

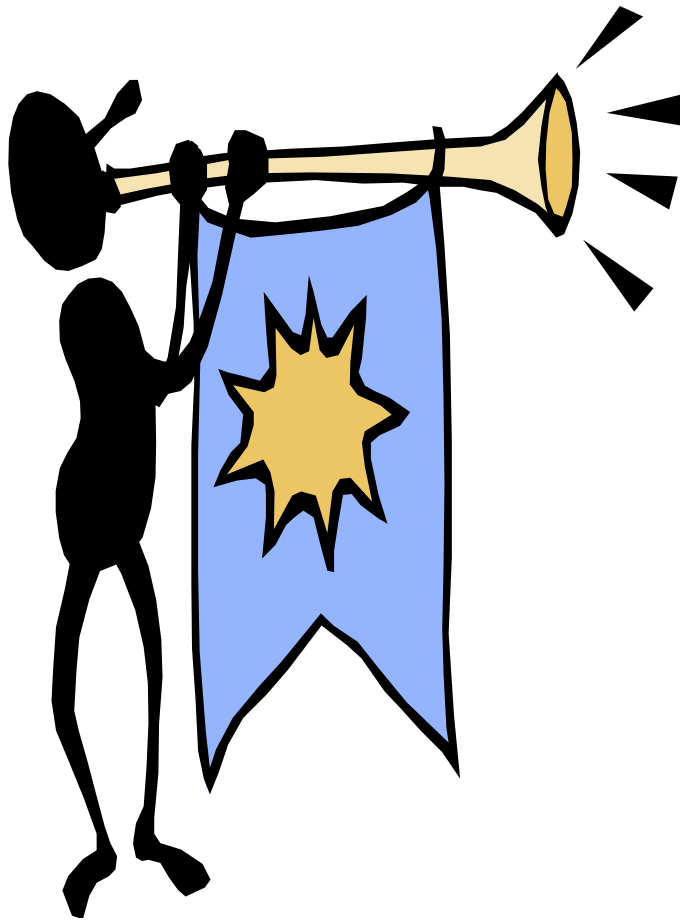
Telecommunication Services Engineering (TSE) Lab



Chapter I – From Circuit Switched Telephony to Next Generation Networks

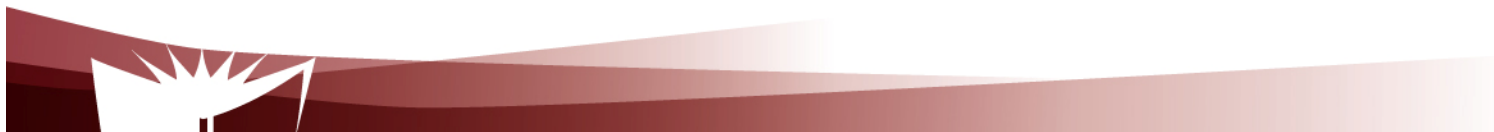
<http://users.encs.concordia.ca/~glitho/>

Outline

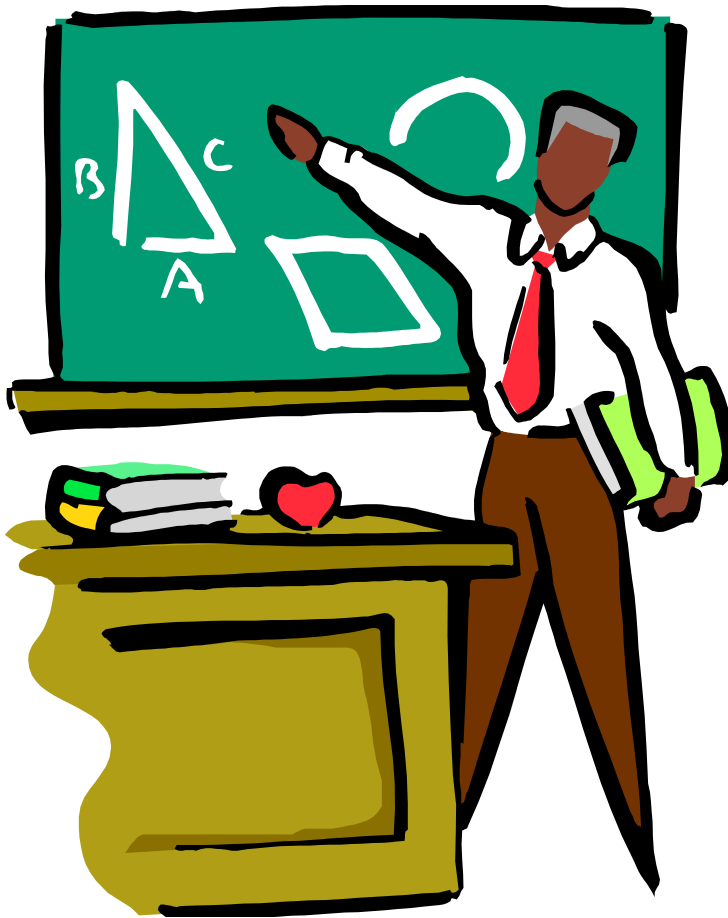


1. Before Next Generation Networks
2. Basics of Next Generation Networks (NGN)

Circuit Switched Telephony



Before Next Generation Networks: Essentials of Circuit Switched Telephony



- Key concepts
- Fixed Telephony
- 2G (e.g. GSM)
- 2.5 G (e.g. GPRS)

Telecommunication Services Engineering (TSE) Lab

Key Concepts: Telephony

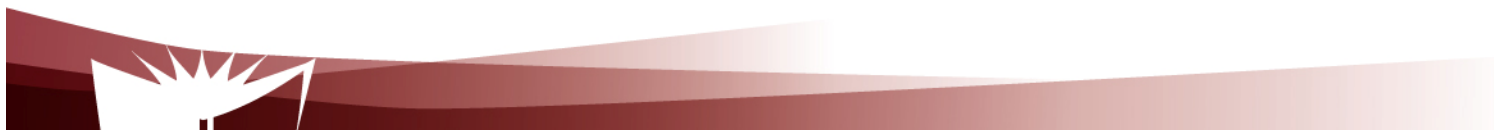
Call / Session: Real time / Conversational exchange of media

Two components:

Signaling

Media (e.g. voice, video)

Signaling: Establishment, modification and tear down of calls



Telecommunication Services Engineering (TSE) Lab

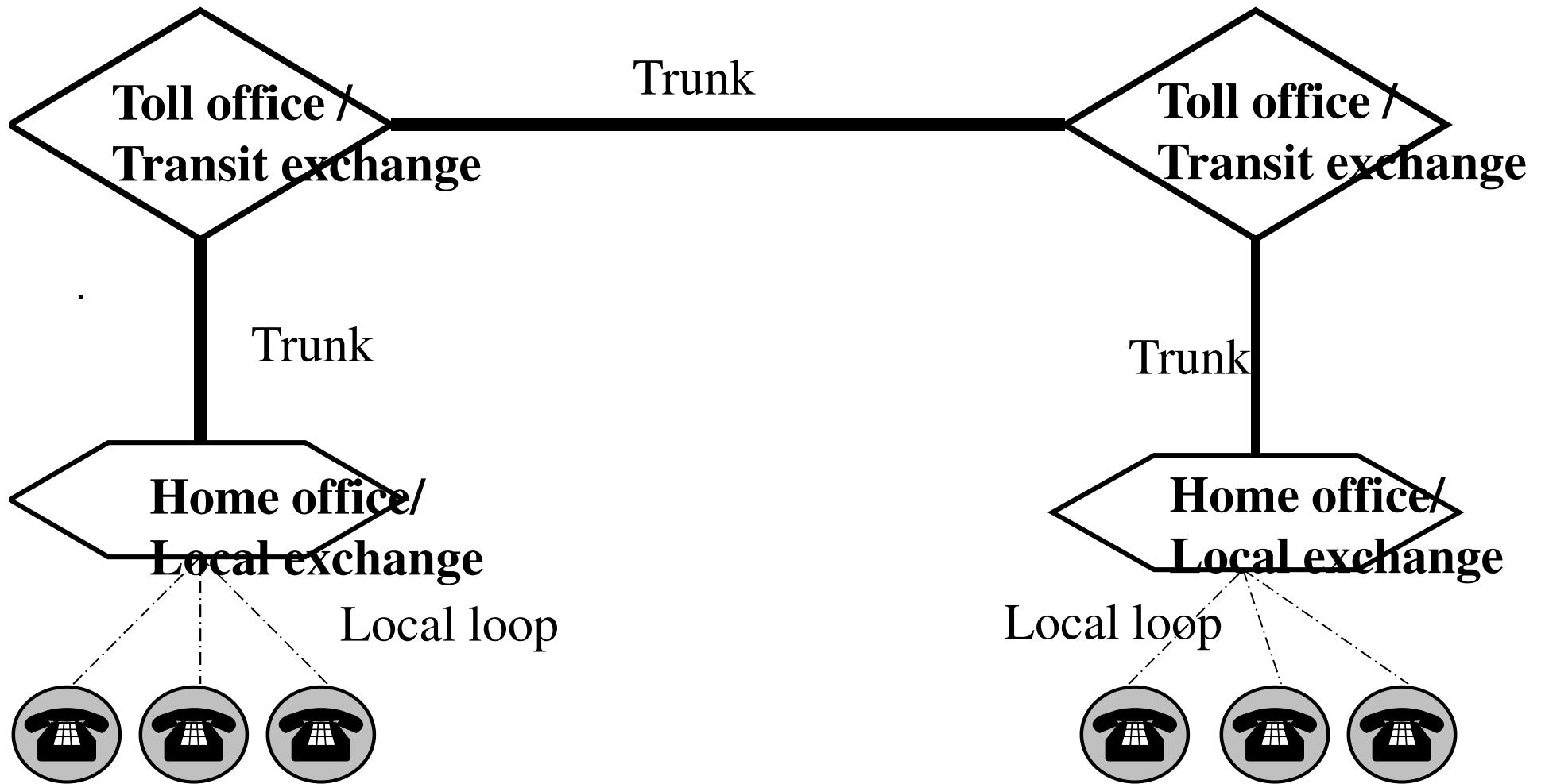
Key concepts: Circuit switching vs. packet switching

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



Telecommunication Services Engineering (TSE) Lab

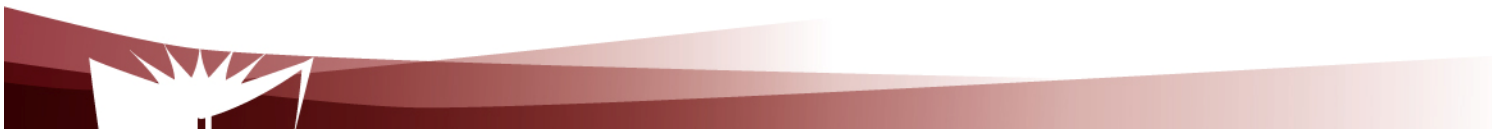
A simplified fixed telephony network ...



