無線網路多媒體系統
Wireless Multimedia System



Dr. Eric Hsiaokuag Wu
hsiao@csie.ncu.edu.tw
http://wmlab.csie.ncu.edu.tw/course/wms
2011 Fall

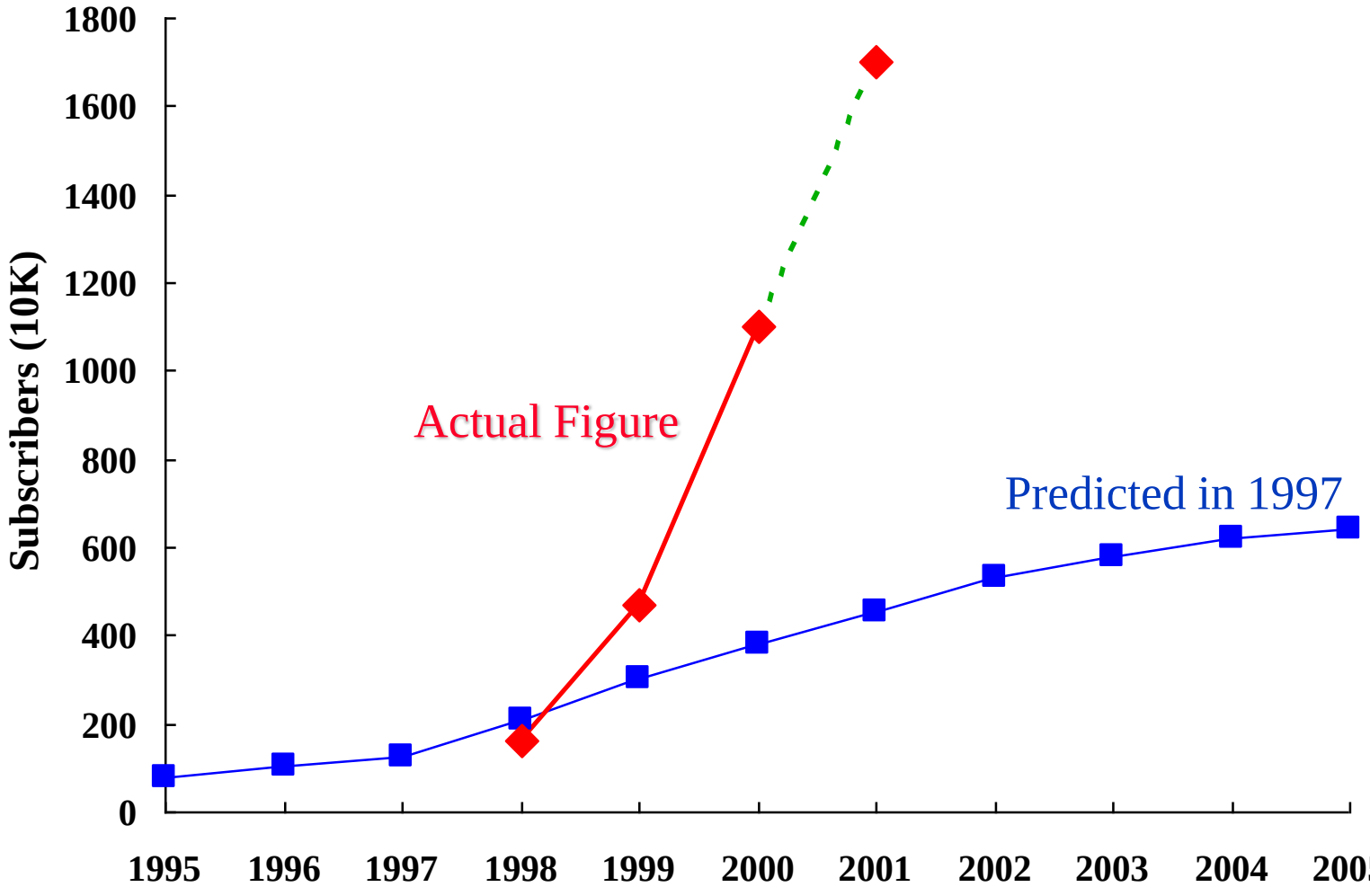
First Week Agenda

- Course Preview
- Wireless Multimedia/Mobile Computing / Pervasive Computing
- Wireless Mobile Communications
- System Review and Fundamental Problems
- Next Week

Course Contents

- Fundamental Wireless Technology
  - Propagation Model
  - Wireless Medium Access
  - Transport Solutions
  - Ad hoc/Mesh Wireless System
  - Cellular System
  - Middleware Systems
  - Multimedia System
- Advanced Wireless Technology
  - Multicasting
  - Beyond 3G
  - Routing Algorithms/Mesh Network/VANET
  - QoS/ Reliable Mutlimedia Transmissions

台灣行動電話發展趨勢圖



Roaming Across a variety of heterogeneous network and service environments

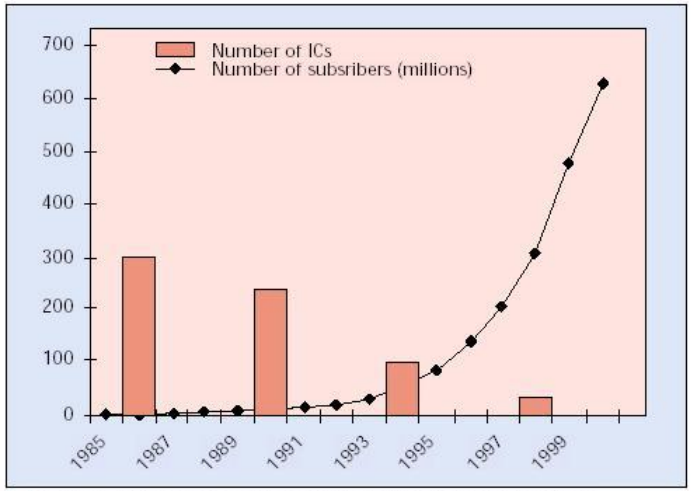


Figure 1. *Subscriber growth and IC reduction in mobile terminals.*

Application

OS, MiddleWare

RTP, TCP, UDP

RSVP

IP, Mobile IP

Wireless Network Layer

Clustering(optional)

Data Link
MAC

Radio

WiMAX Nomadic and Portable

Non Line of Sight
Point to Multi-point

802.16

Line of Sight
BACKHAUL

802.16

802.16e PC
Card

Laptop Connected
Through 802.16

SEEKS BEST
CONNECTION

2 to 3 Kilometers Away

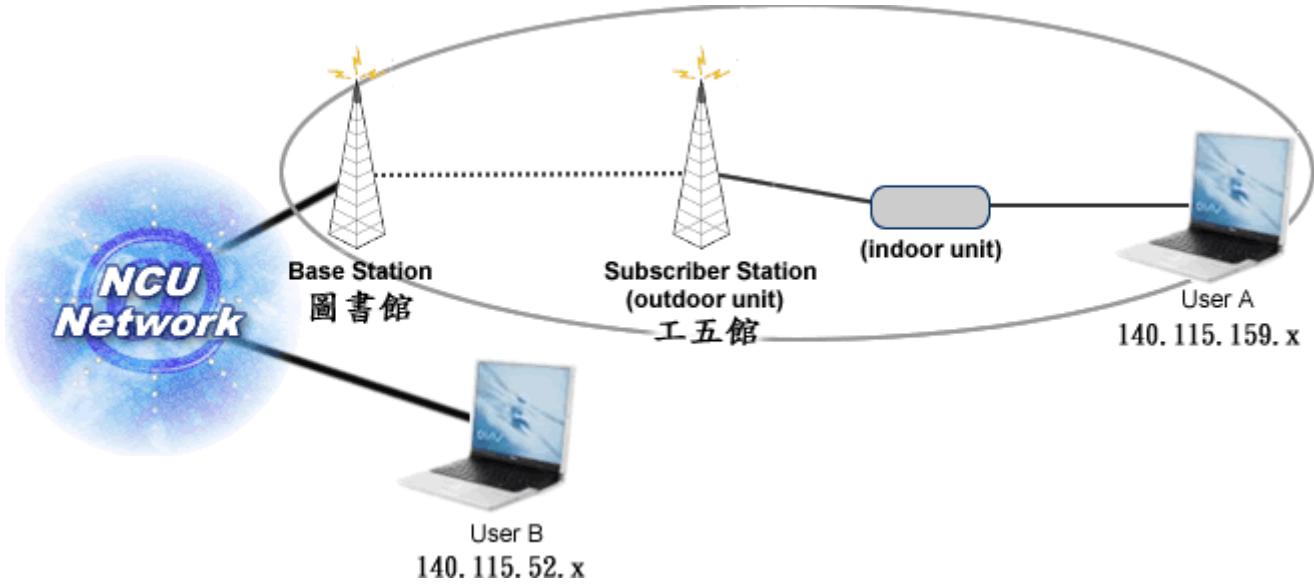
Telco Core
Network or
Private (Fiber)
Network

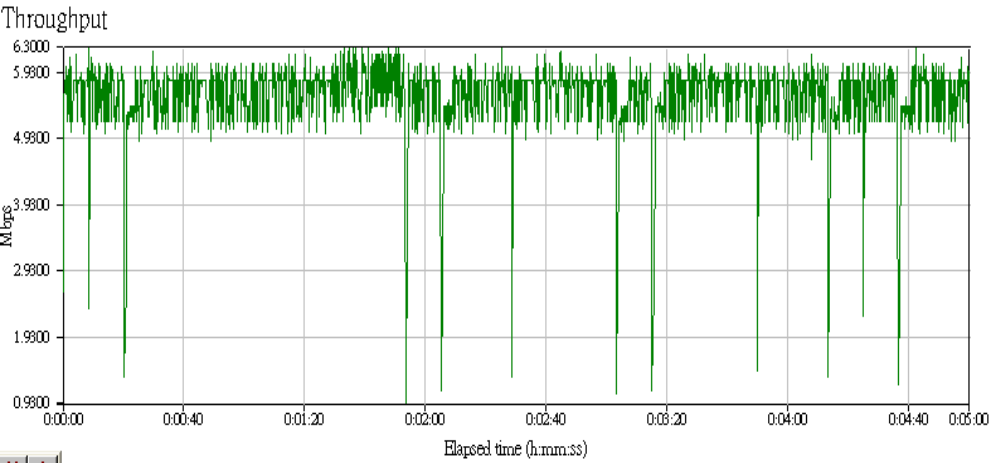
INTERNET
BACKBONE

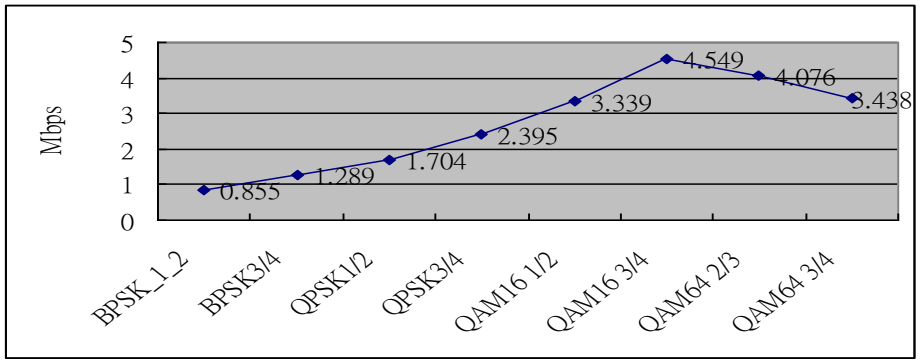
Ref: Margaret LaBrecque , "Enabling Deployments through Standards and Certification," WiMax, 2003

WiMAX 802.16


alvarion
We're on your wavelength.


NCU Network
Base Station
圖書館
Subscriber Station
(outdoor unit)
工五館
(indoor unit)
User A
140. 115. 159. x
User B
140. 115. 52. x


Throughput
6.3000
5.9800
4.9800
3.9800
2.9800
1.9800
0.9800
Mbps
0:00:00
0:00:40
0:01:20
0:02:00
0:02:40
0:03:20
0:04:00
0:04:40
0:05:00
Elapsed time (h:mm:ss)


Mbps
5
4
3
2
1
0
0.855
1.289
1.704
2.395
3.339
4.549
4.076
3.438
BPSK_1_2
BPSK3/4
QPSK1/2
QPSK3/4
QAM16 1/2
QAM16 3/4
QAM64 2/3
QAM64 3/4

WiMAX

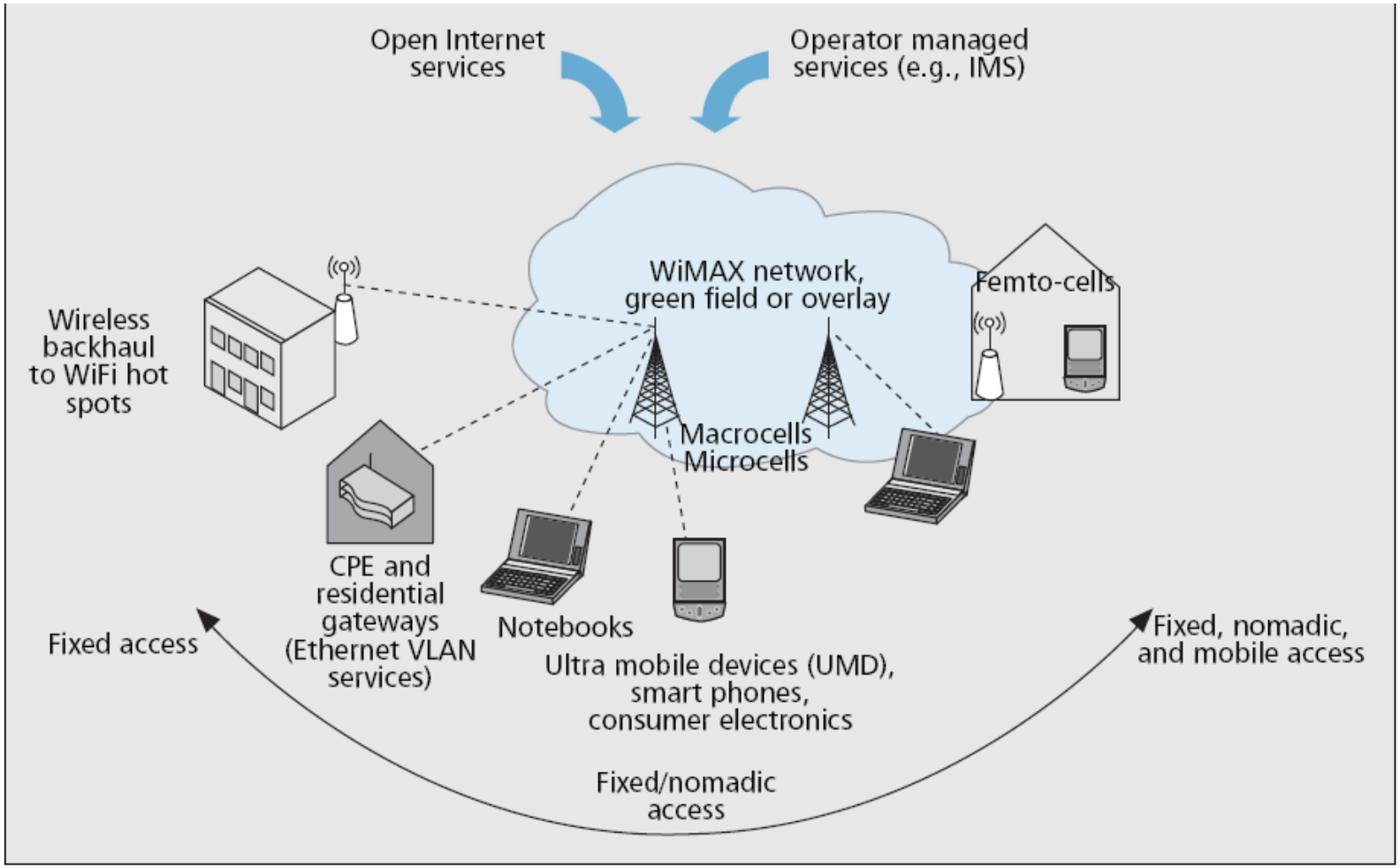
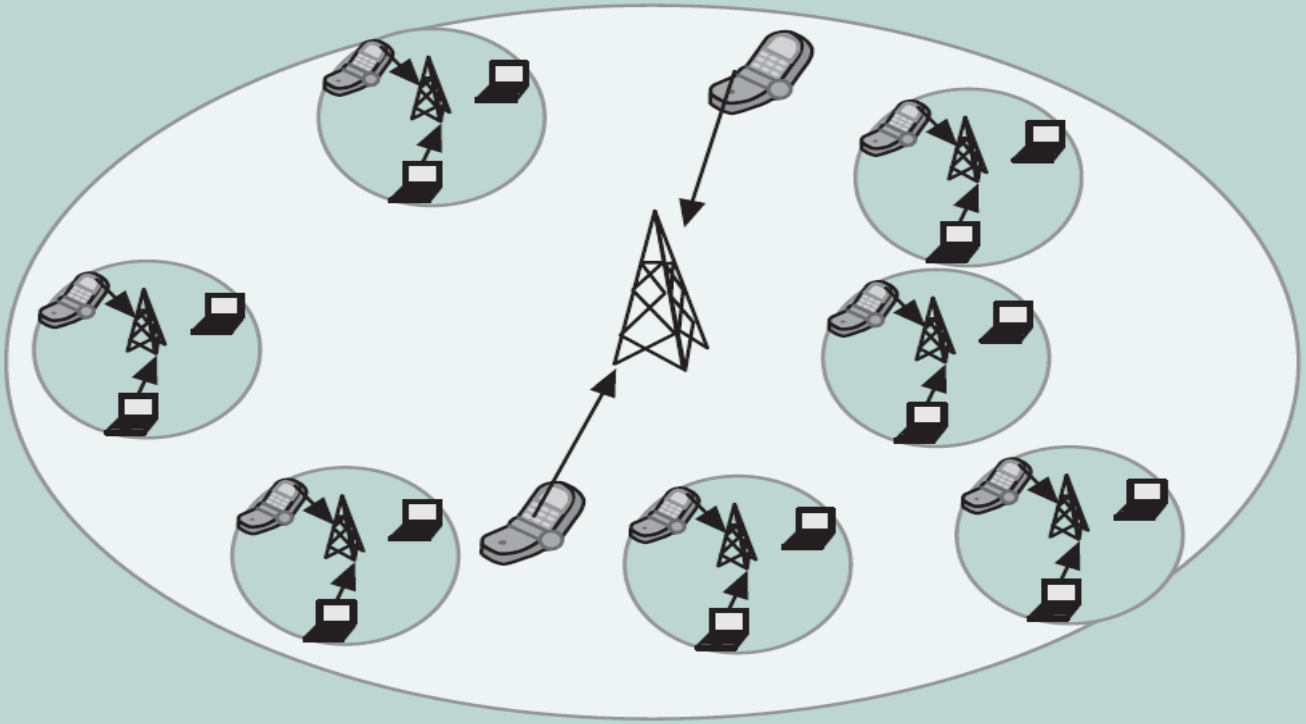


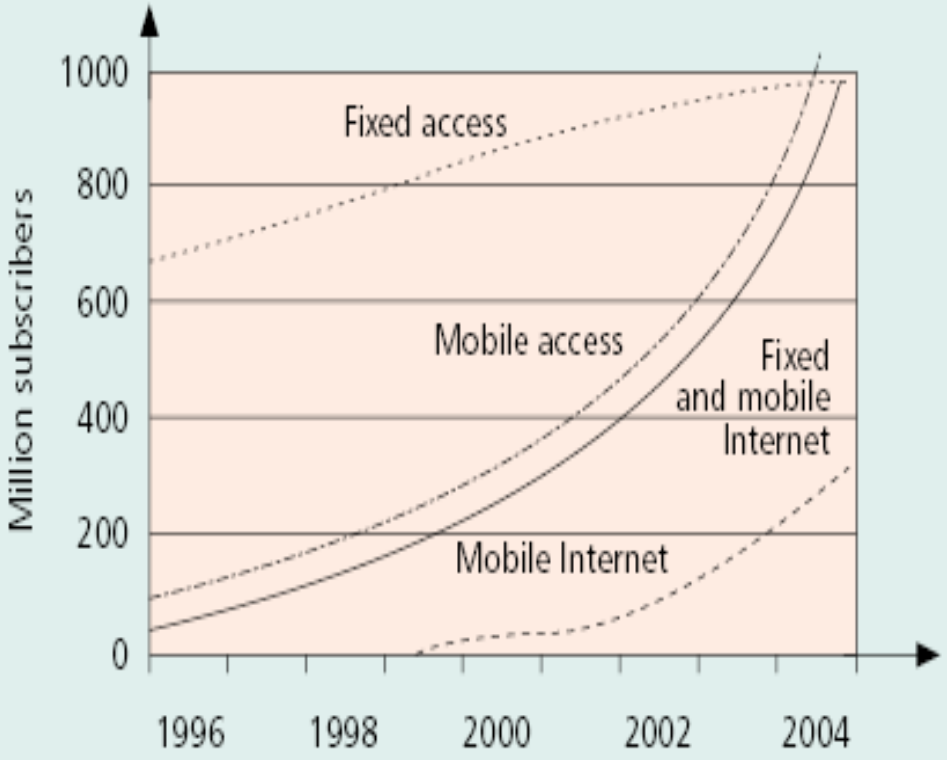
Figure 1. *Mobile WiMAX enabling a variety of usage models in the same network.*

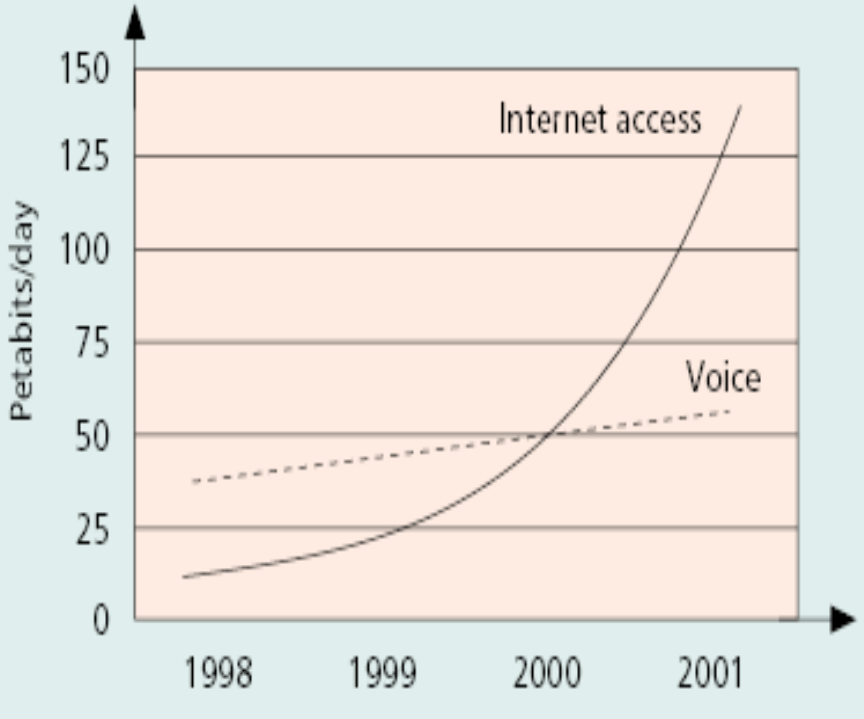
Femtocell

Femtocell: Consumer installed wireless data access point inside homes, which backhauls data through a broadband gateway (DSL/cable/Ethernet/WiMAX) over the Internet to the cellular operator network.



