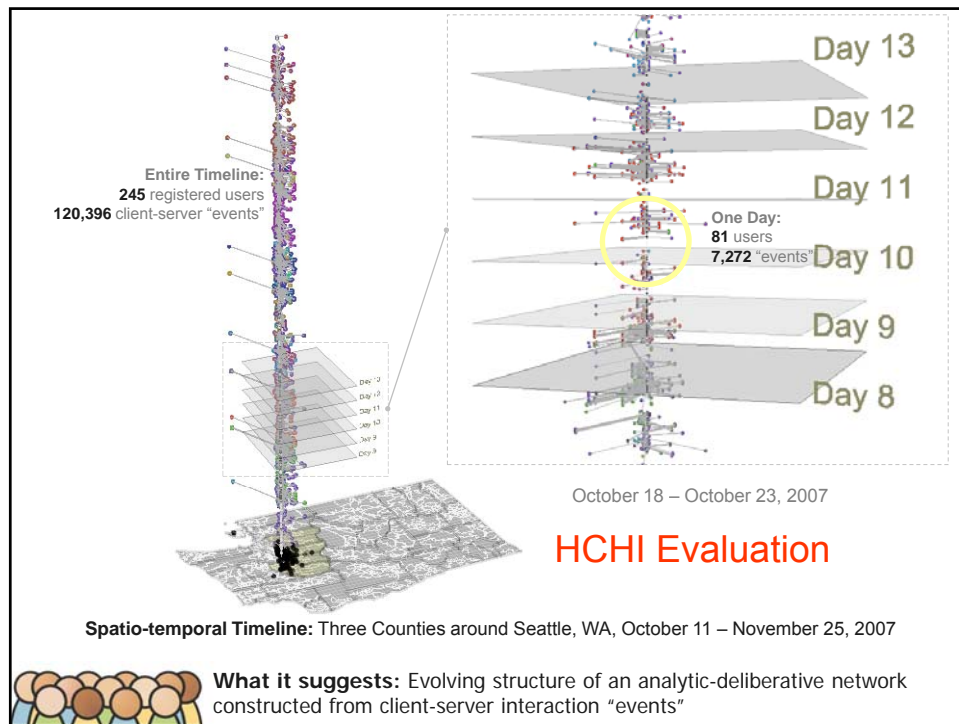
Space

Server location UW

User's home location or home zip code



System log: Client-server interaction "events" captured during decision making occur in time and space



Roles for Tightening the Participatory Design Loop among the Three Domains

| Artifact Abstraction Level | Developer Role | User Role | Analyst Role |
|-------------------------------|-------------------|--------------|-----------------|
| Use Case Narrative | X | X | X |
| Class Diagram | X | X | X |
| Activity Model | X | X | X |
| Architecture Diagram | X | X | X |
| Mock-up | X | X | X |
| Prototype | X | X | X |
| Event Log | X | X | X |

X = Produced by X = Consumed by

Design Loop Outcomes

Tightening the GeoWeb design **loop** improves outcomes...understanding about:

- Participatory GeoWeb technology design
- Effectiveness of complex problem solving
- Participatory workflow patterns of knowledge production

Research Focus PMM on GeoWeb

PMM - linking system development, use and evaluation
...on the

GeoWeb - coupling of SDI, OPGIS, and VGI

...enables many research directions, but two in particular...

- 1) Scaling participation
- 2) Spatio-temporal modeling for GeoDesign
- 3) CyberGIS to support those 2

1. Scaling participation

- a) down-up - scaling up moves the research toward topics about regional places
- b) in-out - scaling out moves the research toward very large numbers of people participating
- c) low-high - scaling high moves the research toward nuanced analyses and rich deliberative processes

How can these dimensions help us understand convergence of SDI, OPGIS, and VGI?

2. Spatio-temporal Modeling for GeoDesign

For example, couple Regional SDI, OPGIS, and VGI to enable GeoDesign contributions for stormwater runoff monitoring of water quality

3. CyberGIS to support directions...

CyberGIS – a forth realm

- a fundamentally new software framework comprising a seamless integration of cyberinfrastructure, GIS, and spatial analysis/modeling capabilities using “services approach”, and
- promises widespread scientific breakthroughs and broad societal impacts due to new level of performance for intense computational problems.

4. Conclusions

- Cyberinfrastructure-enabled participatory GeoWeb will continue to grow, connecting people with similar interests more than ever before
- Need systematic and robust, but at the same time comprehensive and flexible, framework for participatory systems design to guide that growth
- Synergistic activity among SDI, OPGIS, and VGI developments can help formulate consortium GIS for regional governance

Conclusions - 2

- Synthesize comparative architectures that lead to improved designs of GeoWeb solutions; a need for computer-enabled case study synthesis
- Tightening the design loop will require metrics for development, use and evaluation
- Enabling participatory geospatial thinking, learning and decision making using cyber-enabled tools will require nuanced metrics.



Thank you!

Comments / Questions?

Acknowledgements

- Much of this presentation was prepared while Nyerges and Jankowski were on sabbatical at the University of Otago, Dunedin, New Zealand (Spring 2011) sponsored by a William Evans Fellowship and hosted by Brent Hall.
- LIT research was supported by National Science Foundation Grant No. EIA 0325916, funded through the Information Technology Research Program, and managed in the Digital Government Program.
- PIM research is funded by the National Science Foundation Grant No. BCS-0921688, Geography and Spatial Sciences Program
- CyberGIS research is funded by National Science Foundation Grant No. OCI-1047916, Office of Cyberinfrastructure, Software Institutes, Cross-Directorate Active Programs, Geography and Spatial Sciences, Method, Measure & Statistics.
- **Presentation authors** are responsible for any and all errors.