

# 無線網路多媒體系統

# Wireless Multimedia System

## Lecture 6: CDMA & 3G Trend

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

We  
provide  
無線網路多媒體實驗室  
Wireless  
Wireless Network & Multimedia Laboratory  
Solution

# 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

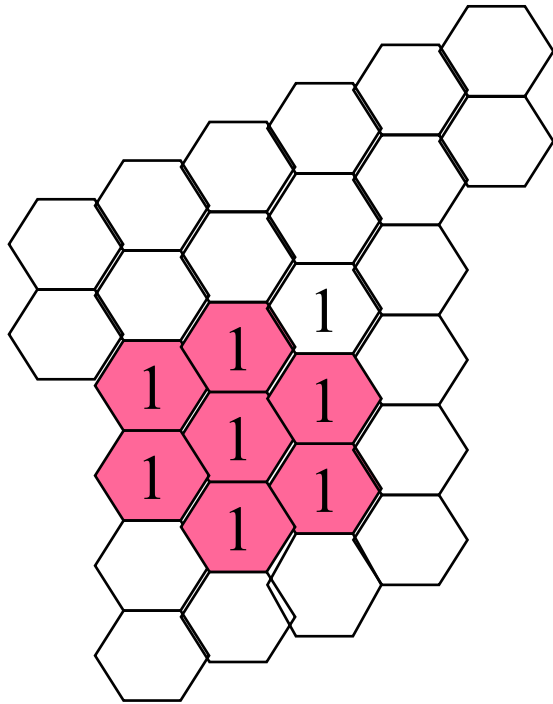


# Code Division, Spread Spectrum



**What is Going to Happen  
in CDMA?**

# Direct Sequence Cellular

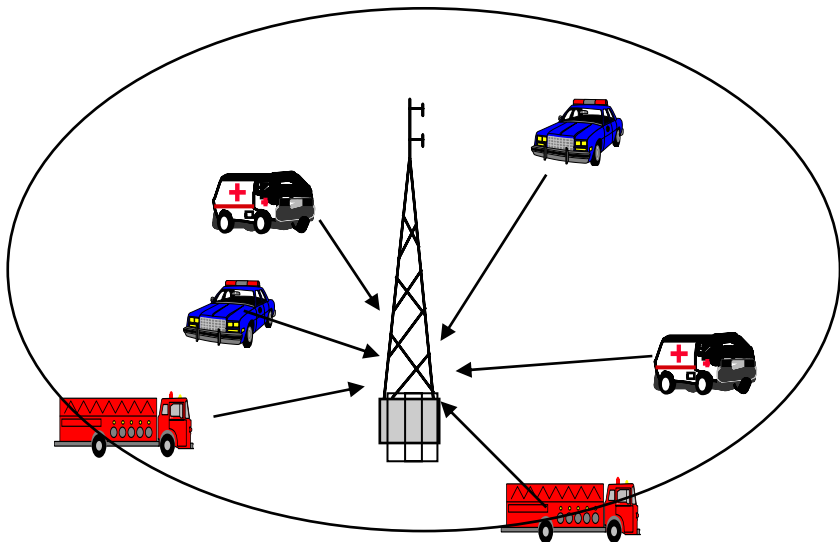


Idealized grid of  
Hexagonal cells

- ◆ 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)

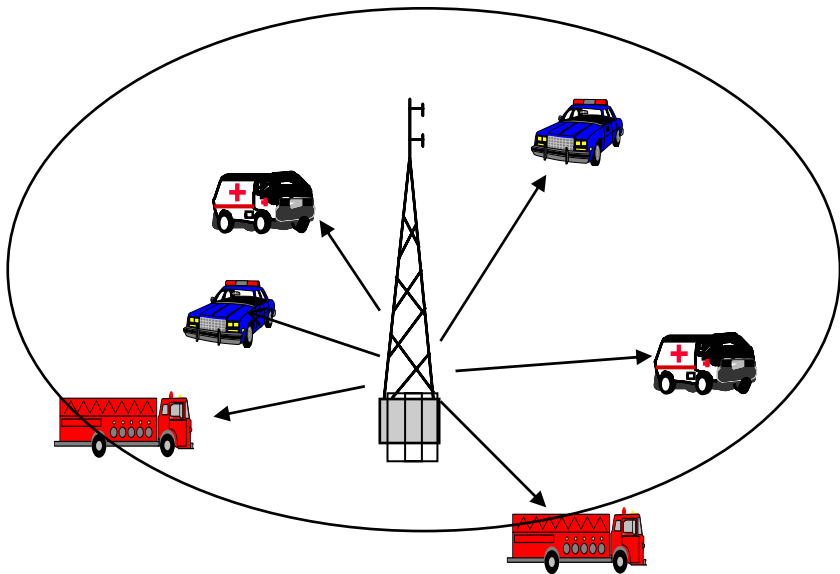


Everybody has a  
Code (PN),  
asynchronous



# 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

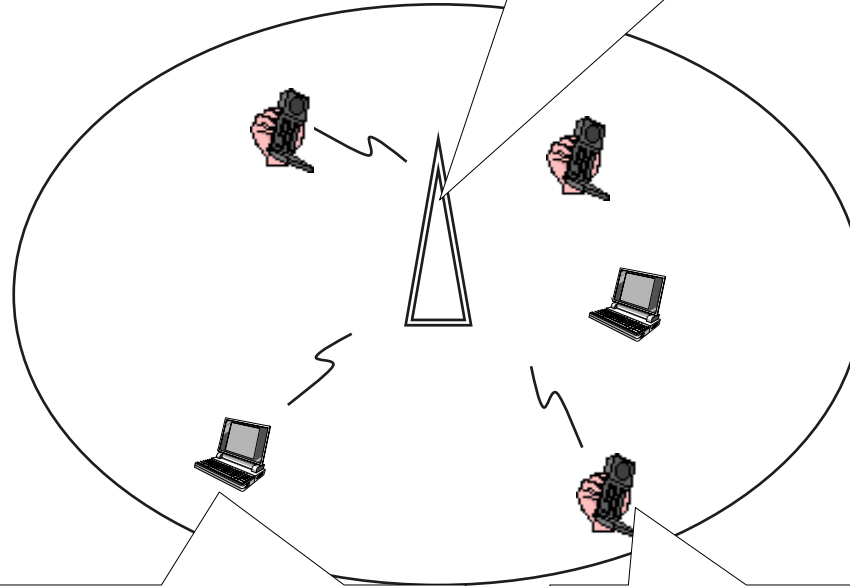


voice user



data user

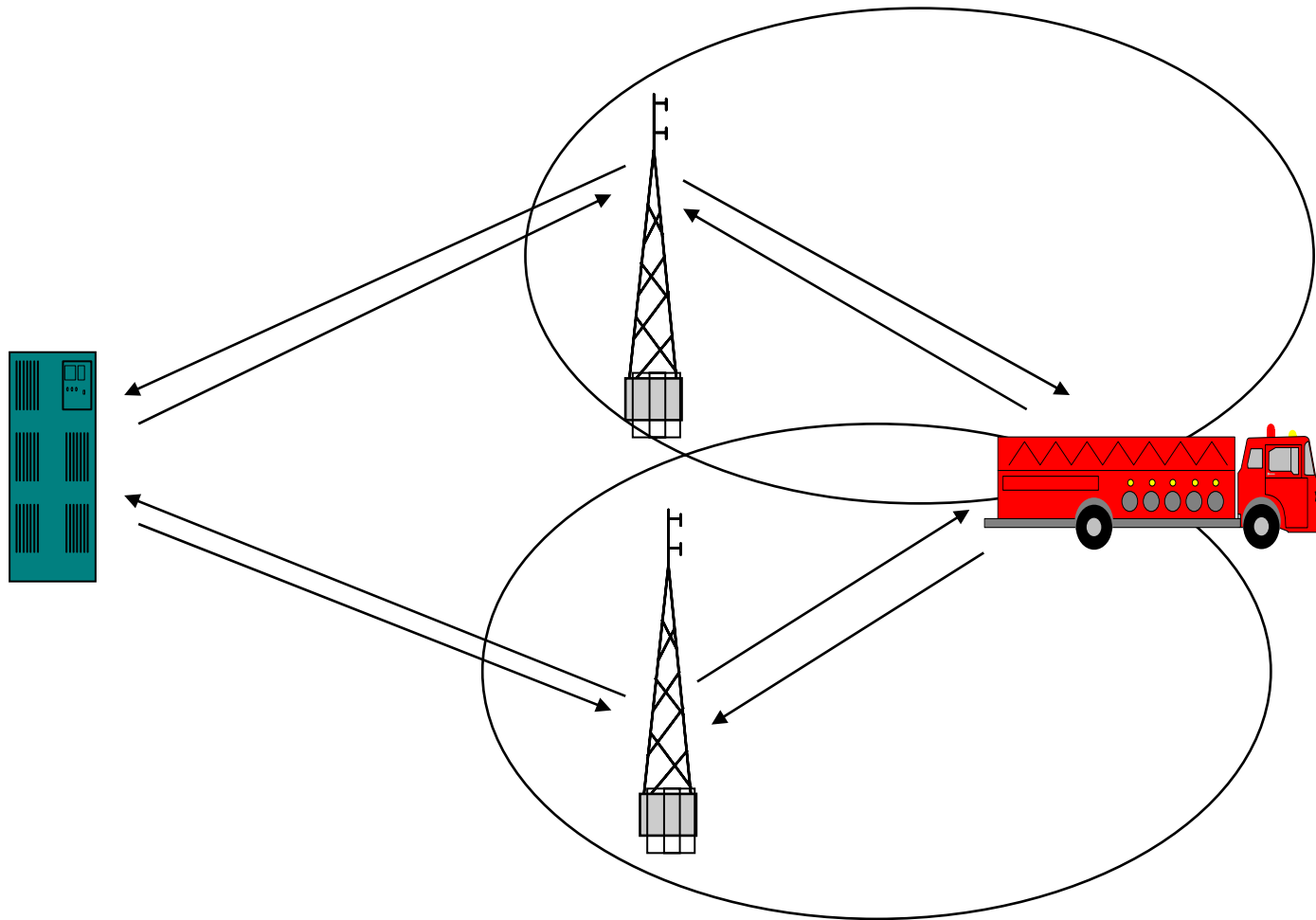
*Optimal Power Control  
Call Admission Control  
Re-negotiation Mechanism*



