

# **Wireless Internet Networking (Carriers' Perspective)**

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**Wireless & Access Technologies  
AT&T IP Architecture**

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# The Big Bad Wolf? or The Dumb Dumb?

- Drive down costs
- Increase revenue/profit
- Maintain reliability

# Key Take Aways

- **IP Mobility Architecture**
- **Decisions and status**
- **Open Issues**

# Outline

- ***Introduction***
- **Mobility Management: PCS v.s. Internet**
- **Existing and Emerging Wide Area Wireless Internet Technologies**
  - ➔ **1G: CDPD**
  - ➔ **2G: GPRS**
  - ➔ **3G.IP, etc**
- **Future Direction**
  - ➔ **Seamless Wireless and Wired Mobility**
  - ➔ **ITU v.s. IETF**
  - ➔ **Parlay, Jain, OMG**

# Multi National Corp. (MNC) Needs

- *Whenever, Wherever, However*
  - ➔ Intranet access, private number dialing, web browsing, email, voice mail, caller id, call forwarding
  - ➔ Terminal Mobility
- Number Convergence
  - ➔ LNP, Tariffs v.s. Tech
  - ➔ Service mobility
- Terminal Convergence
  - ➔ User mobility
- *Fixed & Mobile Convergence*



# Future Mobility Services

- **Wireless personal base station integrated with HFC/DSL/FWS infrastructure**
- **Virtual Home Environment**
- **Advanced Addressing**
- **Simultaneous or Sequential Alerting**
- **Closed User Group**
- **Location Based Services**



# Mobile Telecommunications

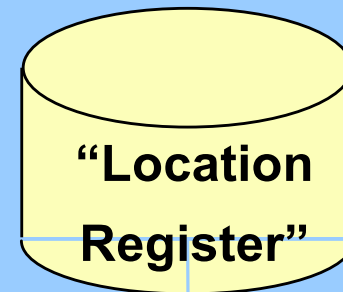
## User View:

- Use of Mobile Telephone / Wireless Handset
- Ability to originate and receive calls from different locations



## Network View:

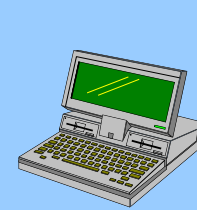
- Mobility Management
- Ability to maintain location and status information for mobile subscribers
- Connection-oriented services



# Mobile Computing

## User View:

- Use of wireless laptop/handset
- Ability to originate and receive seamless IP services from different locations



## Network View:

- Mobility Management
- Ability to maintain location information for mobile subscribers
- Connectionless services

Mobility Agent



# Outline

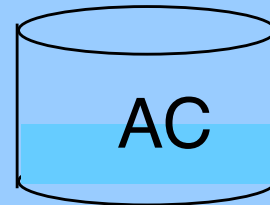
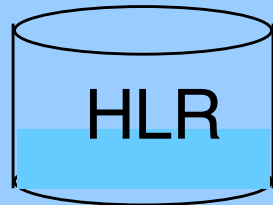
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# Mobility Definitions

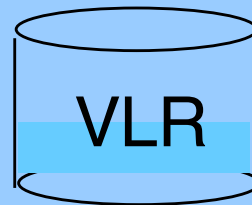
- **Macro Mobility (i.e. Portability):** Users have a home system but can register at visited system to make and receive calls and use their vertical features - Single Number Service
- **Micro Mobility (i.e. Handover/Handoff):** Users can roam among systems during a call and the call is handed-off without being dropped

# PCS Mobility Functional Elements

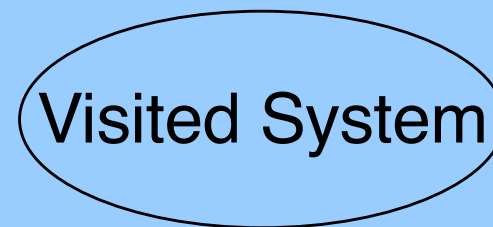
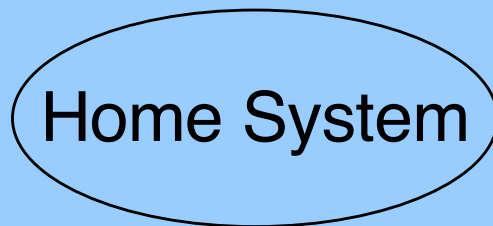
Home Location Register- Maintains current customer location and service profile



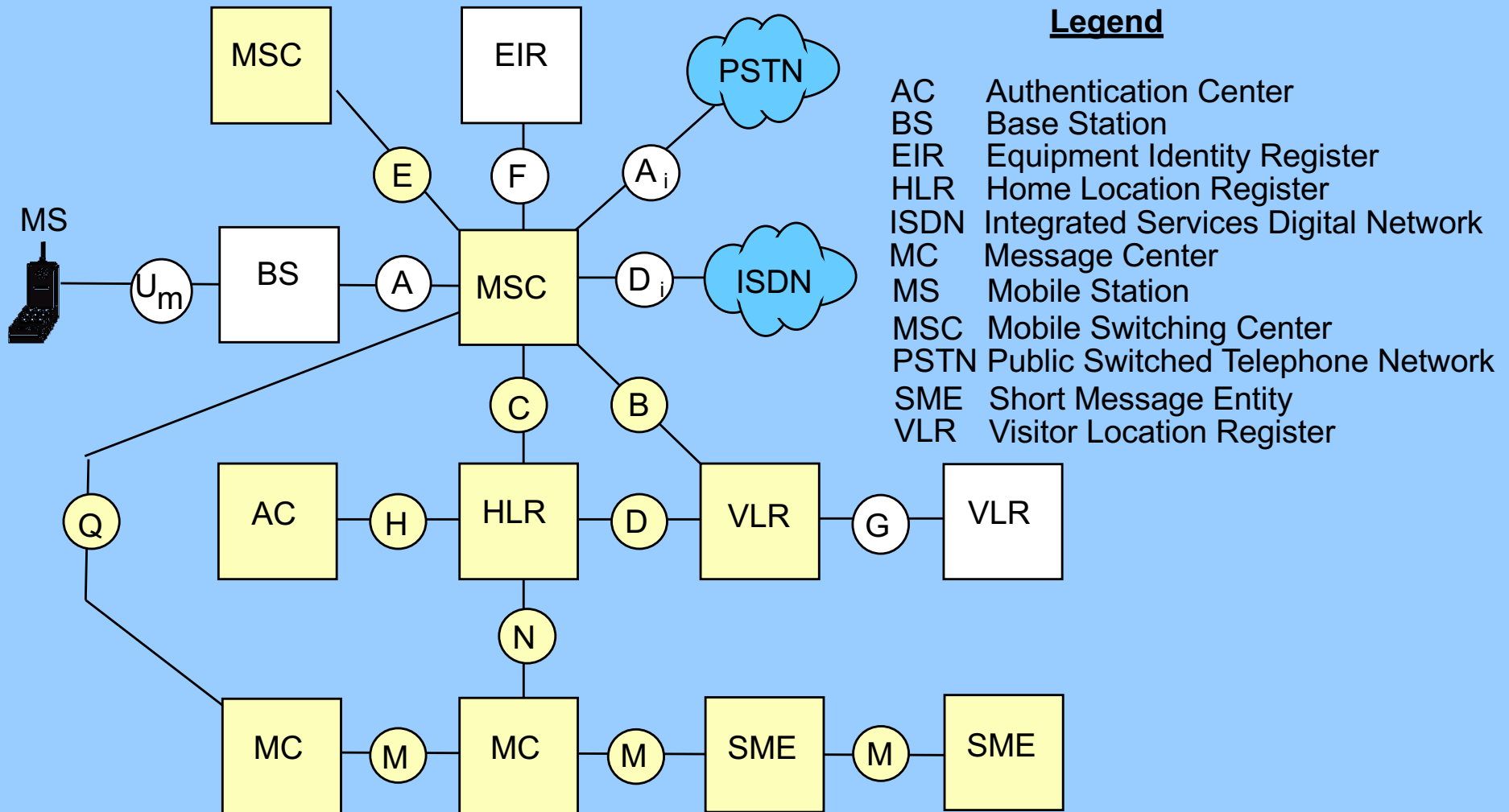
Visitor Location Register- Maintains temporary information on visiting users.



