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Coimbatore – 35

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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

19ECT311 / Wireless Communication

III ECE/ VI SEMESTER

Unit III - **CELLULAR NETWORKS**

Topic 3: GPRS

OVERVIEW

Cellular Mobile Communication Systems

- First Generation Analog (AMPS)
- Second Generation TDMA(GSM, IS-95)
- **2.5G (GPRS**, EDGE)
- Third Generation Wireless Systems (UMTS)
- Fourth Generation Wireless Systems (LTE)

Wireless Networks

- WPAN
- Bluetooth (IEEE 802.15.1)
- WLAN, WLAN equipment, WLAN Topologies, WLAN Technologies
- IEEE 802.11 WLAN architecture
- Zigbee
- Introduction to Heterogeneous Networks

General Packet Radio Service (GPRS)

What is GPRS ?

Part of GSM phase 2+

General Packet Radio Service

- General -> not restricted to GSM use (DECT ?, 3rd generation systems ?)
- Packet Radio -> enables packet mode communication over air
- Service, not System -> existing BSS (partially also NSS) infrastructure is used

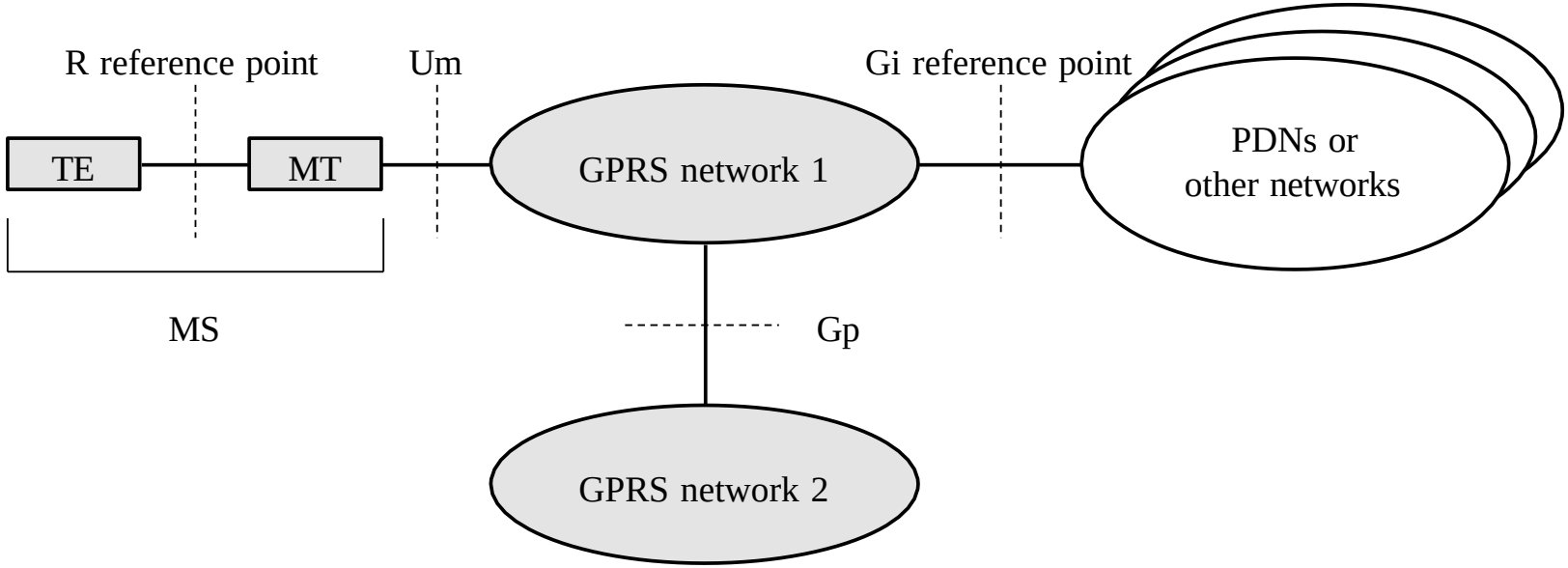
Requires many new network elements into NSS

Provides connections to external packet data networks (Interne t X.25)

Main benefits

- Resources are reserved only when needed and charged accordingly
- Connection setup times are reduced
- Enables new service opportunities

GPRS access interfaces and reference points



- GPRS provides packet switched connections from MS to packet data networks (PDN)
- Different operator's GPRS networks are connected through Gp interface

GPRS characteristics

GPRS uses packet switched resource allocation

- resources allocated only when data is to be sent/received

Flexible channel allocation

- one to eight time slots
- available resources shared by active users
- up and down link channels reserved separately
- GPRS and circuit switched GSM services can use same time slots alternatively

