Overview device mobile network

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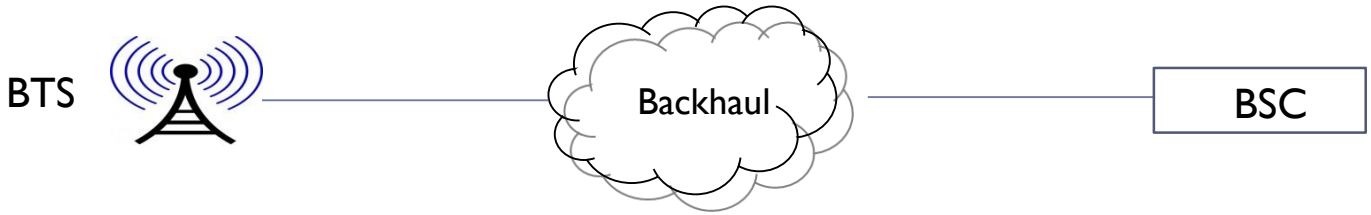
General concepts

TLC technologies and environments:

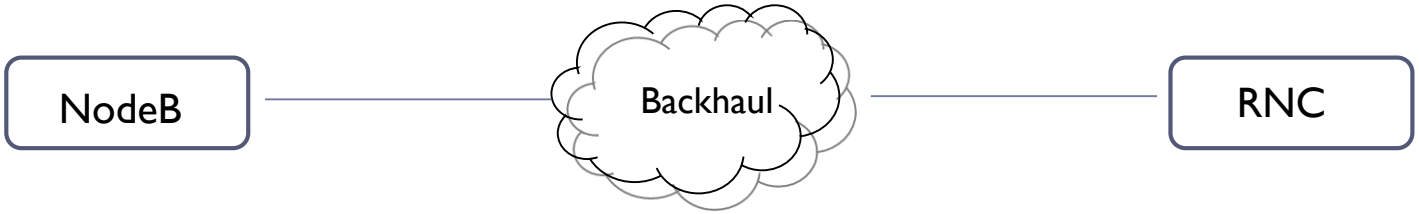
- RAN (Radio Access Network)
  - 2G GSM
  - 3G UMTS
  - 4G LTE
- Backhaul Network
  - BEP Tellabs routers + ADM Legacy
- IP MPLS VPN
  - CPN
  - External Environment
  - CHE Common Hosting Environment
  - HCE Hosting Centre Environment
  - SEE Smart Edge Environment
- CS
  - Circuits Switching (MSC, MSS)
- PS
  - Packets Switching (SGSN, GGSN, MME, SGW, PGW)