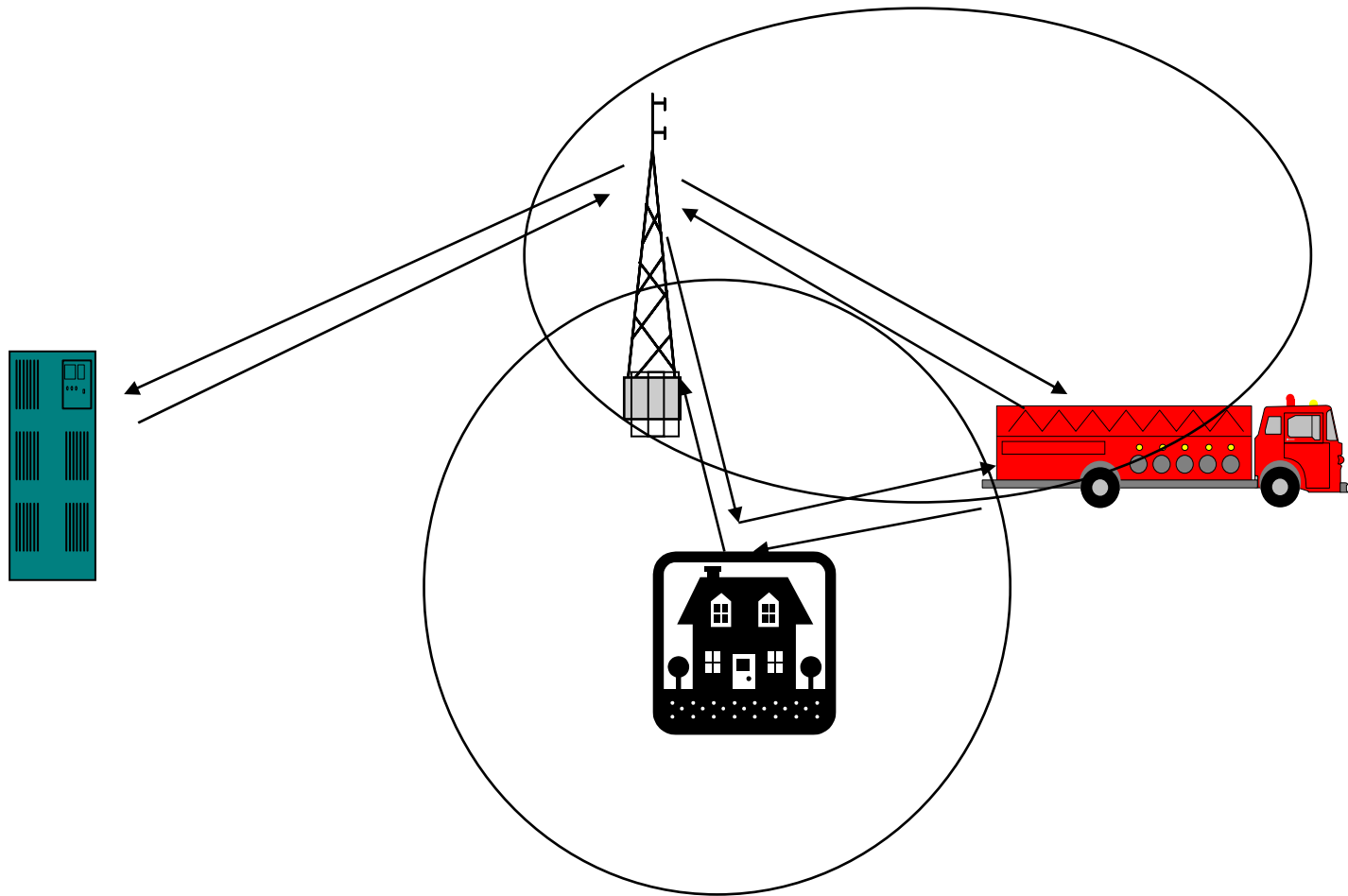
*Optional QOS requirements*

*QOS requirements*

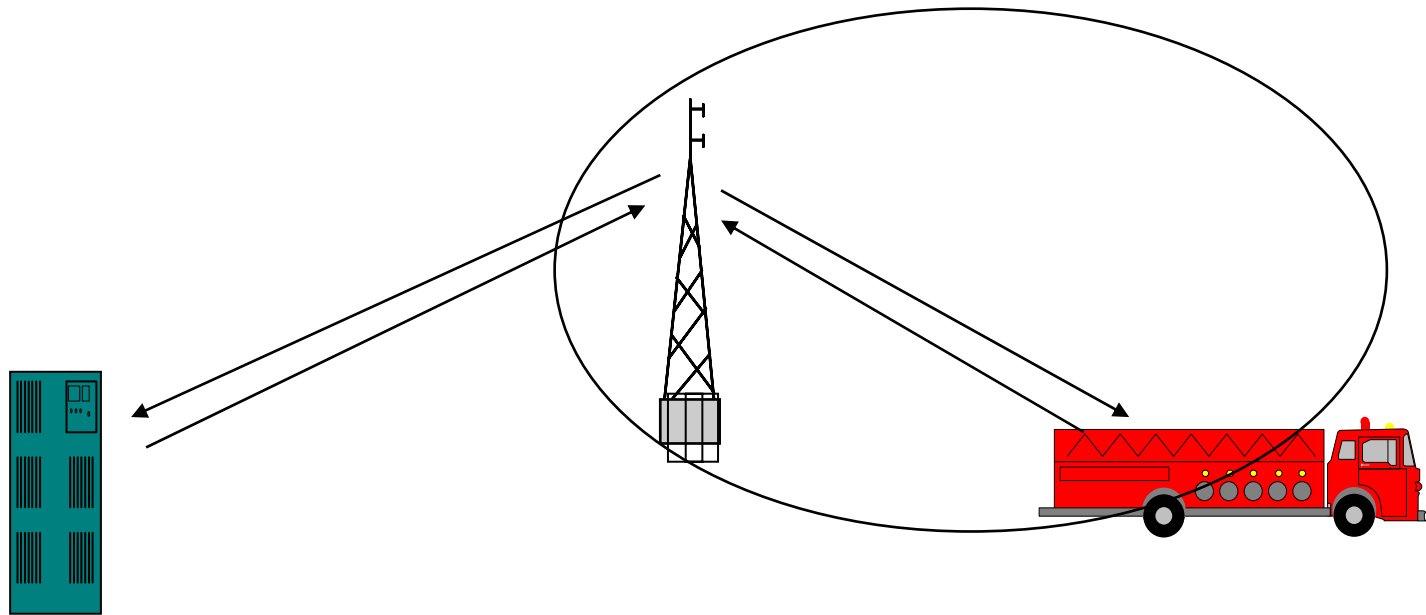
# Soft Handovers (Macro Diversity)



# Softer Handovers (Space Diversity)

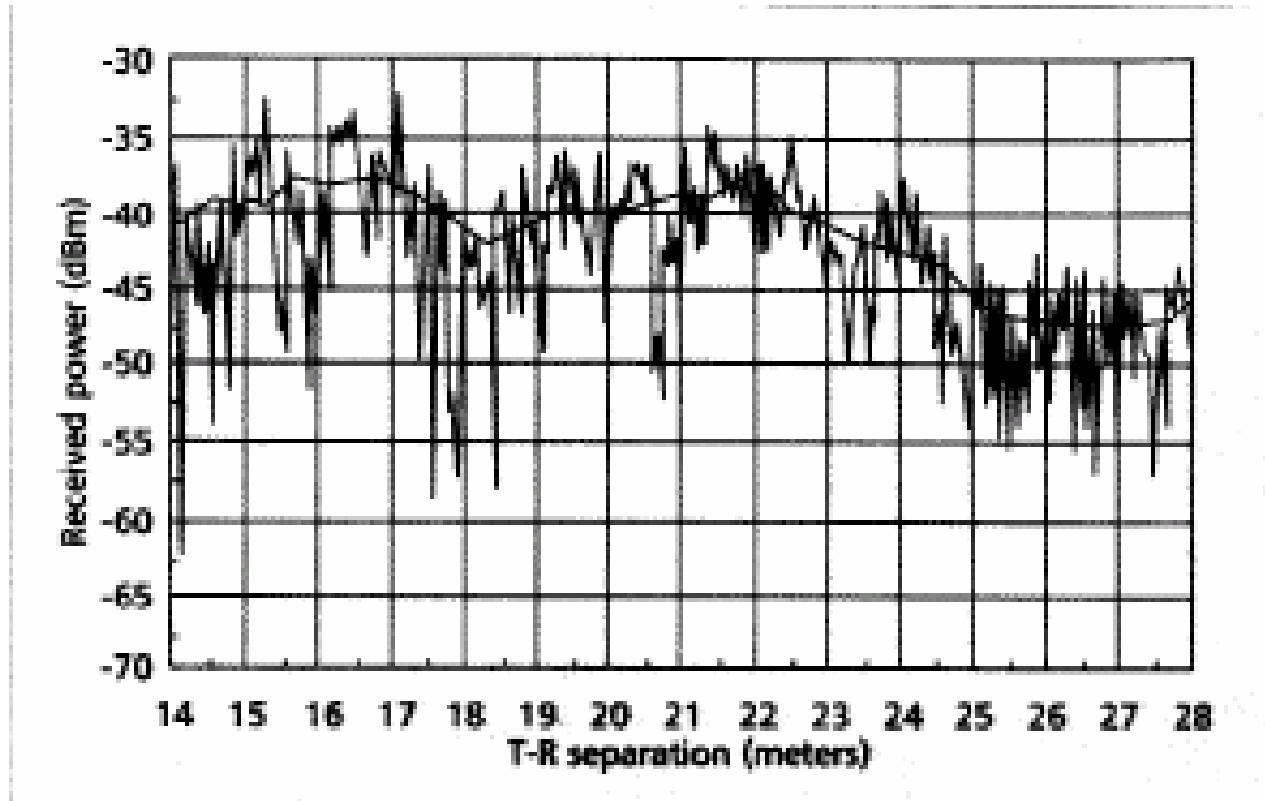


# Power Control (Open & Close Loop)



# Close-Loop Power Control

- ◆ Compensates a fading channel(1500 times per second)