Telecommunication Services Engineering (TSE) Lab

Fixed Telephony: Signaling

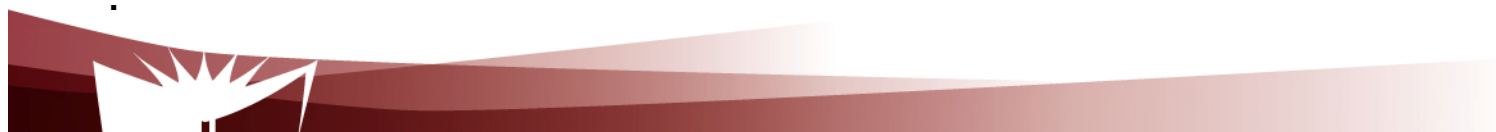
- **Network – Network signalling**
 - Between telephone exchanges
 - Initially in-band (Same trunks as voice)
 - Out-band in modern circuit switched telephony (Do not use same trunks as voice)
 - Example: Signalling System no7 – SS7



Telecommunication Services Engineering (TSE) Lab

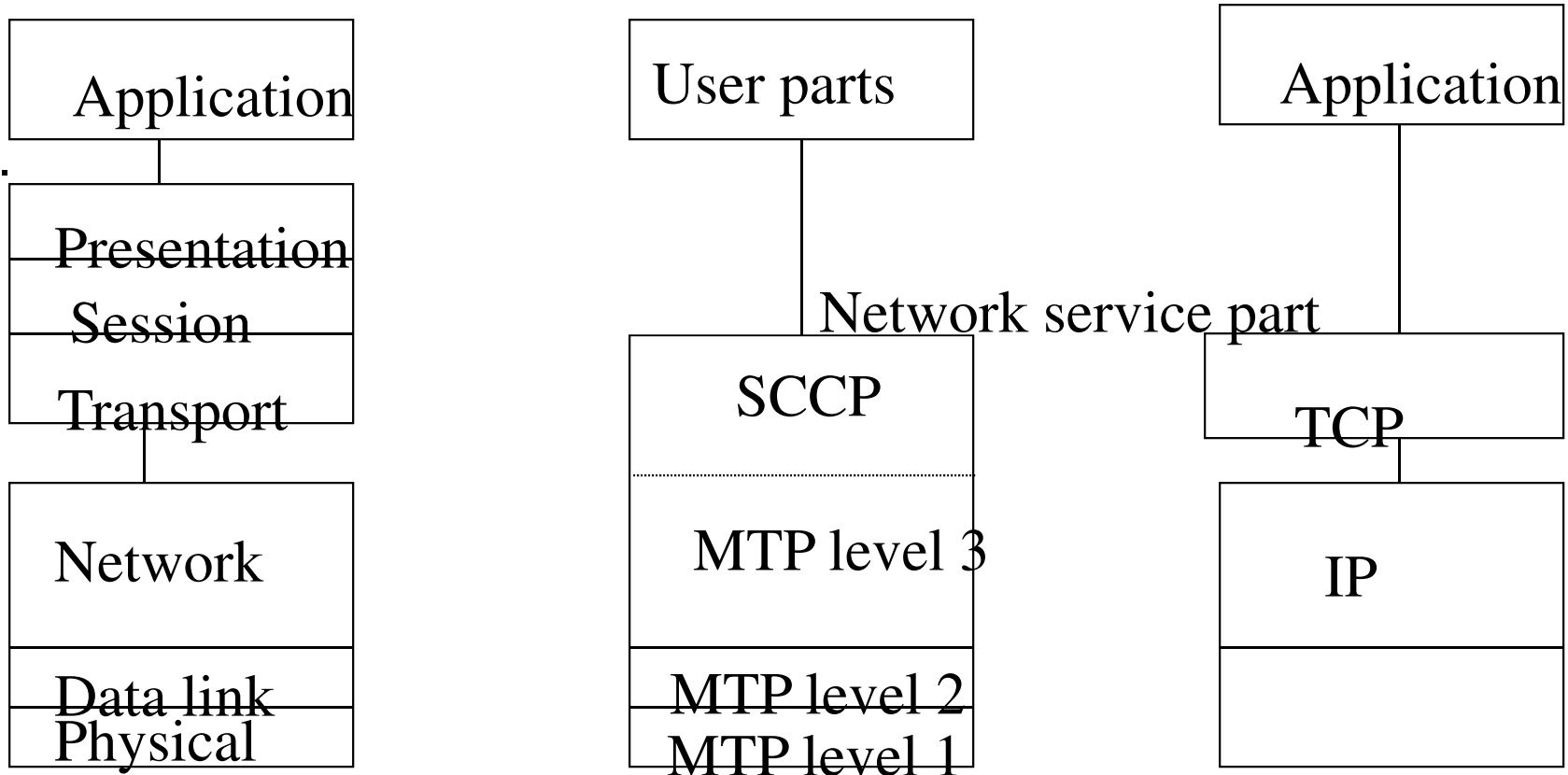
Fixed Telephony: Signaling System No7 (SS7)

- **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)



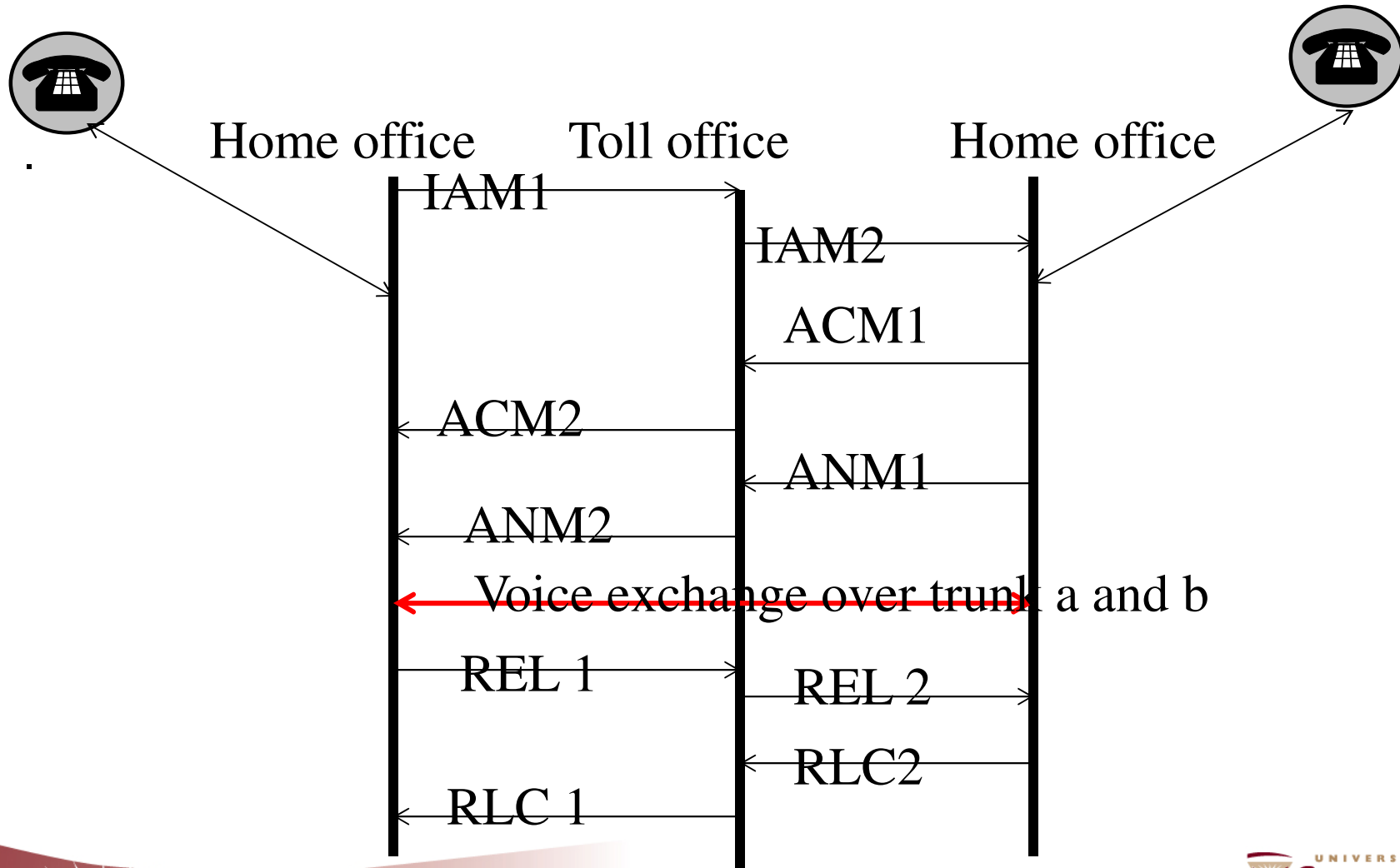
Telecommunication Services Engineering (TSE) Lab

