GPRS
General Packet Radio Service

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Generalities

- Based on the existing GSM infrastructure
- Packet switching functionality
  - Better data transfer rates
  - Statistical multiplexing
    - Traffic based billing
- Migration Path to 3G Networks

Service Types

- Point-to-Point
  - Internet access by user
- Point-to-Multipoint
  - Delivery of information (e.g. news) to multiple locations or interactive conference applications

Circuit Switched Data (CSD)

- Before GPRS
- A channel is allocated to user for duration of connection
- Inefficient use of resources
- Time-based billing
- Deterministic quality of service
  - Resources allocated to communication
  - Suitable to real-time applications

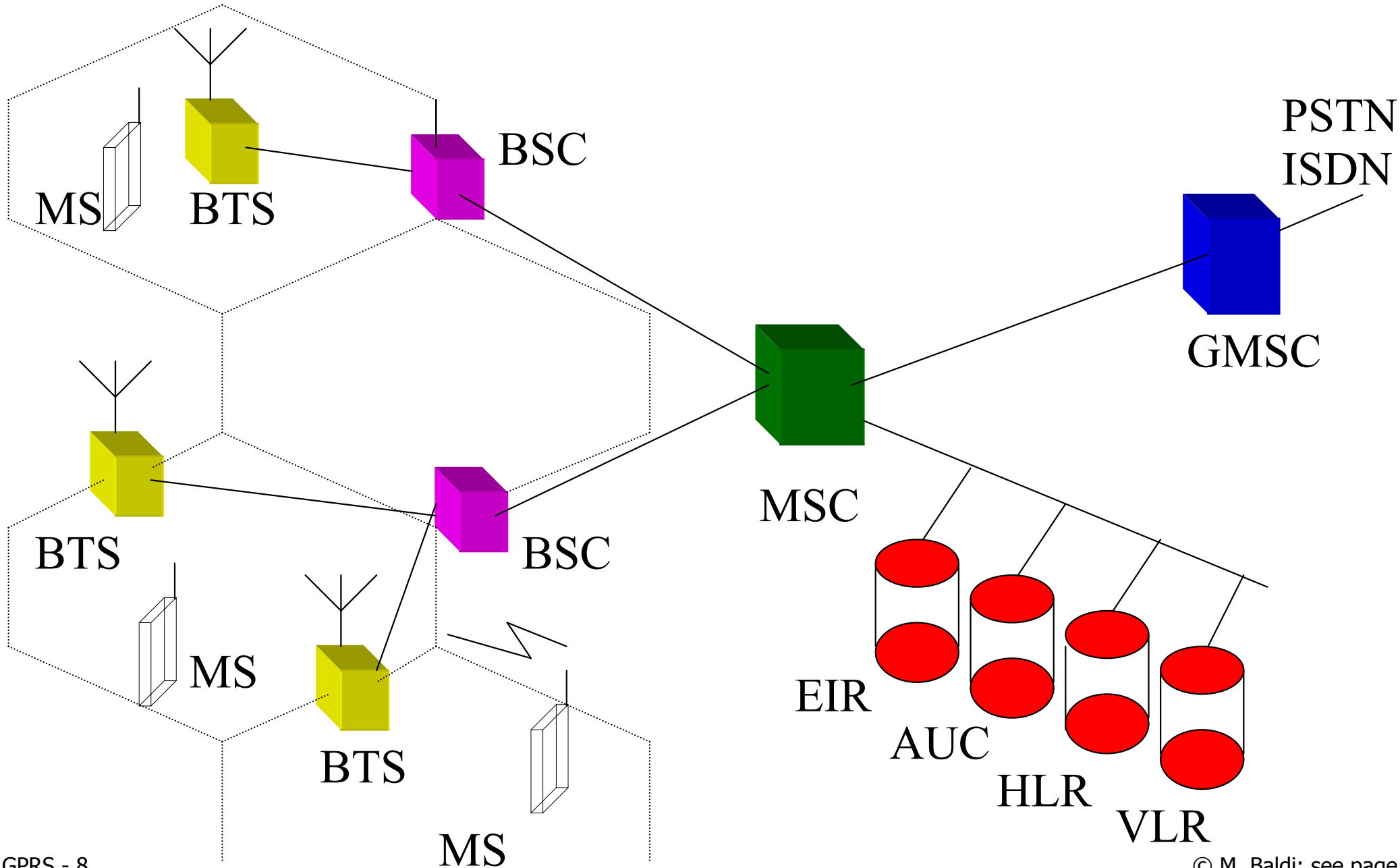
In GPRS

- Resources are allocated to user only for the time it takes to send each packet
- A channel may be shared by many users
- User pays by the packet
- Ideal for "data" traffic

Comparison

CSD	GPRS
Lower bit rates	Higher bit rates
14.4kbit/s	up to 170kbit/s
Reserved bandwidth	Shared bandwidth
Fixed access time	Variable access times
Time-based billing	Traffic based billing