Overview RAN design

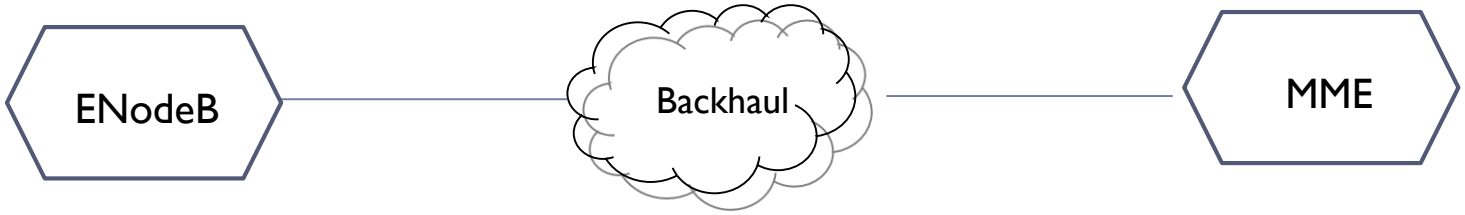
- **2G GSM**
  - ent-to-end BTS to BSC



- **3G UMTS**
  - end-to-end NodeB to RNC

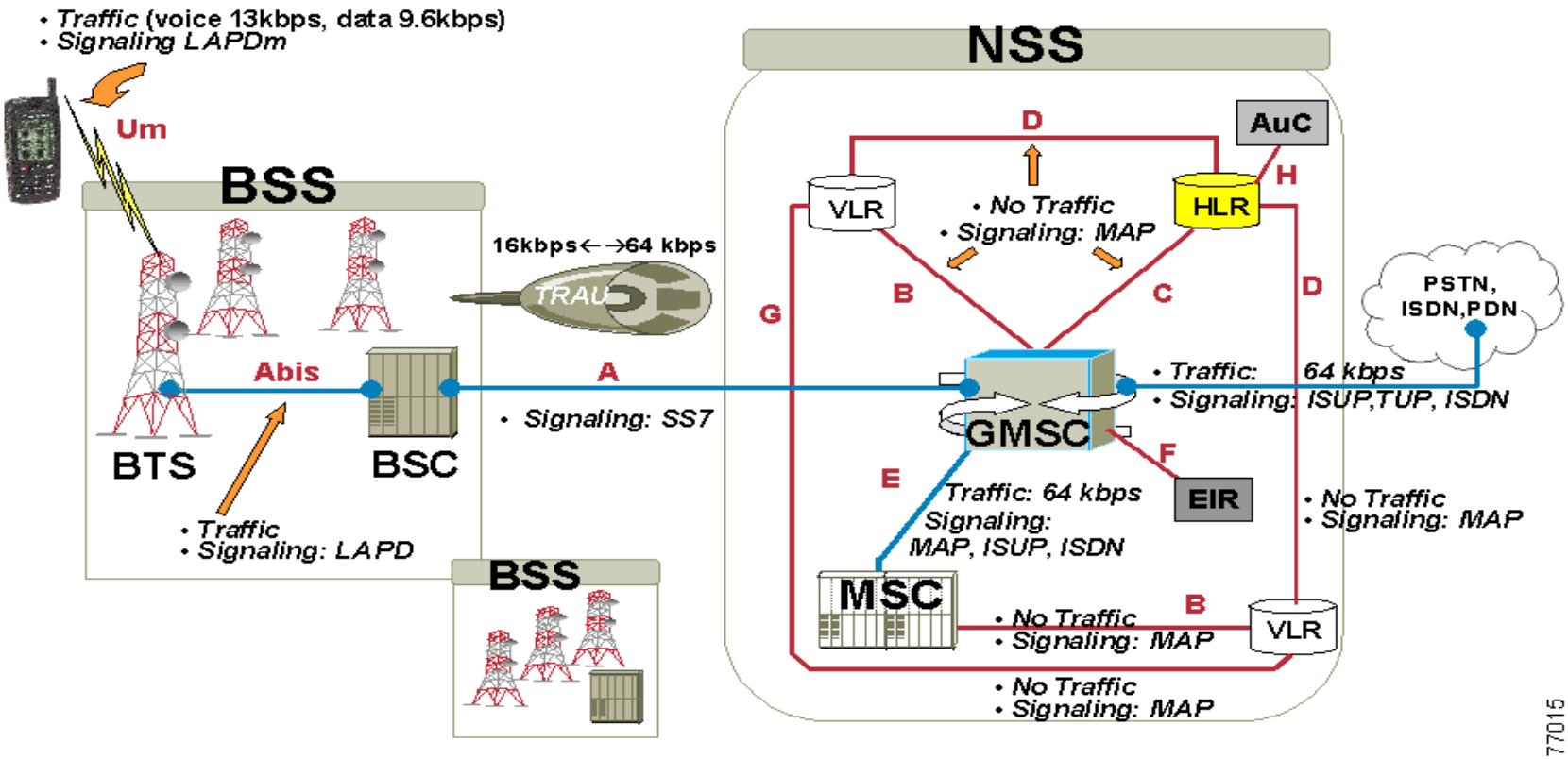


- **4G LTE**
  - end-to-end ENodeB to MME



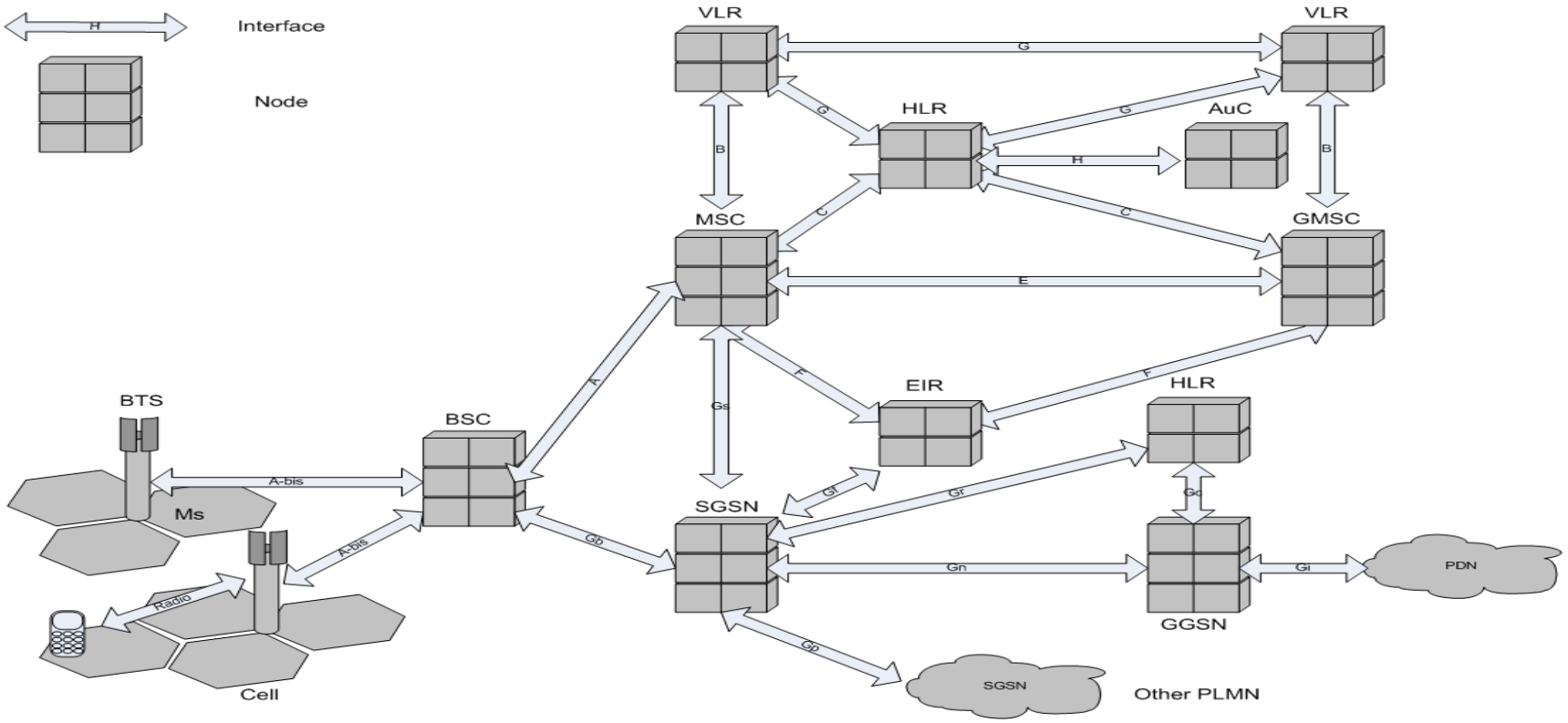
What is an BTS

- **Base Transceiver Station** encodes, encrypts, multiplexes, modulates and feeds the RF signals to the antenna, consists of Transceivers (TRX) units and communicate with BSC and MS (Mobile Station).
- **Um** is the interface between Mobile Station and BTS



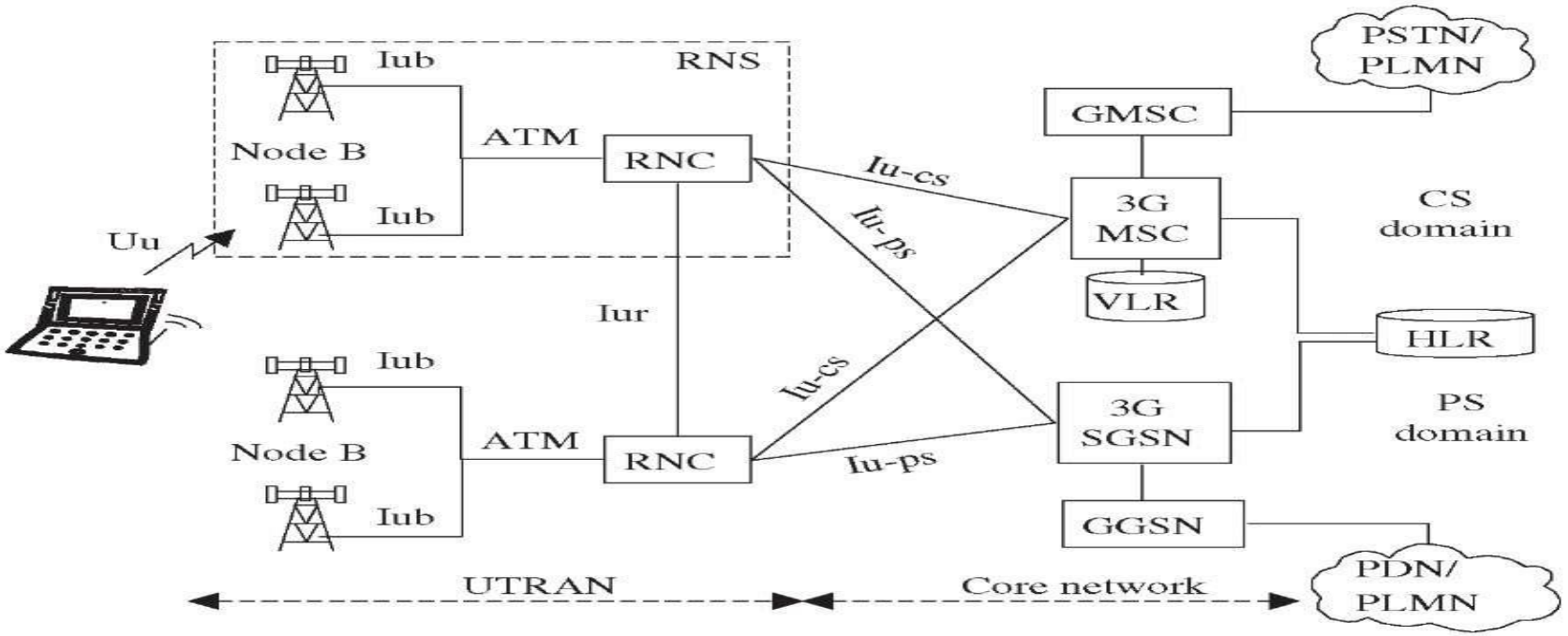
What is an BSC

- **Base Station Controller** manages radio resources for BTS, assigned frequency and TS (time slot) for MS (Mobile Station), handles call set up, has a transcoding and adaptation functionality, communicate with MSC and BTS.
- **A-bis** is the interface between BSC and BTS