SS7 Protocol stack



Telecommunication Services Engineering (TSE) Lab

Fixed Telephony: A simplified two party call



Telecommunication Services Engineering (TSE) Lab

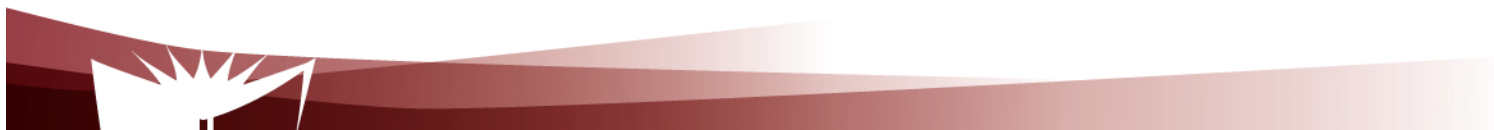
Mobile Telephony: History (Circuit switched based)

First generation cellular networks (70s –)

- 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 –)

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



Telecommunication Services Engineering (TSE) Lab

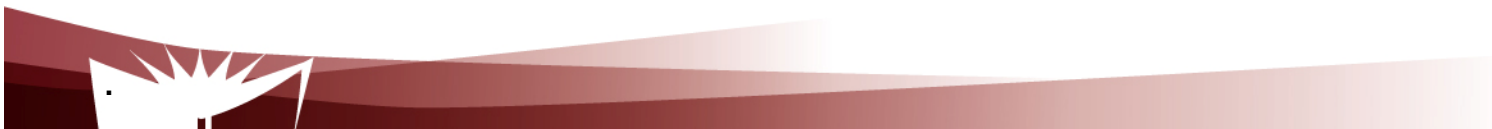
History (Packet switched based)

Third Generation (early 00s –)

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

Fourth Generation (2004/2005 –)

- Still digital, but more capacity (XX Mbits)
- Packet switching based
- Several radio access standards (e.g. Long Term Evolution (LTE), Wimax)
- 1 Core network standard that enables the co-existence between “old” radio access (e.g. CDMA 2000) and new radio access (e.g. LTE, Wimax)

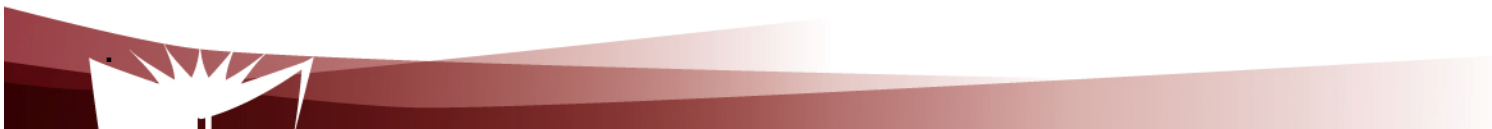


Telecommunication Services Engineering (TSE) Lab

Functional entities (2G)

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

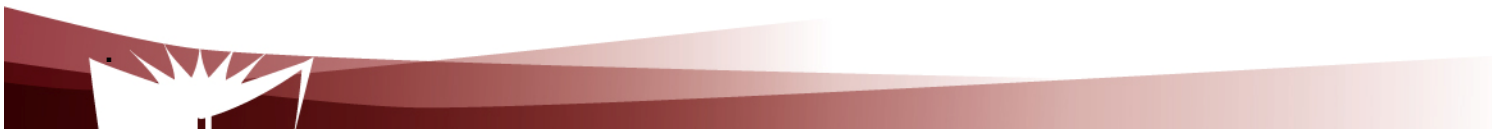


Telecommunication Services Engineering (TSE) Lab

Functional entities (2G)

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

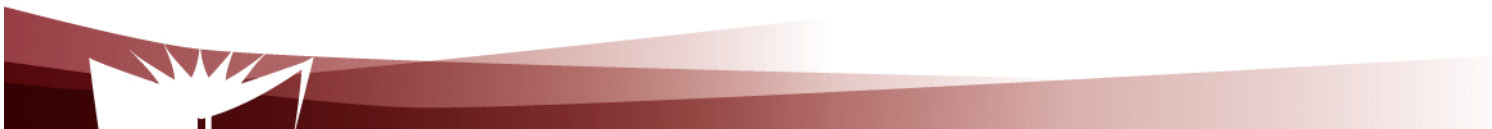


Telecommunication Services Engineering (TSE) Lab

Functional entities (2G)

GSM specifics

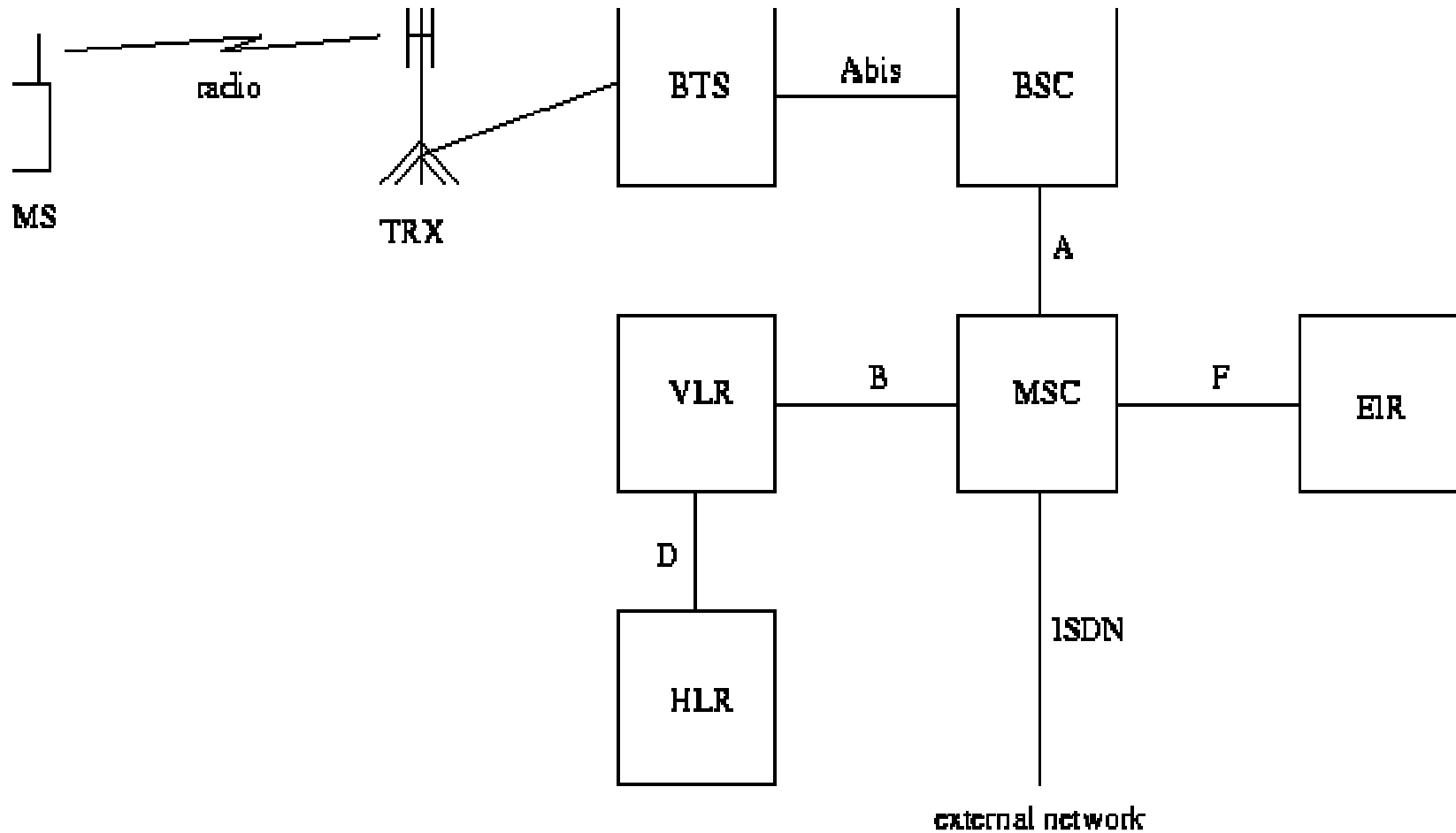
- Base stations
 - Base Transceiver Station (Actual base station)
 - Base station controller (BSC)
 - Controls a set of base stations
- Equipment Identity Register
 - Use for security purpose
 - Can blacklist stolen mobile stations