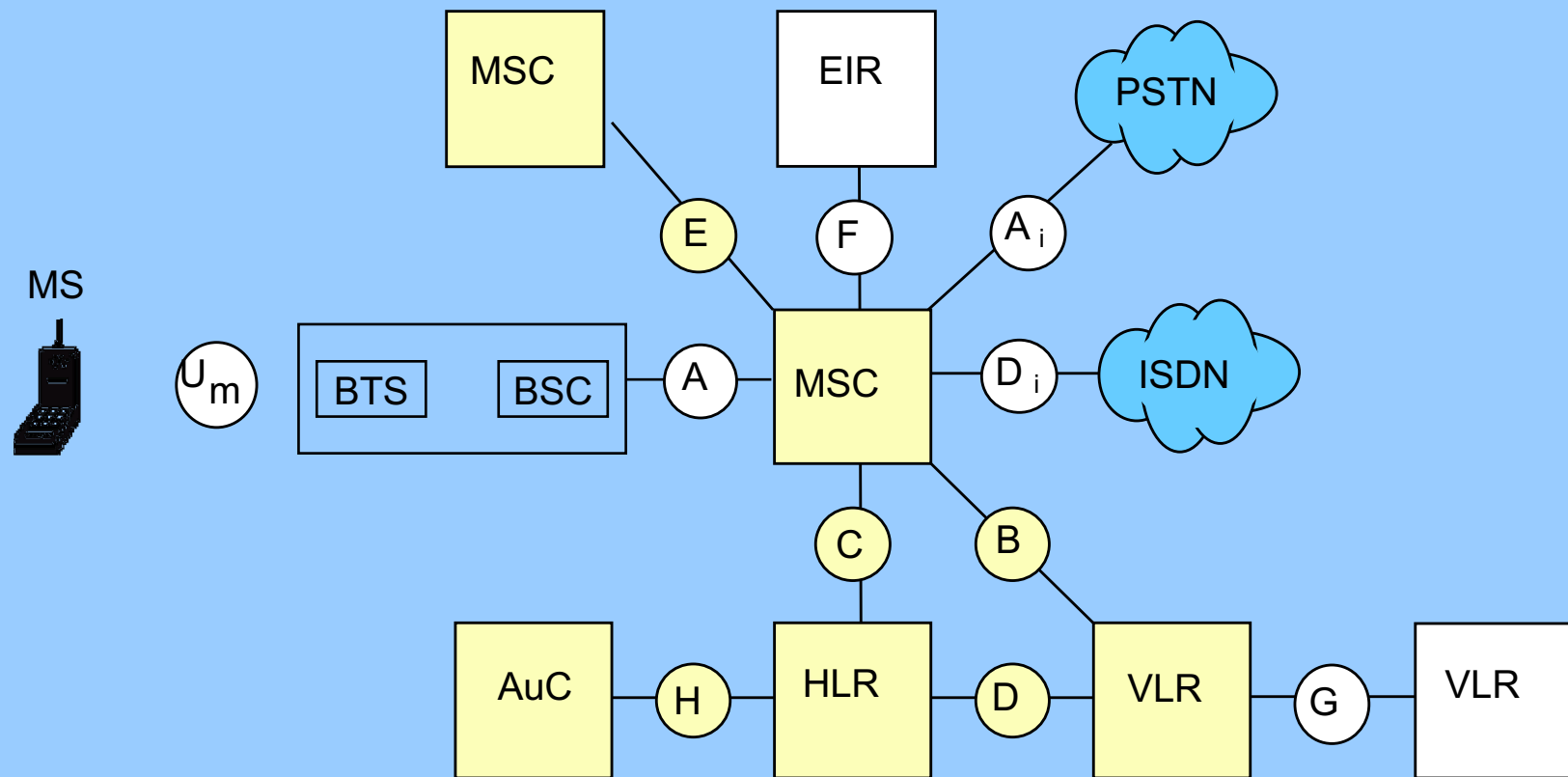
Authentication Center - Authenticates user



# IS-41 NRM (Network Reference Model)



# GSM 900/DCS 1800 NRM

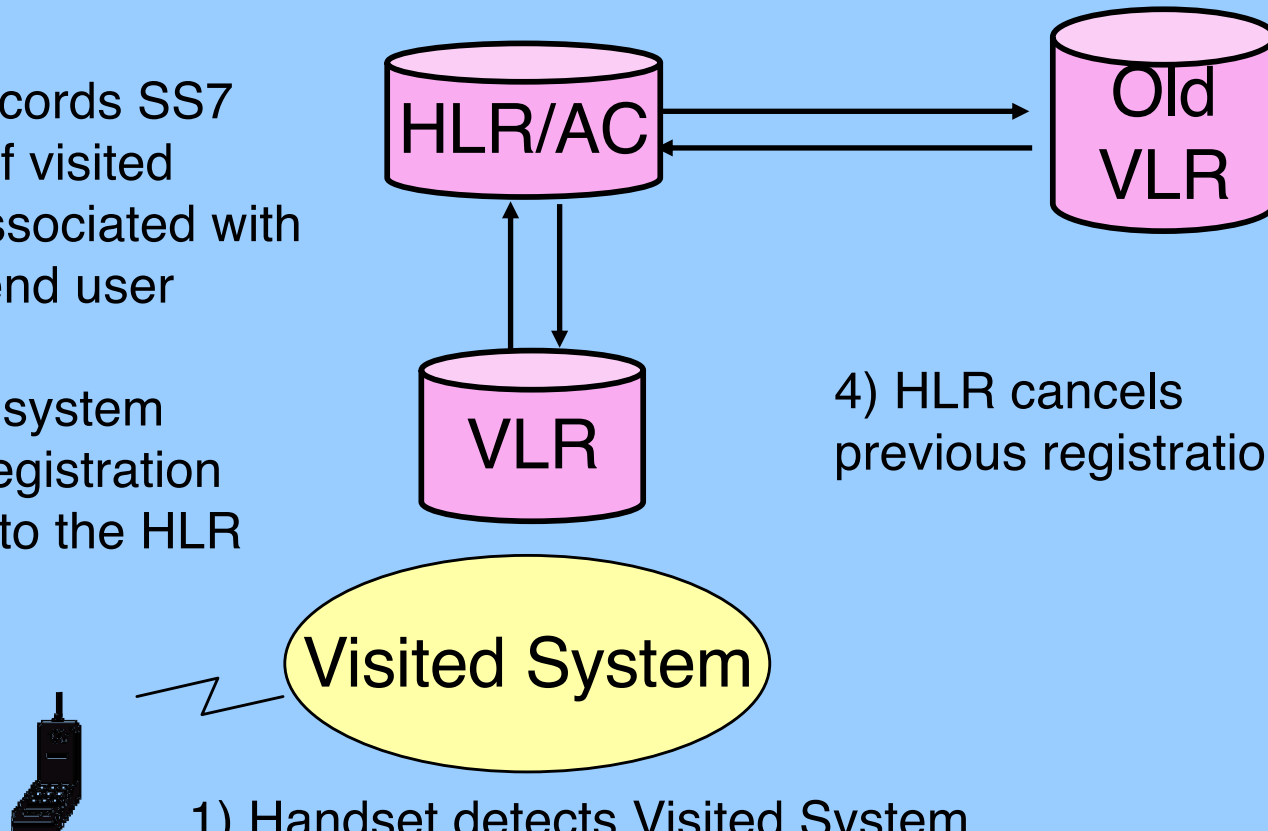


# IS-41 Registration

3) HLR records SS7 address of visited system associated with roaming end user

2) Visited system sends a registration message to the HLR

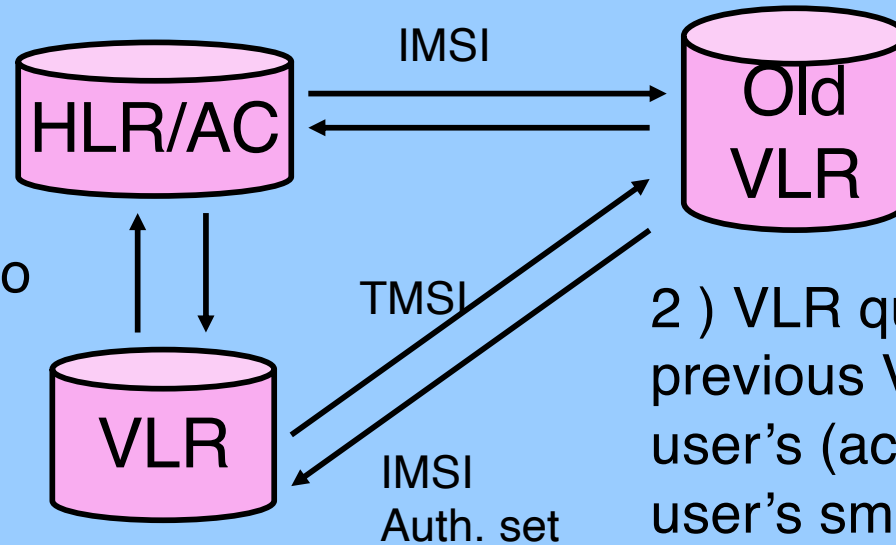
4) HLR cancels previous registration



1) Handset detects Visited System, handset transmits MIN (Mobile Identification Number, the terminal dialable number)