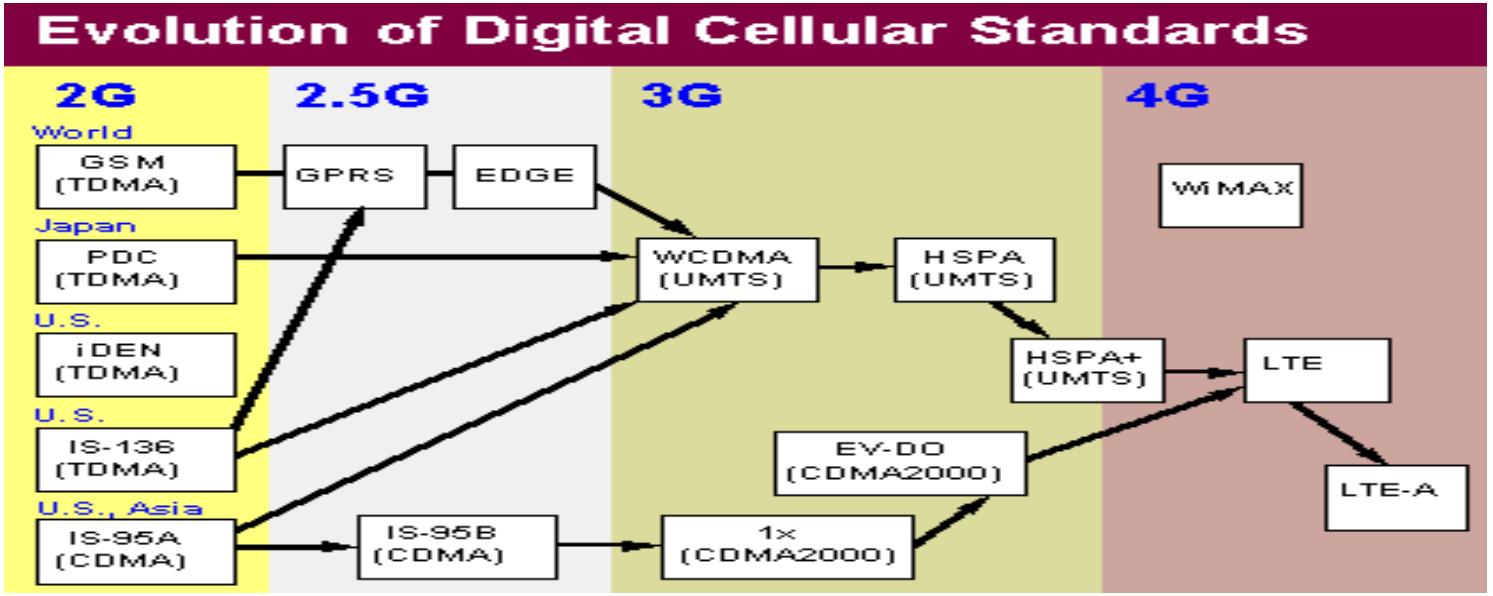
What is an NodeB

- **Node B** is a term used in UMTS equivalent to the BTS. It is the hardware that is connected to the mobile phone network that communicates directly with mobile handsets; in contrast with GSM base stations, Node B uses WCDMA/TD-SCDMA as the air interface technology. As in all cellular systems, such as UMTS and GSM, the Node B contains radio frequency transmitter(s) and the receiver(s) used to communicate directly with mobile devices, which move freely around it. In this type of cellular network, the mobile devices cannot communicate directly with each other but have to communicate with the Node B.
- **IuB** is the interface between RNC and NodeB



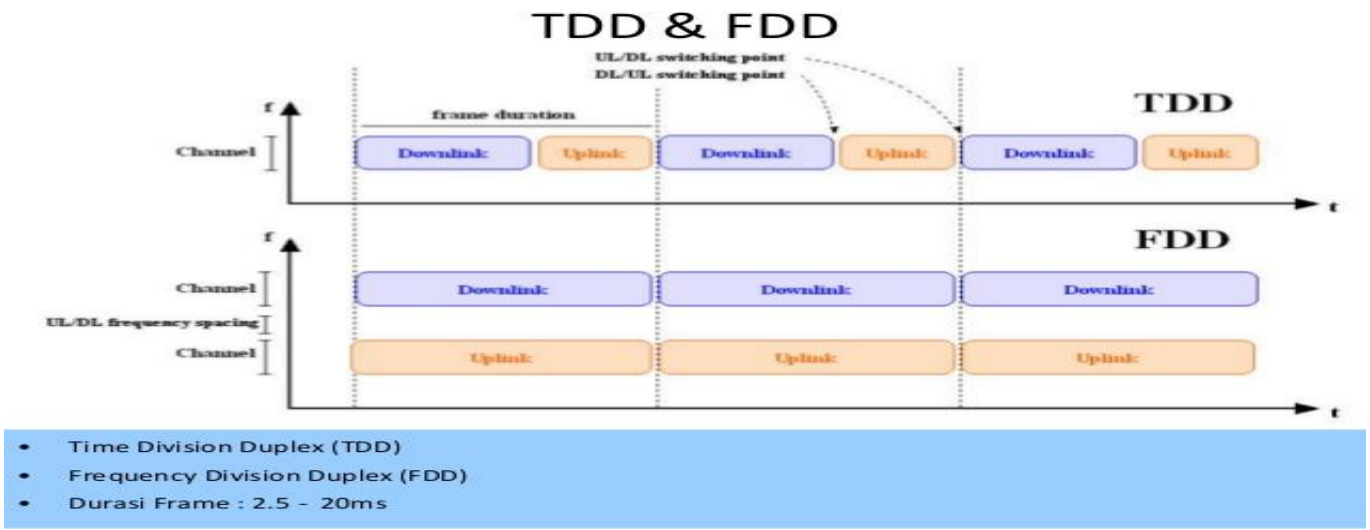
What is WCDMA

- **WCDMA** Wideband Code Division Multiple Access uses a technique called FDD, Frequency Division Duplex. The WCDMA standard is the air-interface of the UMTS system. This technique spreads the users signal over a wide bandwidth; in the old GSM system, every User Equipment (UE) had only 200 kHz of bandwidth, but in this system there exists a 5 MHz bandwidth. The signal is split using different codes for different users. This way multiple calls and/or connections can exist on the same frequency. This removes the need of doing frequency planning, as done in the old system, and you can have a frequency reuse factor of 1, that is you can utilize the same frequency in adjacent cells. The WCDMA technique also gives a higher data-rate, more handover choices, adaptive power control, and so on.



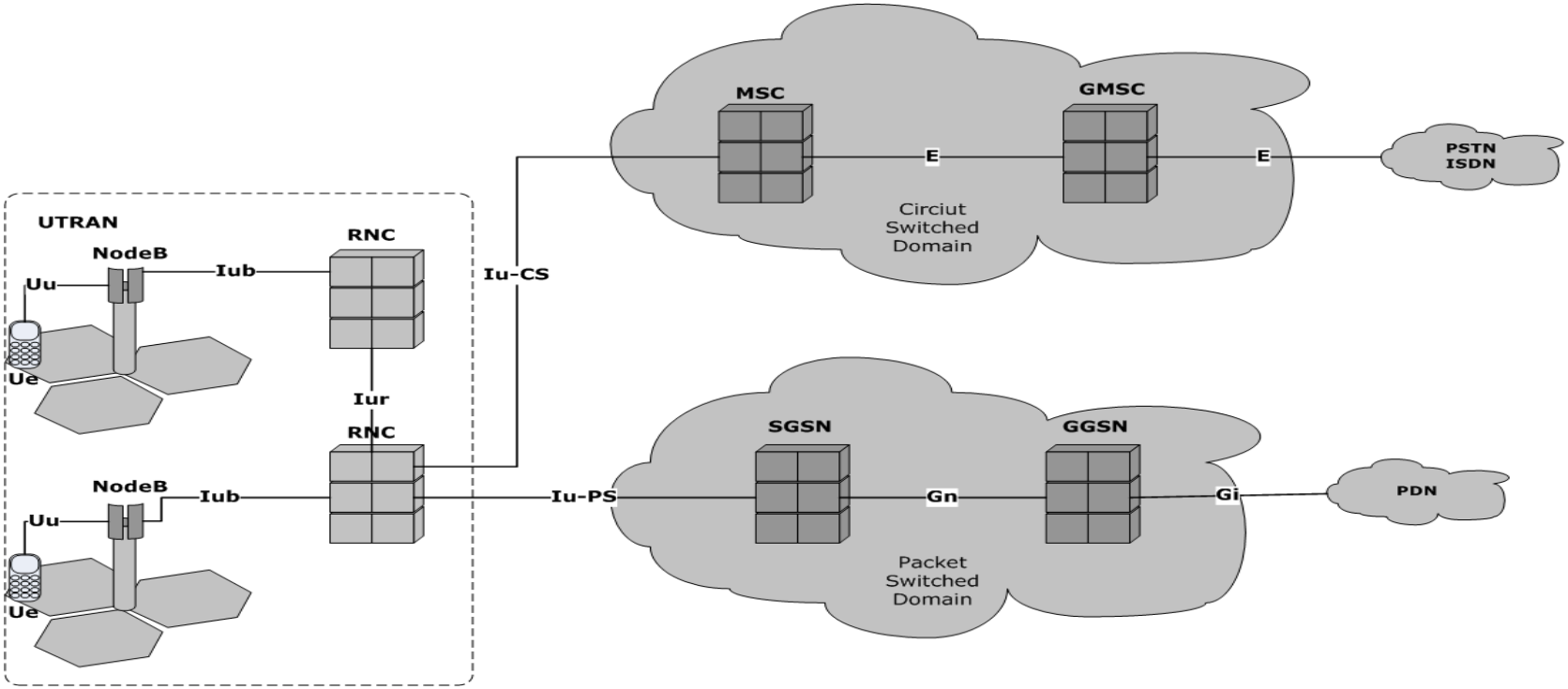
What is TD-SCDMA

- **Time Division Synchronous Code Division Multiple Access** uses a TDD scheme (Time Duplex Division), in opposite of WCDMA. They use the same channel as uplink and downlink. The signal is spread in the same way as in WCMDA, but the signalling is controlled by time division. TD-SCDMA uses a chip-rate of 1.28 Mcps (Mega chips per second), and is therefore referred to as Low Chip Rate TDD (LCR TDD) by the 3GPP (Third Generation Partnership Project)
- TD-SCDMA operates without the needs of a paired spectrum (TDD unpaired band) and works well with asymmetric traffic. The advantage of working without the need of paired spectrum is that it requires a smaller bandwidth, se Figure 5, and better utilization of the spectrum in asymmetric services. This is to be compared to WCDMA that needs a paired spectrum (FDD paired band). TD-SCDMA is also able to cover large areas, up to 40 km [4], and supports high mobility.



