

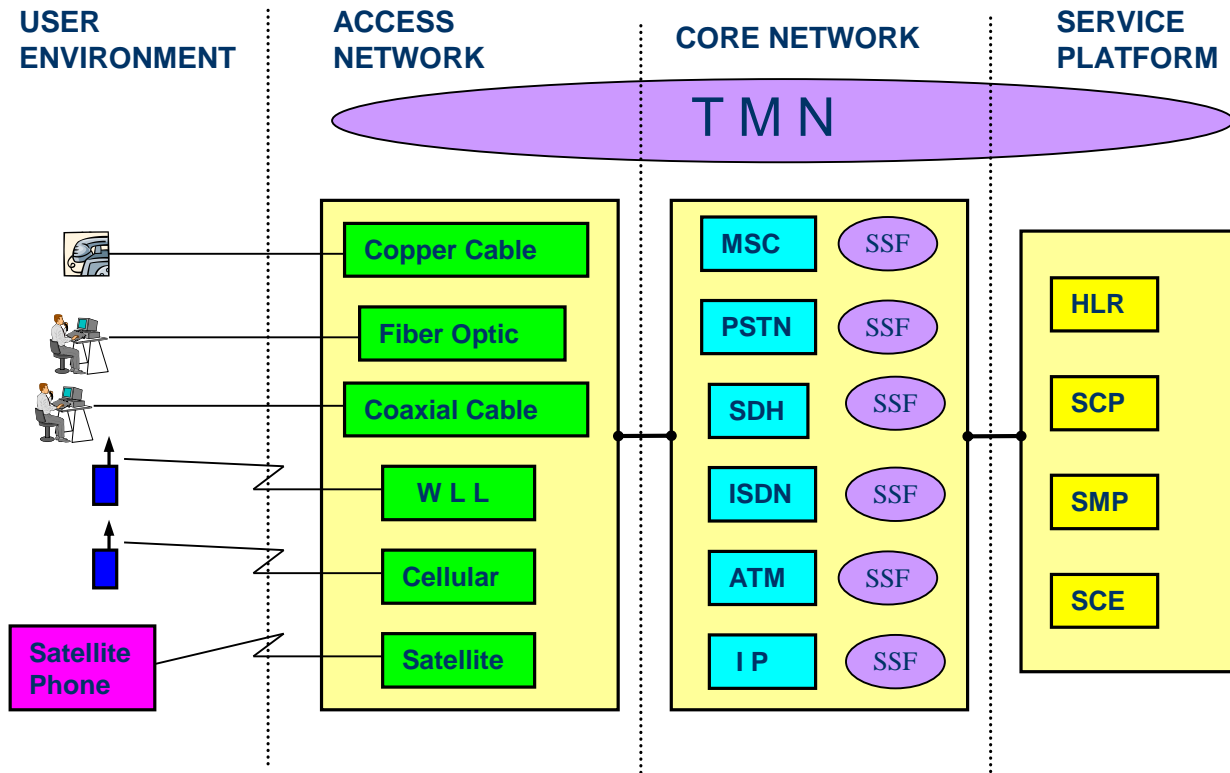
Wireless Communication Systems

Modul 8 Mobility Management



**Faculty of Electrical Engineering
Bandung – 2015**

Universal Telecommunication Platform



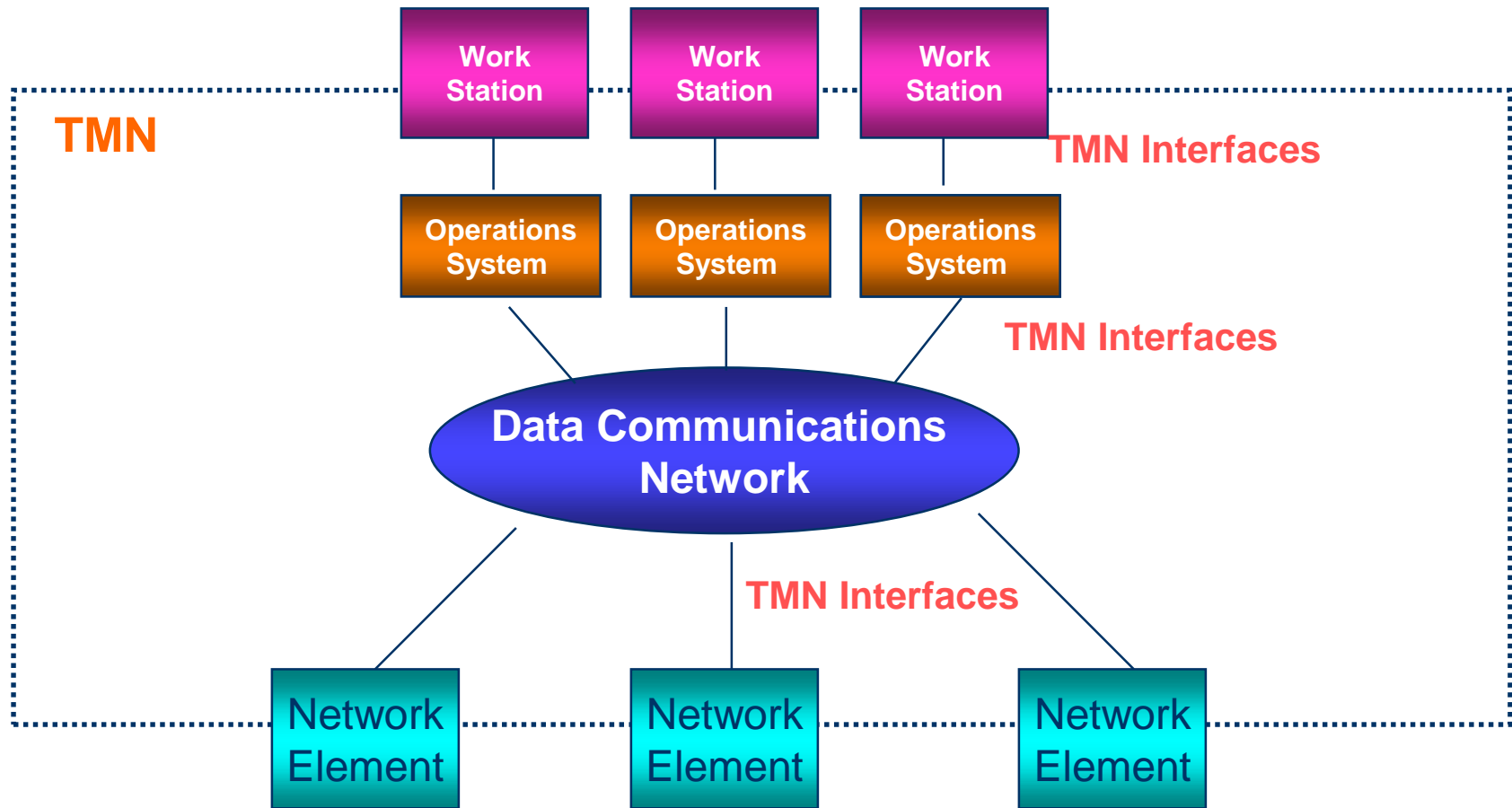
Communication Protocol

- **Rules and procedures** to determine the **format and transmission** of data
- **Packet structure** of the **data** transmitted or the **control commands** that manage the session
- A protocol suite such as TCP/IP is made up of **several levels** of functionality – OSI Model

Network Management Functions

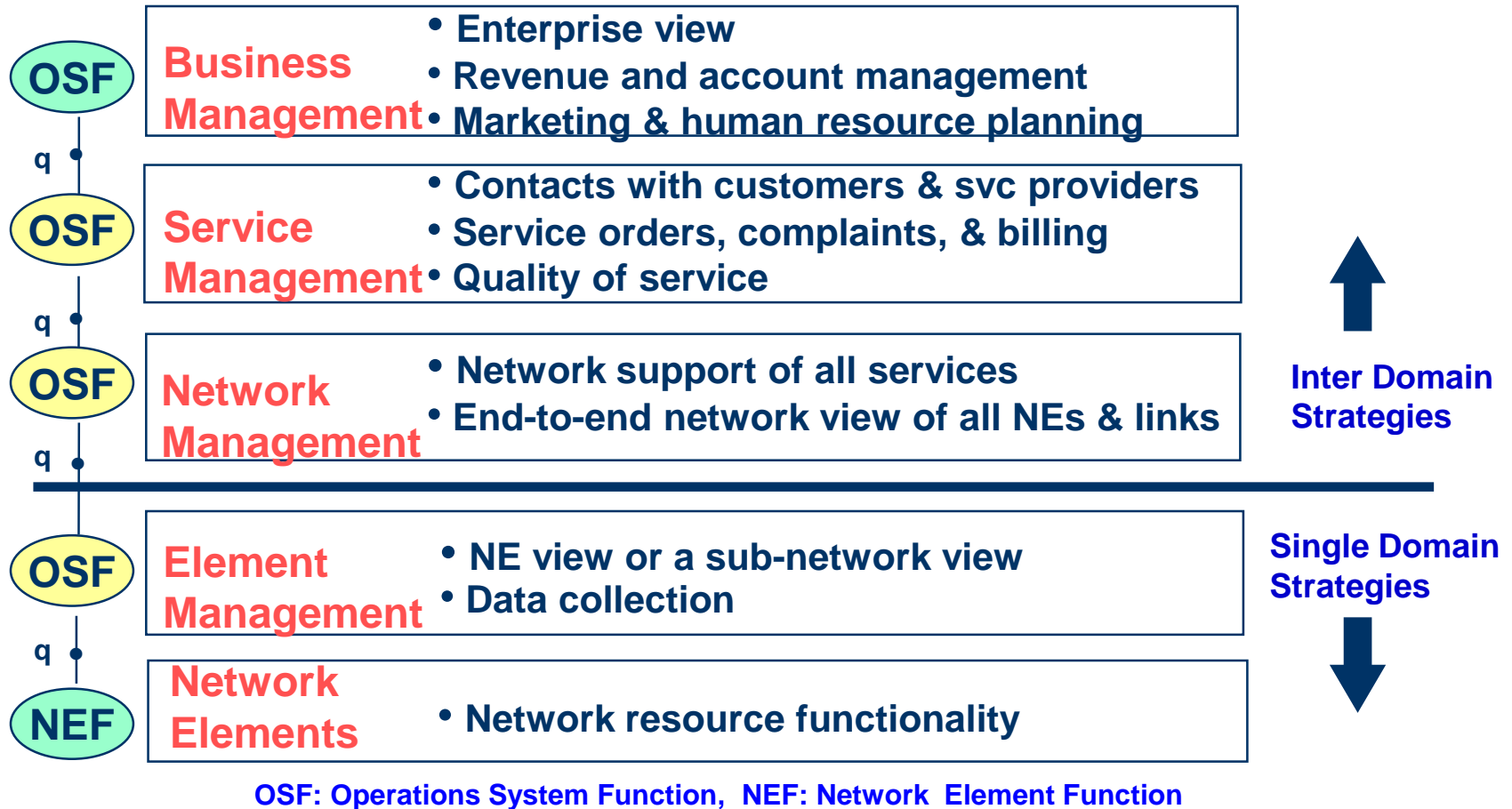
1. Fault Management
2. Configuration Management
3. Performance Management
4. Security Management
5. Accounting Management