GSM Network Architecture



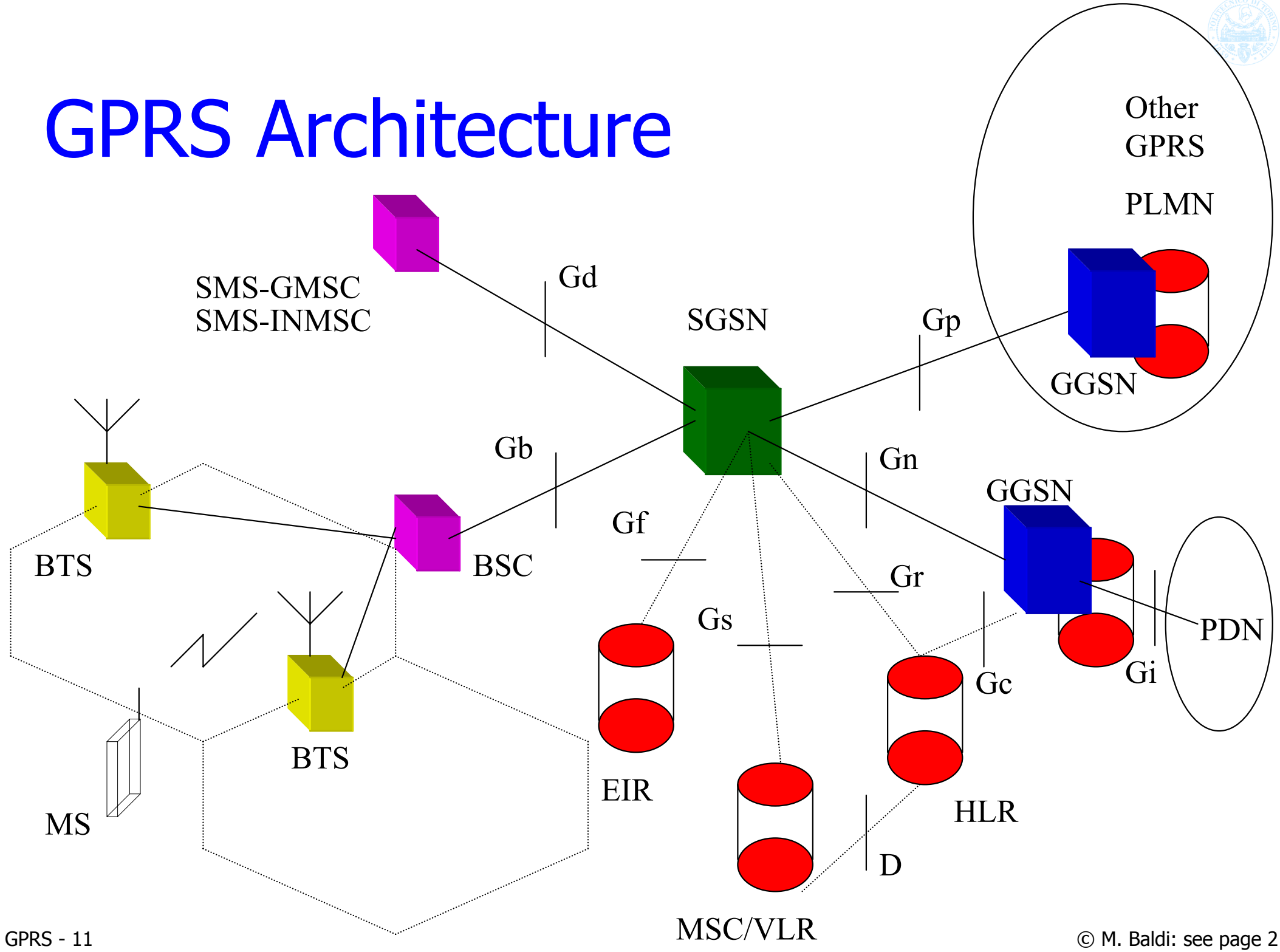
Acronyms

- MS: Mobile Station
- BSC: Base Station Controler
- BTS: Base Transciever Station
- MSC: Mobile Switching Controler
- GMSC: Gateway Mobile Switching Controler
- PSTN: Public Switched Telephone Network

Acronyms

- VLR: Visited Location Register
- EIR: Equipment Identity Register
- AUC: Authentication center
- HLR: Home Location Register
- PLMN: Public Land Mobile Network
  - E.g., GSM network
- PDN: Packet Data Network
  - E.g., IP network, Internet, intranet

GPRS Architecture



GPRS Architecture

- New components
  - SGSN: Serving GPRS Support Node
  - GGSN: Gateway GPRS Support Node
- Components needing upgrade
  - HLR
  - MSC/VLR
  - Mobile Station

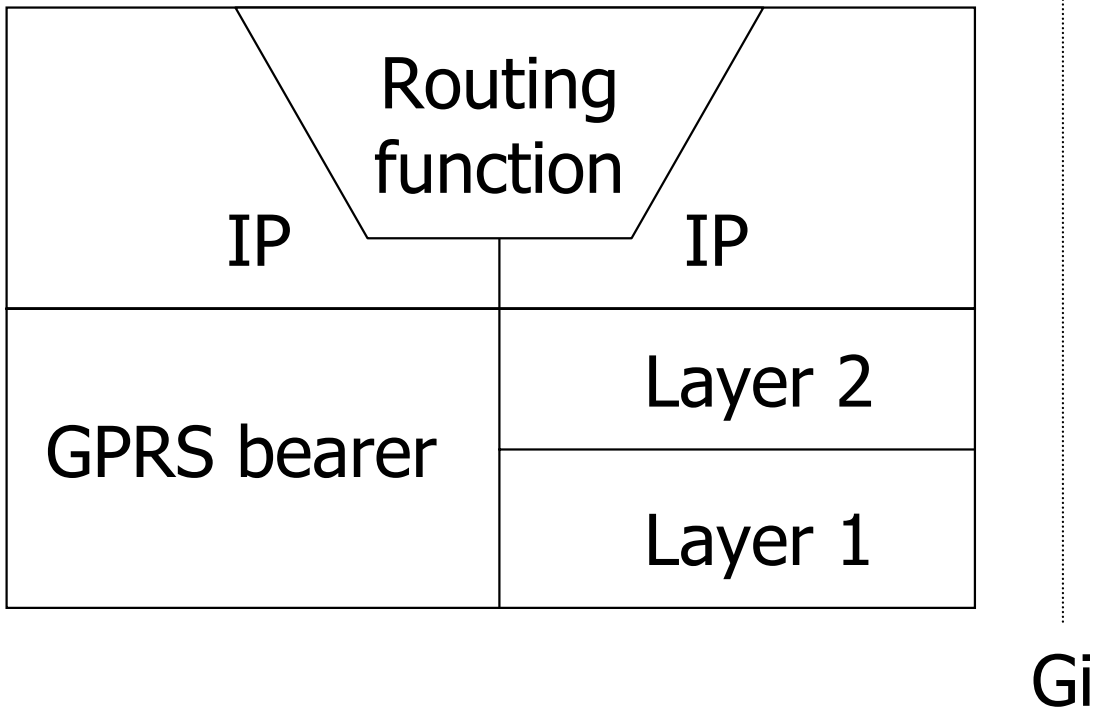
SGSN

- Delivers data packets from and to mobile stations
- Packet Routing and Transfer from MS to GGSN
- Mobility Management
- Logical Link Management
- Authentication
- Billing and maintaining user profiles