# GSM Registration

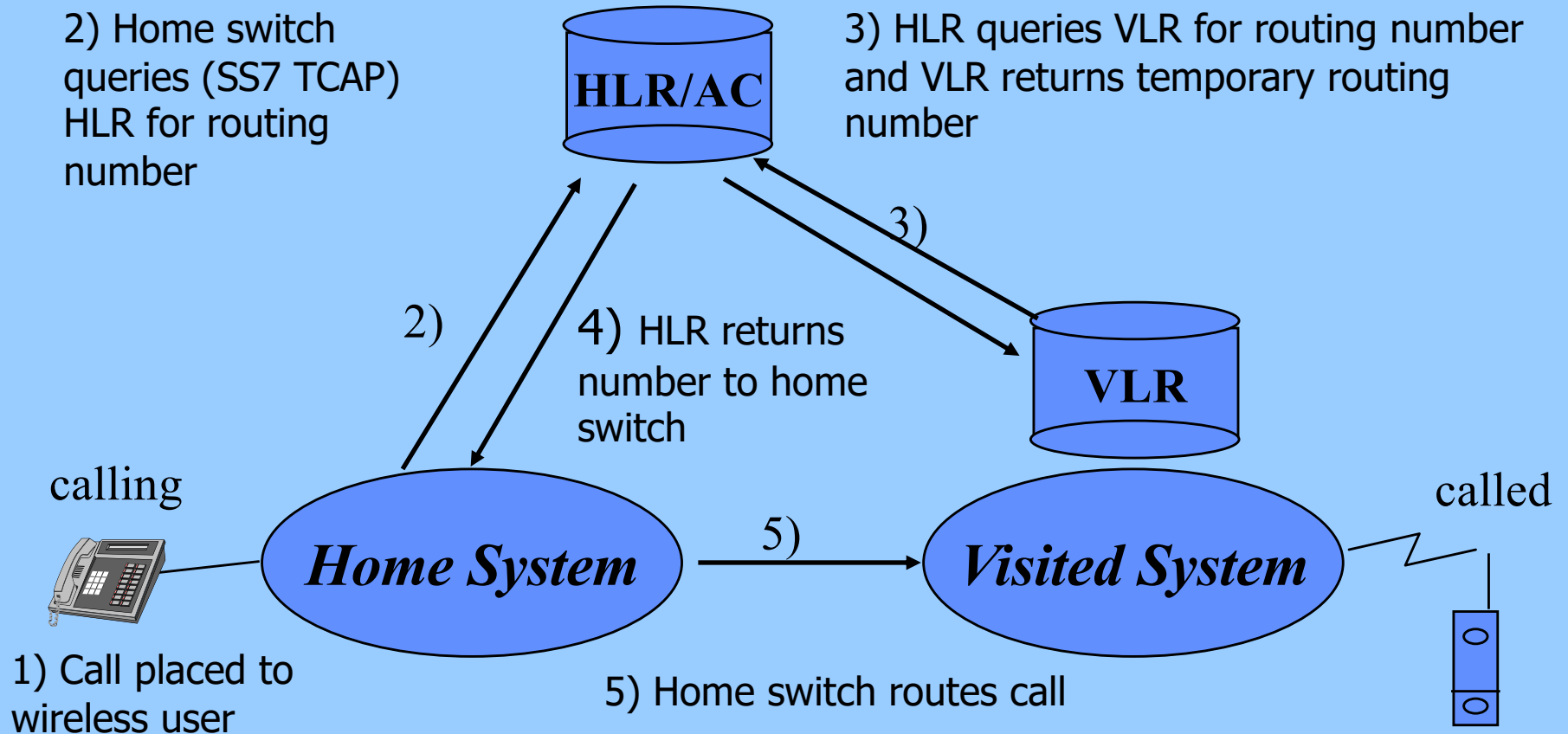
3) The VLR sends a registration message to the HLR, the IMSI is used for routing the TCAP message.



2) VLR queries previous VLR for user's (actually the user's smart card) permanent ID

1) Visited system detects handset, handset transmits temporary ID, TMSI, assigned by previous system

# IS-41 & GSM Call Delivery



HLR: Home Location Register  
AC: Authentication Center

VLR: Visitor Location Register

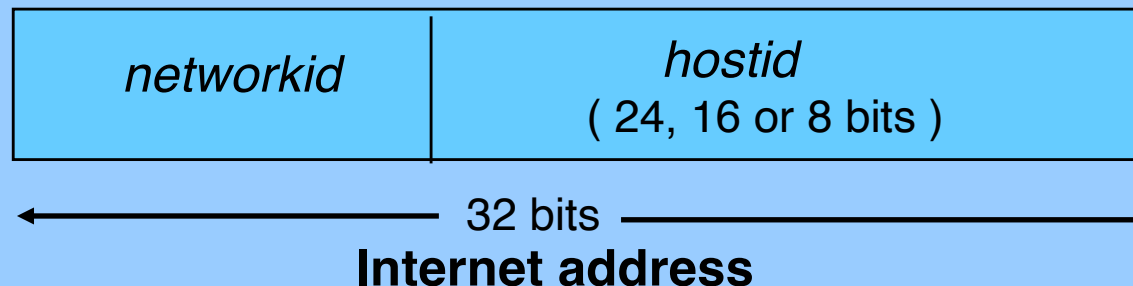




# Mobile IP

*MIP allows users of portable computers to move from one place to another and yet maintain transparent network access through the wireless link.*

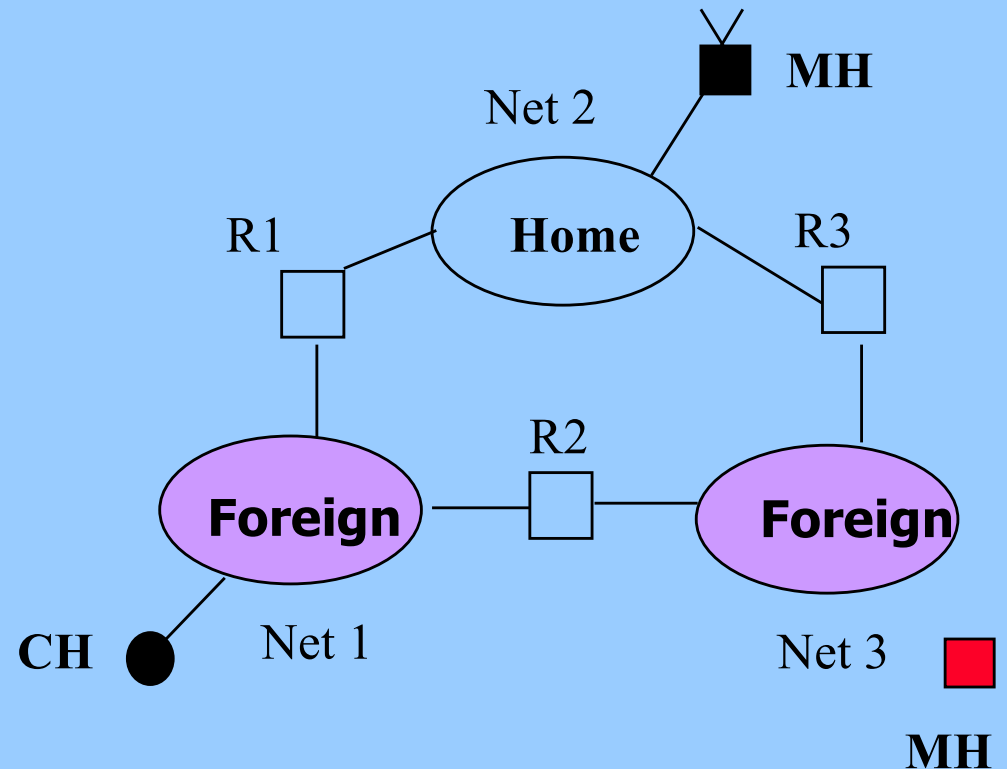
- **Existing set of network protocols do not meet these requirements.**
  - ➔ **Designed for a stationary network topology.**