TMN & Telecommunication Networks



TMN FOCUS: Communication of Management Information

TMN Logical Layered Architecture (M.3010)



Paradigms in Mobile Communications

Operator's Expectation

- Well classified QOS
- Cheap, flexible & efficient network
- The best mobile & personal services
- Profitable business

Circuit Switch

- Mature business
- Expensive
- Unflexible
- High QOS
- End to end QOS

Mobile Communication

- Mobility
- Personality
- Rapid deployment
- Limited frequency
- Limited bandwidth

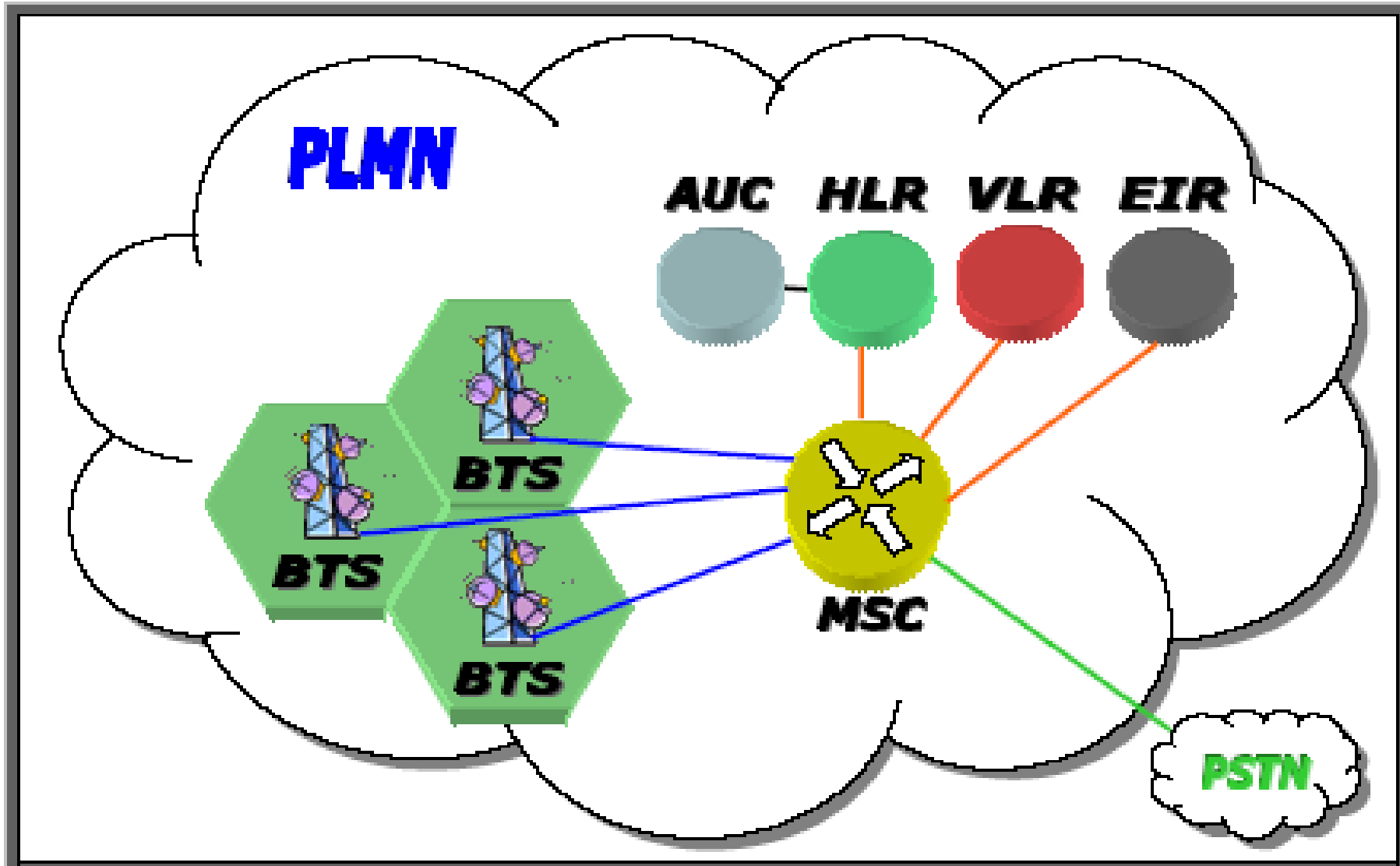
Packet Switch

- Immature business
- Cheap
- Flexible
- Best effort
- No end to end QOS

Mobility Management

- Each generation of Wireless Mobile Network has different mechanisms for Mobility Management.
- Network support of subscriber mobility requires **registration, authentication, paging, roaming, radio resource management** and excess channel capacity.
- Mobility Management focuses on **registration, authentication, paging and roaming processes.**
- Radio Resource Management focuses on **the network's ability to allocate radio access network resources.**
- Mobility Management transitioned from **proprietary processes for voice delivery services to open standards supporting voice and high speed data delivery services.**
- The most significant trends are migration to global roaming, enhanced security, distribution of mobility management between core network and radio access network and optimal use of network resources for registration and paging.
- Radio Resource Management transitioned from simplistic **RSSI** switching criteria to switching based on sophisticated signal quality assessments and assumption of some mobility management responsibilities.

PLMN Architecture



Mobility Management

- The base stations provide network access via a radio interface for mobile subscribers.
- The MSC manages base stations, consults PLMN databases to establish subscriber access rights, routes mobile traffic and serves as a gateway to external networks.
- The HLR, VLR, AUC and EIR are PLMN databases, which contain **subscriber profiles, location, encryption codes and equipment data**.
- Call establishment and connection maintenance are fundamental services required by all telephone networks.

Mobility Management

- Mobility management is the ability of a PLMN to orchestrate calls for its subscribers and radio management maintains the call regardless of the mobility of the subscribers.
- PLMNs must track and dynamically route calls to its subscribers in a transparent fashion.
- Locating, authenticating and tracking mobile subscribers are the main functions of mobility management.
- PLMNs use a registration process to report a mobile subscriber's location.
- Paging process notifies mobile subscribers about incoming calls.
- Authentication establishes the mobile station's right to access network services.
- Roaming allows authorized mobile subscribers to use networks other than their home PLMN.
- Radio Resource Management (RRM) consists of signal quality assessments, base station selection and switching.

Network Requirement for Mobility Management

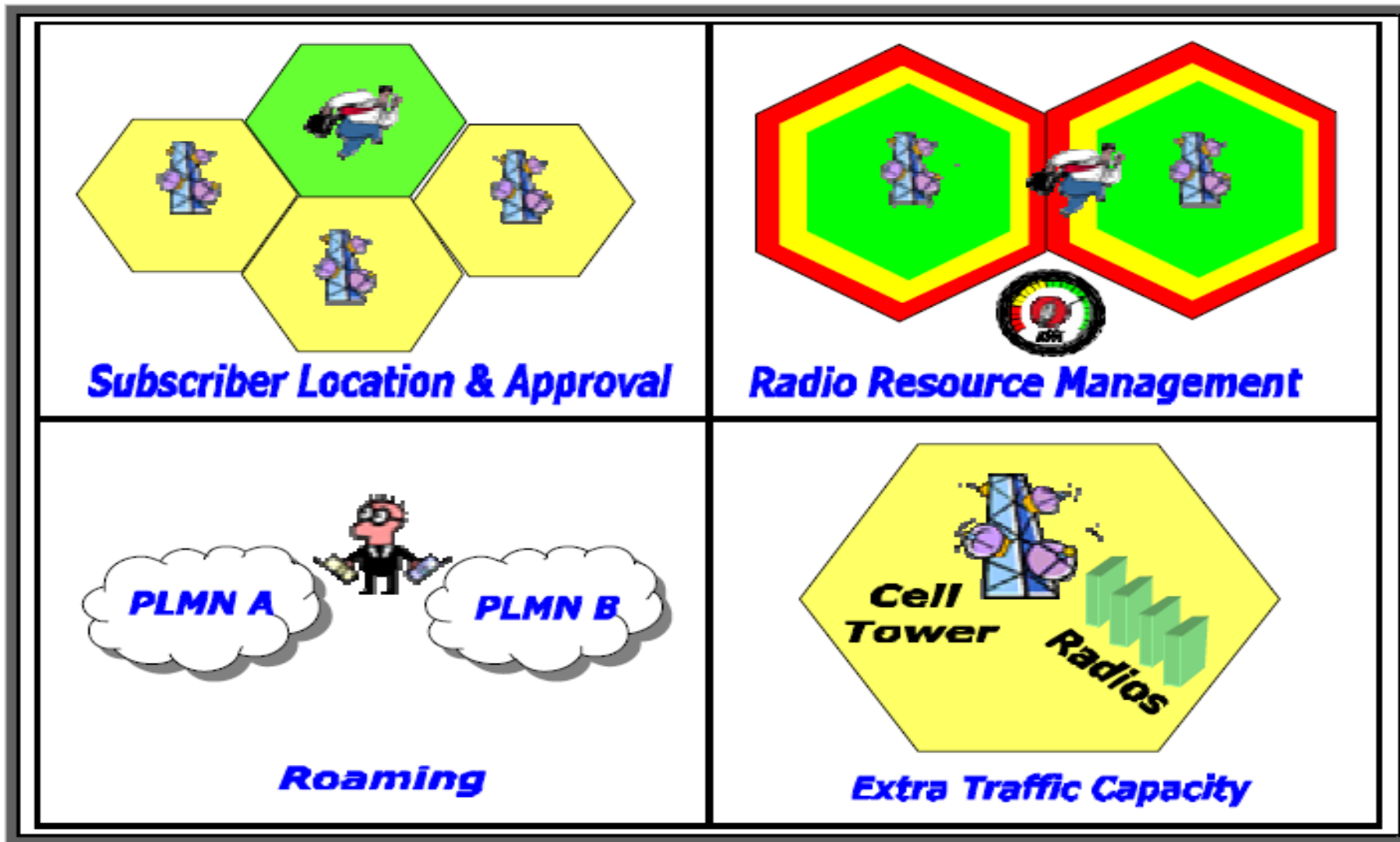


Figure 6 Network Requirements for Mobility Management¹⁰

Registration and Paging

- Registration updates the home PLMN's HLR and serving VLR databases with location information for authorized mobile subscribers.
- The network operator uses the mobile subscriber's registration information to optimize the delivery of services.
- Registration frequency can streamline the paging process and minimize the size of VLR databases.