# UMTS/IMT-2000 Based on Wideband CDMA

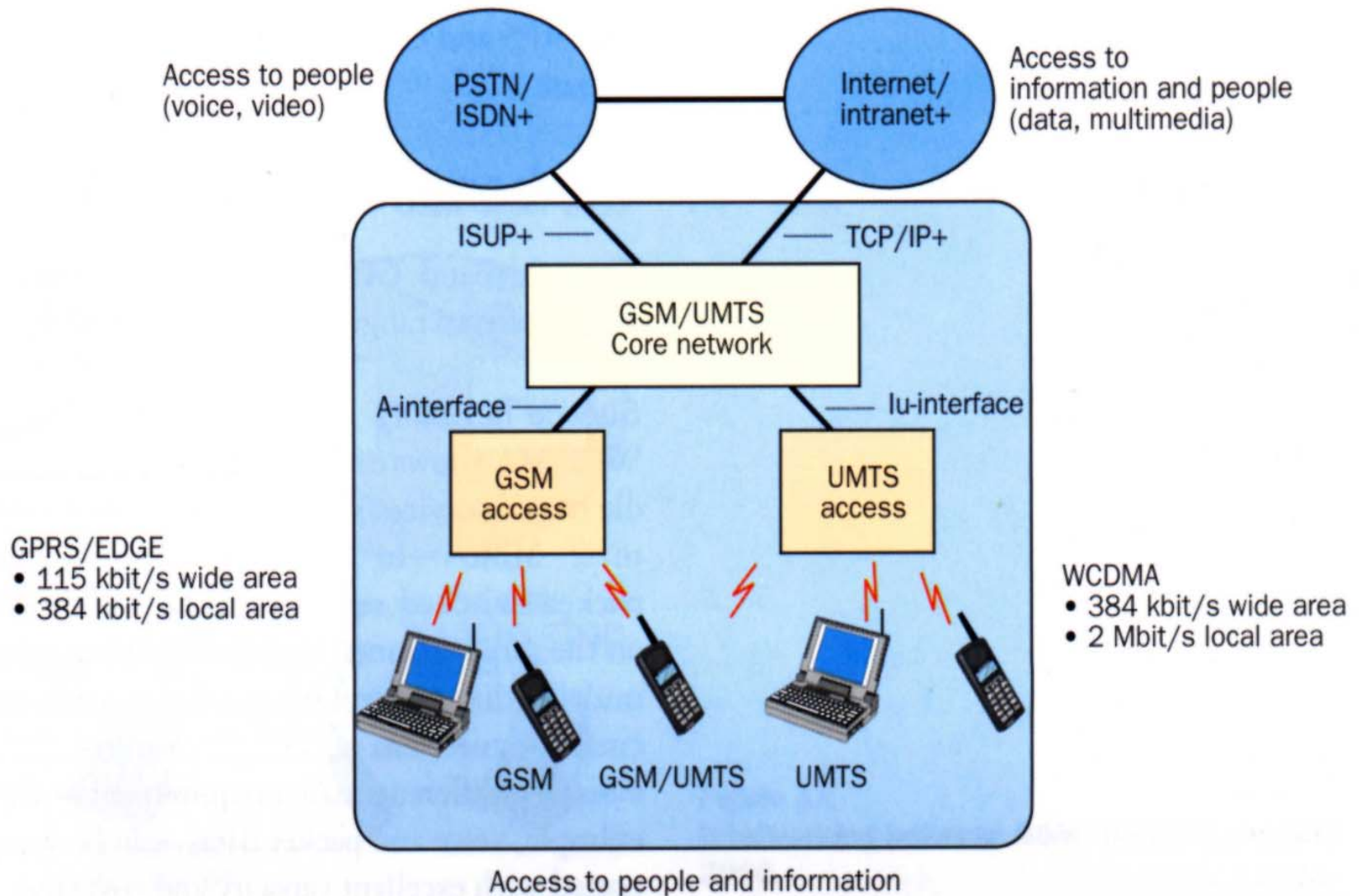


What is going to happen for WCDMA

# 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
  - $E_b / N_0$





# RS Spectrum Allocation

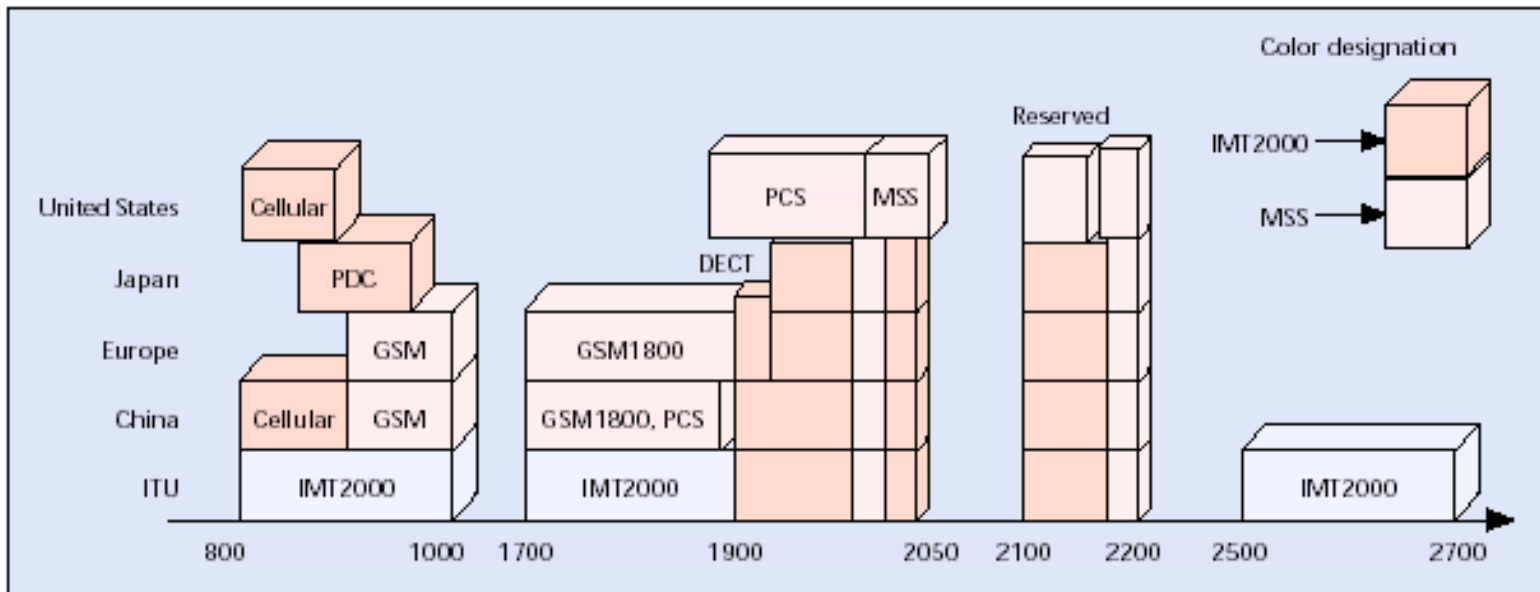
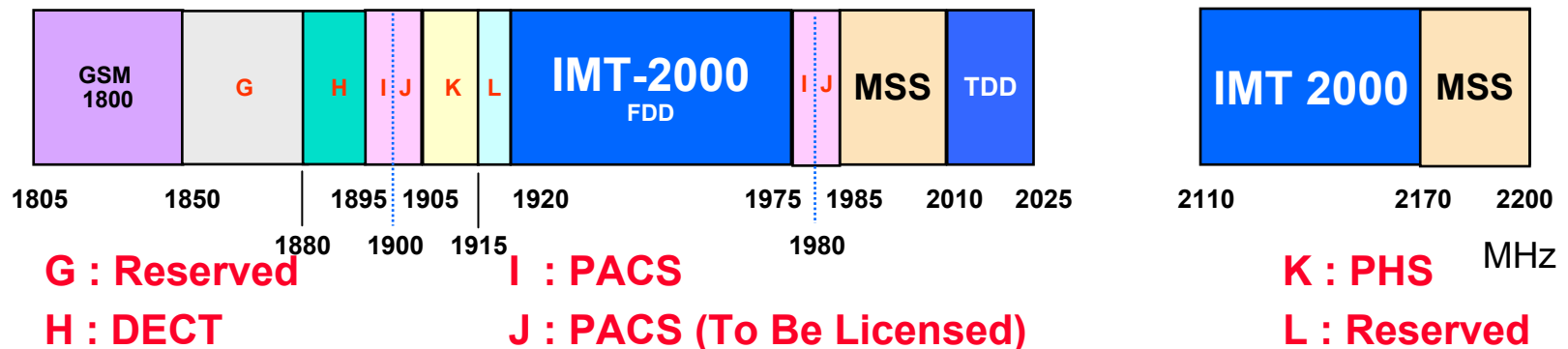
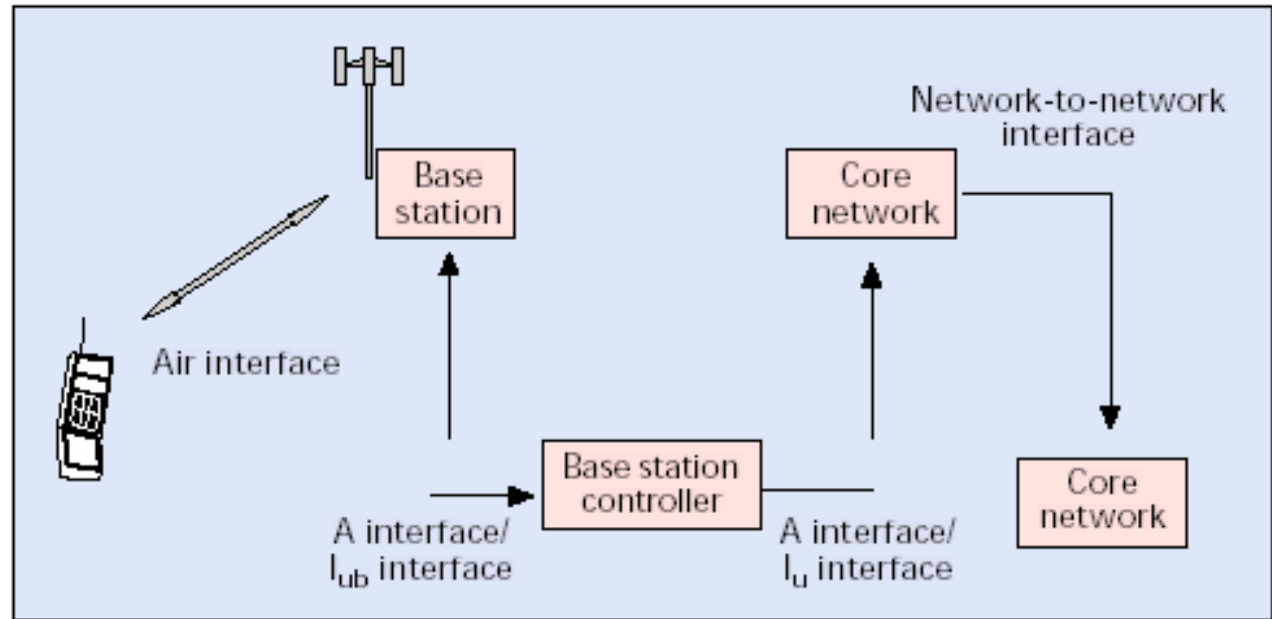


Figure 2. RF spectrum allocation in major regions.

