Logistics

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- **Room**
  Usually: H437.1
  Exceptionally: TBD

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Logistics

- **Evaluation**
  quiz 1: 30%
  quiz 2: 30%
  Project: 40%

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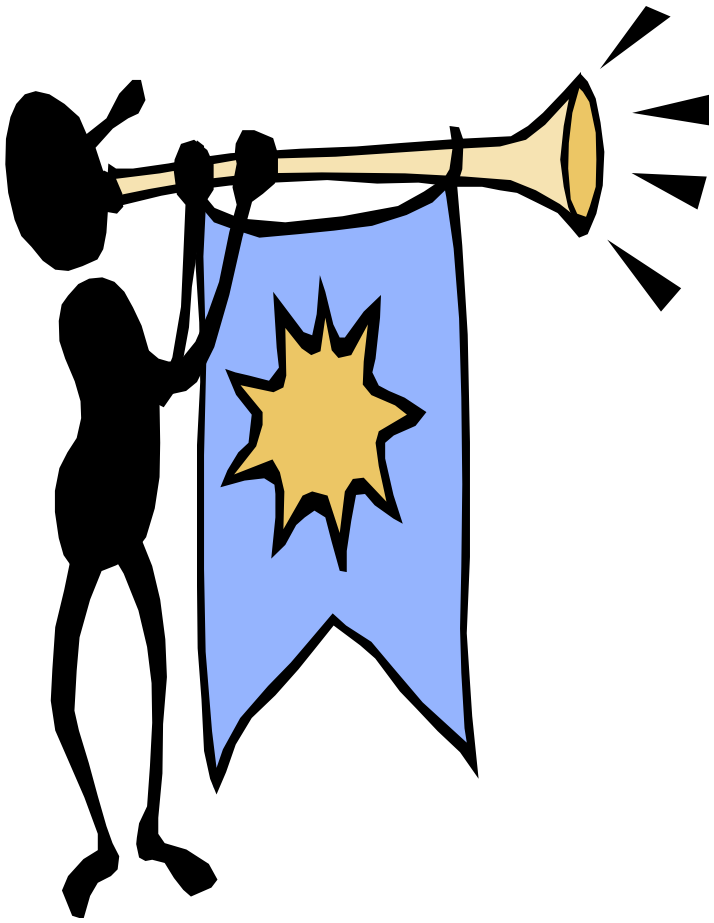
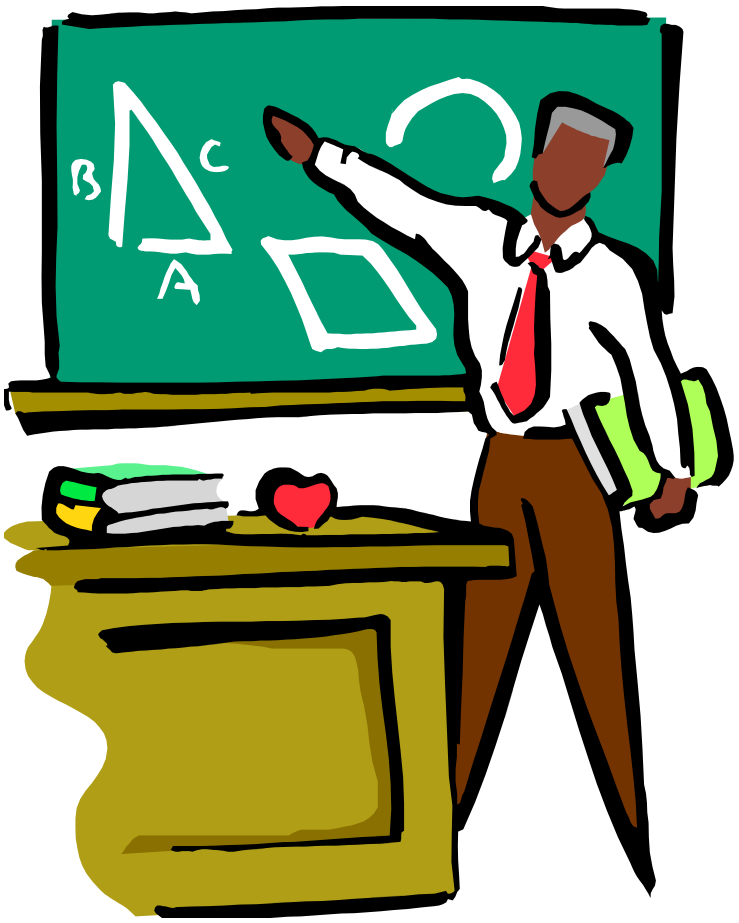
Chapter I
Current Generation Networks: From 2G to 2.5G

Outline



1. Essentials of circuit switched telephony
2. Mobile Telephony
3. 2.5 G
6. References

Essentials of circuit switched telephony

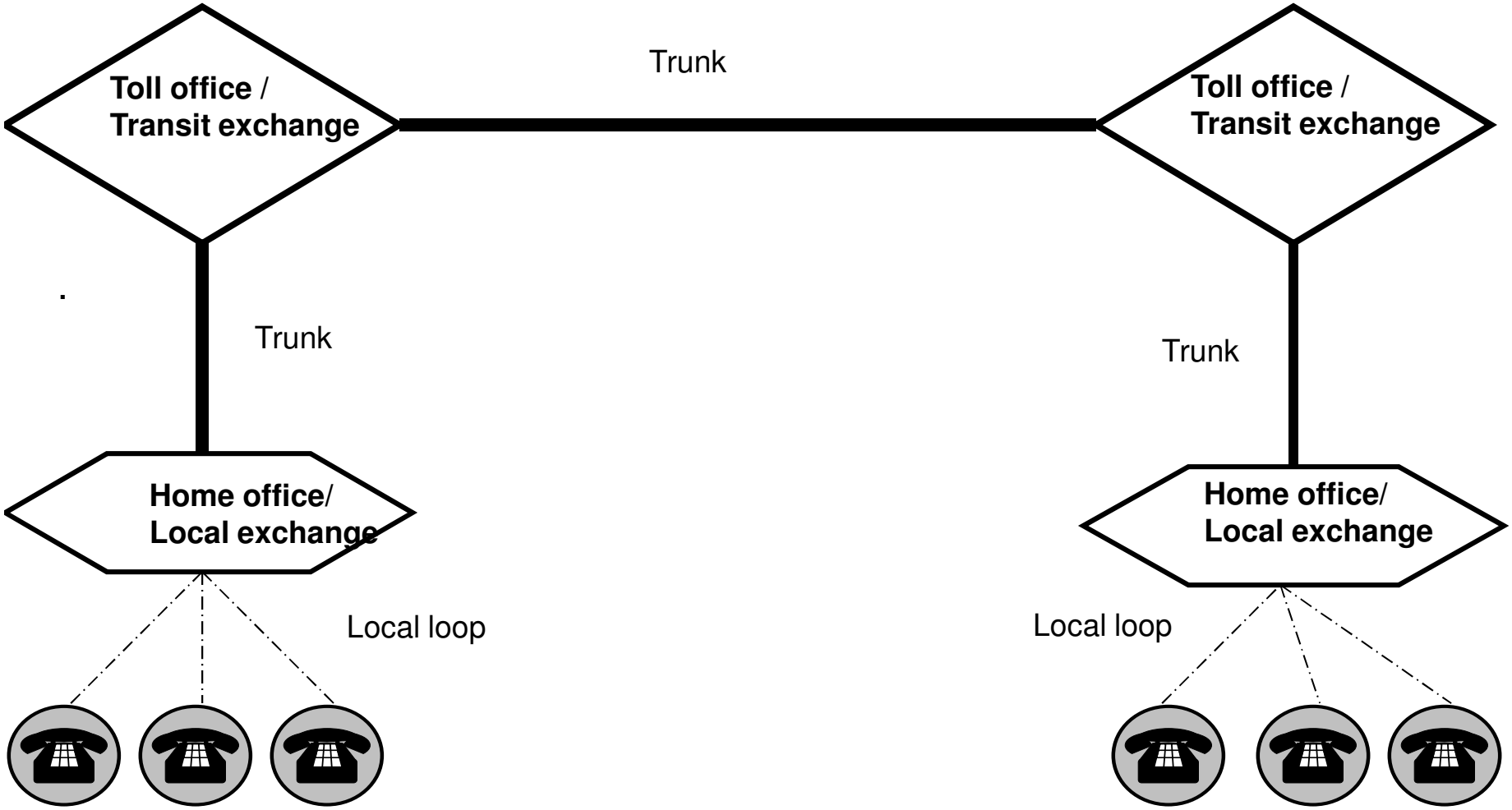


- Circuit switching vs. packet switching
- Local loops, telephone exchanges and trunks
- Signaling

