無線網路多媒體系統
Wireless Multimedia System

Lecture 6: CDMA & 3G Trend

吳曉光博士

http://wmlab.csie.ncu.edu.tw/course/wms

Agenda

- Spread Spectrum (Multipath, interferences from other cells)
- W-CDMA
- Evolutions of PCS
- ALL IP Challenges
  - Mobile IP/Cellular IP
  - QoS Provisions: Integrated Service / DiffServ
- Next Week (Mobile IP)

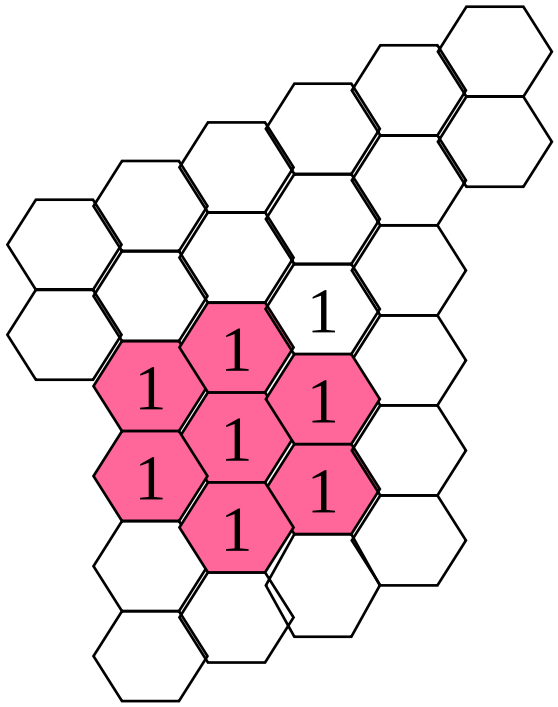
Reading

- [Kohno95]Ryuji Kohno, Reuven Meidan, and Laurence B. Milstein Spread Spectrum Access Methods for Wireless Communications, IEEE Communication Magazine, 1995
- [Dahlman98]Erick Dahlman, Bjorn Gudmundson, Mat Nilsson and Johan Skold, UMTS/IMT-2000 Based on Wideband CDMA, IEEE Communication Magazine 1998
- [Ojanpera98] T. OJanpera, R. Prasad, “An Overview of Third-Generation Wireless Personal Communications: An European Perspective, IEEE Personal Communication Magazine 1998

Code Division, Spread Spectrum

What is Going to Happen in CDMA?

Direct Sequence Cellular

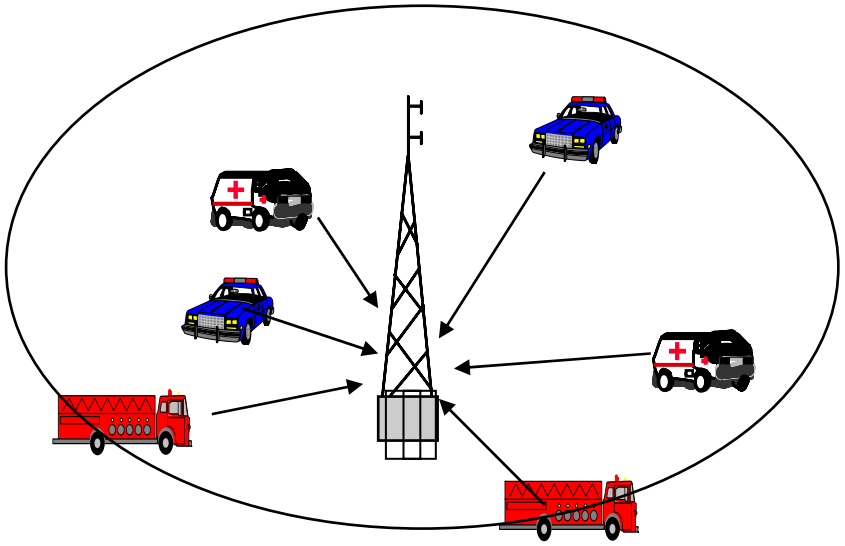


Idealized grid of
Hexagonal cells

- DS spread spectrum signals are generated by linear modulation with wideband PN sequences which are assigned to individual users
- Universal Frequency Reuse: One-cell frequency reuse pattern
- Introduction of a new cell will be less restricted than in the case of either FDMA or TDMA
- (FDD) Frequency Division Duplex Operation: One frequency band is used for the base-to-mobile (forward or down link), one frequency band is used for the mobile-to-base link (the reverse link or uplink)

Power Control (Reverse Link)

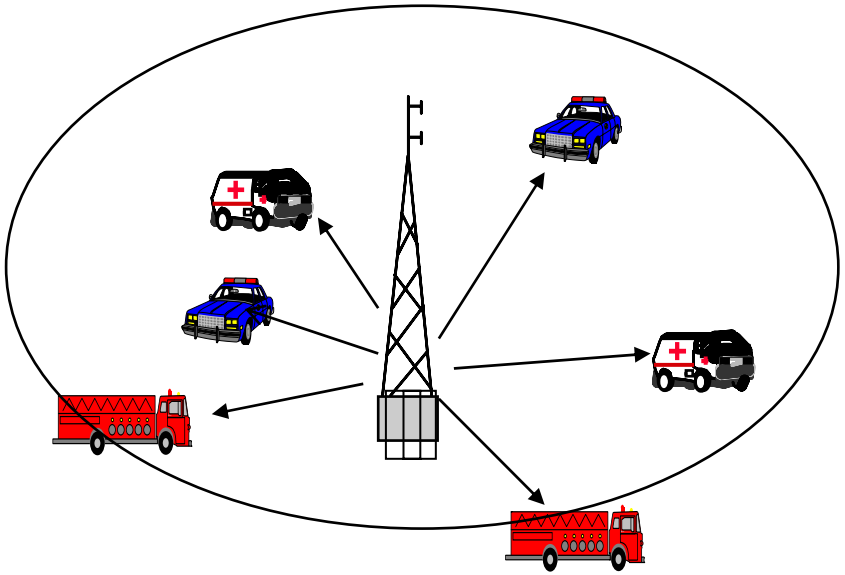
- Reverse Link: asynchronous, asynchronous CDMA system is vulnerable to the “near-far” problem
- Power Control: minimize consumption of the transmitted power, fast enough to compensate for Rayleigh fading
- Capacity is bounded by number of users (MAI Multiple Access interferences)



Everybody has a Code (PN), asynchronous

Power Control (Forward Link)

- Forward Link: the users can be orthogonalized, (however, the orthogonalization is not preserved between different paths of the multipath propagation, nor is it preserved between the forward links of different cells)
- Power Control: Since the cell's signals can be received at the mobile with equal power, the forward link does not suffer from near-far problem
- Cell boundary



Everybody has a Code (PN) synchronous

Cellular Capacity

- Capacity of the reverse link
  (typically asynchronous link)

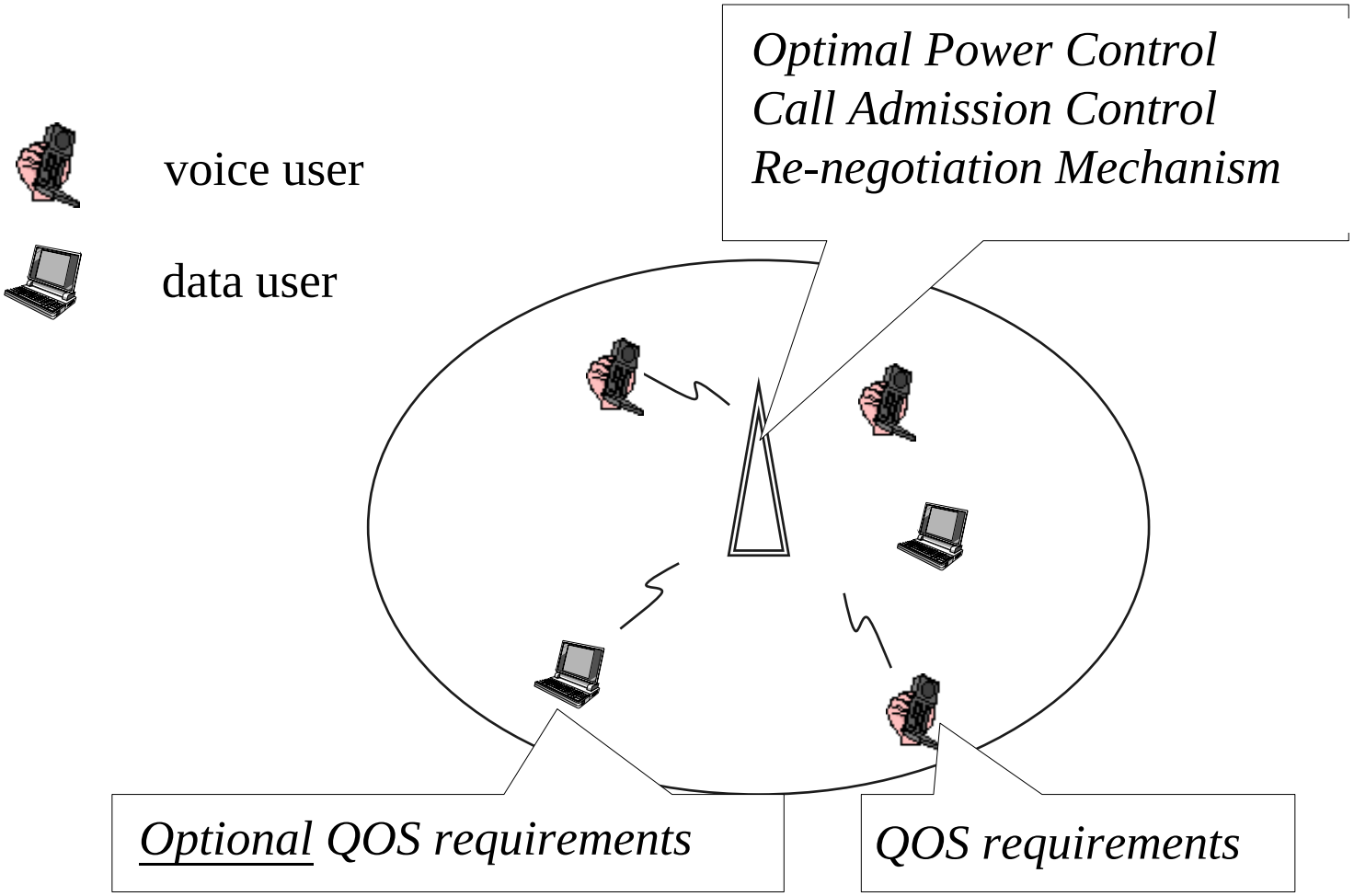
$$\left(\frac{E_b}{\eta_0}\right)_{eff} = \frac{1}{\frac{\eta_0}{E_b} + \frac{2}{3G}(M-1)(1+K)\alpha}$$

$$M \sim \frac{2}{3}\frac{G}{\left(\frac{E_b}{\eta_0}\right)}\frac{1}{(1+K)\alpha}$$

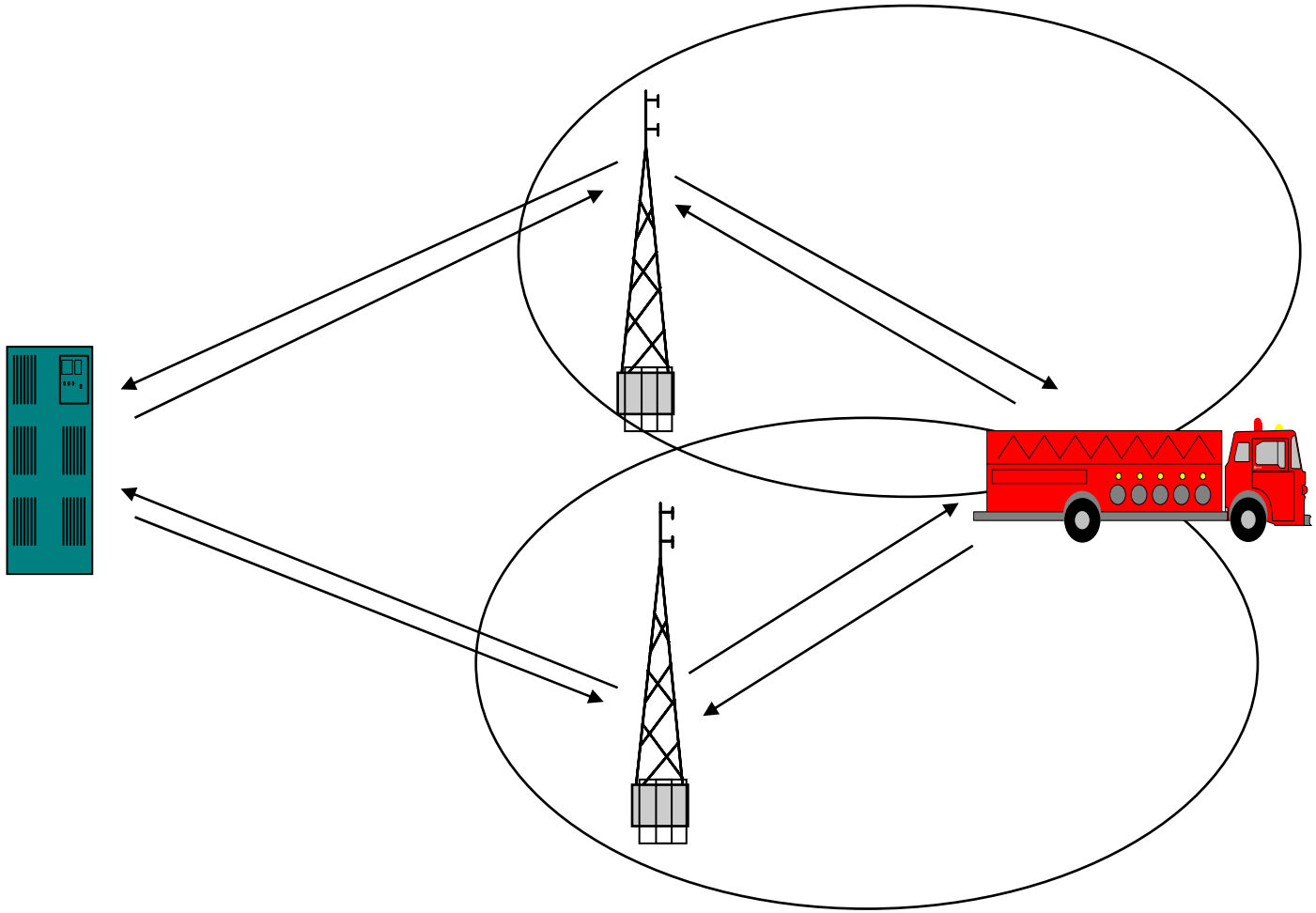
Radio Resource Management

- Power as the common resource makes W-CDMA very flexible
  - Link improvement, less power, more capacity
- Orthogonal variable spreading factor (OVSF) for variable bit rate