Growth in traffic in different access system and voice and data services





25Gb/s(km²)

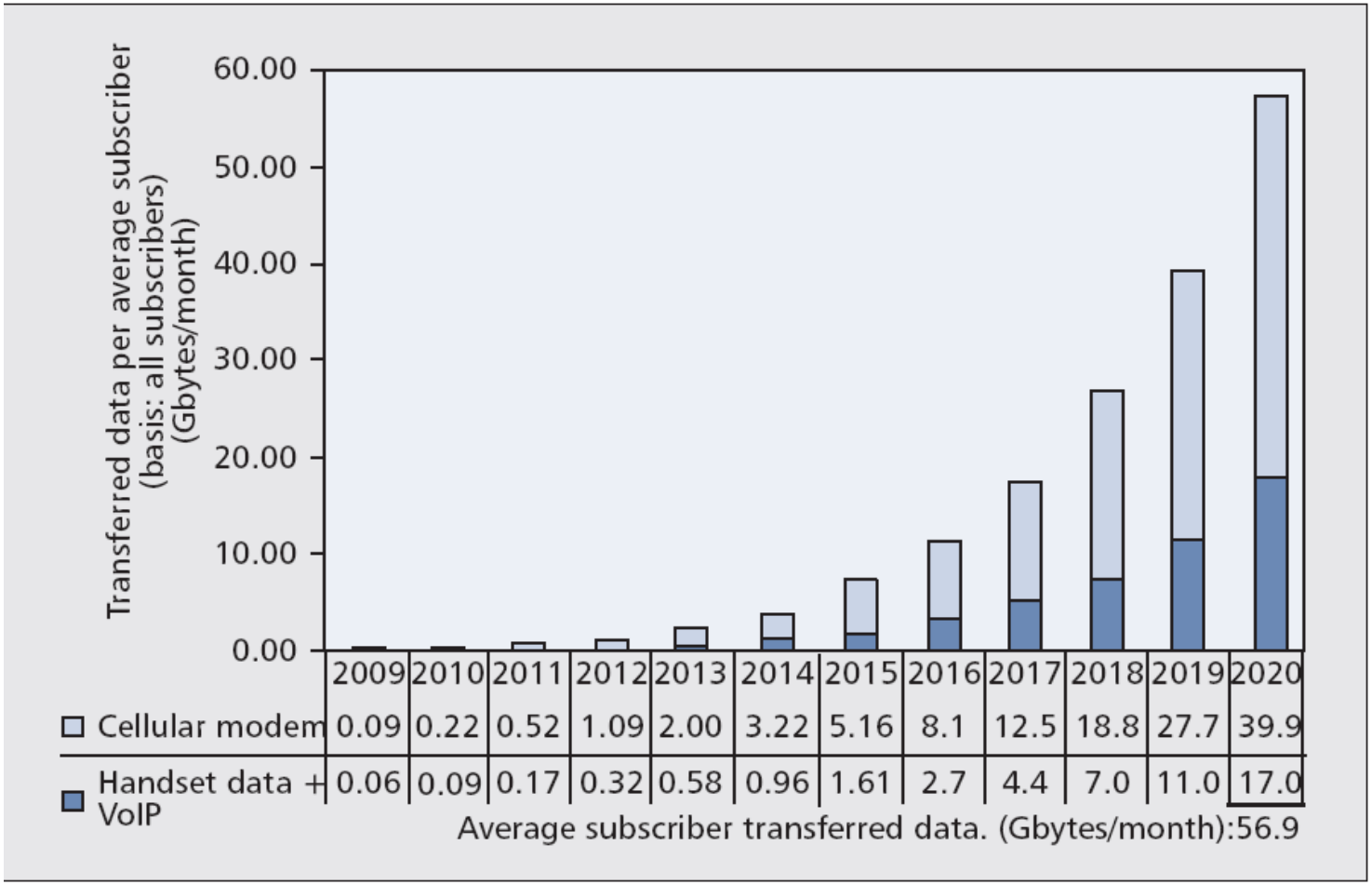


Figure 1. *Growth of transferred data in Western Europe.*

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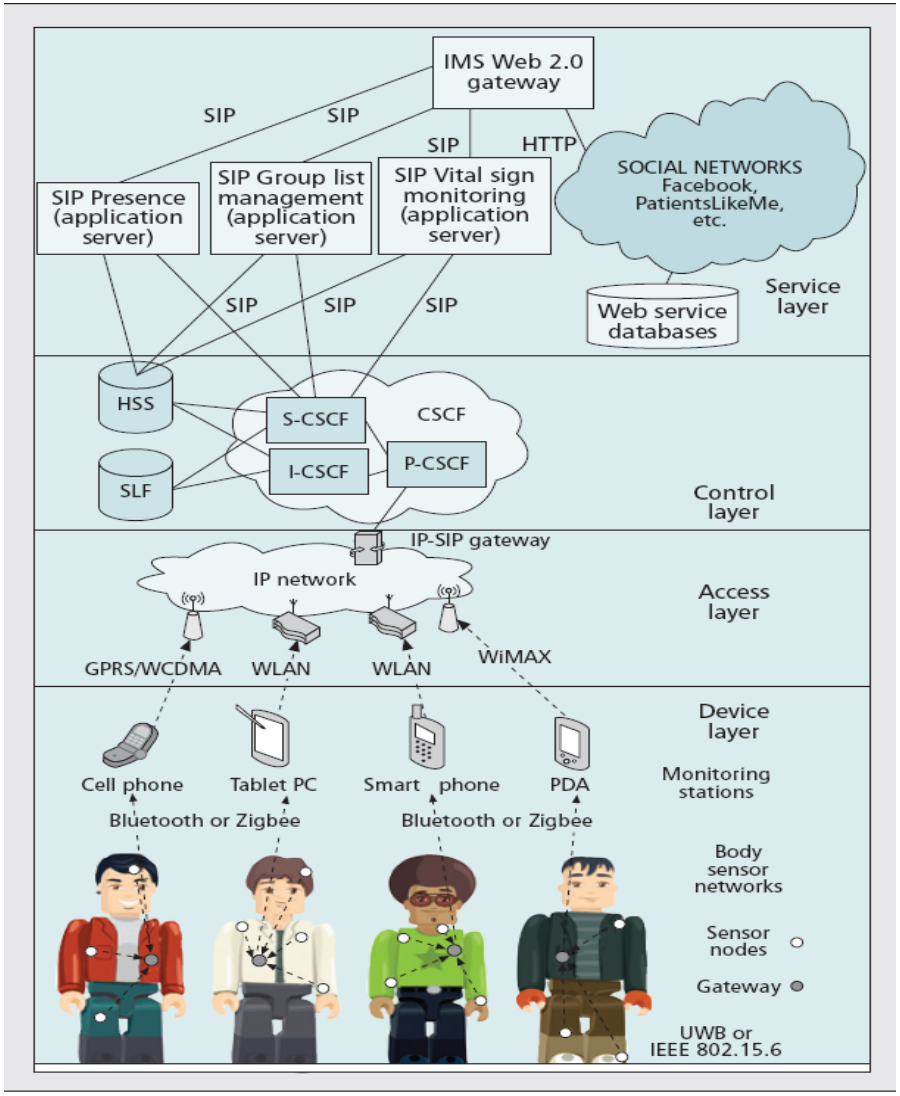
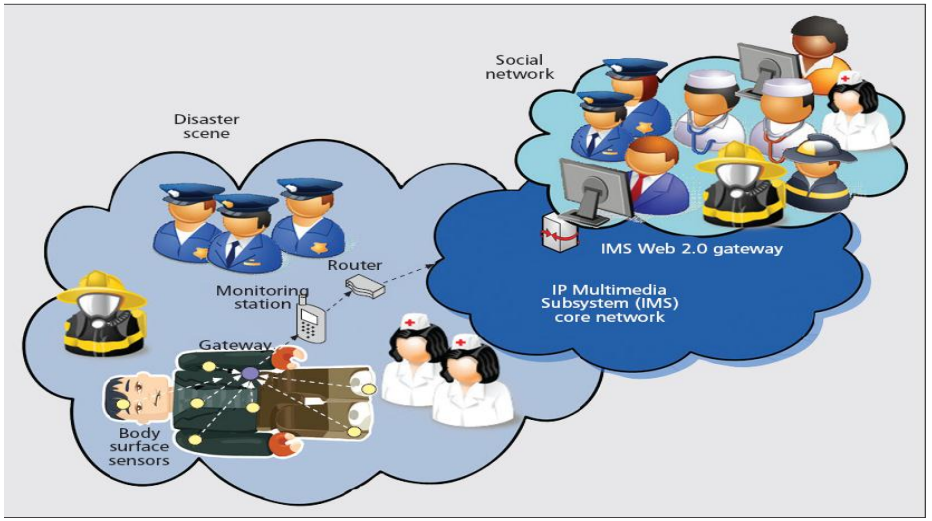
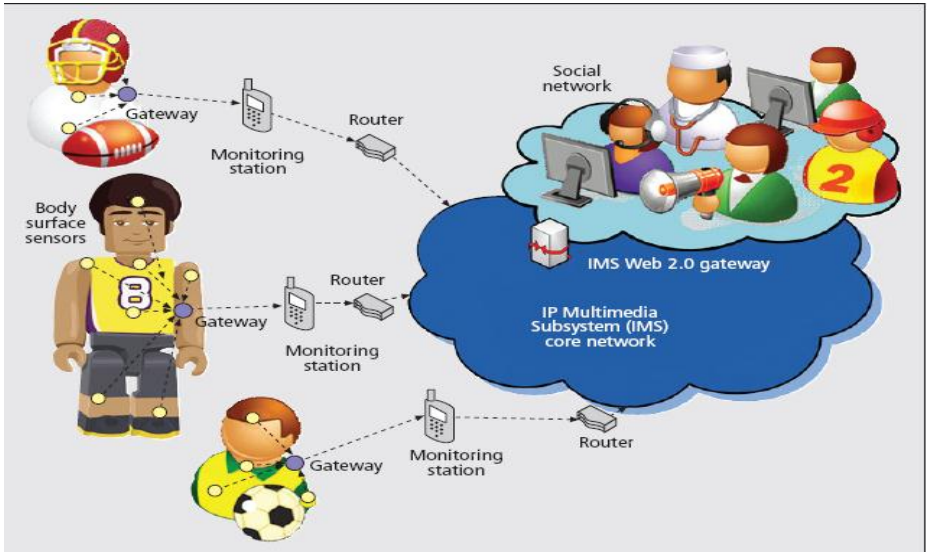
Context Aware Services

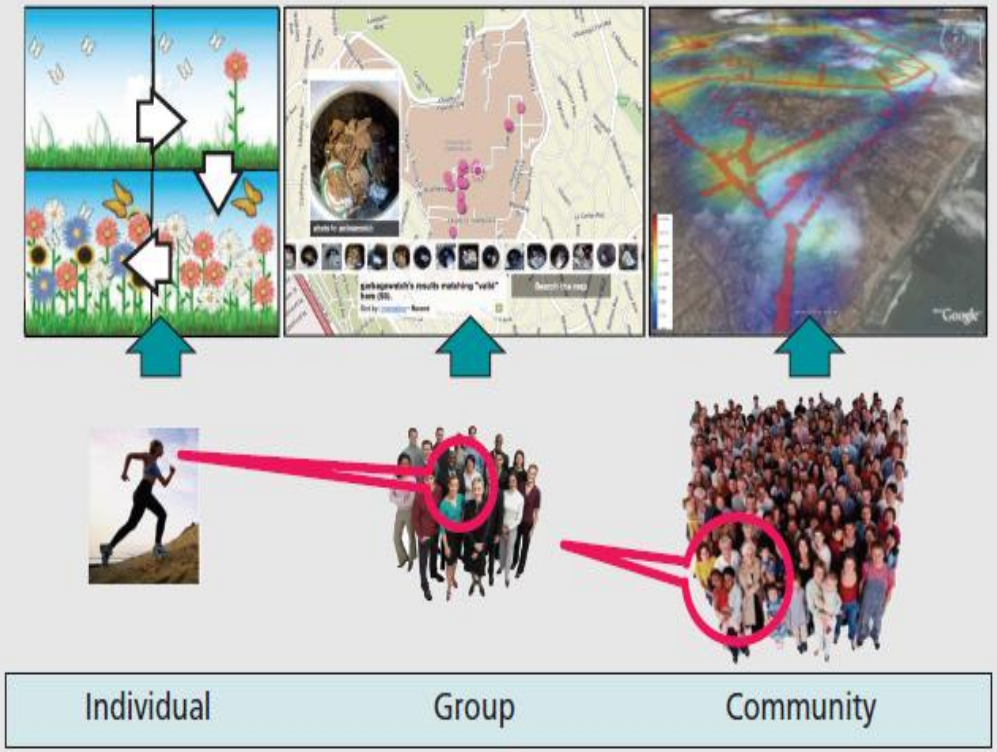






Mobile Sensing

- Ambient light
- Proximity
- Dual cameras
- GPS
- Accelerometer
- Dual microphones
- Compass
- Gyroscope



Recent Wireless Technologies

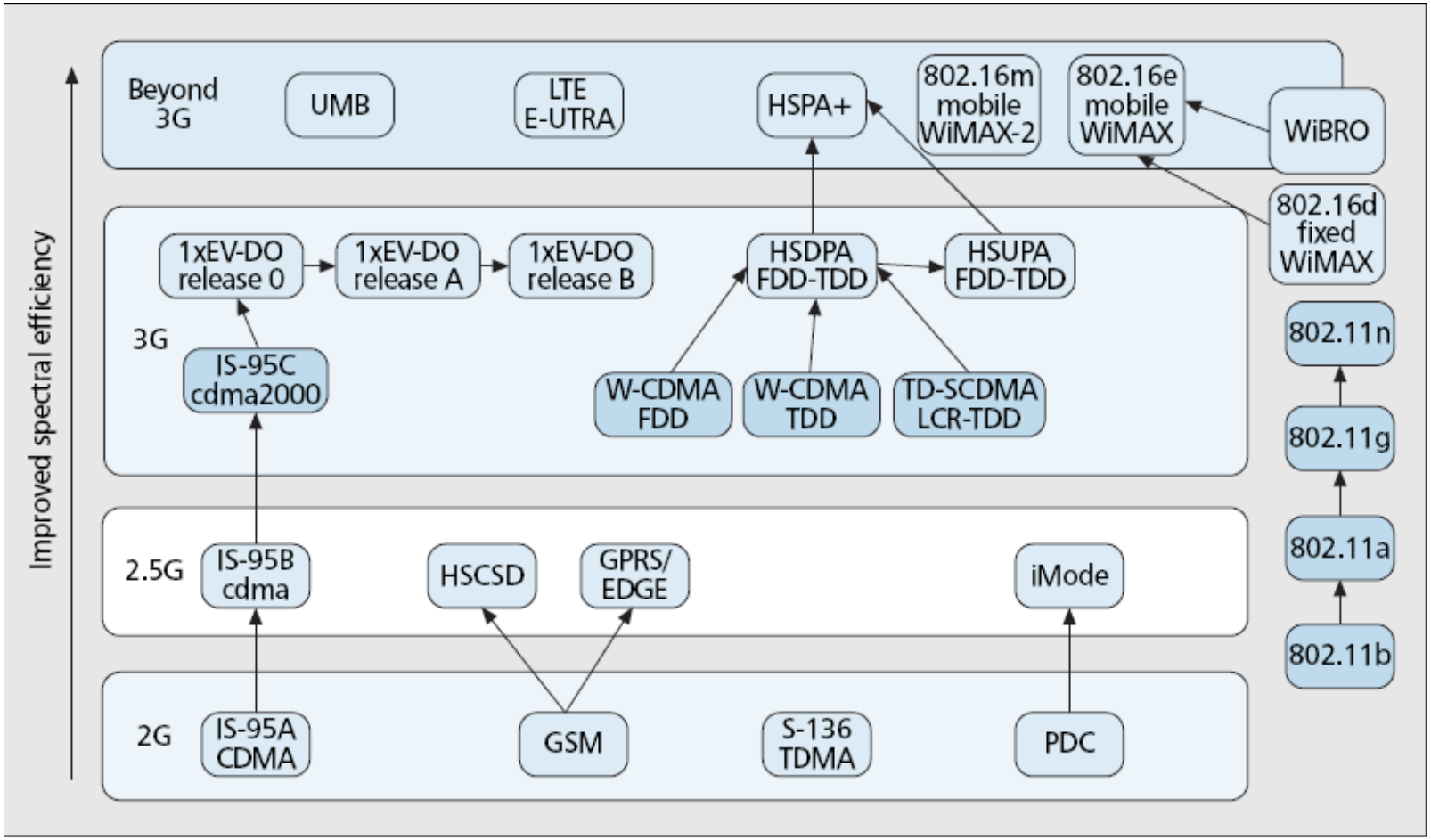
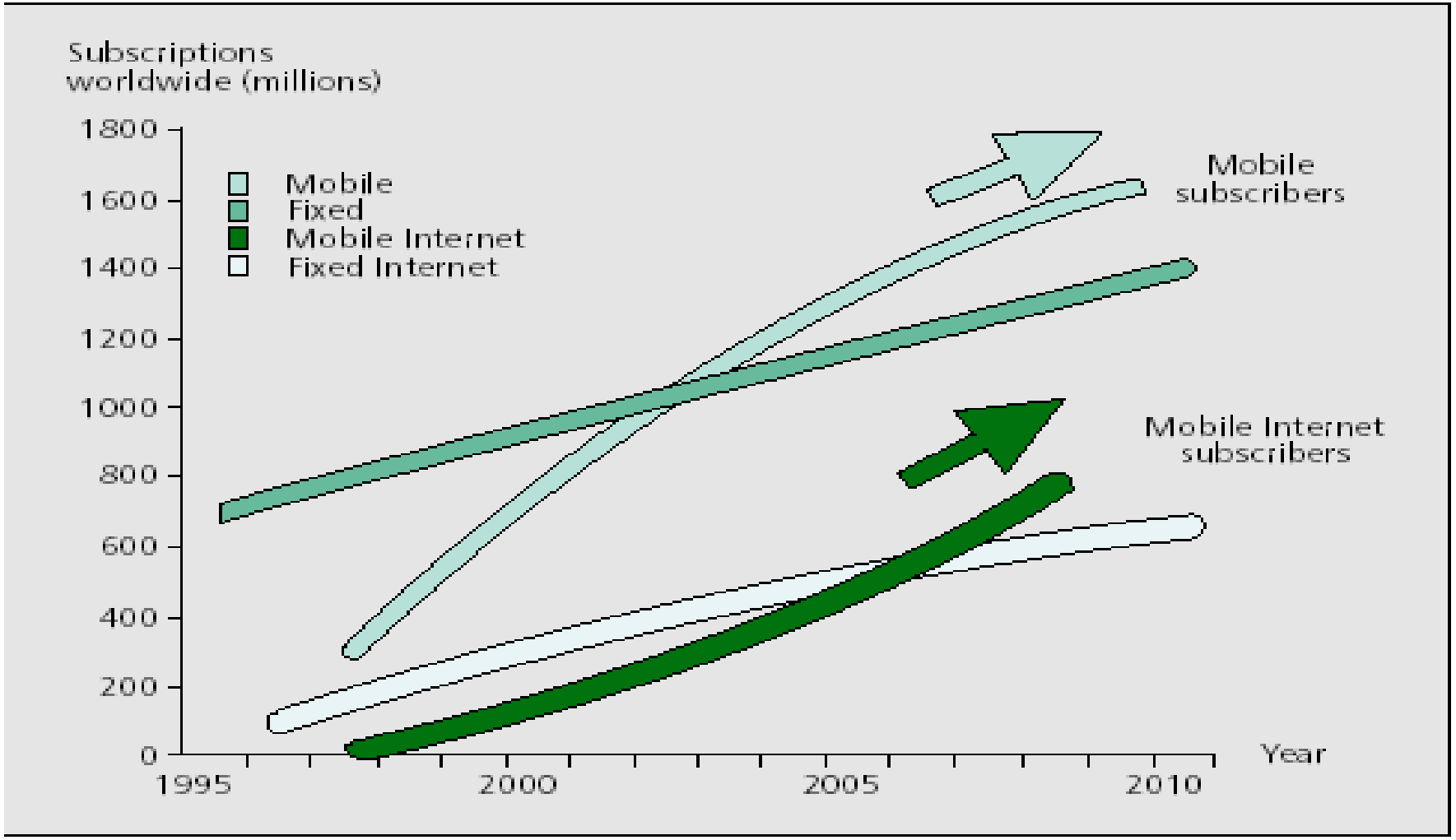


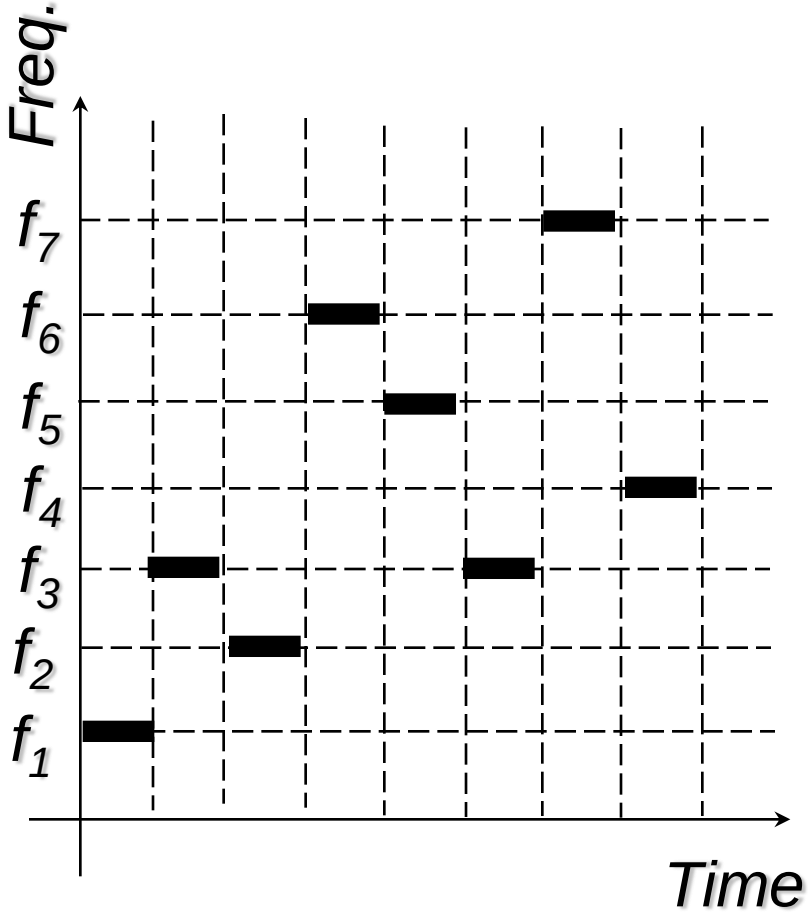
Figure 1. *Evolution and backward compatibility of air interface technologies.*

Forecast number of subscribers



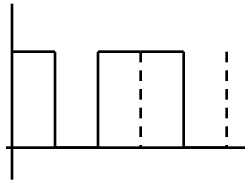
Frequency Hopping Spread Spectrum

- Transmitted signal is spread over a wide range of frequencies. (i.e. 2.400-2.485 GHz)
- Transmission usually hop 35 times per second.