Circuit switching vs. packet switching

Principal Criteria	Circuit switched	Packet switched
Dedicated Physical path	Yes/No	Yes/No
Derived criteria	Circuit switched	Packet switched
Call set up required	Yes/No	Yes/No
Possibility of congestion during communication	Yes/No	Yes/No
Fixed bandwidth available	Yes/No	Yes/No
Non optimal usage of bandwidth	Yes/No	Yes/No

A simplified telephony network …



Signaling ...

Establishment, modification and tear down of calls

- **User Network Signalling**
  - Between user and home office
  - On/off hook, dial tone …
  - Carried over local loops

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Signaling ...

- **Network – Network signalling**
  - Between telephone exchanges
  - Initially in-band (Same trunks as voice)
  - Out-band in modern circuit switched telephony (Do not use same trunks as voice)
    - Example: Signalling System no7 – SS7

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Signaling ...

Criteria	In-band signaling	Out-band Signaling
Potential capacity	More / less	More / less
Potential speed	More/less	More/less
Room for fraud	More/less	More/less
Flexibility (e.g. mid-call signaling)	More / less	More / less

Signaling System No7 (SS7)

- **Network – Network signalling**
  - Signalling data carried over a separate and overlay packet switched network
    - Development initiated in the 80s and completed in the early 90s
    - Most widely deployed signalling system
    - Used initially for two party voice call signalling
    - Then subsequently for other applications such as Short Message Service (SMS)

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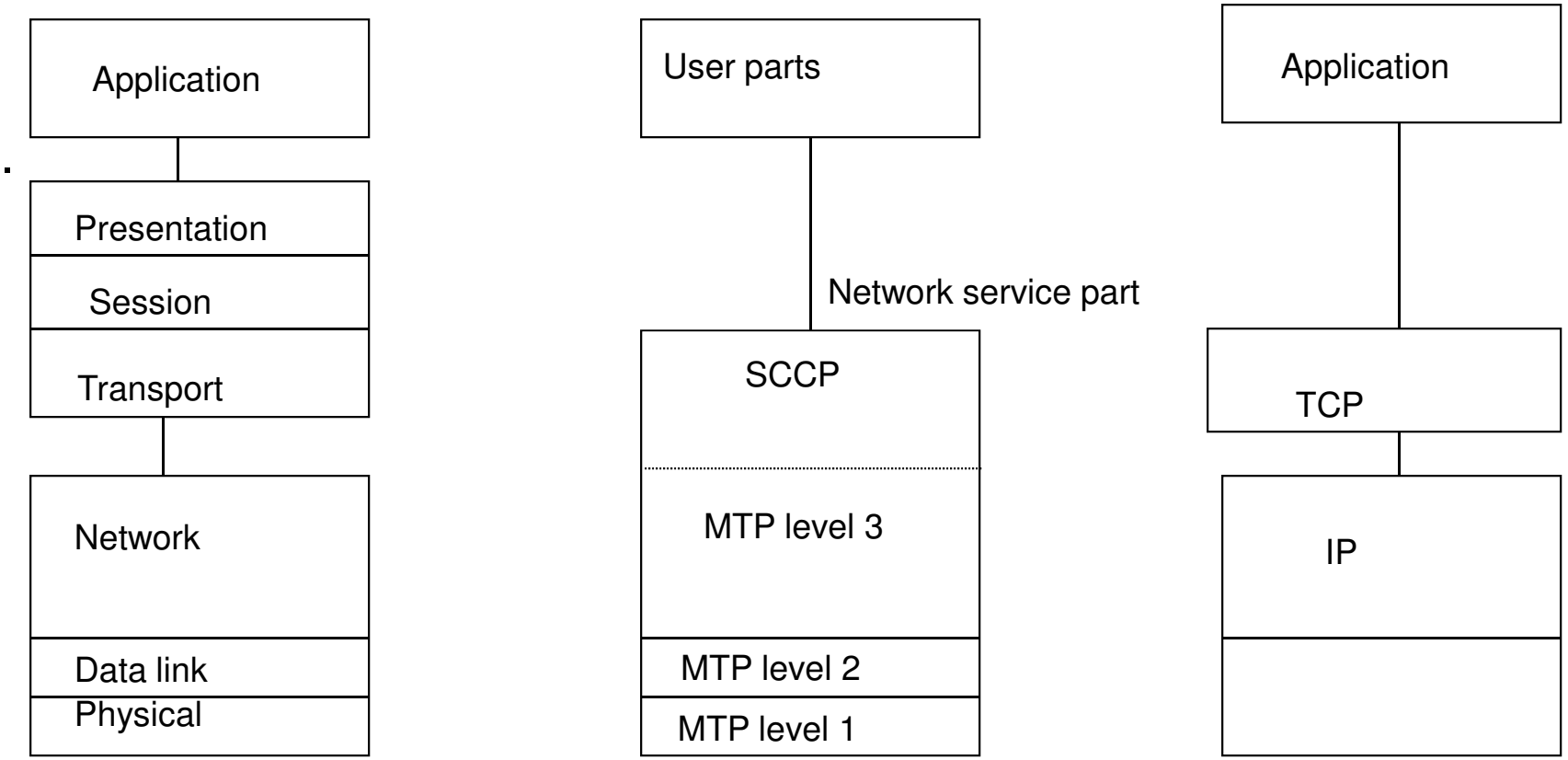
SS7 Protocol stack



Note: There are several different SS7 user parts and some of them connect directly to MTP level 3

SS7 – Network Services Part

Message Transfer Part (MTP)

- **First three layers (Physical, data link, and network)**
  - MTP 1
  - MTP 2
  - MTP 3
- **Signalling Connection Control Part (SCCP)**
  - Fourth layer

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Message Transfer Part

Design goals

- Reliable transfer and delivery of signalling information across the signalling network
- Ability to react and take necessary actions in response to network failures
- Differences with IP / below IP
  - Stark contrast
    - IP / below IP aim at best effort delivery

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Message Transfer Part

MTP 1 – Signaling data link functions (Physical layer)

- Bidirectional transmission path
- Same data rate in the 2 directions
- Data rates
  - 56 kbits/s – 64 kbits/s initially
  - Up to 1.5 Mbits/s – 2Mbits/s now

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Message Transfer Part

MTP 2 – Signaling link functions (Level 2)

- Message transfer between adjacent signalling points
  - Signalling messages of variable length called signalling units
  - Protocol quite similar to classical data link protocols (e.g. HDLC, LAP-B), but important differences due to reliability requirements, such as:
    - Filing Signalling Units (FISUs) are sent when there is no message
    - Enable consistent monitoring of link errors in order to take links out of services before they break down.