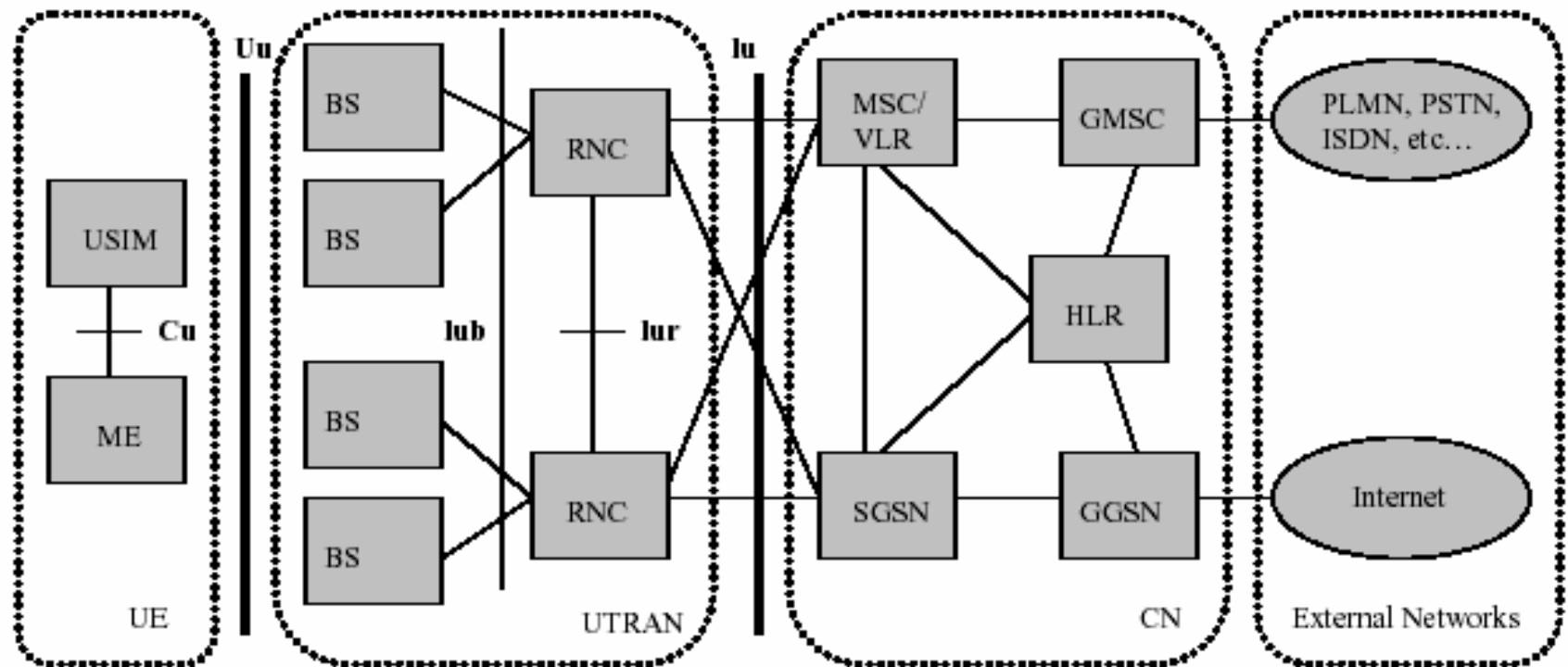


# Wireless Mobile Interface



■ Figure 4. *Wireless mobile system interface definition.*

# Elements of UMTS Architecture



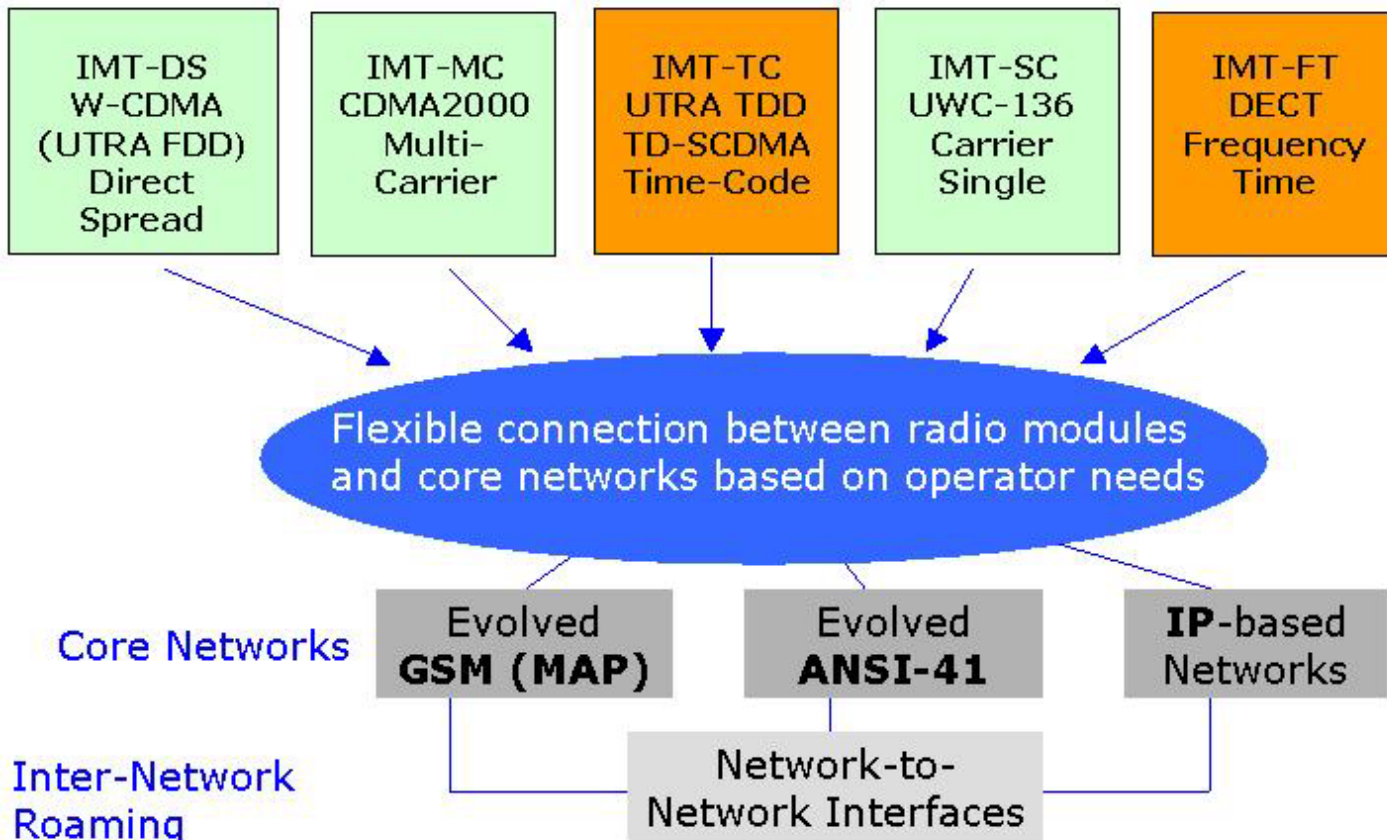
# 第三代行動電話之技術標準

## Modular IMT-2000 Harmonization

Paired spectrum

Unpaired spectrum

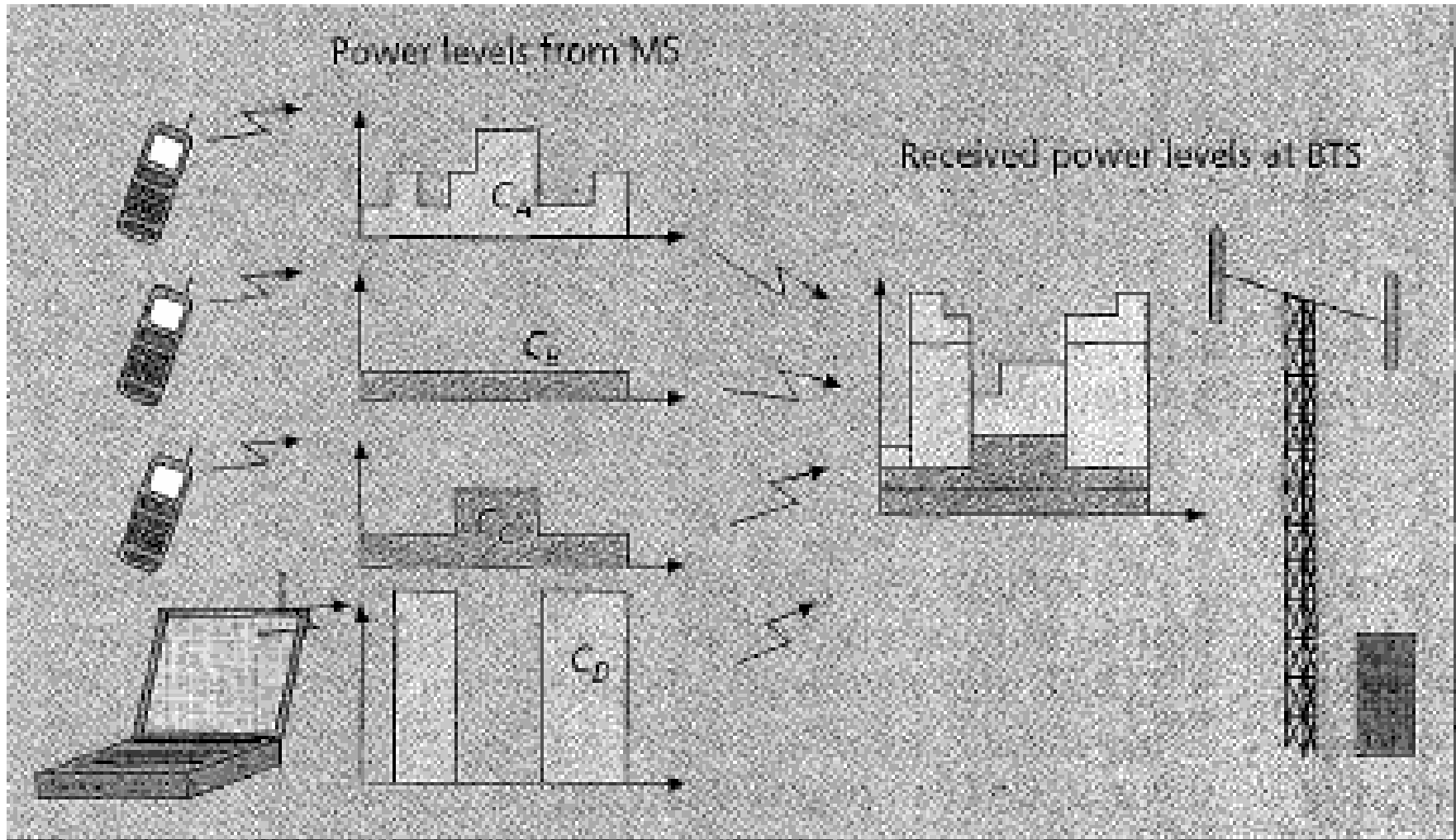
### (Terrestrial Component)



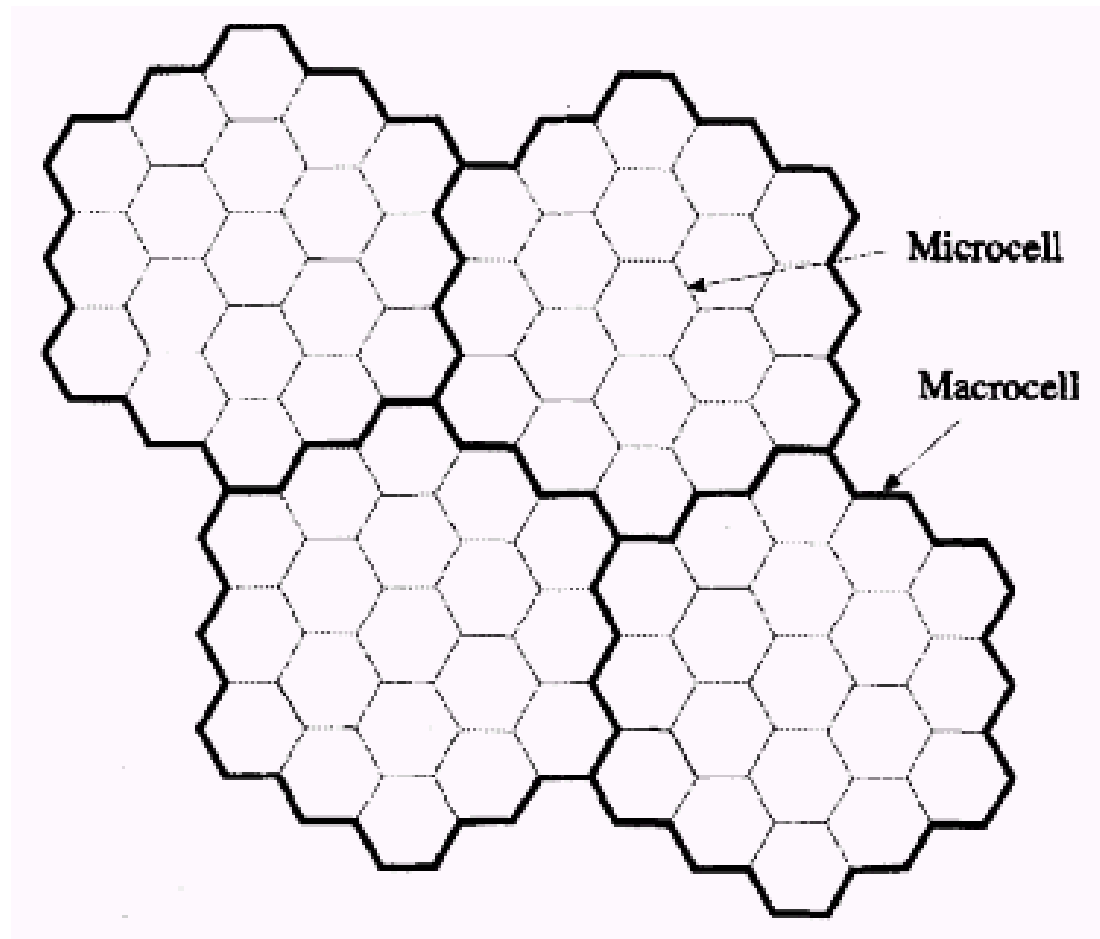
# Key W\_CDMA Features

- ◆ 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-spot
  - 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