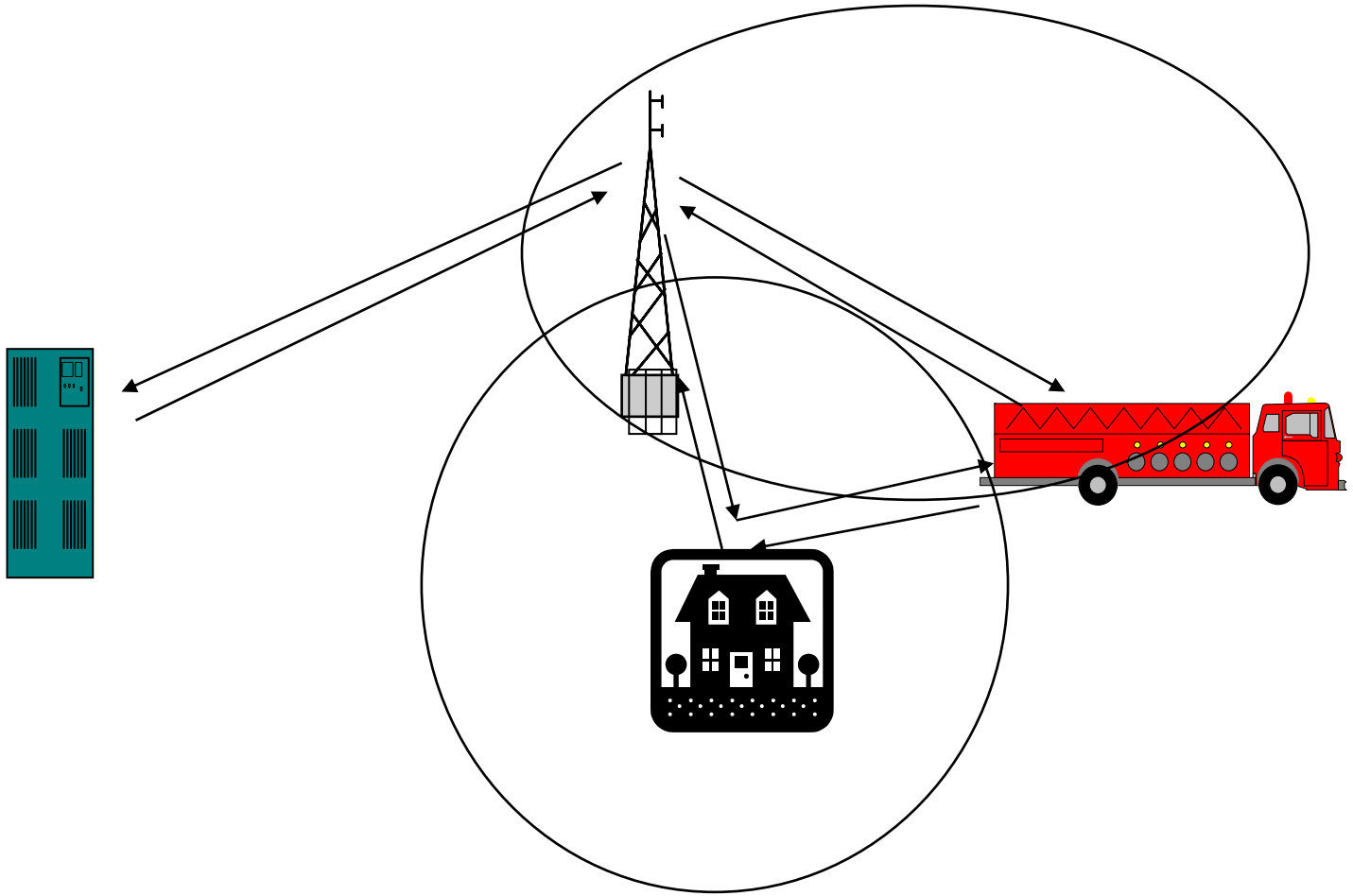
Call Admission Control



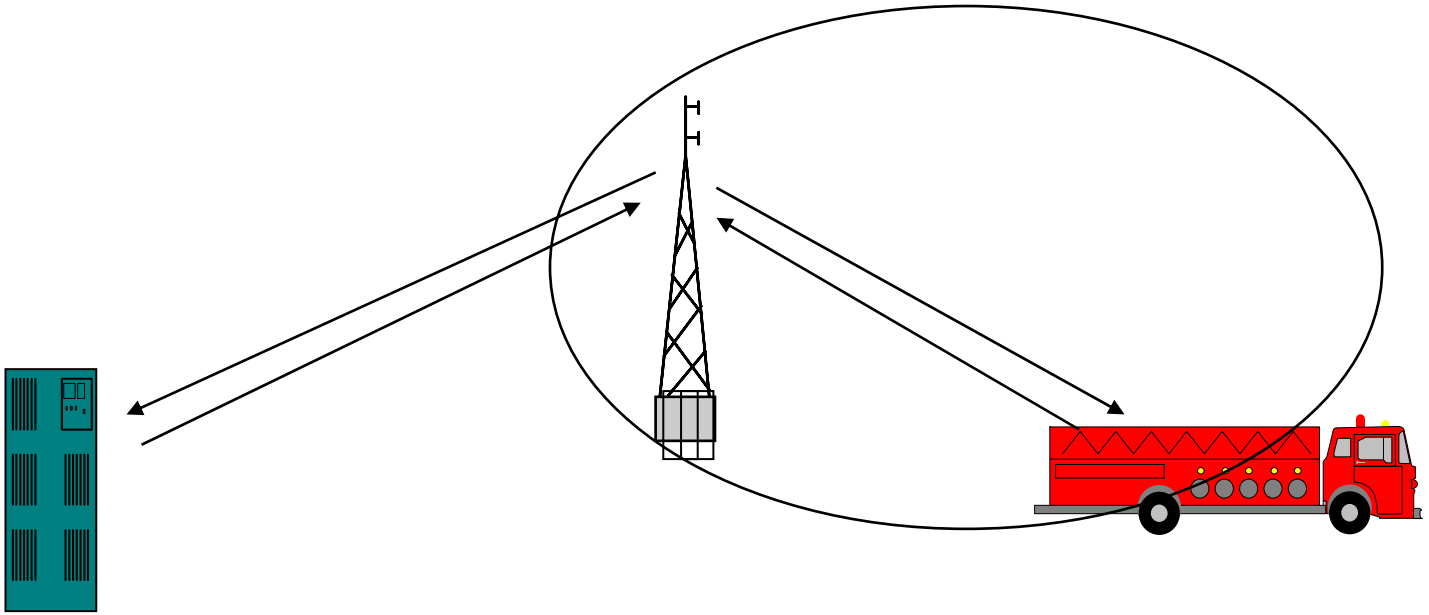
Soft Handovers (Macro Diversity)



Softer Handovers (Space Diversity)

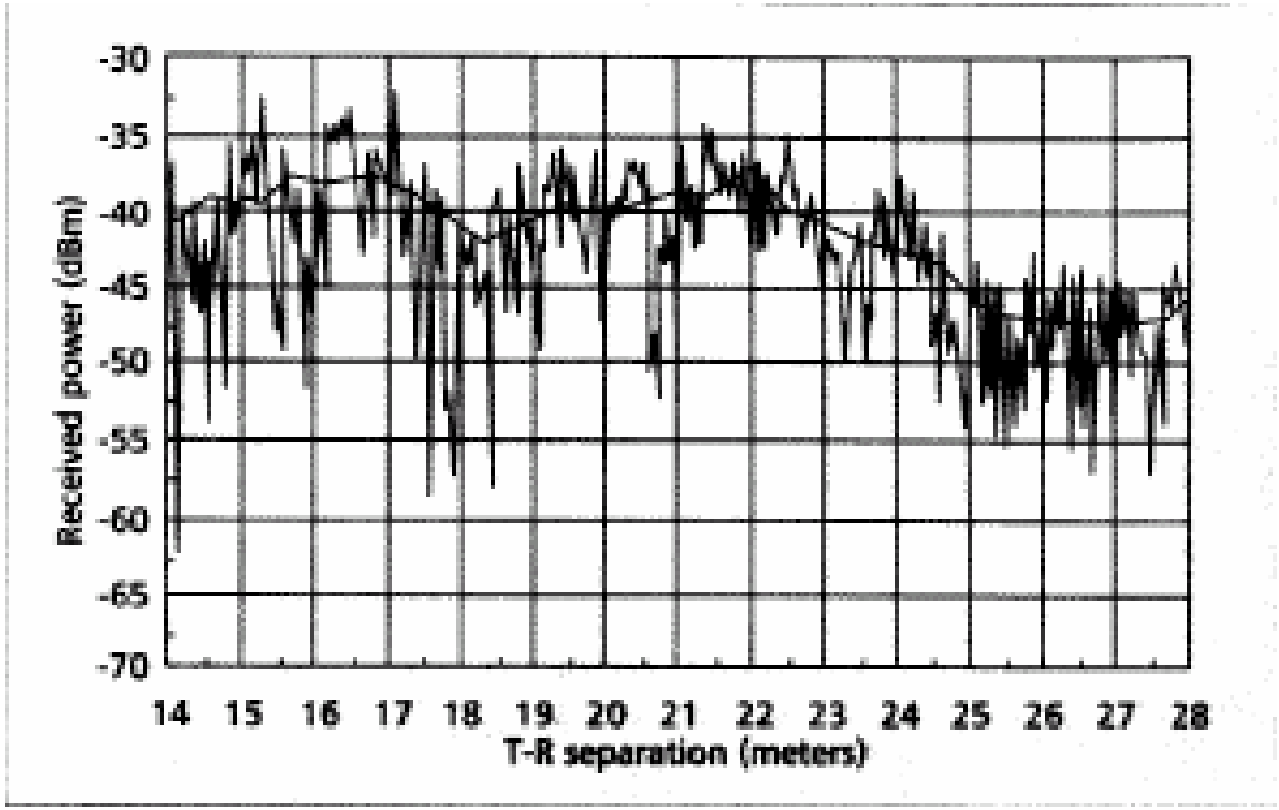


Power Control (Open & Close Loop)



Close-Loop Power Control

- Compensates a fading channe(1500 times per second)

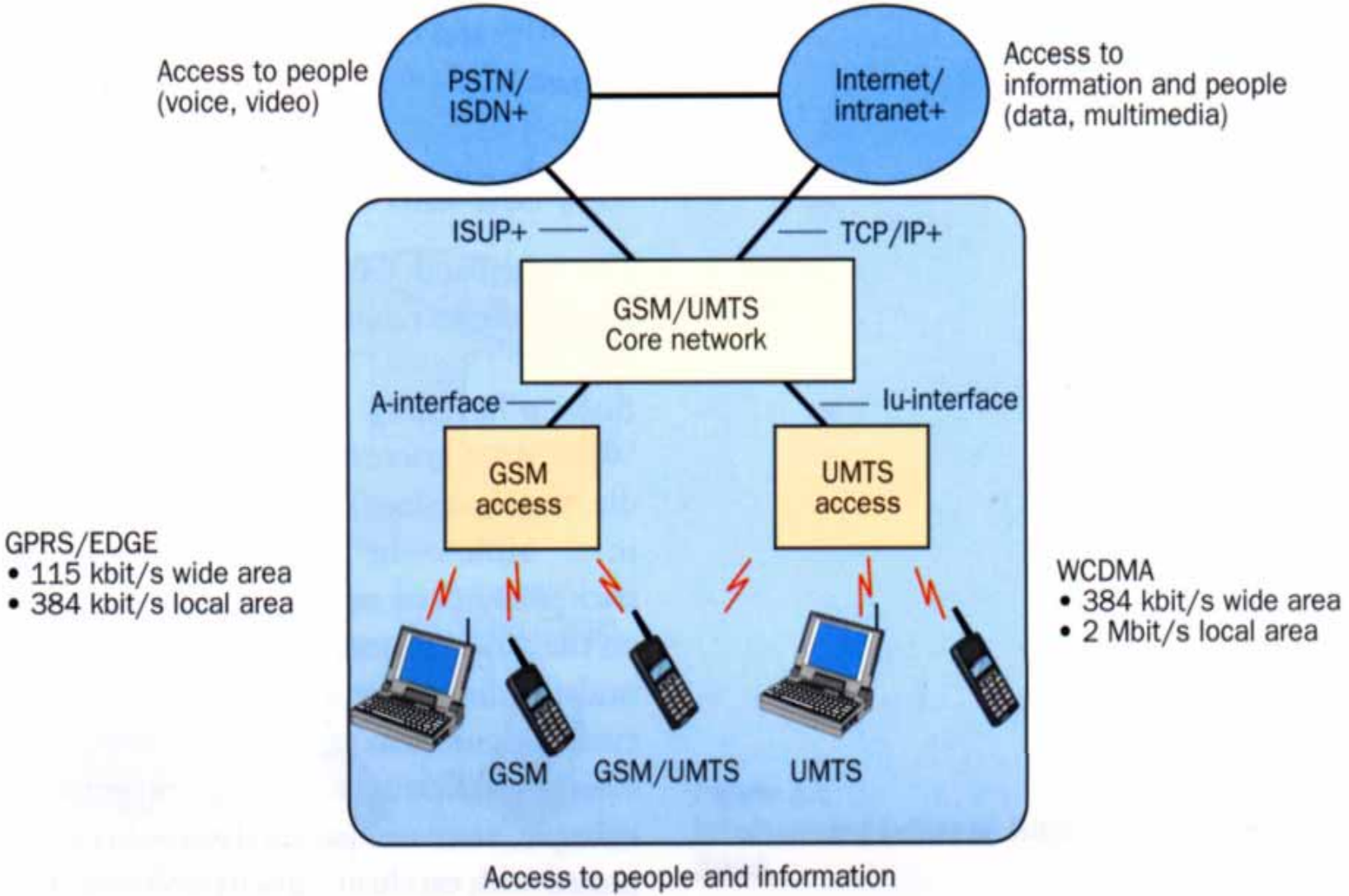


UMTS/IMT-2000
Based on Wideband CDMA

What is going to happen for WCDMA

Application Support in UMTS

- UMTS (Universal Mobile Telecommunication System)
- UTRA (UMTS Terrestrial Radio Access)
- Support:
  - 384 kb/s for wide-area coverage
  - 2 Mb/s for local coverage
- Multimedia Applications Requirements
  - Packet-oriented
  - Variable bit rate
  - Network resources can be available on a shared basis
  - E_b / N_0