Authentication

- Mobile stations registering in an unknown network invoke an authentication process.
- The network solicits unique identifiers from the mobile station and passes the information to the HLR.
- The HLR processes the information with the AUC and the EIR.
- The mobile station's subscription and equipment status is established and provided to the network.
- If the status is valid, the network issues encryption information and permits access. If the status is invalid, the network denies access.

Authentication

- Authentication is sophisticated and uses the A3 algorithm.
- Every new GSM subscriber receives a Subscription Authentication Key (Ki) with the International Mobile Subscriber Identifier (IMSI). The Ki is confidential and secure. It is stored on the SIM and in the AUC.
- During Authentication, the network issues a Random Number (RAND). Both the mobile station and the network derive a Signature Response (SRES) from a calculation with the Ki and the RAND.
- The mobile station transmits its SRES to the network for comparison with the AUC's calculated value of SRES. If they match, the mobile station receives network access and encryption information. If they do not match, the network denies access.

Roaming

- Roaming is the ability to access services from a network other than a home network.
- Registration, authentication and paging processes must be capable of supporting subscribers in foreign networks.
- Agreements between network operators are required as well.

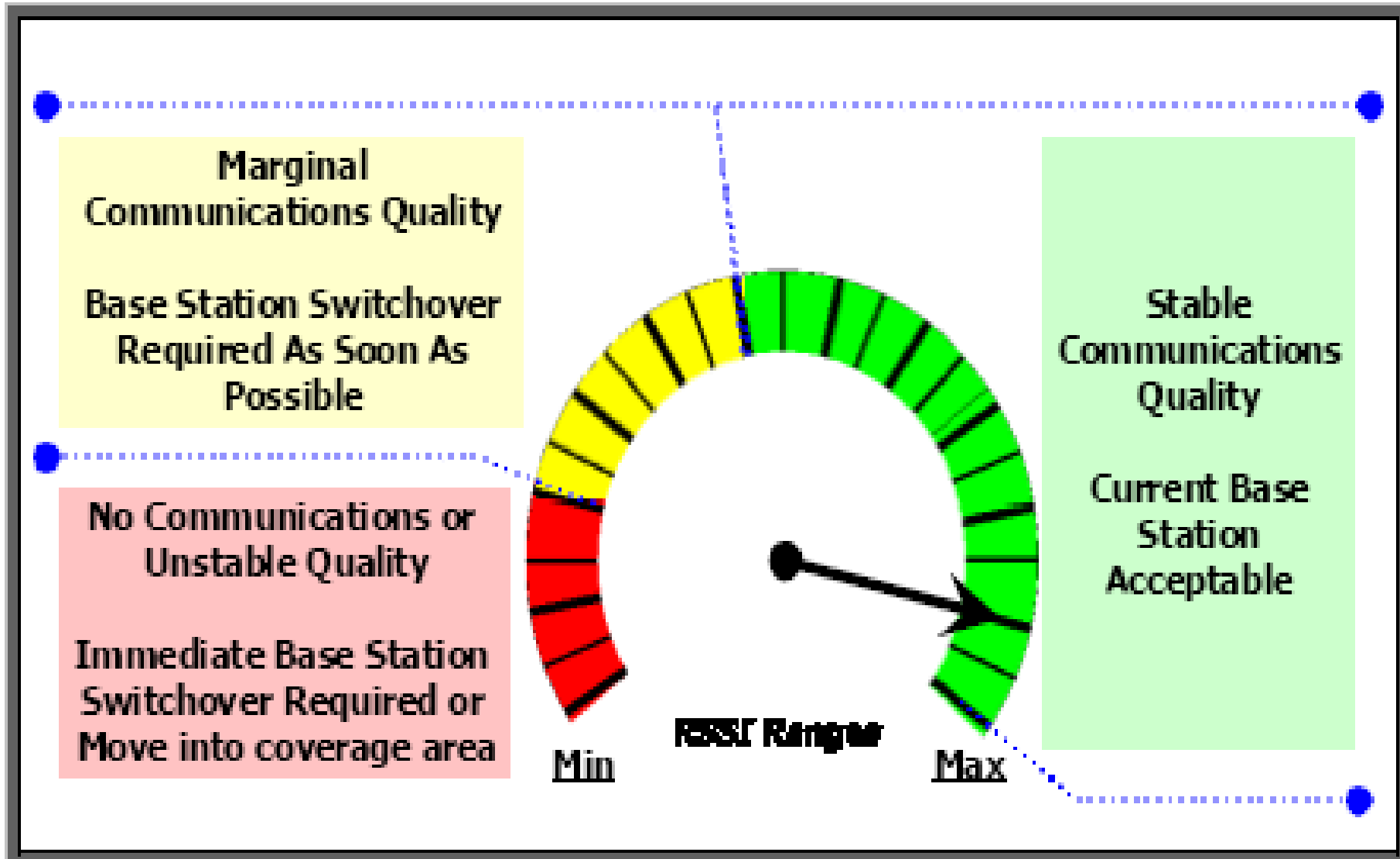
Radio Resource Management

- The most vulnerable part of a PLMN is the signal quality between an authorized mobile subscriber and its serving base station.
- Distance between antennas and interference sources attenuate radio signals.
- Frequency hopping and RF transmit power level controls mitigate interference issues.
- Handoffs, base station resource switching, mitigate distance related signal attenuation, traffic overloads and persistent interference.

Handoff

- All handovers are hard. GSM networks support Intracell and Intercell handovers within a common PLMN.
- Handovers occur due to the following reasons:
 - 1.) Signal quality between the mobile station and the base station deteriorates indicated by excessive errors or low values of RSSI.
 - 2.) Distance between the mobile station and the base station exceeds a predetermined limit
 - 3.) Cell traffic load management
 - 4.) Maintenance
- The wealth of standardization at every level in the architecture expedites information transfer between network elements. Network decision execution times are 5 to 10 times faster than AMPS for handovers. The network architecture is an excellent implementation of 2G concepts and a foundation for future generations.

Handoff and RSSI



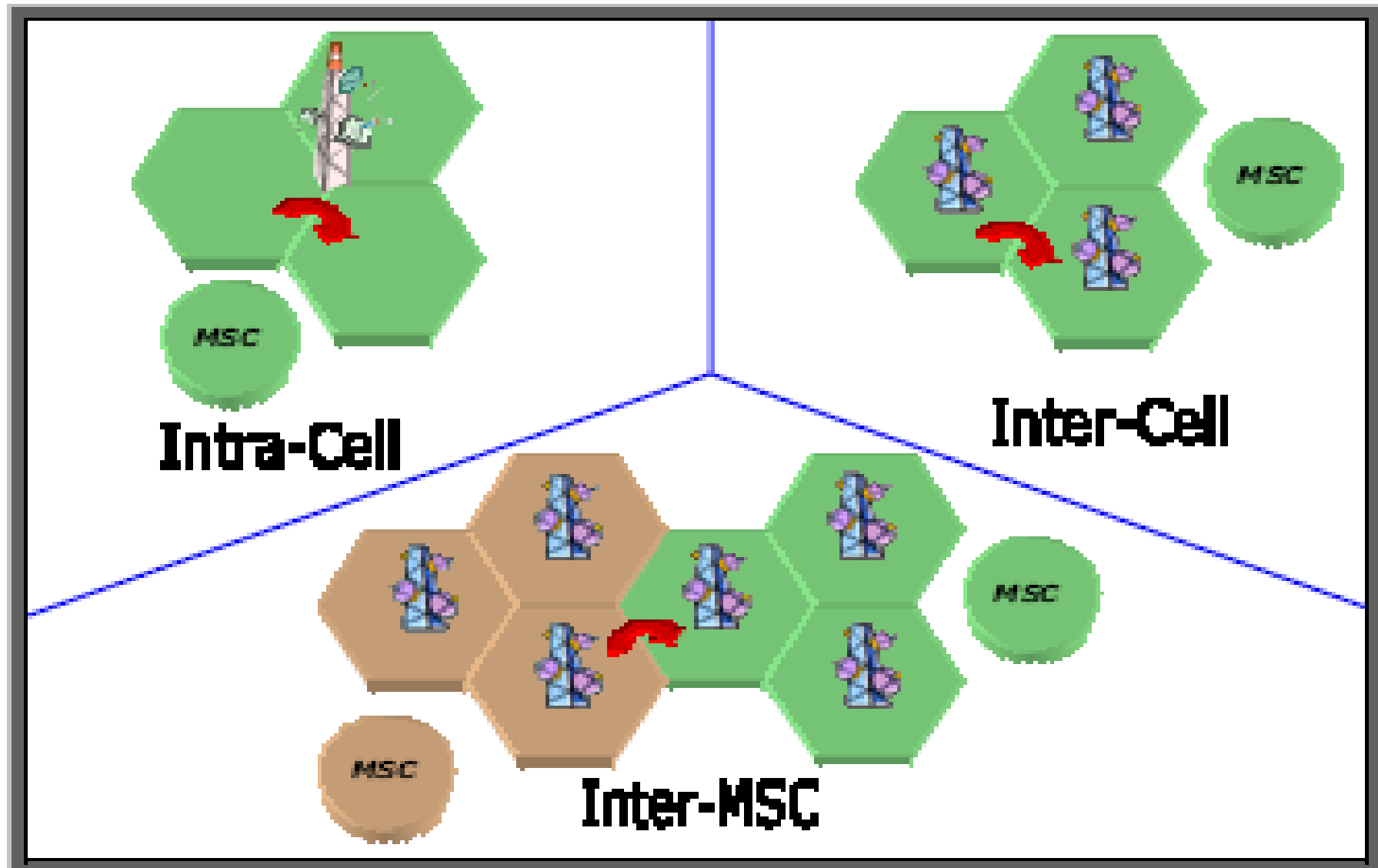
Handoff Scenario

The majority of handoffs support calls as mobiles traverse cell or sector boundaries.