# Mobile IP: overview

- Mobile - IP addresses the problem of providing mobility support to IP hosts

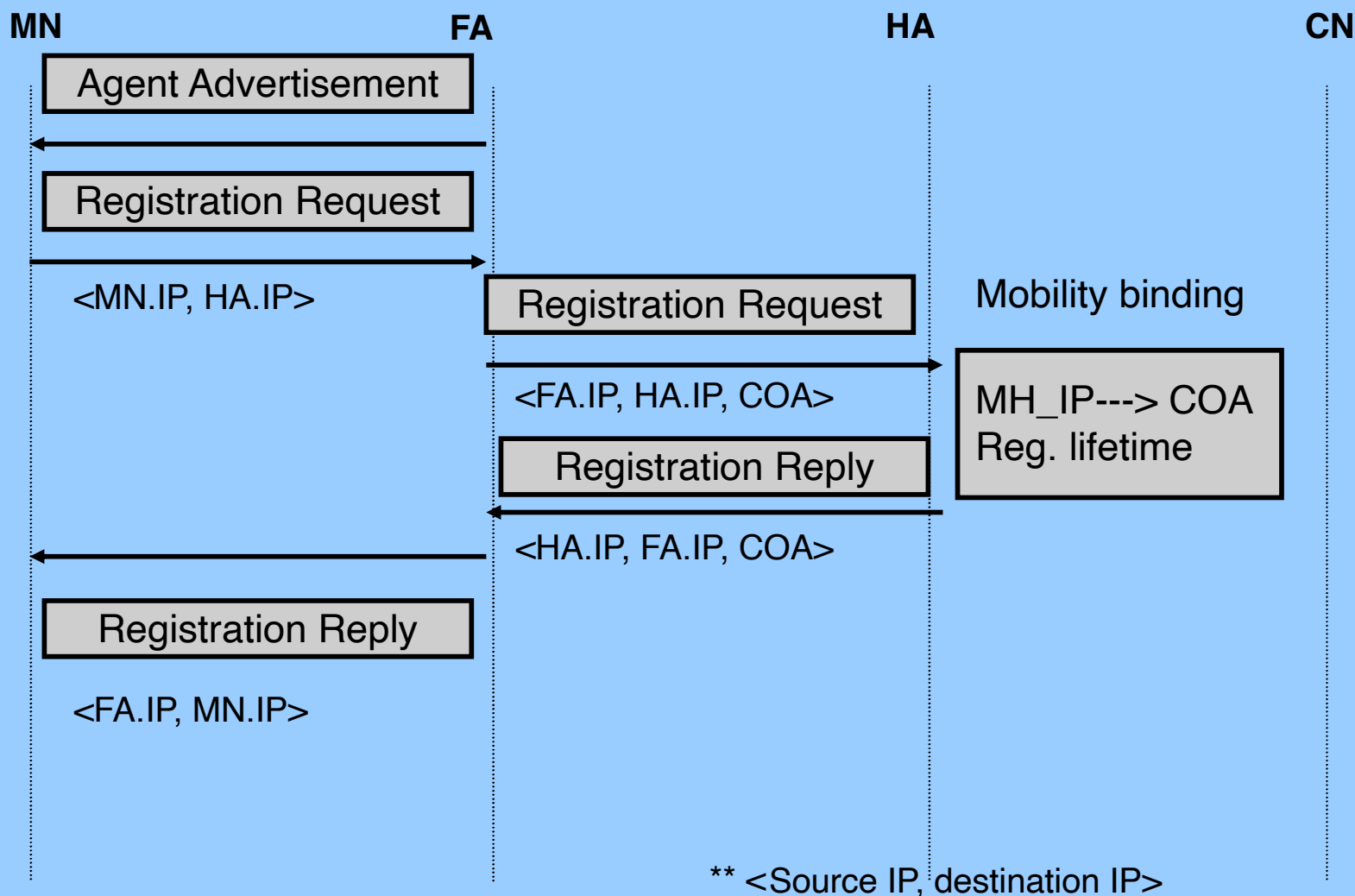
- ➔ Mobile Host, MH
- ➔ Correspondent Host, CH
- ➔ Home network
- ➔ Home Agent, HA
- ➔ Home address
- ➔ Foreign network
- ➔ Foreign Agent, FA
- ➔ Foreign address



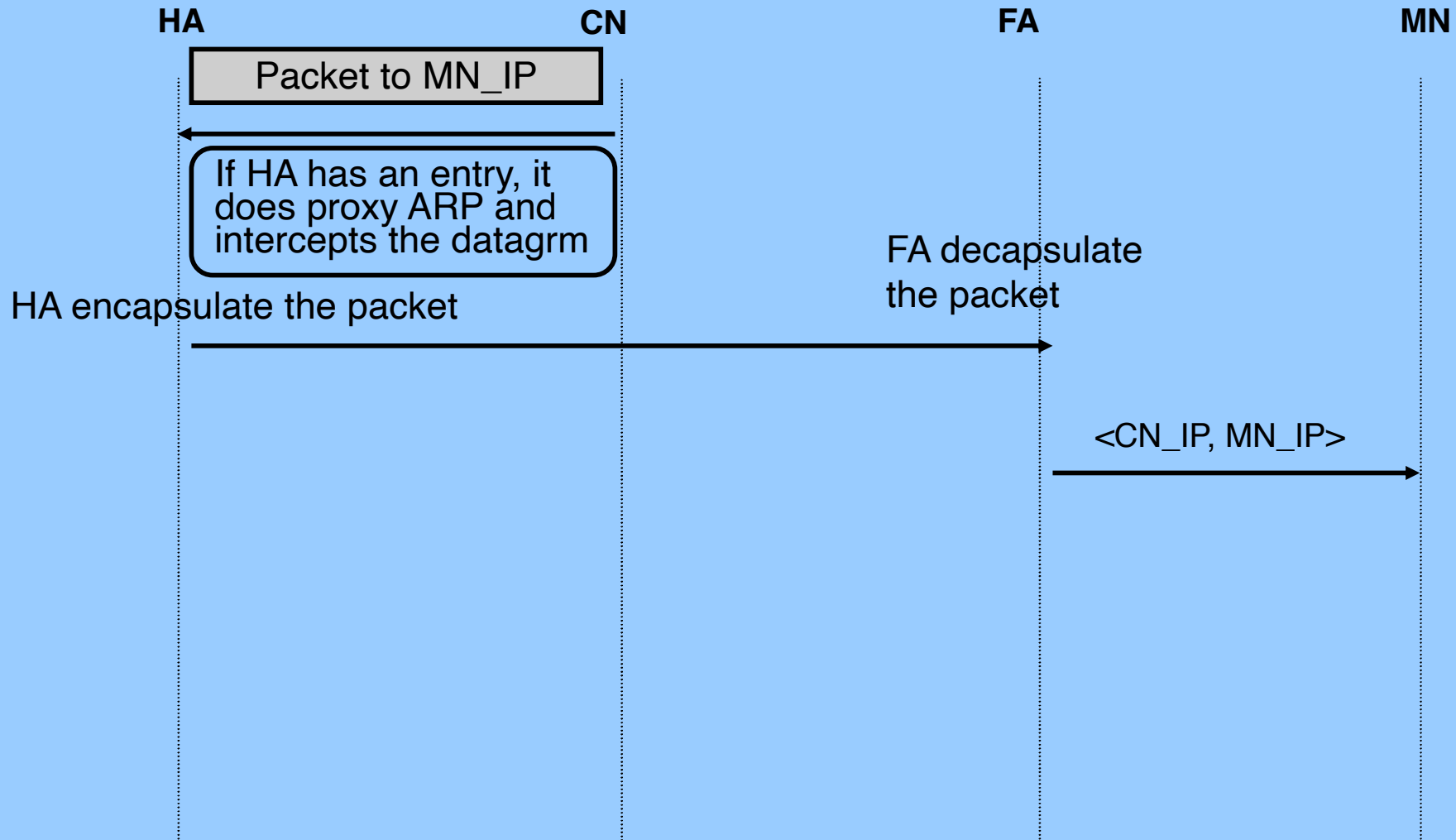
# Basic Mobile IP

- **Agent discovery: advertisement/solicitation**
- **MH registration**
- **Use of Care-Of-Address (COA)**
- **Proxy ARP (Address Resolution Protocol)**
- **Packet tunneling**
- **Triangle routing**

# Mobile IP - Registration



# Mobile IP - Datagram Delivery



# PCS Mobility Management

- **Connection oriented**
- **HLR, VLR are not involved in datagram delivery**
- **Authentication is based on the Network Access Identifier such as IMSI**
- **Handoff is at the radio system level**
- **Does not provide session connectivity above radio system level**
- **Not efficient for packet data transmission**



# Internet Mobility Management

- **Connectionless**
- **HA, FA are involved in datagram deliver**
  - ➔ **bottleneck at HA and FA**
- **Authentication is based on the static IP address**
- **Mobile node's IP address needs to have the same subnet prefix as HA**
- **Handoff at IP layer**
- **The amount of Mobile IP signaling traffics over the radio link is excessive**
- **Delay due to mobile IP signaling may not be appropriate for real-time applications**



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# Cellular Digital Packet Data (CDPD)