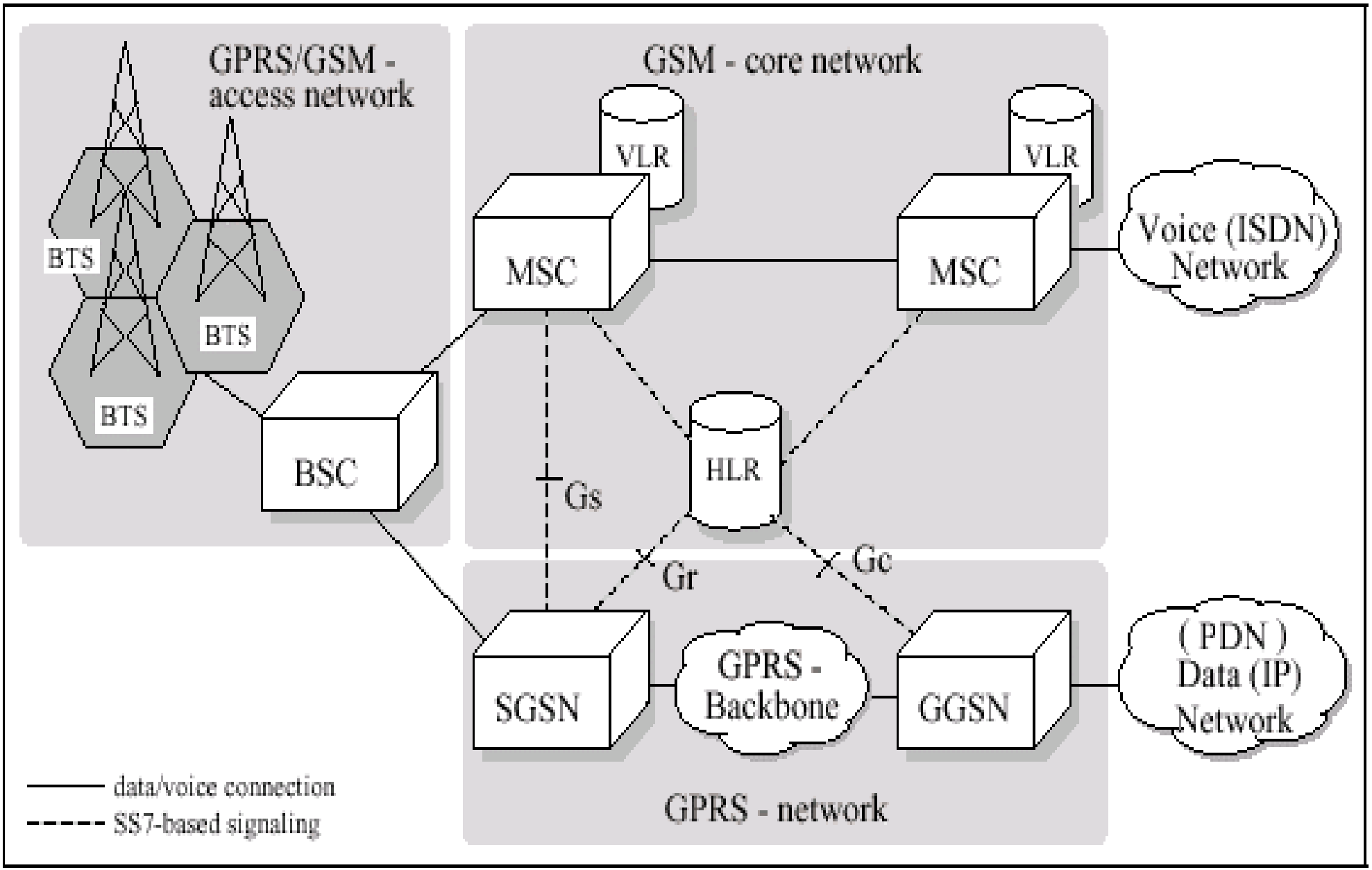
GGSN

- Interfaces GPRS backbone network with external packet data networks (PDNs)
  - E.g., IP networks, Internet
- Translation between PDP (packet data protocol) addresses and GSM addresses
- Authentication and billing
- Many-to- many relations among SGSNs and GGSNs