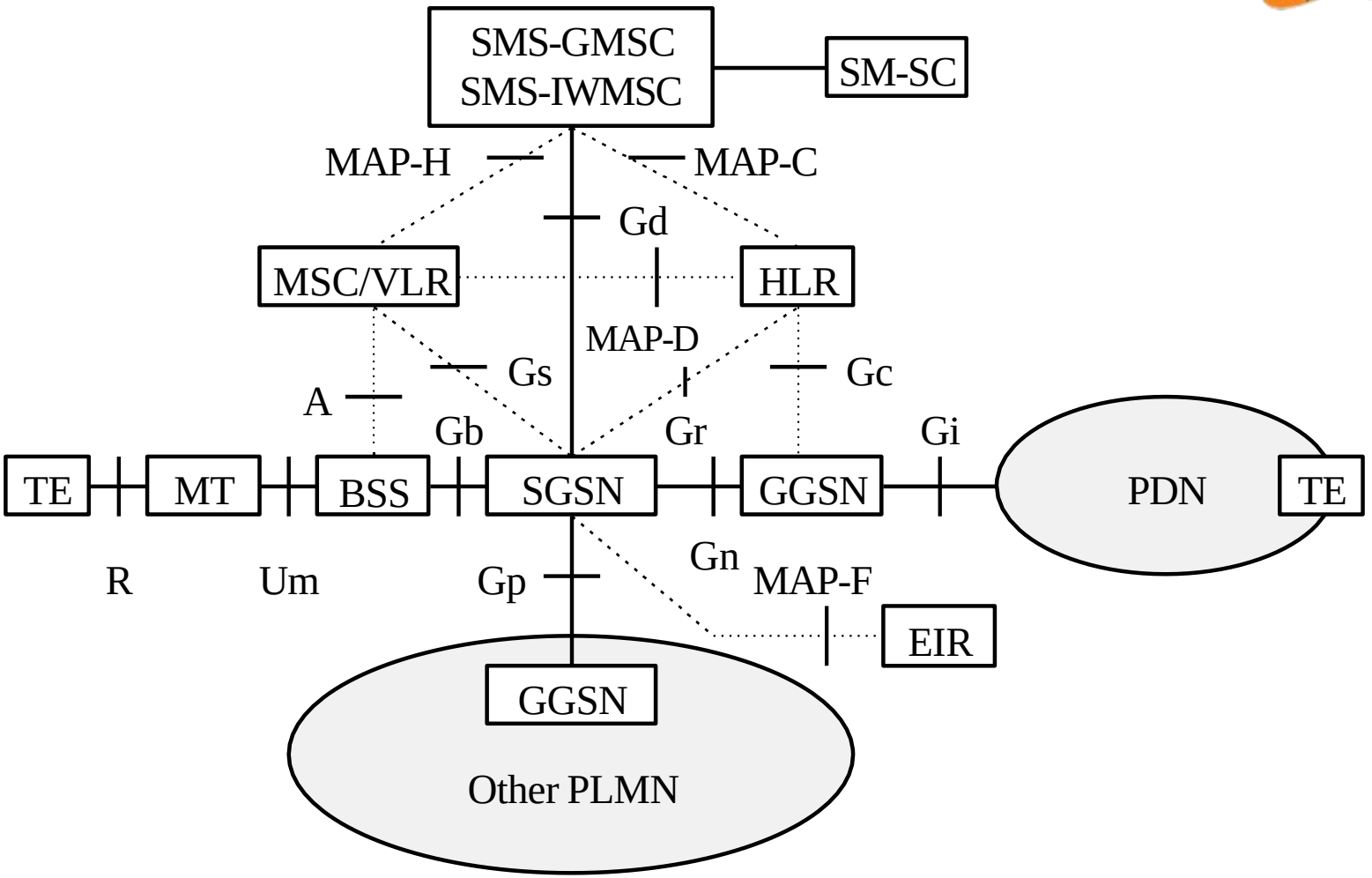
Traffic characteristics suitable for GPRS

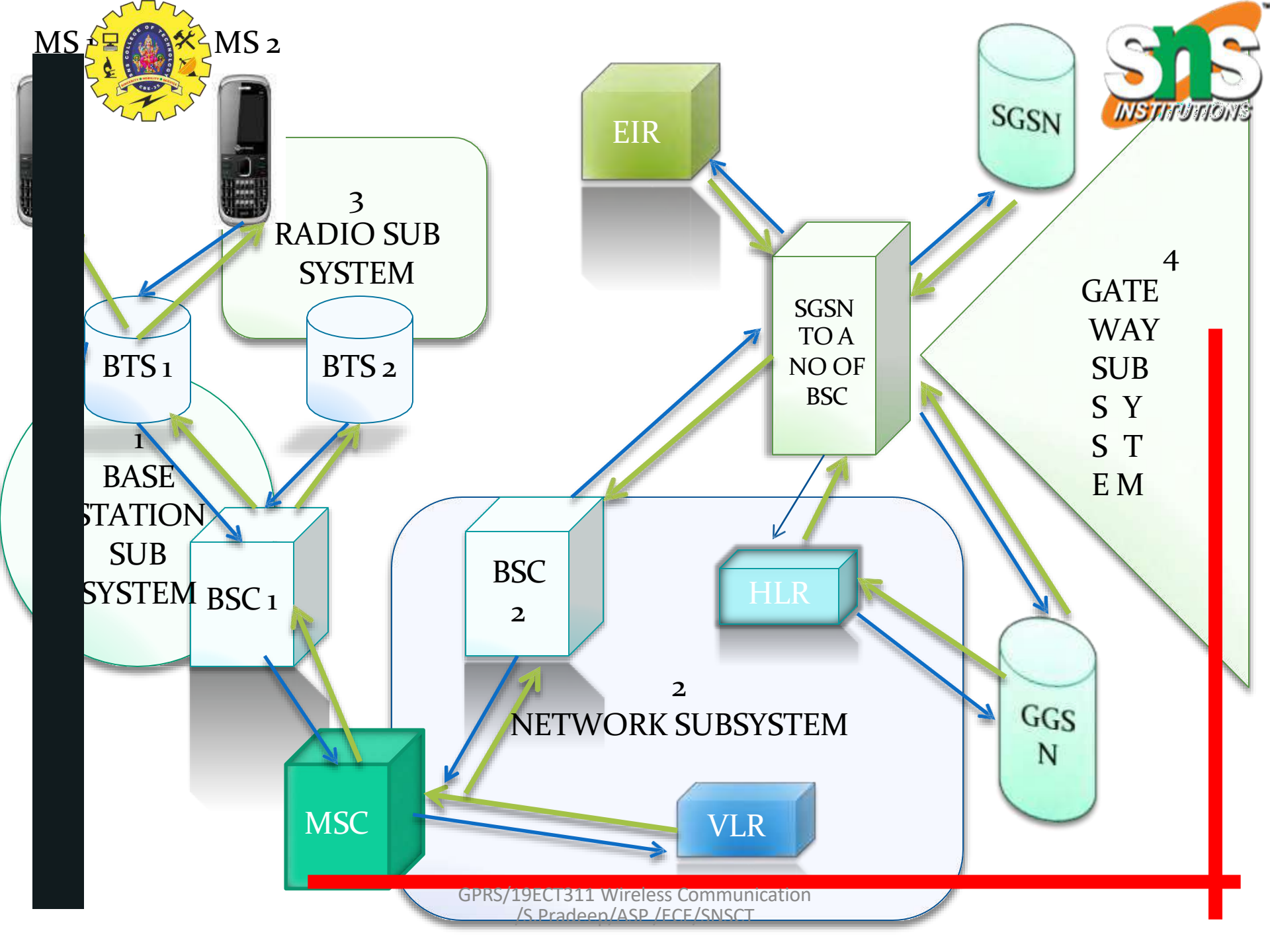
- Intermittent, bursty data transmissions
- Frequent transmissions of small volumes of data
- Infrequent transmission of larger volumes of data