Access to people
(voice, video)
PSTN/
ISDN+
Internet/
intranet+
Access to
information and people
(data, multimedia)
ISUP+
TCP/IP+
GSM/UMTS
Core network
A-interface
Iu-interface
GSM
access
UMTS
access
GPRS/EDGE
• 115 kbit/s wide area
• 384 kbit/s local area
WCDMA
• 384 kbit/s wide area
• 2 Mbit/s local area
GSM
GSM/UMTS
UMTS
Access to people and information

RS Spectrum Allocation

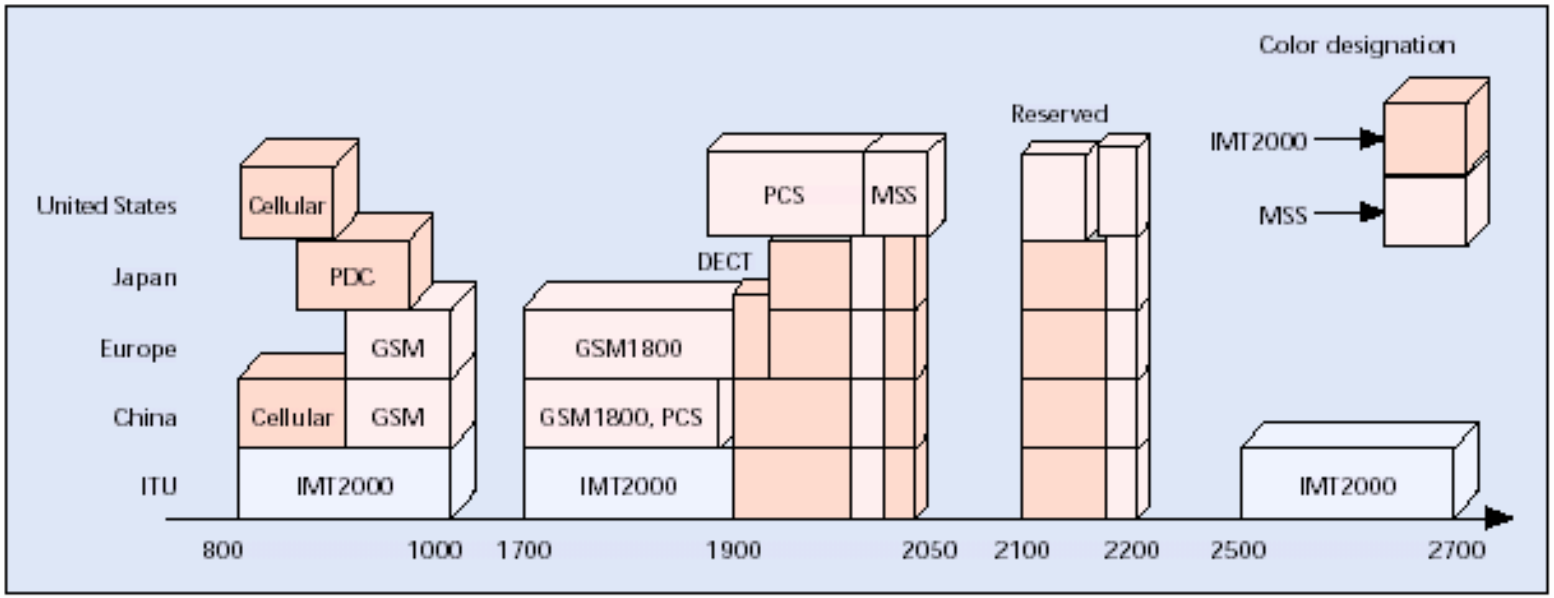
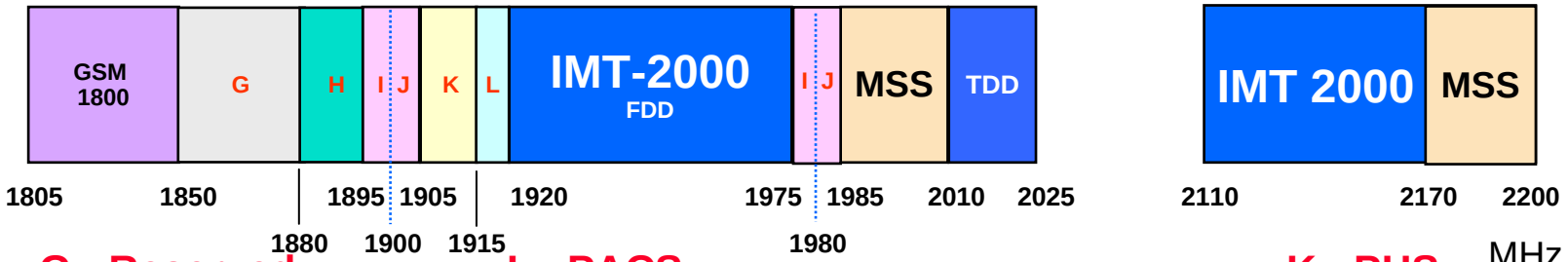


Figure 2. *RF spectrum allocation in major regions.*



G : Reserved
H : DECT
I : PACS
J : PACS (To Be Licensed)
K : PHS
L : Reserved

Wireless Mobile Interface

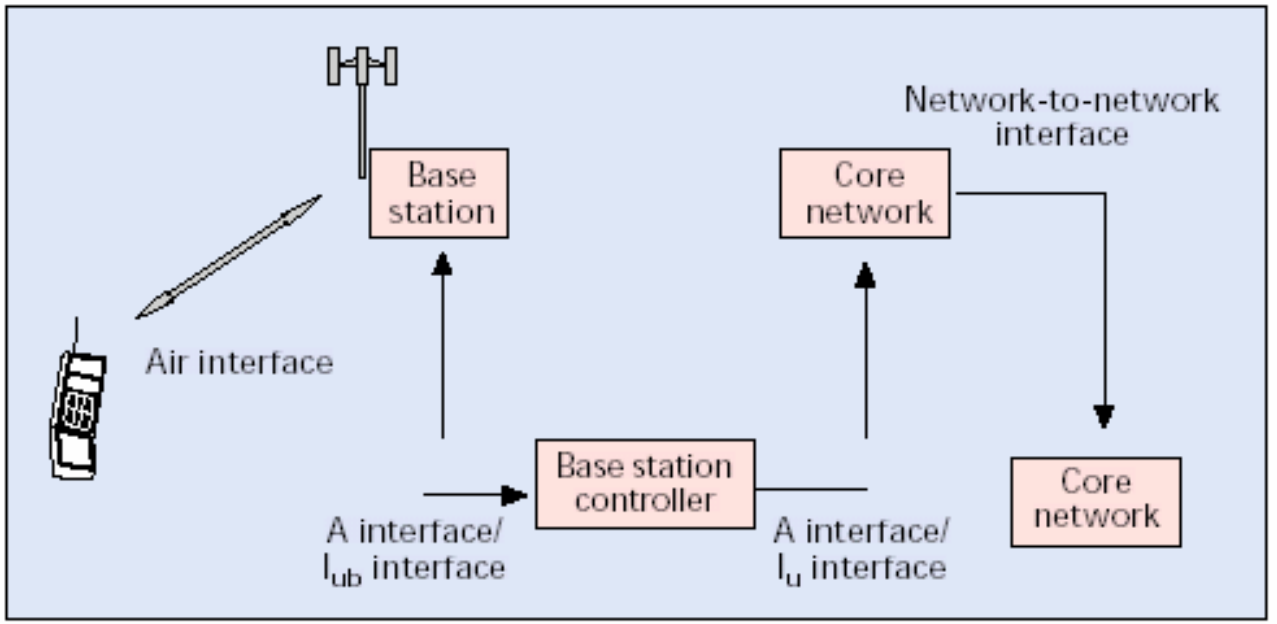
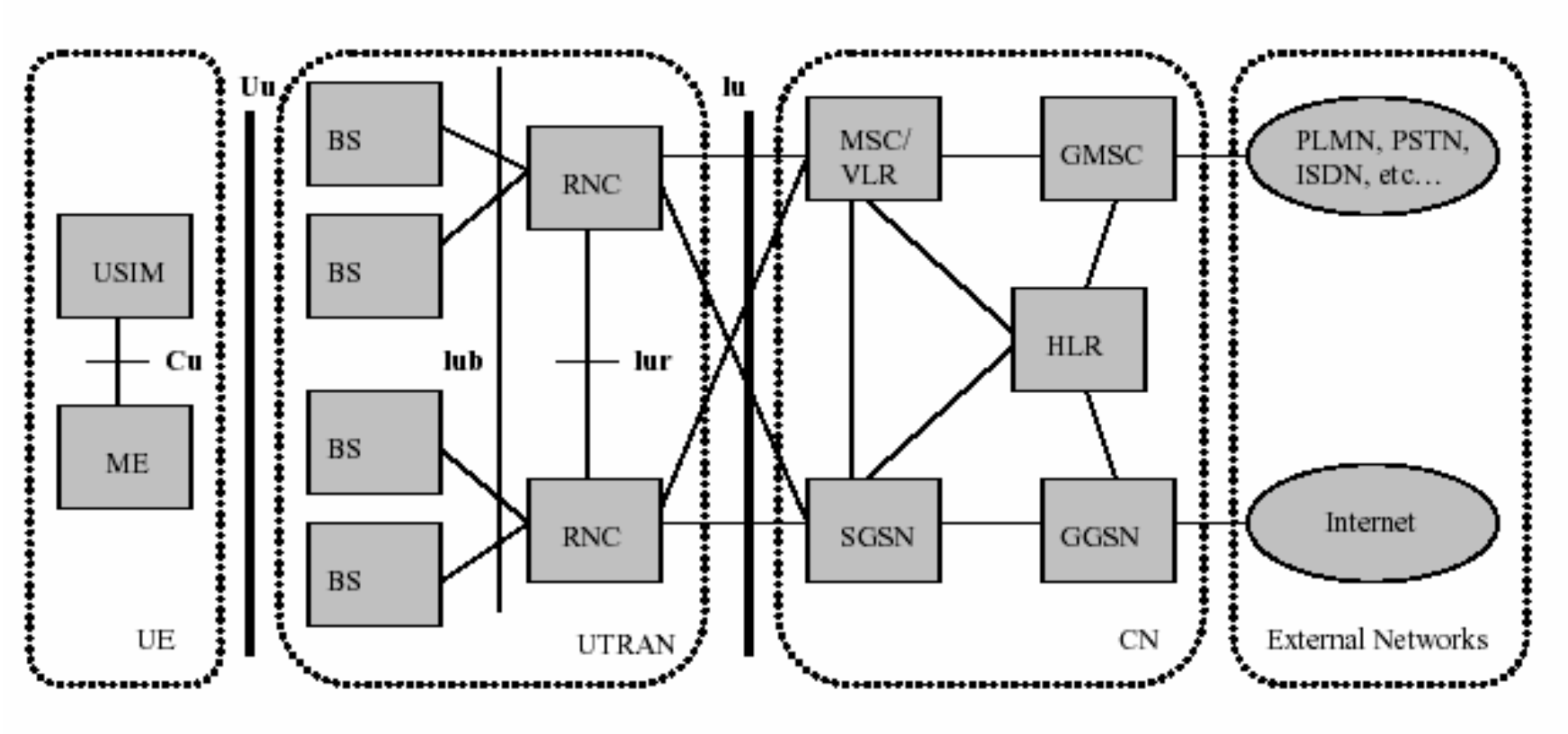
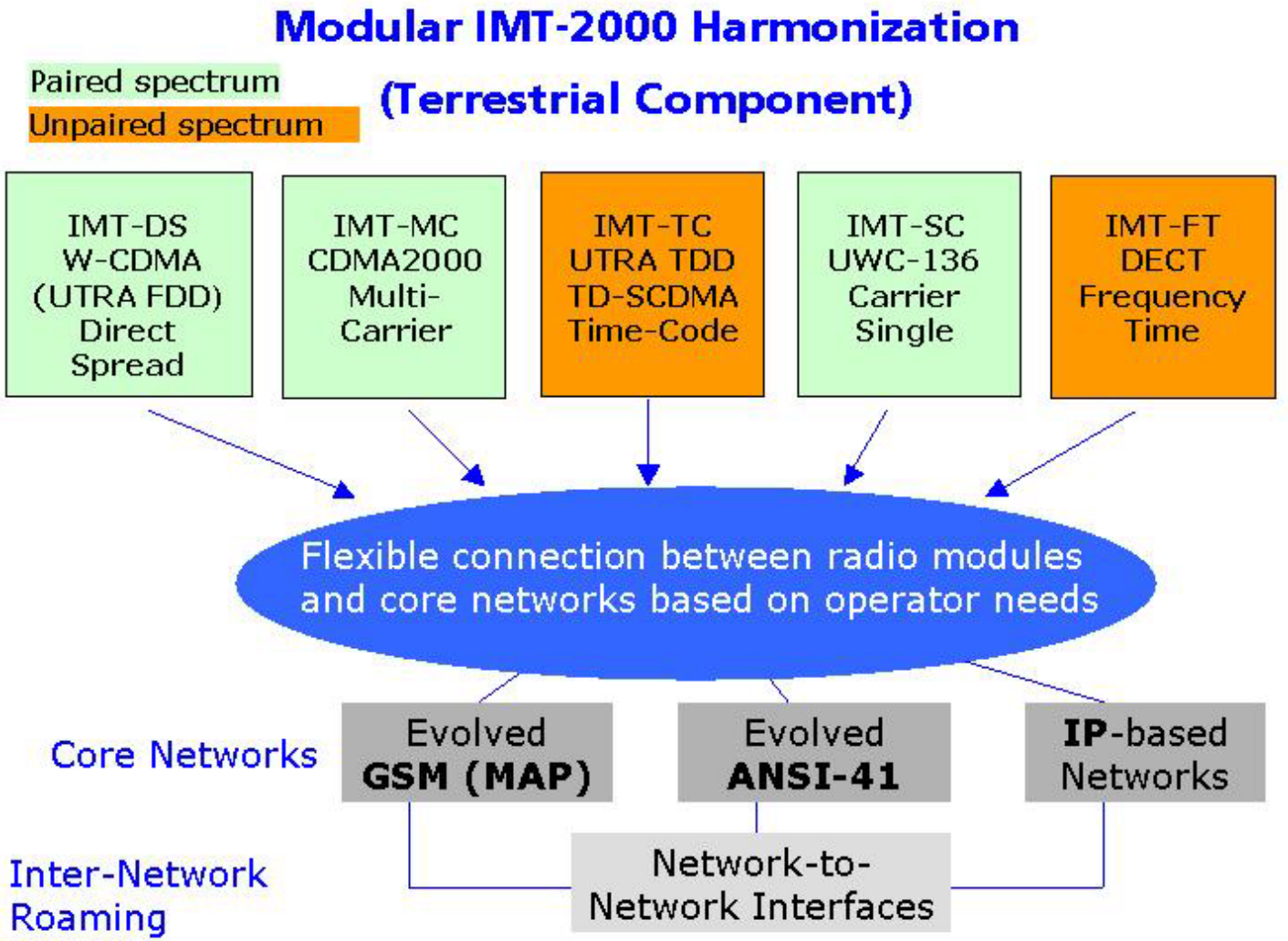