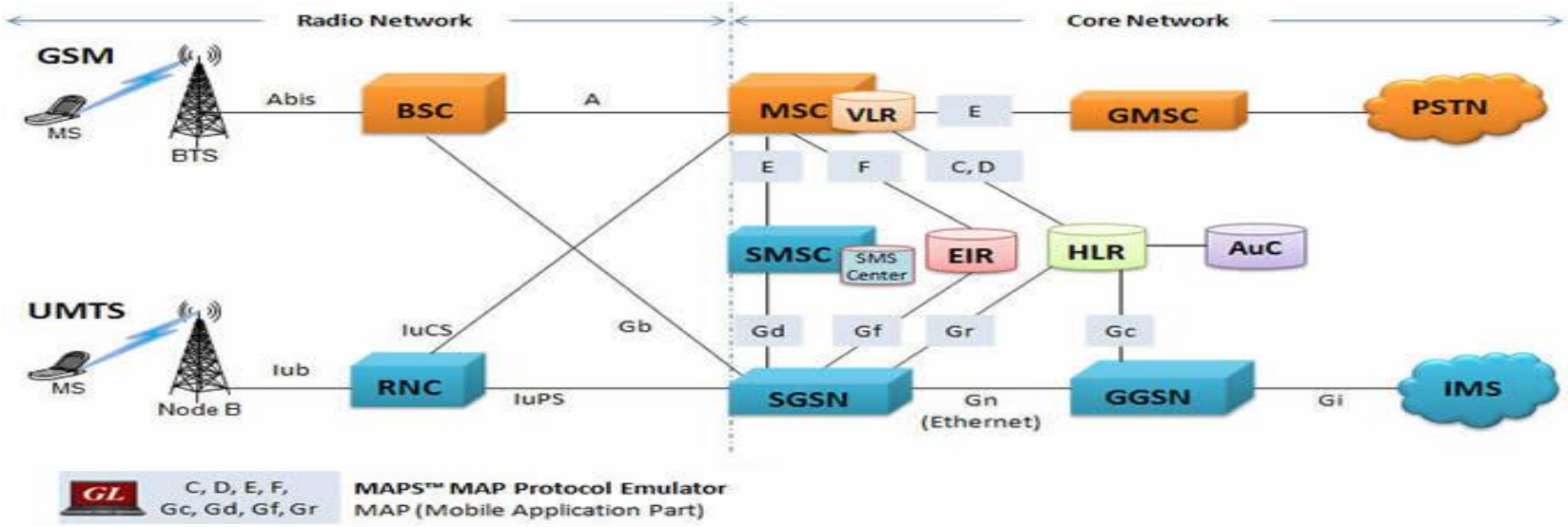
What is an RNC

- The **Radio Network Controller** (or **RNC**) is a governing element in the UMTS radio access network (UTRAN) and is responsible for controlling the Node-Bs that are connected to it. The RNC carries out radio resource management, some of the mobility management functions and is the point where encryption is done before user data is sent to and from the mobile. The RNC connects to the Circuit Switched Core Network through Media Gateway (MGW) and to the SGSN (Serving GPRS Support Node) in the Packet Switched Core Network.



What is an MSC - MSS

- **Mobile switching Center** is element which controls the network switching subsystem elements and interfaces versus radio network. Manages communication between GSM and other networks. It has a call setup function and basic switching, call routing, billing information and collection. Also has a Mobility management function, registration, location Updating and inter BSS and inter MSC call handoff.
- **Mobile switching Center Server** is element which controls the network switching subsystem elements and interfaces vs radio network. This is the evolution of MSC.
  - **A** is the interface between MSS and BSC in GSM domain
  - **IuCS** is the interface between MSS and RNC in UMTS domain



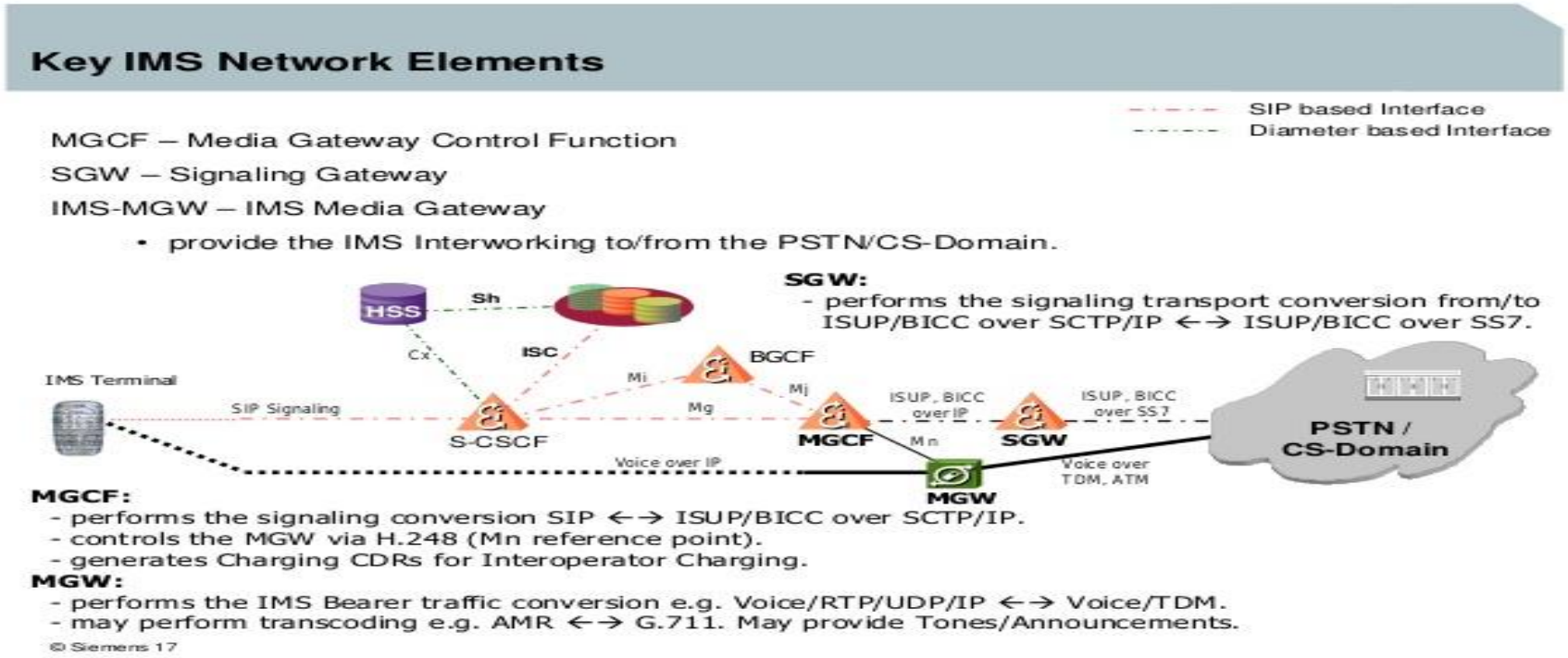
What is an HLR and VLR

- **Home Location Register:** permanent data information about subscribers with a service profile, location and activity status

- **Visitors Location Register:** temporary data information about subscribers that is needed by the MSC in order to service visiting subscribers.
  - The VLR is always integrated with the MSC; when a mobile station roam into a new MSC area, the VLR connected to that MSC will request data about the mobile station from the HLR; later if the mobile station makes a call, the VLR will have the information needed for call setup without having to interrogate the HLR each time.