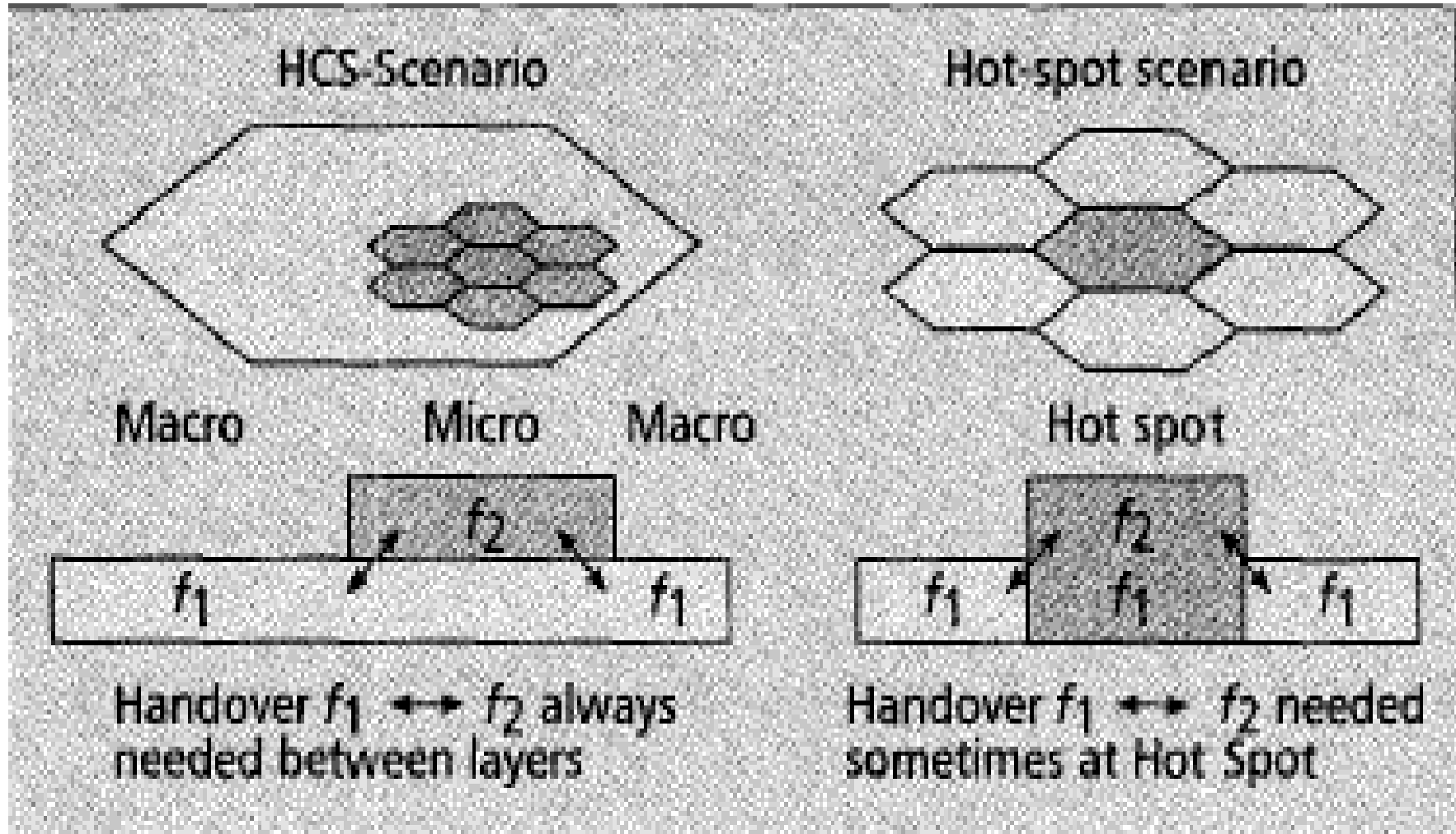


# An example of two-tier cellular system

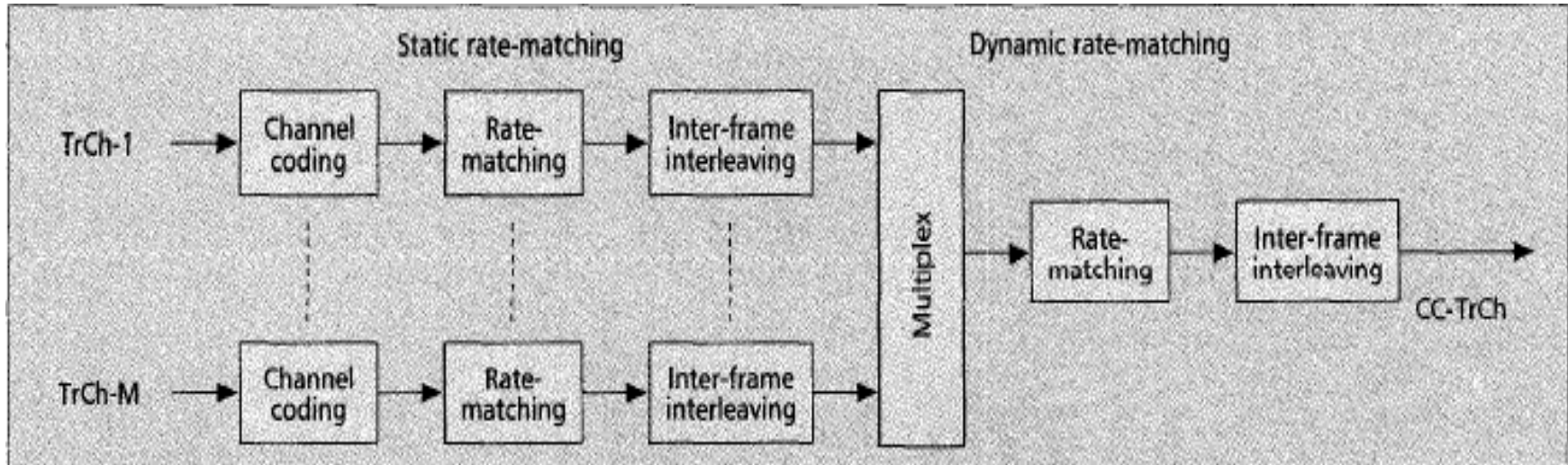




# Handoff



# Transport of the channel

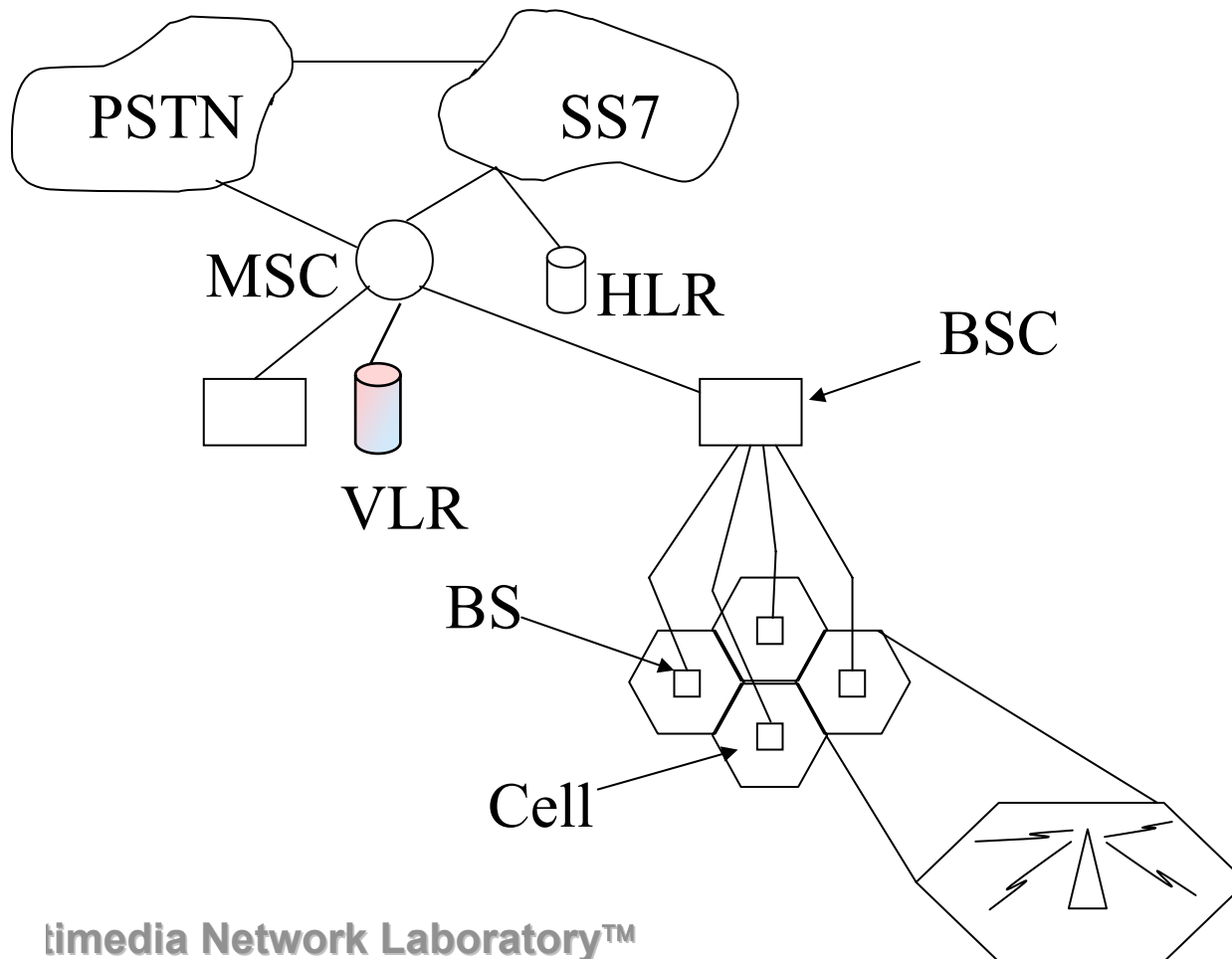


# Evolutions of PCS

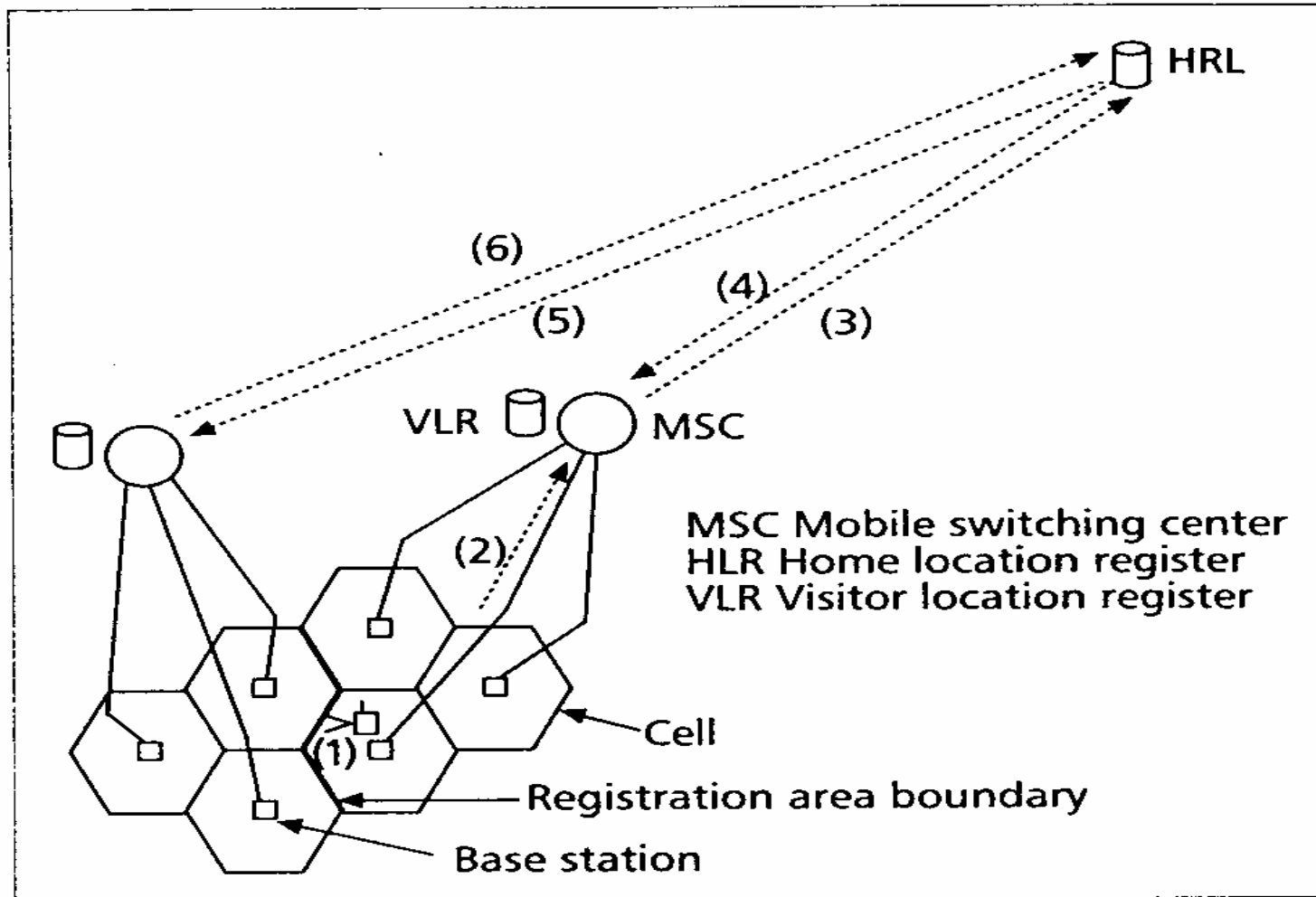


PCS Requirements

# PCS network architecture

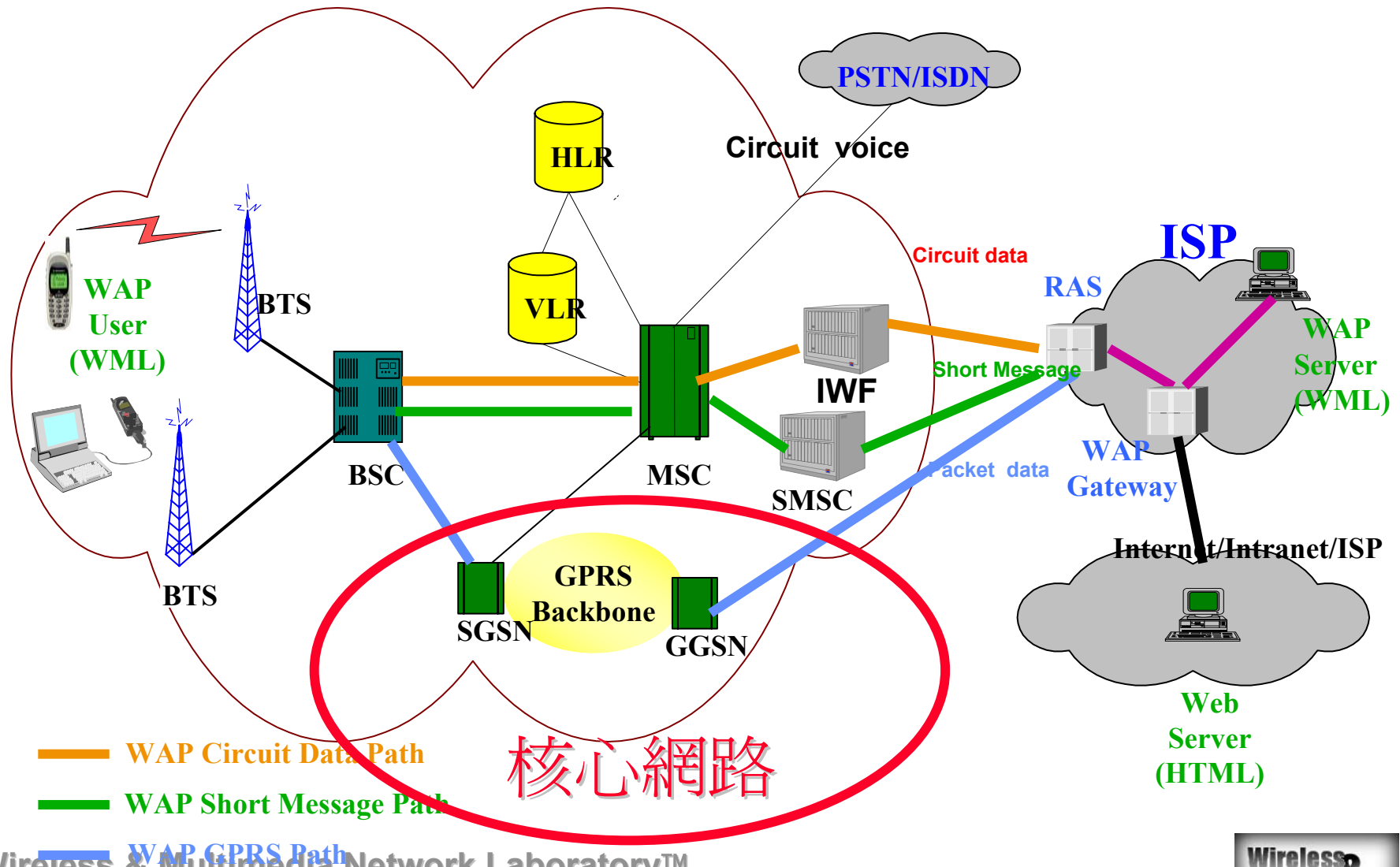


# Location Update Procedure

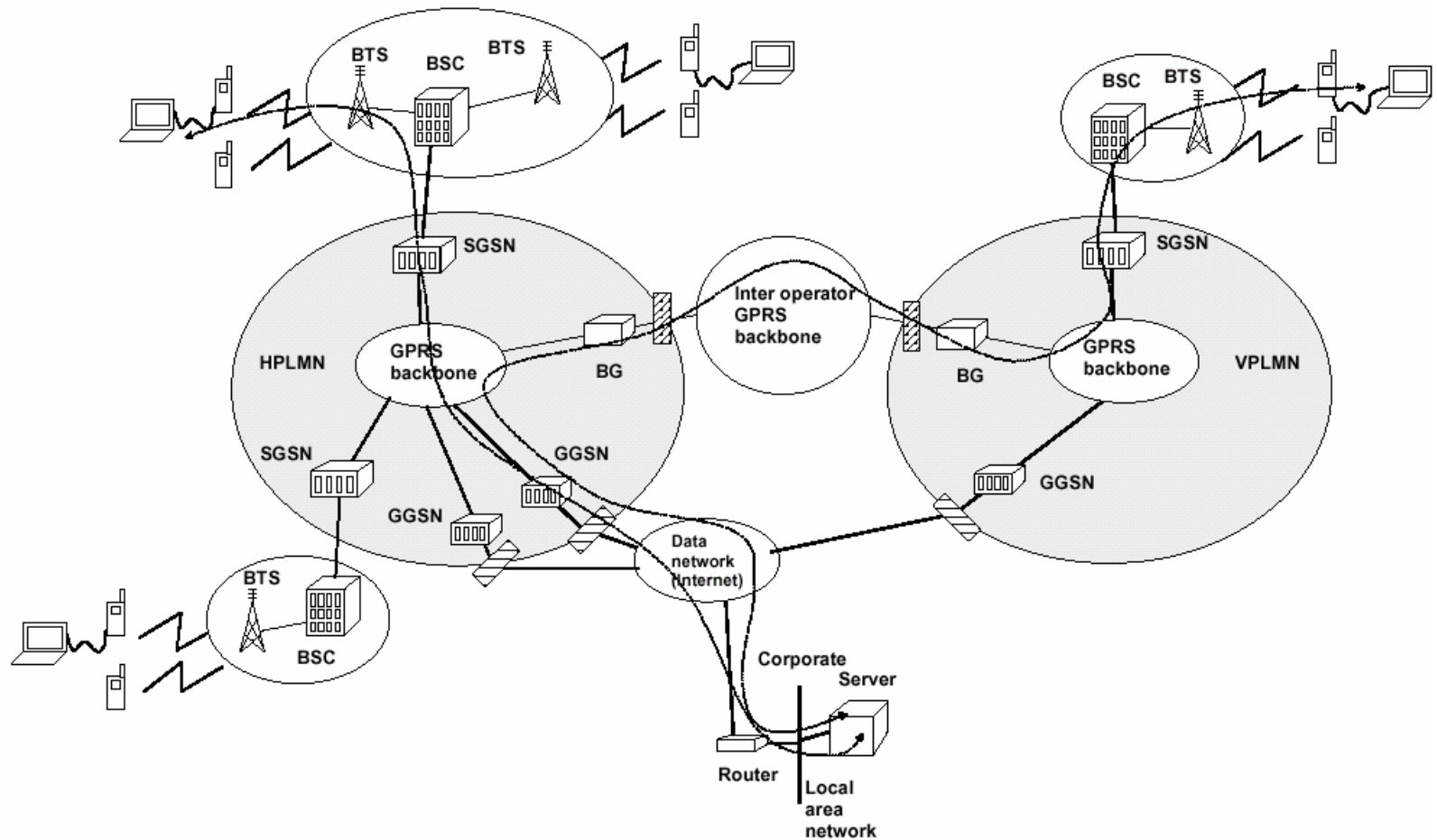


■ Figure 3. Location registration procedures.