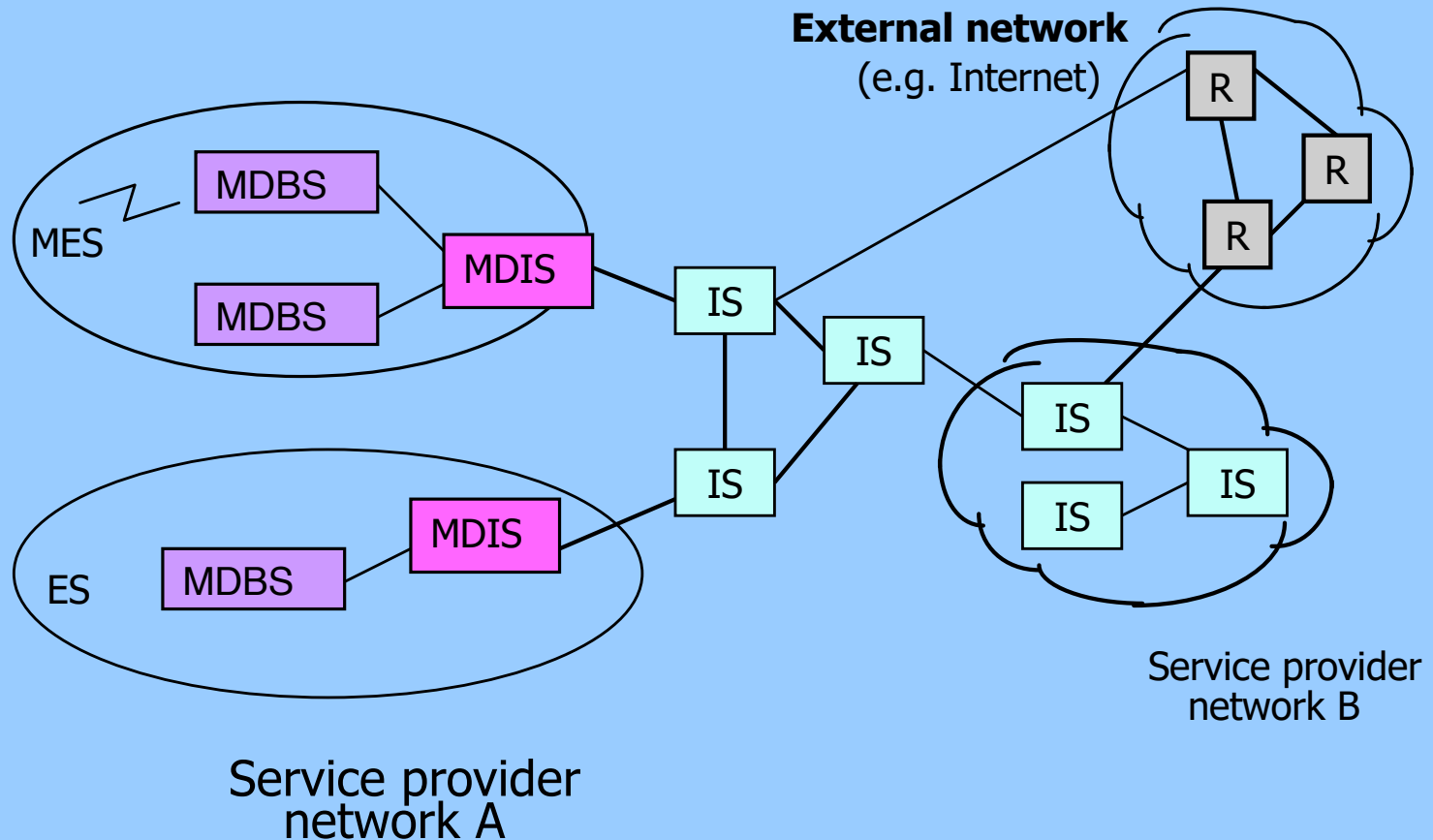
- **Goals**

- ➔ **Use available cellular capacity**
  - Sniffing to find idle channels
  - Hops among available channels
  - Voice always higher priority
- ➔ **Share cellular infrastructure**
  - Frequencies
  - Towers and antennas

# CDPD (con't)

- **Different radio technologies and protocols**
  - Different network switching equipment
- **Raw bit rates - 19.2 kb/s (GMSK)**
  - Forward error correction
  - Encryption over radio link

# CDPD Network Architecture



R Router  
 MDIS Mobile Data Intermediate System  
 MDBS Mobile Data Base Station

ES End System  
 MES Mobile End System  
 IS Intermediate System



# CDPD

- **Pros**

- Potential widespread coverage
- Suitable for bursty data
- Broad industry support - standard
- May be able to use same handset
- Support of Internet and OSI protocols

- **Cons**

- Delay-not suitable for interactive applications
- Effective throughput is lower
- Slower than expected growth

# General Packet Radio Service (GPRS)

- New packet data service in GSM
- Packet wireless access network and IP-based backbone
- Access to packet data networks (PDN)
  - ➔ Internet
  - ➔ X.25 (NO MORE!)

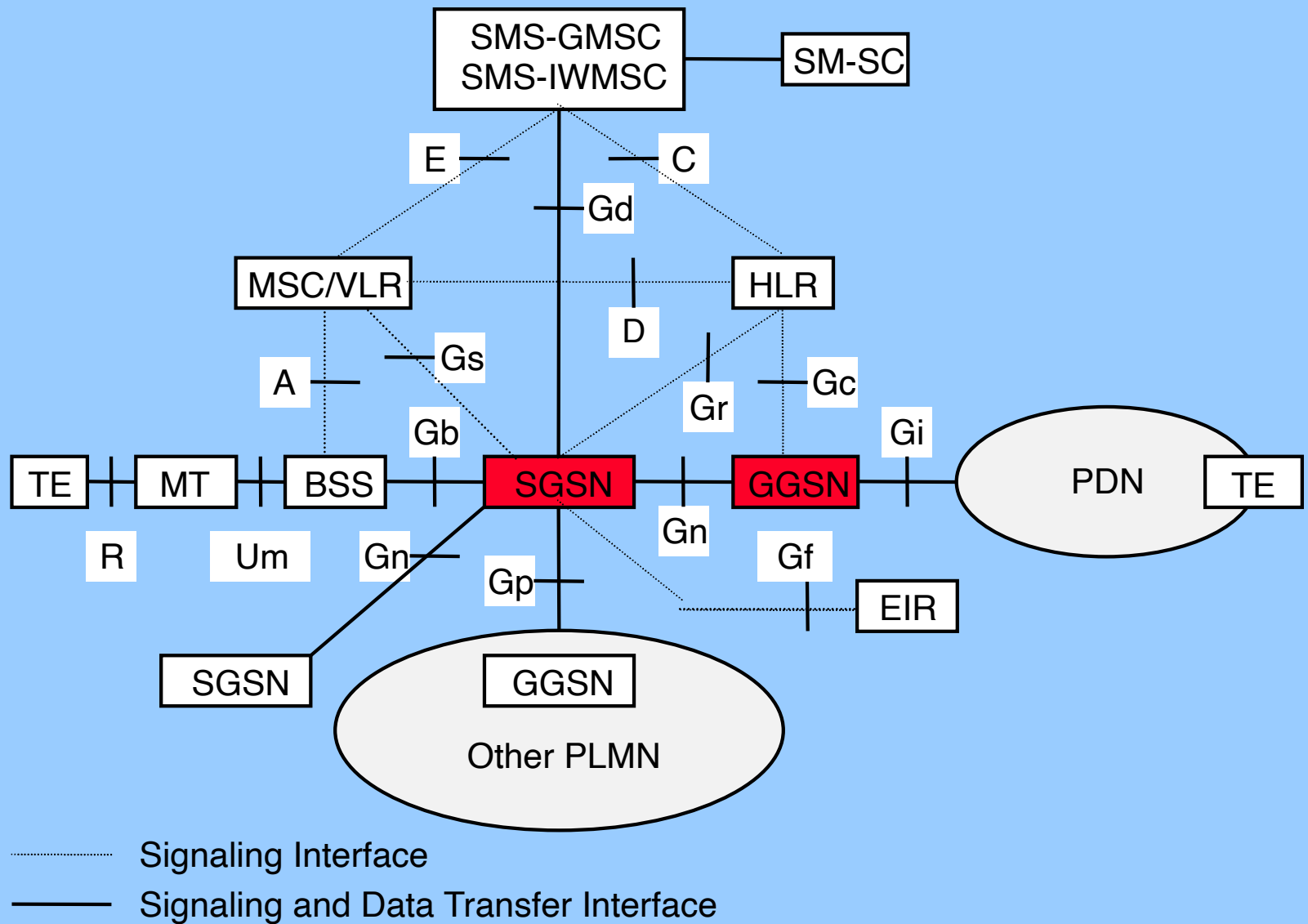
# GPRS Key Features

- **Packet-mode**
- **Flexible time slot allocation (1-8)**
- **Radio resources shared dynamically between speech and data services**
- **Independent uplink and downlink resource allocation**
- **Interworking with IP and X.25 networks**