Message Transfer Part

MTP 3 – Signaling network functions (Level 3)

- Between non adjacent signalling points
- Two parts
  - Signalling message handling
  - Signalling network management

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Message Transfer Part

Signaling message handling

- Three functions
  - Message routing
  - Message discrimination
  - Message distribution
- Performed using the routing label
  - Destination Point Code (DPC): destination
  - Originating Point Code (OPC): source
  - Signalling Link Selection (SLS)
  - Service Information Octet (SIO)

Message Transfer Part

Signaling message handling

- Message received from higher layer
  - Routing function used to select on which adjacent link to the message should be sent using a routing table
    - Selection criteria
      - Destination point code
      - Signalling link selection (SLS)
        - » Links are usually redundant for load balancing (link sets)

Message Transfer Part

Signaling message handling

- Message received from lower layer (level 2)
  - Discrimination function used to decide if the message should be sent to the higher layers of the node or sent to another node
    - Selection criteria
      - Destination point code
        - » If the message should be sent to another node, it is sent to the message routing function
        - » If the message should be sent to the higher layers, message distribution is used and selection is based on the service information octet

Message Transfer Part

Signaling message handling

- Signalling network management
  - Reconfiguration of signalling network in case of signalling point failure
  - Traffic control in case of congestion

Message Transfer Part

Signaling message handling

- Reconfiguration of signalling network in case of signalling point failure
  - No loss
  - No duplication
  - No excessive delay

Message Transfer Part

Signaling message handling

- Signalling network management
  - Three functions
    - Signalling traffic management
    - Signalling route management
    - Signalling link management

Message Transfer Part

Signaling message handling

- Signalling traffic management
  - Divert signalling traffic from unavailable links or routes to alternative links or routes
  - Reduce traffic in case of congestion
  - No loss message
  - No duplicated message

Message Transfer Part

Signaling message handling

- Signalling traffic management
  - Signalling link available / unavailable
    - Change back procedure
    - Change over procedure
  - Routes available / unavailable
    - Controlled re-routing
    - Forced re-routing

Message Transfer Part

Signaling message handling

- Signalling route management
  - Distribute information about signalling network status in order to block/un-block routes
- Signalling link management
    - Restore / activate / de-activate links

Signaling Connection Control Part

4 classes of services

- Class 0
  - Basic connectionless service
- Class 1
  - Sequenced connectionless service
- Class 2
  - Basic connection oriented service
    - No flow control
- Class 3
  - Flow control connection oriented class

An example of user Part

Integrated Service Digital Network Part (ISDN)

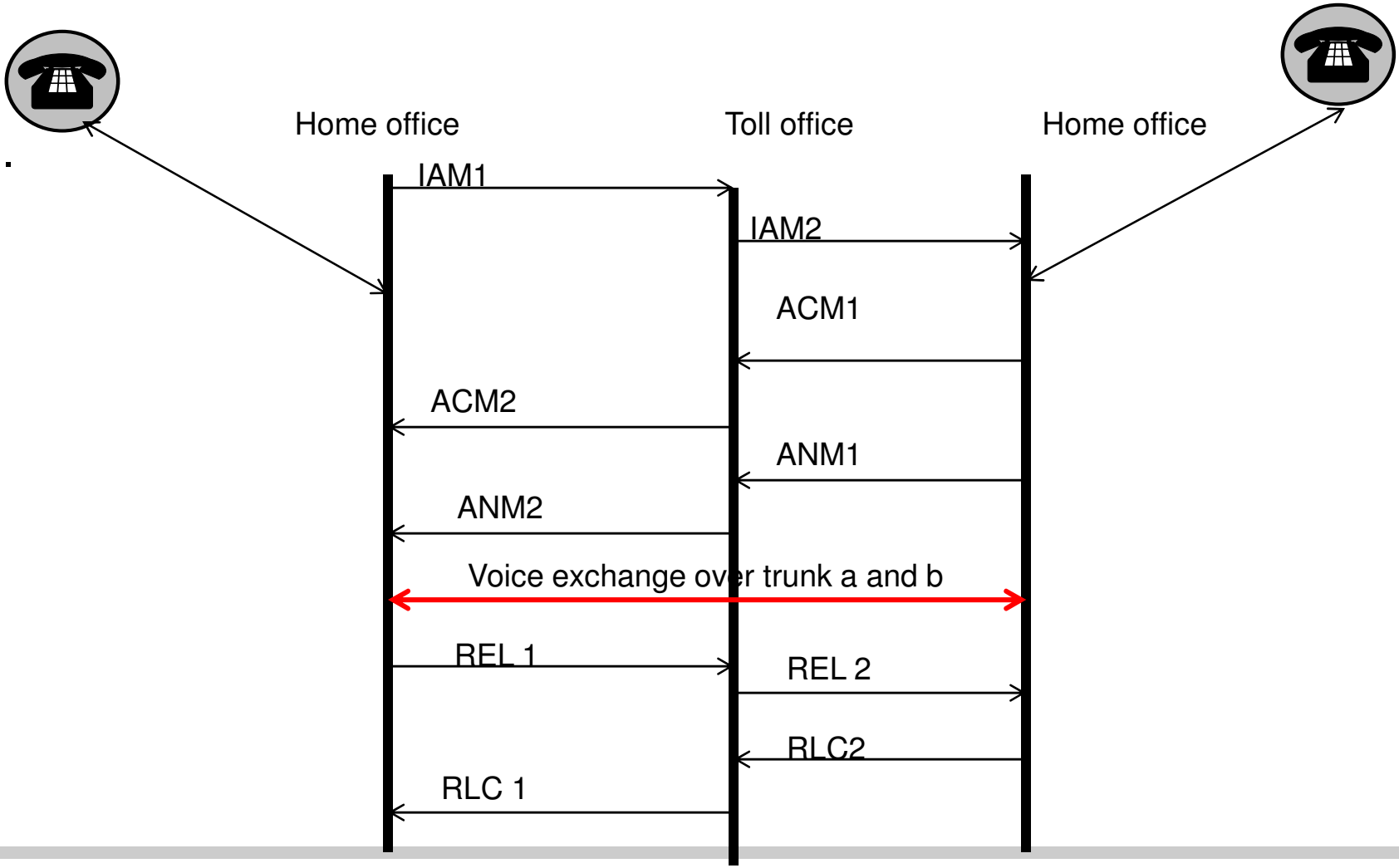
- Basic Bearer Service
  - Call establishment
- Supplementary Services
  - Some examples
    - Calling line identification
    - Call forwarding

An example of user Part

Integrated Service Digital Network Part (ISDN)

- Basic Bearer Service
  - Call establishment and tear down
    - Instant Address Message (IAM)
      - Request to set up a trunk
    - Address Complete Message (ACM)
      - Indicate that subscriber has been alerted (phone ringing)
    - Answer Message (ANM)
      - Indicate that user has answered