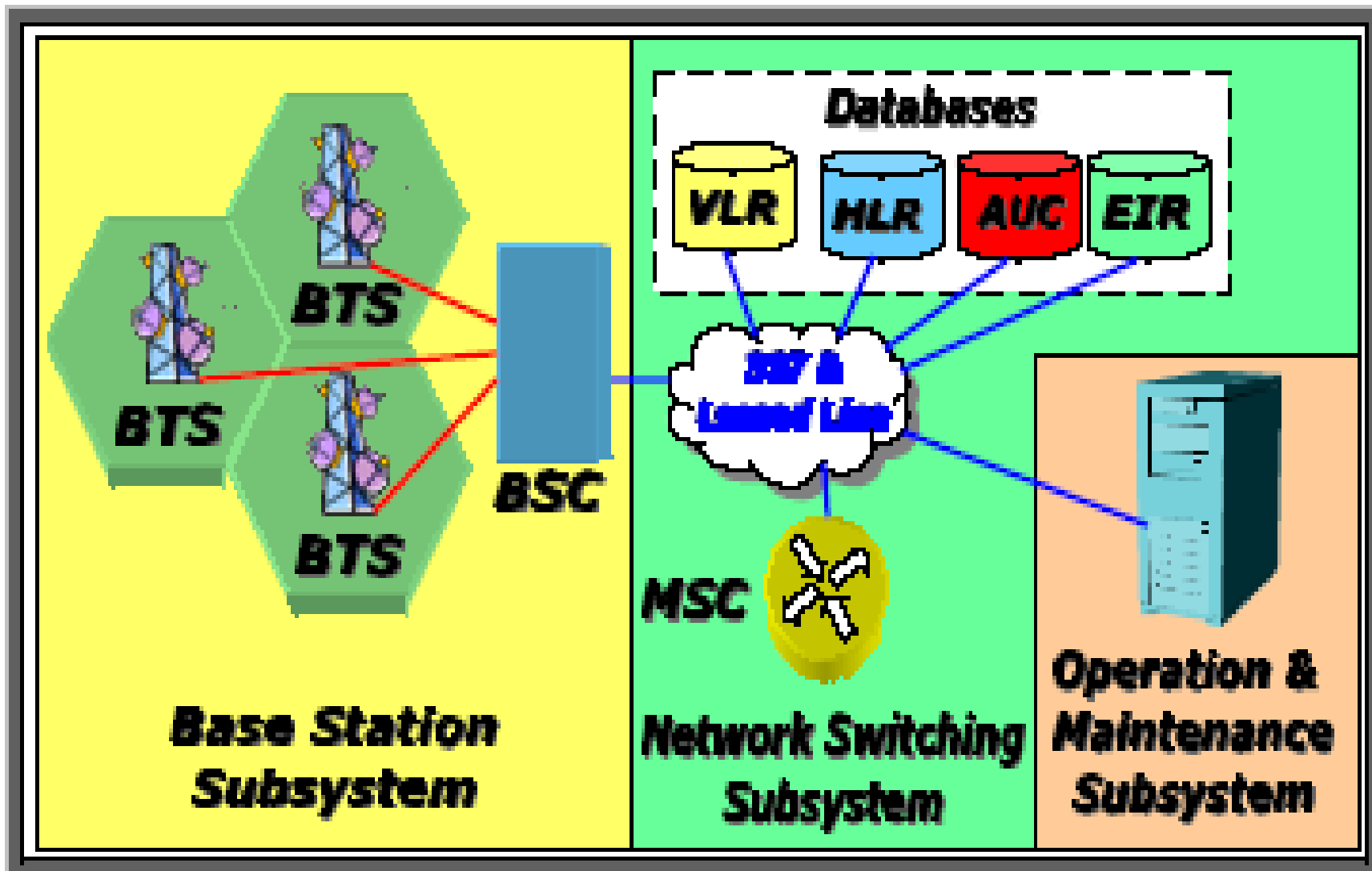
Handoff processes are required for each of the following scenarios :

- 1.) Crossing cell boundaries within a MSC's service area (Intra-MSC)
- 2.) Crossing cell boundaries between MSCs (Inter-MSC)
- 3.) Crossing cell boundaries between different network operators (Roaming)
- 4.) Crossing sector boundaries within a cell (Intra-cell)
- 5.) Switching channels to circumvent persistent interference

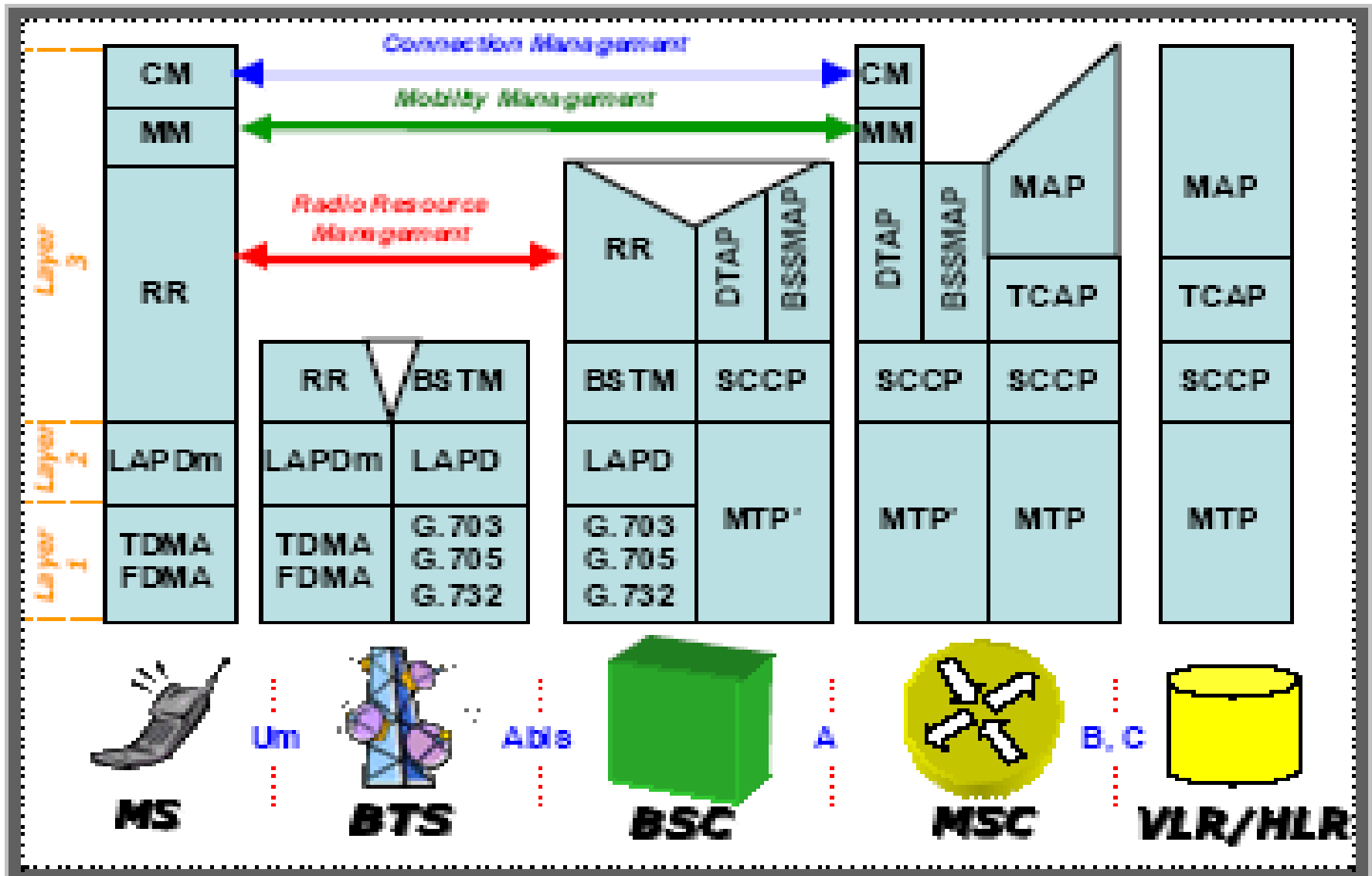
Handoff Scenario



GSM Architecture



GSM Protocol



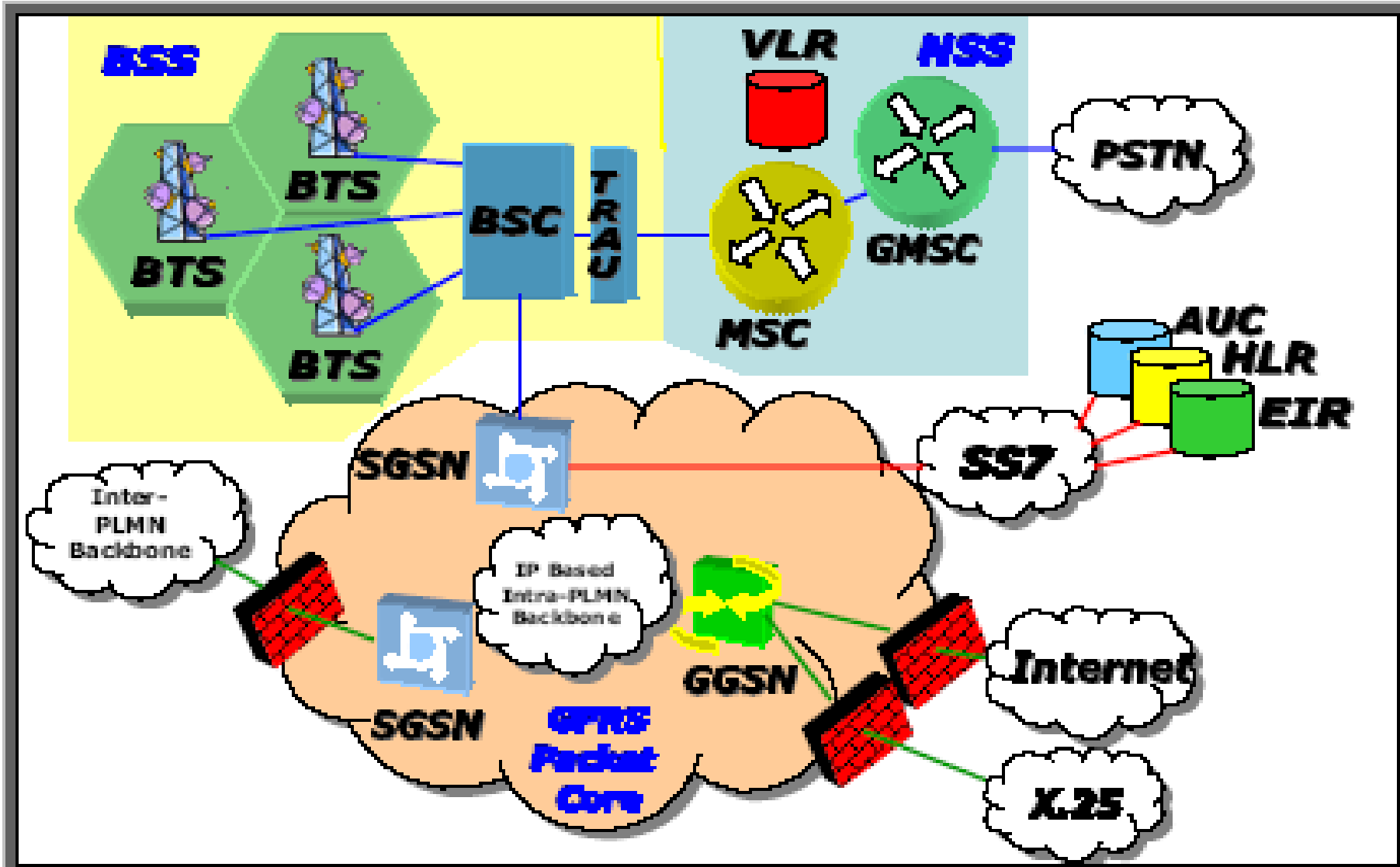
Layer 3 Protocol

- **Layer 3 provides Radio Resource (RR), Mobility Management (MM), and Connection Management (CM) functions.**
- **RR manages all air interface procedures such as frequency selection, cell choice, handovers, signal quality assessments, channel assignment requests and encryption/decryption synchronization.**
- **MM is responsible for issuing TMSIs, finding the mobile station, tracking the mobile station, IMSI attach/detach, mobile station recognition, subscription verification and protecting subscriber identity.**
- **CM is responsible for call setup and termination.**