GGSN Protocol Architecture



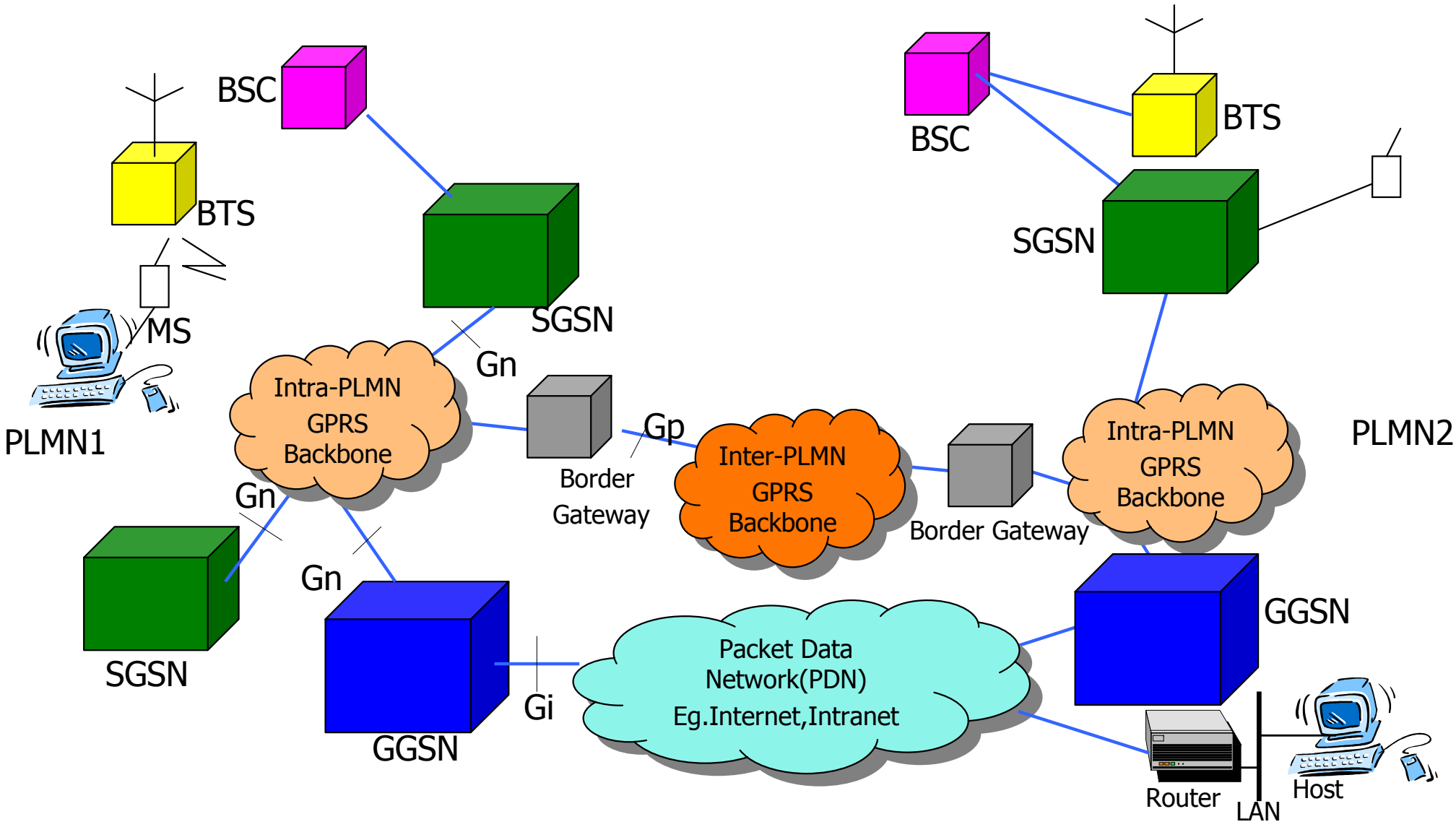
Integrated Architecture Overview



GPRS Backbone

- Based on the Internet Protocol (IP)
- Tunnels of data and signaling messages between GPRS support nodes (GSNs)
  - Intra-PLMN backbone network
  - Inter-PLMN backbone network
- Intra-PLMN backbone networks are connected by *Border Gateways* and an inter-PLMN backbone network

GPRS Backbone Overview



GTP

- GPRS Tunneling Protocol
- Tunnels user data and signaling on the GPRS backbone
- Encapsulates PDP (Packet Data Protocol) packets

Protocol Architechture

- Transmission Plane: GTP
- Signalling Plane
  - GTP tunnel control management protocol
  - Tunnel creation, modification, and deletion

Registration of a Mobile Node

A mobile station must register itself with GPRS network.

- GPRS attach
- GPRS detach
  - GPRS detach can be initiated by the MS or the network.

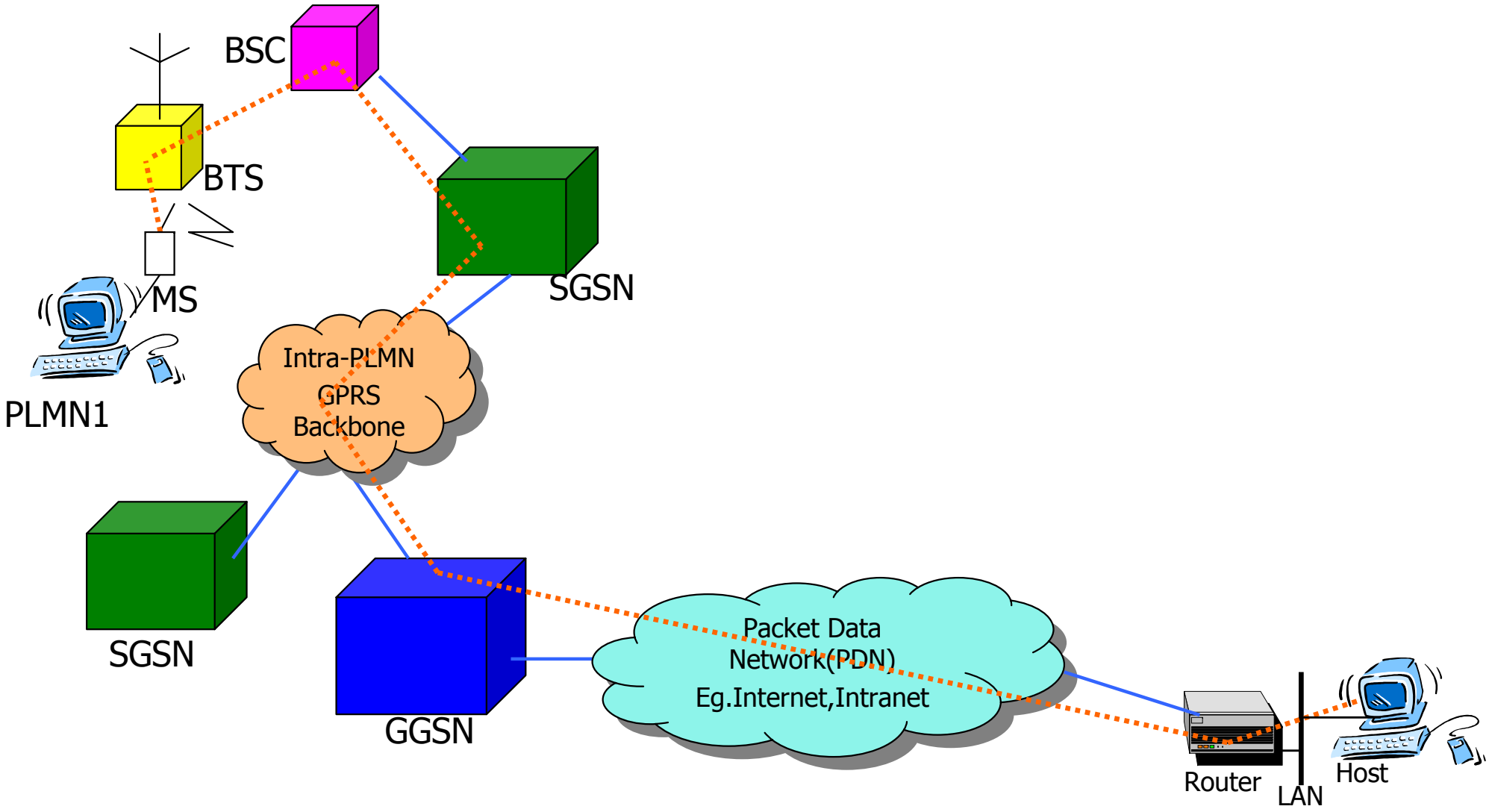
Session Management

- Successfully attached MS gets one or more Packet Data Protocol (PDP) address.
  - Unique only for a particular session.
- PDP address consists of
  - PDP type
  - PDP address assigned to MS
  - Requested quality of service
  - Address of the corresponding GGSN

PDP Address Assignment

- Static
  - Assigned by network operator
- Dynamic
  - Assigned by Corresponding GGSN.