Telecommunication Services Engineering (TSE) Lab

Functional entities

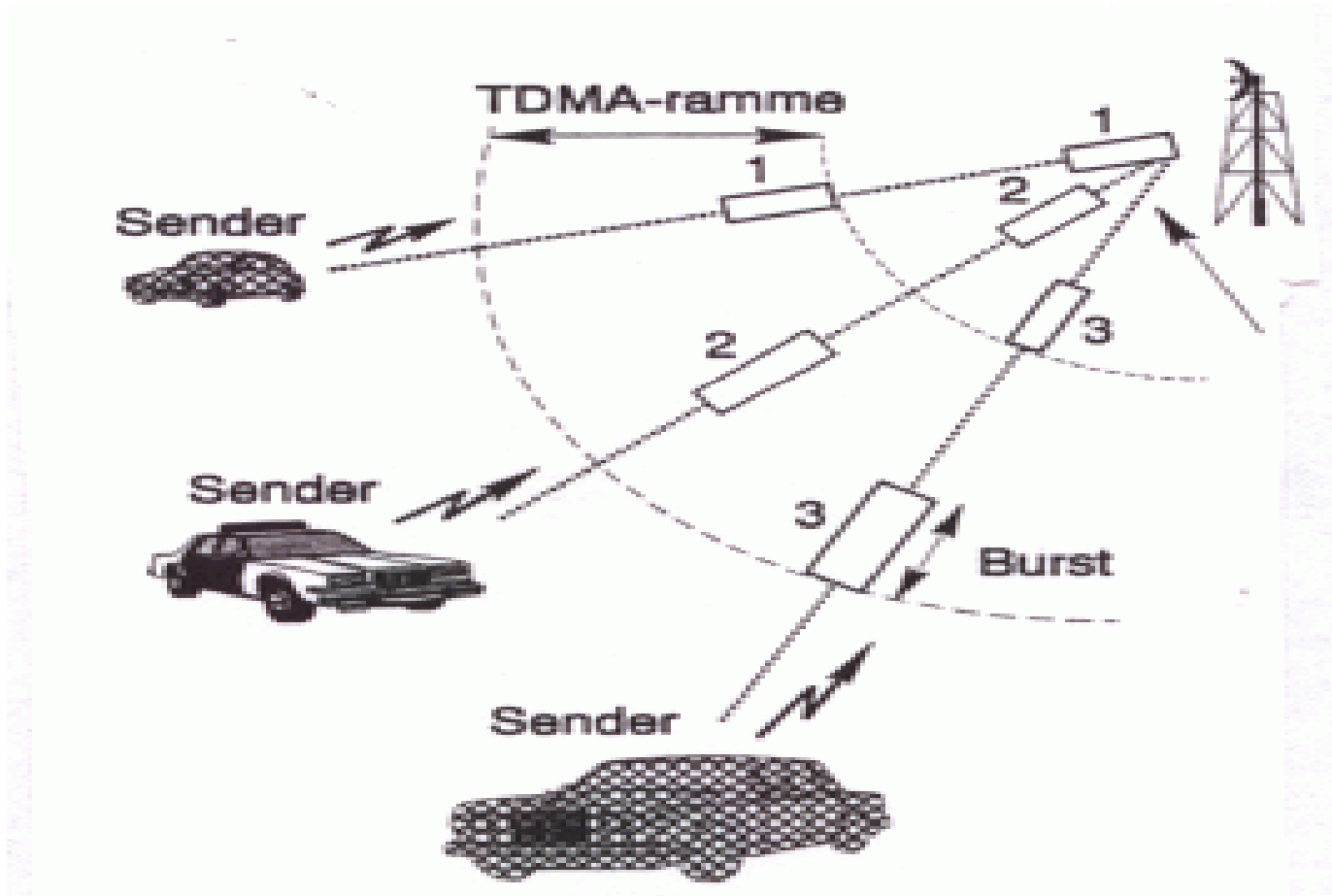
<http://www.willassen.no/msl/node4.html>



Telecommunication Services Engineering (TSE) Lab

More on GSM – Air interface

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

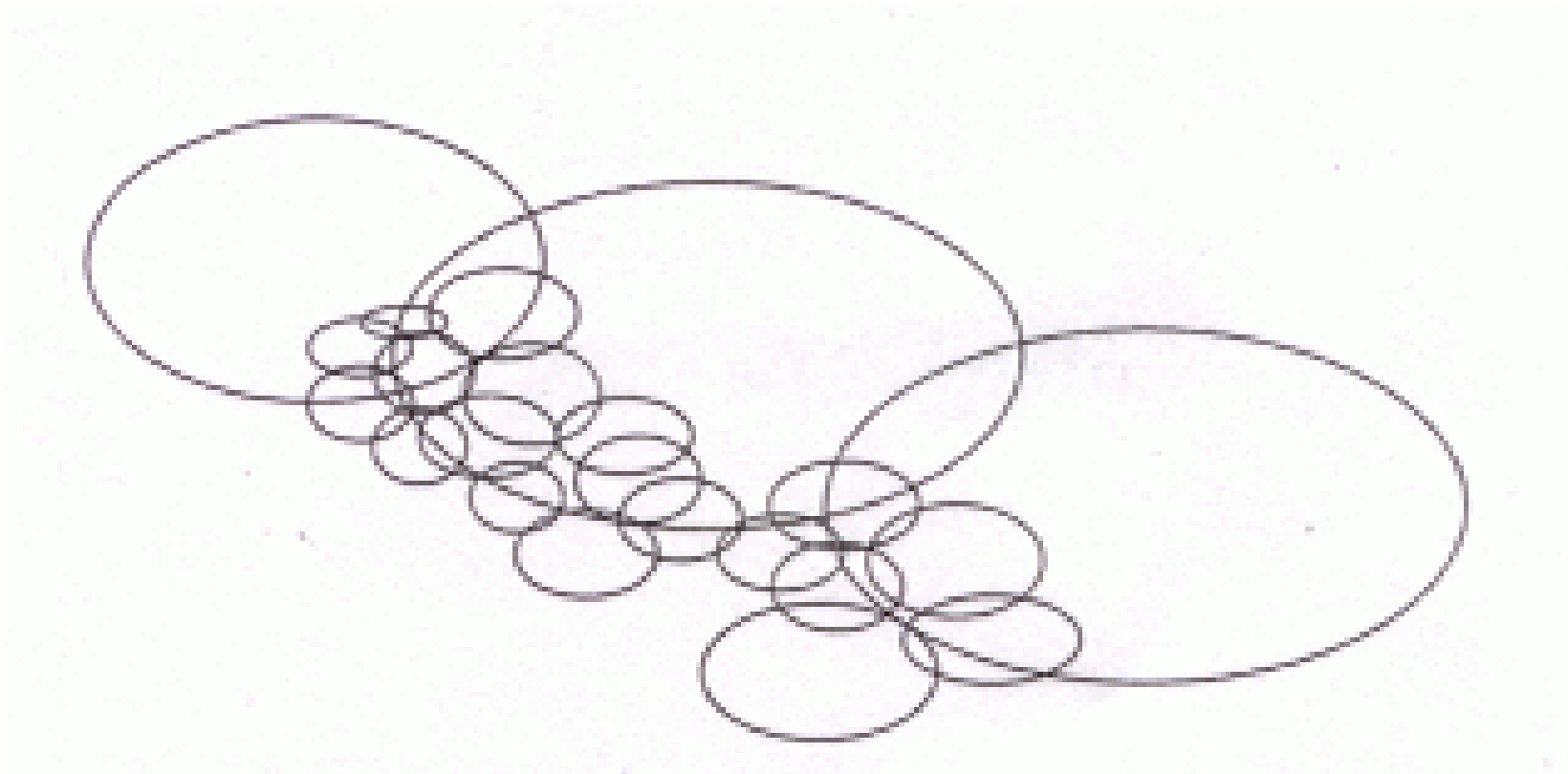


<http://www.willassen.no/msl/node4.html>

Telecommunication Services Engineering (TSE) Lab

More on GSM – Cell structure

GSM - cells



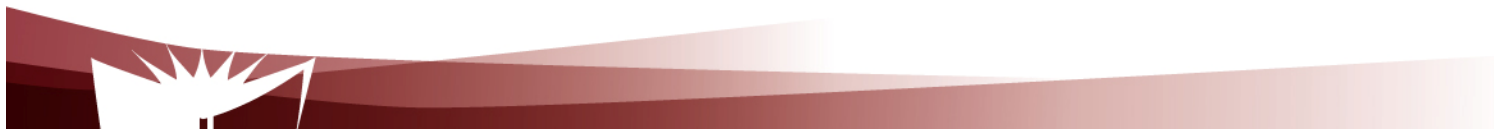
<http://www.willassen.no/msl/node4.html>