Registration and Paging

- Registration and paging processes benefit from well-defined service areas, which have internationally unique designations.
- Cells are grouped together to form Location Areas and are represented by Location Area Indicators (LAI).
- LAIs are globally unique and include country, mobile network and location area codes.
- All individual cells have global identifiers, which specify their LAI and Cell Identifier (CI)

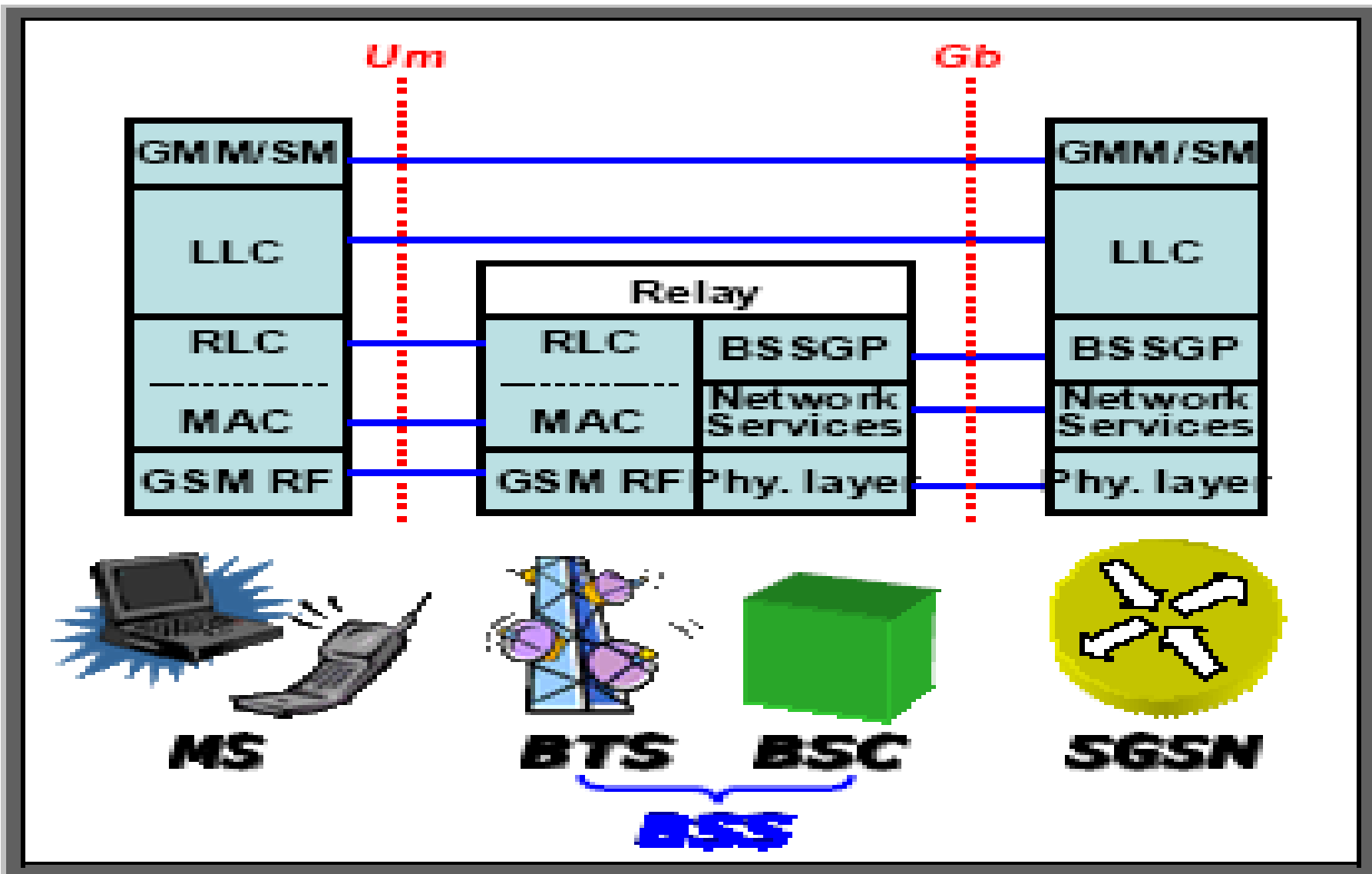
GPRS Architecture



SGSN and GGSN

- The Serving GPRS Support Node (SGSN) routes all mobile station packet traffic, performs logical link management, supports the mobile station attach /detach process and authenticates mobile stations.
- Subscriber profiles and location information is stored in the SGSN's location register.
- SGSNs serve a group of cells, Routing Area, within a location area.
- The Gateway GPRS Support Node (GGSN) is a protocol converter and it interfaces the GPRS network to external packet data networks. It transforms GPRS traffic to the packet data format of the external network, readdresses, and routes external packets terminating in the GPRS network to the appropriate SGSN.