Applications

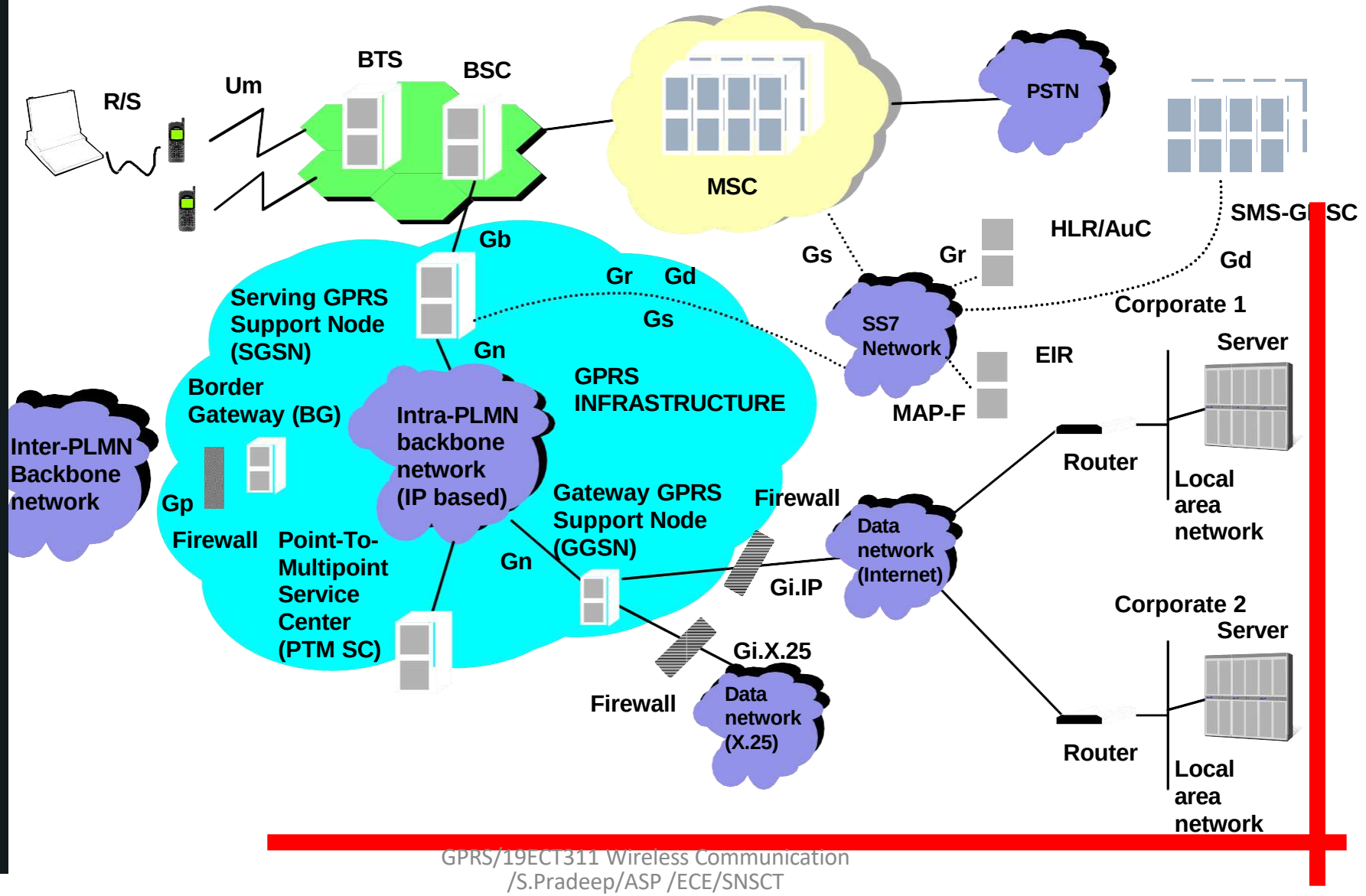
- Standard data network protocol based
  - IP based applications
    - WWW, FTP, Telnet, ...
    - Any conventional TCP/IP based applications
  - X.25 based applications
    - Packet Assembly/Disassembly (PAD) type approach
- GPRS specific protocol based
  - Point-to-point applications
    - Toll road system, UIC train control system
  - Point-to-multipoint applications
    - Weather info, road traffic info, news, fleet management
- SMS delivery (GPRS as a bearer for SMS)

GPRS Architecture




MS 1
MS 2
3
RADIO SUB
SYSTEM
EIR
SGSN
SGSN
TO A
NO OF
BSC
4
GATE
WAY
SUB
S Y
S T
E M
BTS 1
BTS 2
1
BASE
STATION
SUB
SYSTEM
BSC 1
BSC
2
HLR
2
NETWORK SUBSYSTEM
GGS
N
MSC
VLR

Functional view on GPRS



ssignment of functions to general logical architecture

unction	MS	BSS	SGSN	GGSN	HLR
etwork Access Control:					
egistration					X
uthentication and Authorisation	X		X		X
dmission Control	X	X	X		
lessage Screening				X	
acket Terminal Adaptation	X				
harging Data Collection			X	X	
acket Routeing & Transfer:					
elay	X	X	X	X	
outeing	X	X	X	X	
ddress Translation and Mapping	X		X	X	
ncapsulation	X		X	X	
unnelling			X	X	
ompression	X		X		
iphering	X		X		X
lobility Management:	X		X	X	X
ogical Link Management:					
ogical Link Establishment	X		X		
ogical Link Maintenance	X		X		
ogical Link Release	X		X		
adio Resource Management:					
m Management	X	X			
ell Selection	X	X			
m-Tranx	X	X			
ath Management		X	X		

GPRS support nodes

- There are two network nodes use to offer packet data service called GPRS support nodes
  1) Serving GPRS Support Node (SGSN)
  2) Gateway GPRS Support Node (GGSN)

rving GPRS Support Nod

SGSN

- Functionally connected with BSC, physically can be at MSC or BSC site
- One for few BSCs or one (or few) per every BSC
- One SGSN can support BSCs of several MSC sites