Integrated Service Digital Network (ISDN) - User Part



SS7 Network architecture

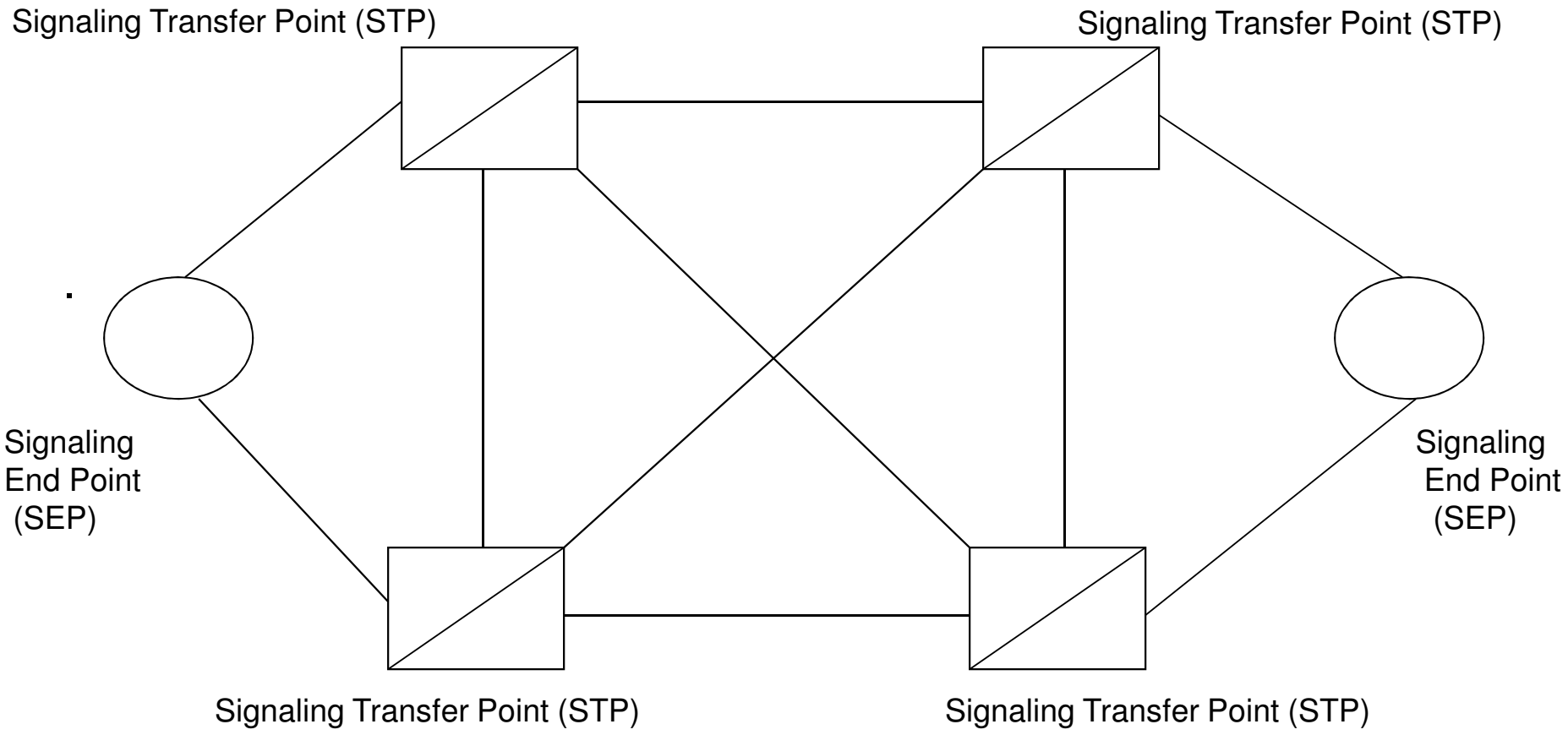
Signaling Transfer Point (STP)

- Routers
  - No SCCP
  - No User part

Signaling End Point (SEP)

- "Host"
  - SCCP (eventually)
  - User part

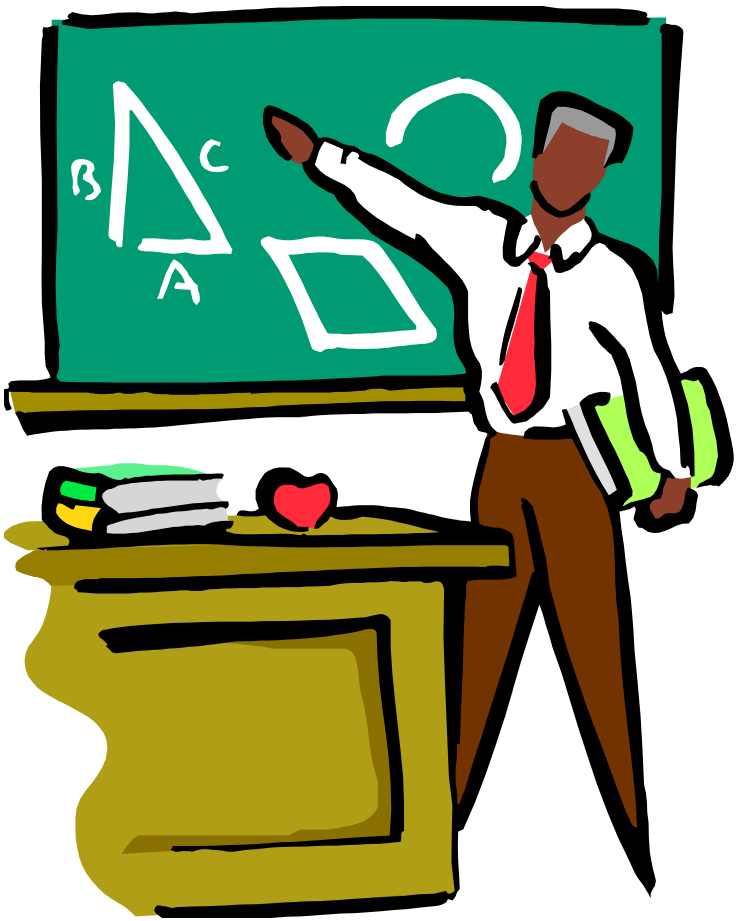
A Simplified SS7 network architecture



Perspectives

- Medium term
  - SS7 user parts (applications) over IP
    - Work done by IETF (SIGTRAN)
    - Requires very robust transport protocols (e.g. Stream Control Transmission Protocol)
  - May be bypassed by many operators depending on their NGN evolution strategy
- Long term
  - Replacement of SS7 by 3G signalling protocols (e.g. Session Initiation Protocol – SIP, H.323)
    - Main reason: SS7 is not suitable for multimedia multiparty session signalling
      - Was designed for two party voice calls

Mobile telephony



- History
- Functional entities
- Roaming scenarios

History

First generation cellular networks (70s – 80s)

- Analog systems, circuit switching based
  - Total Access Communications Systems (TACS) – UK
  - Advanced Mobile Phone Systems (AMPS) – USA/Canada
  - Nordic Mobile Telephone System (NMT) – Scandinavia

Second Generation (90s – early 00s)

- Digital systems, circuit switching based
  - GSM – Europe mainly – However, gaining ground in North America
  - D-AMPS (Digital version of AMPS)
  - PDC (Japan)

Third Generation (early 00s –)

  - Still digital, but more capacity
  - Packet switching based
  - Two main standards
    - UMTS
    - CDMA 2000

Functional entities

Generic Cellular telephony network

- Mobile Switching Centre
  - Switches used in cellular telephony – Additional features for mobility management
- Home location register (HLR) /Visitor location register (VLR)
  - Keep information on user location
- Base stations
  - Access point to cellular networks
  - Communicate with end user terminals
  - Control cells
- Signalling in cellular networks
  - SS7 based

Functional entities

GSM specifics

- Base stations
  - Base Transceiver Station (Actual base station)
  - Base station controller (BSC)
    - Controls a set of base stations
- Equipment Identity Register
  - Use for security purpose
    - Can blacklist stolen mobile stations