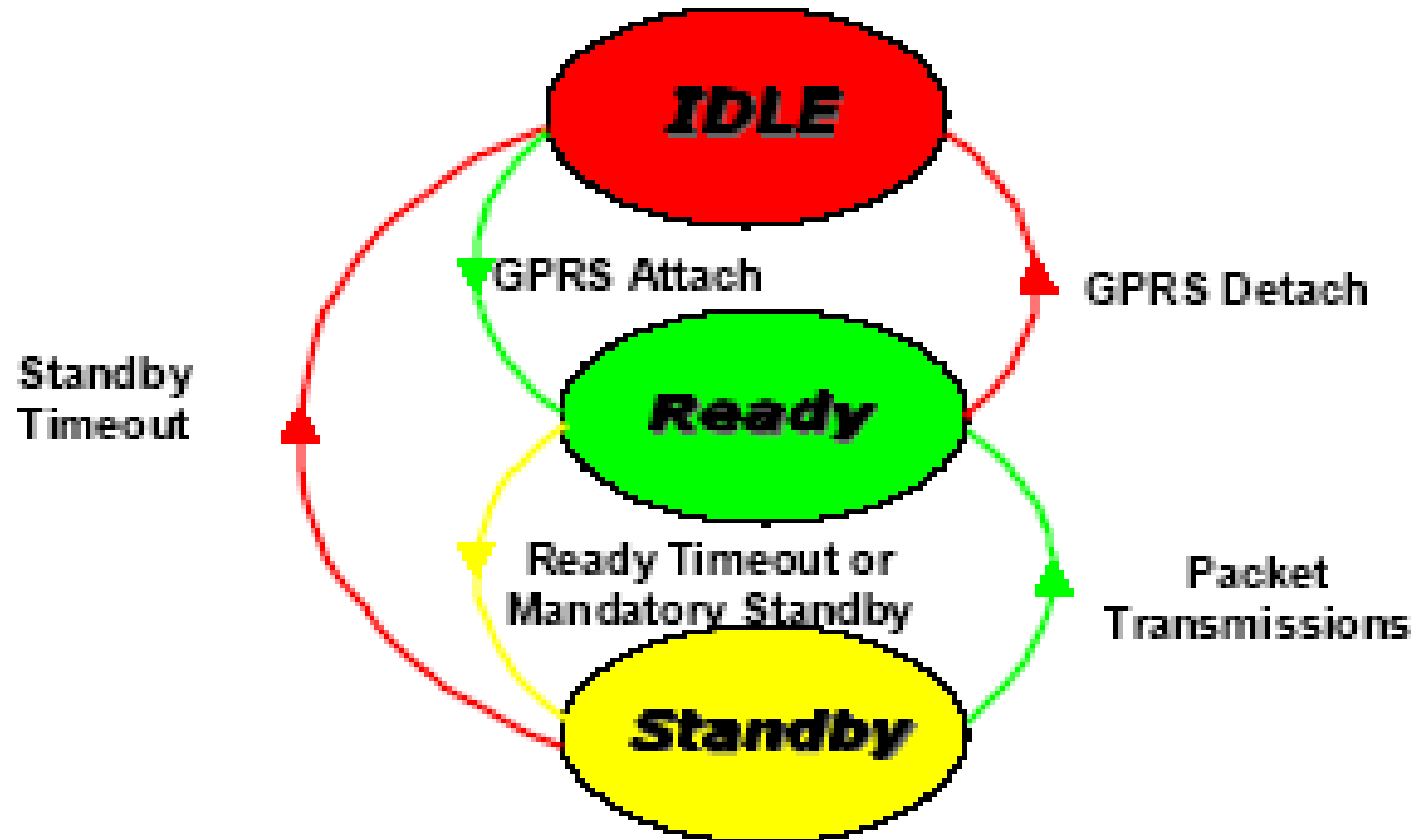
GPRS Protocol



GMM and SM

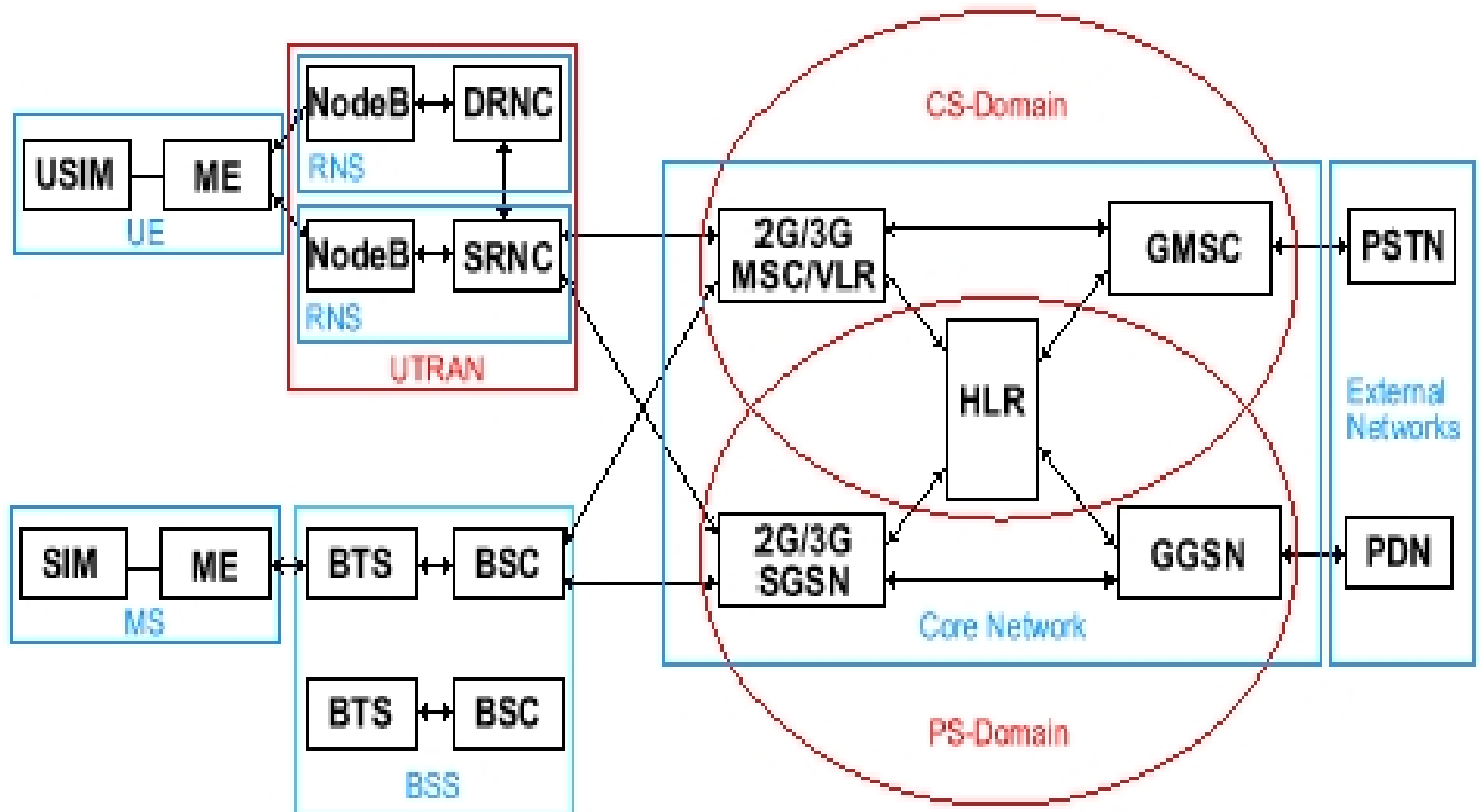
- GPRS Mobility Management (GMM) and Session Management (SM) perform security processes, GPRS Attach / Detach procedures, routing area updates and protocol data packet context activation.
- GPRS implements mobility management with Idle, Ready and Standby states.
- The Idle state indicates that the GPRS network is not aware of the mobile terminal.
- The Standby state indicates that the GPRS network knows the subscriber and its routing area.
- The Ready state indicates that GPRS network knows the subscriber, its cell location and is exchanging packets at will.
- Attach /Detach processes register and deregister mobile terminals with the GPRS network. A successful attachment to the GPRS network transitions a mobile station from the “Idle” state to the Ready state.

GPRS MM Model



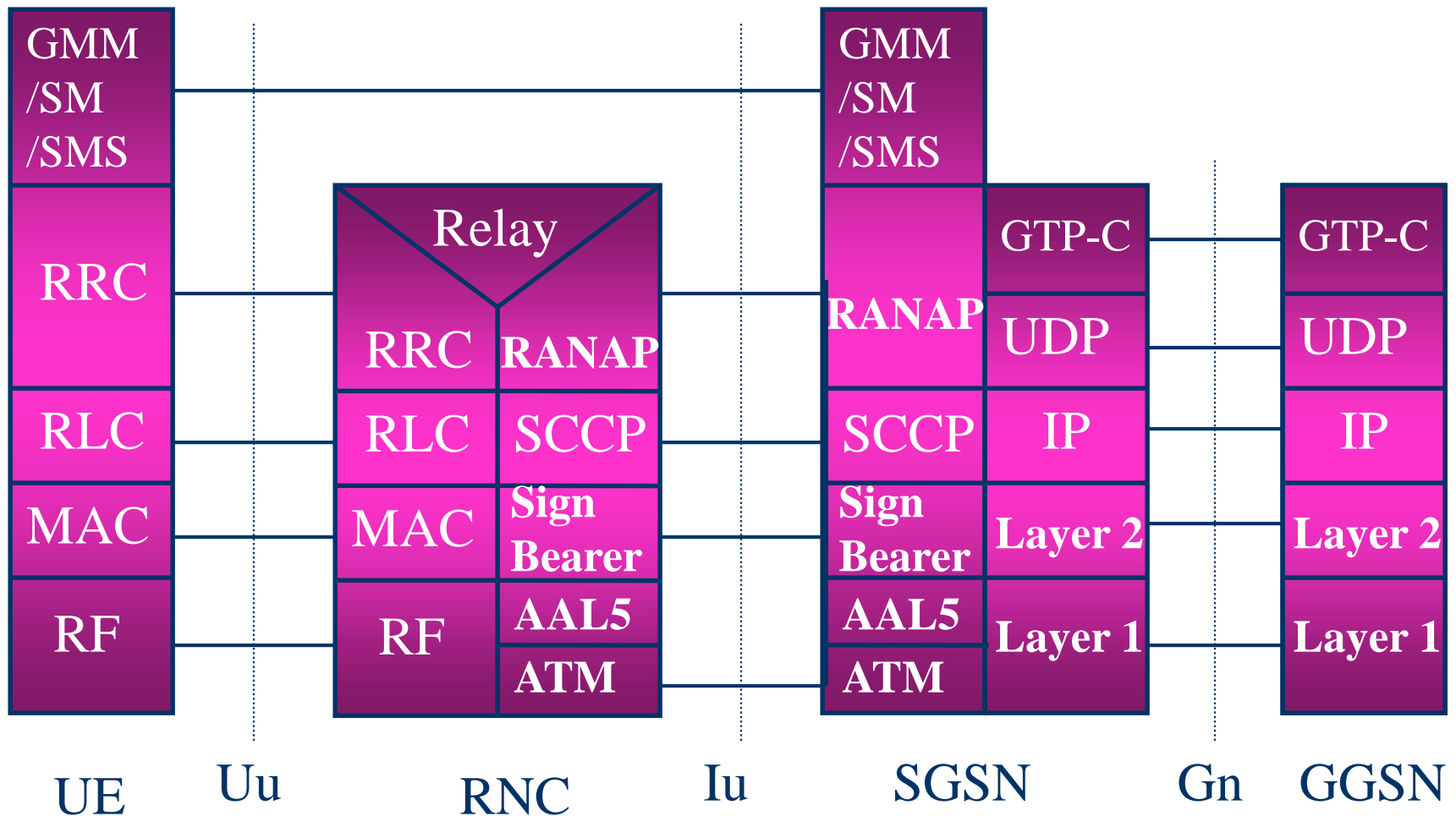
Mobile Station's
Mobility Management
State Model