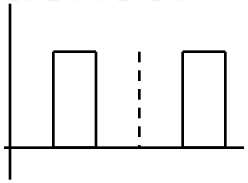
Direct Sequence Spread Spectrum

To transmit a 0 the station use a unique "chip sequence":



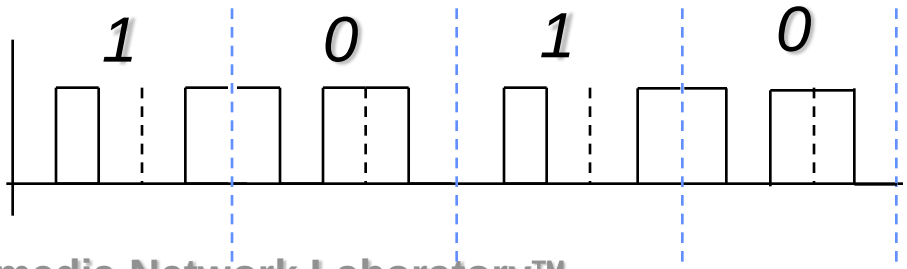
1 0 1 1 0

To transmit a 1 the station use the one's complement of its chip sequence:



0 1 0 0 1

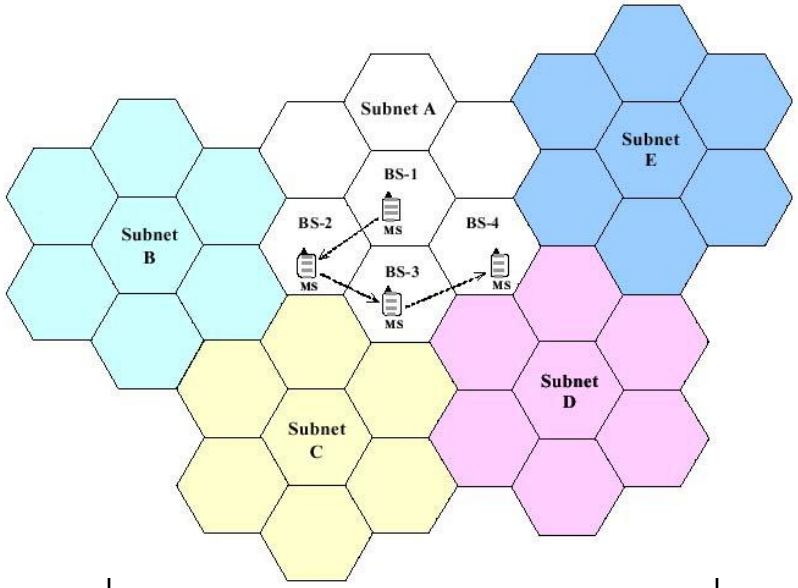
Therefore if data is 1010 it will transmit:

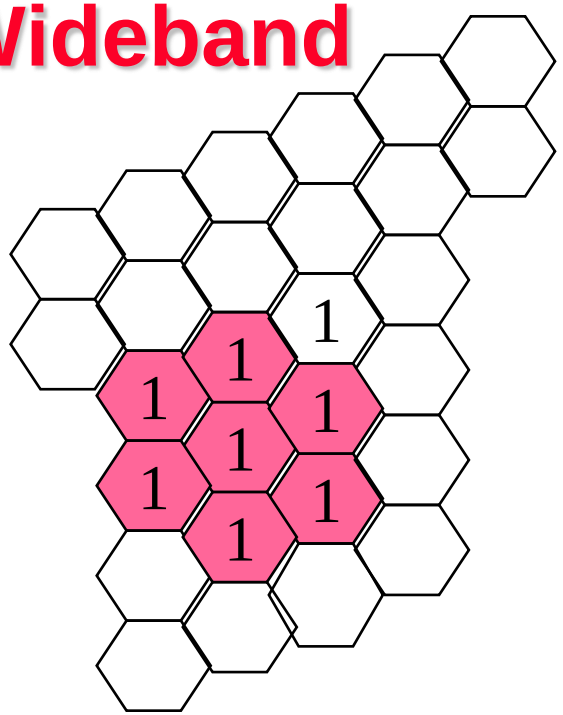


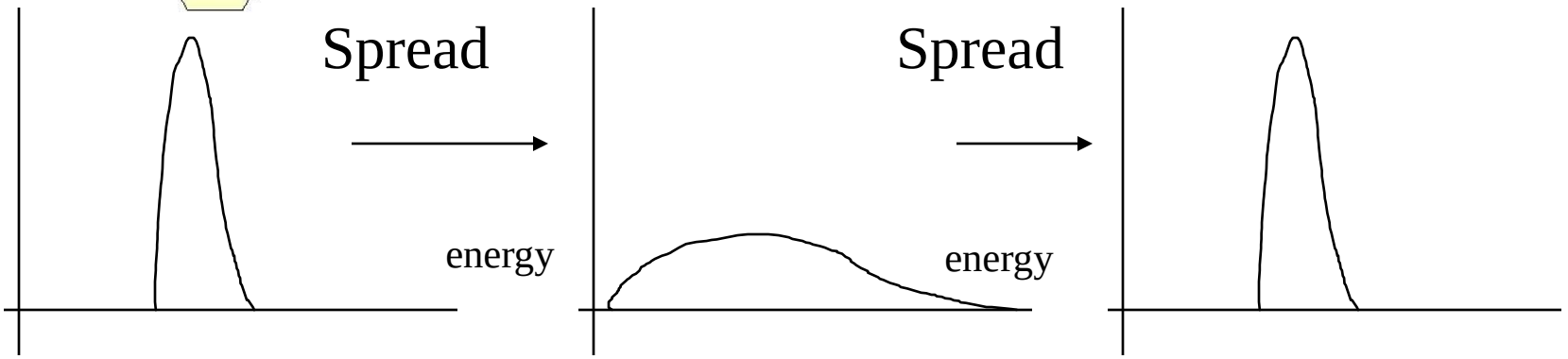
DS-CDMA

- Processing Gain:
- SF=2 cases:
- (1, 1) ⊗ (1, 1) = 1+1=2 (Processing Gain)
- (1, 1) ⊗ (1,-1) = 1-1=0 (orthogonal)
- SF=4 cases:
- (1, 1, 1, 1) ⊗ (1, 1, 1, 1) = 1 + 1 + 1 + 1 = 4 (Processing Gain)
- (1, 1, 1, 1) ⊗ (1, 1,-1,-1) = 1+ 1 – 1 -1 =0 (Orthogonal)
- SIR = Pr * Processing Gain / Interference
- = Pr * (Total_Radio_Frequencyband / Bitrate) / Interference

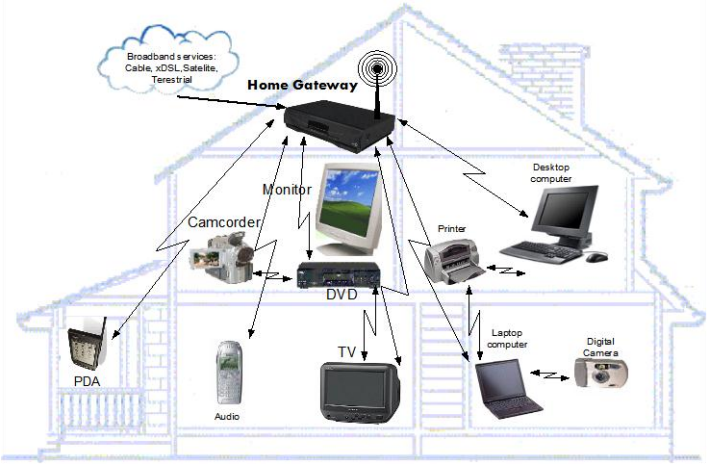
Narrowband vs. Wideband

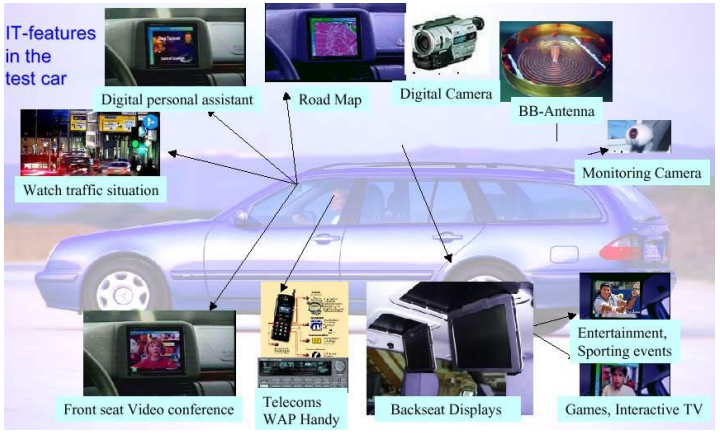


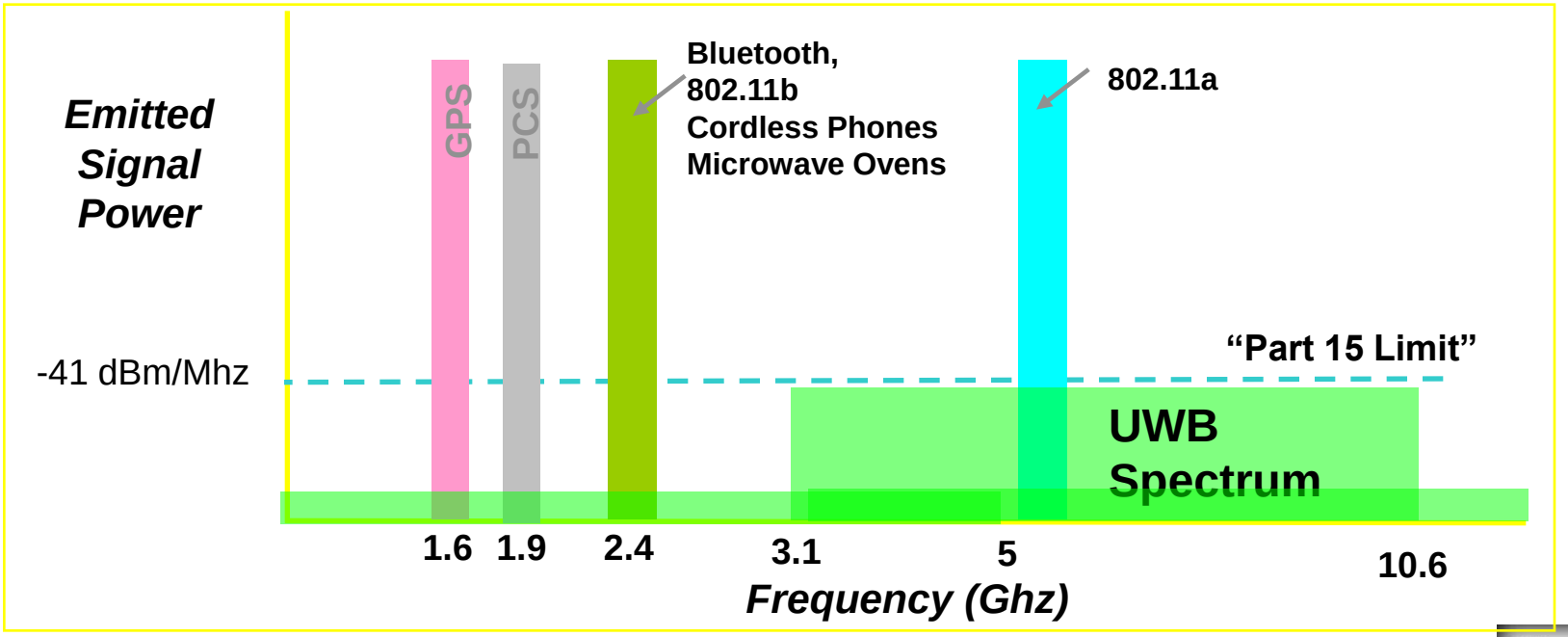




Ultra-Wideband Radio

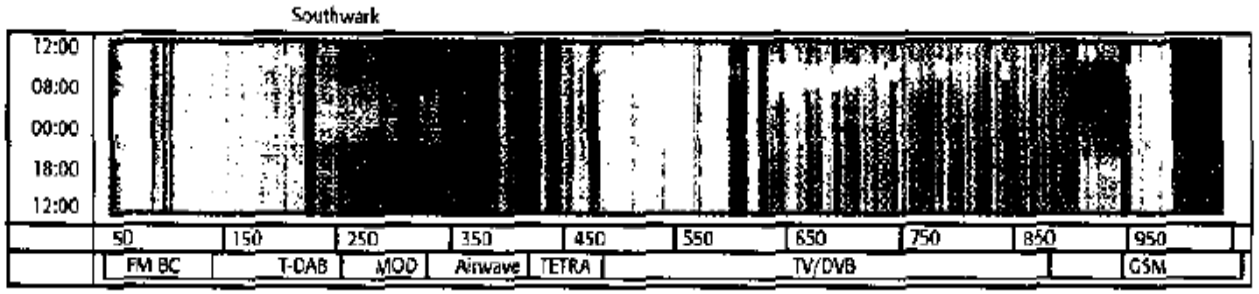


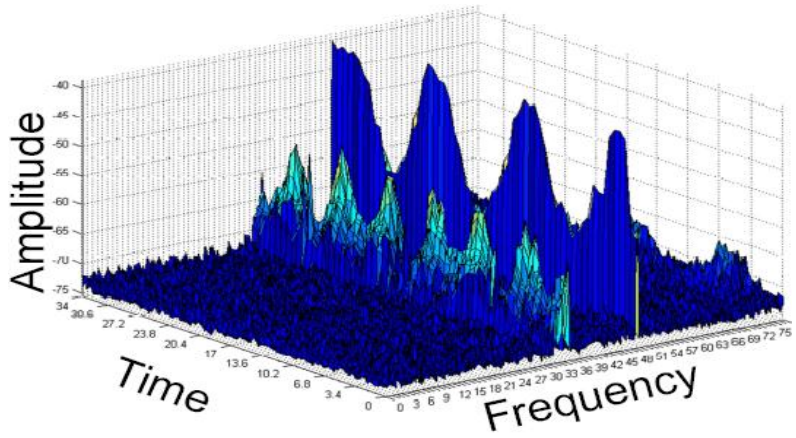




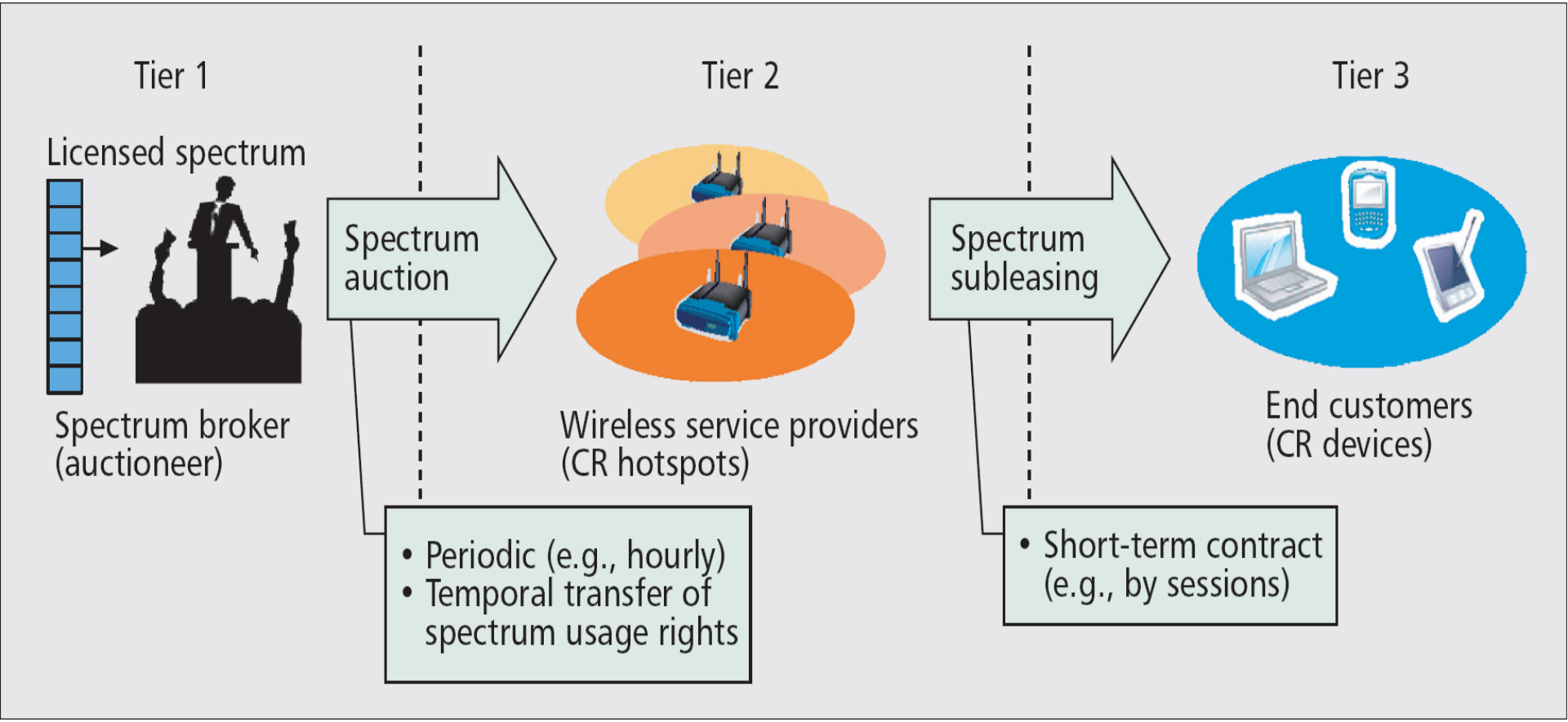
CR (Cognitive Radio)

- The CR idea was initially introduced by Joseph Mitola. On average, only 2% of allocated spectrum in the U.S. is actually in use





Wi-Fi 2.0


Tier 1
Licensed spectrum
Spectrum broker
(auctioneer)
Spectrum
auction
Tier 2
Wireless service providers
(CR hotspots)
Spectrum
subleasing
Tier 3
End customers
(CR devices)
• Periodic (e.g., hourly)
• Temporal transfer of spectrum usage rights
• Short-term contract (e.g., by sessions)

A 60 GHz Wireless Network

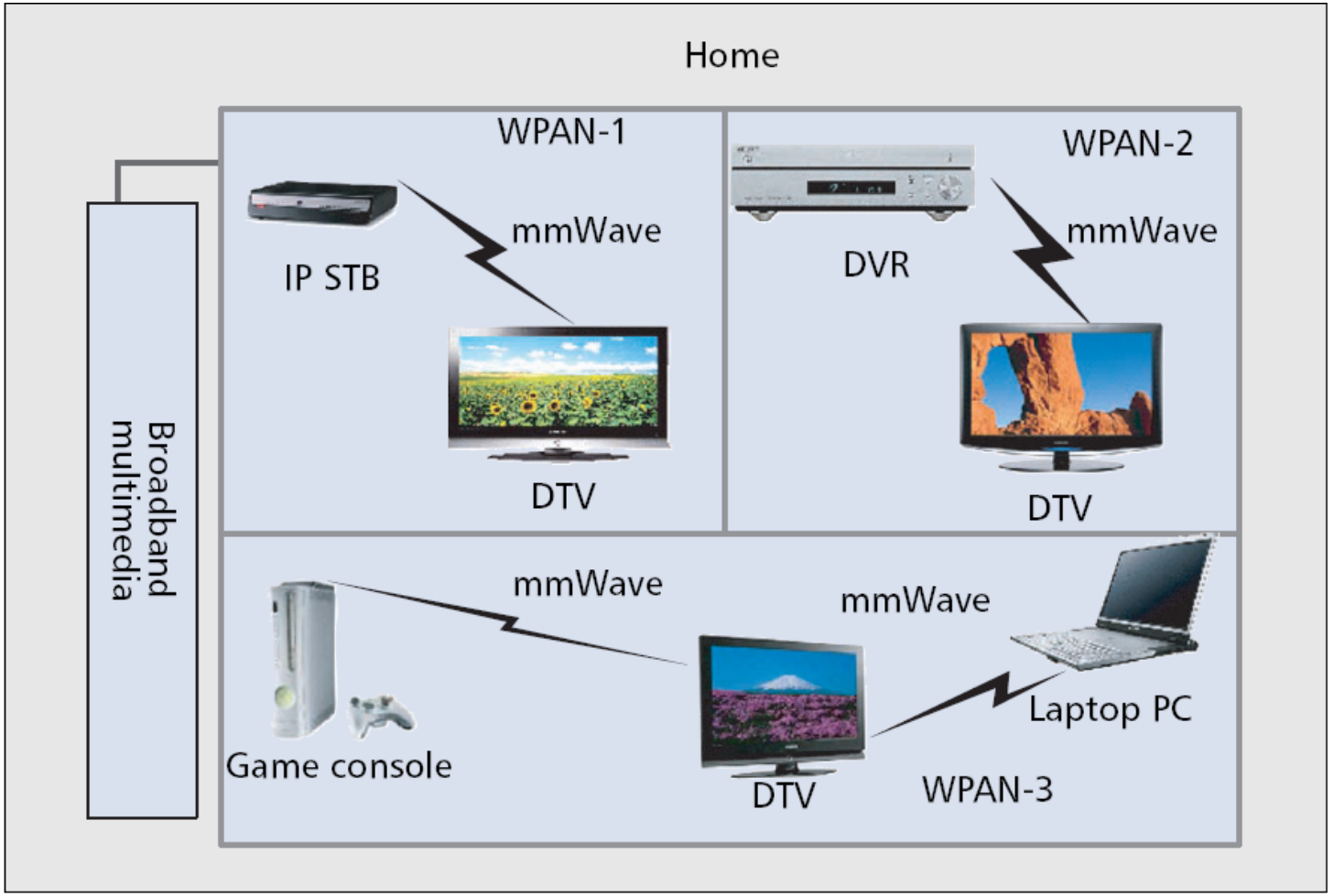
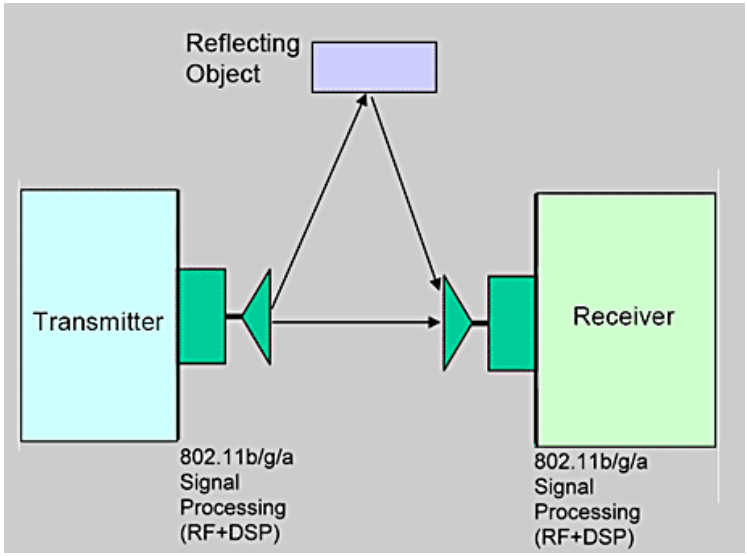
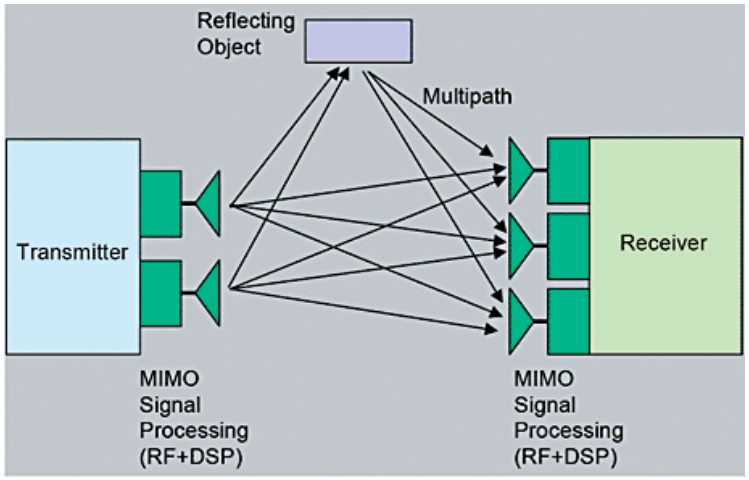


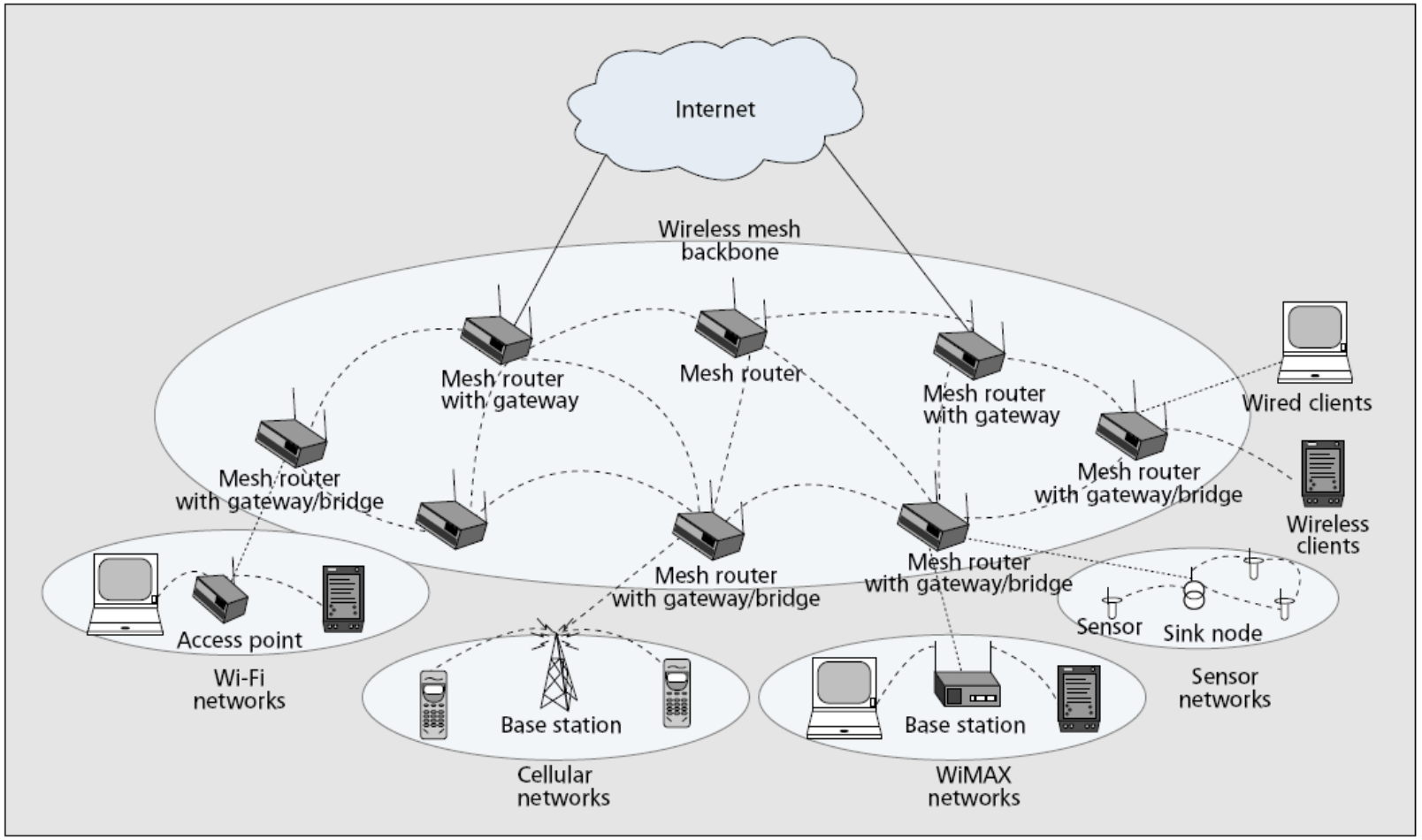
Figure 1. *Configuration of gigabit WPANs in a typical home environment.*