Telecommunication Services Engineering (TSE) Lab

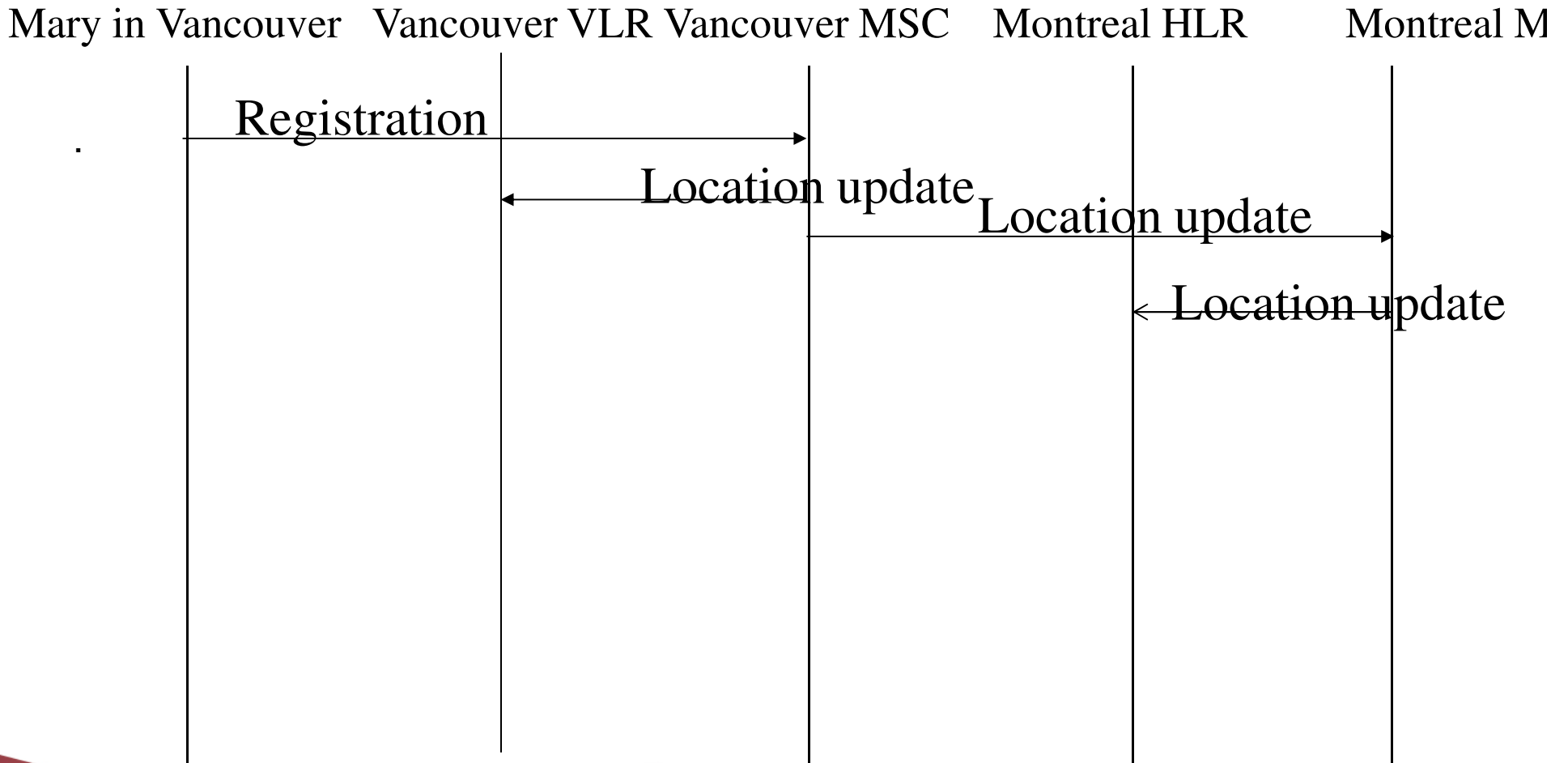
Roaming scenarios

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



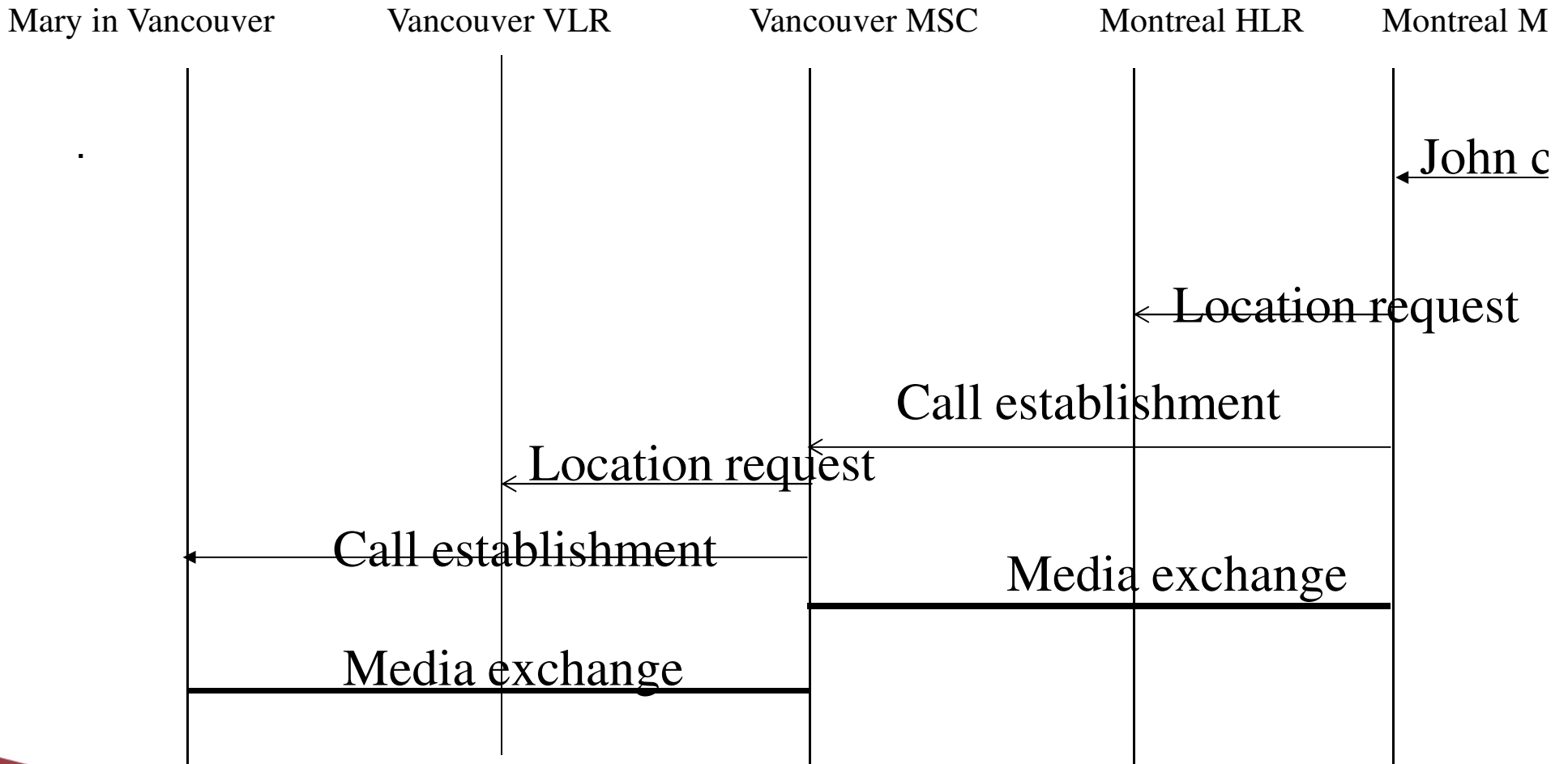
Telecommunication Services Engineering (TSE) Lab

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



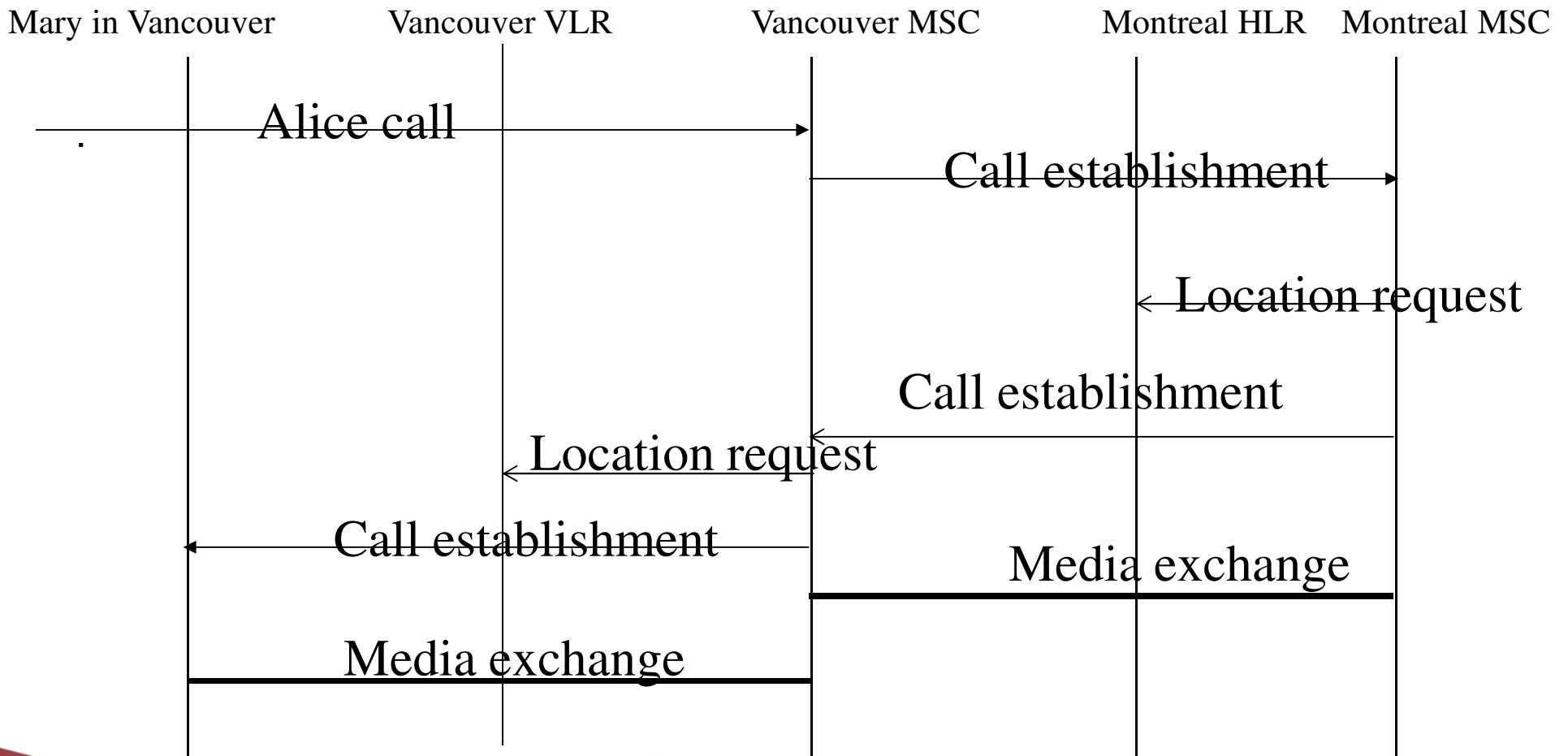
Telecommunication Services Engineering (TSE) Lab

John in Montreal calls Mary



Telecommunication Services Engineering (TSE) Lab

Alice in Vancouver calls Mary



Telecommunication Services Engineering (TSE) Lab

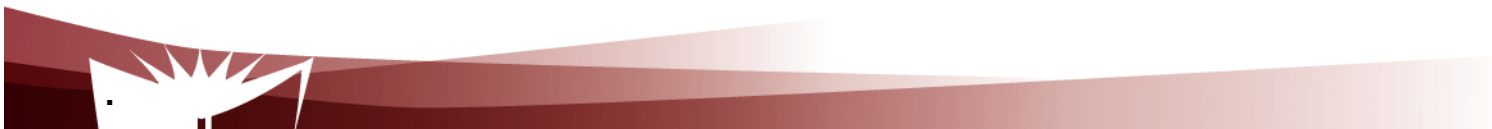
2.5 G

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



Telecommunication Services Engineering (TSE) Lab

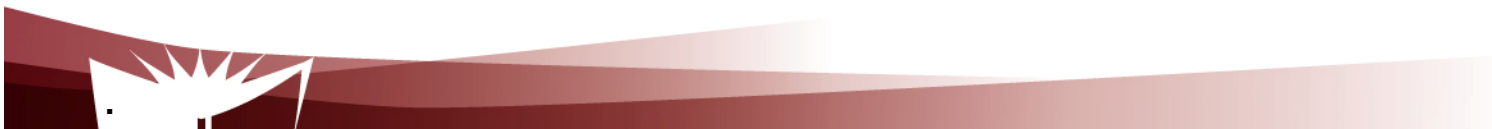
GPRS as illustration

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)