W-CDMA Network

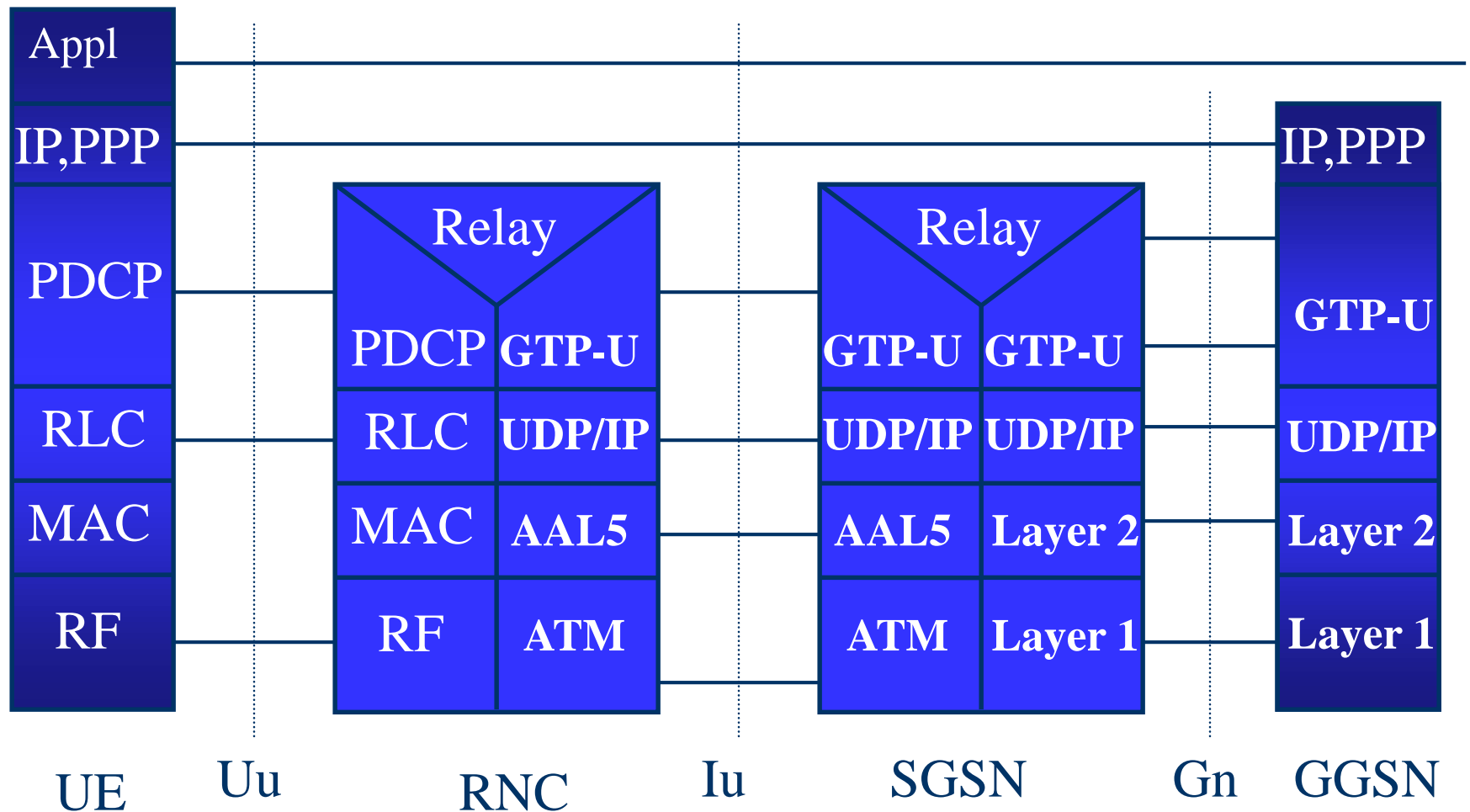


UMTS R99 Architecture

W-CDMA Control Plane Protocol



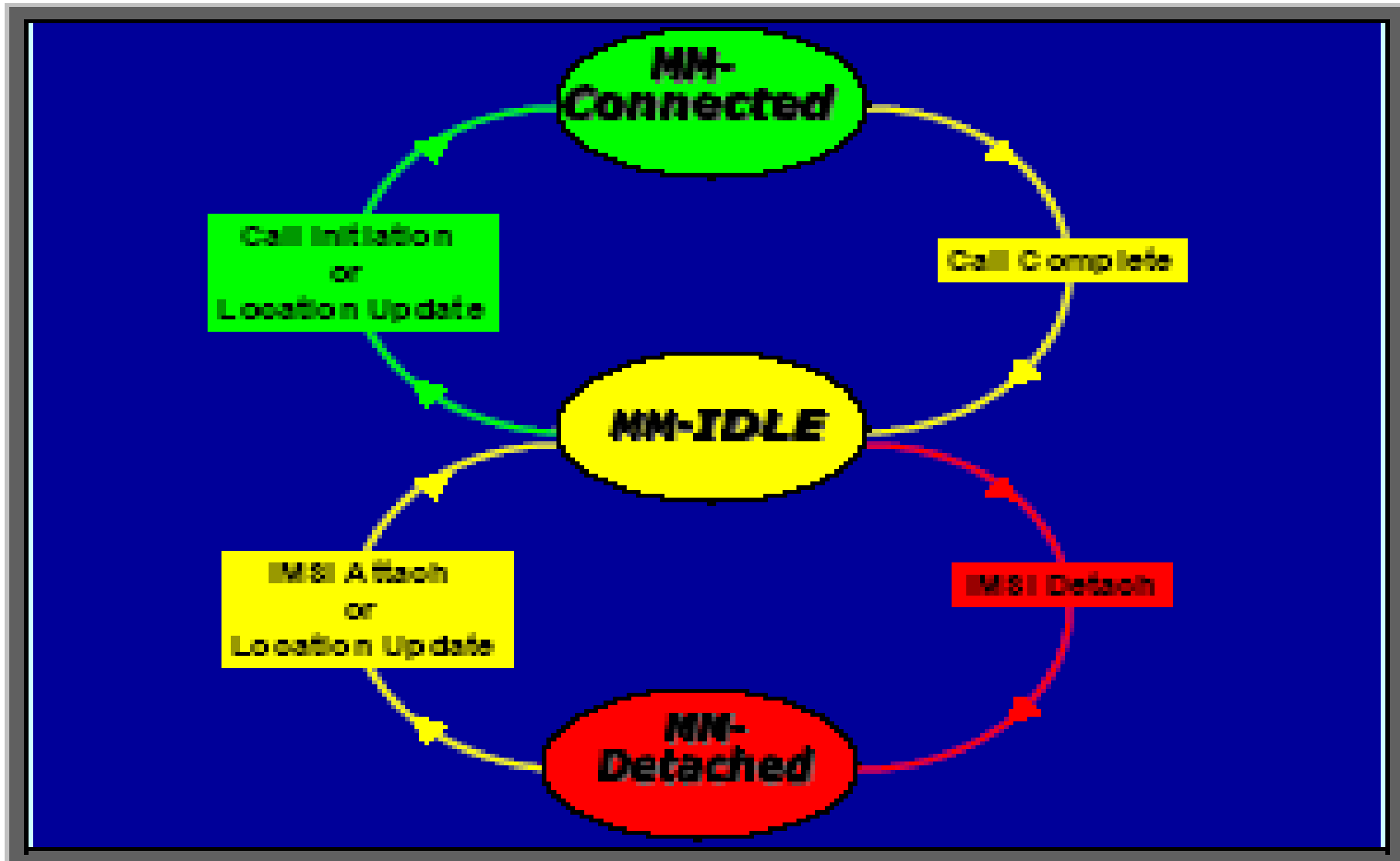
W-CDMA User Plane Protocol



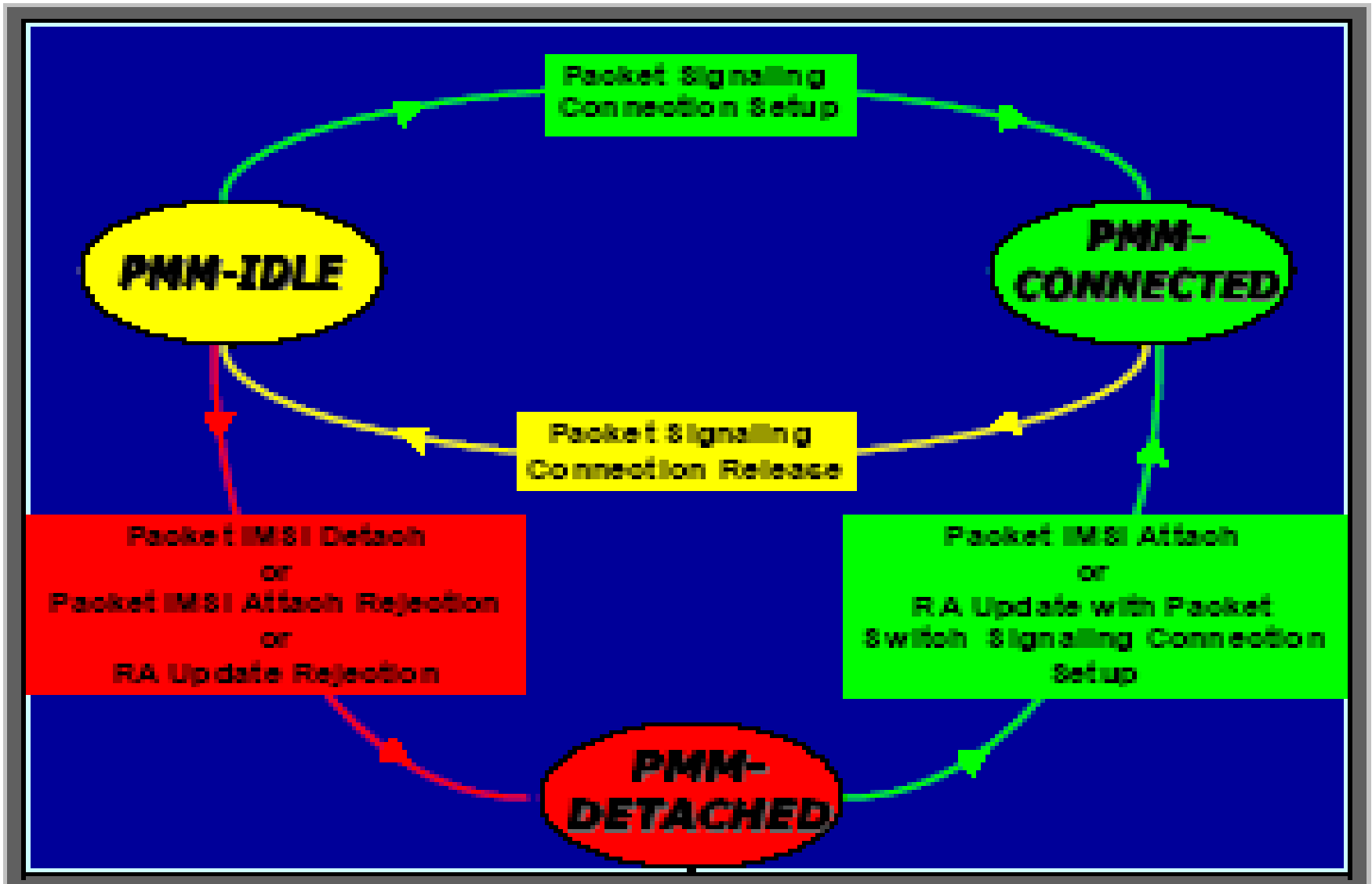
Mobility Management

- **Registration, authentication and paging activities** are determined by mobility management states. Two different three state models are used for circuit and packet switched mobility management.
- Circuit switched mobility management uses MM-Idle, MM-Connected and MM-Detached states.
- Packet switched mobility management uses PMM-Idle, PMM-Connected and PMM-Detached states.
- The mobility management states are indicators of mobile station location resolution.