Multi-channel, Multi-Radio, MIMO

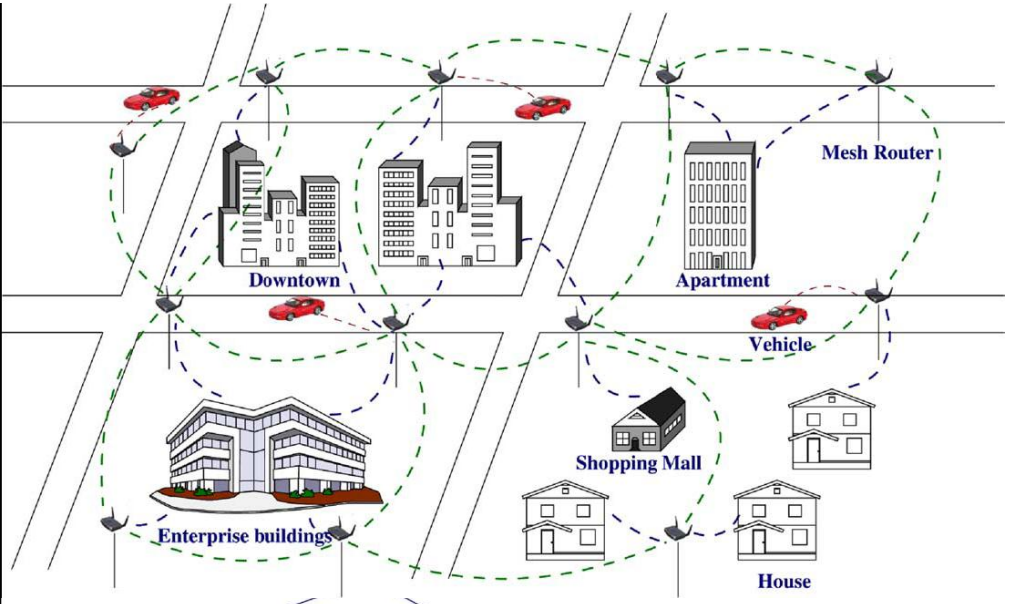


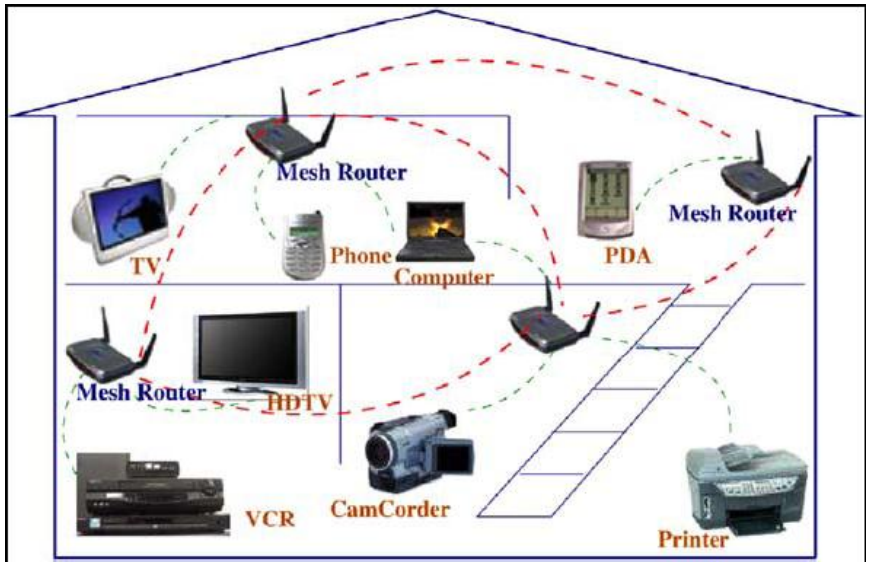


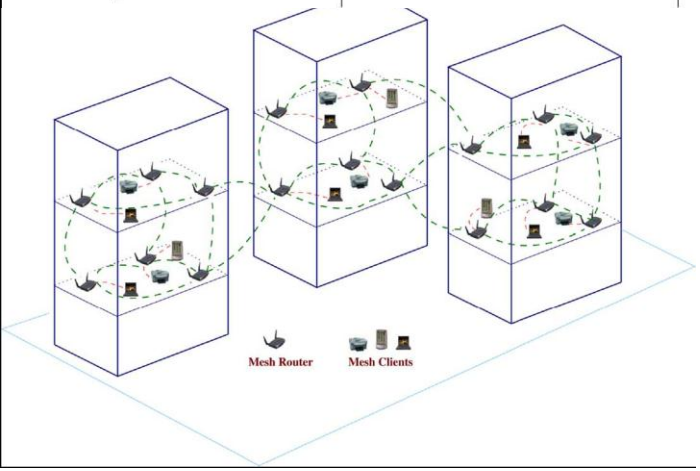
Wireless Mesh Network.

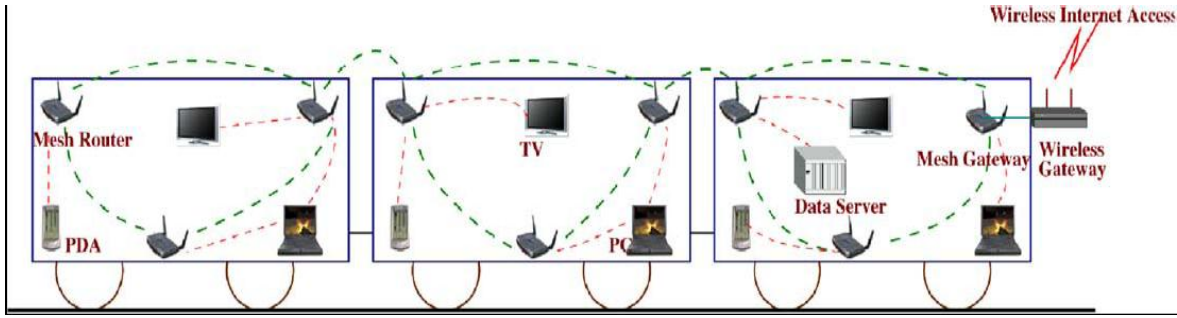


Mesh Network Scenario









Aeronautical Communications

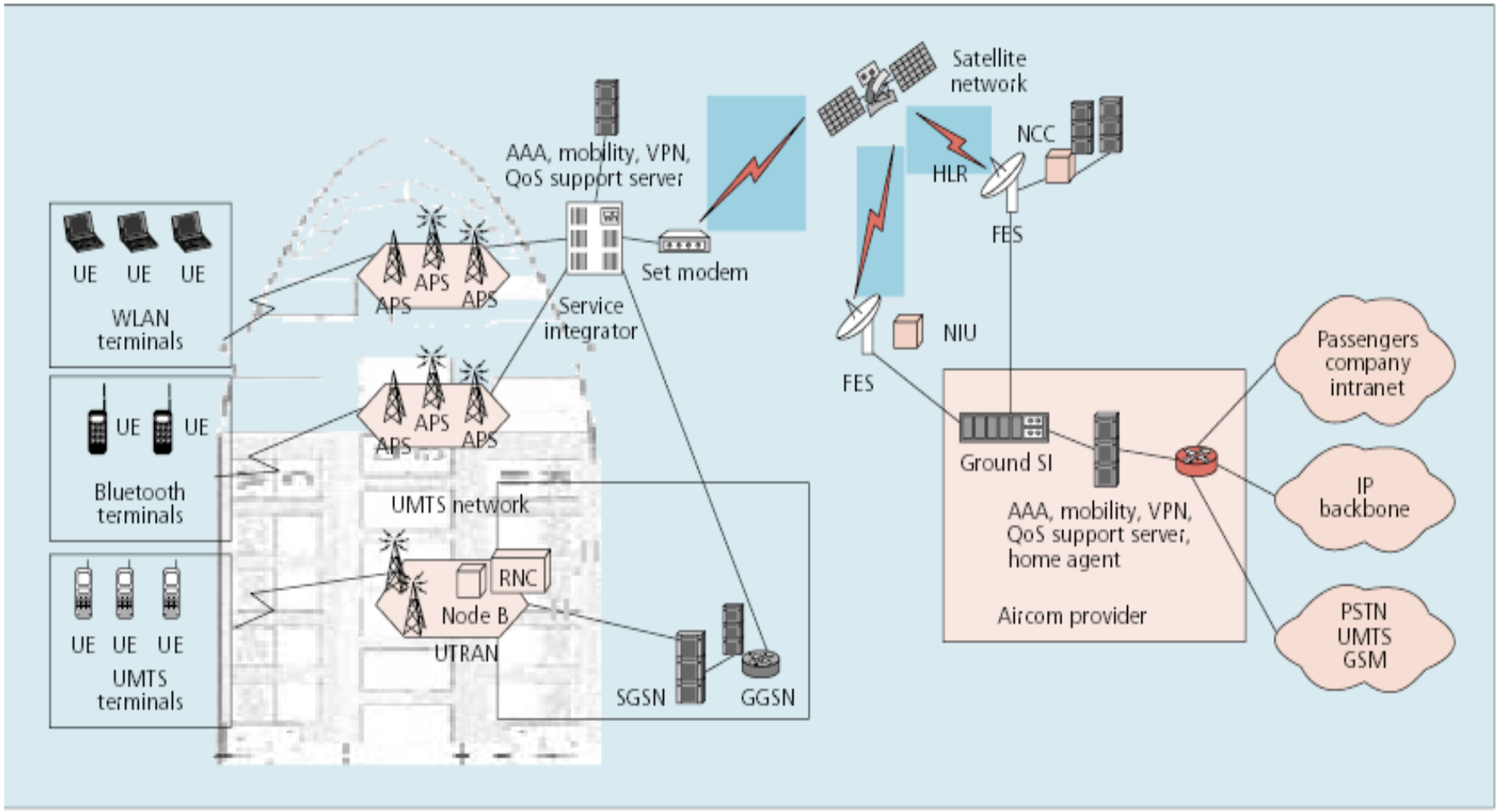
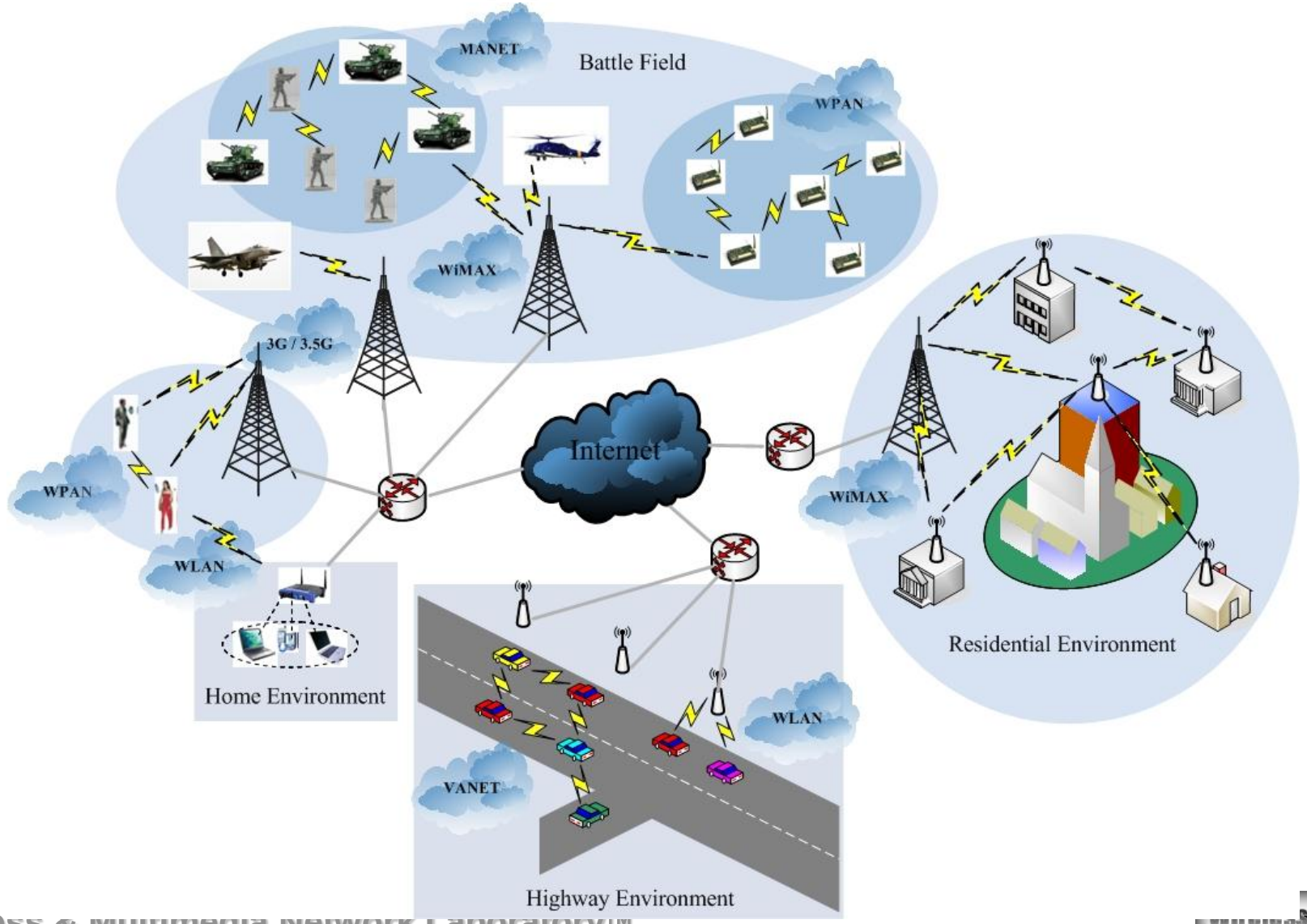
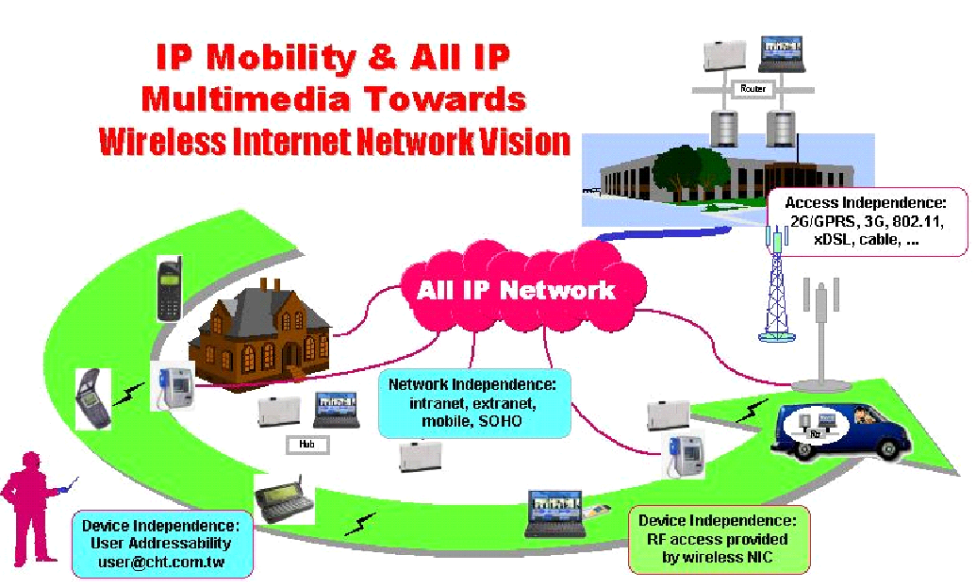


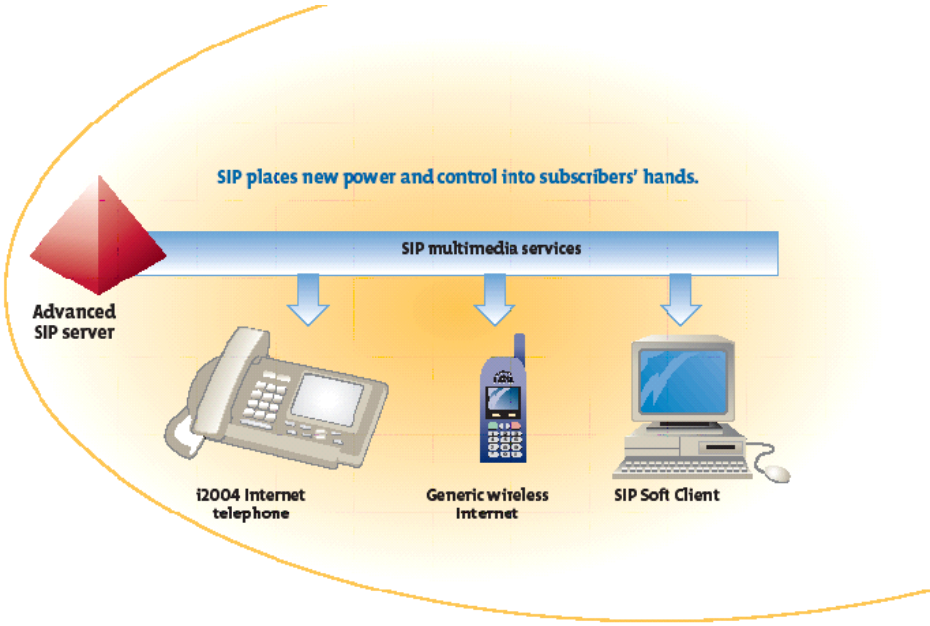
Figure 2. *Aeronautical communications network architecture.*