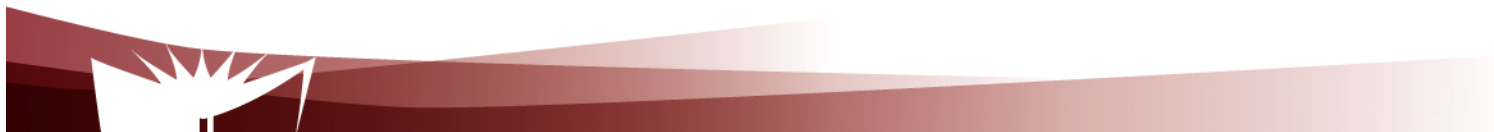
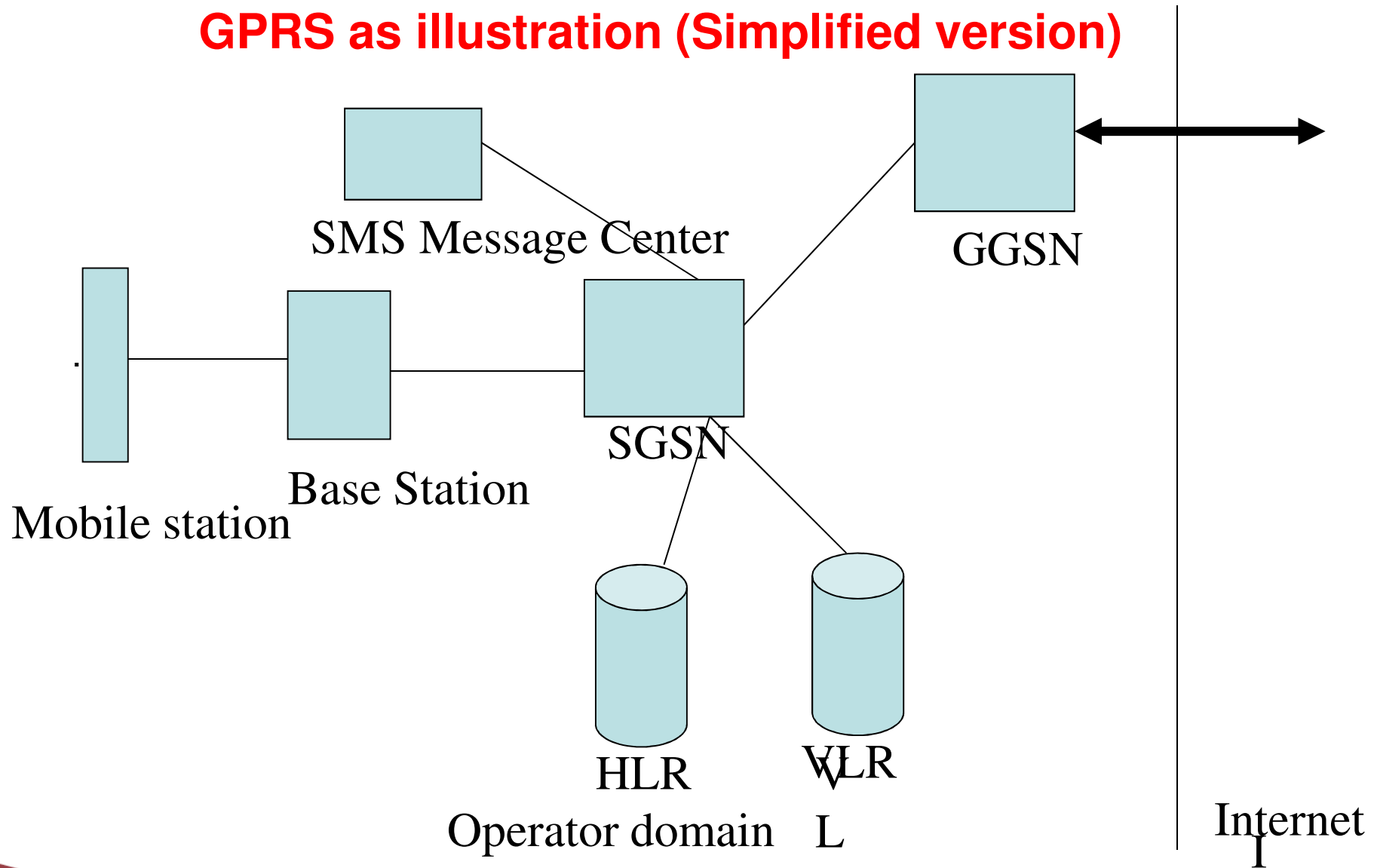
New interfaces

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



Telecommunication Services Engineering (TSE) Lab

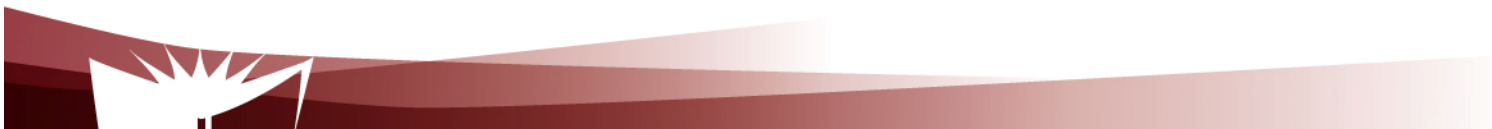
GPRS as illustration (Simplified version)



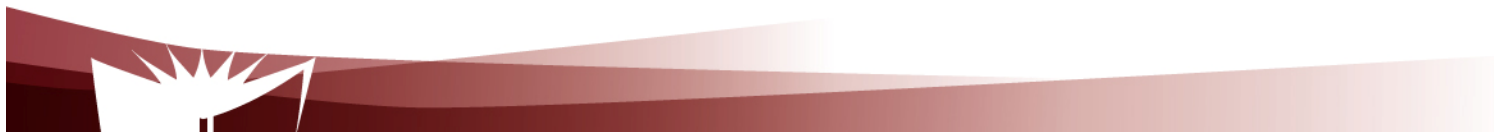
Telecommunication Services Engineering (TSE) Lab

References

1. Tanenbaum, Computer Networks, 4th edition, Prentice Hall 2003 (Chapter 2.5 – The public switched telephone system network)
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



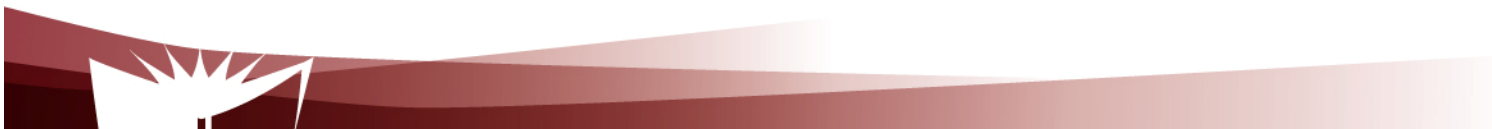
ITU-T Next Generation Network Vision



Layering in next generation networks

Services (Basic services + value-added services)

Transport (Below IP + IP + transport layer)



Layering in next generation networks

Services (value-added services) also called application / services

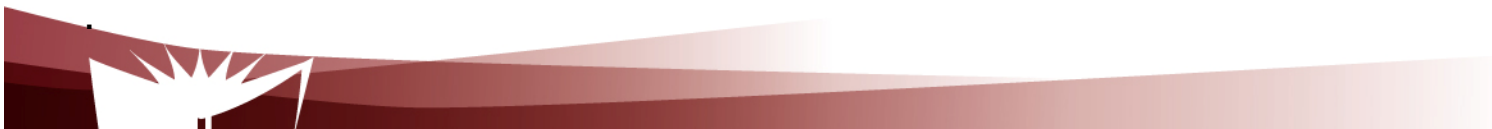
Services (Basic service) also called call/session

Transport (Below IP + IP + transport layer) also called bearer

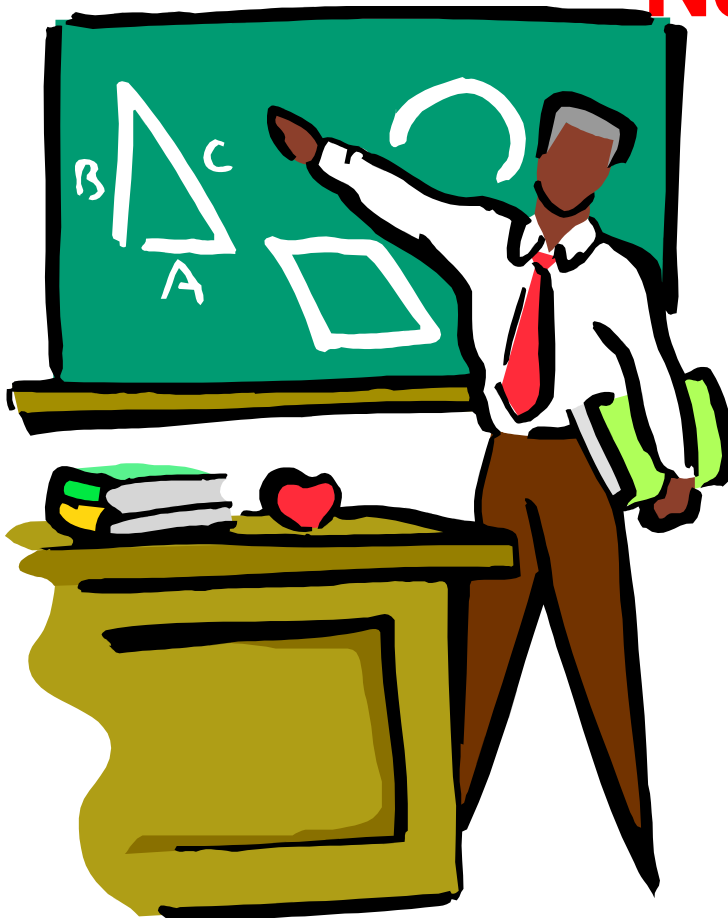


Examples of technologies for next generation networks

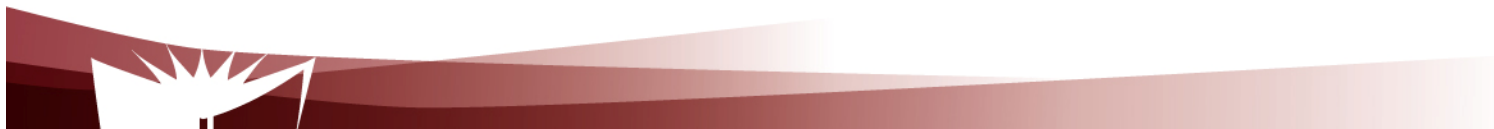
- Transport technologies (Examples)
 - Wimax, long term evolution (LTE)
- Call / session technologies (Examples)
 - SIP, H.323
- Value added services (or services technologies) - Examples
 - SIP servlets, Web services