What is an MGW

- A **Media gateway** is a translation device or service that converts digital media streams between disparate telecommunications networks such as PSTN, SS7, Next Generation Networks (2G, 2.5G and 3G radio access networks) or PBX. Media gateways enable multimedia communications across Next Generation Networks over multiple transport protocols such as Asynchronous Transfer Mode (ATM) and Internet Protocol (IP).
- **A-ter** is the interface between MGW and BSC in GPRS architecture

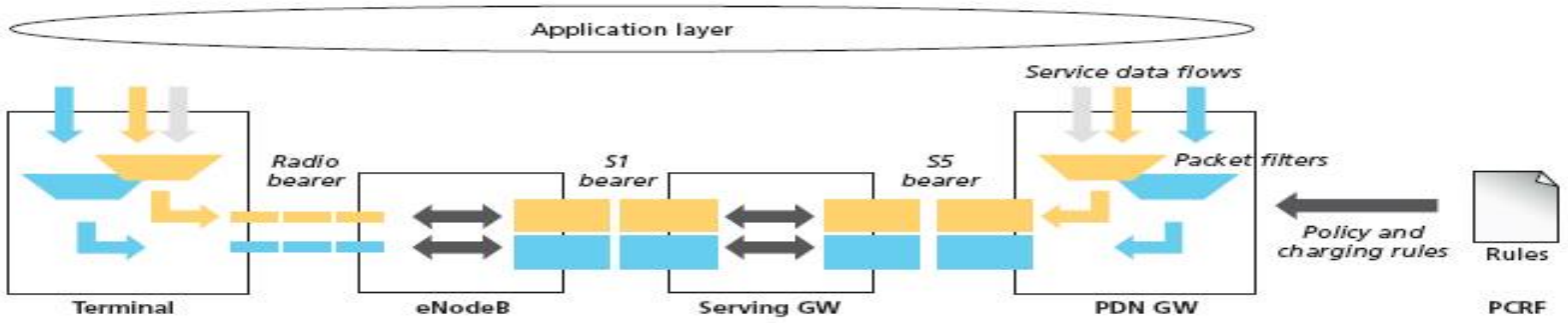


What is a an SGW

The **Serving Gateway** functions in LTE architecture are:

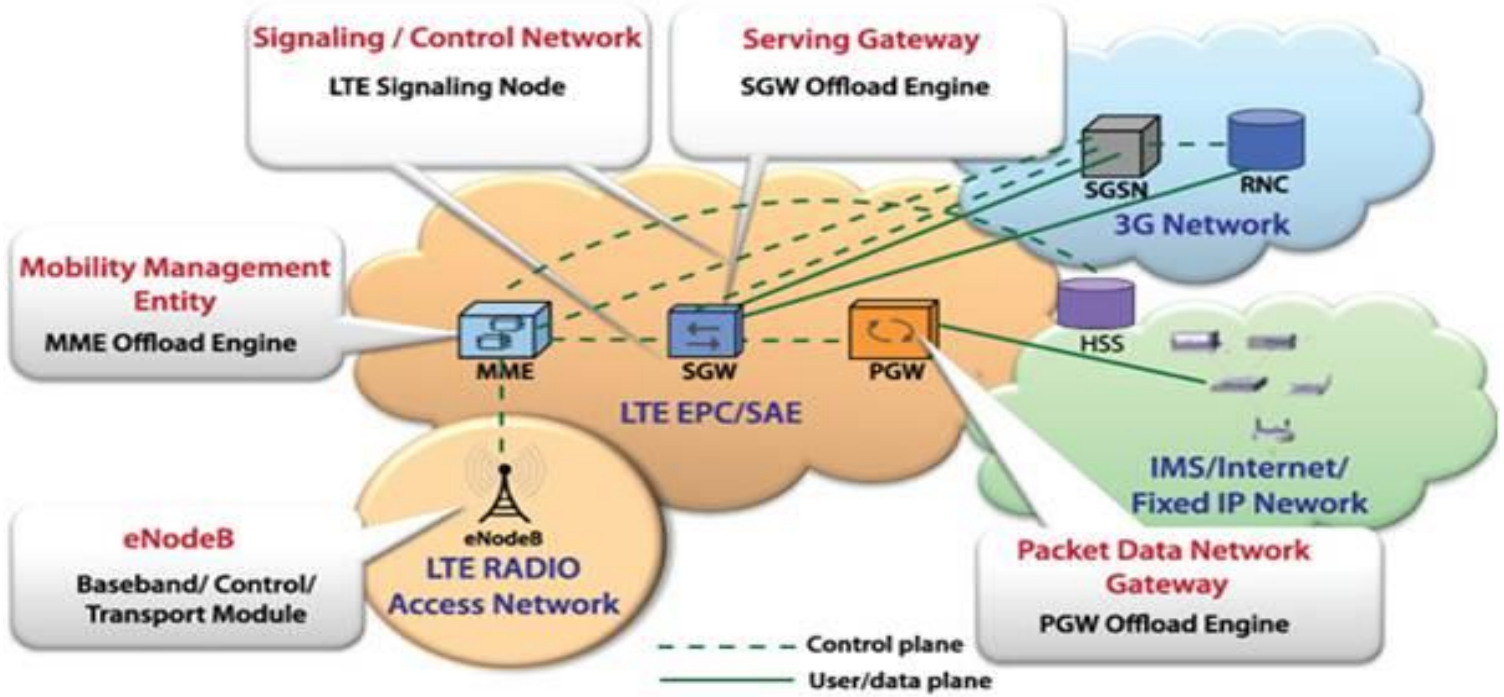
- routing and forwarding of user data packets,
- acting as the mobility anchor for the user plane during inter-eNodeB handovers
- the anchor for mobility between LTE and other 3GPP technologies.
- SGW terminates the downlink data path and triggers paging when downlink data arrives for the UE, for idle state UEs.
- It manages and stores UE contexts, e.g. parameters of the IP bearer service, network internal routing information.
- performs replication of the user traffic in case of lawful interception.