Wireless Applications Scenario

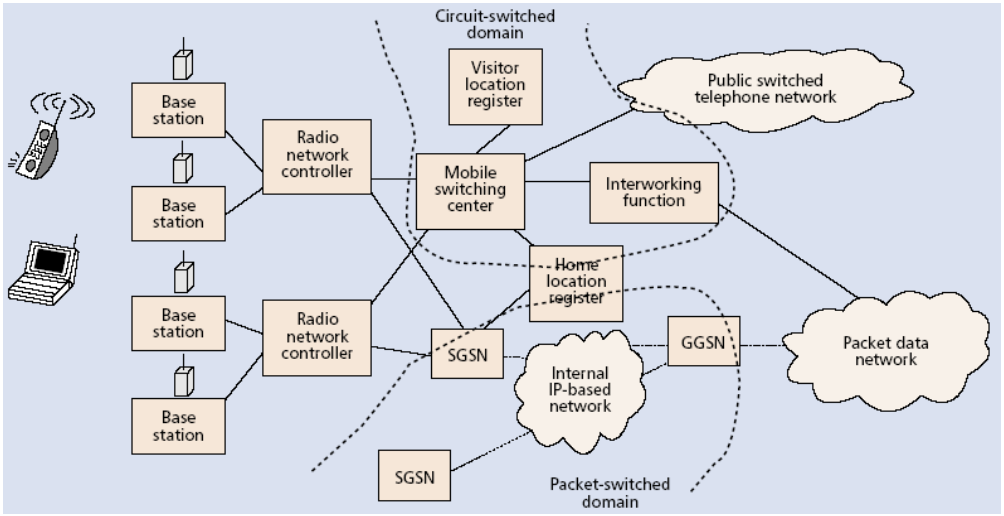


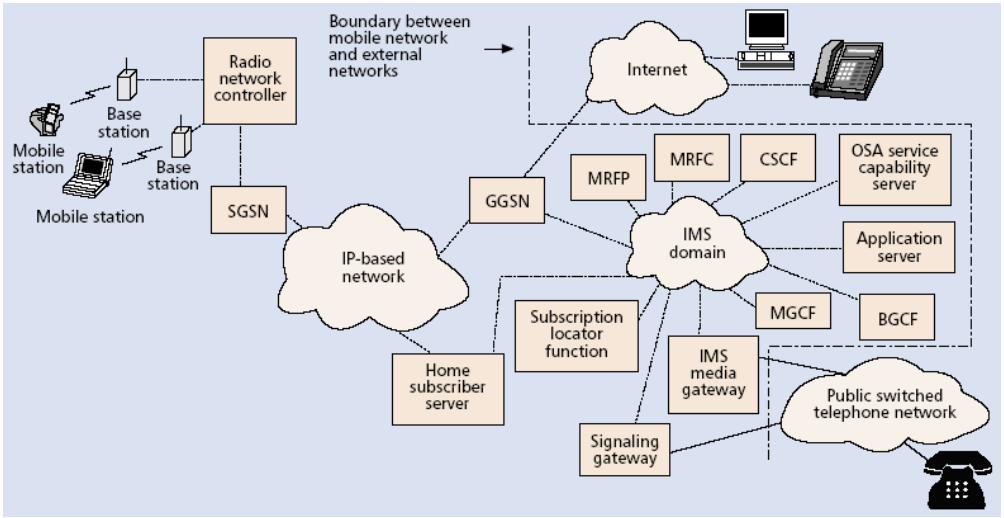
Multimedia over IP



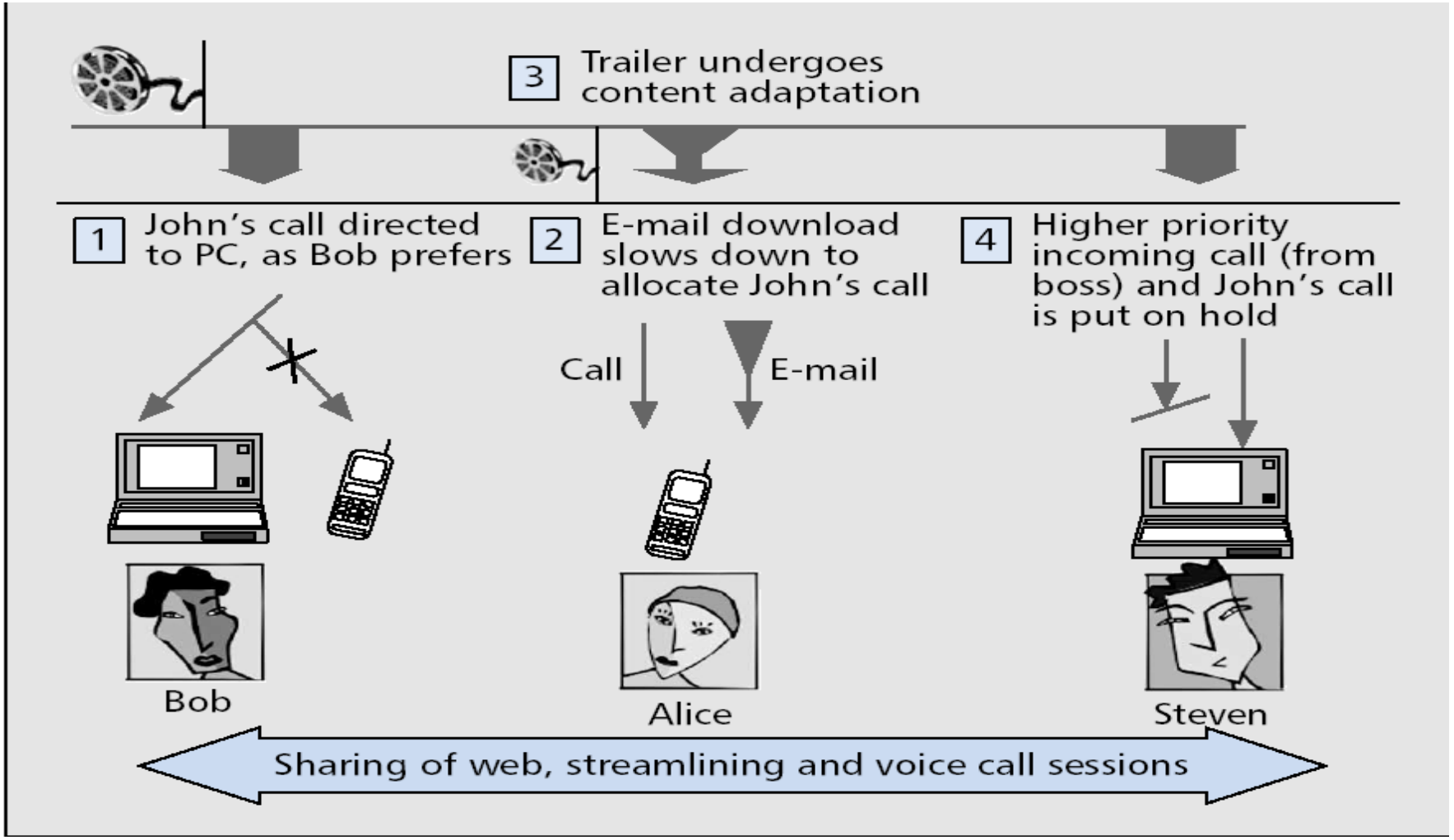


3GPP - Release 5 IMS & HSDPA

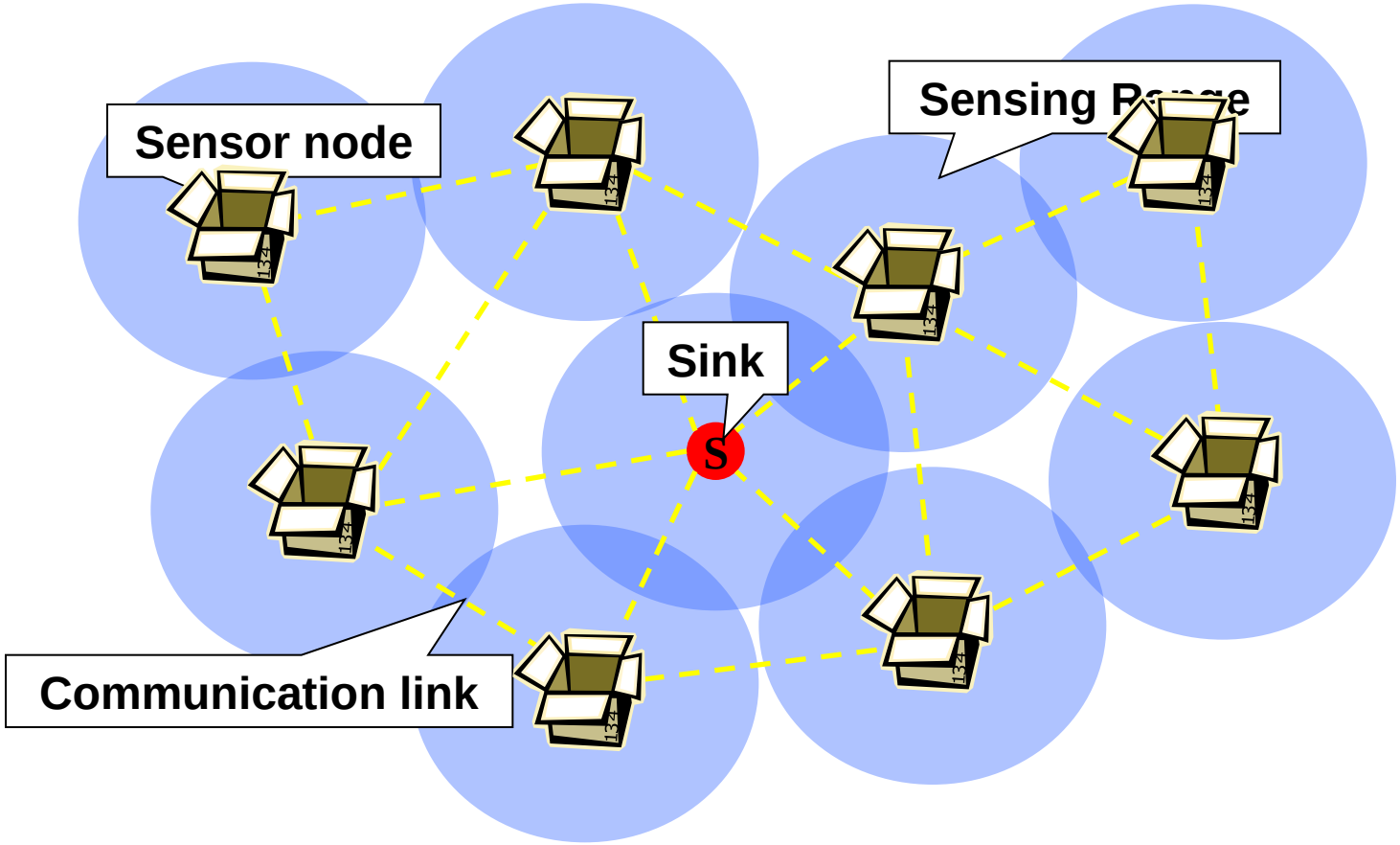




IMS Service Scenario



Wireless sensor network: data gathering

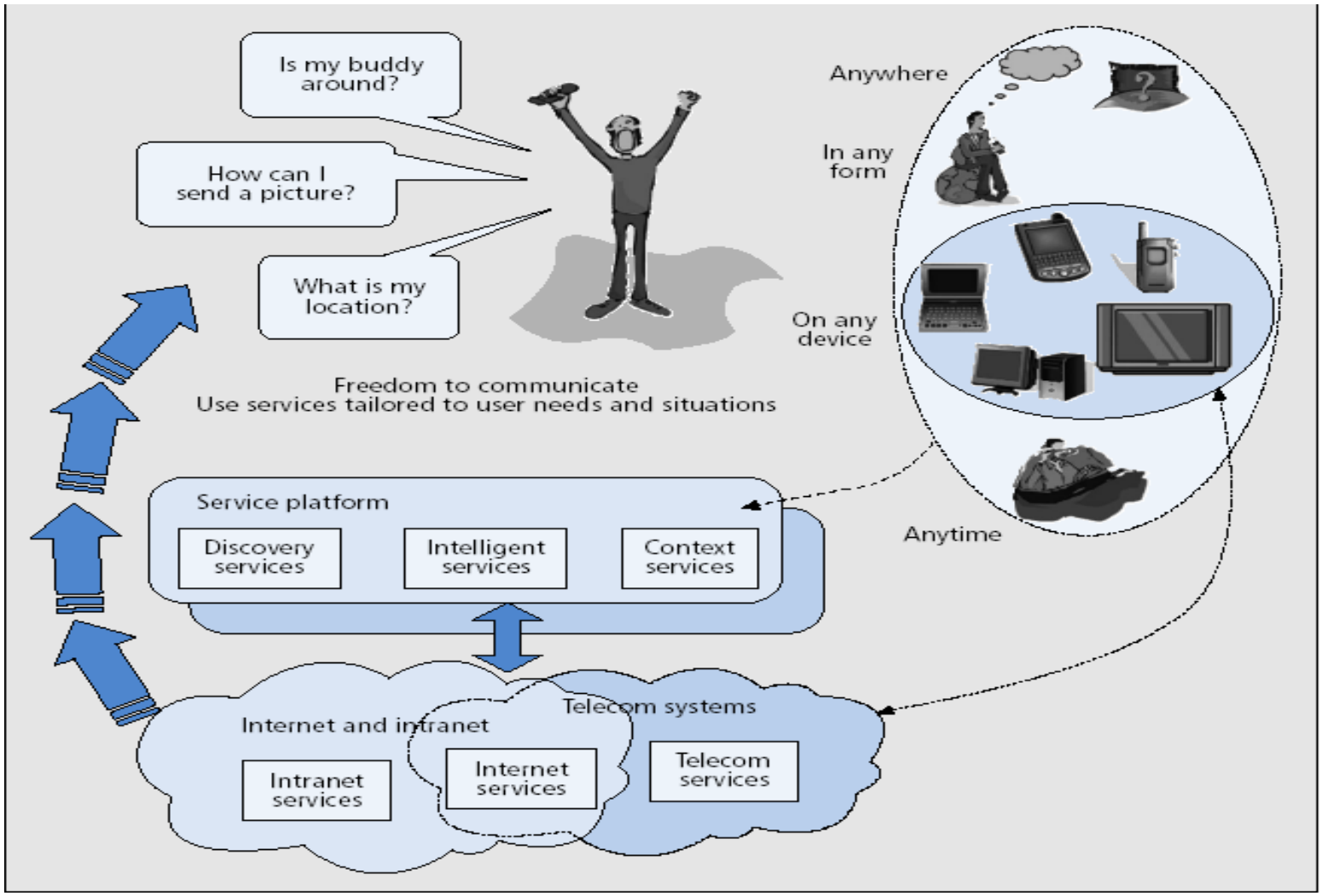


Video Transmission in VANET

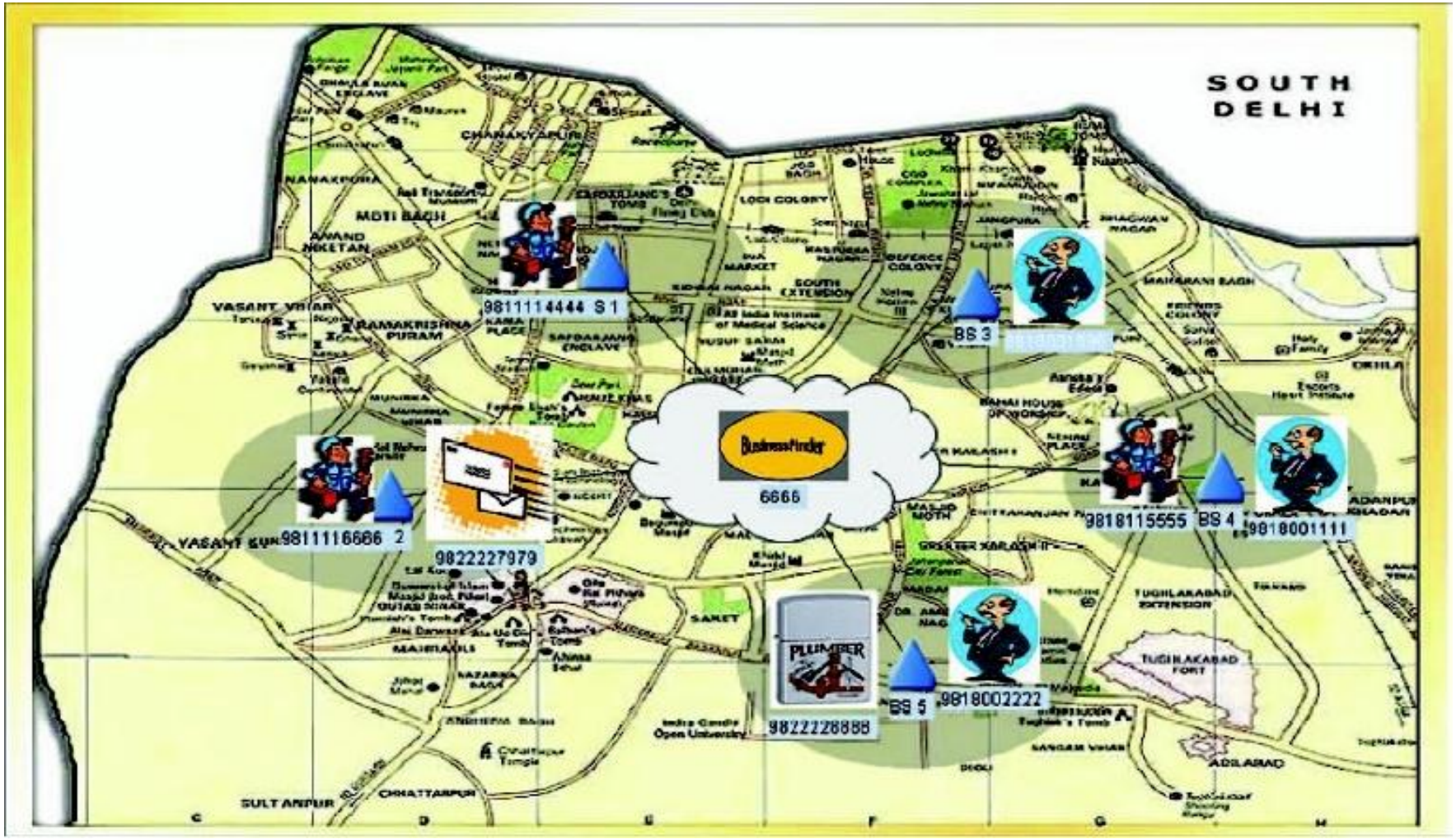
GPS gets instant video streams from the surveillance cameras at an intersection.

The driver can get a better view of the traffic.

Context Aware Communication



Business Finder



Adaptive Applications

Varied type of service

Video | Audio | Graph | Text

Adaptive application coding

High ..... **Quality** ..... Low

Situation-Aware Wireless Networks

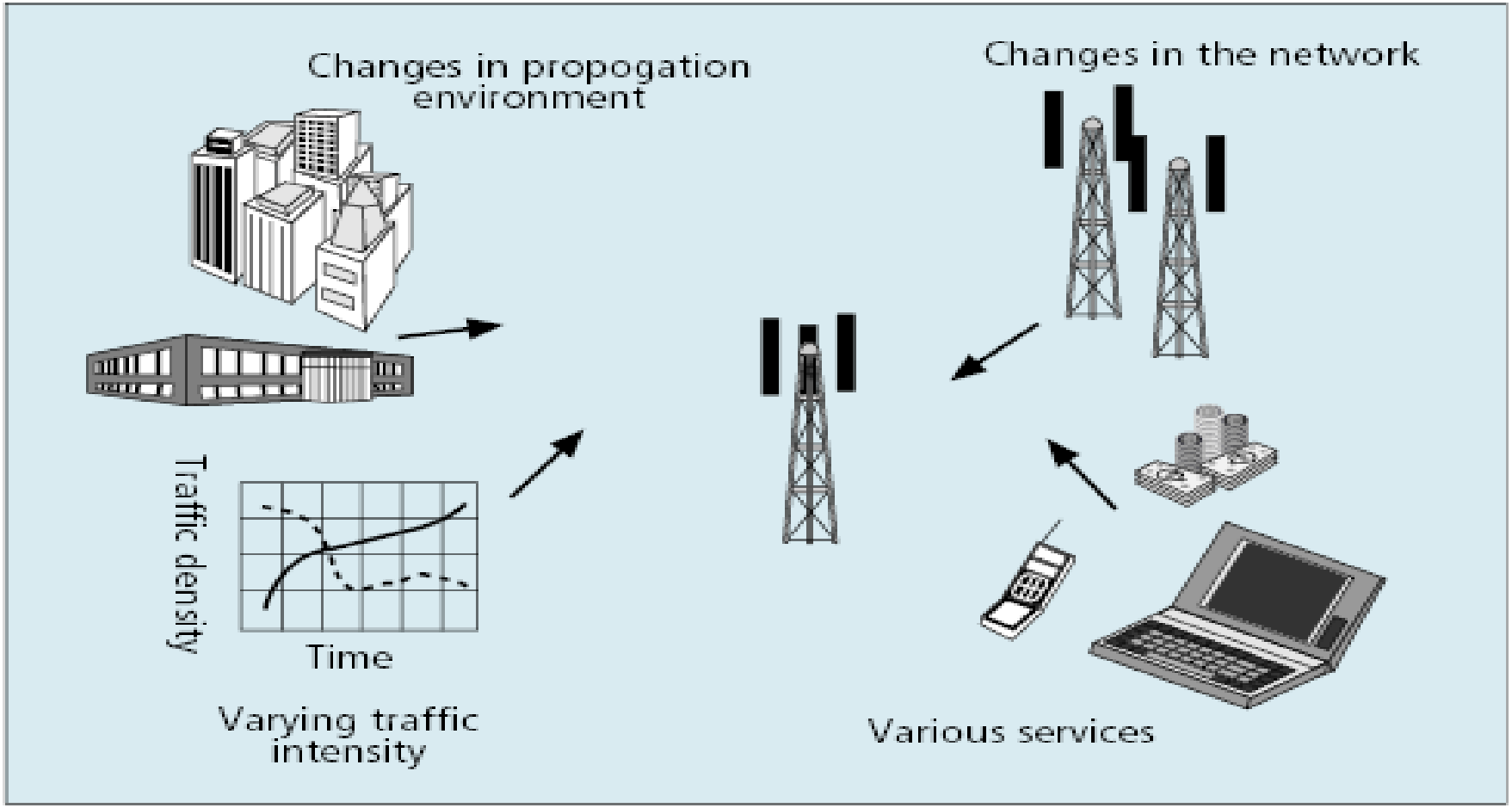


Figure 4. *Situation awareness functionality.*

Network Mobility Management

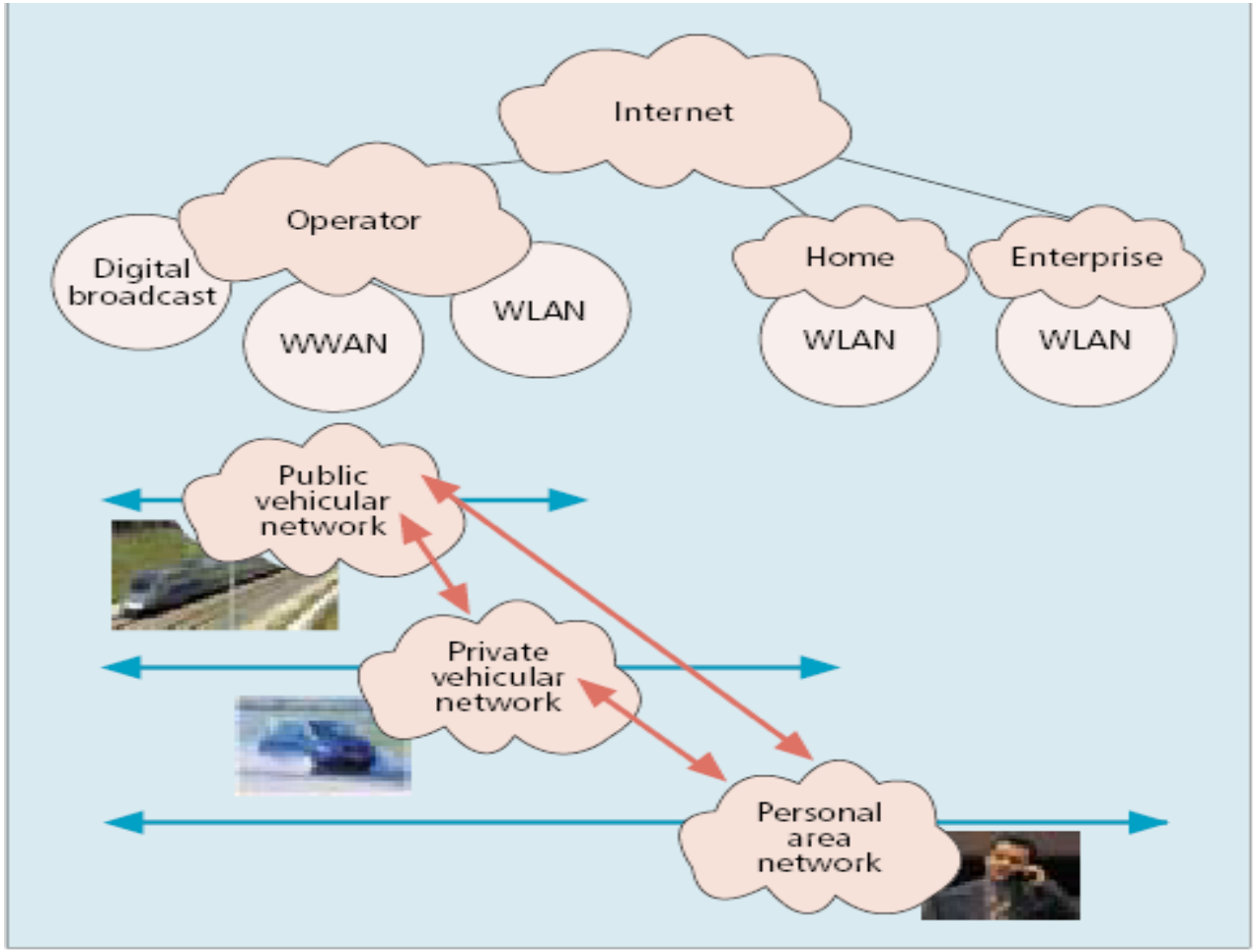


Figure 1. *A mobile network in a B3G system.*

IEEE 802.11 WLAN

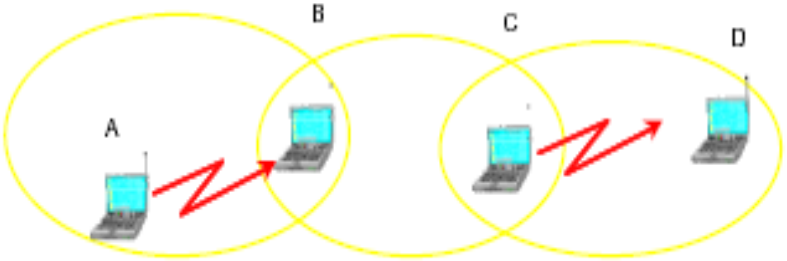
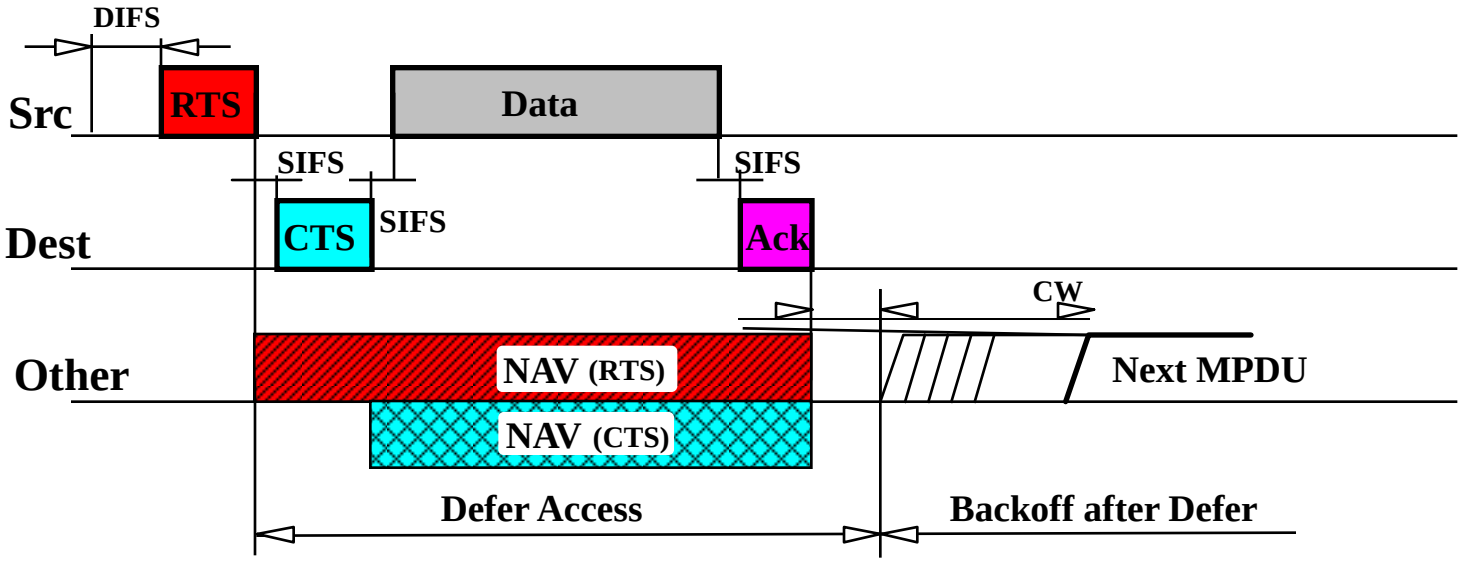


Fig. 1. A is sending a packet to B when C should decide whether to transmit to D.