The ITU-T Vision of Next Generation Networks



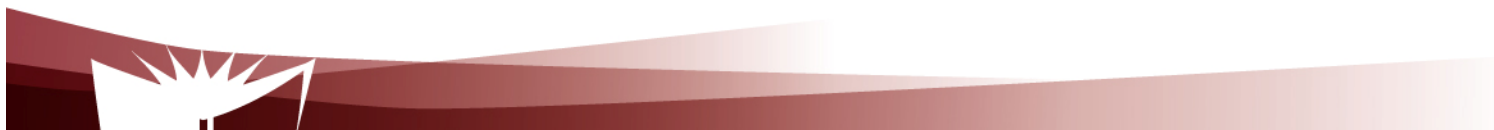
- Fundamental characteristics
- Architectural framework



Fundamental characteristics (or requirements, or design goals)

Categorization scheme used in this lecture

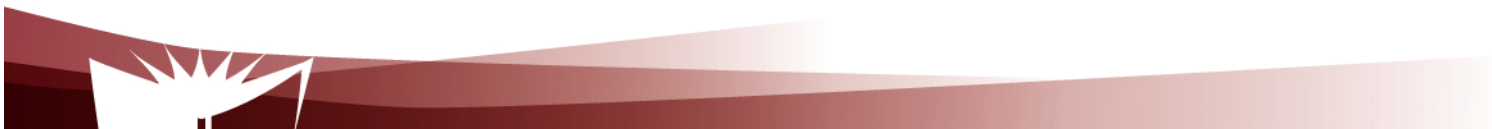
- Layer independent characteristics
 - Impact all layers
- Layer specific characteristics
 - Impact specific layers



Fundamental characteristics (or requirements, or design goals)

Categorization scheme used in this lecture

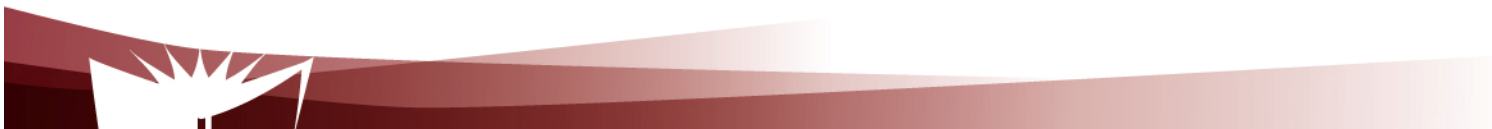
- Layer independent characteristics
 - Business model
 - Separation of concerns
 - Regulatory issues
 - Inter-working with legacy
- Layer specific characteristics
 - Network capacities
 - En-user services and their provision



Fundamental characteristics

Layer independent characteristics

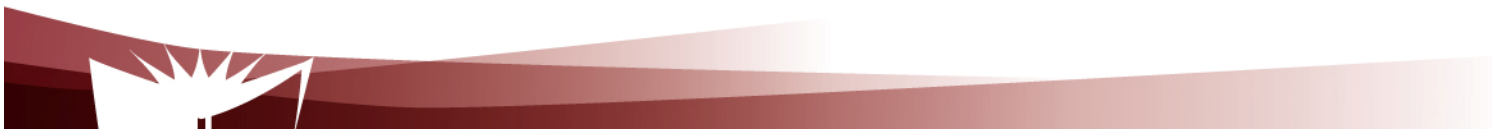
- Business model
 - Unrestricted access to different service providers
 - Has a lot of implications
 - Plug and play by end – users when it comes to subscriptions
 - Last mile from provider A
 - Internet access from provider B
 - Telephony services running on the last mile from provider C
 - Streaming services running on last mile from provider D



Fundamental characteristics

Layer independent characteristics

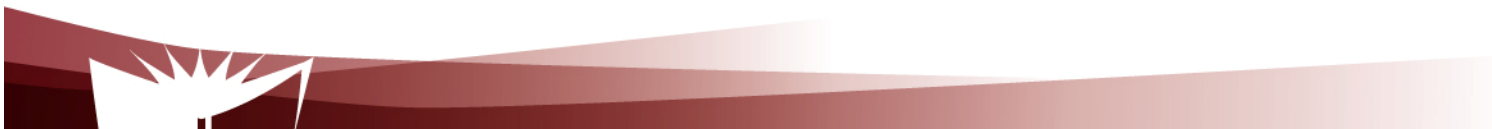
- Separation of concerns
 - Separation of control functions between bearer, call/session and application / service
 - Decoupling of service provision from transport and provision of open interfaces
 - Independence of service related functions from underlying transport technologies



Fundamental characteristics

Layer independent characteristics

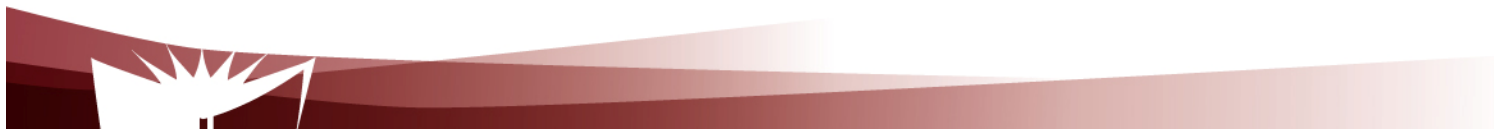
- Compliance with all regulatory issues
 - Emergency communications
 - Lawful interception
 - Security



Fundamental characteristics

Inter-working with legacy

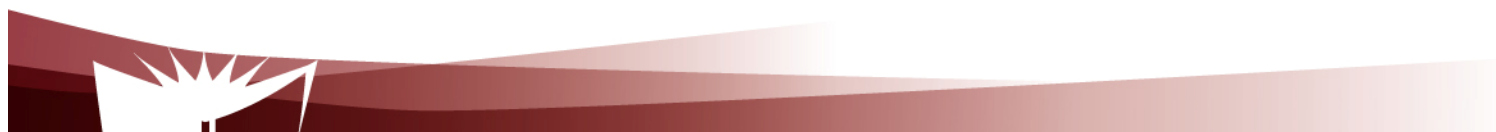
- Through open interfaces



Fundamental characteristics

Layer dependent characteristics

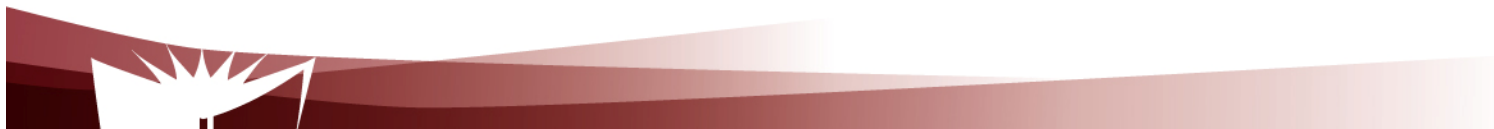
- End-user services and their provision
 - Support of a wide range of services, applications and mechanisms based on building blocks
 - Generalized mobility (terminal, end-user and services)
 - Unified characteristics for the same service as perceived by the user
 - Converged services between fixed and mobile