Figure 4. *Wireless mobile system interface definition.*

Elements of UMTS Architecture



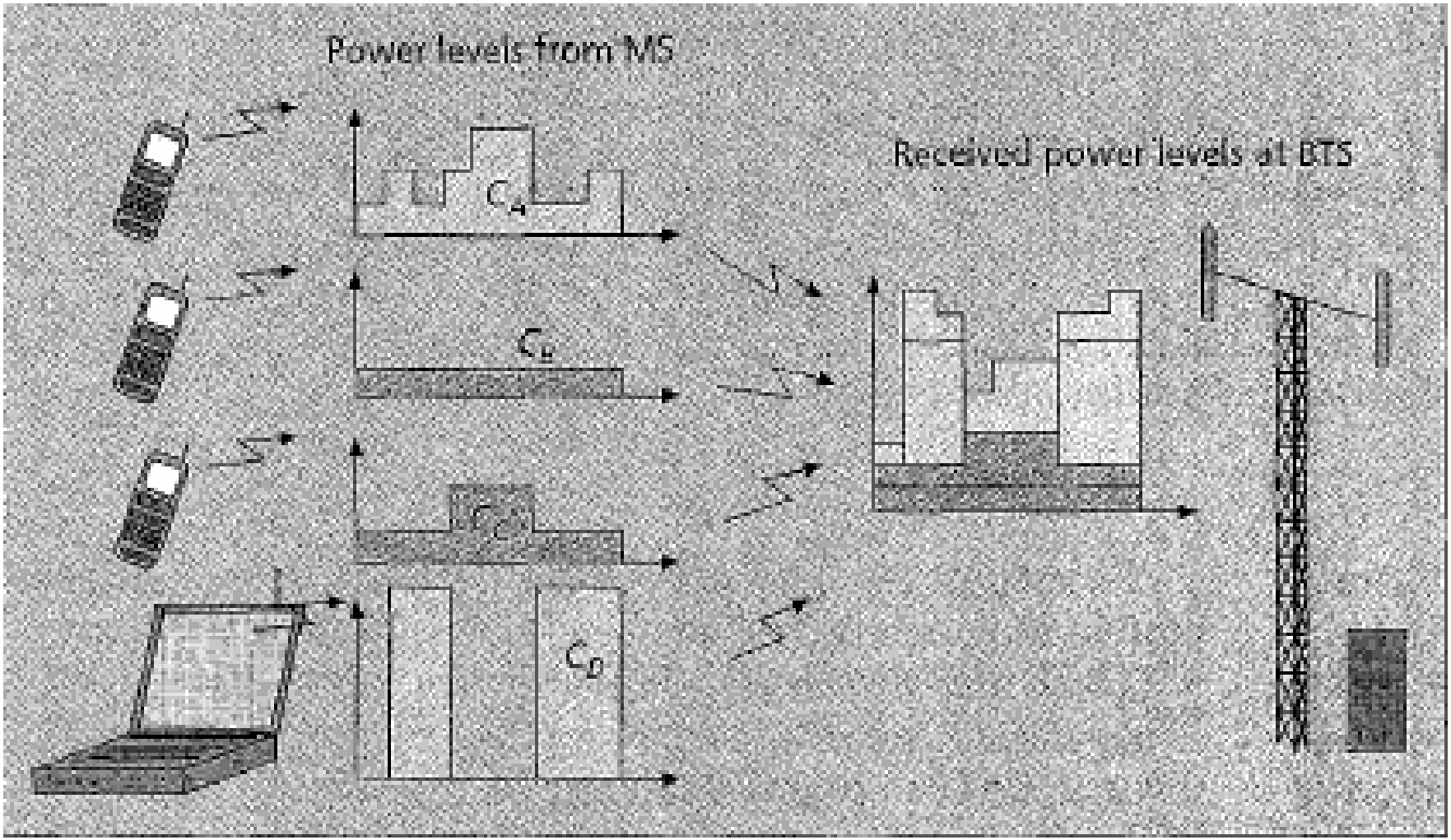
第三代行動電話之技術標準



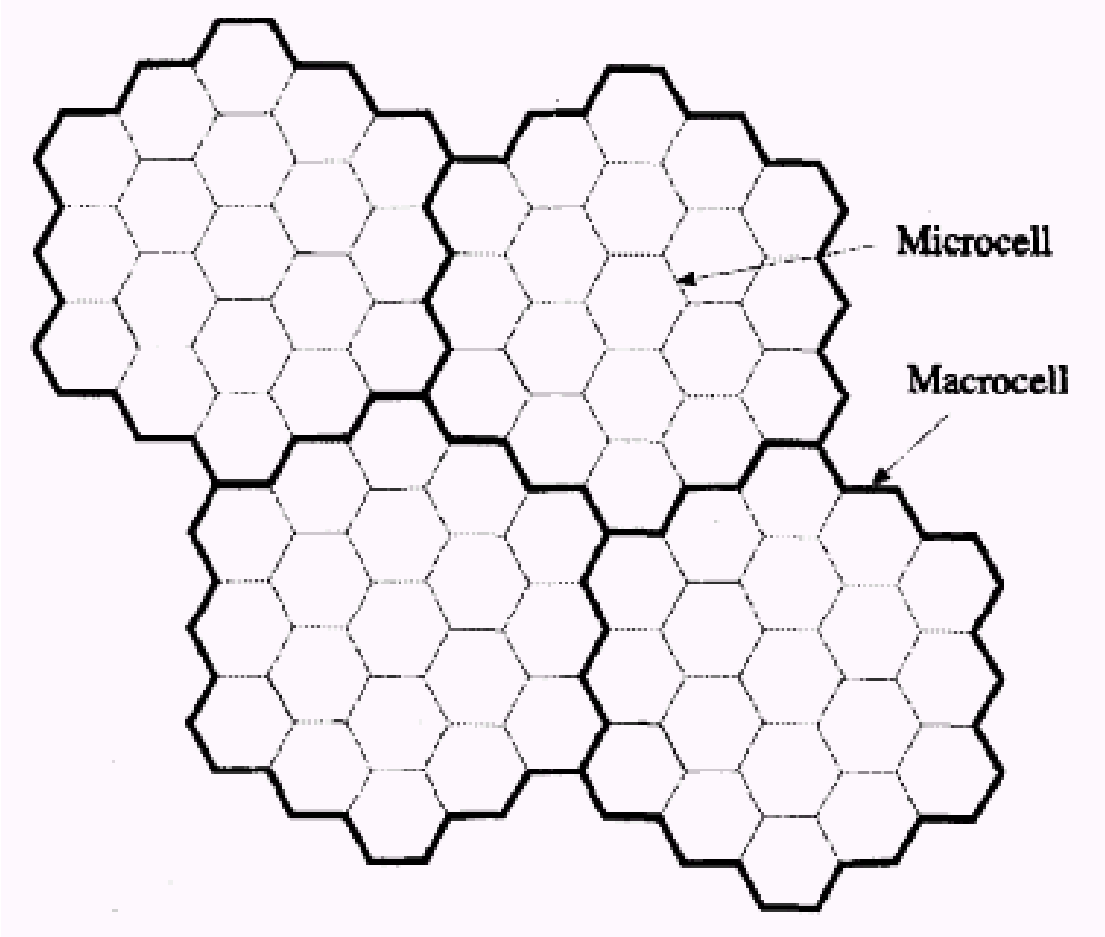
Key W_CDMA Features

- Performance Improvements
  - Capacity Improvements (3 dB, 384 kb/s, 1.9 Mb/s, 130 users)
  - Coverage and Link Budget Improvements (reuse GSM cell, 144 kb/s)
- Service Flexibility
  - Support of a wide range of services with maximum rate of 2 Mb/s, the possibility for multiple parallel services on one connection
  - A fast and efficient packet-access scheme
- Operator Flexibility
  - Support of asynchronous inter-base-station operation
  - Efficient support of different deployment scenarios, HCS, hot-sport
  - Support of evolutionary technologies such as adaptive antenna arrays and multi-user detection
  - A TDD mode designed for efficient operation in uncoordinated environment

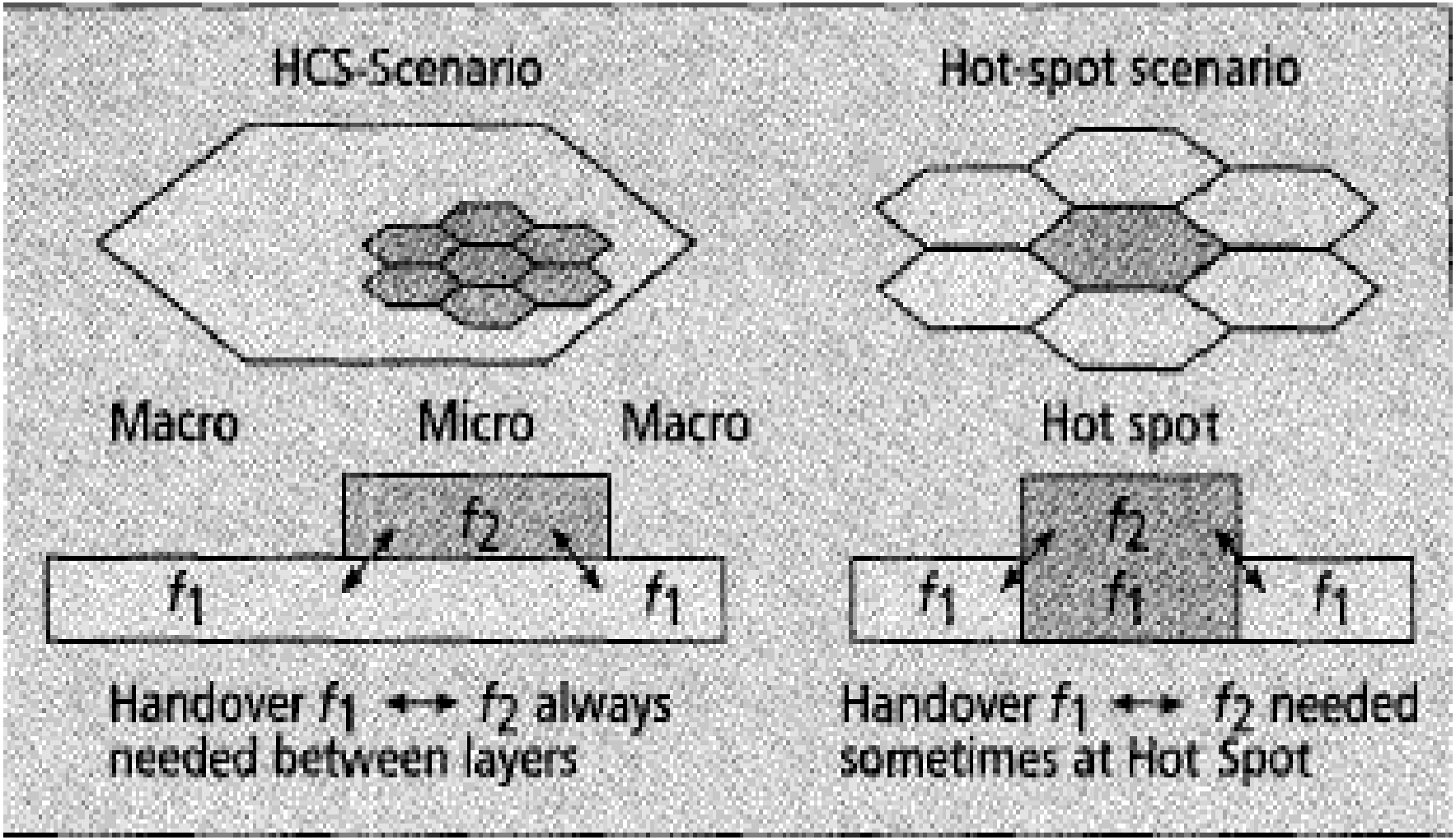
Multiplexing variable bit rate users



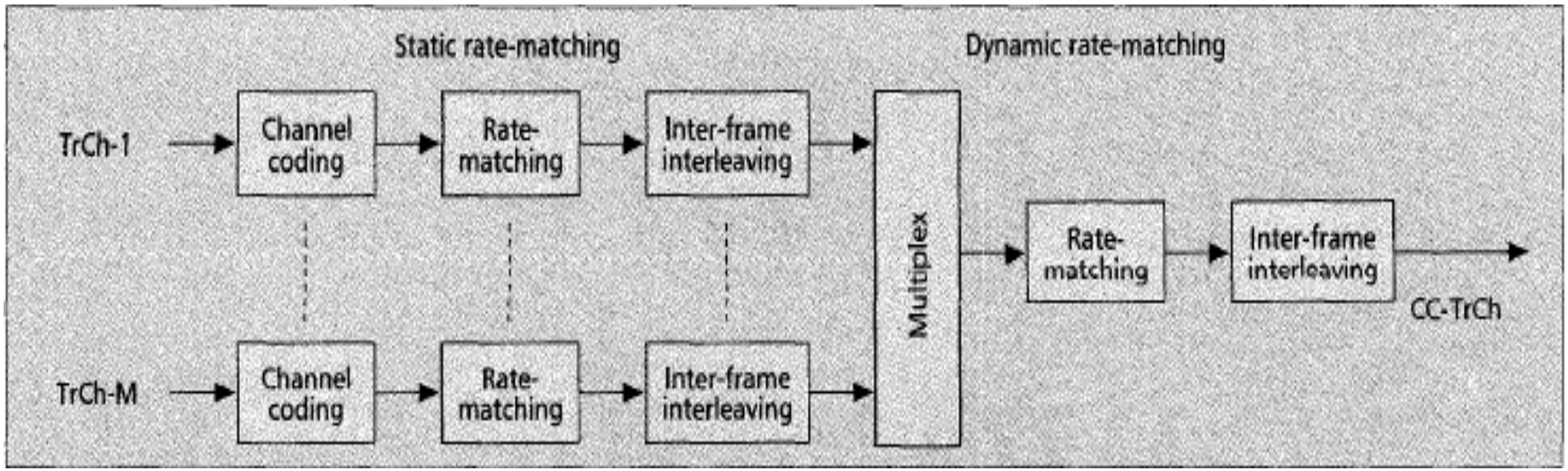
An example of two-tier cellular system



Handoff


HCS-Scenario
Hot-spot scenario
Macro
Micro
Macro
Hot spot
f_2
f_1
f_1
f_2
f_1
f_1
Handover f_1 ↔ f_2 always needed between layers
Handover f_1 ↔ f_2 needed sometimes at Hot Spot