Ad hoc mode

Infrastructure mode



802.11 family

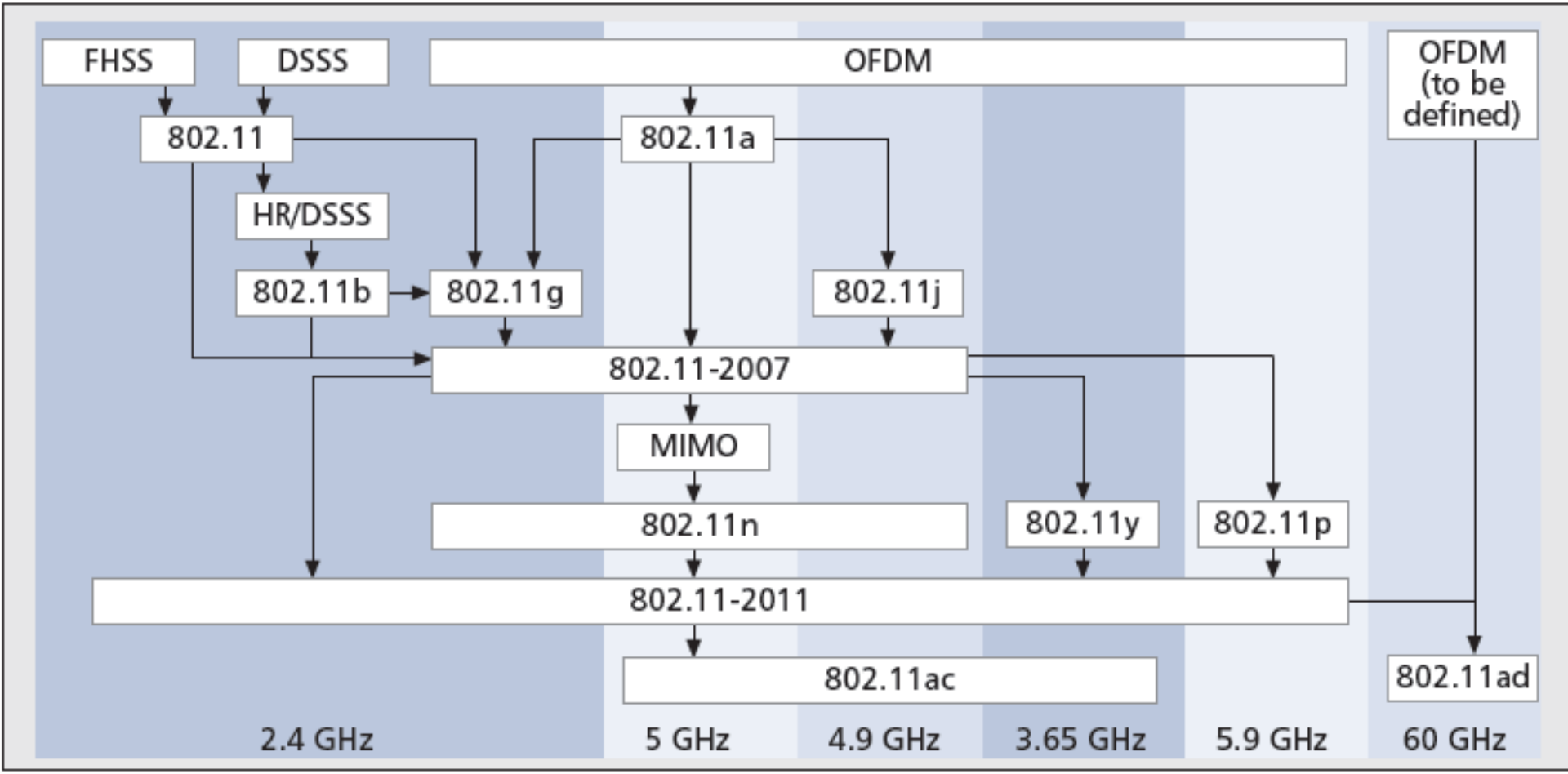
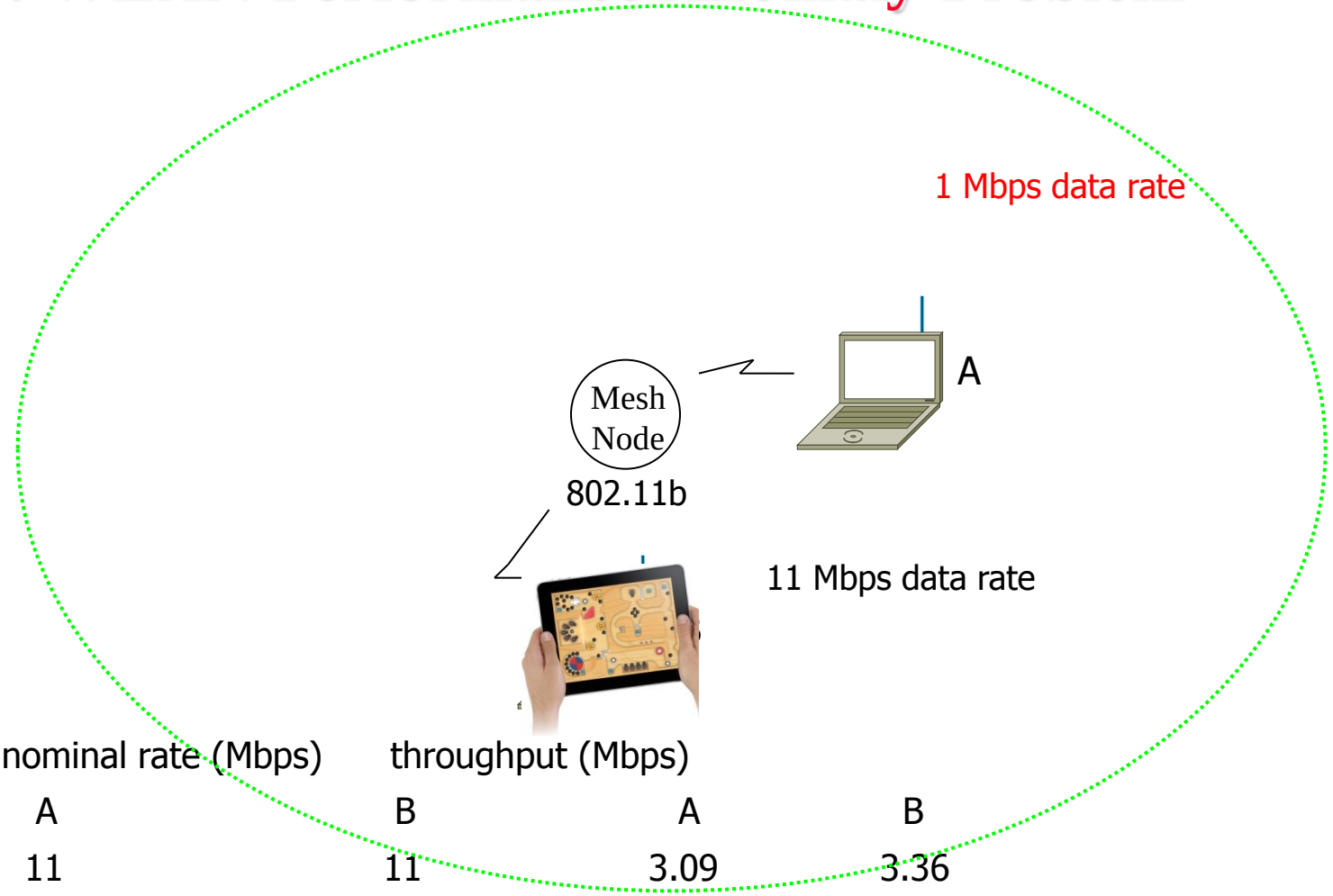


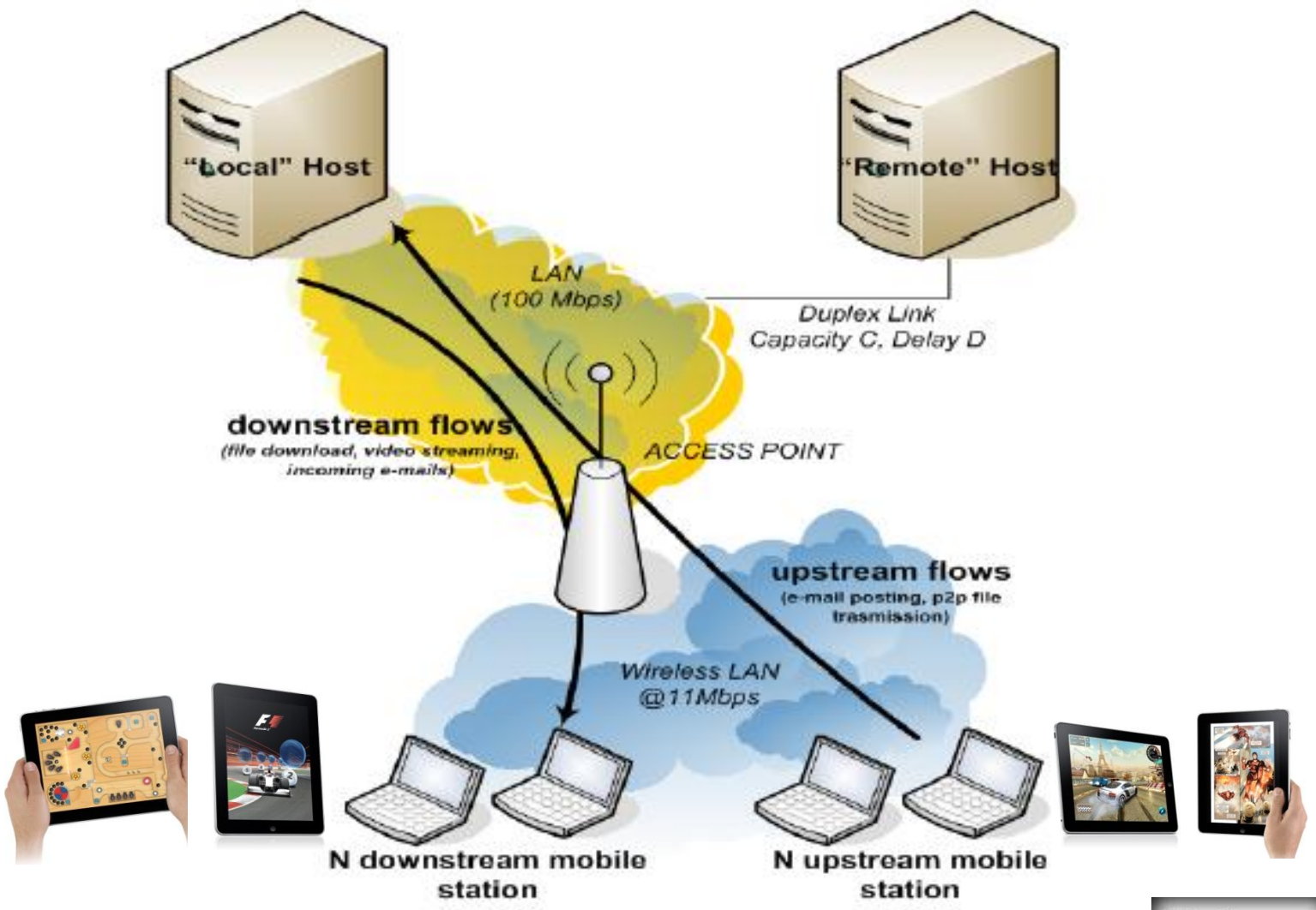
Figure 1. *The 802.11 PHY layer amendments and their dependencies.*

Quiz 0: WLAN Performance Anomaly Problem



nominal rate (Mbps)		throughput (Mbps)	
A	B	A	B
11	11	3.09	3.36
1	**11**	**0.73**	**0.76**

Fairness for upstream and downstream



Expectation of the Class

- Basic Understanding of PCS world
- Being able to do the wireless research
- Developing the capability to invent the key wireless applications

Course Process

- Paper reading and your presentations
- Wireless Multimedia Applications Exercises

Mobile Computing

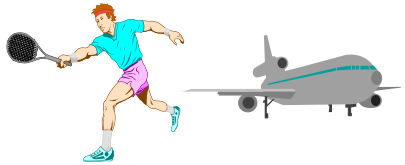
Mobile phone today = multipurpose terminal for ...

Internet Browser

E-mail Client

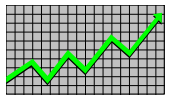
Authentication Device

Information Client



E-purse

Share dealing, etc.



Reading list for This Lecture

- Required Reading:

  (S.2001) M. Satyanaraynan, “Pervasive Computing: Vision and Challenges”, IEEE Personal Communication Magazine, (August 2001), pp.10-17

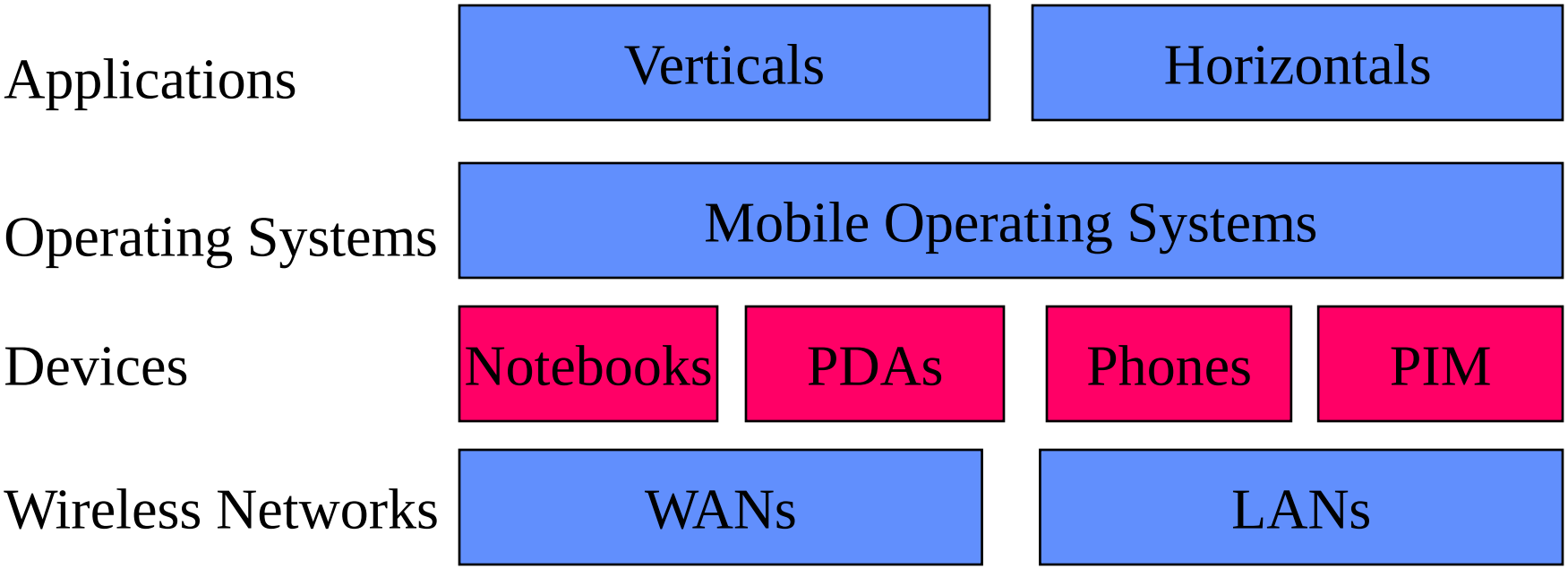
  (Bi2001) Qi Bi, George I. Zysman, and Hank Menkes, “Wireless Mobile Communications at the Start of the 21 Century”, IEEE Communication Magazine (January 2001), pp. 110-116

  Reference Papers:

  (Heusse 2003) M **Heusse**, F Rousseau, G Berger-Sabbatel, A Duda – “Performance anomaly of 802.11” IEEE INFOCOM, 2003

  (Guido 2010) Guido R. Hiertz, Dee Denteneer, Lothar Stibor, Yunpeng Zang, Xavier Perez Costa, Bernhard Walke, “The IEEE 802.11 Universe”. IEEE Communication Magazine January 2010, pp 62-70.

Mobile Computing



Mobile Computing

- information processing in general
  - not just communication or just computing, but both
- Any medium or combination of medium
  - process not just telephone voice or just data, but multimedia
- Mobility
  - components of the systems may be
    - moving, tether-less (wireless), portable
  - uses of the system may be moving

Why should we care ?

- Reason # 1 : $$$ & jobs
- Explosive growth of wireless voice, paging, and data services
  - 35-60 percent annual growth in the past decade
  - mobile phones in US will be 42 % of fixed -line phones by 2000
  - 700 million mobile users at the end of 2000
  - One billion expected by 2003
- Big demand for portable communicators and computers
  - 2 M portable computer in 1988 to 74.1 M units in 1998

Is there a more “academic” reason ?

- Reason # 2: a next step in the evolution of information system
- Evolution from personal computing to networked computing to mobile computing
- Evolution from wired telephony to cordless telephony to mobile cellular telephony
- At the same time, unification of computing and communication

Mobile Multimedia Systems

- Ubiquitous information access (everybody else)
  - e.g. wireless computing, mobile computing, nomadic computing
  - information distributed everywhere by “the net”
  - users carry (wireless) terminals to access the information services
  - terminal is the universal service access device
  - terminals adapt to location and services
  - Knowledge-based society
- Flexible Users Choices
  - In terms of access, service, content
  - Any where, anytime, any terminal equipments

- Wearable Computing terminal / Mobile Broadband services (MBS)

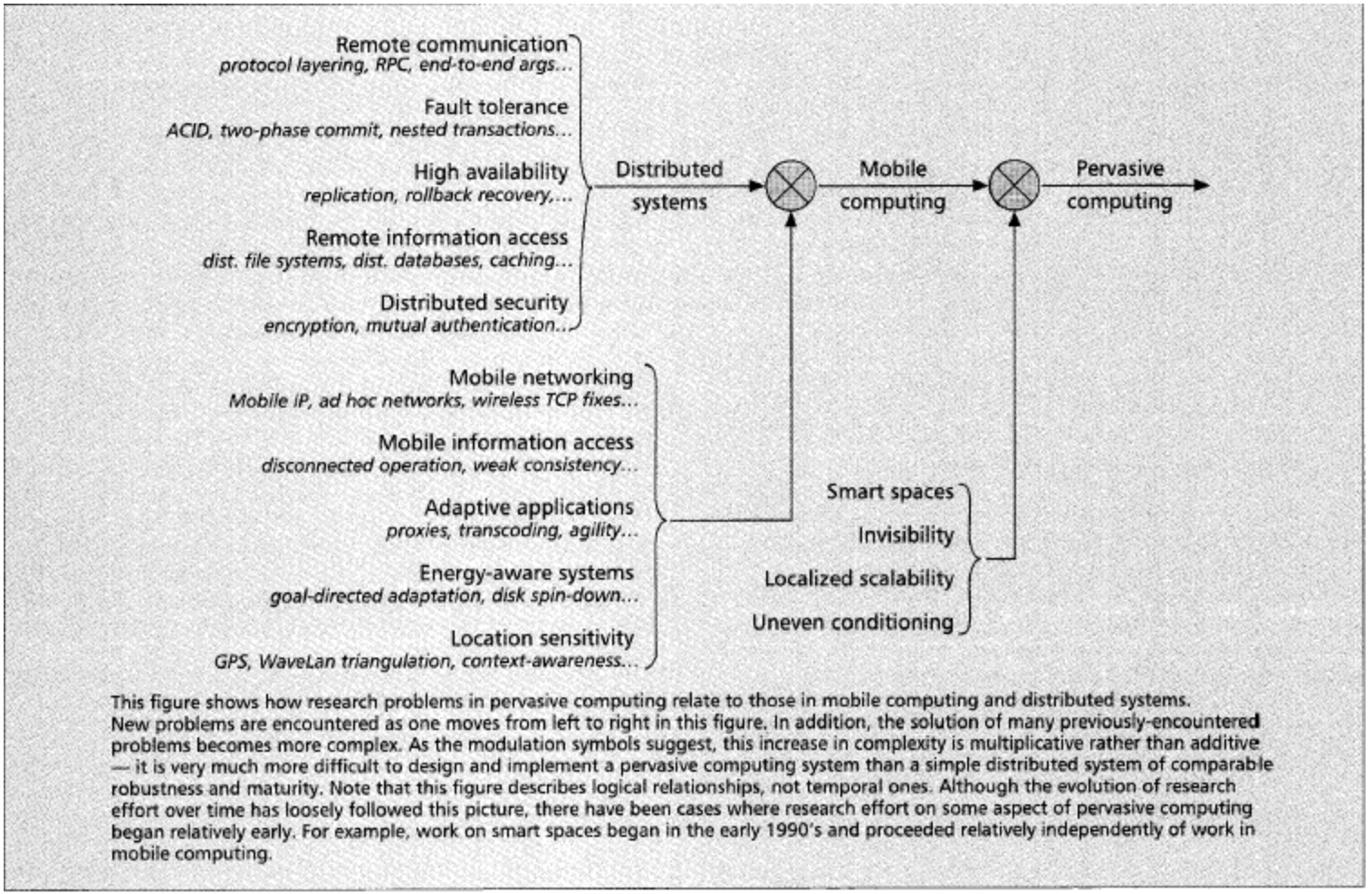
Pervasive Computing

- Technology that disappears
  - The most profound technologies are those that disappear. They weave themselves into the fabric of everyday life until they are indistinguishable from it".
- Ubiquitous (Invisible) Computing (Xerox PARC)
  - Cheap computers of different scale and types embedded everywhere
  - Potentially 100s of computers per room that disappear into background (e.g. active badge, tabs, pads, live boards..)
  - User centric, not terminal centric
  - Computers swapped and shared among users
- Effective Use of Smart Spaces
- Invisibility
- Localized Scalability
- Masking Uneven Conditioning

Support for Pervasive Computing

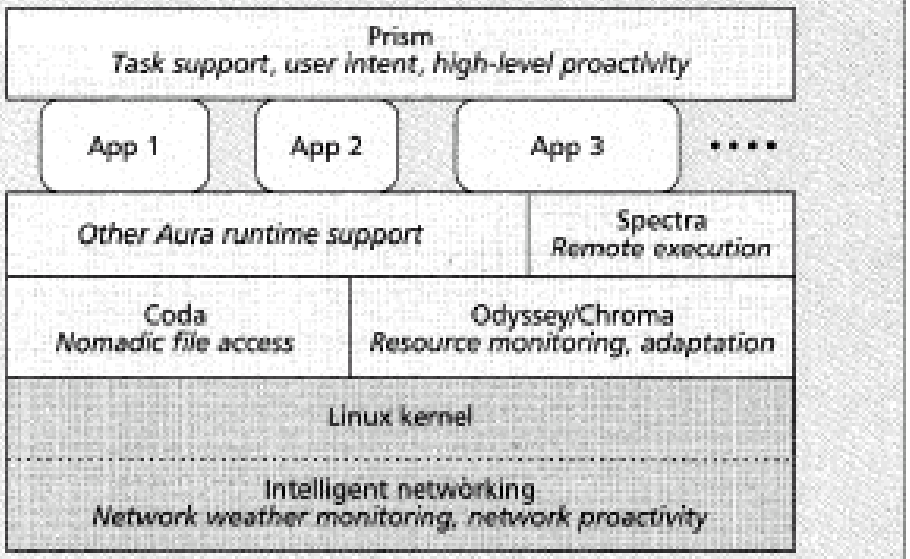
- User Intent
- Cyber Foraging
- Adaptation Strategy
- High-Level Energy Management
- Balancing Pro-activity and Transparency
- Privacy and Trust
- Impact on Layering

Pervasive Computing



■ **Figure 1.** *Taxonomy of computer systems research problems in pervasive computing.*

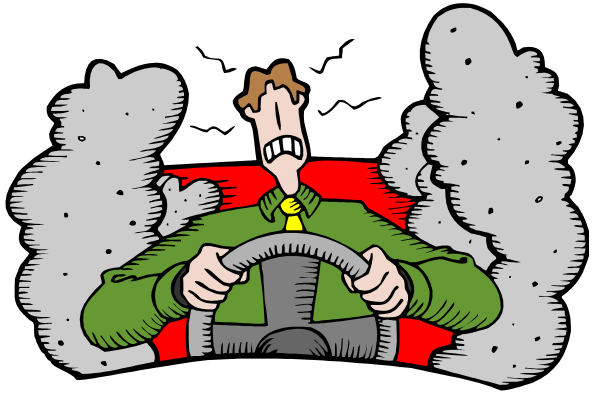
Aura Client



This figure shows the components of an Aura client and their logical relationships. The text in italics indicates the role played by each component. Coda and Odyssey were created prior to Aura, but are being modified substantially to meet the demands of pervasive computing. In the case of Odyssey, these changes are sufficiently extensive that they will result in Chroma, a replacement. Other components, such as Prism and Spectra, are being created specifically for use in Aura. Additional components are likely to be added over time since Aura is relatively early in its design at the time of this writing. Server and infrastructure support for Aura are not shown here.