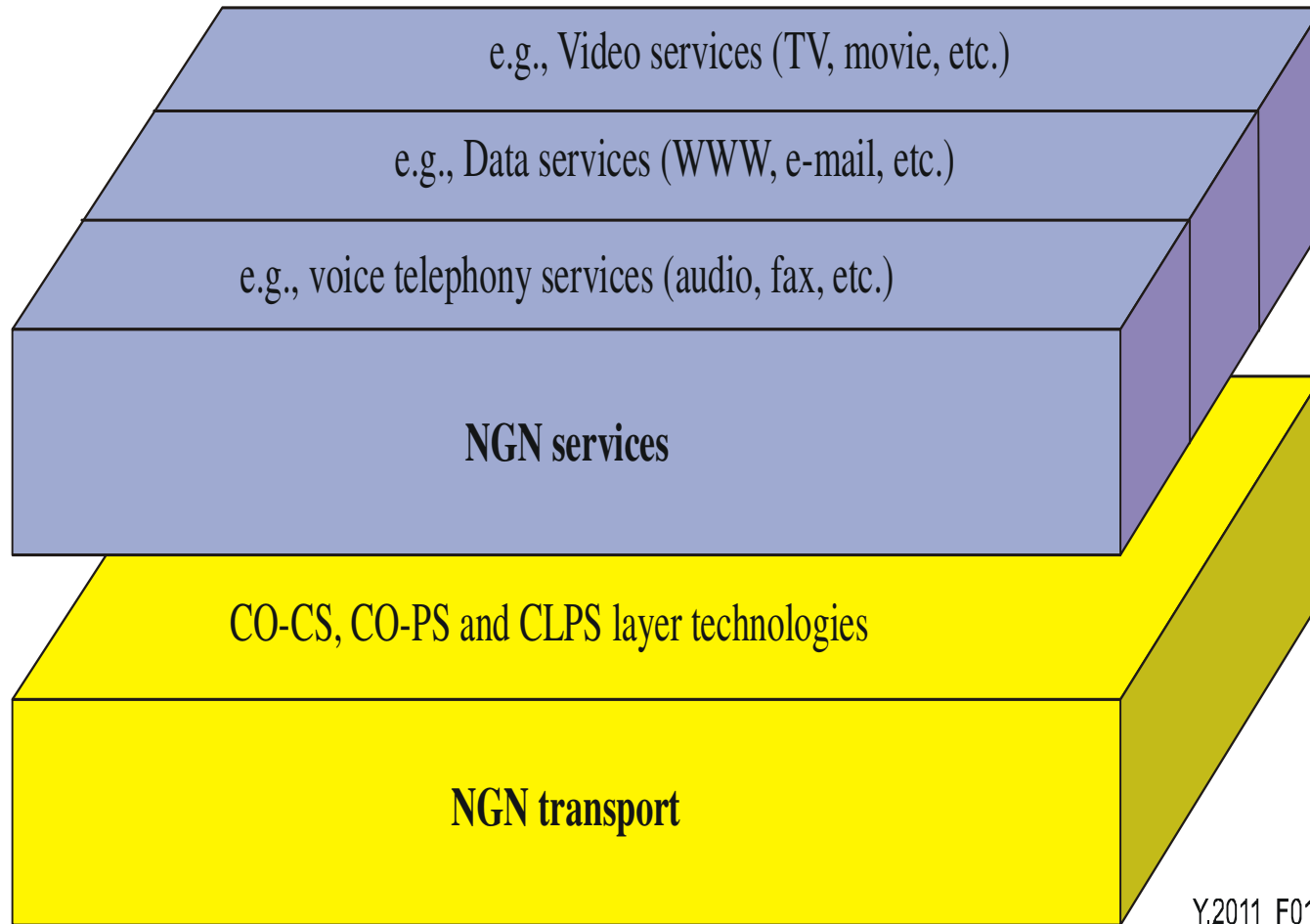
Fundamental characteristics

Layer dependent characteristics

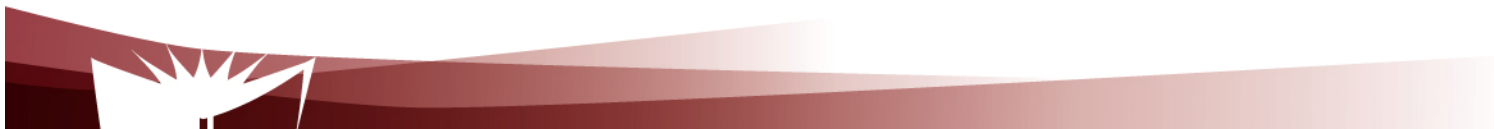
- Transport
 - Broadband
 - Multiple last mile technologies
 - Packet based transfer



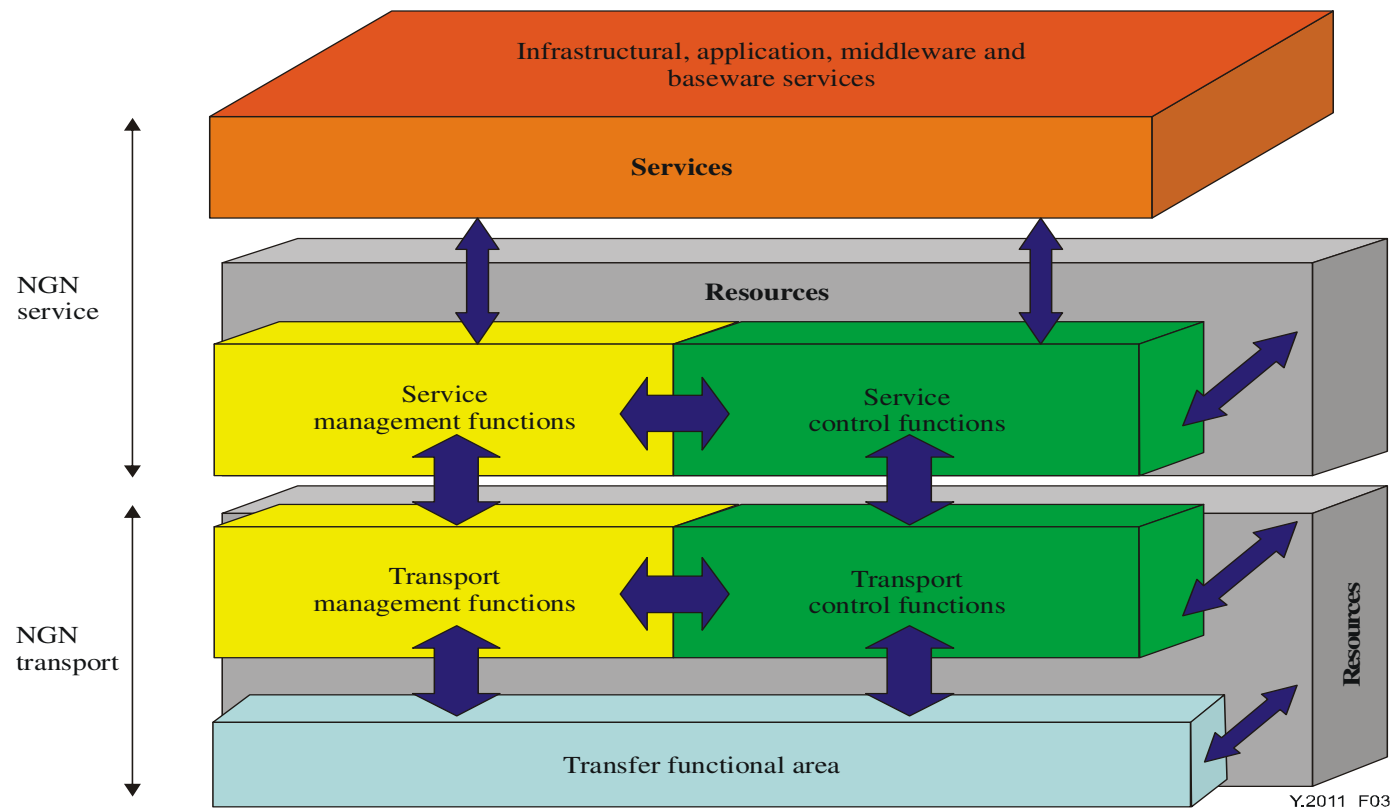
Architectural framework



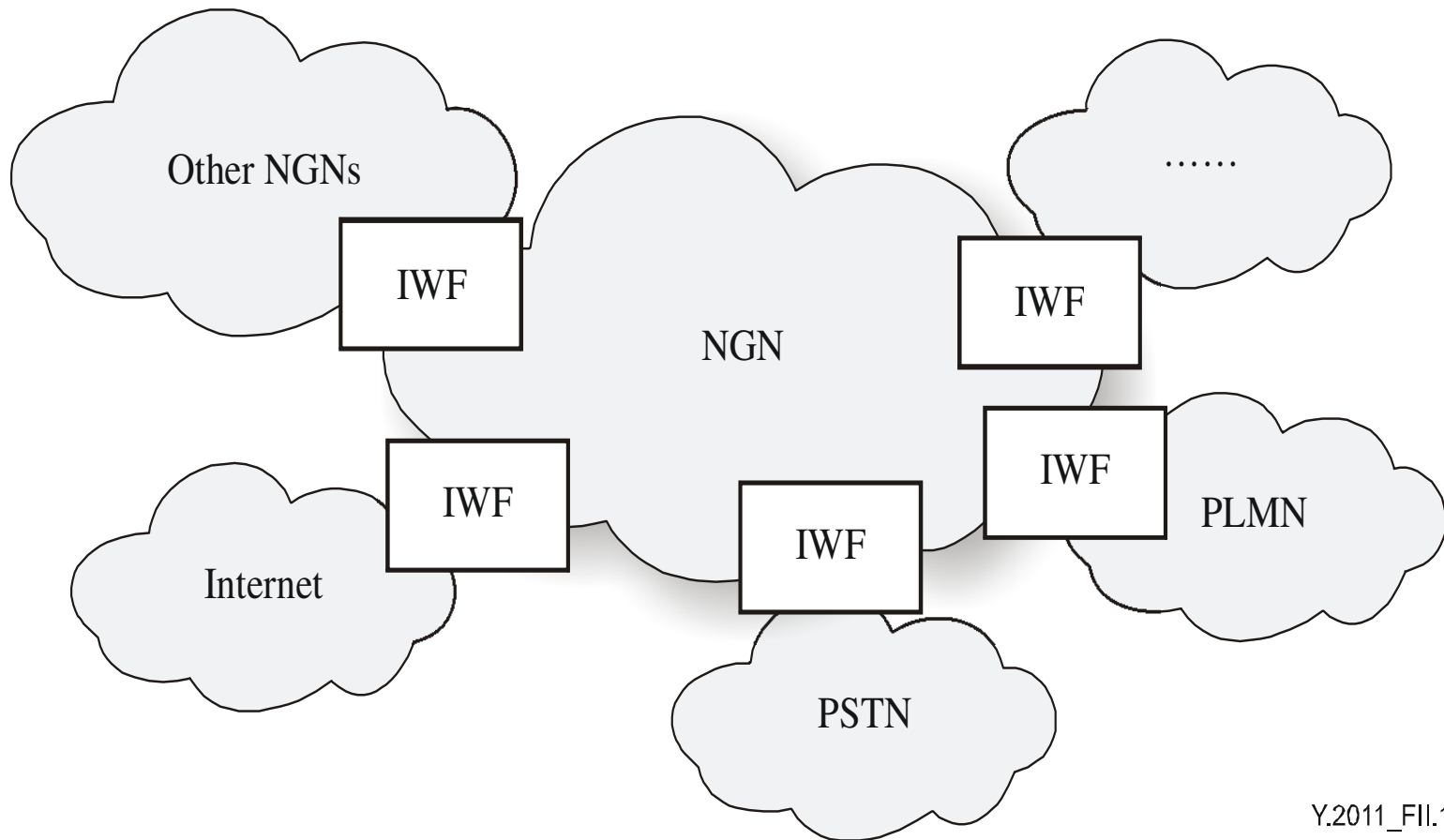
Y.2011_F01



Architectural framework



Architectural framework



Y.2011_FII.1



References

- C-S and D. Knight, Realization of the Next Generation Network, IEEE Communications Magazine, October 2005, Vol. 43, No. 10
- K. Knightson et al., NGN Architecture: General Principles, Functional Architecture, and Implementation, IEEE Communications Magazine, October 2005, Vol. 43, No. 10