- Main functions
  - Authenticates GPRS mobiles
  - Handles mobile's registration in GPRS network
  - Handles mobile's mobility management
  - Relays MO and MT data traffic
    - TCP/IP header compression, V.42bis data compression, error control MS- SGSN (ARQ)
  - Collect charging information of air interface usage

Gateway GPRS Support Node

GGSN

- Typically located at one of the MSC sites
- One (or few) per operator
- Main functions
  - Interface to external data networks
  - Resembles to a data network router
  - Forwards end user data to right SGSN
  - Routes mobile originated packets to right destination
  - Filters end user traffic
  - Collects charging information for data network usage
  - Data packets are not sent to MS unless the user has activated the PDP address

Other elements

G (Border Gateway)

- (Not defined within GPRS)
- Routes packets from SGSN/GGSN of one operator to a SGSN/GGSN of an other operator
- Provides protection against intruders from external networks

NS (Domain Name Server)

- Translates addresses from ggsn1.oper1.fi -format to 123.45.67.89 format (i.e. as used in Internet)

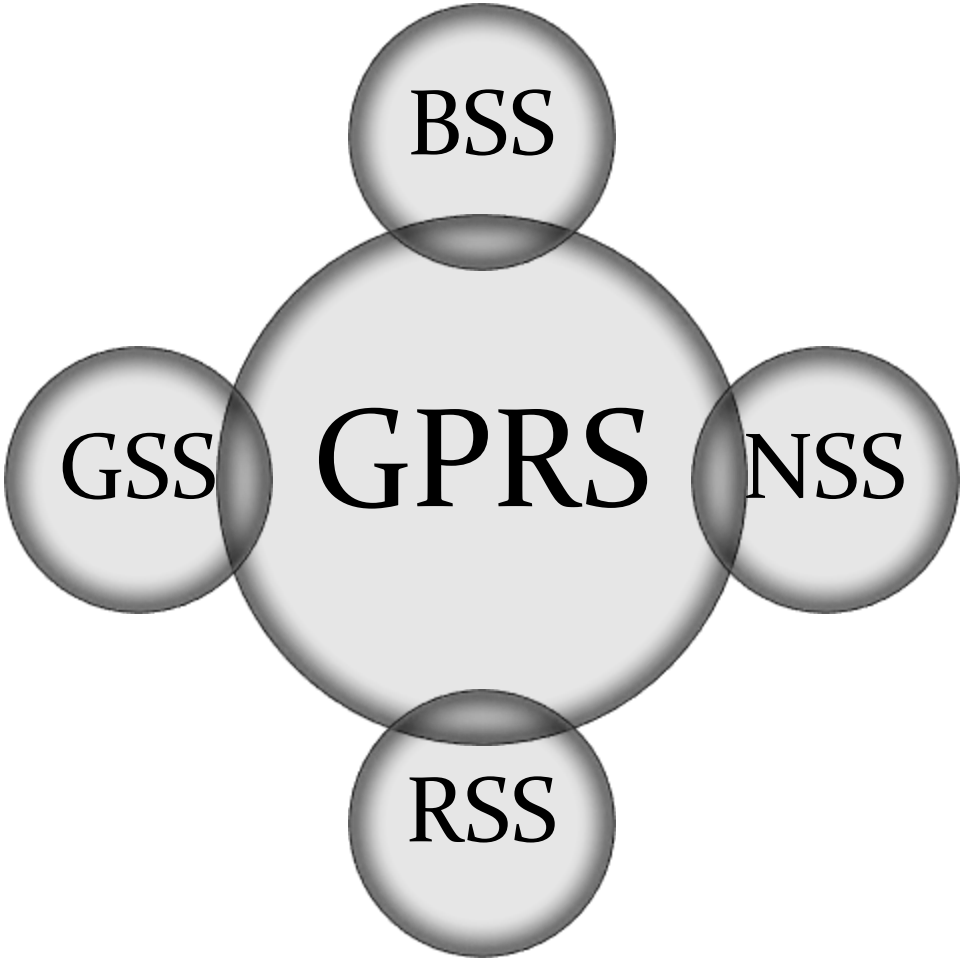
harging Gateway

- Collects charging information from SGSNs and GGSNs

TM-SC (Point to Multipoint -Service Center)

- PTM Multicast (PTM-M): Downlink broadcast; no subscription; no ciphering
- PTM Group call (PTM-G): Closed or open groups; Down/up -link; ciphered
- Geographical area limitation