■ **Figure 2.** *The structure of an Aura client.*

Wireless Communications



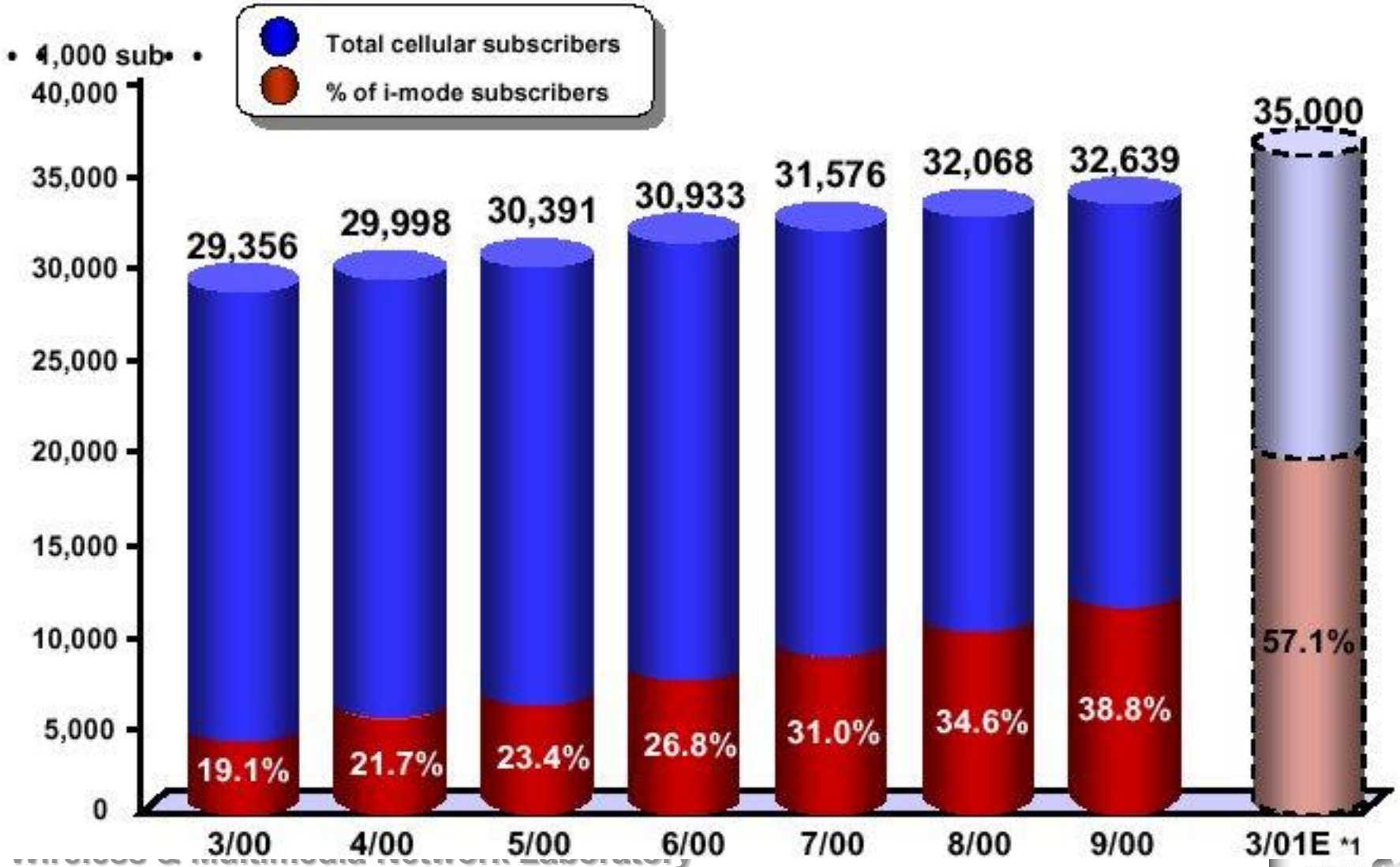
Mobile Communications

Fixed Broadband Wireless Communications

Evolution of Mobile Wireless Systems

- First Generation : Analog – Voice (Early 1980s)
  - Analog modulation
  - Cellular phone (AMPS) with manual roaming
  - Cordless phones
  - Packet radio networks
- Second Generation : Digital - Voice & Data (Early 1990s)
  - WAP (wireless application protocol)
  - 2.5 G GPRS
  - TDMA and narrowband CDMA: EX-GSM, IS-95(cdmaOne)
- Third Generation: Digital – Multimedia (Late 1990s)
  - Unified digital wireless access anytime, anywhere
  - Voice, data, images, video, music, sensor etc.
- 4G~ Life after Third-Generation Mobile Communications
  - LTE (Long Term Evolution), Wimax

Cellular Service Subscription



Wireless Personal Communications

- What is it?
  - Cellular telephone
  - Cordless telephone
  - Paging systems
  - Wide area data networks
  - Local area data networks
- Many ways to segment PCS
  - Applications
  - Extent of coverage
  - Degree of mobility (speed, area)
  - Circuit switched voice vs. packet-switched data
  - Mode of communication (messaging, two-way real time, paging, agents)
  - User location (indoor vs. outdoor, train, airplane)
- **Common ingredients in all PCS activity**
  - Desire for mobility in communications
  - Desire to be free from tethers

2000 Market Share

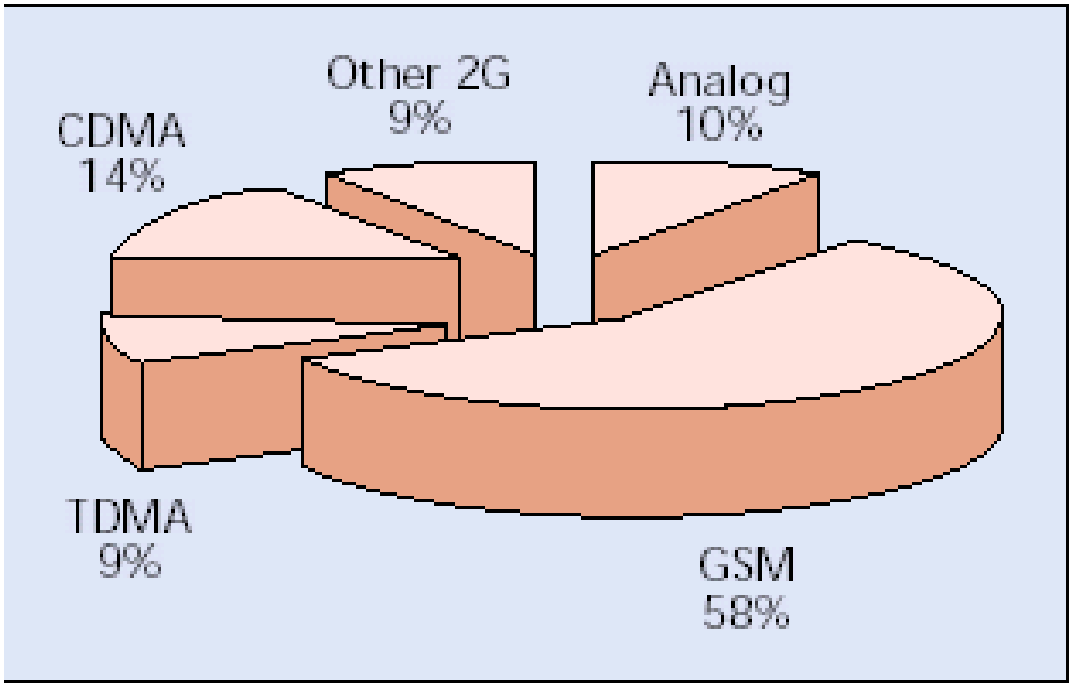


Figure 5. *Estimated market shares of 1G and 2G wireless mobile systems in 2000.*

Mobile Terminal Growth

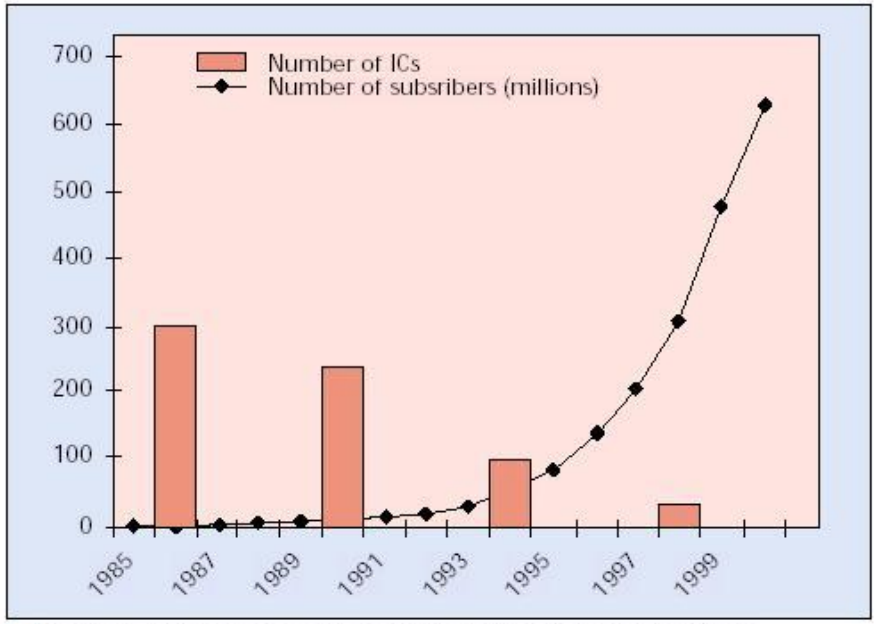
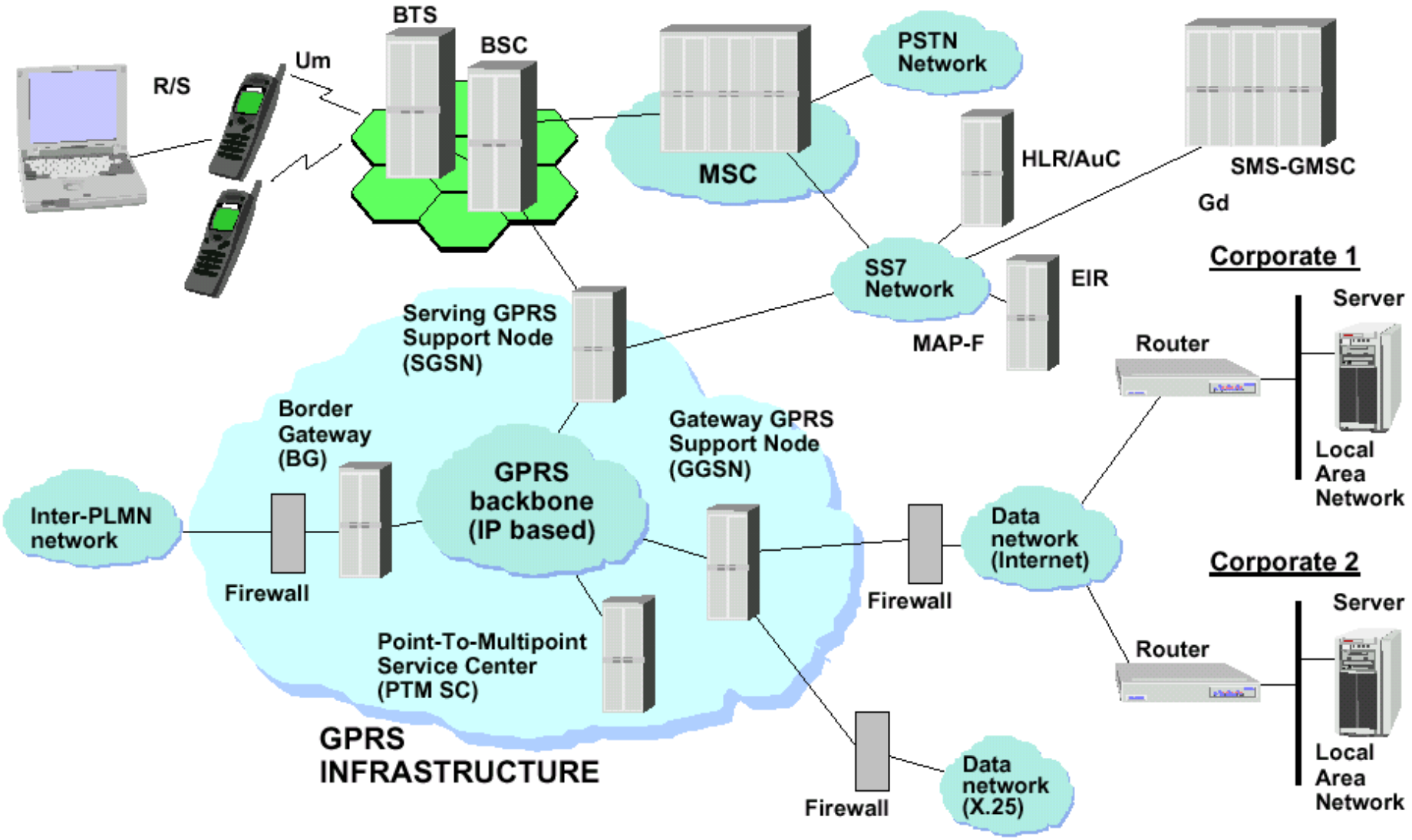


Figure 1. *Subscriber growth and IC reduction in mobile terminals.*

GPRS Architecture



RS Spectrum Allocation

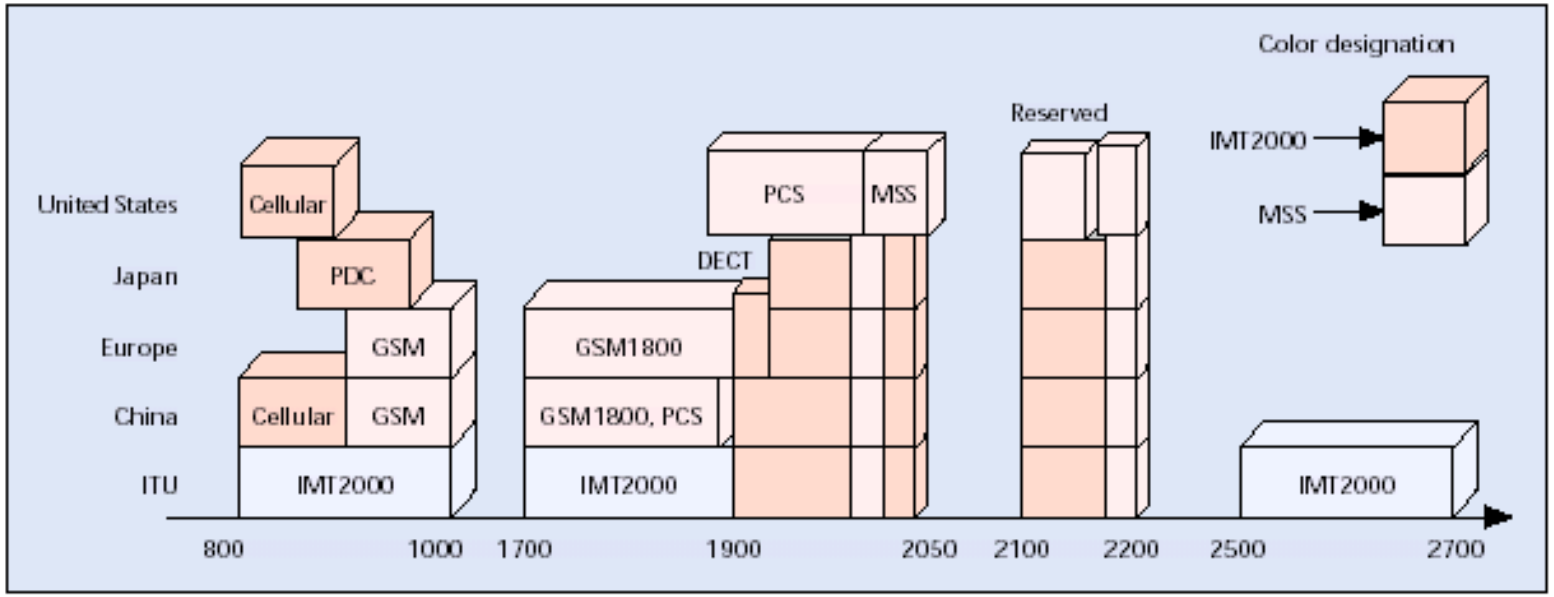
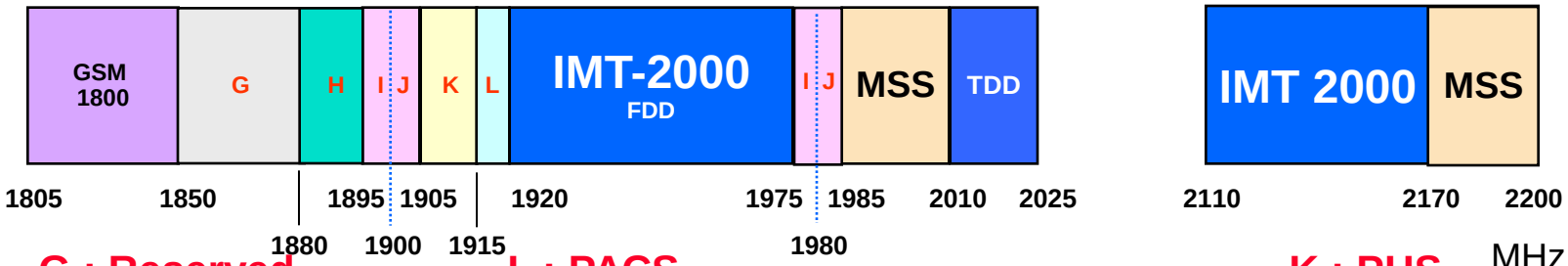


Figure 2. *RF spectrum allocation in major regions.*



G : Reserved

H : DECT

I : PACS

J : PACS (To Be Licensed)

K : PHS

L : Reserved

Wireless Mobile Interface

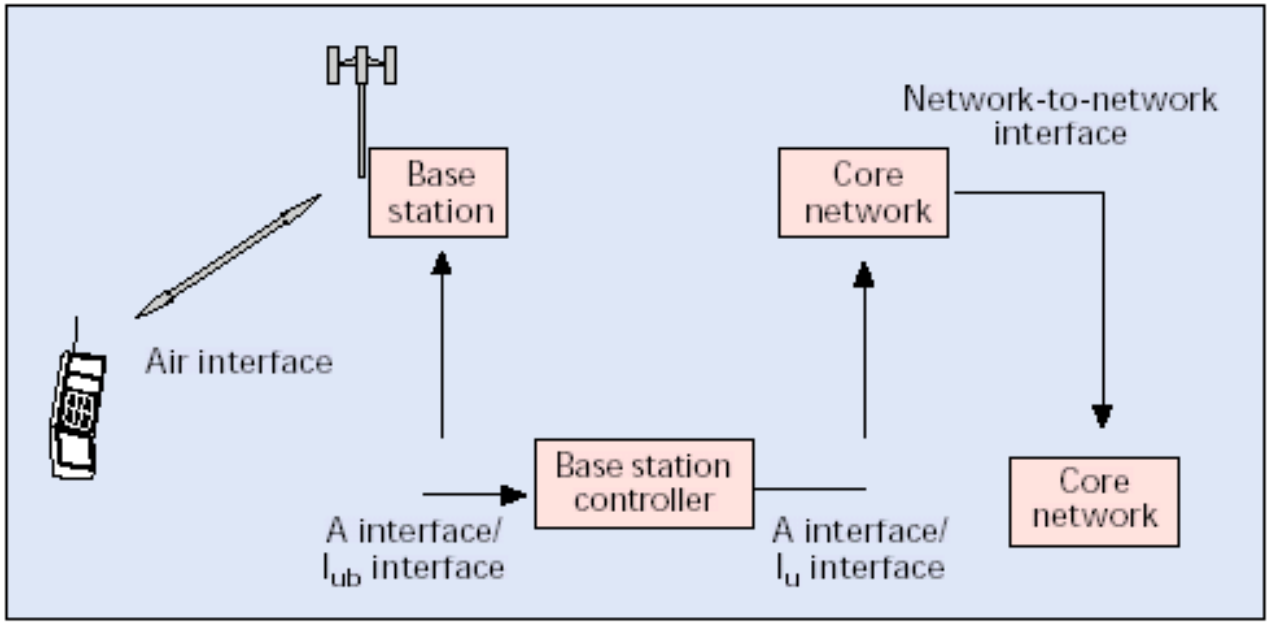
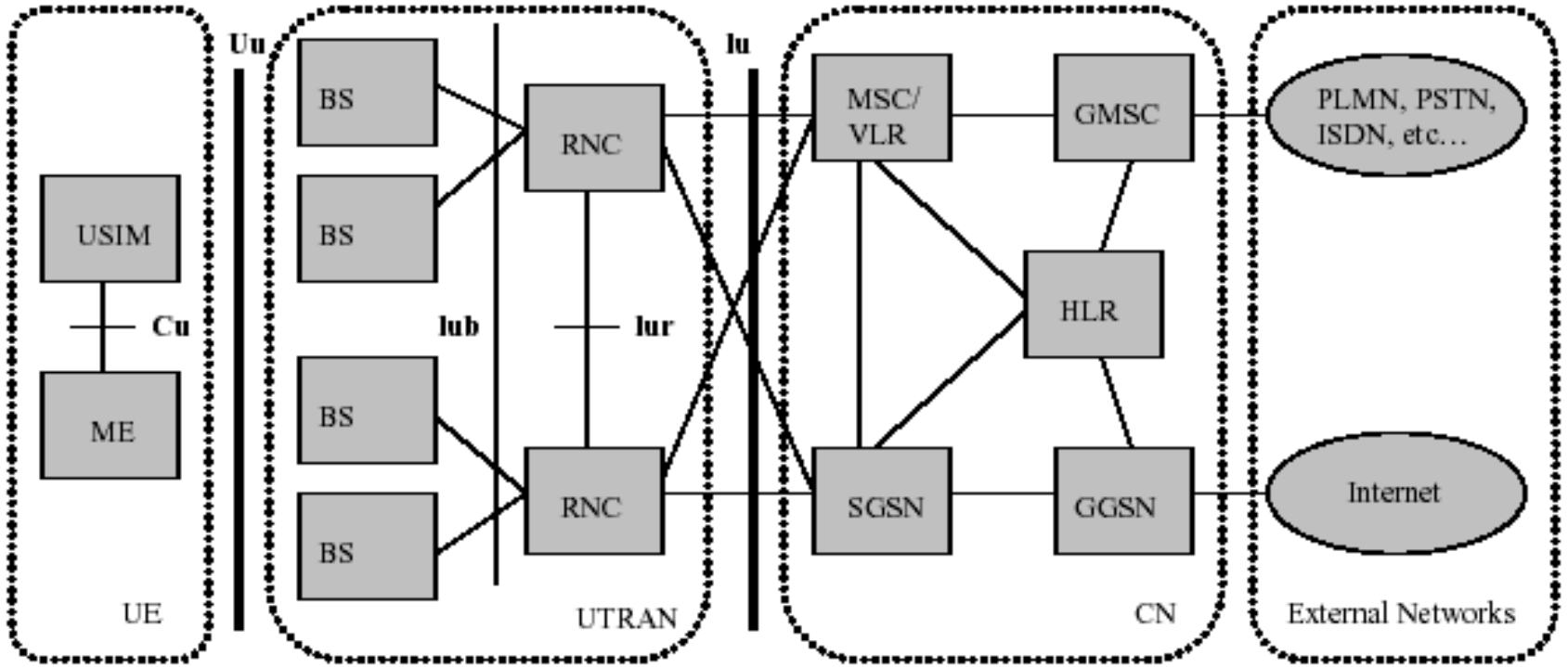
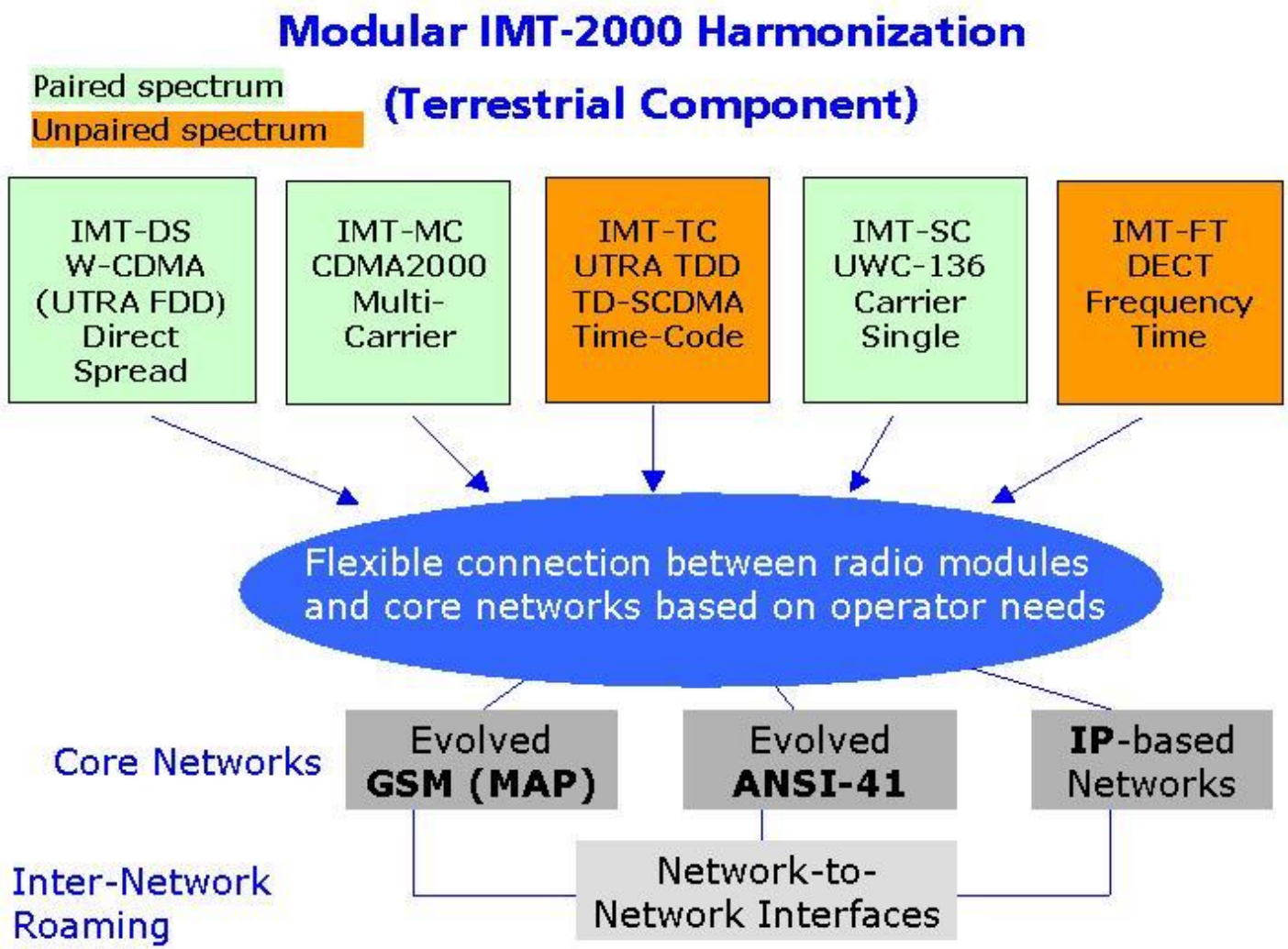