Figure 5. End-to-end data path in LTE



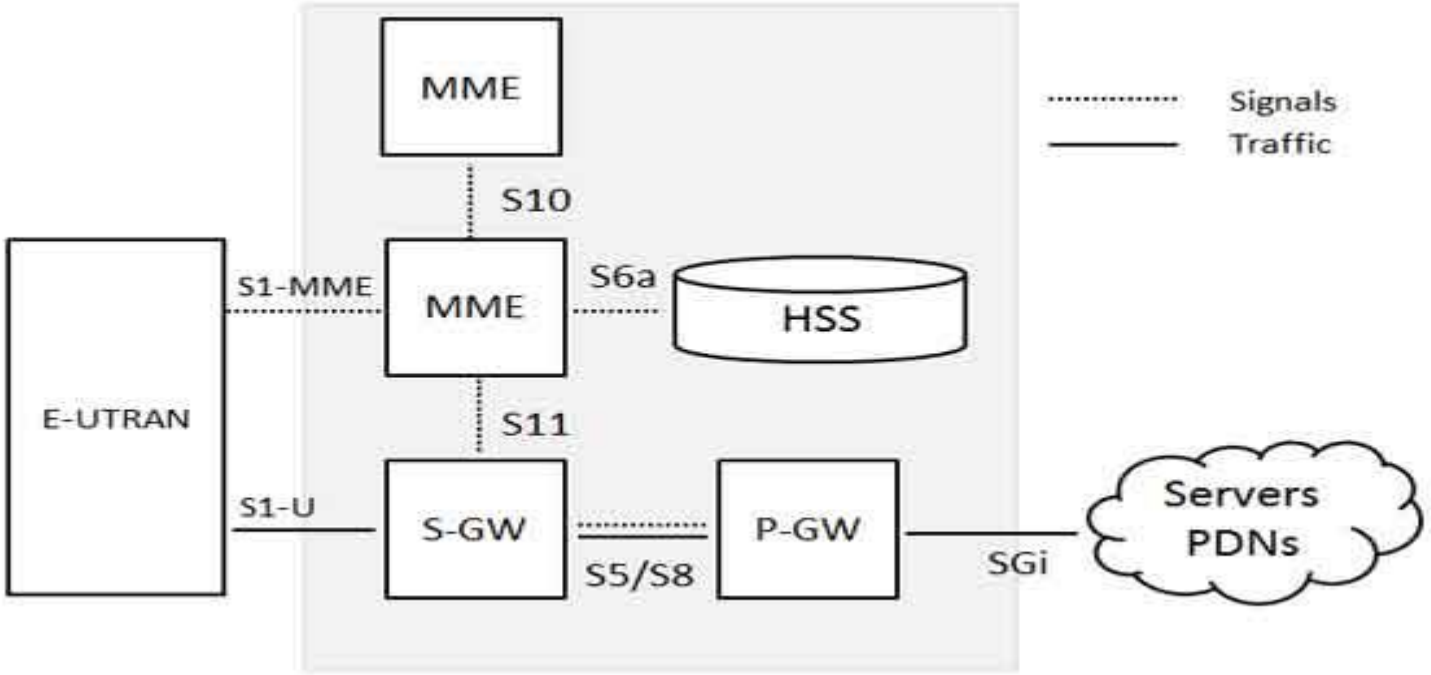
What is a an PGW

- The PDN Gateway provides connectivity from the UE to external packet data networks by being the point of exit and entry of traffic for the UE. A UE may have simultaneous connectivity with more than one PGW for accessing multiple PDNs.
- The PGW performs policy enforcement, packet filtering for each user, charging support, lawful interception and packet screening.



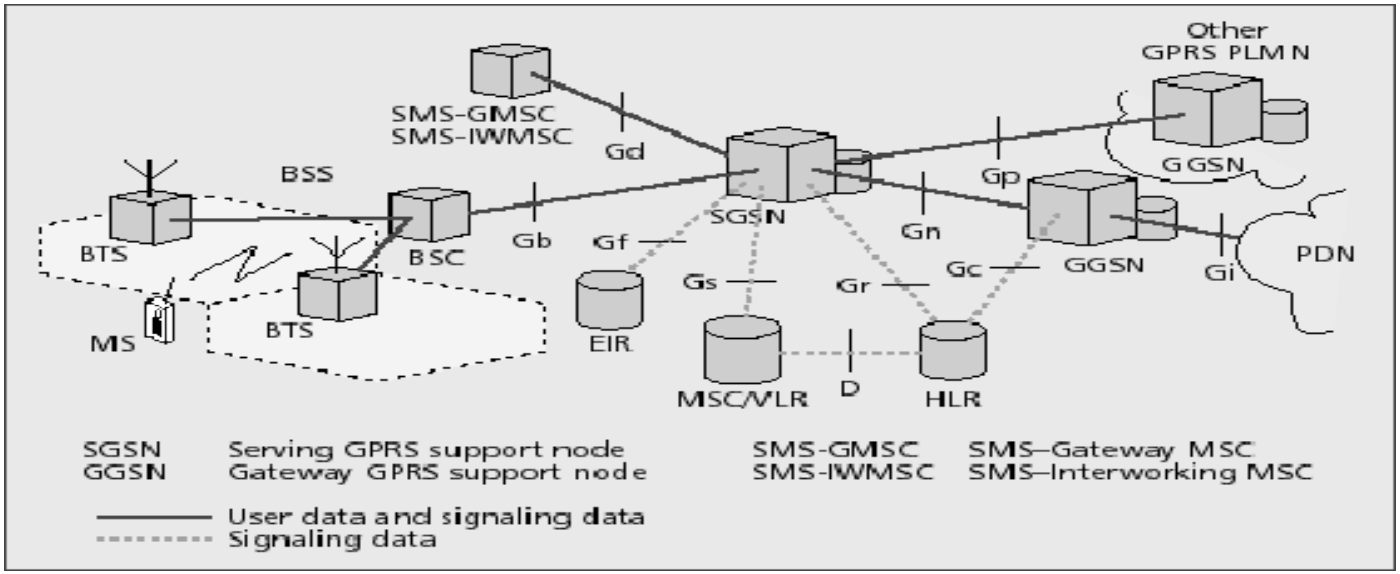
What is a HSS

- The HSS is a central database that contains user-related and subscription-related information.
- The functions of the HSS include functionalities such as mobility management, call and session establishment support, user authentication and access authorization.
- The HSS is based on pre-Rel-4 Home Location Register (HLR) and Authentication Center (AuC).



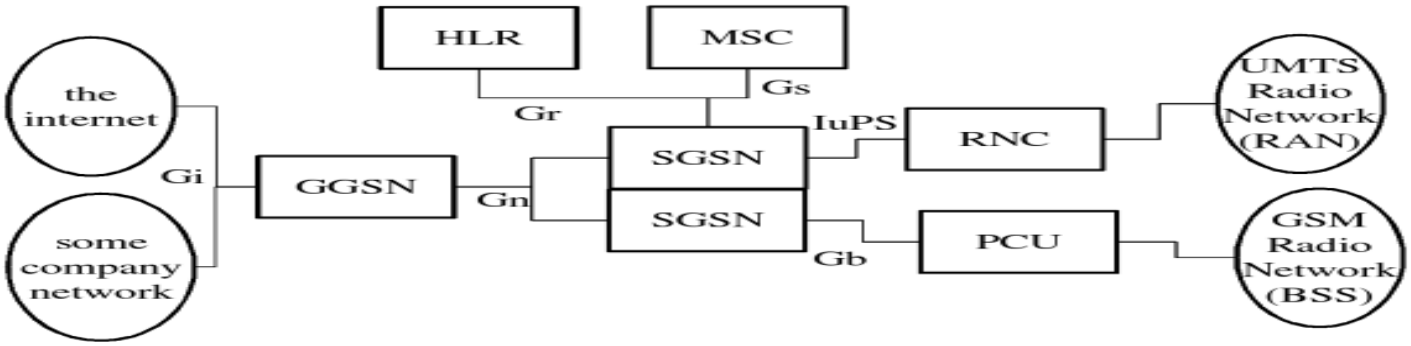
What is an SGSN

- The ***Serving GPRS Support Node*** (SGSN) is a main component of the GPRS network, which handles all packet switched data within the network, e.g. the mobility management and authentication of the users.
- The SGSN performs the same functions as the MSC for voice traffic. The SGSN and the MSC are often co-located. A serving GPRS support node (SGSN) is responsible for the delivery of data packets from and to the mobile stations within its geographical service area. Its tasks include packet routing and transfer, mobility management (attach/detach and location management), logical link management, and authentication and charging functions. The location register of the SGSN stores location information (e.g., current cell, currentVLR) and user profiles (e.g., IMSI, address(es) used in the packet data network) of all GPRS users registered with it.



What is an GGSN

- The GGSN is responsible for the internetworking between the GPRS network and external packet switched networks, like the Internet. From an external network's point of view, the GGSN is a router to a "sub-network", because the GGSN 'hides' the GPRS infrastructure from the external network.
- When the GGSN receives data addressed to a specific user, it checks if the user is active. If it is, the GGSN forwards the data to the SGSN serving the mobile user, but if the mobile user is inactive, the data is discarded. On the other hand, mobile-originated packets are routed to the right network by the GGSN. Some functions are subscriber screening, IP pool management and address mapping, QoS and PDP enforcement.
- With LTE scenario the GGSN functionality moves to SAE gateway (with SGSN functionality working in MME).