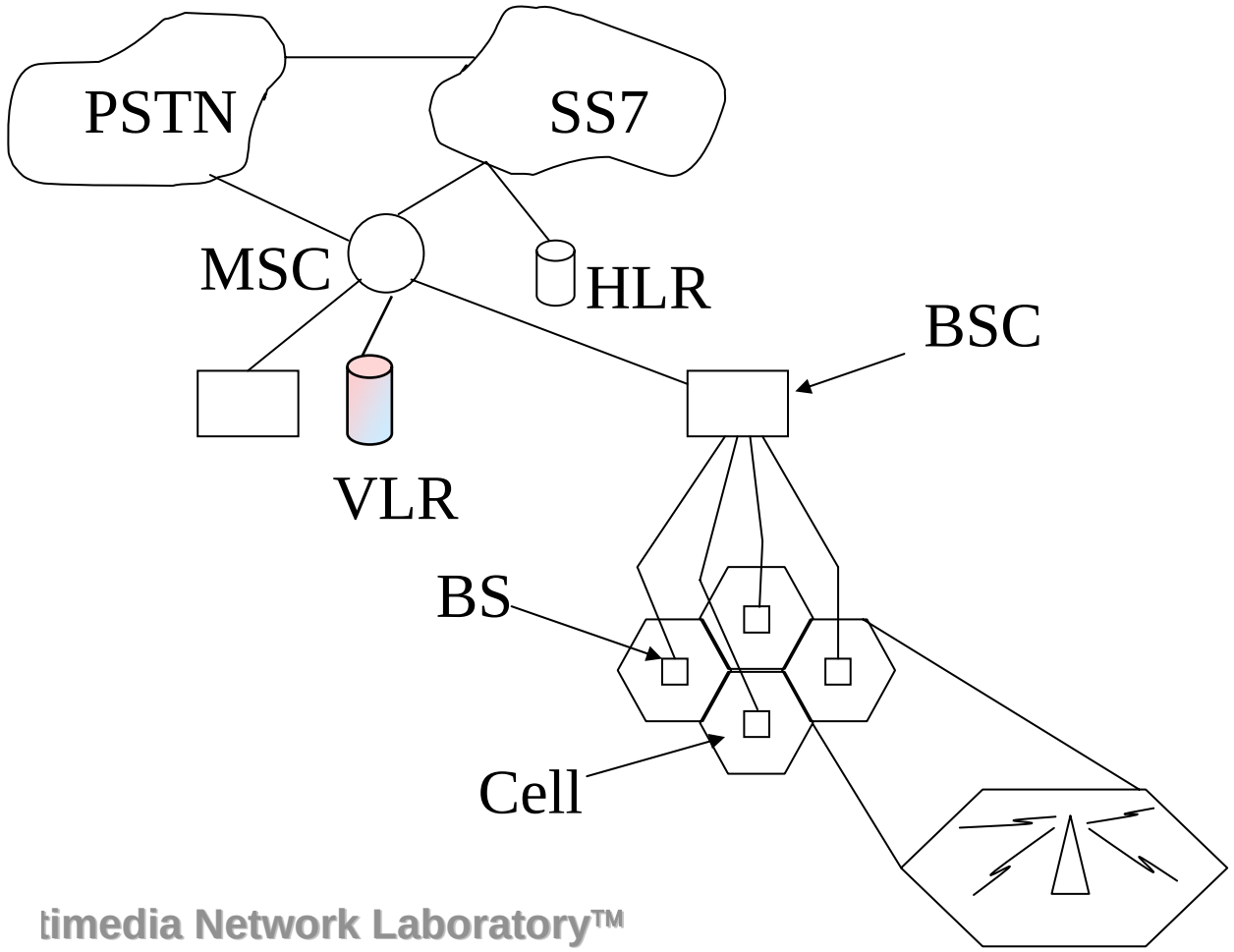
Transport of the channel



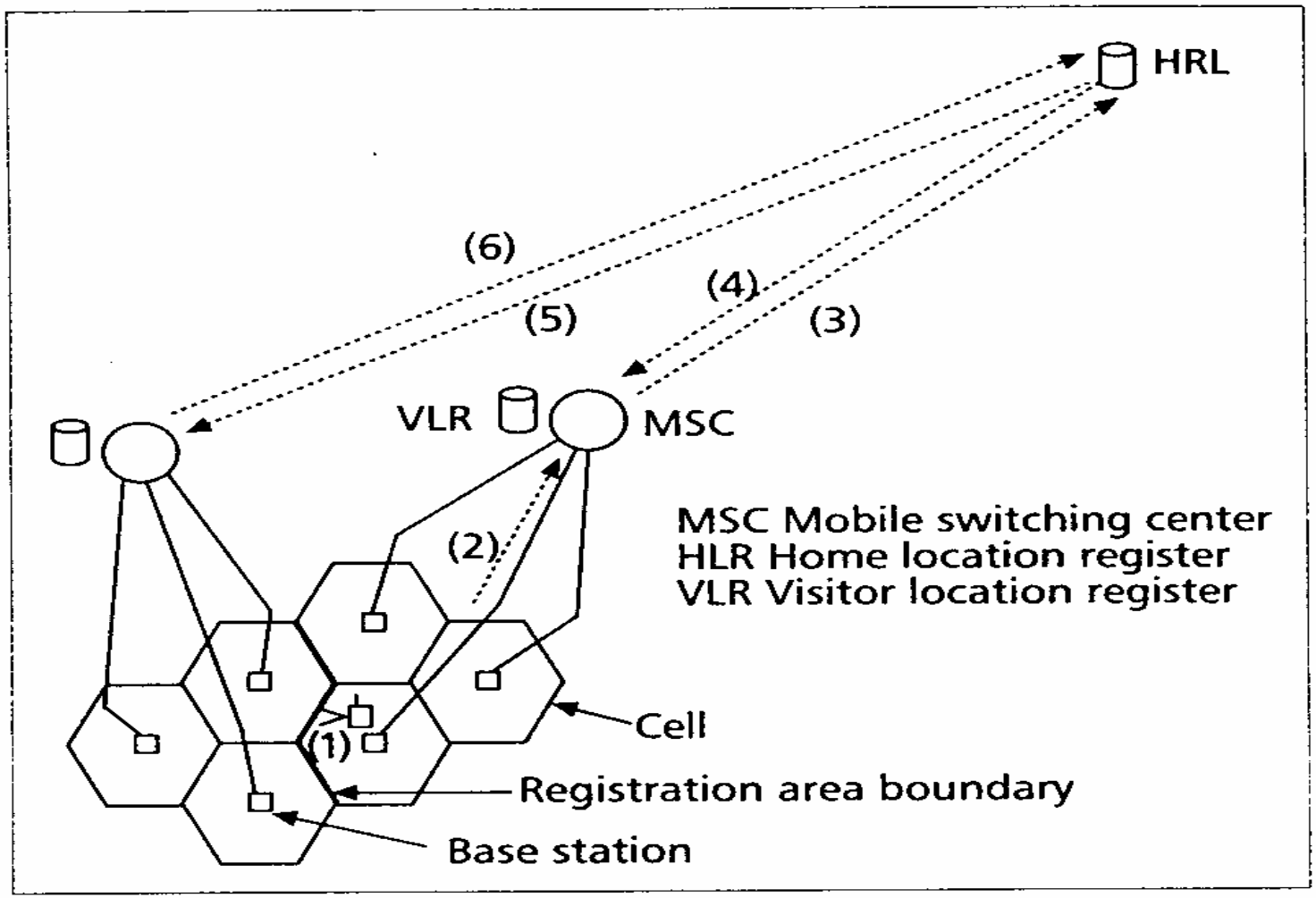
Evolutions of PCS

PCS Requirements

PCS network architecture

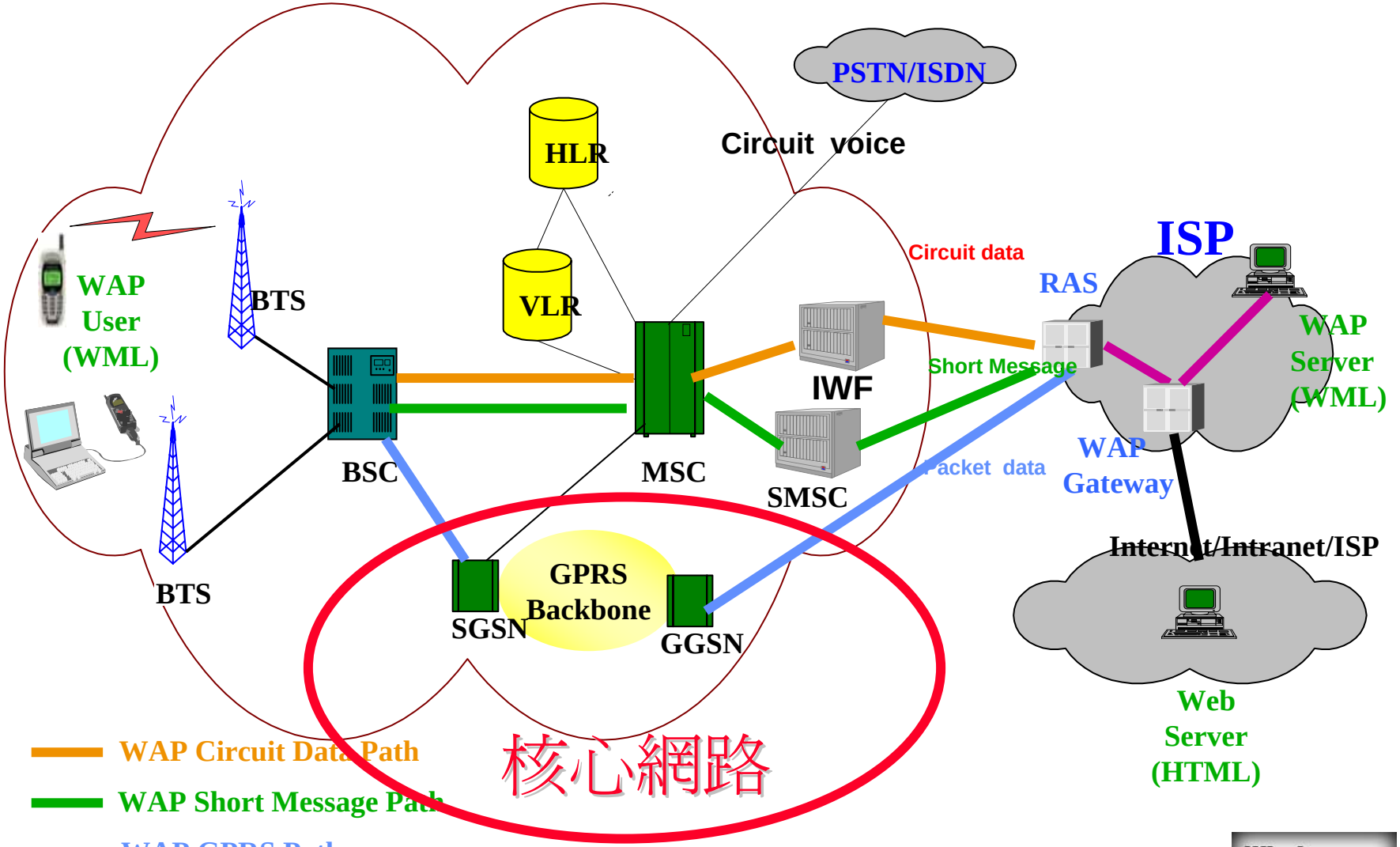


Location Update Procedure

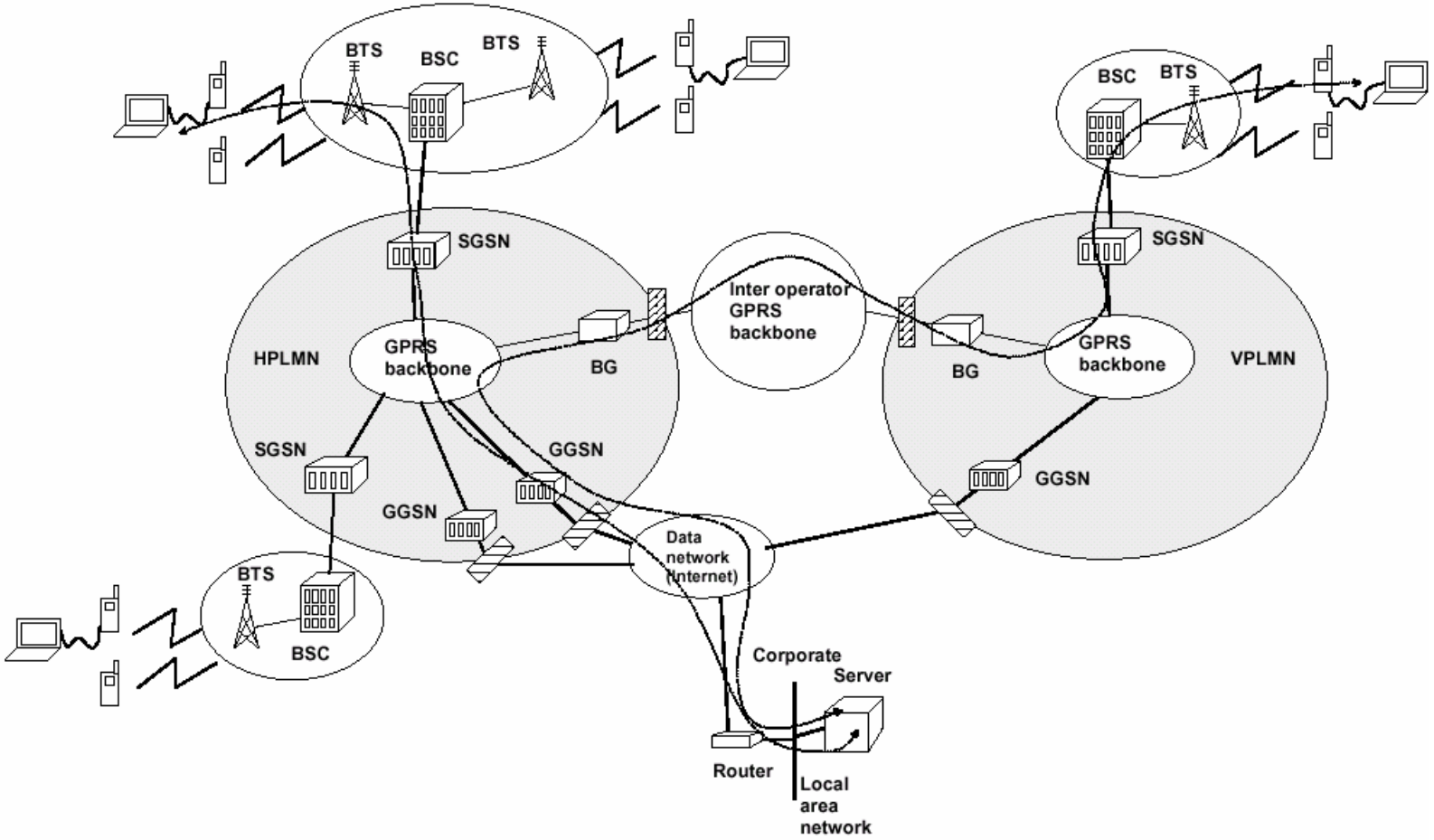


■ **Figure 3.** *Location registration procedures.*

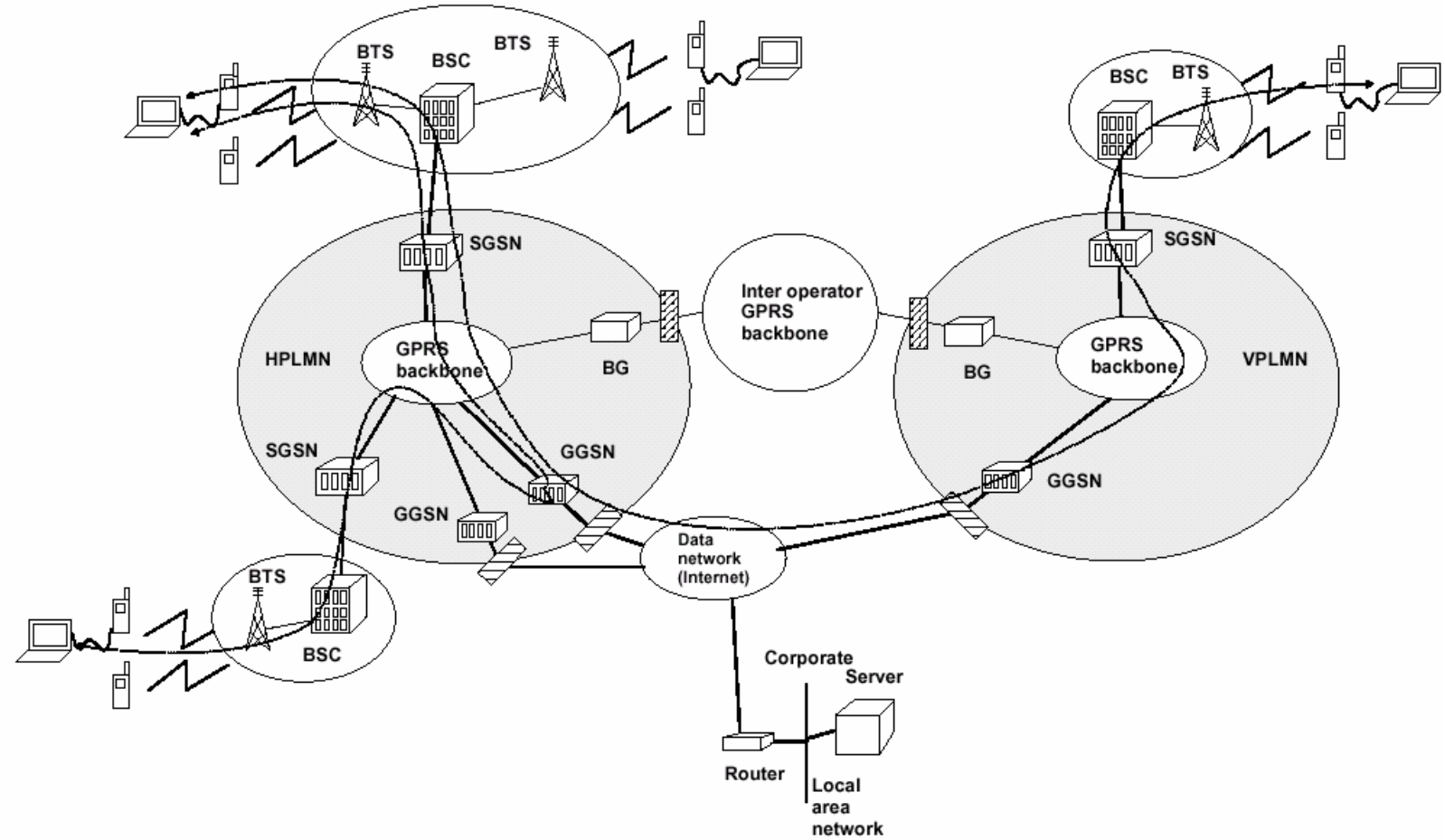
GPRS


PSTN/ISDN
HLR
Circuit voice
VLR
Circuit data
ISP
RAS
WAP
User
(WML)
BTS
IWF
Short Message
WAP
Server
(WML)
BSC
MSC
SMSC
Packet data
WAP
Gateway
Internet/Intranet/ISP