HAVING 4 SUBSYSTEMS

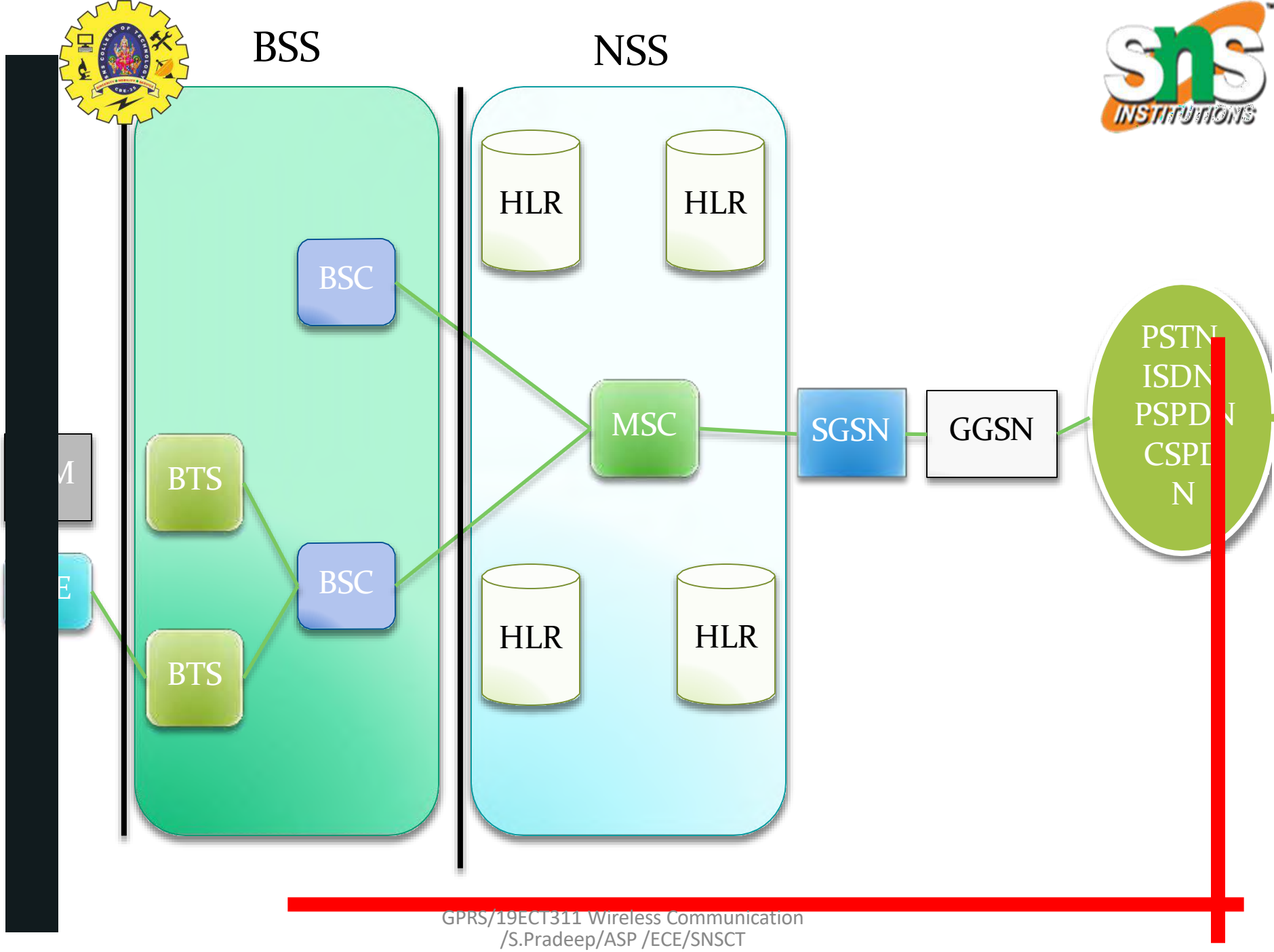


Base Station System(BSS)

- BSS system needs to enhancement to recognize and send packet data.
- BSS includes BTS and MS.

Network Subsystem(NSS)

- It consist of a number of sgsns
- Also consist of a number of msc
- helps in – authentication, operation & maintenance of subsystems


BSS
NSS
HLR
HLR
BSC
MSC
SGSN
GGSN
PSTN
ISDN
PSPDN
CSPDN
BTS
BSC
BTS
HLR
HLR

RADIO STATION SUBSYSTEM

- Consist of a number of ms, bts & bsc's
- Ms having gprs capability
- Stores a cksn(cipher key sequence number – a logical entity)

GATEWAY SUBSYSTEM

- Consist of sgsn & ggsn
- Provide connections to other networks & pda
- Pda – public data network

GPRSother components

Home Location Register(HLR): registers user profile and responds to queries from GSNs .

Mobile Station(MS): it is the mobile phone or device

SMS Nodes: used for sms transmission via the SGSN

GPRS mobile types

Class A:

- Simultaneous GPRS and conventional GSM operation
- Supports simultaneous circuit switched and GPRS data transfer

Class B:

- Can be attached to both GPRS and conventional GSM services simultaneously
- Can listen circuit switched and GPRS pages (via GPRS)
- Supports either circuit switched calls or GPRS data transfer but not simultaneous communication

Class C:

- Alternatively attached in GPRS or conventional GSM
- No simultaneous operation
- 'GPRS only' mobiles also possible (e.g. for telemetric applications)

GPRS operations

- Security: Basic security rules
  - Authentication, key management, ciphering
- GPRS attach
- Data transmission
  - MO, MT, MO+MT
- Mobility management
- Interworking with GSM services

Security: Based on GSM phase

Authentication

- SGSN uses same principle as MSC/VLR:
  - Get triplet, send RAND to MS, wait for SRES from MS, use Kc
- MS can't authenticate the network

Key management in MS

- Kc generated same way from RAND using Ki as in GSM

Ciphering

- Ciphering algorithm is optimized for GPRS traffic ('GPRS - A5')
- Ciphering is done between MS and SGSN

User confidentiality

- IMSI is only used if a temporary identity is not available
- Temporary identity (TLLI) is exchanged over ciphered link

GPRS Attach

GPRS Attach function is similar to IMSI attach

- Authenticate the mobile
- Generate the ciphering key
- Enable the ciphering
- Allocate temporary identity (TLLI)
- Copy subscriber profile from HLR to SGSN