# GPRS High-Level Functions

- **Network access control**
  - ➔ registration, admission control, authentication, etc.
- **Packet routing and transfer**
  - ➔ address translation, encapsulation, tunneling, etc.
- **Mobility management**
- **Logical link management**
  - ➔ establishment, maintenance and release
- **Radio resource management**
- **Network management: OA&M**

# GPRS Logical Architecture





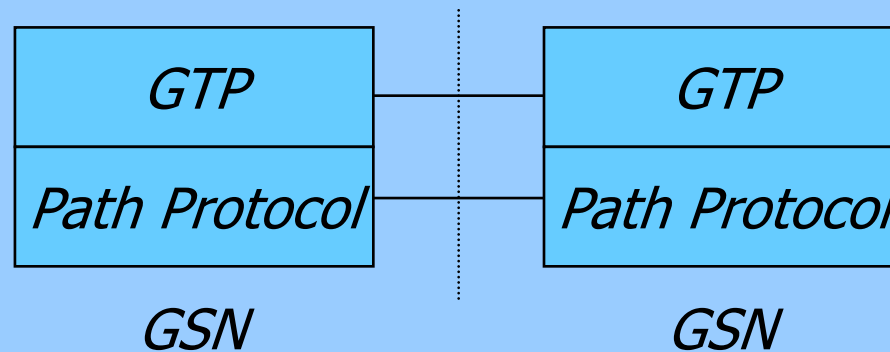
# Key Processes

- **Dynamic radio resource management**
  - ➔ capacity on demand (PS vs. CS)
  - ➔ flexible time slot assignment for both up-link and down-link
- **GPRS attachment/detachment: MS & SGSN**
- **GPRS mobility management**
  - ➔ MM Context: ID, state, RA, AAA, etc
  - ➔ Location Update: Cell, RA, LA
- **PDP activation/de-activation: MS & GGSN**
  - ➔ PDP Context: QoS, Compression, Address, type, etc

# **GPRS Tunneling Protocol (GTP)**

- **Forward packets between an external PDN and MU**
- **Carry GPRS signaling messages between GSNs**
- **Allows multi-protocol packets to be tunneled through the GPRS backbone**

# GTP Protocol Stack

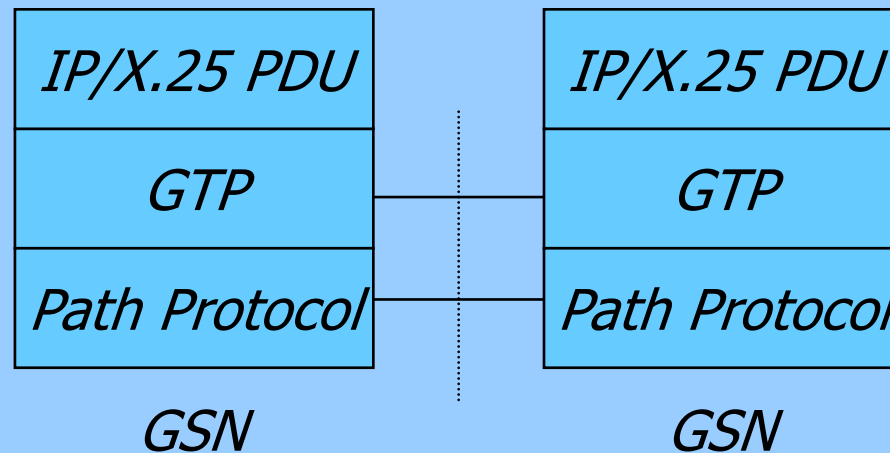


*GSN*

*GSN*

*Signaling Plane*

*Path Protocol  
- UDP/IP*



*GSN*

*GSN*

*Transmission Plane*

*Path Protocol  
- TCP, UDP/IP*



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# Wireless Internet Services

- **High bit rate transmission over wireless channel**
  - ➔ **IMT-2000 related air interfaces**
- **Maximum spectrum utilization efficiency**
- **Packet transmission control protocol**
  - ➔ **MAC, admission control**
- **Voice and data integration**
  - ➔ **Wireless VoIP**
- **Wireless QoS for IP services**

# Seamless Mobility World

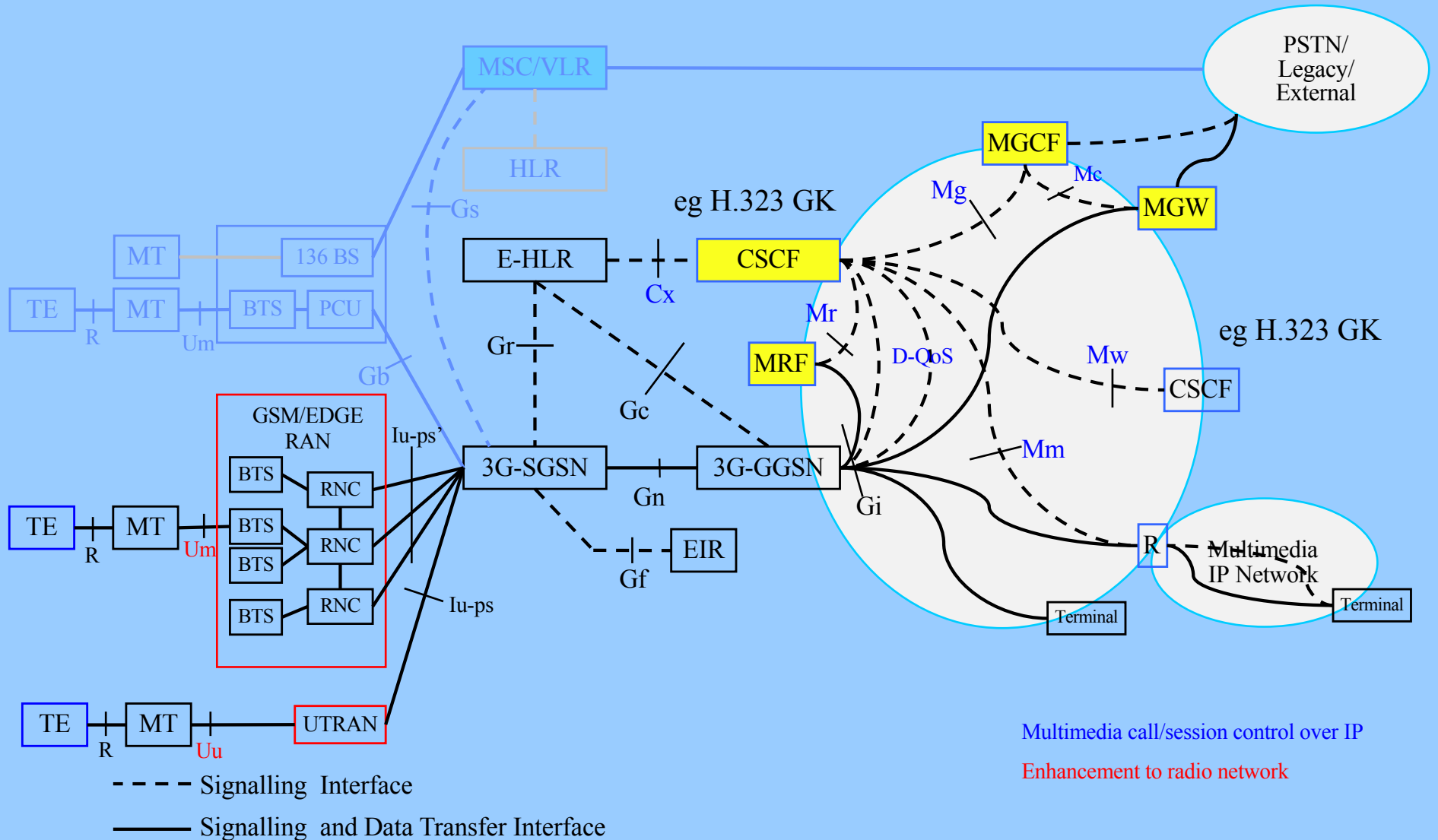
- **Wireless and Wired/Fixed**
- **Fixed BB access**
  - ➔ Cable
  - ➔ DSL
  - ➔ FWS
  - ➔ etc
- **A/B/C**
- **Internet, Intranet, HomeLAN, PersonalNet**
- **Core Capability, not “product”!**

# 3G.IP

- **Supporter of IP centric networking**
  - ➔ **Reference Network Architecture Evolved from GPRS**
- **Formed May 99**
- **10 Operators**
  - **AT&T Wireless, BT, TIM/CSELT, Rogers Cantel, Telnor, T-Mobil, Telia, SBC, Bell South, Japan Telecom**
- **7 Suppliers**
  - **Ericsson, Nokia, Lucent, Nortel, Motorola, Siemens, Alcatel**
- **Pre-standards work to drive next round of standardization**