BTS
GPRS
Backbone
SGSN
GGSN
Web
Server
(HTML)
WAP Circuit Data Path
WAP Short Message Path
WAP GPRS Path
核心網路

Data transfer MS-fixed



Data transfer MS-MS



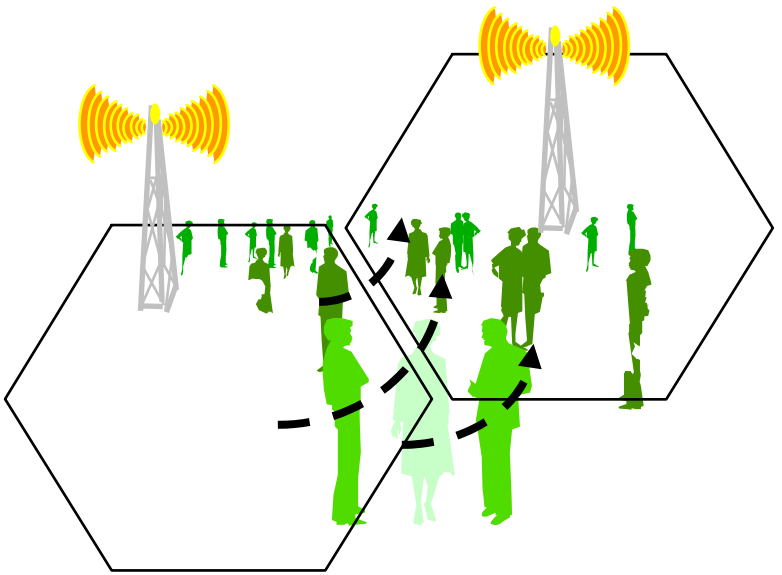
Coming Challenges for IP

Location Managements~ handoff, roaming

QoS Transport~ Backbone delivery

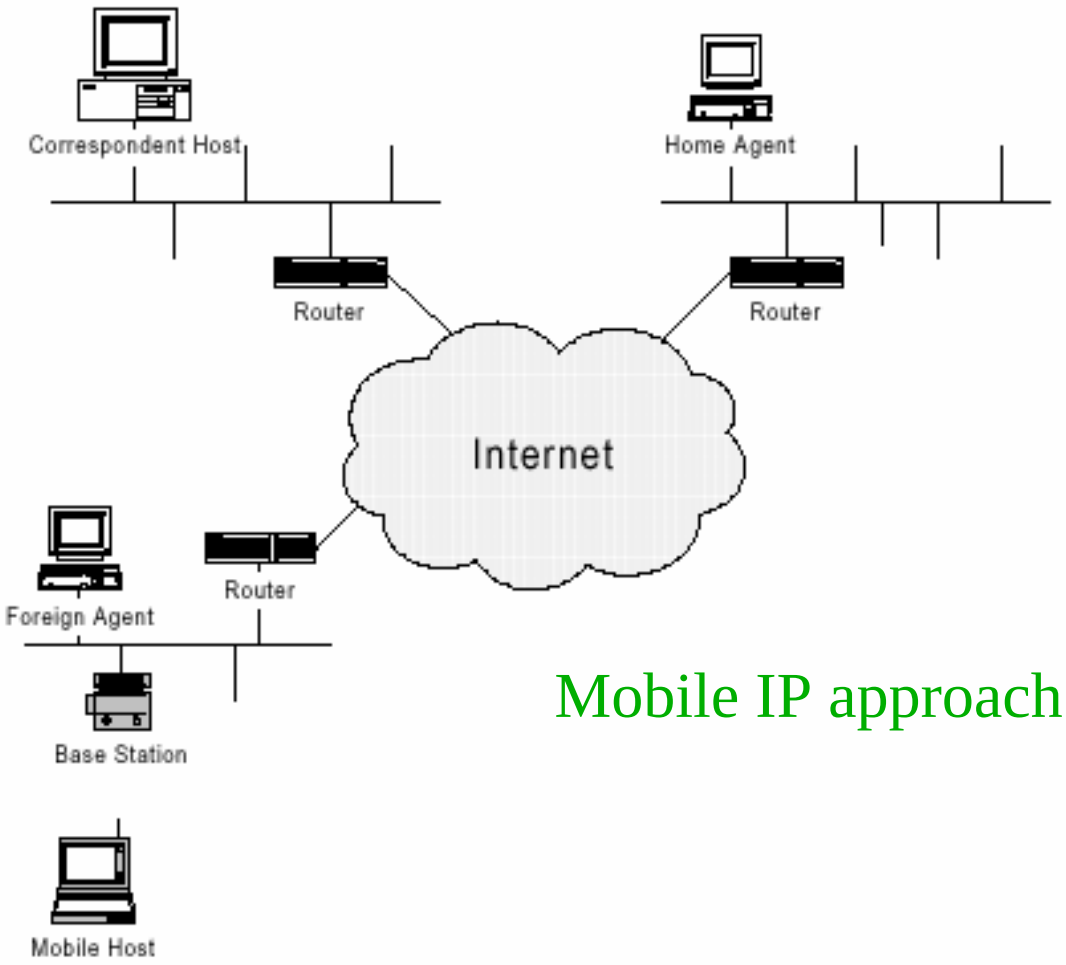
Mobility

- User mobility
  - Micro
  - Macro
- IP mobility support
  - Mobile IP
  - Cellular IP
  - HAWAII



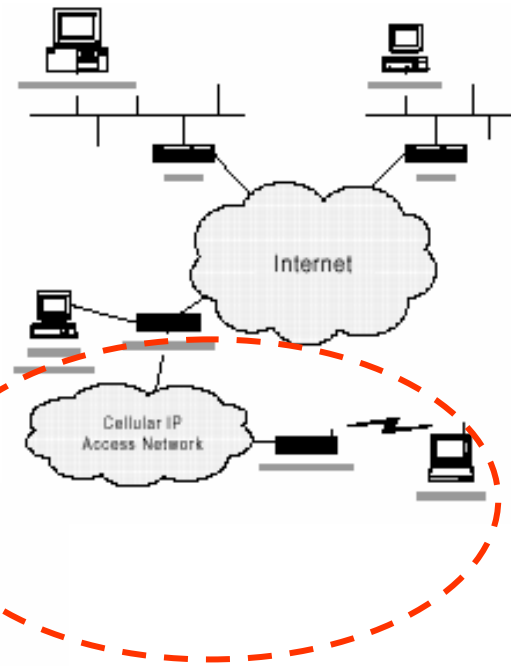
- Handoff issue
- Location management
- Paging

