Wireless Communication Systems

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Lesson Outline

- GSM Data
- GPRS
- High Speed Circuit Switched Data
- Wireless LAN
- Bluetooth

GSM data

- Fixed capacity and radio channel allocations for entire call period
- "Reliable"
- User pays based on connection time, not based on the volume transmitted during the call
- Connection setup takes time
- Slow data connections
- GSM is designed for speech!
- High Speed Circuit Switched Data (HSCSD) and advanced modulation techniques enhance the bit rates in the future

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Packet-like data services in GSM

- GSM (Phase 2 in standardization terms) already provides packet-oriented data transmission services, e.g. SMS and USSD
- Short Message Service (SMS): max 160 characters (140 octets) messages delivered to/from a MS via a signalling channel; both in a call and outside a call
- store-and-forward service provided by a SMS Service Center
- messages are kept within SMS-SC until delivered to MS
- paging of the MS is needed for each SMS message
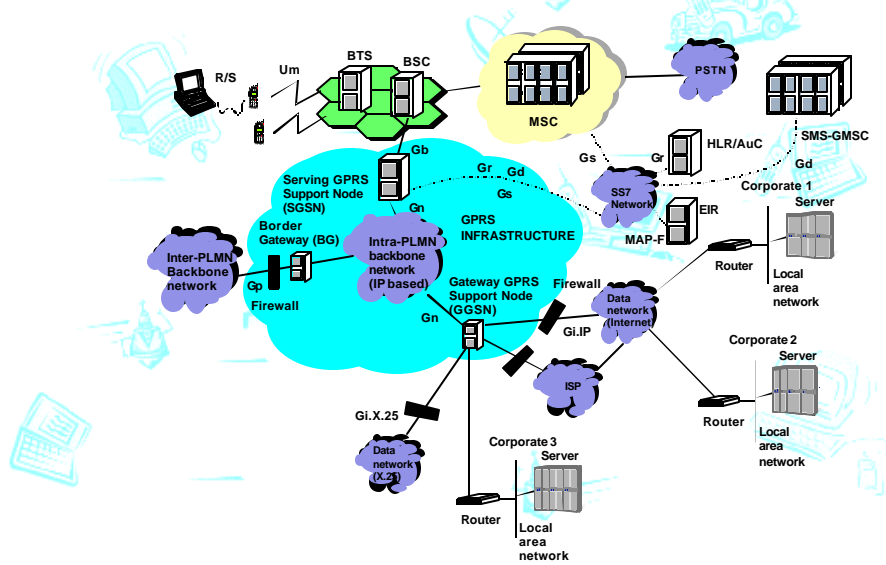- data rate appr. 100 bit/s

Packet-like data services in GSM

- Unstructured Supplementary Service Data (USSD): max 160 octets per SS message delivered via a signalling channel
- Transaction-oriented service: multiple MO and MT messages during a dialogue
- GSM network can route USSD data to an external server
- No paging per USSD message is needed
- Data rate appr. 100 bit/s; User-to-user signalling between two MSs
- Both SMS and USSD can be used for applications like
  – news, weather, stock or road traffic information etc.

GSM/GPRS data

- Bit rate evolution per single user
  – Current GSM non-transparent 9.6 or 14.4 kbit/s
  – High-Speed Data   38-64 kbit/s (4 time slots)
  – GPRS   64-128 kbit/s (3-6 time slots)
  – Enhanced GSM   128-384 kbit/s
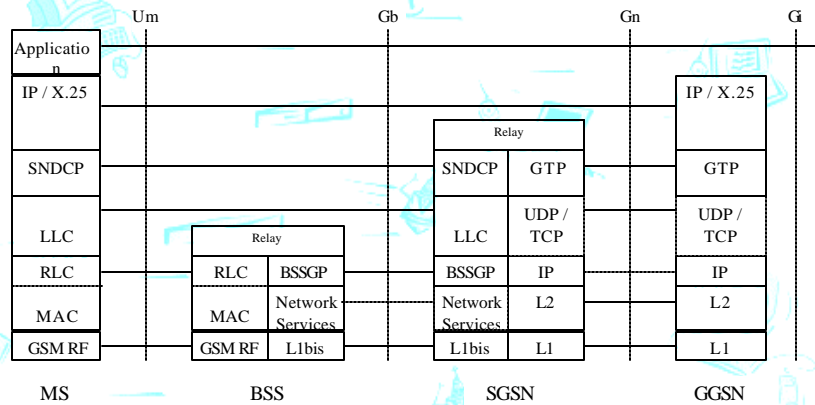 – 3rd generation WCDMA   up to 2 Mbit/s
  – with mobility!

GSM + GPRS network

GPRS system characteristics

- Packet-switched data transfer with peak bit rates up to 21.4 kbit/s per time-slot and max 8 time-slots per user
- Two new network elements: SGSN and GGSN
- GPRS backbone network, which carries user data, is based on IP networking
- GPRS provides location management of mobile users in wide-area scale
- Standard IP applications can be used
- Billing can be based on the amount of data transferred
- Cost of the transmission can be negotiated (higher price for higher QoS)

GPRS User Plane

	Um		Gb		Gn		Gi

MS		BSS		SGSN		GGSN

Layers (MS): Application, IP / X.25, SNDCP, LLC, RLC, MAC, GSM RF

BSS (Relay): RLC, MAC, GSM RF | BSSGP, Network Services, L1bis

SGSN (Relay): SNDCP, LLC, BSSGP, Network Services, L1bis | GTP, UDP / TCP, IP, L2, L1

GGSN: IP / X.25, GTP, UDP / TCP, IP, L2, L1

High Speed Circuit Switched Data

- Five variations
- 1 slot up and 1 slot down
  - 96cc or 144cc
- 2 slots up and 2 slots down
  - 96cc or 144cc
- 1 slot up and 3 slots down
  - 96 cc

GSM Summary

- GSM Radio Link Protocol (RLP) provides quite good reliability (c. 10^{-6}) by retransmissions
- retransmissions create high variability in poor radio conditions (up to 10 secs)
- GPRS has even higher variability than GSM data
  - some number of time slots shared by all GPRS users in a cell

WLAN Summary

- IEEE 802.11
  - old one: nominal capacity 2 Mb/s
  - new one: nominal capacity 11 Mb/s
  - behaves like wireless Ethernet
  - two modes of operations
    - infra-structure
    - add-hoc
  - "not designed for mobility"
    - handoff time 50-500 ms

Bluetooth

- The Bluetooth wireless specification includes both link layer and application layer definitions
- Radios that comply with the Bluetooth wireless specification operate in the unlicensed, 2.4 GHz radio spectrum
- These radios use a spread spectrum, frequency hopping, full-duplex signal at up to 1600 hops/sec.
- The signal hops among 79 frequencies at 1 MHz intervals
- Up to seven simultaneous connections can established and maintained.

Bluetooth Specs

- 1.1 Core Specification
- 1.1. Profiles
  - ESDP UPnP Specification
  - PAN profile
  - Network encapsulation protocol
  - Basic printing profile
  - Hands free profile
  - Basic imaging profile
  - Hardcopy cable replacement profile