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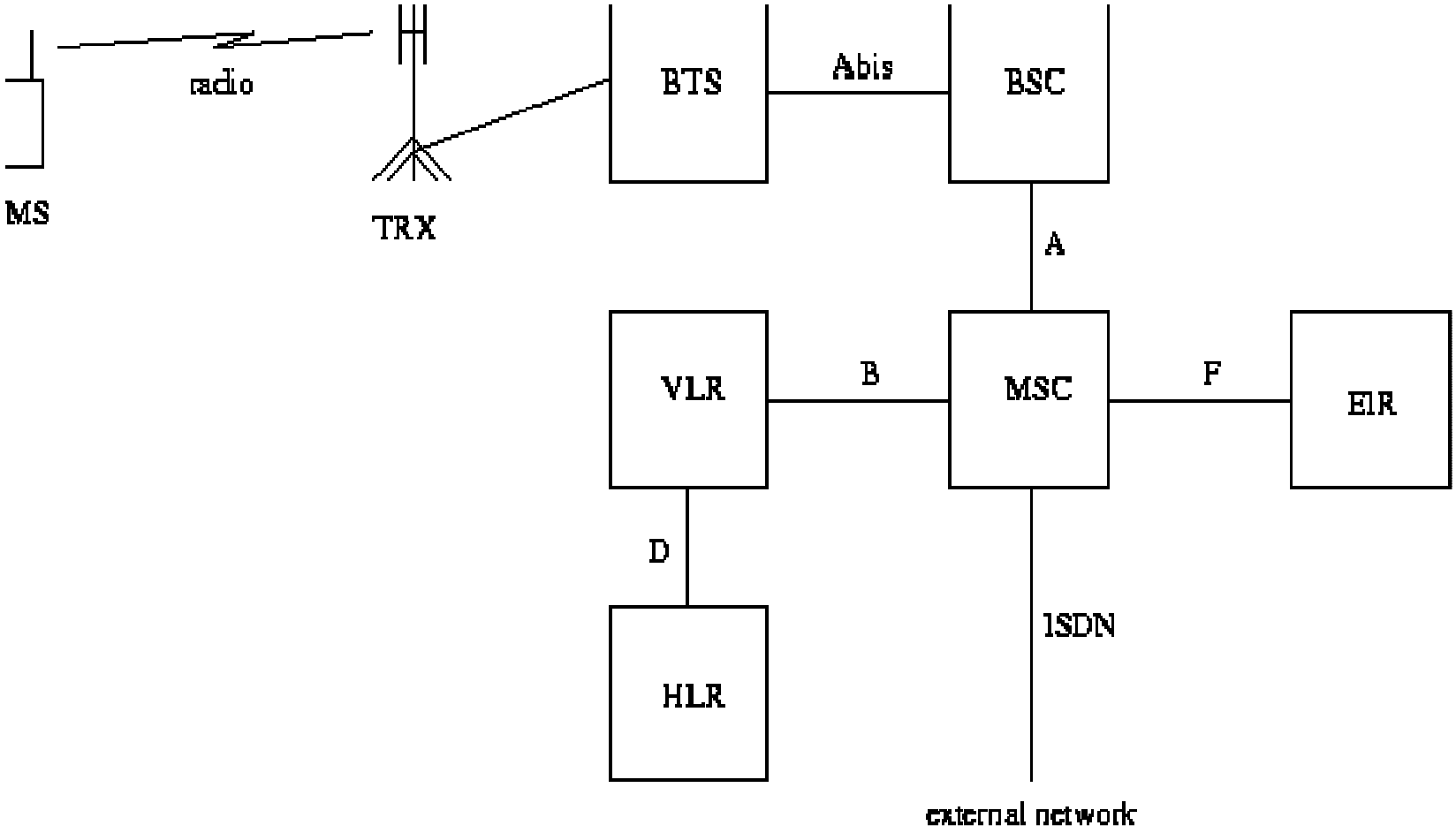
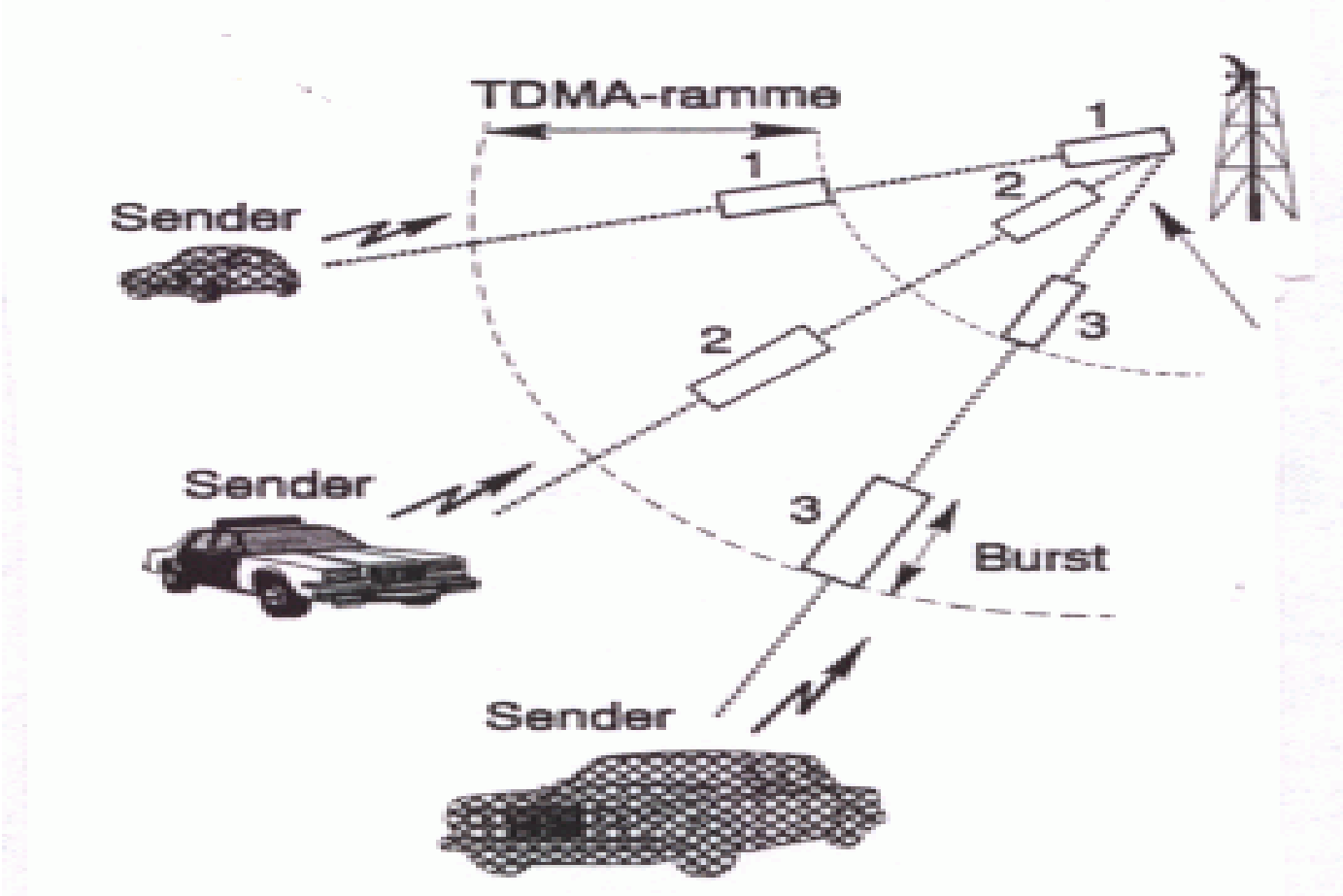
Functional entities