# 3GPP Release 2000

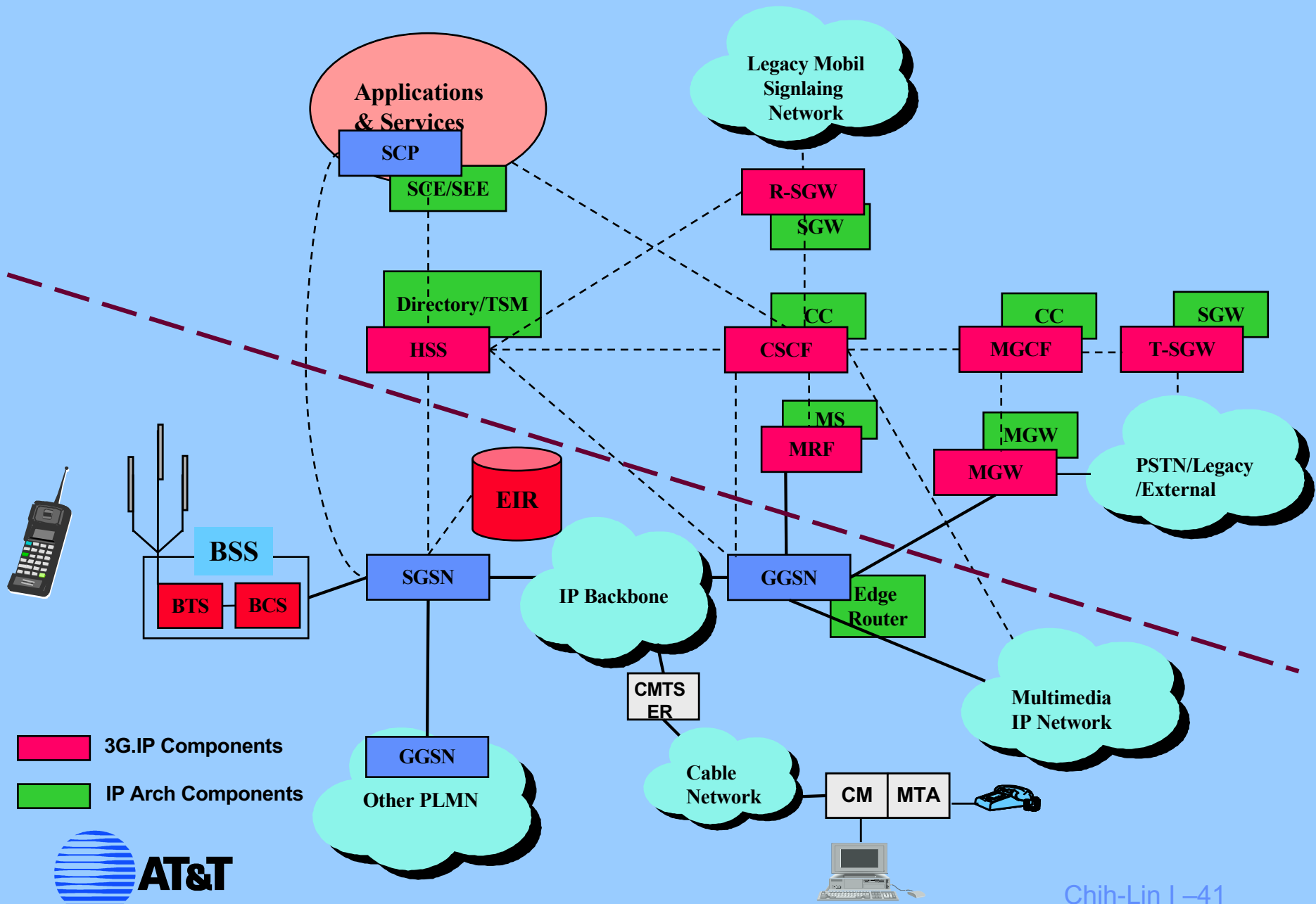


Multimedia call/session control over IP  
 Enhancement to radio network

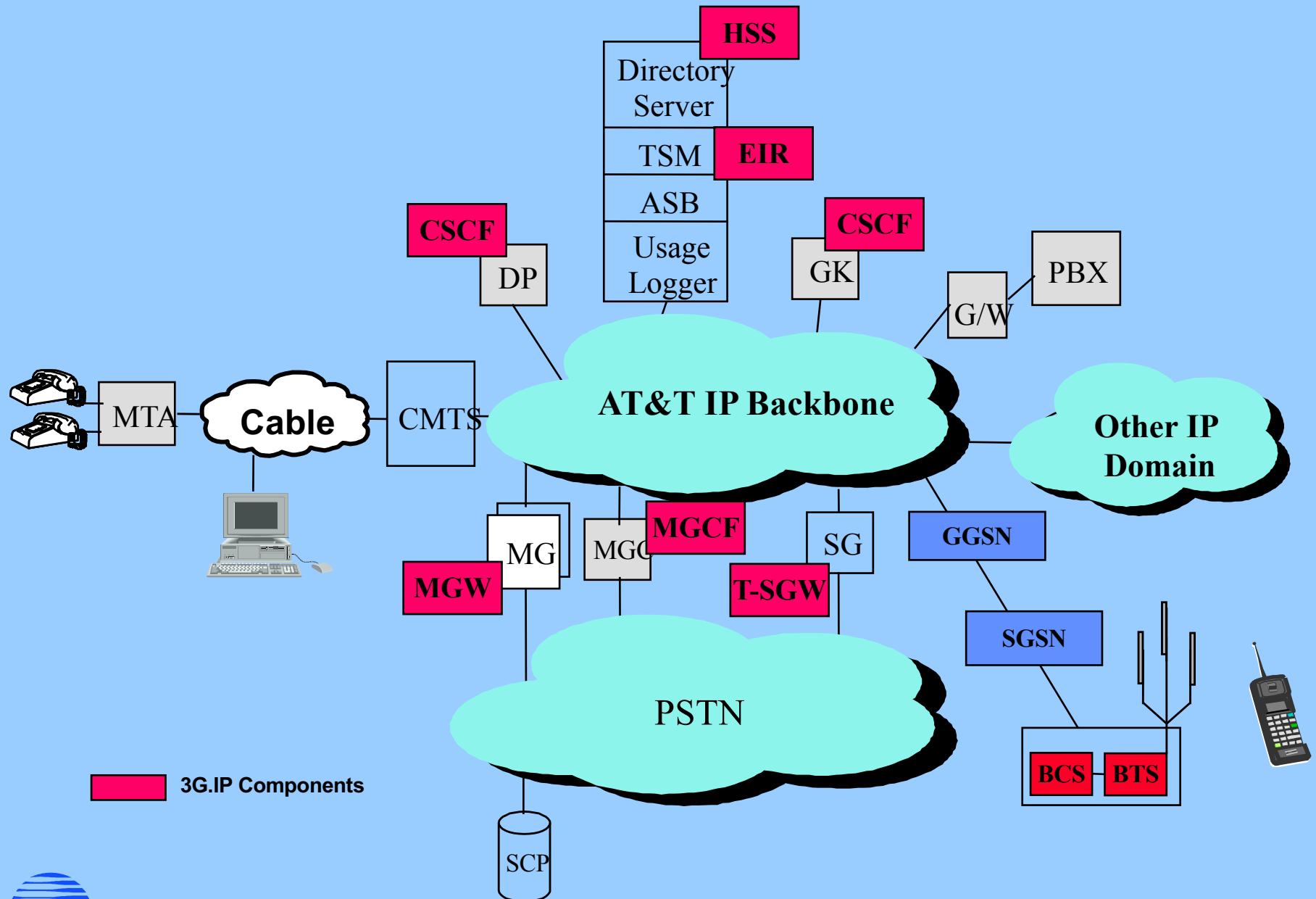




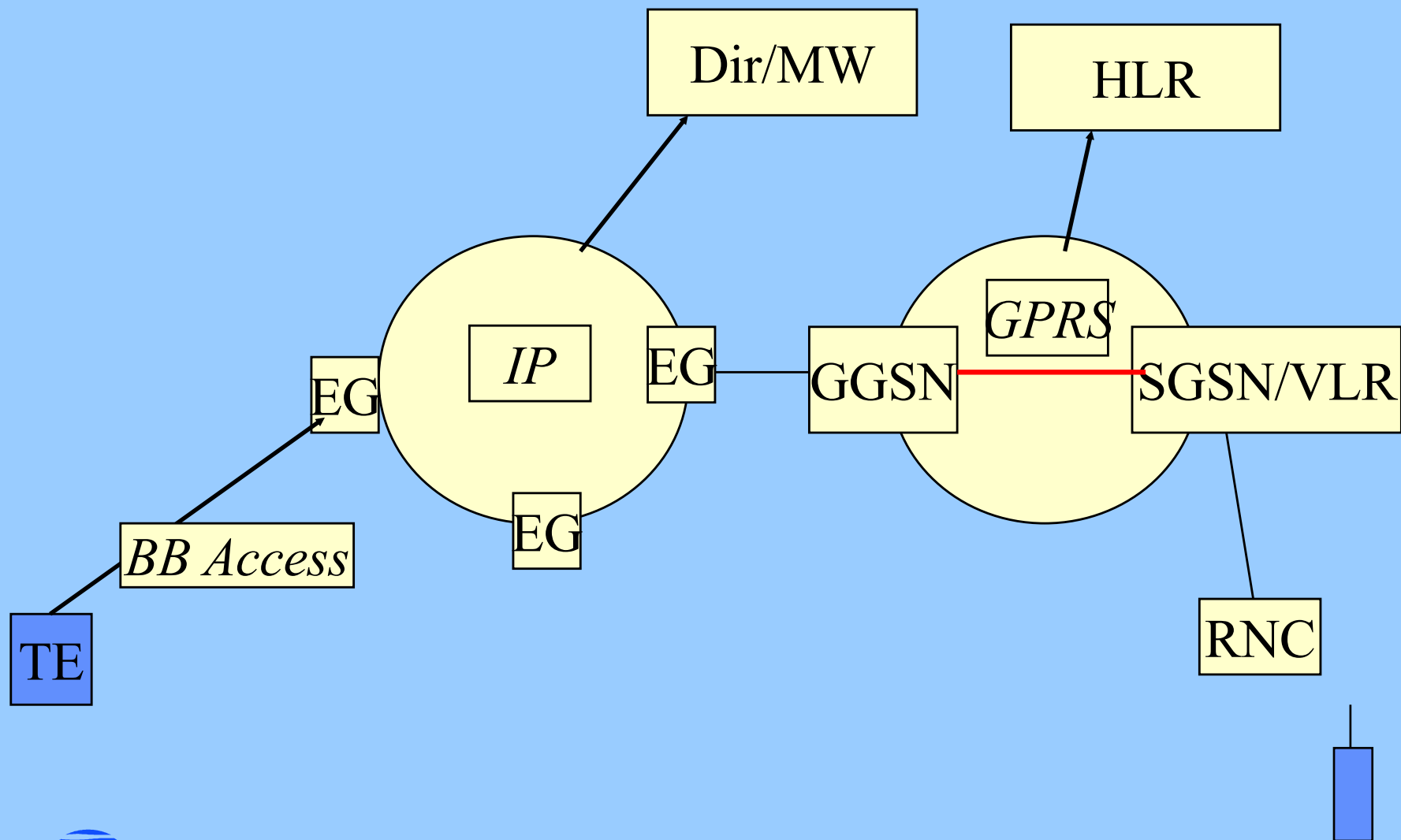
# 3G.IP Instantiation



# Cable Access Instantiation



# Virtual Home Environment (VHS)



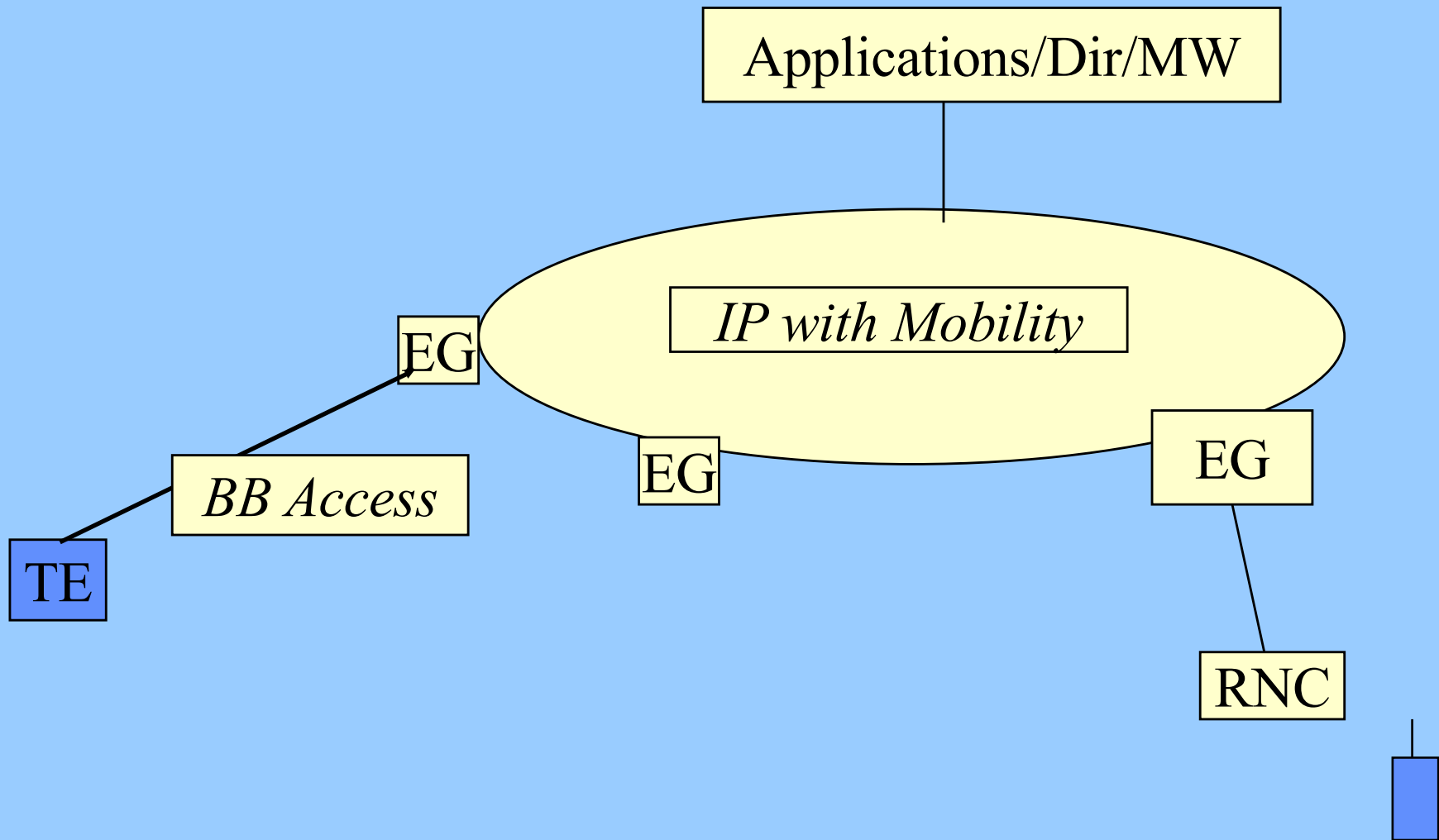
# VHE Issues

- **Product/Service/Operation/Technology Arch**
  - 3G.IP & Integrated BB Access (Cable, DSL, FWS)
  - Single look 'n feel multimedia session
- **Call Control**
  - Protocol selection: SIP v.s. H.323
  - C.C. location: Home v.s. Foreign
  - Service logic, Feature trigger location: Basic, Supplementary
  - (Inter-carrier) Home Control of Roamer: Adaptation
- **Connectivity Management**
  - QoS: Diffserv, RSVP, MPLS
  - Routing: Tunnel concatenation; GTP, MIPv4, MIPv6

# VHE Issues (Conti.)

- **Directory (HSS/HLR, HA/LD)**
  - ➔ User profile (location, service, AAA parameters)
  - ➔ Dispatcher v.s. Meta directory
- **Trust in foreign network (Proxy?)**
  - ➔ Common Security Infrastructure
  - ➔ Single sign-on for access, Layered security measure for applications
  - ➔ User experience, Inter-access coherence?
  - ➔ Firewall, VPN, VNC?
- **Local Resources**
  - ➔ Discovery, Assignment
  - ➔ SLP?

# One Network



# One Network Issues

- **Micro and Macro Mobility**
  - ➔ Mobile IP has no “fast” handoff
- **Network topology without GGSN and SGSN**
  - ➔ IP straight to RNC
- **IETF mobility proposals**
  - ➔ Hierarchical Mobile IP, Cellular IP, Hawaii, Taro, HMMP
  - ➔ Interactions of “mobility tunnel” and “security tunnel”, etc

# IP Mobility Architecture !

- **End-to-end IP-based architecture?**
  - ➔ **Every nodes in the network is IP capable**
- **Evolving from GPRS?**
- **Mobile IP++ for seamless wireless and wireline mobility management?**