Modeling and simulation of the GPRS protocol

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Roadmap

- Introduction to GPRS
- OPNET model:
  - existing GPRS model
  - radio link control/medium access control protocol
- Simulation results
- Conclusions and future work
Introduction to GPRS networks

- General Packet Radio Service (GPRS) is a packet-switched wireless network technology
- Introduced as a bearer service for Global System for Mobile Communications (GSM):
  - circuit switched technology
  - bandwidth:
    - 900 MHz and 1,800 MHz (Europe and Asia)
    - 1,900 MHz (North America)
- billing is based on a connection time
- entire radio channel dedicated to a single user
- slow data transmission: 9.6 kbps
GPRS overview

- Radio channels can be concurrently shared among several users
- Up to eight radio interface timeslots can be allocated per TDMA frame, supporting a speed up to 150 kbps
- Users may always be connected to the network
- Radio resources are allocated when users send or receive data
- GPRS employs same frequencies as GSM
- Average transmission speeds: 28.8 kbps to 40 kbps
- Billing may be based on traffic volume
Main Components of a GPRS network:

- Mobile Station (MS)
- Base Station Subsystem (BSS)
- Serving GPRS Support Node (SGSN)
- Gateway GPRS Support Node (GGSN)
- Packet Data Network (PDN)
- Equipment Identity Register (EIR)
- Visitors Location Register (VLR)
- Home Location Register (HLR)
GPRS transmission plane

SNDCP: Sub Network Dependent Convergence Protocol
LLC: Logical Link Control layer
RLC: Radio Link Control
MAC: Medium Access Control
BSSGP: Base Station Subsystem GPRS Protocol
GTP: GPRS Tunneling Protocol
Transmission plane functions

- SNDCP
- LLC
- BSSGP
- GTP
Mobile Application Part (MAP) protocol

- Implementation of MAP protocol provides signaling between SGSN and Home Location Register (HLR)
- MAP protocol resides on top of the Signaling System 7 (SS7) protocol stack
- SS7 is an out-of-band signaling system for:
  - Public Switched Telephone Networks (PSTNs)
  - Public Land Mobile Networks (PLMNs)
- MAP provides procedures for:
  - location management
  - subscriber data management
  - authentication
  - call handling
  - subscriber tracing
  - short message service (SMS) management

TCAP: Transaction Capabilities Application Part
SCCP: Signaling Connection Control Part
MTP: Message Transfer Part
L1: Level 1
GPRS OPNET model: previous work
Node model: Mobile Station
Node model: GGSN
Node model: HLR
Physical and logical channels

- Packet Data Channel (PDCH): physical channel used for packet logical channels

- **Logical channels**
  - Control
    - Broadcast: PBCCH
    - Common: PCCCH, PRACH, PAGCH, PPCH
    - Dedicated: PACCH, PTCCH
  - Traffic: PDTCH

PBCCH: Packet Broadcast Control Channel
PCCCH: Packet Common Control Channel
PRACH: Packet Random Access Channel
PAGCH: Packet Access Grant Channel
PPCH: Packet Paging Channel
PACCH: Packet Associated Control Channel
PTCCH: Packet Timing Advance Control Channel
PDTCH: Packet Data Traffic Channel

11/29/2005 GPRS model
RLC/MAC layer: functions

- RLC/MAC layer manages radio resources in a GPRS system
- Direction of data transfer:
  - Mobile Station to BSS: uplink
  - BSS to MS: downlink
- Radio Link Control layer:
  - segments and reassembles LLC PDUs into RLC/MAC blocks
  - acknowledged operation: Backward Error Correction (BEC)
  - unacknowledged operation
- Medium Access Control layer:
  - controls the allocation of channels and timeslots
  - multiplexes data and control signals
  - provides contention resolution
RLC/MAC parameters

- Temporary Block Flow (TBF): physical connection used by two radio resource entities to support unidirectional data transfer on physical channels
  - downlink and uplink TBF
  - temporary
  - maintained for the duration of data transfer only
- Network assigns a Temporary Flow Identity (TFI) to each TBF
  - TFI is unique among TBFs in the same direction
One phase access and contention resolution
Process model: RLC/MAC (MS)
Process Model: RLC/MAC (BS)
Simulation: configuration of attributes

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Simulation results: throughput
Conclusions and future work

- Completed:
  - GPRS model was implemented in OPNET
  - Implementation includes the RLC/MAC protocol
- Future work:
  - implementation of RLC/MAC layer will be enhanced by adding a two-phase access procedure
  - additional simulations to demonstrate the contention resolution
  - implementation of Network service and BSSGP layers
  - performance evaluation

BSSGP: base station subsystem GPRS protocol
References

- 3rd Generation Partnership Project, TS 03.60 version 7.9.0 General Packet Radio Service (GPRS) Service description.
- 3rd Generation Partnership Project, TS 04.64 version 8.7.0 General Packet Radio Service (GPRS) Logical Link Control (LLC) layer specification.
- 3rd Generation Partnership Project, TS 04.60 version 7.9.0 General Packet Radio Service (GPRS) Radio Link Control/Medium Access Control (RLC/MAC) layer specification.