http://www.willassen.no/msl/node4.html



More on GSM – Air interface

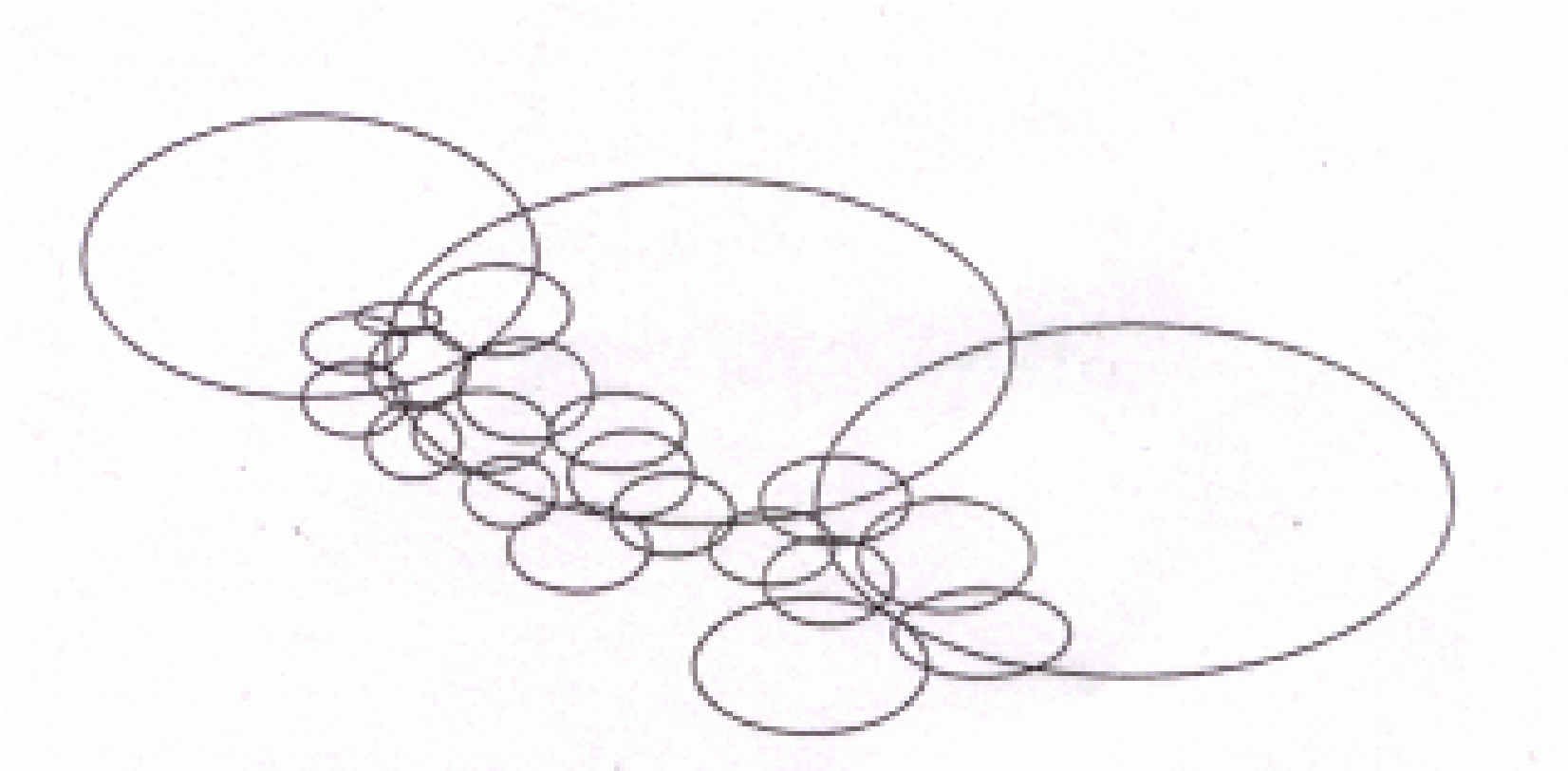
GSM – TDMA (Initial rate: around 20 kbits / second)