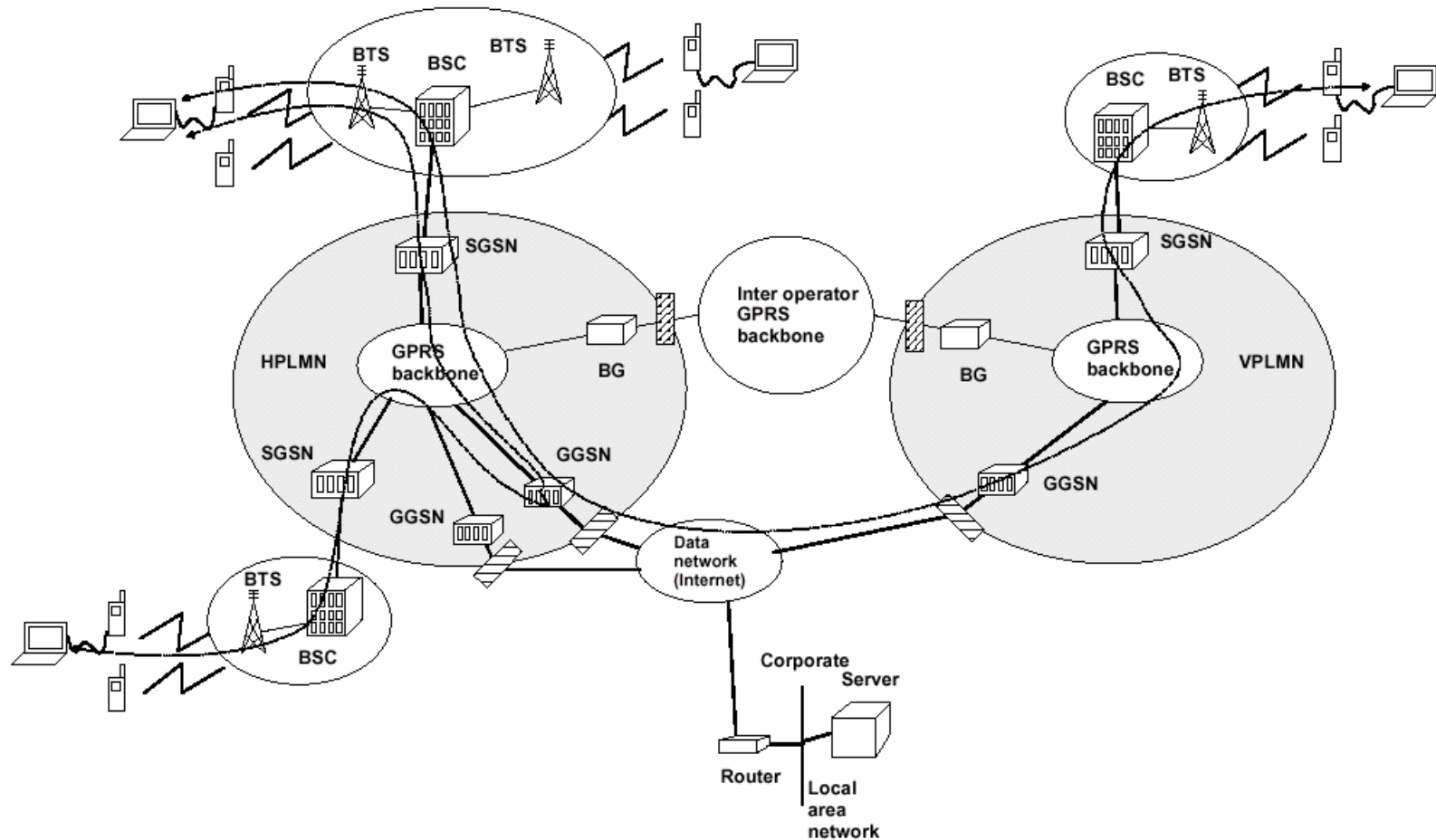
# GPRS



# Data transfer MS-fixed



# Data transfer MS-MS





# Coming Challenges for IP



Location Managements~ handoff, roaming  
QoS Transport~ Backbone delivery

# Mobility

## ◆ User mobility

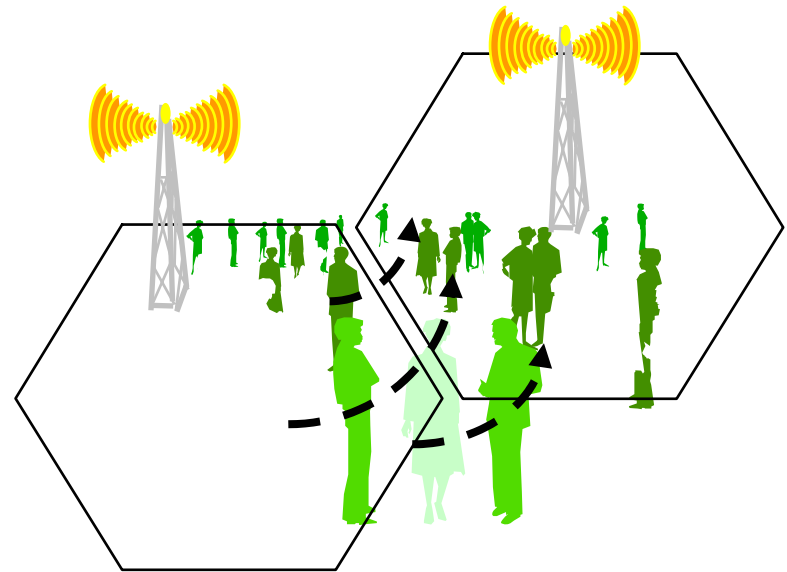
- Micro
- Macro



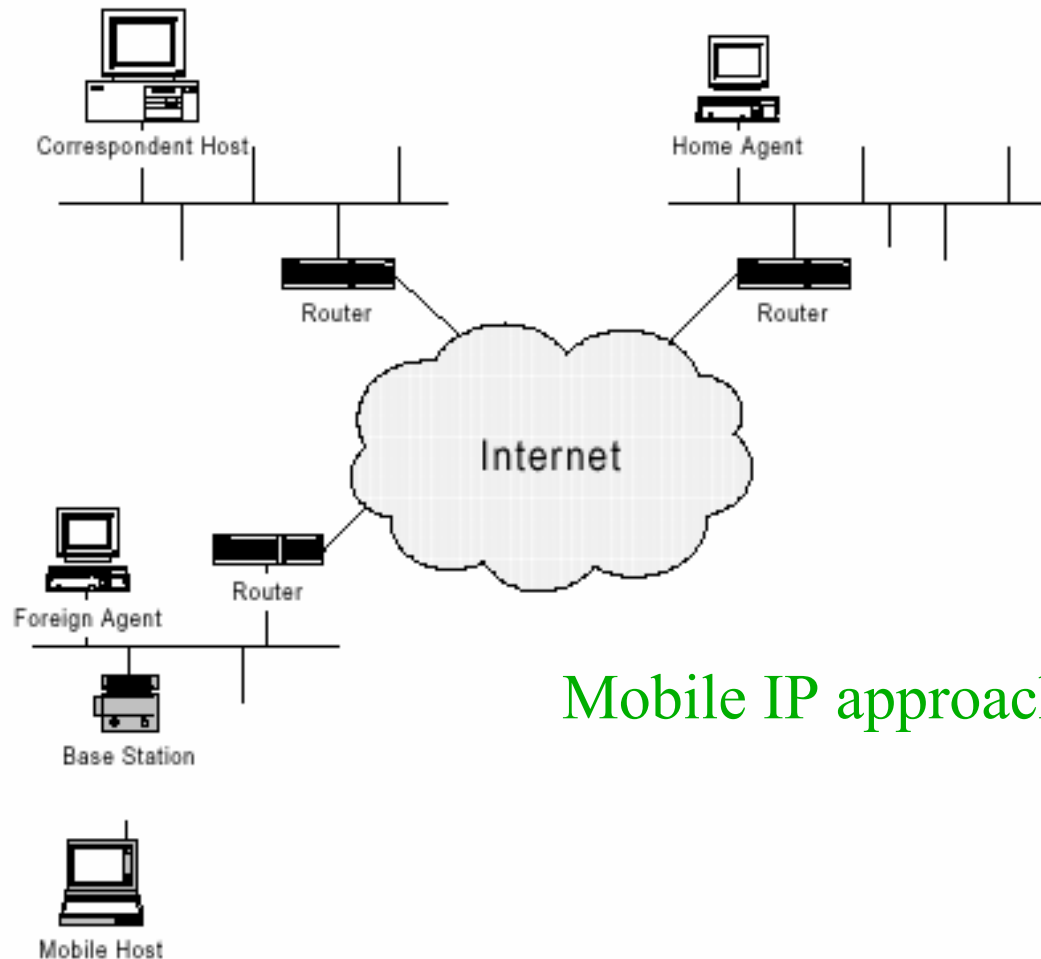
- Handoff issue
- Location management
- Paging