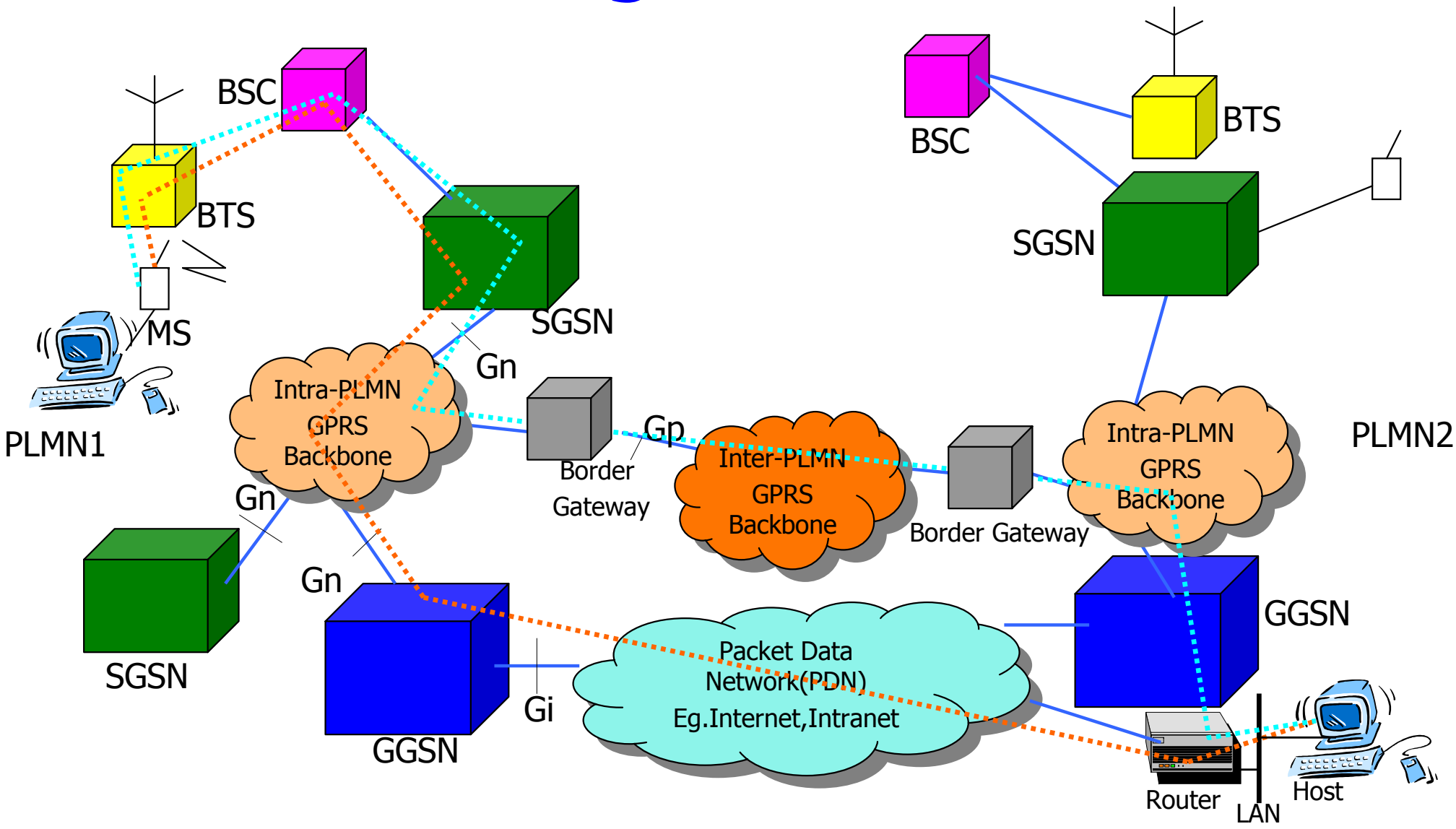
Packet Routing



Packet Transfer

- A laptop connects with a GPRS-capable handset
- The handset communicates with GSM BS
- BS sends the GPRS packets to SGSN
- SGSN encapsulates packets
- Handset location information is updated in GSM components (e.g., HLR)
- SGSN sends encapsulated packets to GGSN
- GGSN decapsulates and sends to PDNs

Packet Routing



Routing

- MS roaming in PLMN1 sends IP packet to host (e.g. Web server)
- Host sends reply packet to MS home PLMN2
  - PLMN2's GGSN queries HLR and finds that MS is in PLMN1
  - Packet is encapsulated and sent to SGSN in PLMN1
    - Packet travels over inter-PLMN backbone not through PDN
    - No encapsulation-decapsulation needed on GPRS backbones
  - SGSN decapsulates packet and delivers to MS

Radio Interface Protocols

- User plane and Control Plane
- Layer 1
  - Physical (PHY)
  - Combination of TDMA and FDMA
    - TDMA: Time Division Multiple Access
    - FDMA: Frequency Division Multiple Access

Radio Interface Protocols: Layer 2

- Data Link
- Media Access Control (MAC)
- Radio Link Control (RLC)
- Packet Data Convergence Protocol (PDCP)

Radio Interface Protocols: Layer 3

- Radio Resource Control (RRC)
  - Iu mode
- Radio Resource (RR)
  - A/Gb mode

Physical Layer

- Channel separation: 200 kHz
- Power output control
  - Find minimum acceptable level
- Synchronization with base station
- Handover
- Quality monitoring

Release 5 Protocol Architecture

- Physical Channels
- Logical, Control and Traffic Channels
- Media Access Control and Radio Link Control
- Radio Resource Control and Radio Resource