http://www.willassen.no/msl/node4.html

More on GSM – Cell structure

GSM - cells



http://www.willassen.no/msl/node4.html

Roaming scenarios

- Mary turns her phone one
- John calls Mary
- Alice calls Mary

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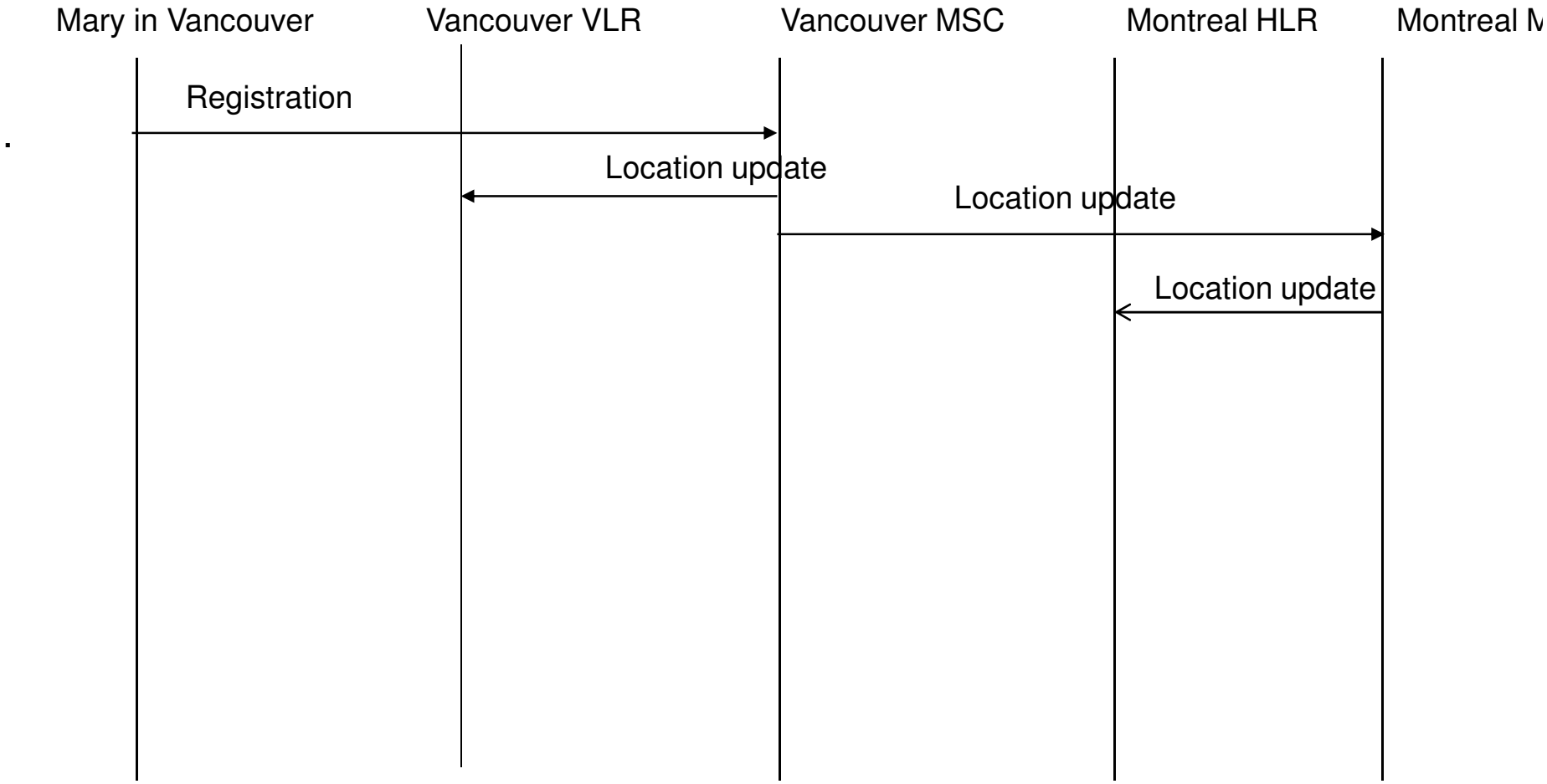
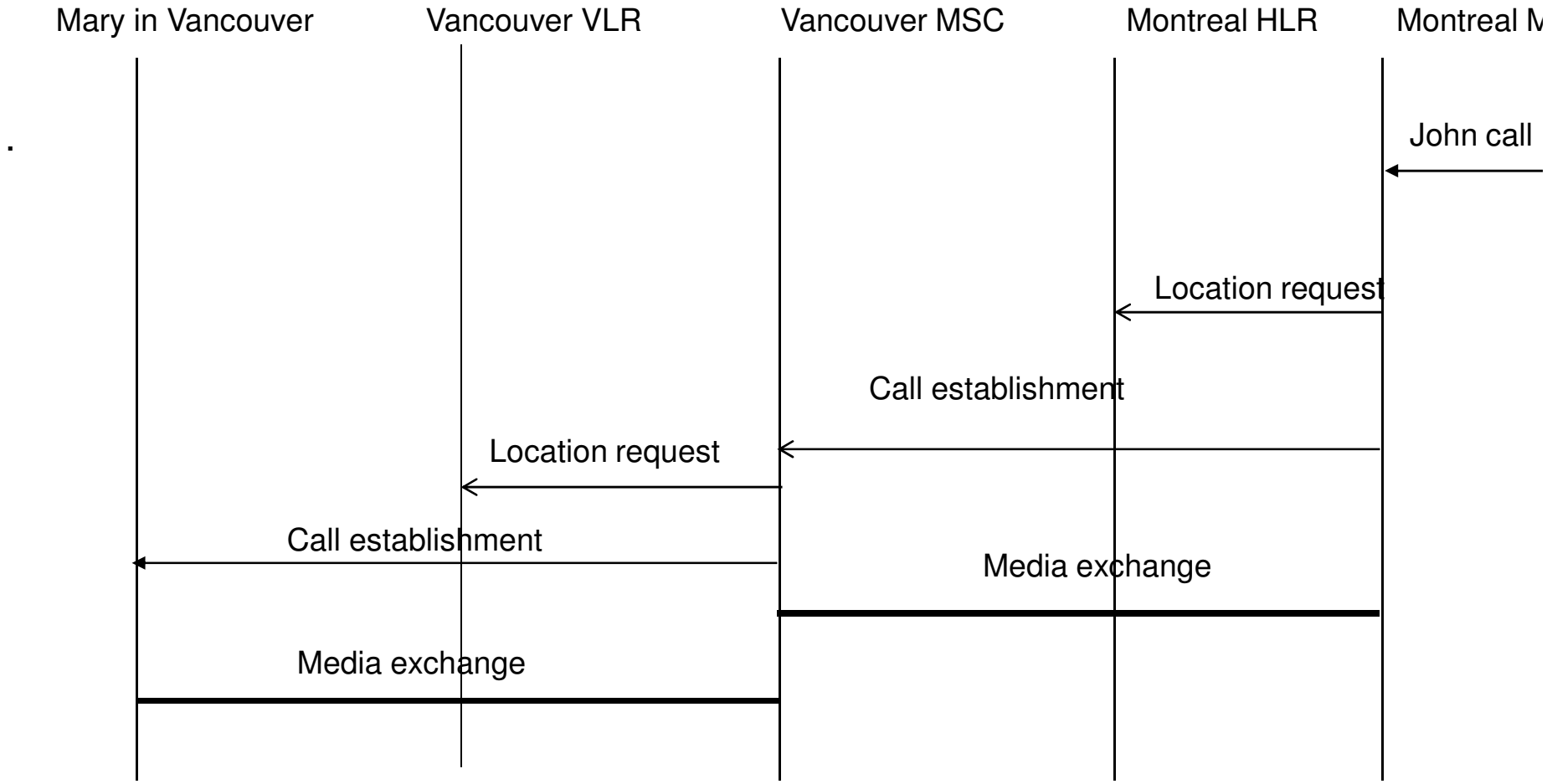
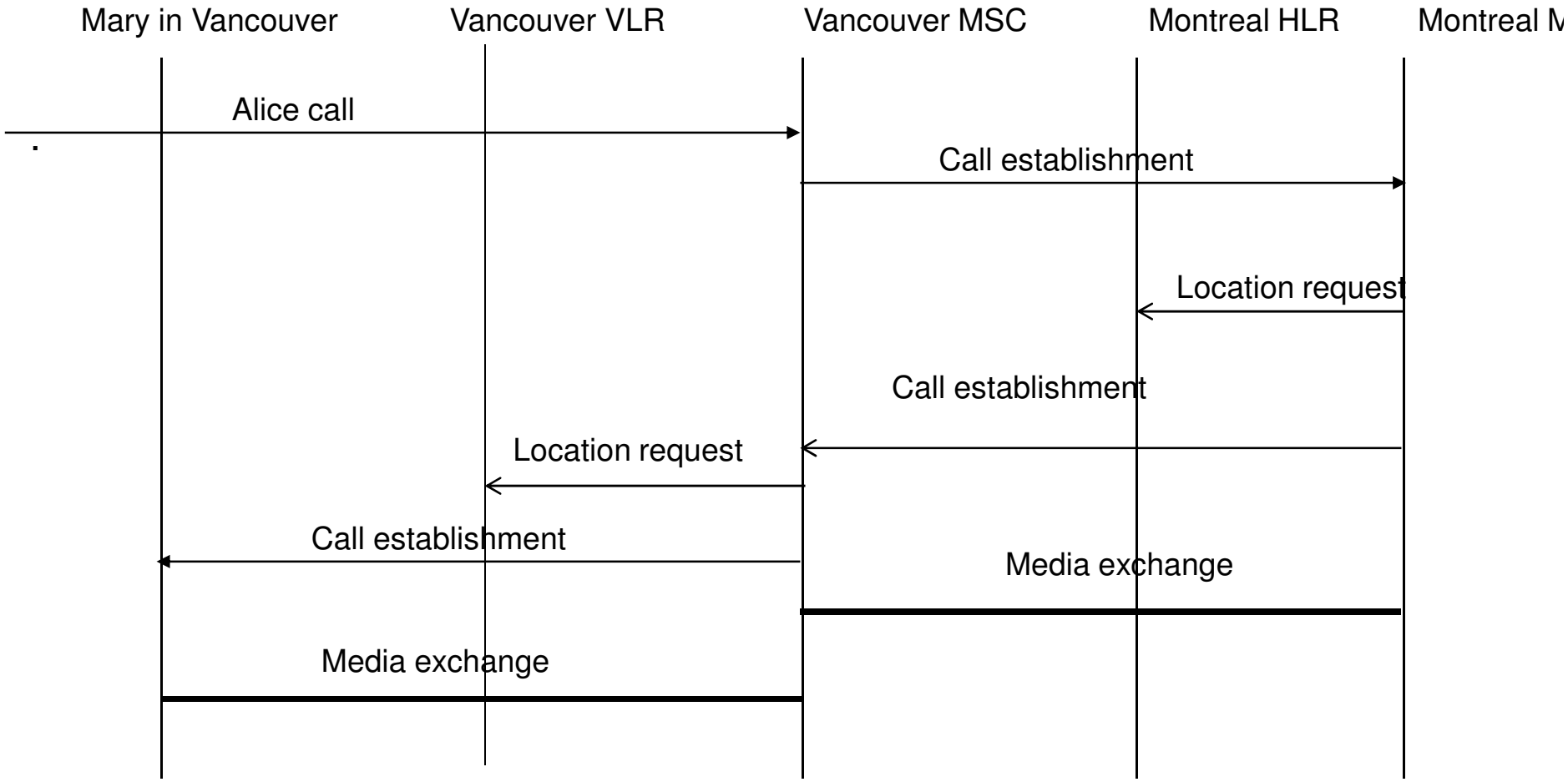
Mary a Montreal subscriber turns her phone on while roaming in Vancouver