After GPRS attach

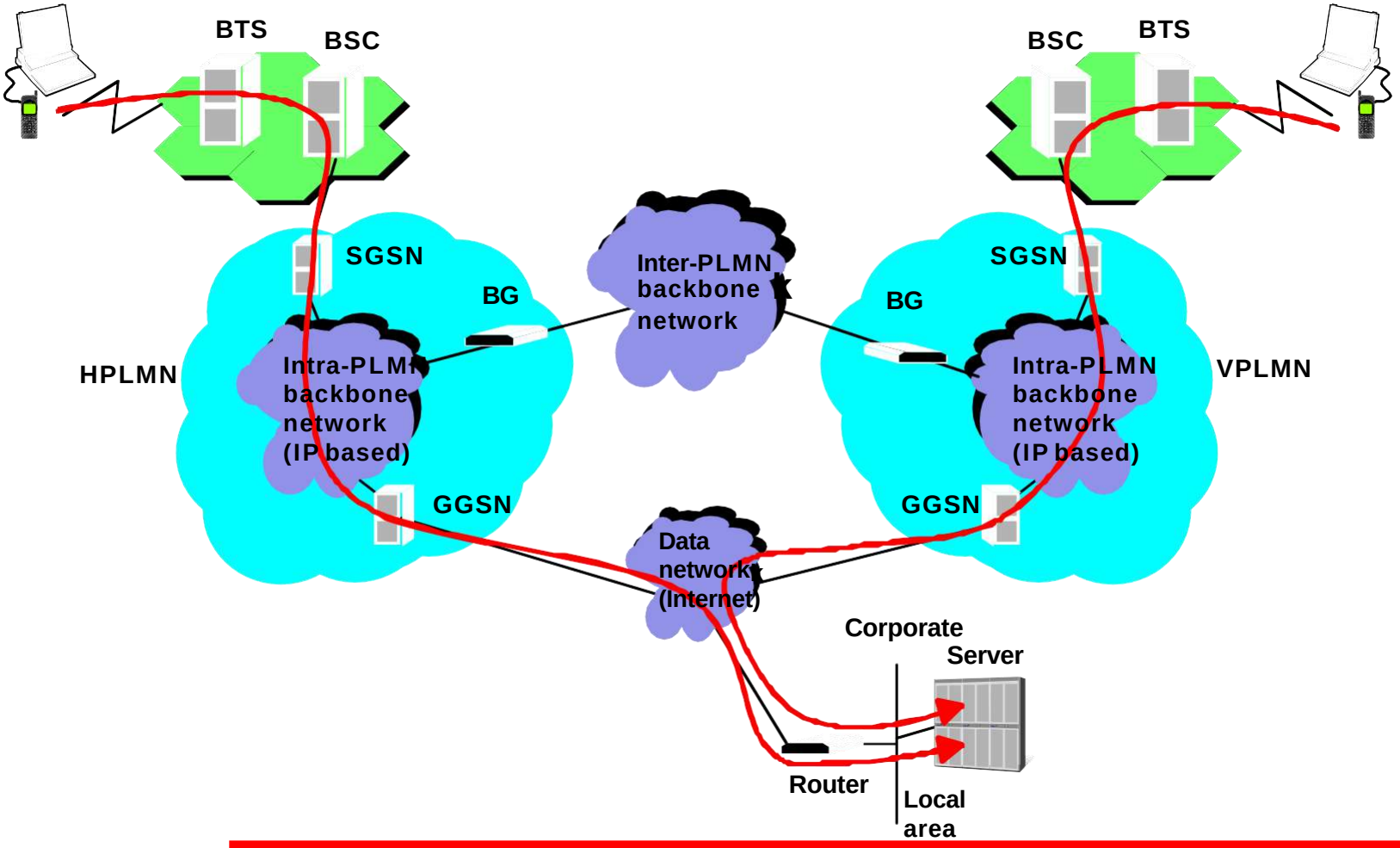
- The location of the mobile is tracked
- Communication between MS and SGSN is secured
- Charging information is collected
- SGSN knows what the subscriber is allowed to do
- HLR knows the location of the MS in accuracy of SGSN

Data transfer: Basic rules

- SGSN:
  - Does not interpret user data, except
    - SGSN may perform TCP/IP header compression
  - Does not interpret source or destination addresses
  - Sends all packets to specified GGSN that handles the PDP context
- GGSN:
  - Performs optional filtering
  - Decides where and how to route the packet

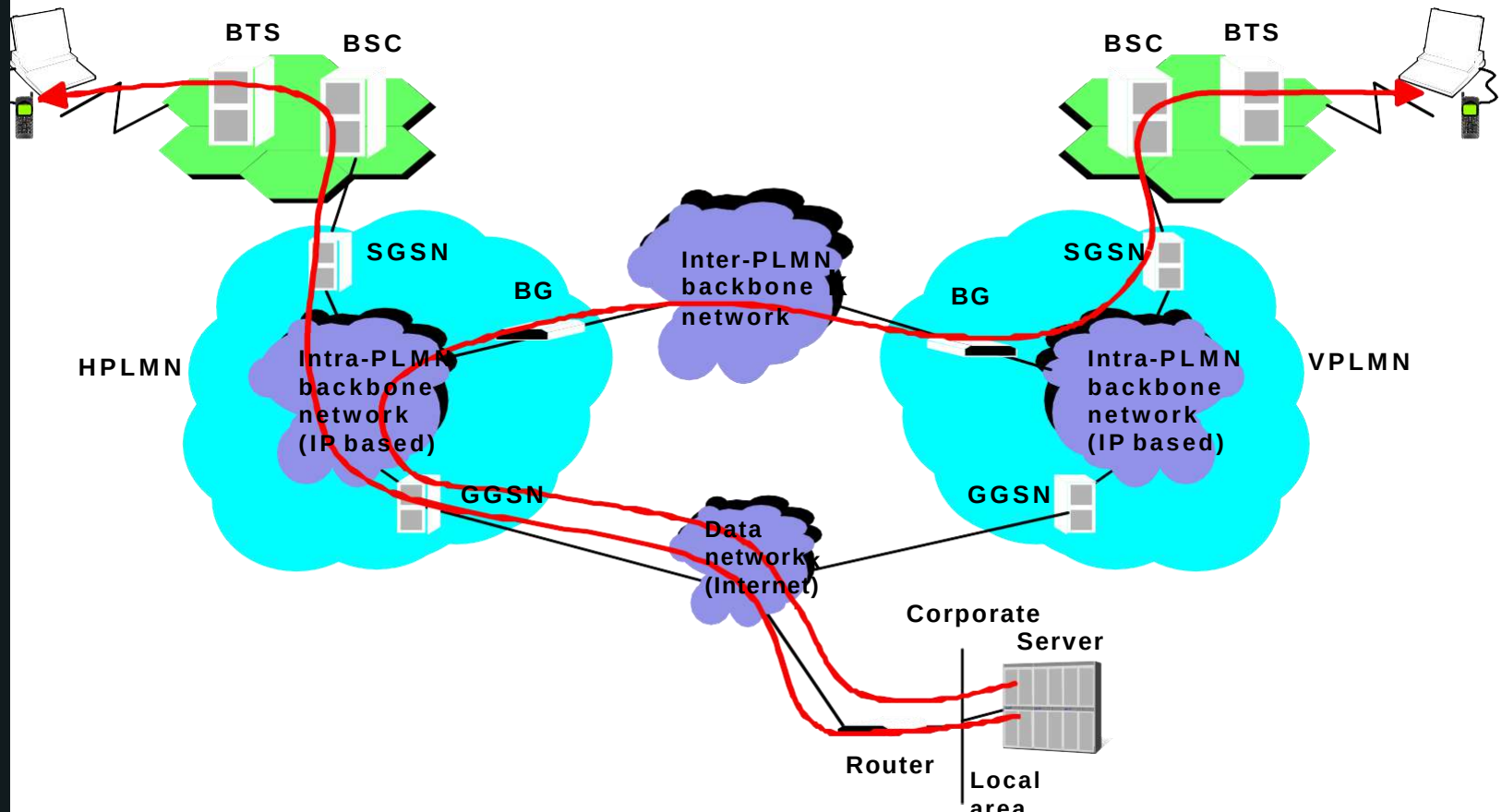
Data transfer

Mobile originated (left when MS in HPLMN, right when in VPLMN, no filtering/screening)