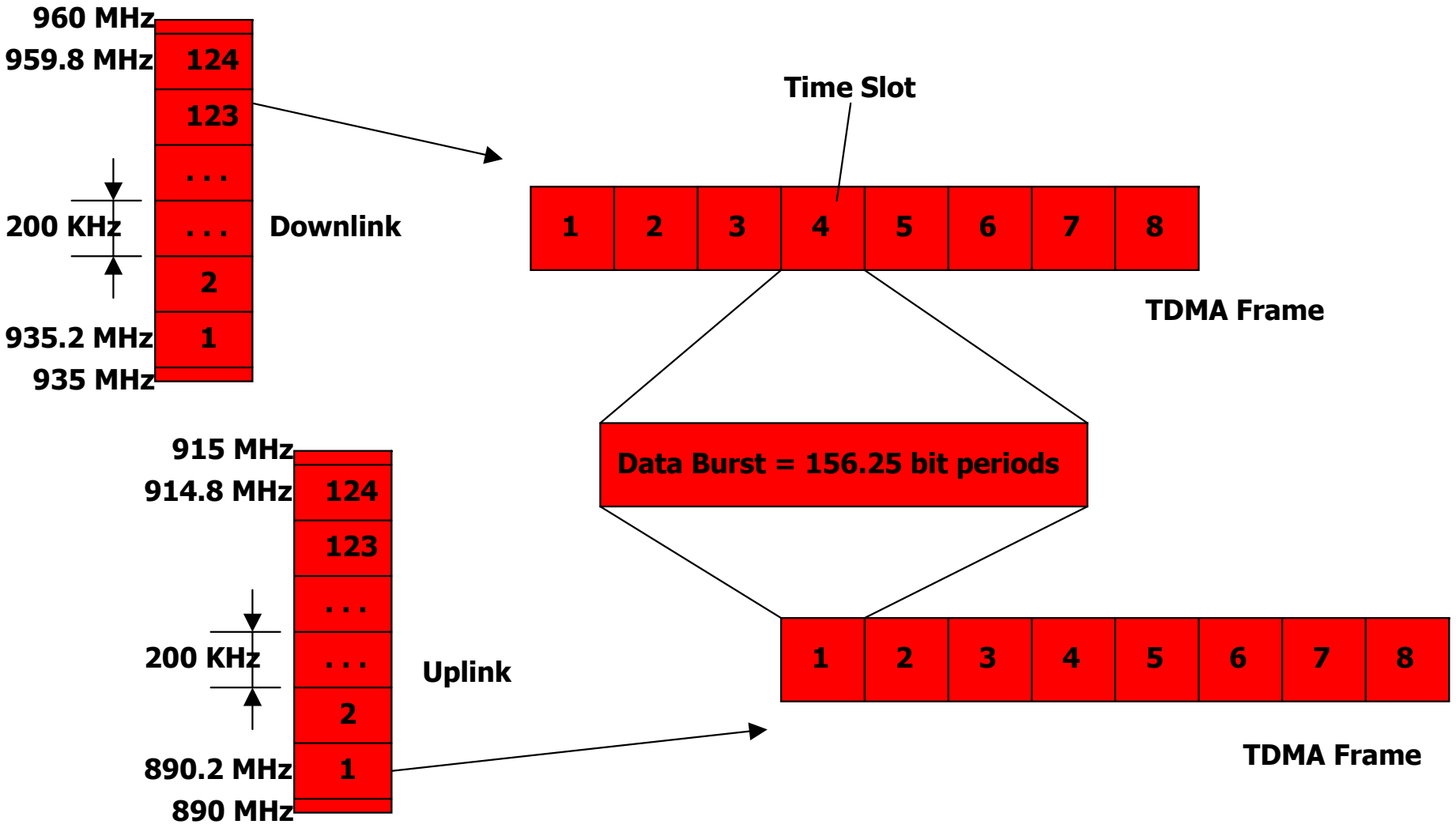
Physical Channels

- Defined by timeslot (0-7) and radio frequency channel
- Shared Basic Physical Sub Channel
  - Shared among several users (up to 8)
  - Uplink Stage Flag (USF) controls multiple access
- Dedicated Basic Physical Sub Channel
  - One user

Physical Channels

- Packet Data Channel (PDCH)
  - Dedicated to packet data traffic from logical channels
    - Control
    - User data