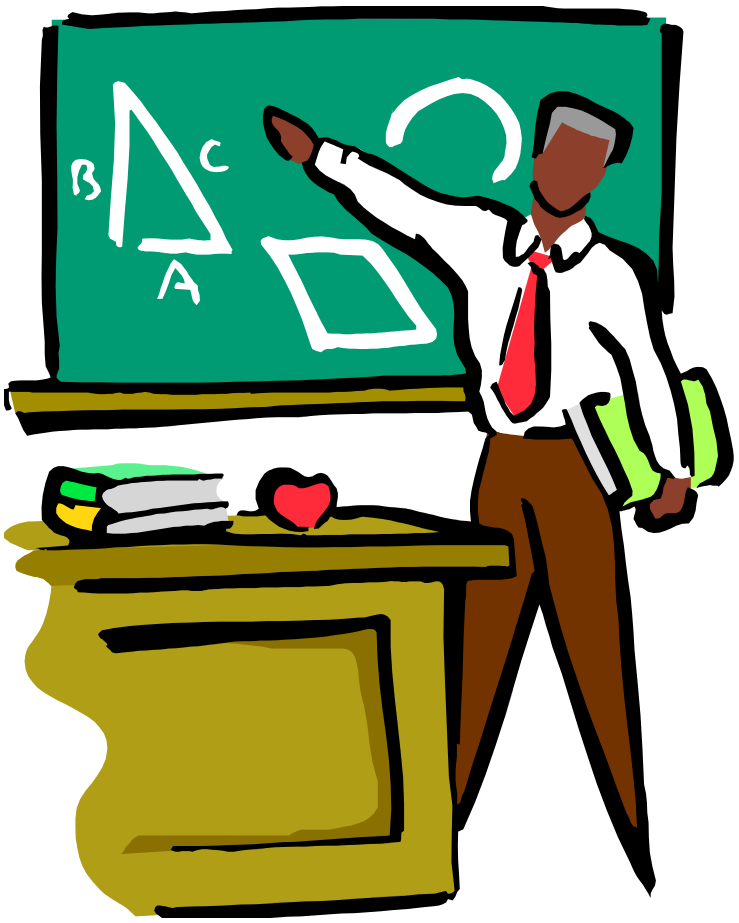
John in Montreal calls Mary



Alice in Vancouver calls Mary



2.5 G



- General principles
- GPRS as illustration

2.5 G

Target solely data services

- Use packet switching principles between mobiles and bases stations for:
  - Faster connection set up
  - Higher data rates
  - Lower cost
- Rely on new nodes which communicate using packet switching principles

No impact on telephony

- Still based on circuit switching principles
- No change at all on the circuit switched part of 2G

GPRS as illustration

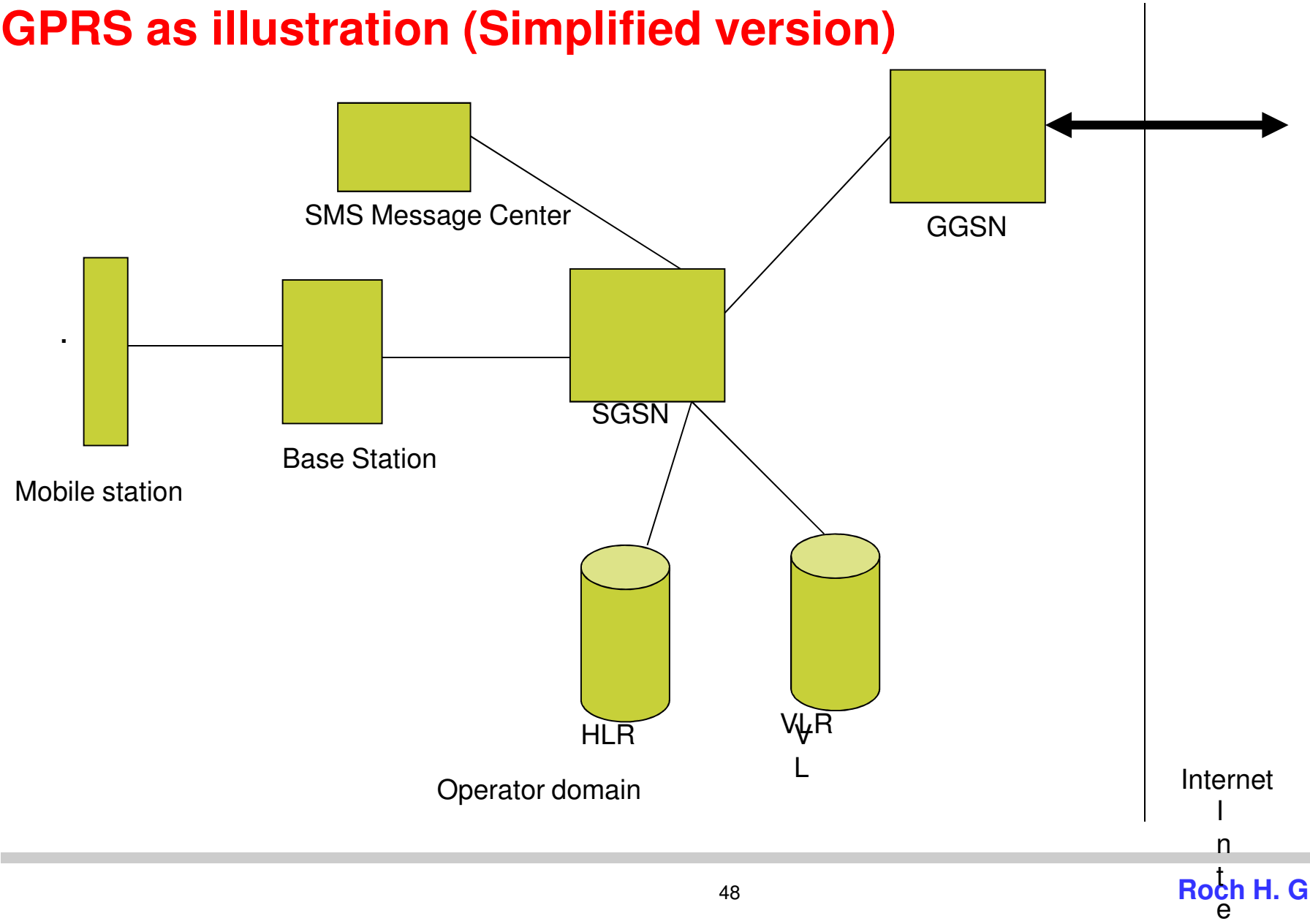
New class of nodes:

- **GPRS Support Node (GSN)**
  - Serving GPRS Support Node (S-GSN)
    - Entry point
  - Gateway GPRS Support Node (G-GSN)
    - Gateway to the external packet switched network (e.g. Internet)

New interfaces

- Interface S-GSN / G-GSN
- Interface S-GSN with the existing GSM nodes

GPRS as illustration (Simplified version)



References

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2. R. Moderassi and R. Skoog, Signaling System No7: A Tutorial, IEEE Communications Magazine, July 1990
3. M. Rahnema, Overview of the GSM System and Protocol Architecture, IEEE Communications Magazine, April 1993
4. C. Bettstetter, H-J Vogel, J. Eberspacher, GSM Phase2+, General Radio Service GPRS: Architecture, Protocols and Air Interface, IEEE Communications Surveys & Tutorials, Third Quarter 1999, Vol. 2, No3