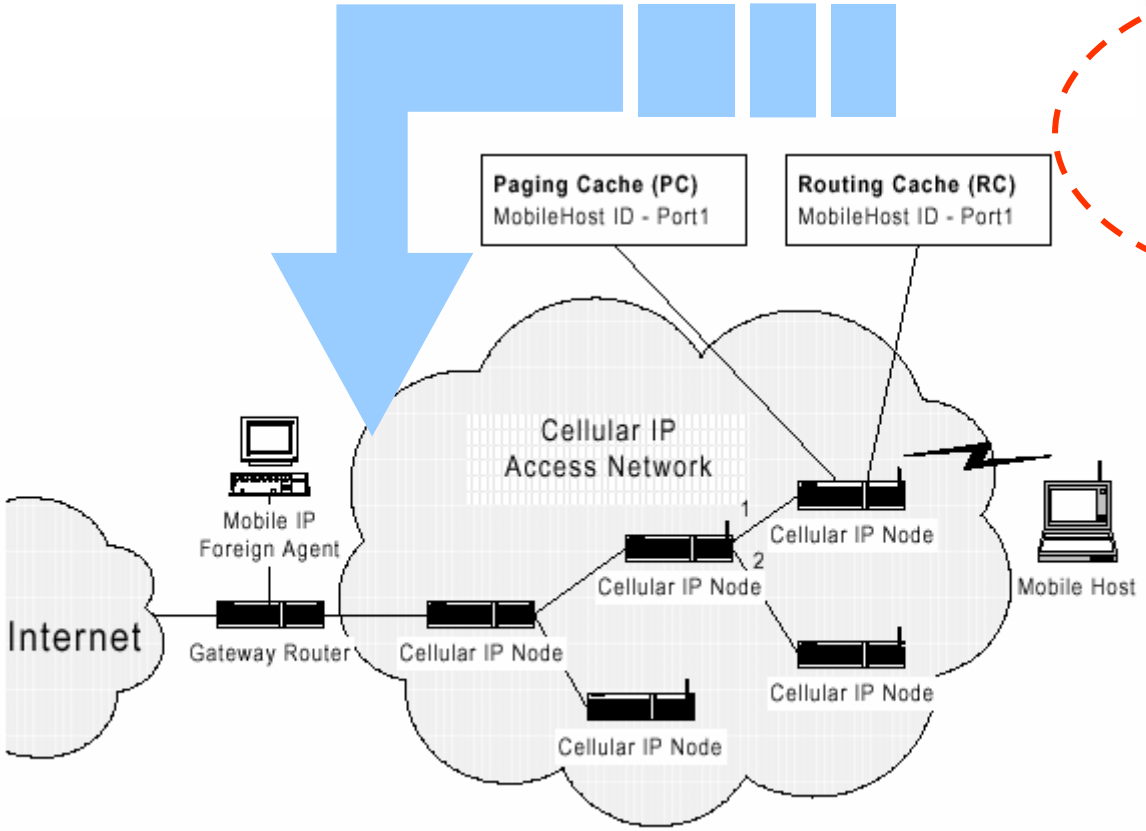
Nomadic wireless access



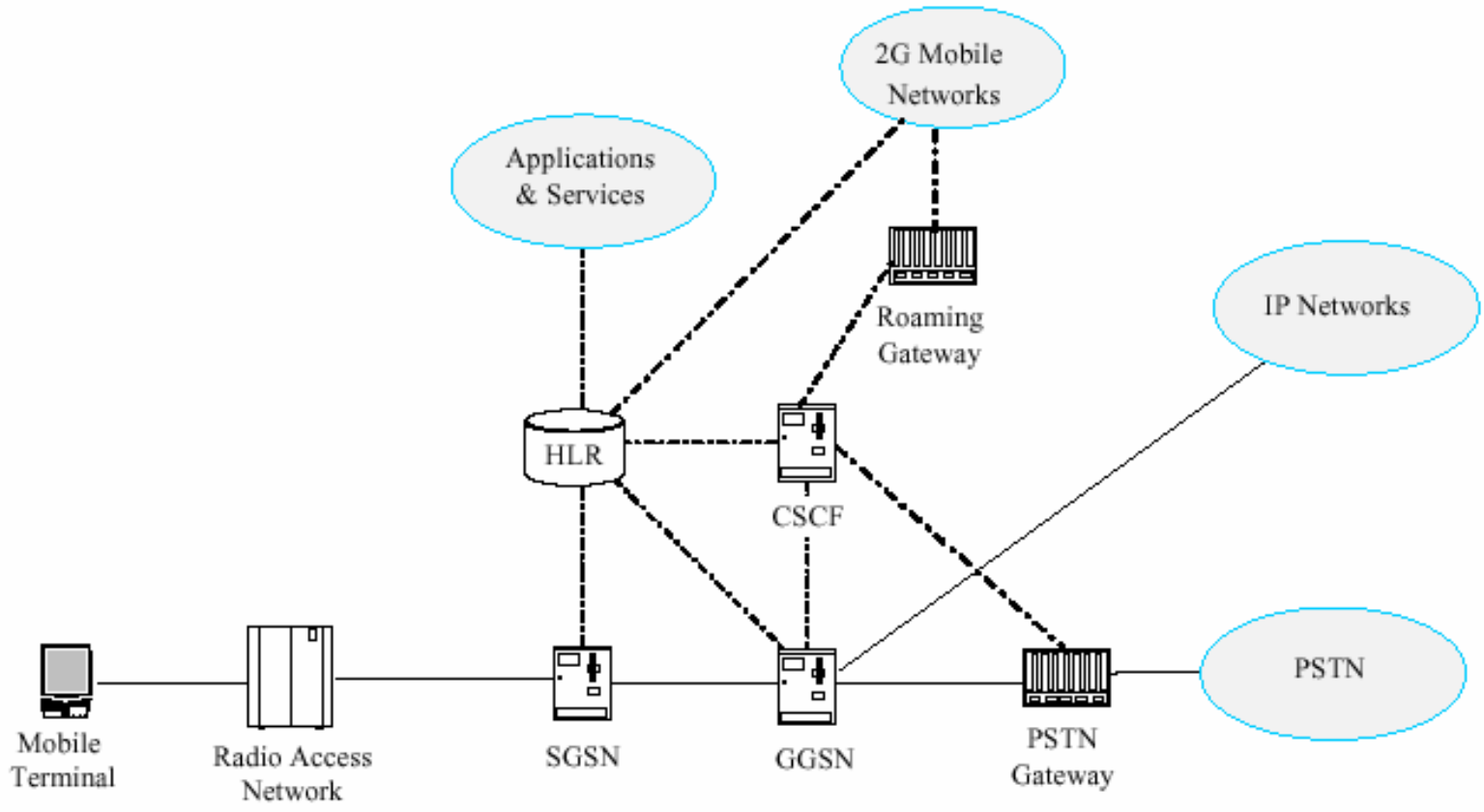
Mobile IP approach

Cellular IP

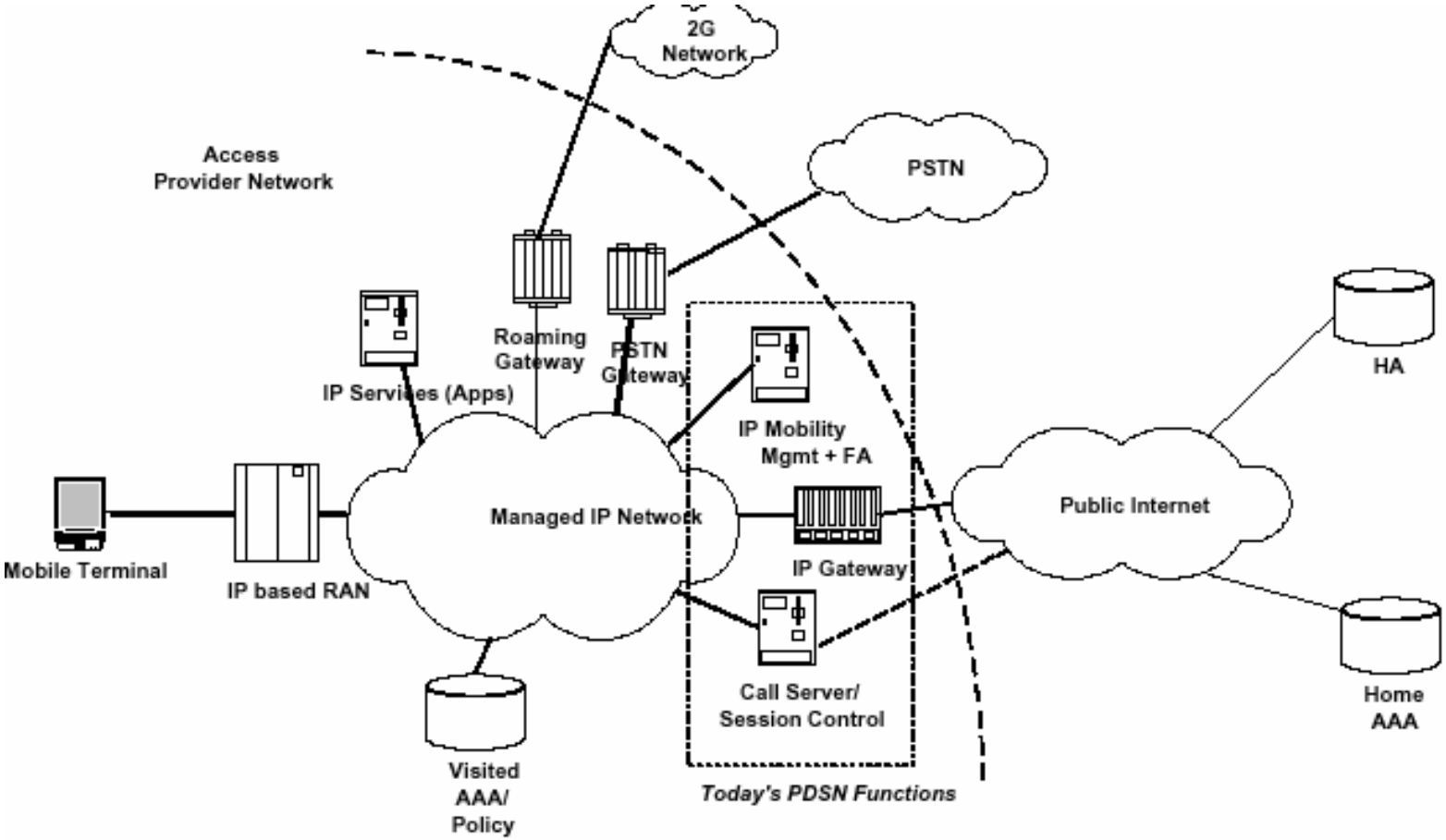

Internet
Cellular IP
Access Network


Paging Cache (PC)
MobileHost ID - Port1
Routing Cache (RC)
MobileHost ID - Port1
Cellular IP
Access Network
Mobile IP
Foreign Agent
Internet
Gateway Router
Cellular IP Node
Cellular IP Node
1
2
Cellular IP Node
Cellular IP Node
Cellular IP Node
Mobile Host