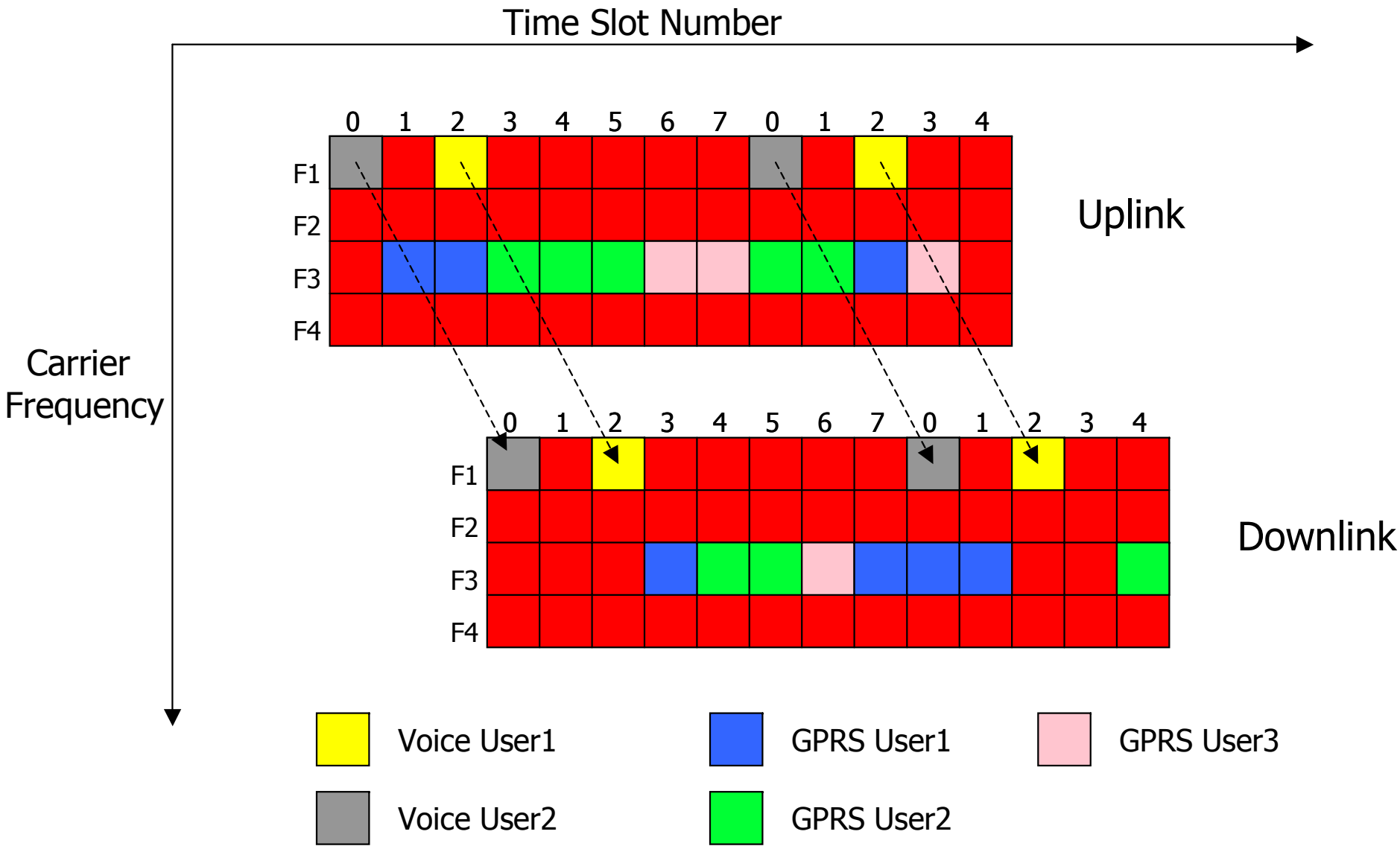
TDMA Frame Slots and Bursts



Multi Slot Operation

- GPRS allows a mobile to transmit data in up to 8 PDCHs
  - Eight-slot operation
- 3-bit USF at beginning of each radio block in downlink points to next uplink radio block
- Comparison with single-slot GSM
    - Higher delay at higher load
    - Low blocking rate
    - Improved Throughput

GPRS Air Inteface

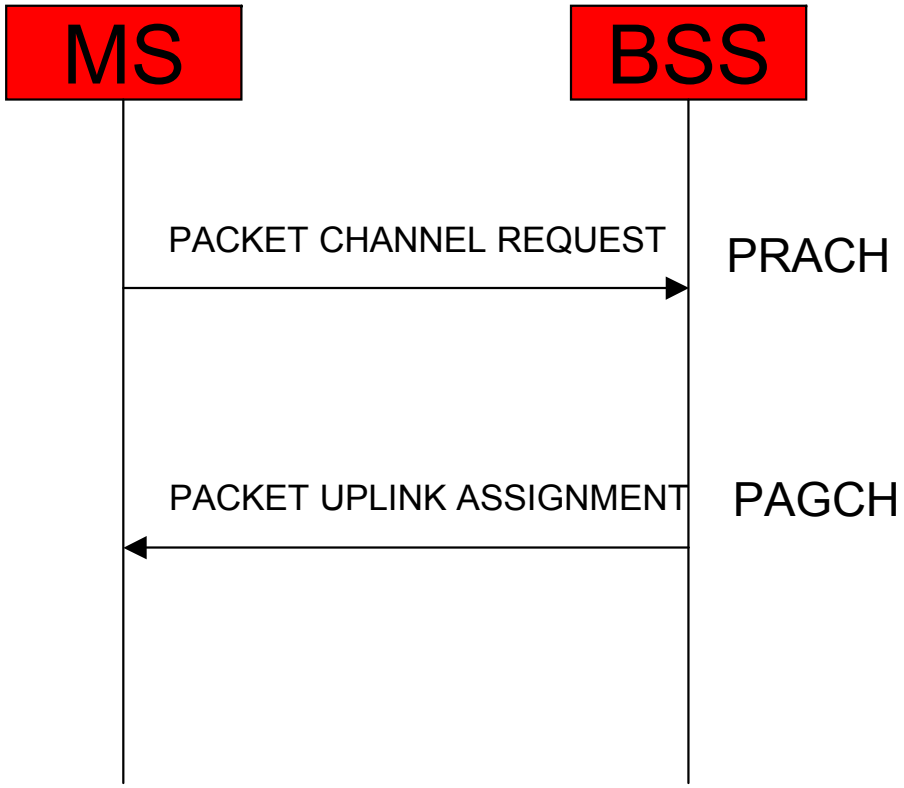


Media Access Control (MAC)

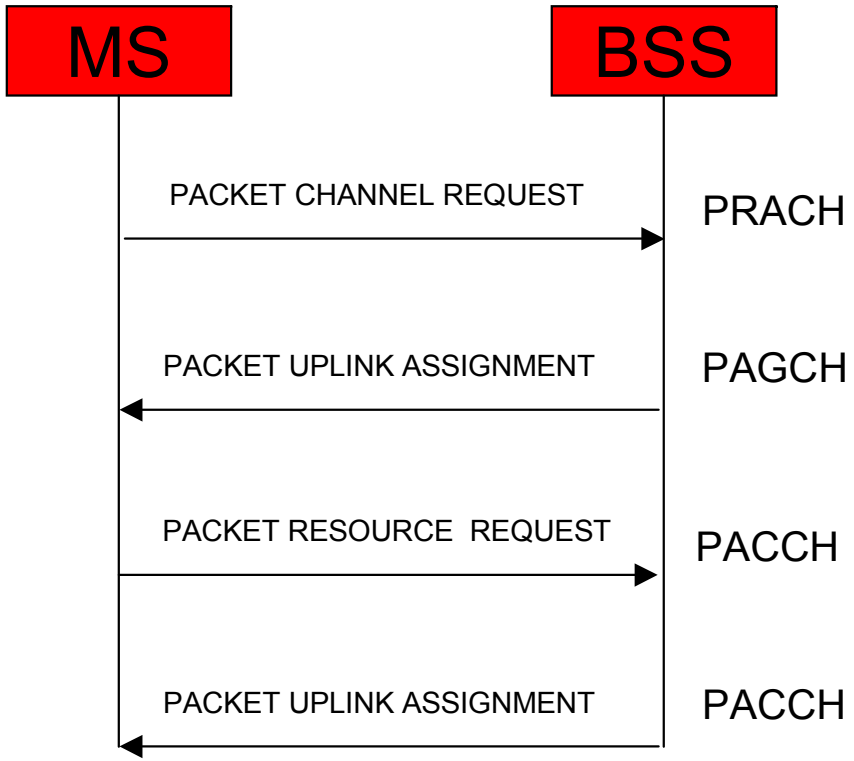
- Connection oriented
- Connections are called Temporary Block Flows (TBF)
  - Logical unidirectional connection between two MAC entities
  - Allocated resources on PDCH(s)
  - One PDCH can accomodate multiple TBFs
  - Temporary Flow Identity (TFI) is unique among concurrent TBFs in the same direction
  - Global_TFI to each station