## ◆ IP mobility support

- Mobile IP
- Cellular IP
- HAWAII

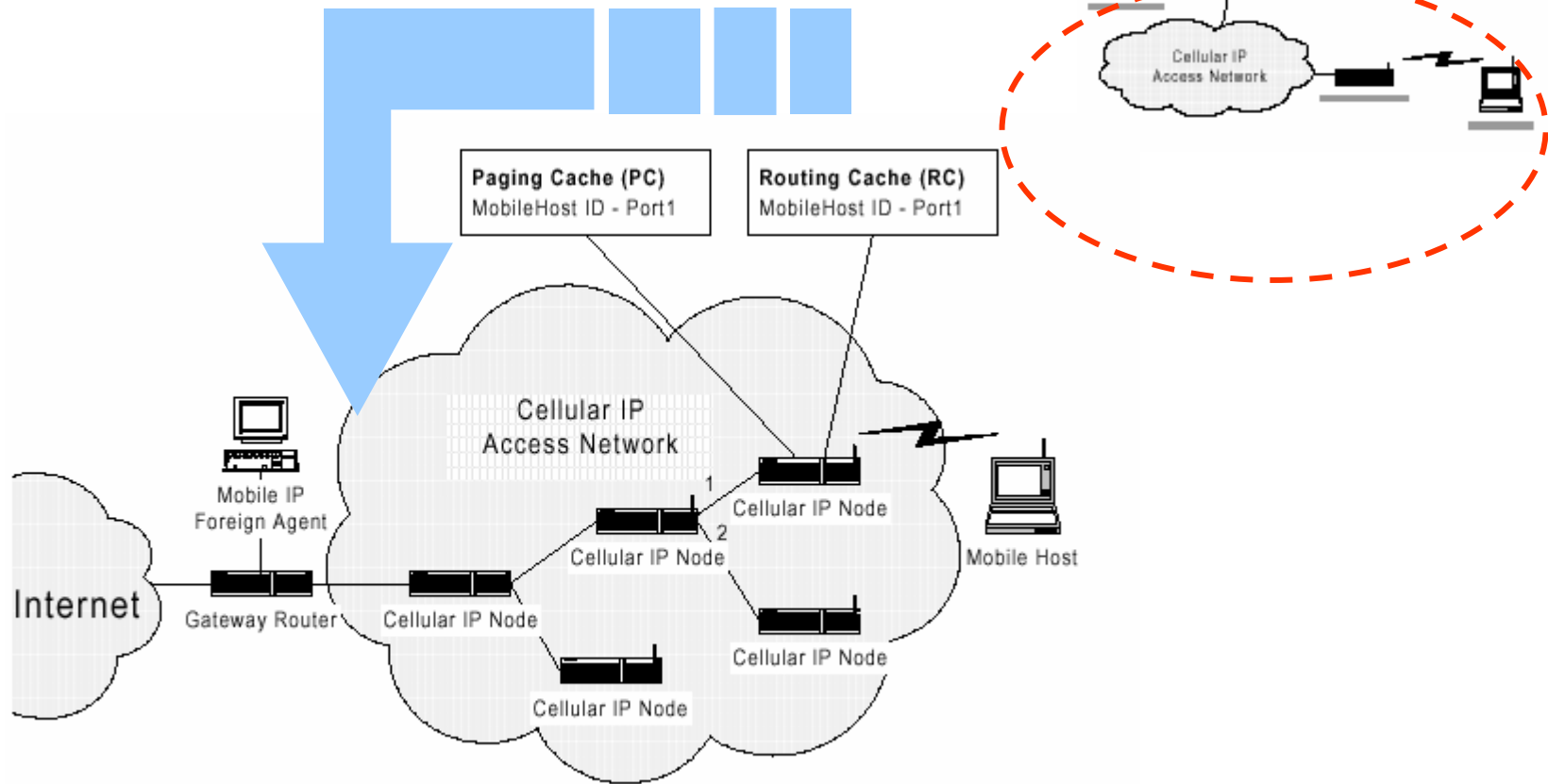


# Nomadic wireless access

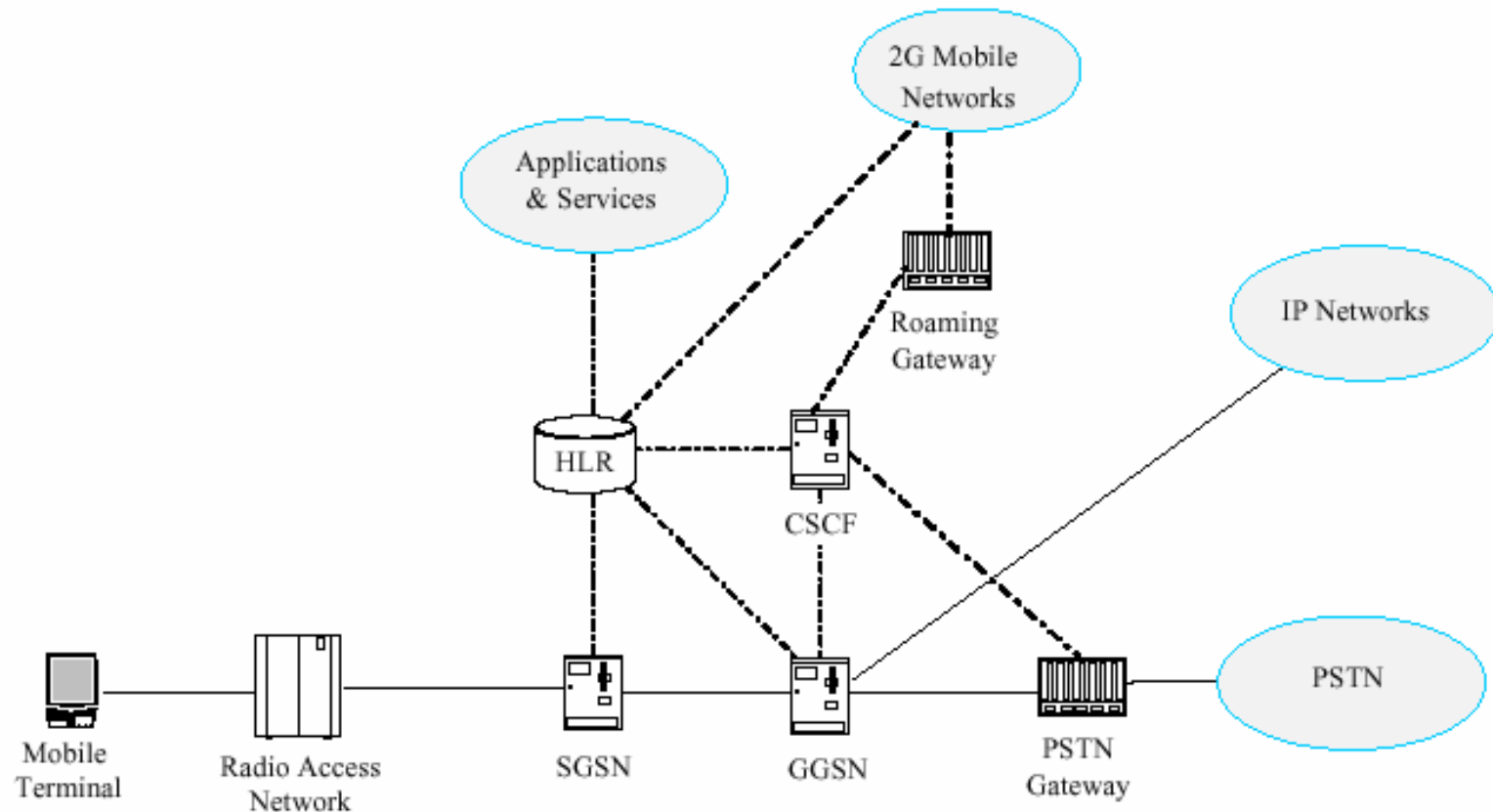


Mobile IP approach

# Cellular IP

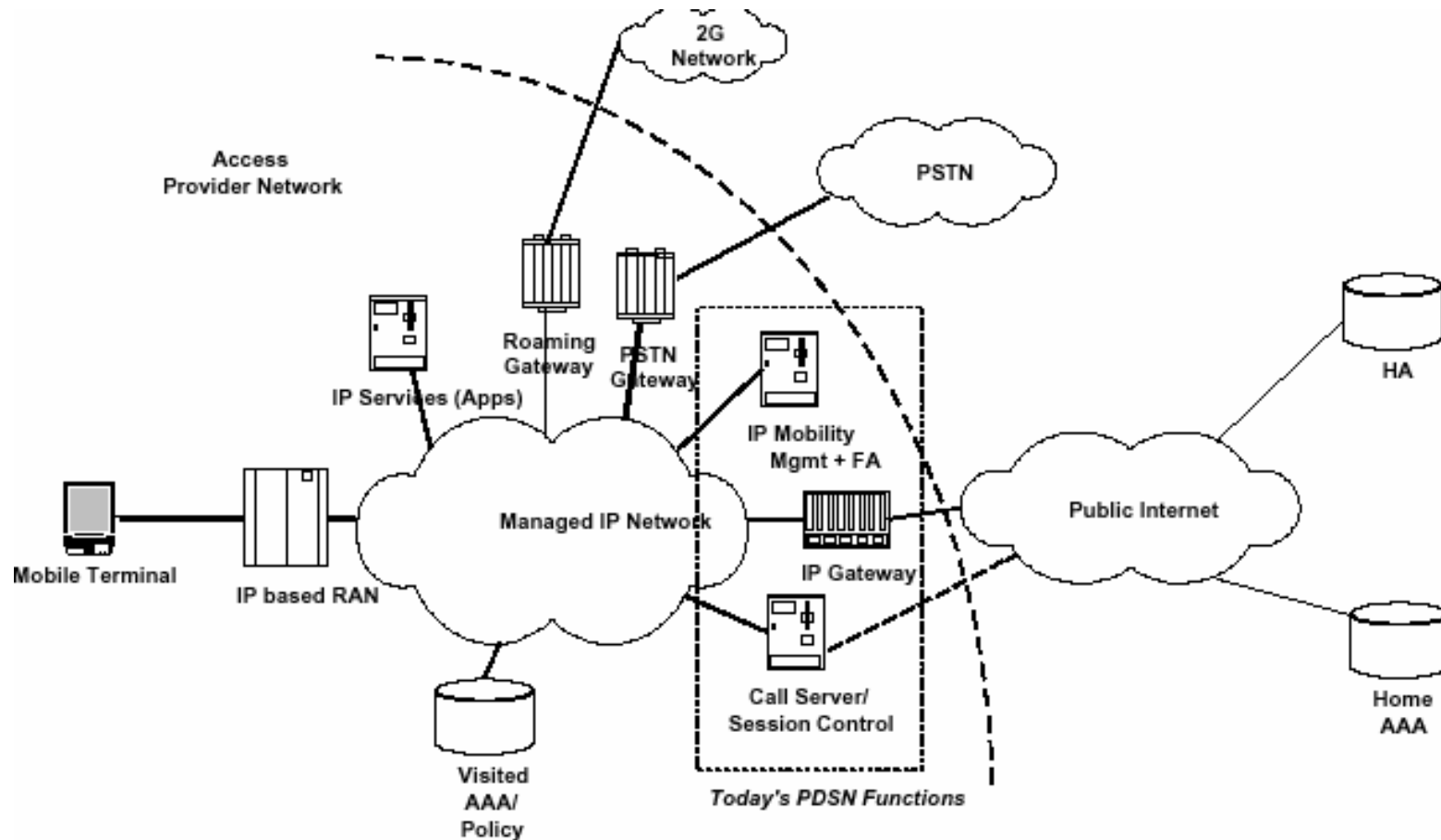


# 3GPP IP reference architecture

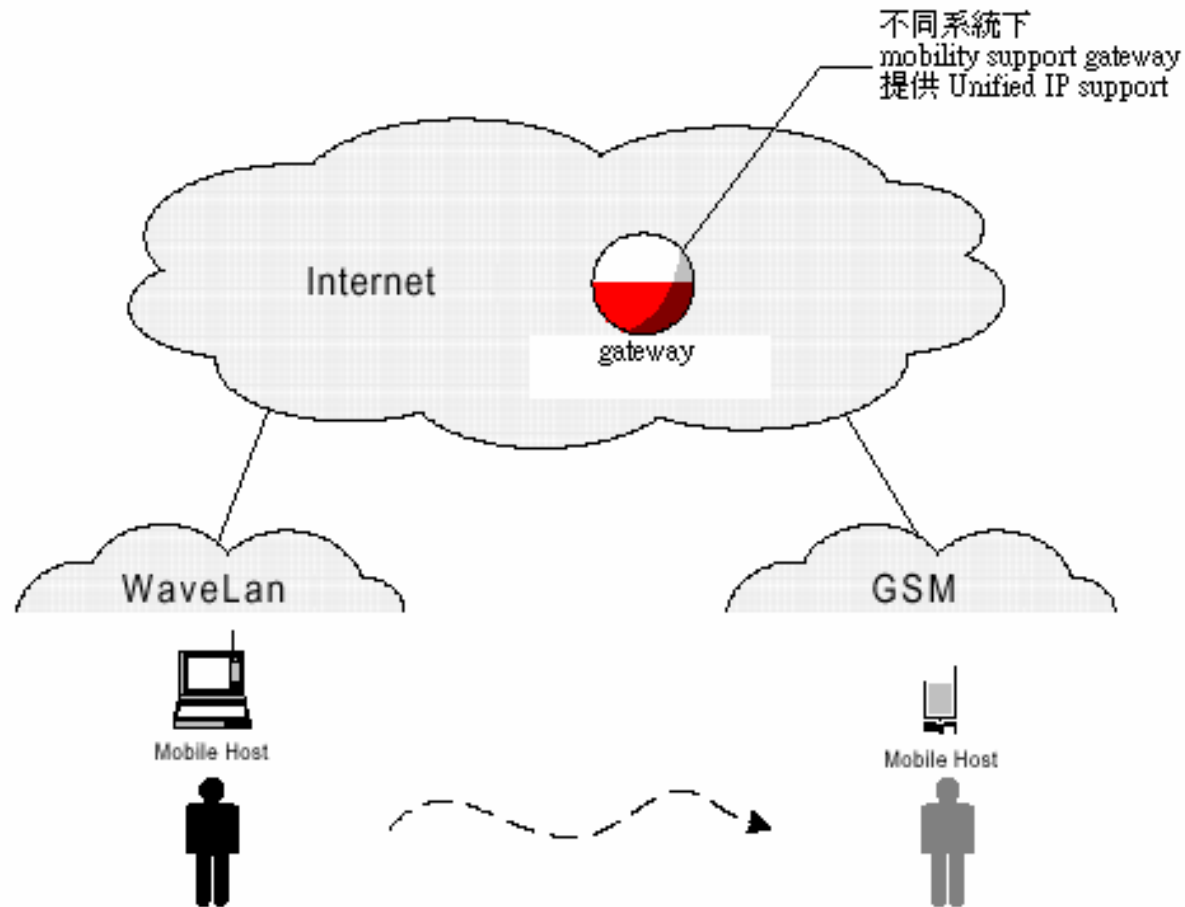


— Signaling Interface  
 — Signaling and Data Transfer Interface

# 3GPP2 IP reference architecture

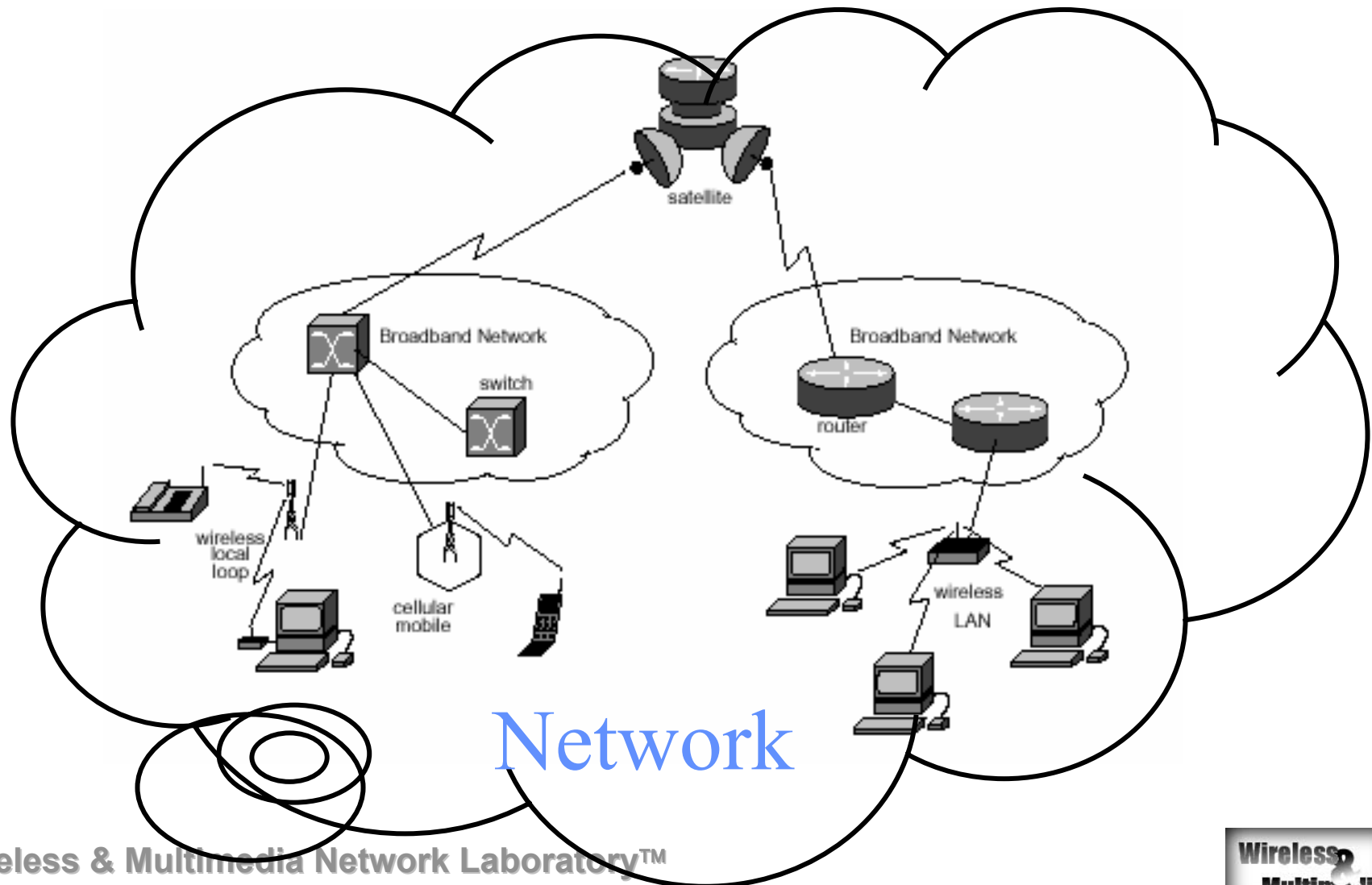