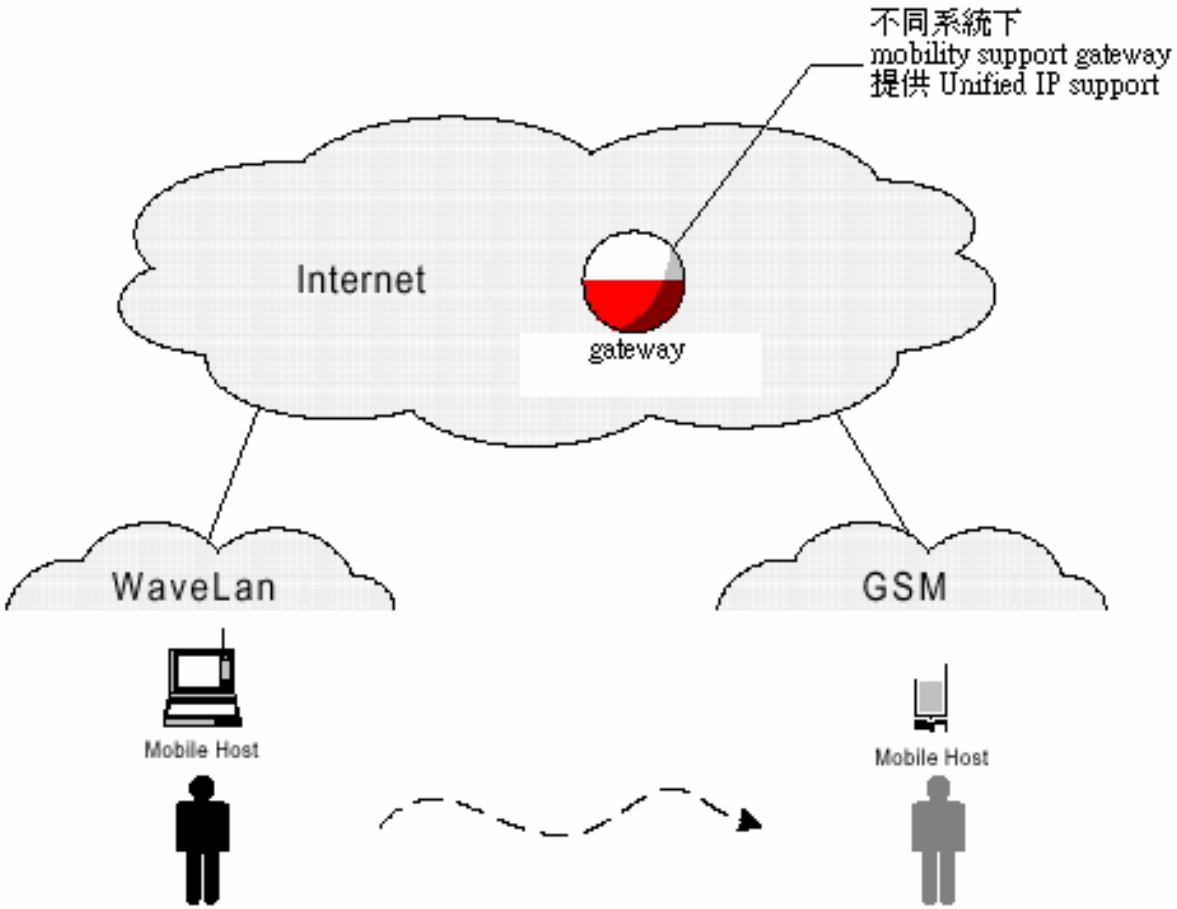
3GPP IP reference architecture



3GPP2 IP reference architecture

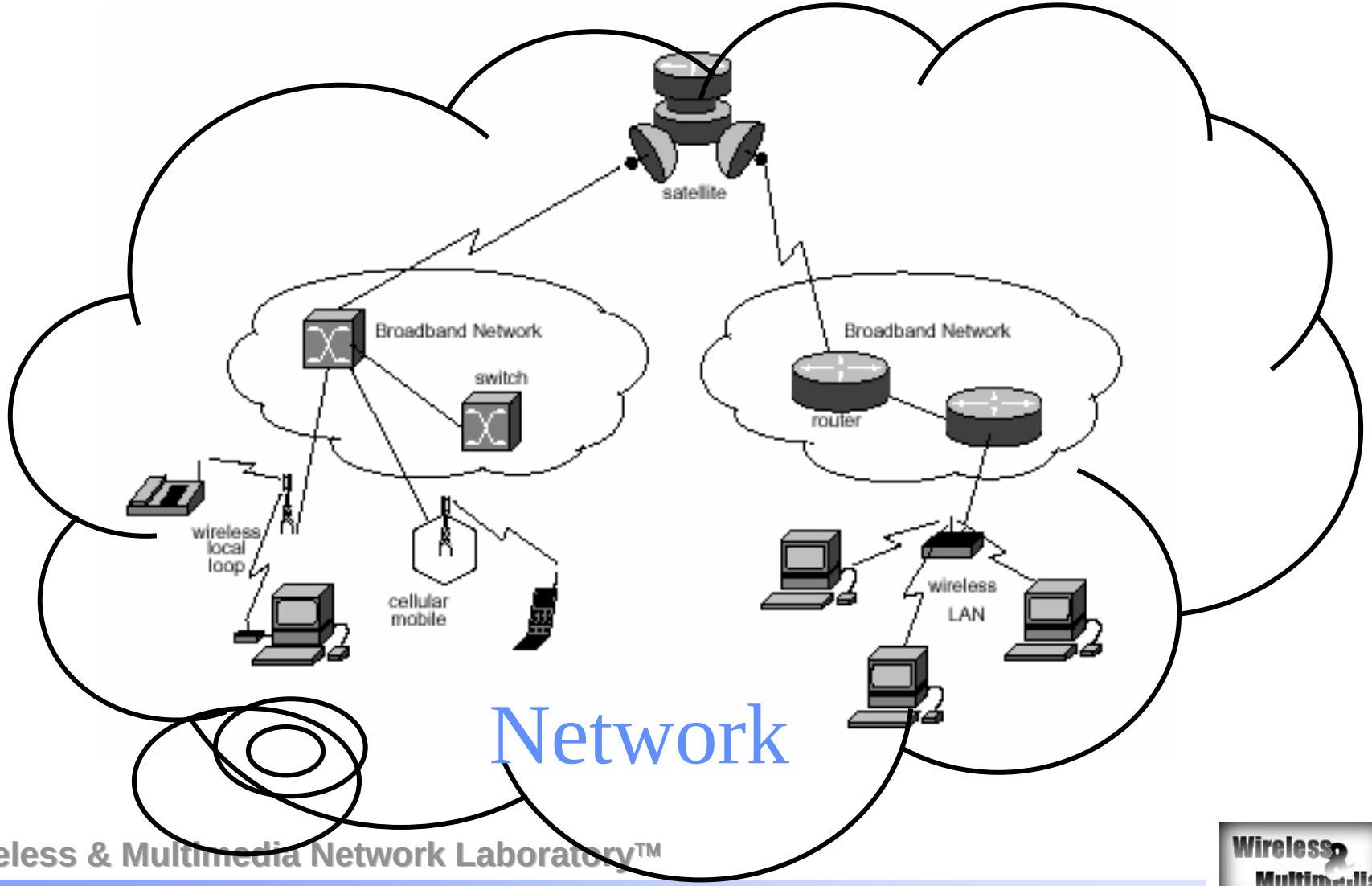


Heterogeneous access network



The Mobile People network architecture

Heterogeneous End System



Last Mile QoS Issues

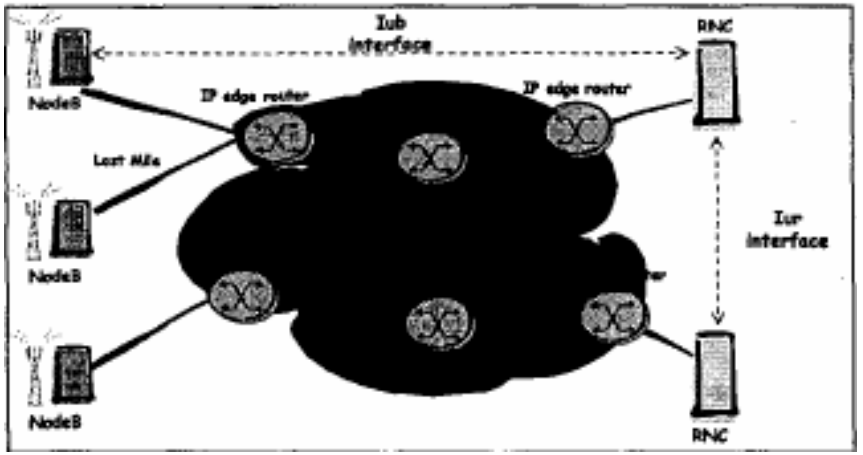
- Last mile connect NodeB and RAN. It is usually low bandwidth links.
- limit the transmission

  time for a packet.
- Three choices

  -- Fragmentation on a layer below

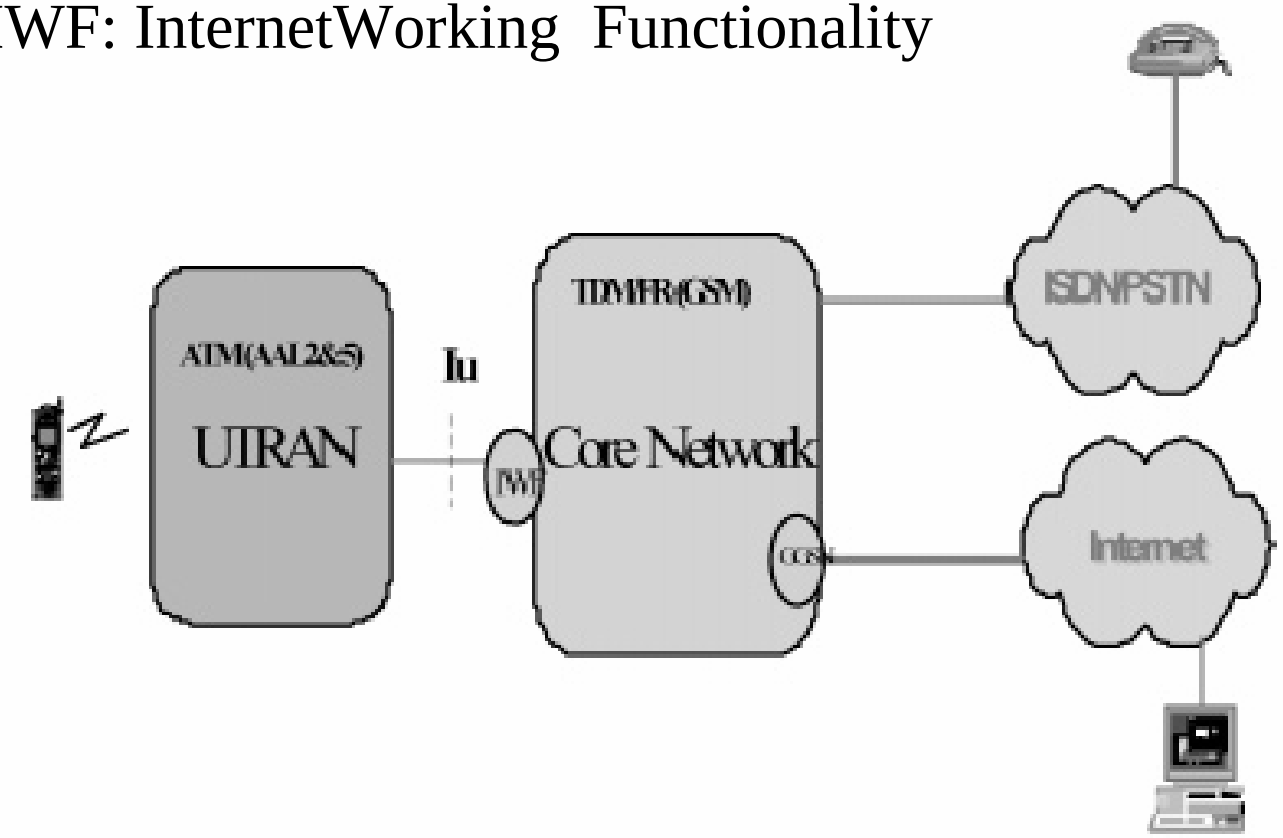
  -- Fragmentation on a layer above

  -- Fragmentation in IP Layer

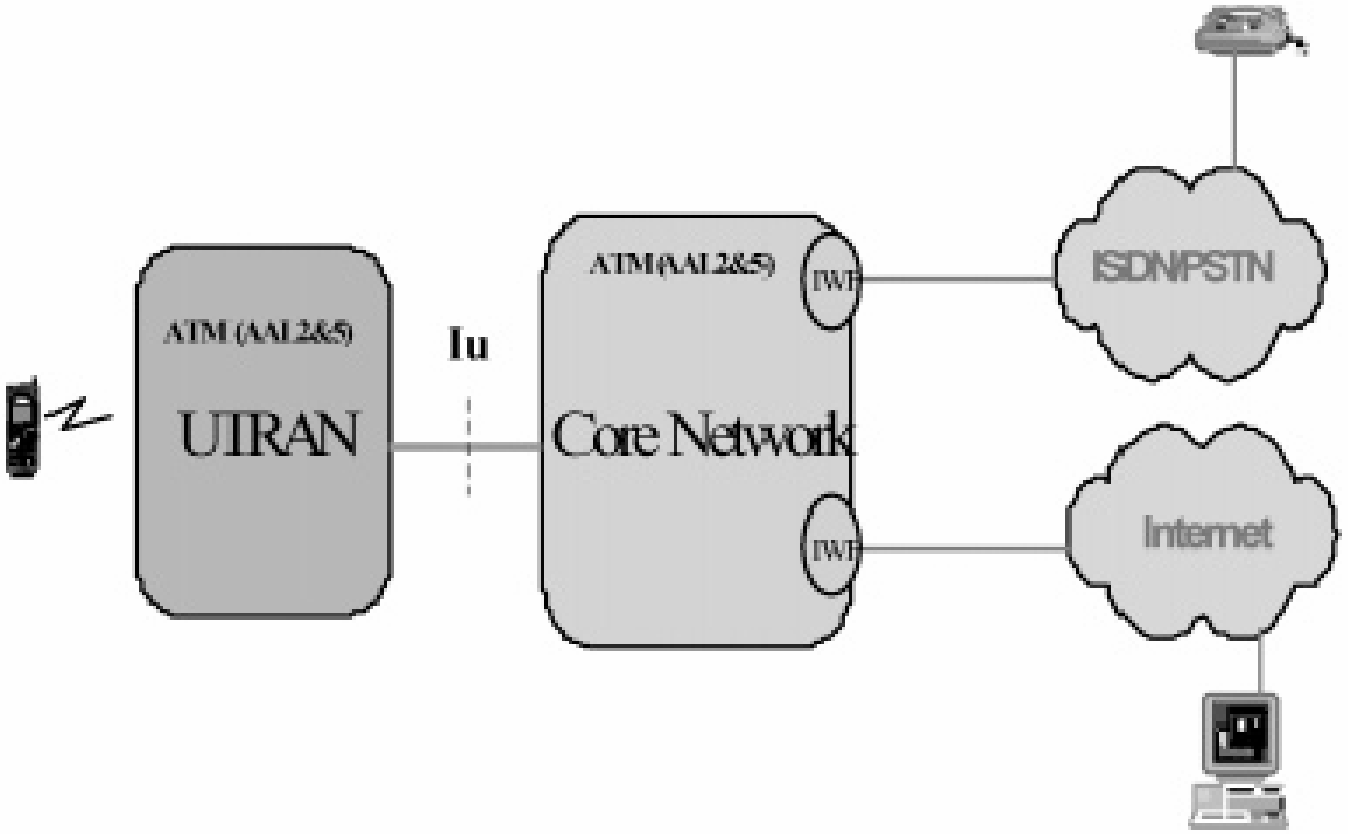


Option1

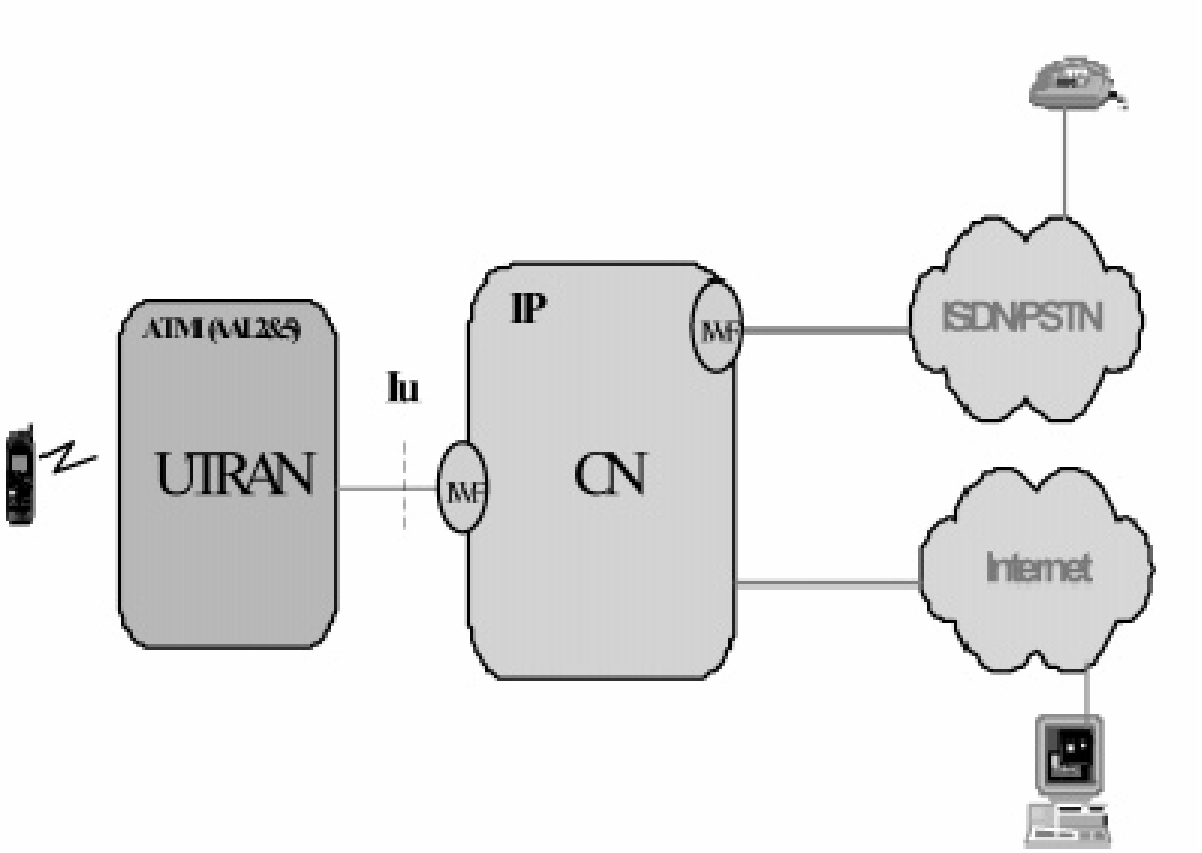
IWF: InternetWorking Functionality



Option 2


ATM (AAL2&5)
UTRAN
Iu
ATM(AAL2&5)
Core Network
IWF
IWF
ISDN/PSTN
Internet

Option 3



Option 4