What is an E-NodeB

The eNodeB performs the following functions in LTE:

- Radio Resource Management, Radio Bearer Control, Radio Admission Control,
- Connection Mobility Control, Dynamic allocation of resources to LTE UEs in both Uplink and Downlink (scheduling)
- IP header compression and encryption of user data stream
- Selection of MME at LTE UE attachment
- Routing User Plane data to LTE SAE Gateway
- Scheduling and transmission of paging messages (originated from the MME)
- Scheduling and transmission of broadcast information (originated from the MME or Operations, Administration and Maintenance (OAM)
- Measurement and measurement reporting configuration for mobility and scheduling in LTE

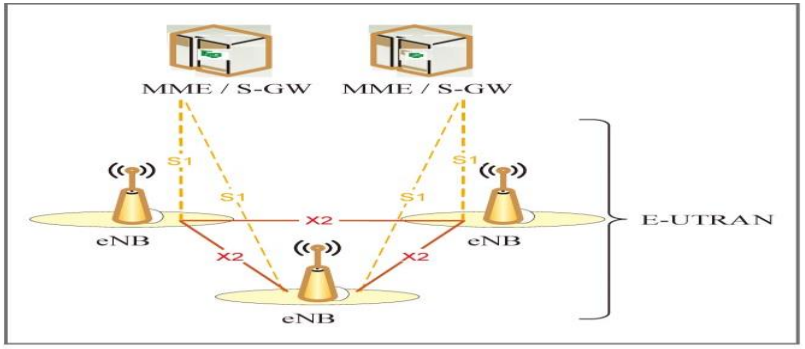
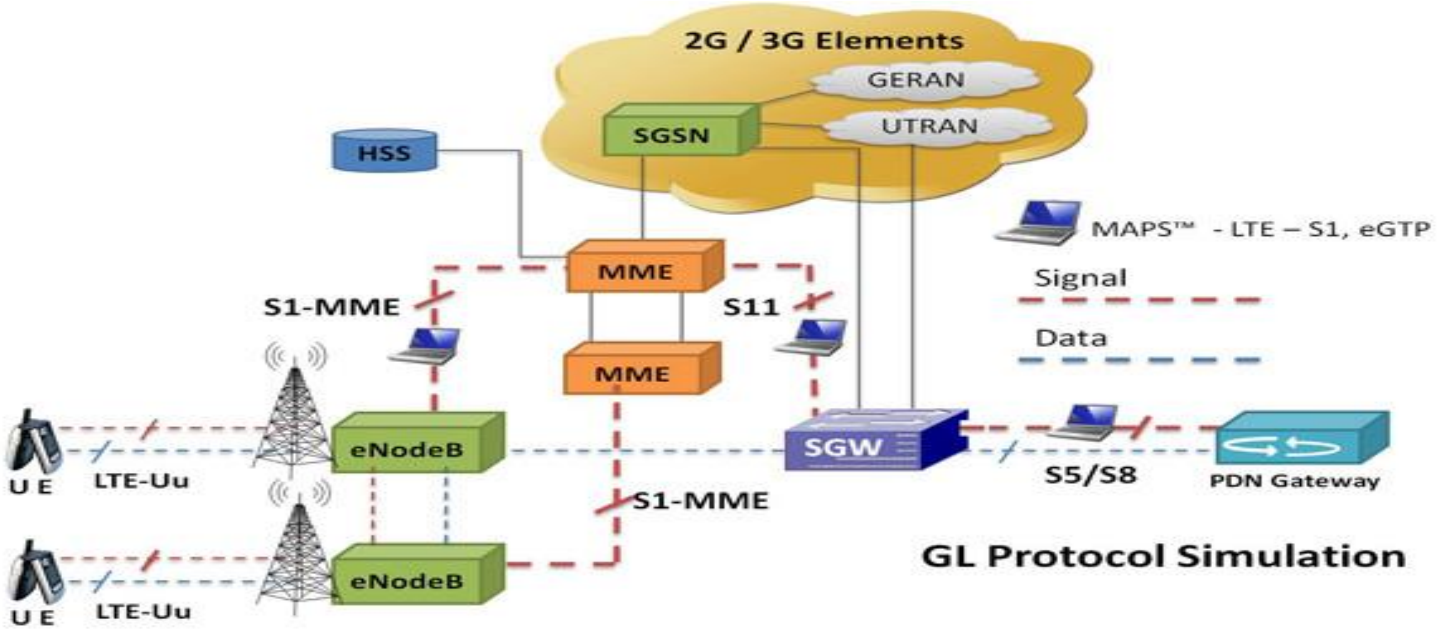


Figure 2 LTE architecture

What is an MME

The MME performs the following functions in LTE:

- Distribution of paging messages to the LTE eNodeBs
- Security control in LTE call
- Idle state mobility control
- SAE bearer control
- Ciphering and integrity protection of NAS signaling



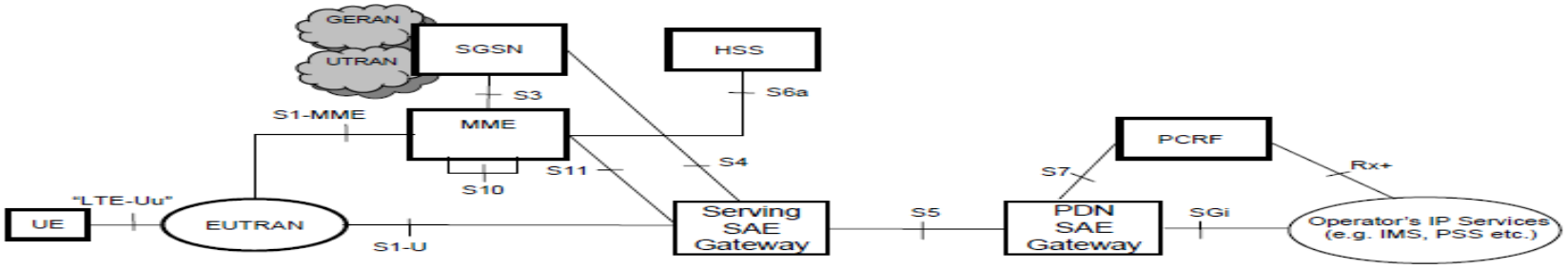
What is SAE

System Architecture Evolution (aka **SAE**) is the core network architecture of LTE wireless communication standard.

SAE is the evolution of the GPRS Core Network, with some differences:

- simplified architecture
- all-IP Network
- support for higher throughput and lower latency radio access network
- support for, and mobility between, multiple heterogeneous access networks, including E-UTRA (LTE and LTE Advanced air interface), 3GPP legacy systems (for example GERAN or UTRAN, air interfaces of GPRS and UMTS respectively)

The main component of the SAE architecture is the **Evolved Packet Core** (**EPC**), also known as **SAE Core**. The EPC will serve as the equivalent of GPRS networks (via the **Mobility Management Entity**, **Serving Gateway** and **PDN Gateway** subcomponents).



Architecture new interfaces

Architecture
New interfaces

orange

Interface	elements	Main usage	Protocol type
Um	MS – BTS	Radio interface	RLC/MAC
Abis	BTS – BSC	Standard GSM if.	RLC/MAC
Gb	BSC – SGSN	GPRS data	LLC/FR
Gc	GGSN – HLR	HLR queries for PDP context activation	(IP)/SS7
Gd	SGSN – SMS GMSC	Short Messages exchange	SS7
Gf	SGSN – EIR	Terminal identity check	SS7
Gi	GGSN – Data Network	Data transfer	IP
Gn	SGSN – SGSN	Mobility management	IP
	SGSN - GGSN	PDP context activation Data transfer	
Gp	BG – BG	Inter-operator link	IP
Gr	SGSN – HLR	Location management	SS7
Gs	SGSN – MSC/VLR	GSM/GPRS mobility Management	SS7

Backhaul concepts

Backhaul represents the network of interconnection between satellites routers Tellabs more ADM legacy, allowing the end-to-end connectivity RAN starting with cell site and end up with Mobile Core.