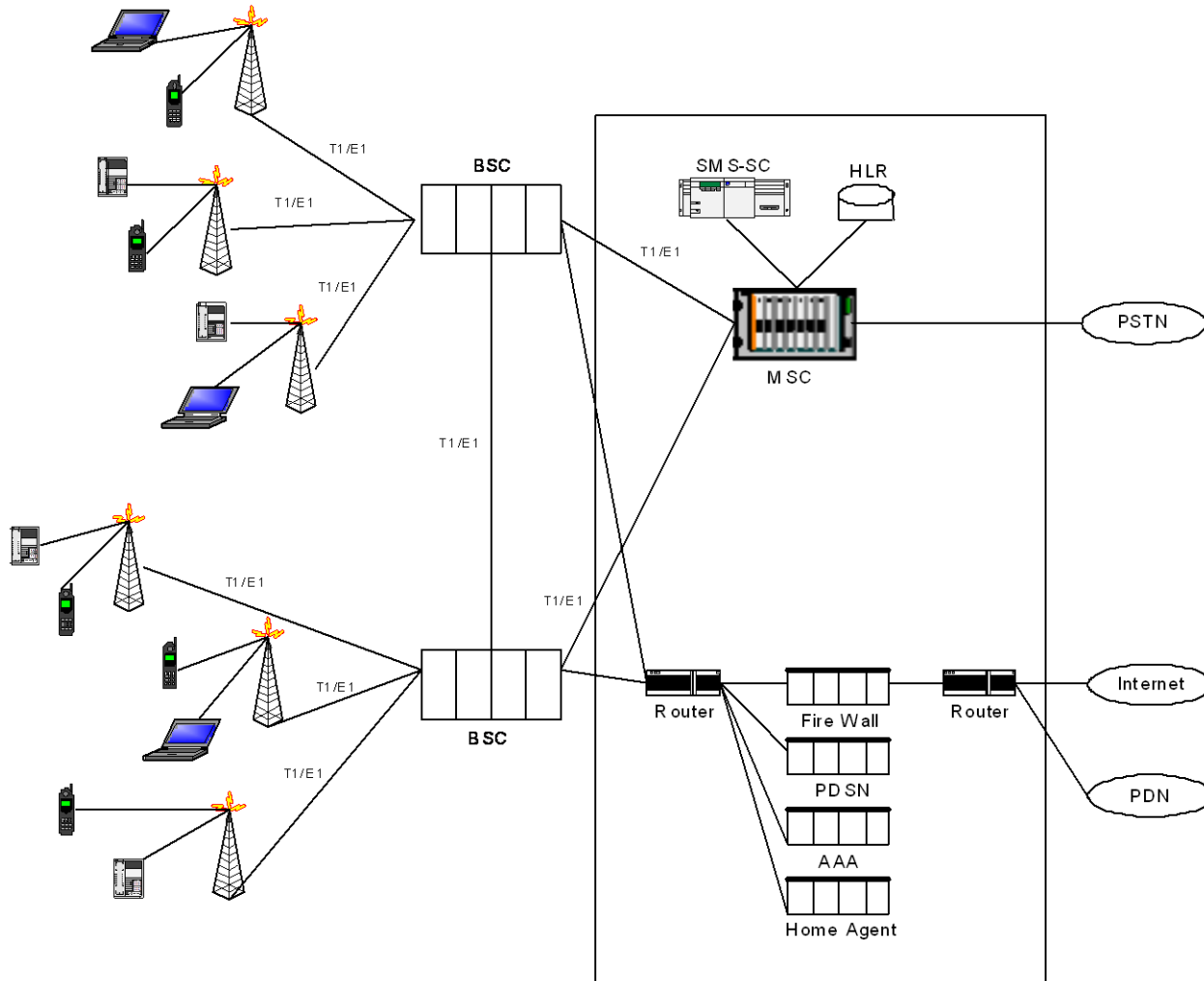
CS-MM



PM-MM

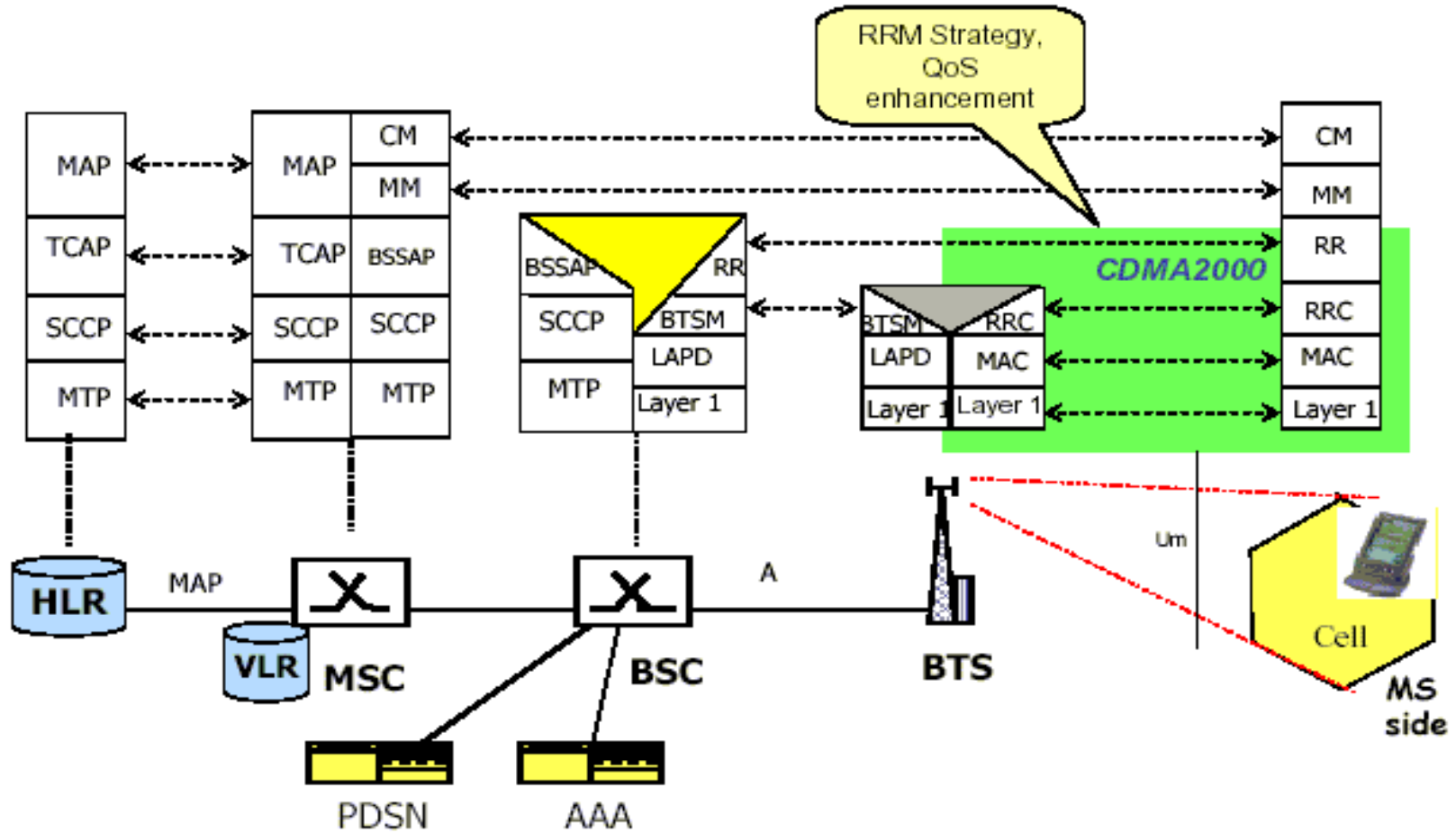


CDMA2000 Network



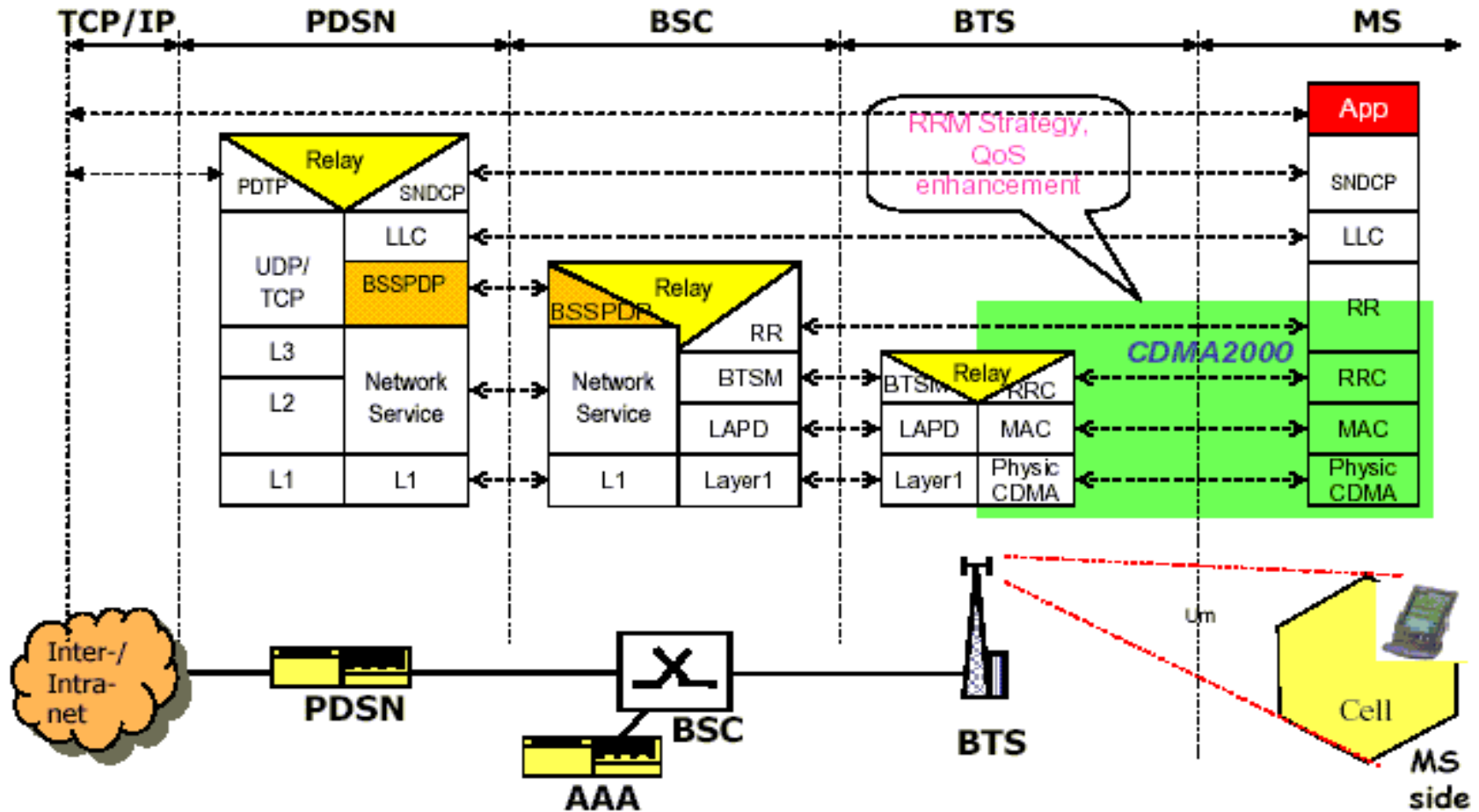
CDMA2000 Layering Protocol

Radio Layering Structure CDMA2000, **Validate MS**, and/or **Voice & CSD Application** → QoS Related



CDMA2000 Layering Protocol

Radio Layering Structure in PDSN, **Data Communication**
 → QoS Related



MM Scheme Comparison

Table 1 Network Type		Mobility Management			Radio Resource Management
		Registration & Paging Areas	AUC	Roaming	Handoff Types
1G	AMPS	Single Cell & Proprietary Cell Groups	MS Only Simple MIN & ESN	Conditional Difficult	Network Controlled, Hard, Intra-MSC, Inter-MSC IS41
2G	GSM	Global Single Cell & Location Areas (LAI)	MS Only 3 keys A3 Algor.	Good between GSM Operators	Network Controlled, MAHO, Hard, Intra- BSC, Intra-MSC & Inter-MSC
2G	NA- TDMA	Single Cell & Location Areas (LAI) ⁷⁵	IS54, CAVE ⁷⁶	Conditional	Network Controlled, MAHO, Hard, Intra-MSC & Inter-MSC IS41

MM Scheme Comparison

Table 1 Continued Network Type		Mobility Management			Radio Resource Management
		Registration & Paging Areas	AUC	Roaming	Handoff Types
2G 2.5G	CDMA One IS95 A & B	Single Cell & zone	MS Only Based on Long Code Masks, CAVE	Conditional ANSI 41	Mobile Initiated, Network Controlled, Soft, Hard & HO to Analog ANSI 41 compliant
2.5G	GPRS	Global Single Cell, Location Areas (LAI), Routing Areas (RAI)	MS Only 3 keys A3 Algor.	Good between GSM Operators, SIM	Network Controlled, MAHO, Hard, Intra- BSC, Intra-MSC & Inter-MSC
3G	UMTS	Global Single Cell, Location Areas (LAI), Routing Areas (RAI) & UTRAN Routing Area	MS & Network Private Master Key algor.	Almost Everywhere SIM	NEHO, MEHO, Hard, Soft, and Softer Intra- BS, Inter-BS, Intra- MSC, Inter-RNC, Inter- SGSN & Inter-Sys. Inter-MSC ⁷⁷