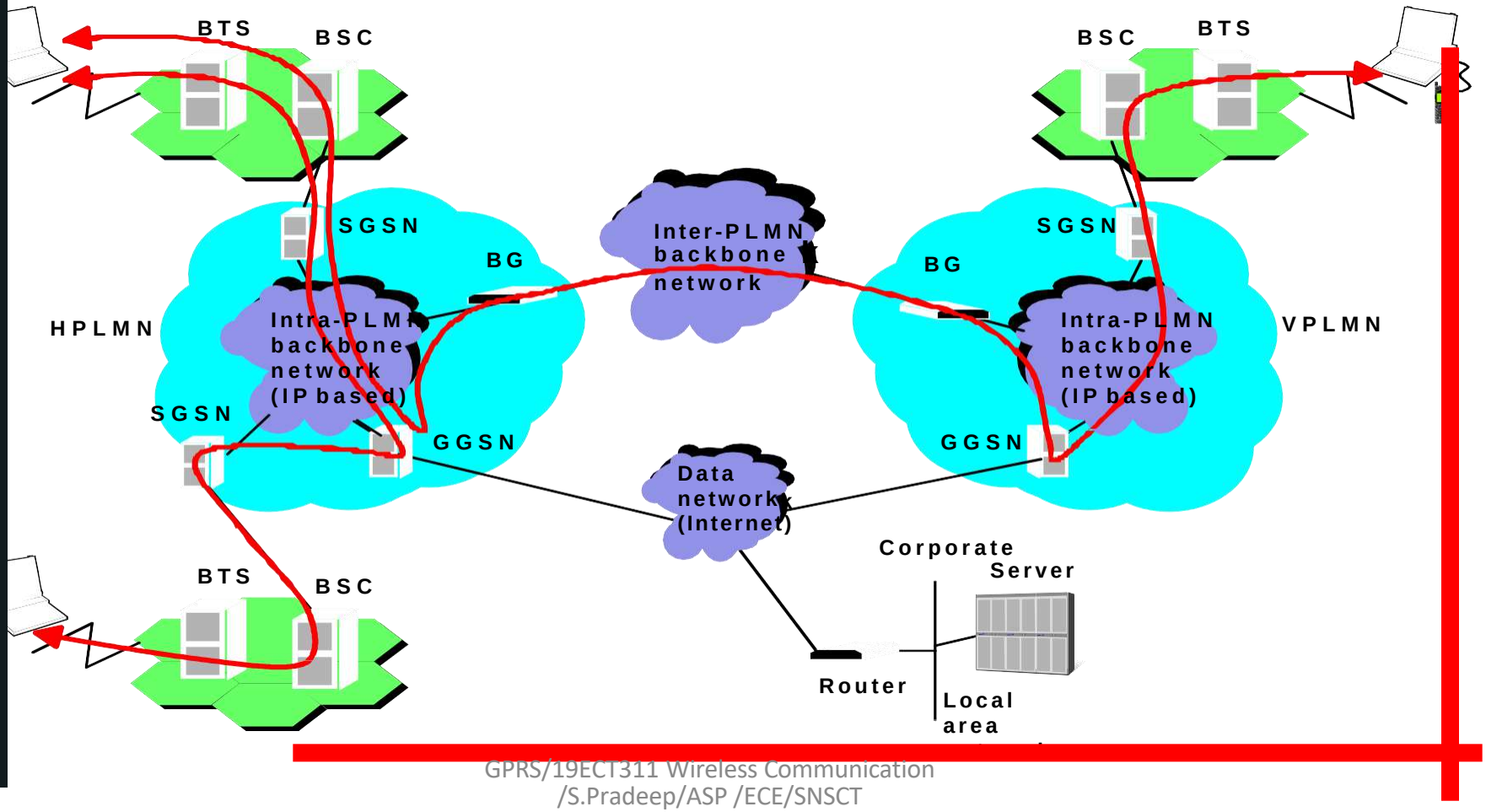
Data transfer

lobile terminated (left when MS in HPLMN, right when in VPLMN, with/without filtering/screening)



Data transfer

lobile originated and terminated (left MSs in same PLMN, right MSs in different PLMN)



Mobility management

Instead of Location Area, GPRS uses Routing Areas to group cells. RA is a subset of LA.

- IDLE:
  - MS is not known by the network (SGSN)
- STANDBY:
  - MS's location is known in accuracy of Routing Area
  - MS can utilize DRX (to save battery)
  - MS must inform its location after every Routing Area change (no need to inform if MS changes from one cell to another within same Routing Area)
  - Before the network can perform MT data transfer MS must be paged within the Routing Area
  - MS may initiate MO data transfer at any time

Mobility management

- READY:
  - MS's location is known in accuracy of cell
  - MS must inform its location after every cell change
  - MS can initiate MO data transfer at any time
  - SGSN does not need to page the MS before MT data transfer
  - MS listens continuously GPRS PCCCH channel
  - DRX in READY state is optional

Mobility management

Mobility management messages:

- Cell update (implicit, with any message)
  - When MS changes the cell within a Routing Area in READY state
- Routing Area update
  - When MS changes the cell between two Routing Areas in READY or STANDBY state
  - Two types of Routing Area Updates (from MS's point of view only one type)
    - Intra-SGSN Routing Area Update
    - Inter-SGSN Routing Area Update
- Periodic Routing Area updates are applicable

rworking with GSM services

GPRS can interwork with GSM services through Gs-interface

If no Gs interface exists:

- Type of the location update procedure is indicated by the network in the response message to MS

Effects on different MS classes if Gs does not exist:

- A-class mobiles must use conventional GSM services via normal GSM channels
- B-class mobiles won't get simultaneous support from the network. Depending on MS design
  - MS can try listen both paging channels simultaneously by themselves
  - MS does IMSI detach and use only GPRS service
- No effect on C-class mobiles as simultaneous services are not supported

Interworking with GSM service

Combined GPRS and IMSI attach

- To save radio resources
- MS indicates its request for combined attach
- MS sends combined GPRS and IMSI attach to SGSN
- SGSN may authenticate the MS
- SGSN informs MSC/VLR about the new MS

Combined Location and Routing Area update

- To save radio resources
- MS indicates its request for combined update
- This is done when both Location Area and Routing Area changes at the same time
- Combined Location and Routing Area update is not done if MS has CS connection

erworking with GSM services

aging CS services via GPRS network

- MSC/VLR gets MT call or SMS
- In VLR, presence of SGSN address tells that the MS is in GPRS attached state
- MSC/VLR sends the paging request to SGSN address (not to BSC)
- SGSN checks the location of MS (identified by IMSI)
- SGSN pages the MS via GPRS channels indicating “CS page” status
- MS replies to the page using normal GSM channels

Special issues

- SMS
- Charging
- O&M
- Supplementary services

SMS support

MO and MT SMSs can be carried via GPRS network

HLR stores and returns two SS7 addresses to GMSC:

- SGSN address
- MSC/VLR address

Primary route:

- Via SGSN, if available

Secondary route:

- Via MSC/VLR, if available and primary failed

GPRS charging of PTP

SGSN gathers charging:

- usage of radio resources (packets, bits)
- usage of packet data protocols (time)
- usage of general GPRS resources
  - e.g. signaling messages, GPRS backbone

GGSN gathers charging :

- based on destination/source of data packets
- usage of external data networks (packets, bits)
- usage of general GPRS resources

Operator selects what information is used for billing

GPRS charging of PTM

SGSN gathers usage of:

- usage of radio resources
  - amount of data
  - geographical areas
  - number of repetition
- usage of general GPRS resources

PTM Service Center gathers charging :

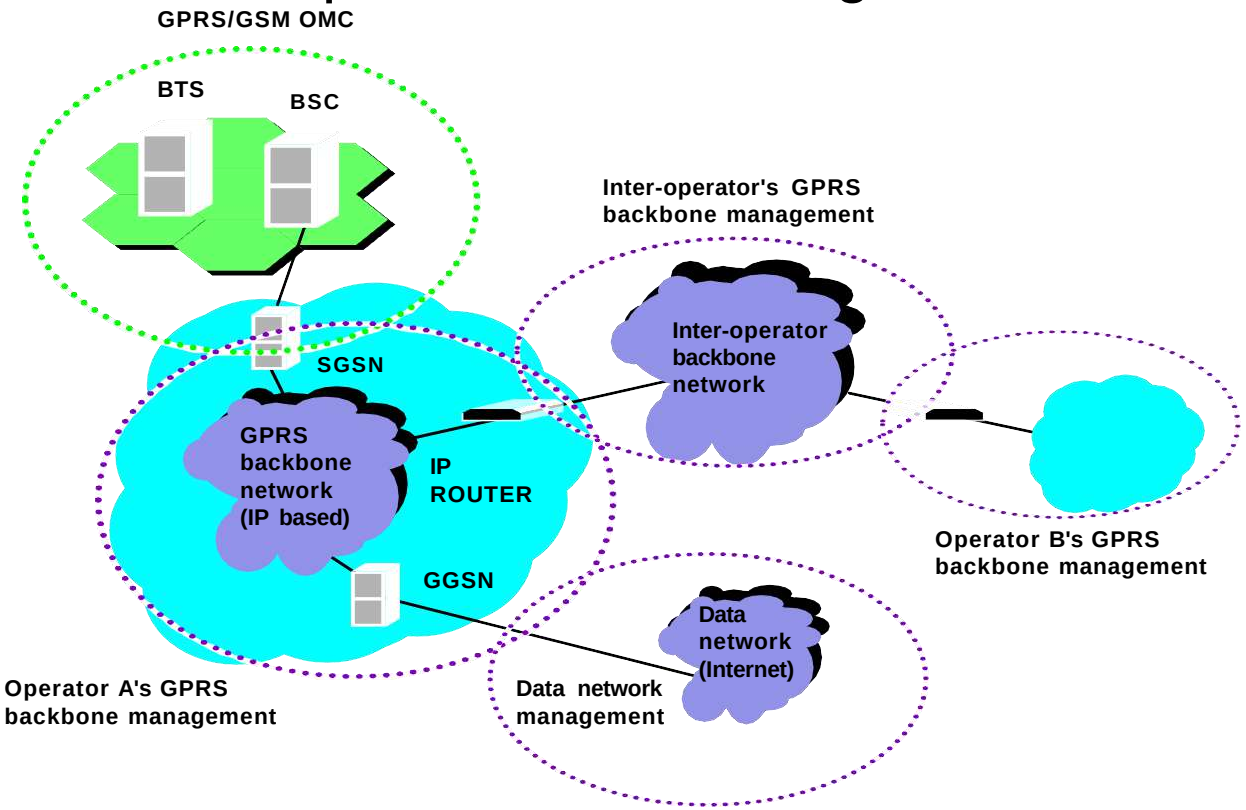
- usage of general GPRS resource
- usage of PTM-G groups

Operation and managemen

SM related parts can be handled with Q3

PRS backbone network is based on IP network

- IP network uses Simple Network Management Protocol (SNMP)



Supplementary services

Most of the conventional GSM supplementary services are not applicable for GPRS

- E.g., Call forwarding when busy, Calling line identification, Call waiting

Some supplementary services may be applicable

- Advice of charge (can be difficult to realize)
- Closed user group (can be implemented as part of external data network)

GPRS has its own supplementary services

- Barring of GPRS Interworking Profile(s)


QUIZ


THANK YOU