# Heterogeneous access network



The Mobile People network architecture

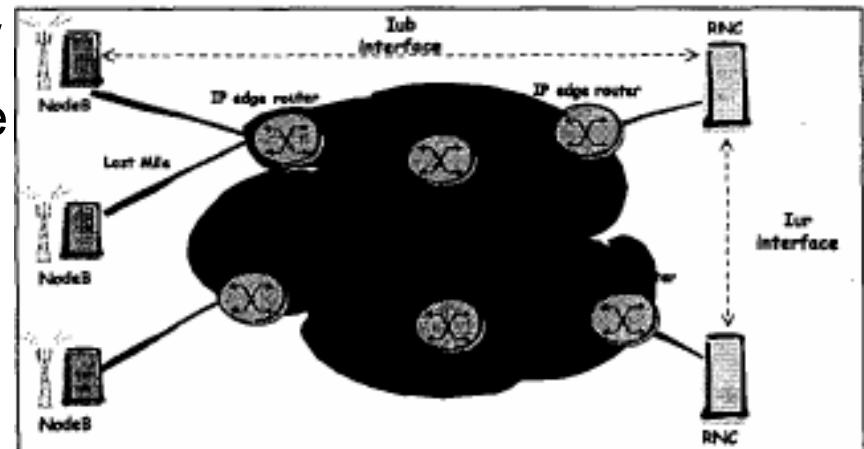
# Heterogeneous End System





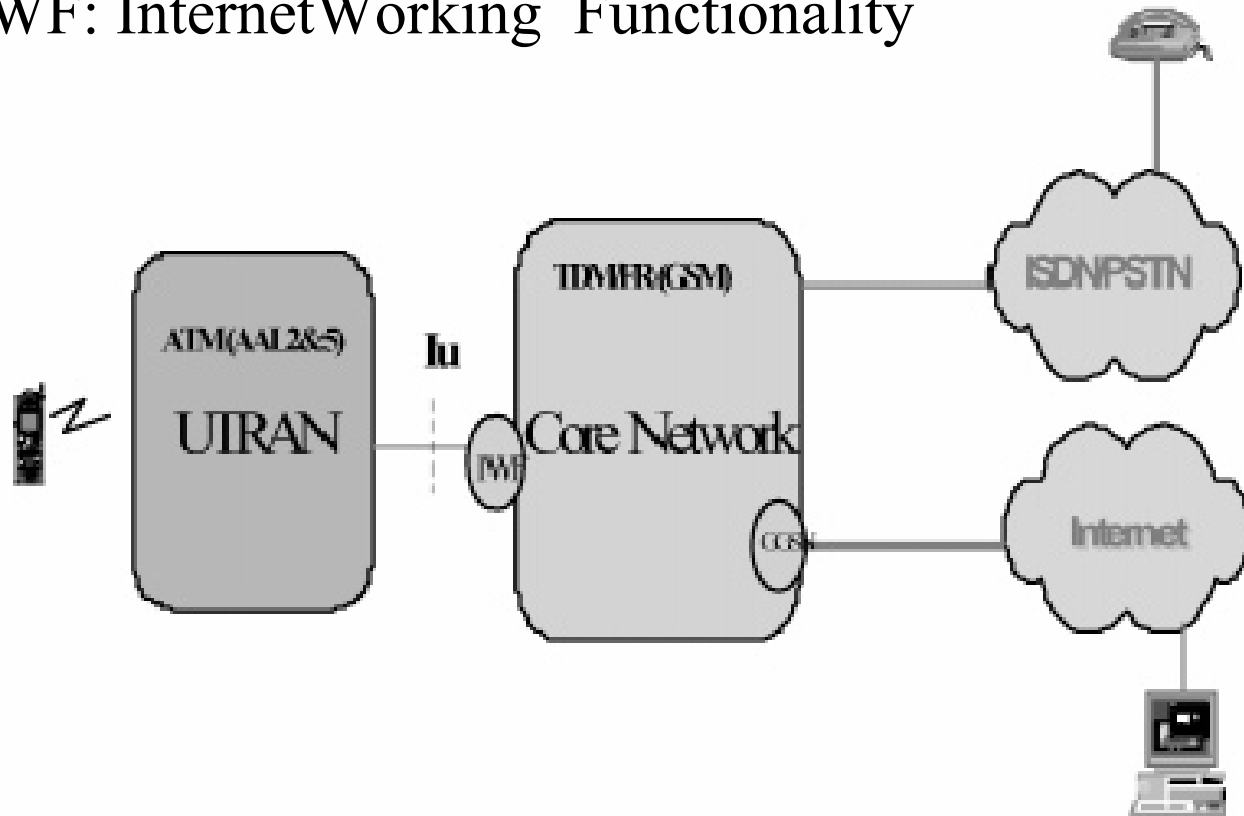
# Last Mile QoS Issues

- ◆ 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

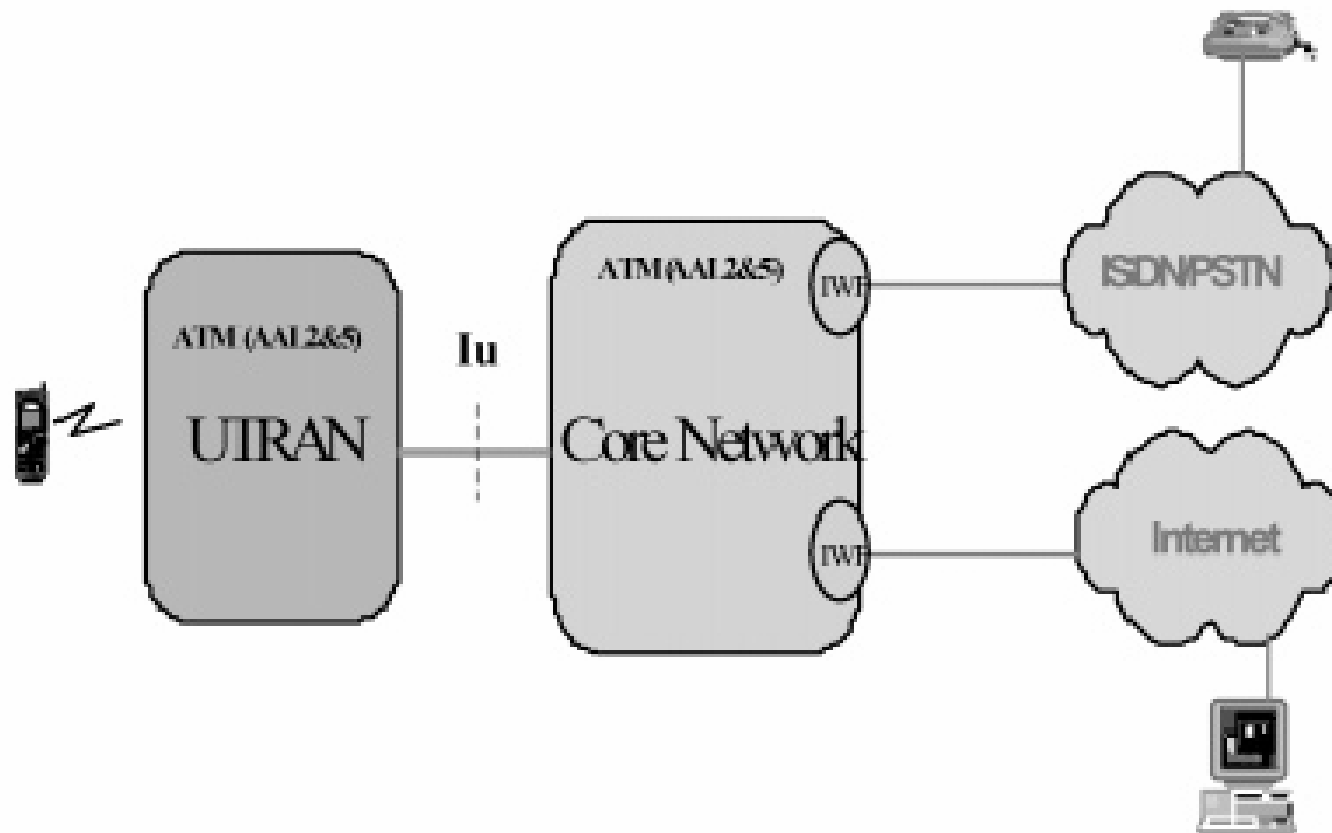


# Option1

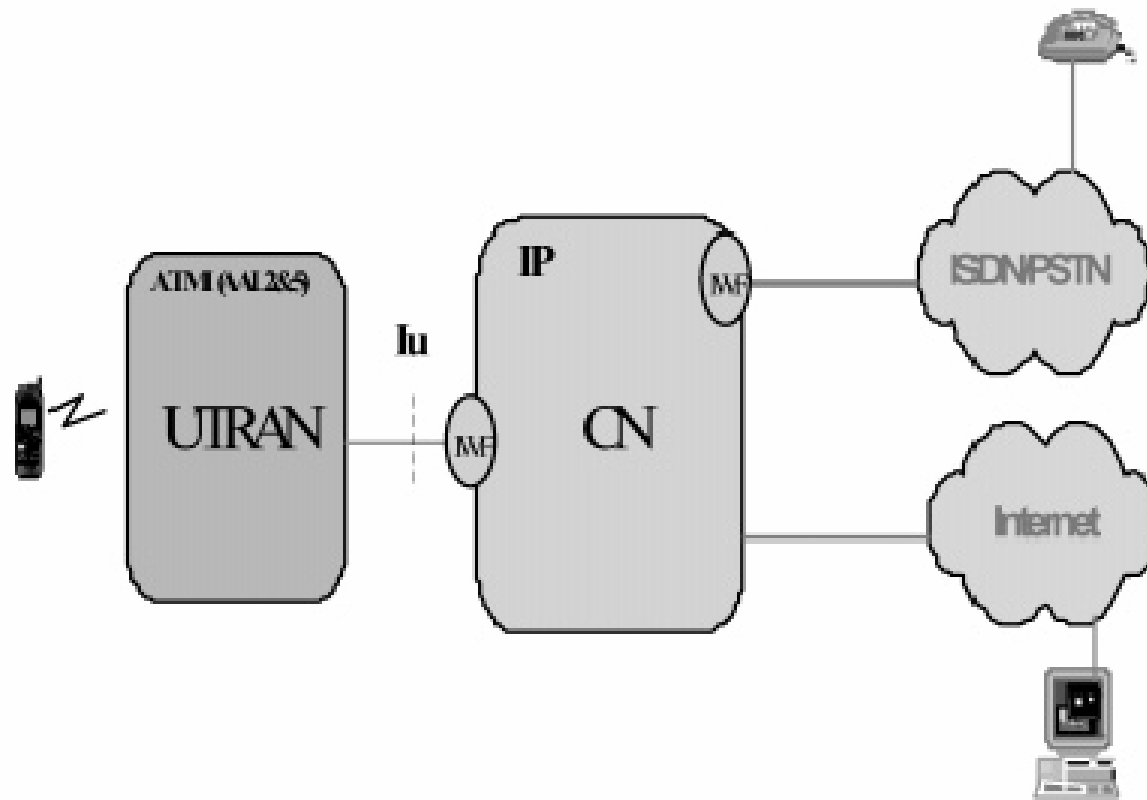
IWF: Internet Working Functionality



# Option 2



# Option 3



# Option 4