MS Initiated TBF Establishment

- One Phase Access, or
- Two Phase Access

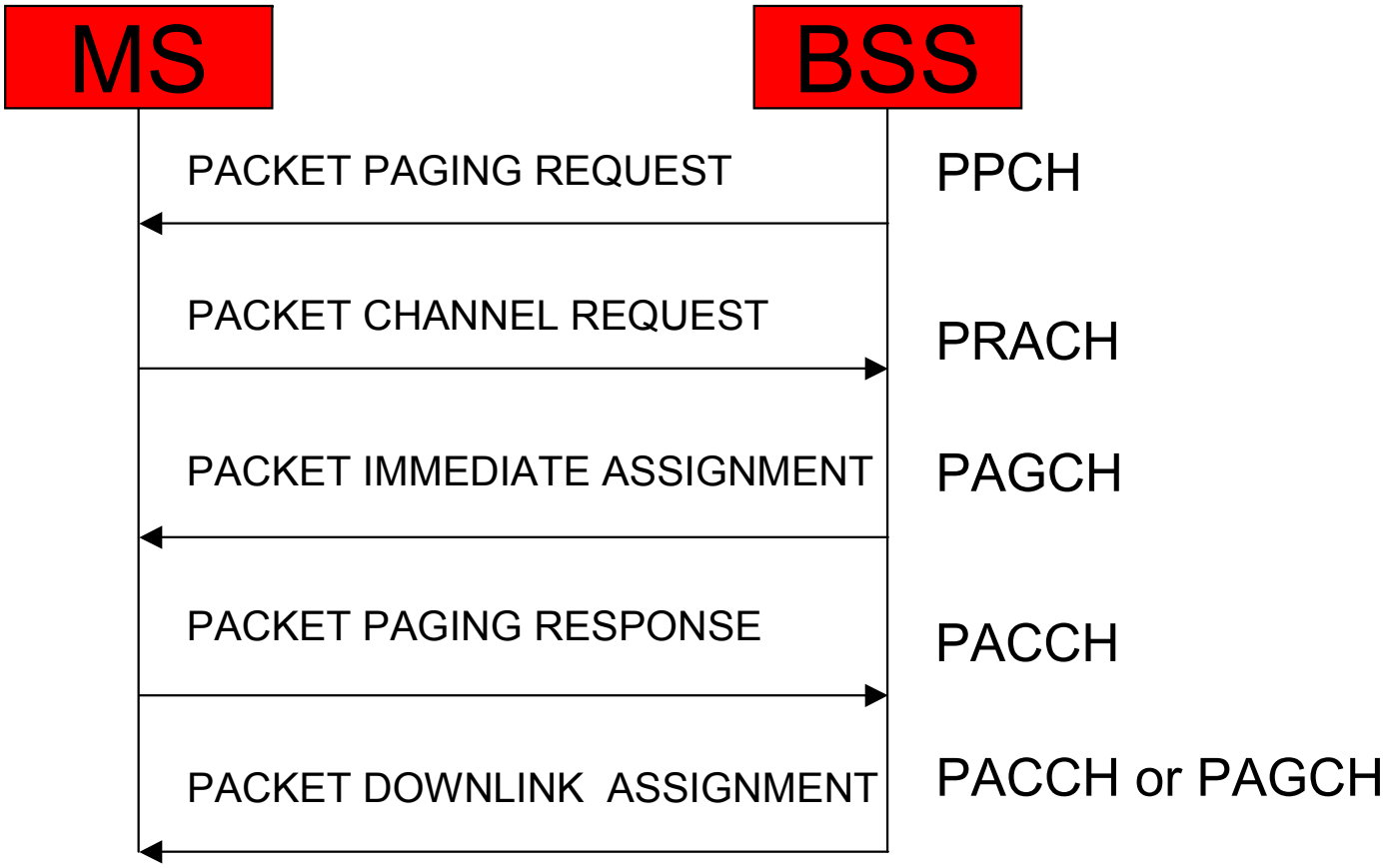


TBF Est. By MS: One Phase Access



TBF Est. By MS: Two Phase Access

Network Initiated TBF Establishm.



TBF Est. By Network

Channel Access & Resource Allocation

- Slotted Aloha
  - Used in PRACH (packet random access)
    - MSs send packets in uplink direction at the beginning of a slot
    - Collision: Back off -> timer (arbitrary) -> re-transmit
- Time Division Multiple Access (TDMA)
  - Predefined slots allocated by BSS
  - Contention-free channel access
  - All logical channels except PRACH

Quality of Service (QoS) Support

- Service Level Agreements to specify End-to-end QoS
- IP multimedia applications must be able to
  - Define their requirements
  - Negotiate their capabilities
  - Identify and select available media components
- GPRS signaling supports various traffic types
  - Constant/variable bit rate
  - Connection oriented/connection less
  - Etc.

QoS Profile for GPRS Bearers

- Describes QoS requirements
- 4 parameters:
  - Service precedence
    - 3 classes
  - Reliability
    - 3 classes
  - Delay
    - 4 classes
  - Throughput
    - Maximum and mean bit rates

QoS Profile for GPRS Bearers

- QoS profile is included in Packet Data Protocol (PDP) context
- Negotiation managed through PDP procedures
  - Activation
  - Modification
  - Deactivation

Packet Classification and Scheduling

- TBF tagged with TFI
- TFI different for each TBF
- Packet scheduling algorithms are not defined by the standard
  - Defined and implemented by GPRS network designers and carriers
- GPRS supports per-flow quantitative QoS with proper packet classification and scheduling algorithms (?)

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