In LAB Vodafone UK are present the follow technologies:

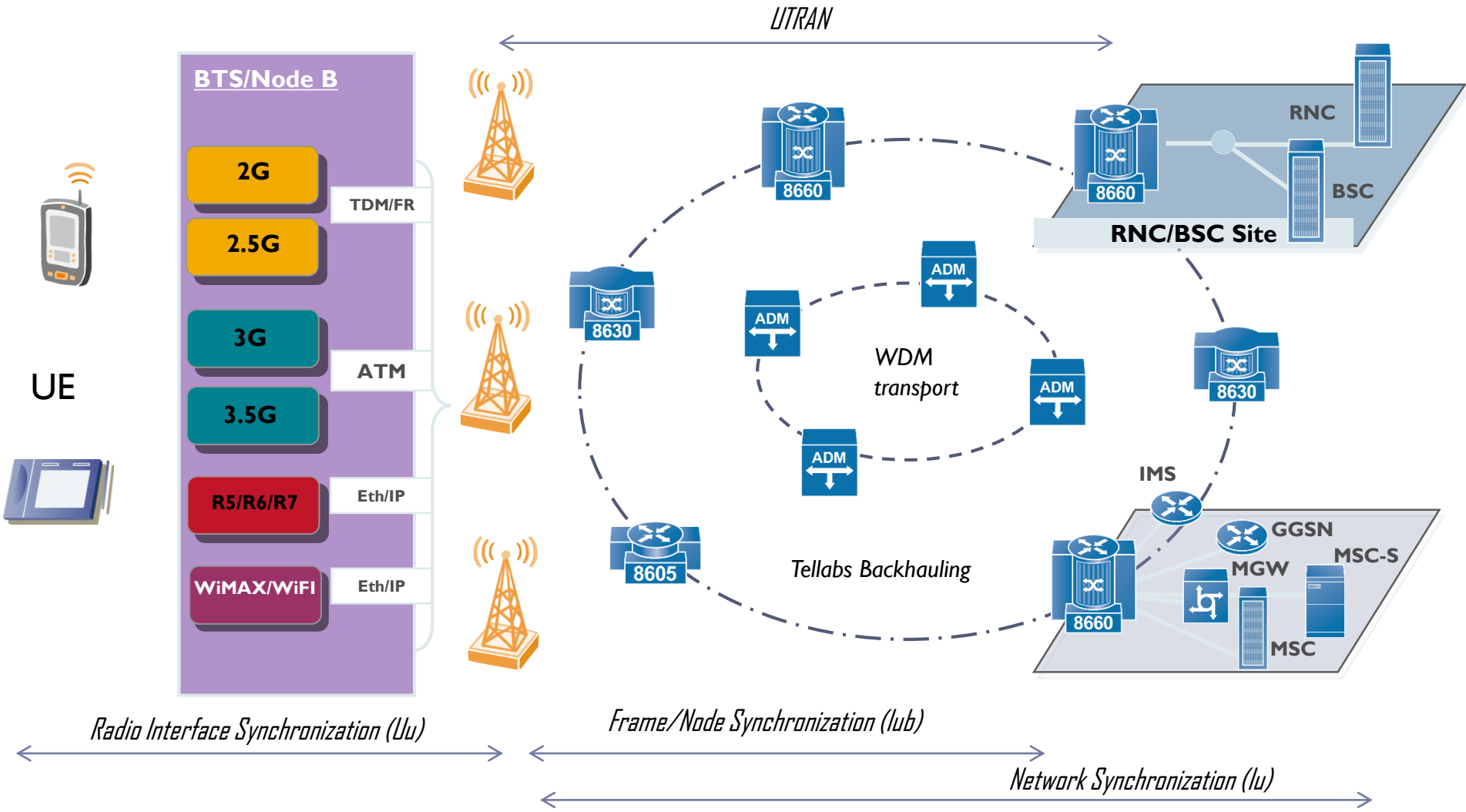
- Tellabs models 8605 and 8660
- NTM management (for Tellabs equipment)
- Nortel Passport 7000
- Alcatel Lucent CBX 3500
- Marconi Communication SDSX
- Ericsson Media Gateway
- ADM Ring legacy

Backhaul technologies

Backhaul use different technologies and protocol, which:

- Optical Transport Hierarchy
  - WDM systems; offer transport of payload with different kind of signal (SDH, Ethernet, SAN, ADM, etc….); main advantage is the great performance by fiber optic.
- ATM
  - Asynchronous time division multiplexing and encoding data into small fixed size 53 bytes cell; use a conenction oriented mode in which a virtual circuit (VP + VC) must be established between two end-point
- PDH
  - Plesiochronous digital Hierarchy is a TDM technologies used in access and aggregation transport:
    - Voice: 64 Kb/s
    - E1: 2 Mb/s
    - E3: 34 Mb/s
    - E4: 139 Mb/s
- SDH
  - Synchronous digital Hierarchy with high rate transport data streams:
    - STM-1; 155 Mb/s
    - STM-4: 622 Mb/s
    - STM-12: 2,4 Gb/s
- IP
  - Transport with high rate data stream (Gigabit/s)

Backhaul architectures referent



Synchronization concepts

- **Network Synchronization:** is responsible for the distribution of clocks allowing all nodes to operate at the same frequency.

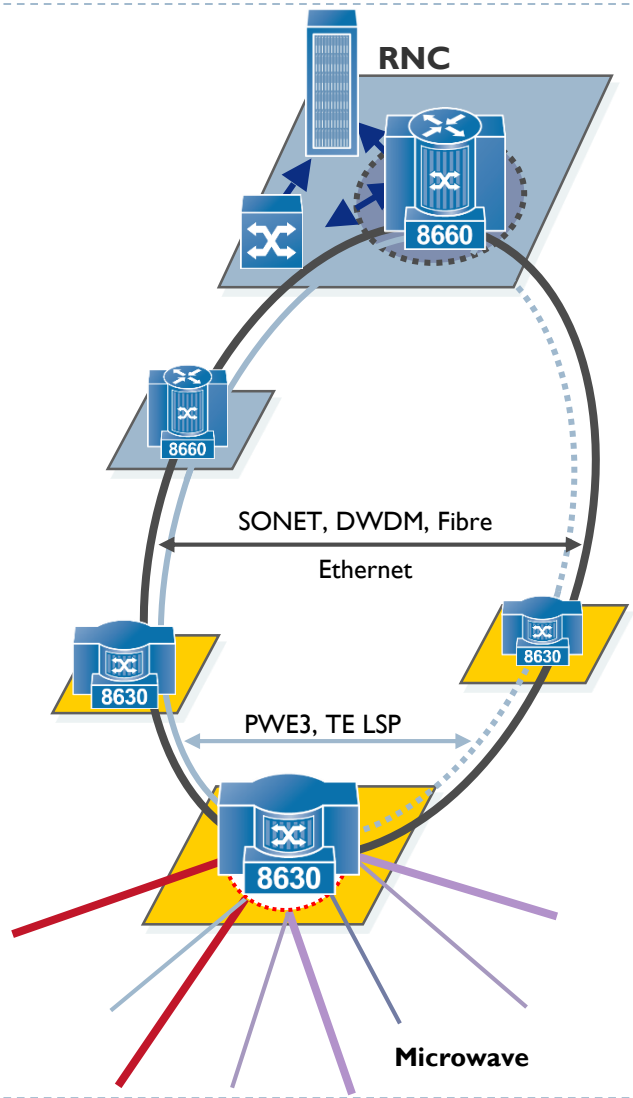
- **Node Synchronization:** is the basis for the numbering of frames between the RNC and BTS/Node B stations, and for frame timing; the correct operation of Node Synchronization is dependent on the proper operation of Network Synchronization

- **Frame Synchronization:** is responsible for the numbering of user frame and for the trasmission and reception of frames to and from RNC nodes at the correct times, to compensate for transfer and processing delay in the RNC-BTS/NodeB path.

- **Radio Interface Synchronization:** is responsible for the alignment of radio frames between BTS/NodeB and User Equipment (UE)

HUB Aggregation Values

1. Enhance scalability at RNC site
   - Low rate interfaces and IMA offload (WCDMA) handled before switch site
2. Savings in transport with switching and statistical gain, possibility to select the optimal transport solution
   - New leased line alternatives with optimized TDM, Ethernet and xDSL transport
   - Dark fiber utilization
   - Scalability for new broadband services, HSPA/EV-DO
   - New protection scenarios, OAM based LSP 1+1, traffic priorities
3. Common transport infrastructure for all mobile releases
4. Easy operations with NMS
5. Network convergence with additional services like WiFi, WiMAX, Broadband aggregation, IP TV etc.



IP RAN and Tellabs 8600

Tellabs 8600 key attributes

- End-to-end visibility and control
  - Traffic engineering, E2E testing & diagnostics
  - Automated provisioning and re-parenting
  - Service quality and traffic aggregation are under the mobile operator's control
- Transport independent
  - Utilizes the most cost-effective transport available for each link in the RAN

And enables full convergence

- Legacy support
- Seamless evolution to LTE mesh & future controller architectures

Tellabs 8600 System Benefits

NMS

Advanced service level management system – for TDM, FR, ATM and Ethernet pseudowires and IP VPN services

QoS

Advanced mechanism for guaranteeing differentiated service quality with easy-to-use configuration tools

Optimized for access

Low entry cost with Tellabs 8600 – intelligent distributed switching architecture

Synchroniza tion

TDM quality synchronization over packet networks

Multiple technologies

Flexible platform – various interface and protocol options