Figure 4. *Wireless mobile system interface definition.*

Elements of UMTS Architecture



第三代行動電話之技術標準



	Cdma2000	WCDMA	TD-SCDMA
Multiple access	DS-CDMA/MC-CDMA	DS-CDMA	TDMA/DS-CDMA
CLPCF	800 Hz	1600 Hz	200 Hz
PCSS	1 dB (0.5, 0.25 optional)	0.25–1.5 dB	1, 2, 3 dB
Channel coding	Convolutional or turbo coding	Convolutional, RS, or turbo coding	Convolutional or turbo
Spreading code	DL:Walsh, UL:M-ary Walsh mapping	OVSF	OVSF
VSF	4…256	4…256	1…16
Carrier	2 GHz	2 GHz	2 GHz
Modulation	DL: QPSK, UL: BPSK	DL: QPSK, UL: BPSK	QPSK, 8-PSK (at 2 Mb/s
Bandwidth	1.25*2/3.75*2 MHz	5*2 MHz	1.6 MHz
UL-DL spectrum	Paired	Paired	Unpaired
Chip rate	1.2288/3.6864 Mchips/s	3.84 Mchips/s	1.28 Mchip/s
Frame length	20 ms, 5 ms	10 ms	10 ms
Interleaving periods	5/20/40/80 ms	10/20/40/80 ms	10/20/40/80 ms
Maximum data rate	2.4 Mb/s	2 Mb/s	2 Mb/s
Pilot structure	DL: CCMP, UL: DTMP	DL: DTMP, UL: DTMP	CCMP
Detection	PSBC	PCBC	PSBC
Inter-BS timing	Synchronous	Asynchronous/synchronous	Synchronous

CCMP: common channel multiplexing pilot; DTMP: dedicated time multiplexing pilot; VSF: variable spreading factor; CLPCF: clo
power control frequency; PCSS: power control step size; DL: downlink; UL: uplink; PSBC: pilot symbol based coherent; PCBC: pi
nel based coherent

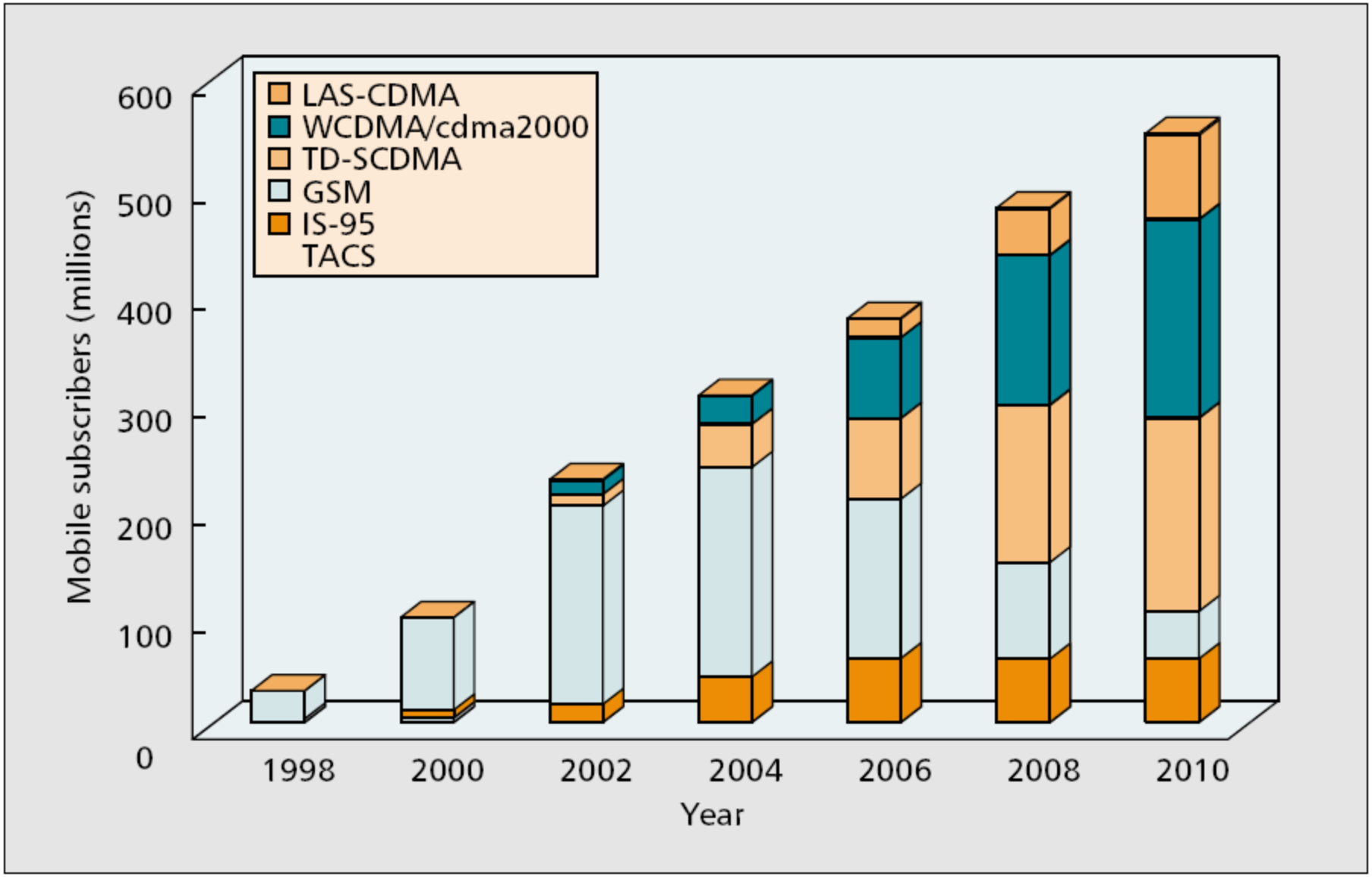
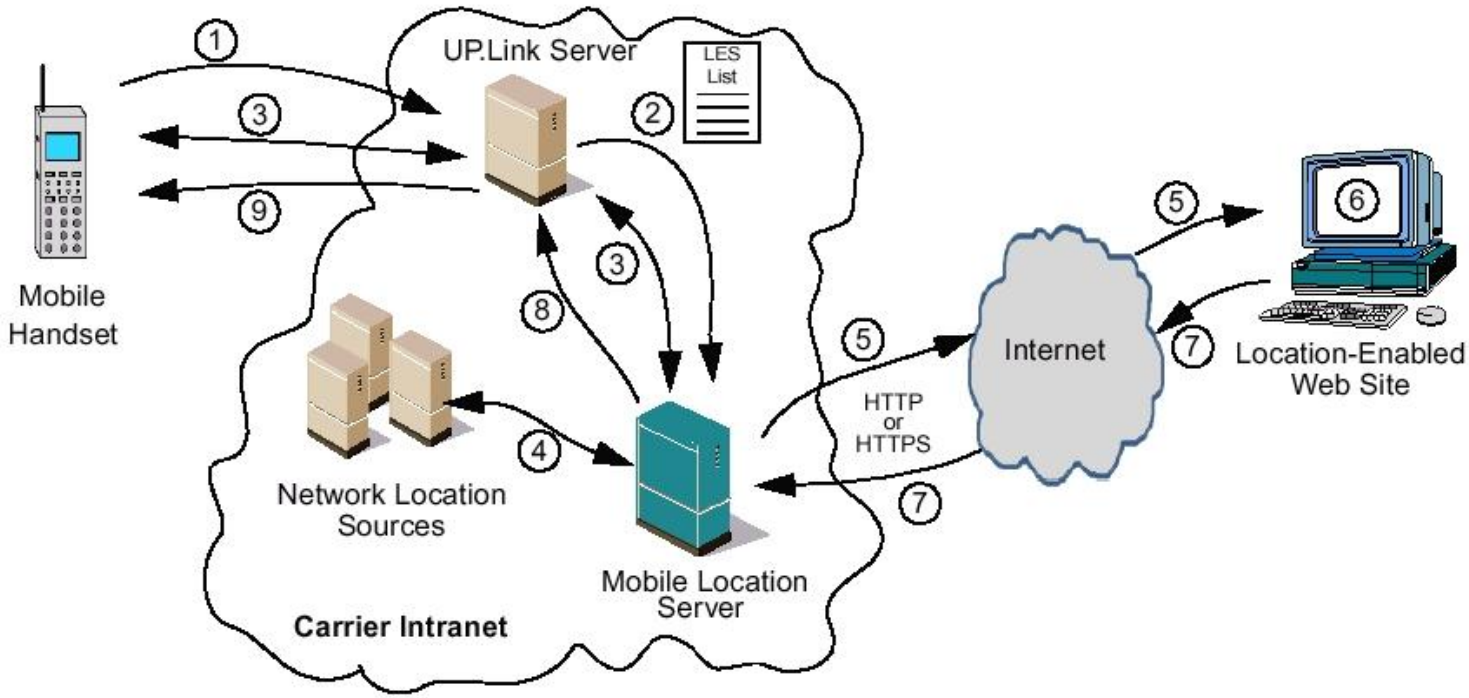


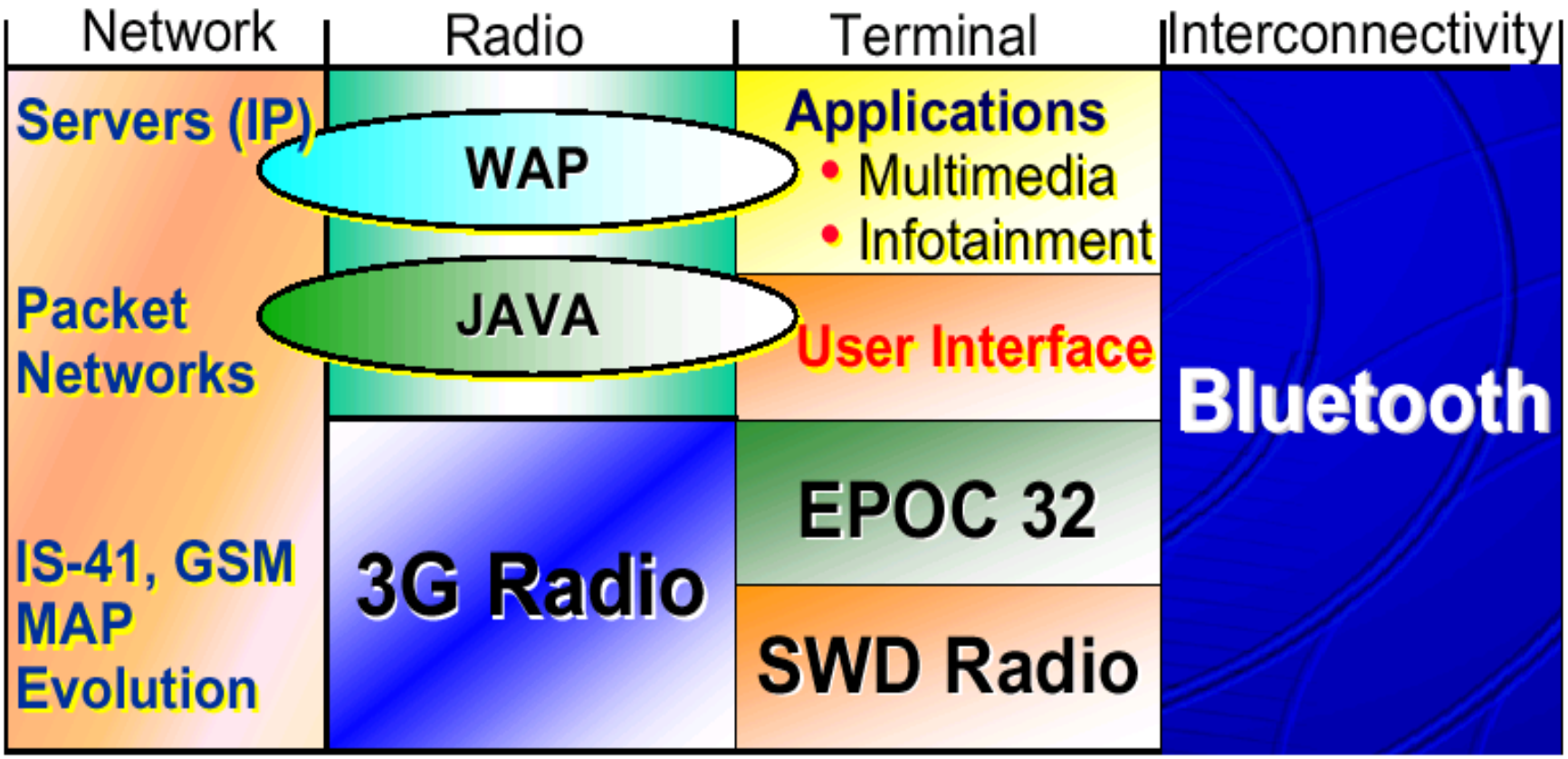
Figure 1. *The increasing trend in estimated population of mobile subscribers in China from 1998 to 2010. The total mobile communication related product value is estimated at about US$ 180–220 billions.*

Location-Based Applications

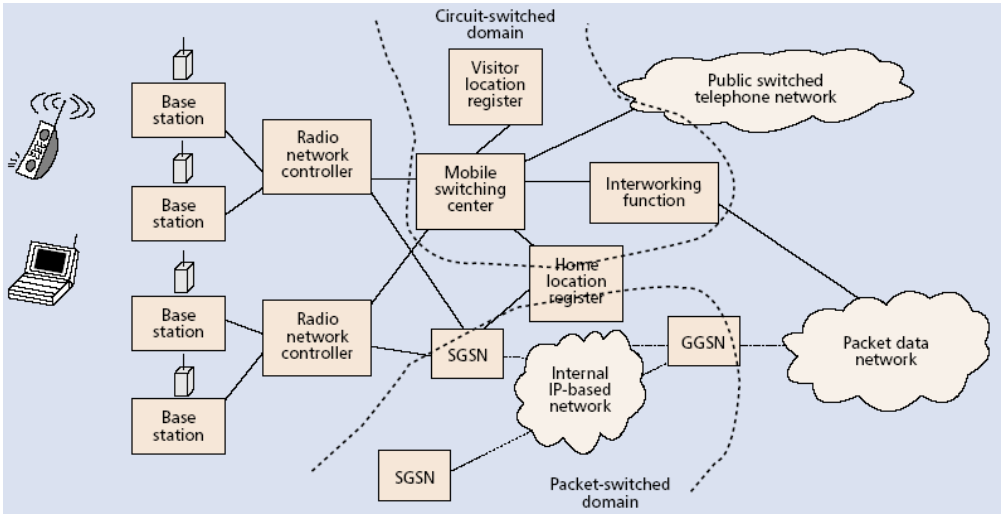
Figure 1. A typical location data transaction

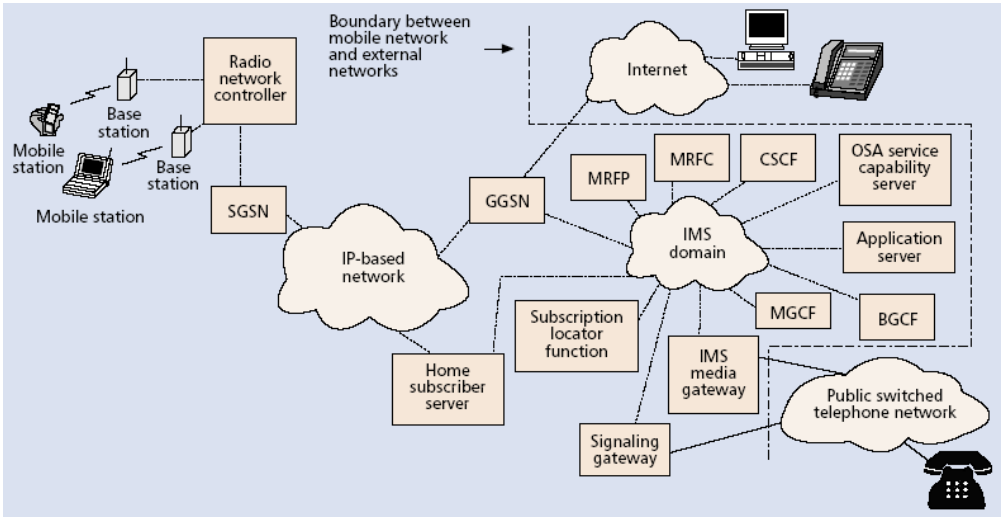


3G-Network integration



3GPP-Release 5
IMS & HSDPA





Mobile Broadband System

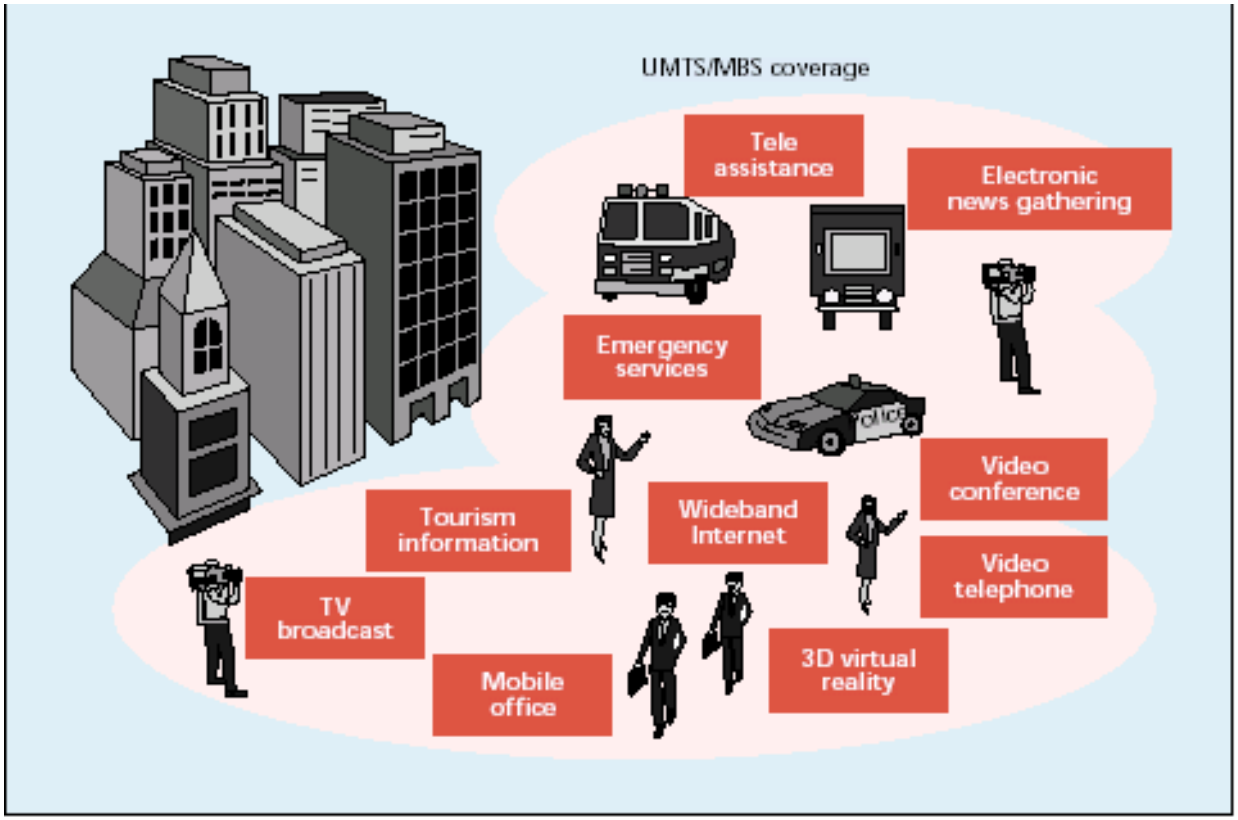


Figure 1. *MBS and UMTS coverage and applications.*

Mobile System Evolution

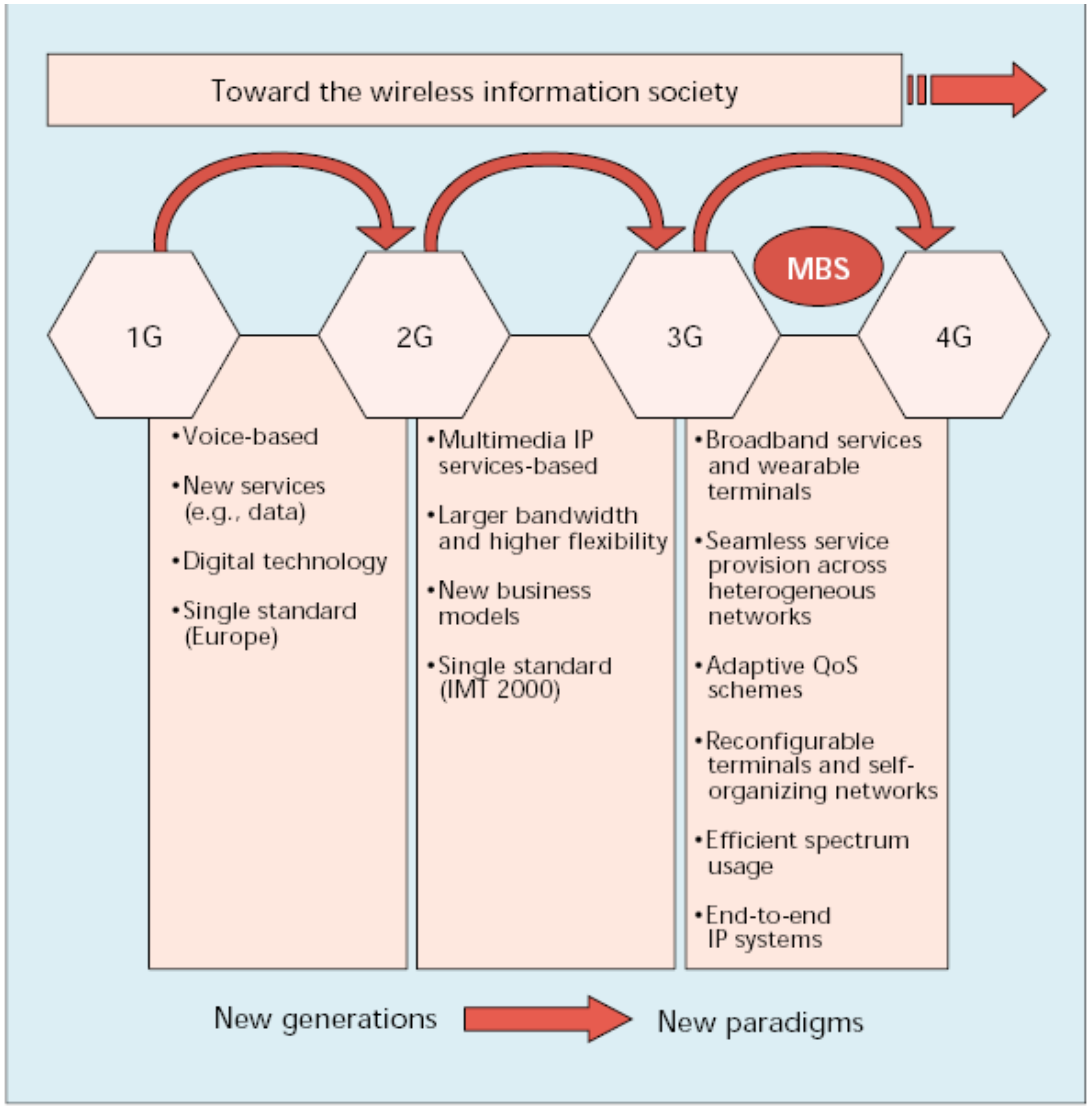
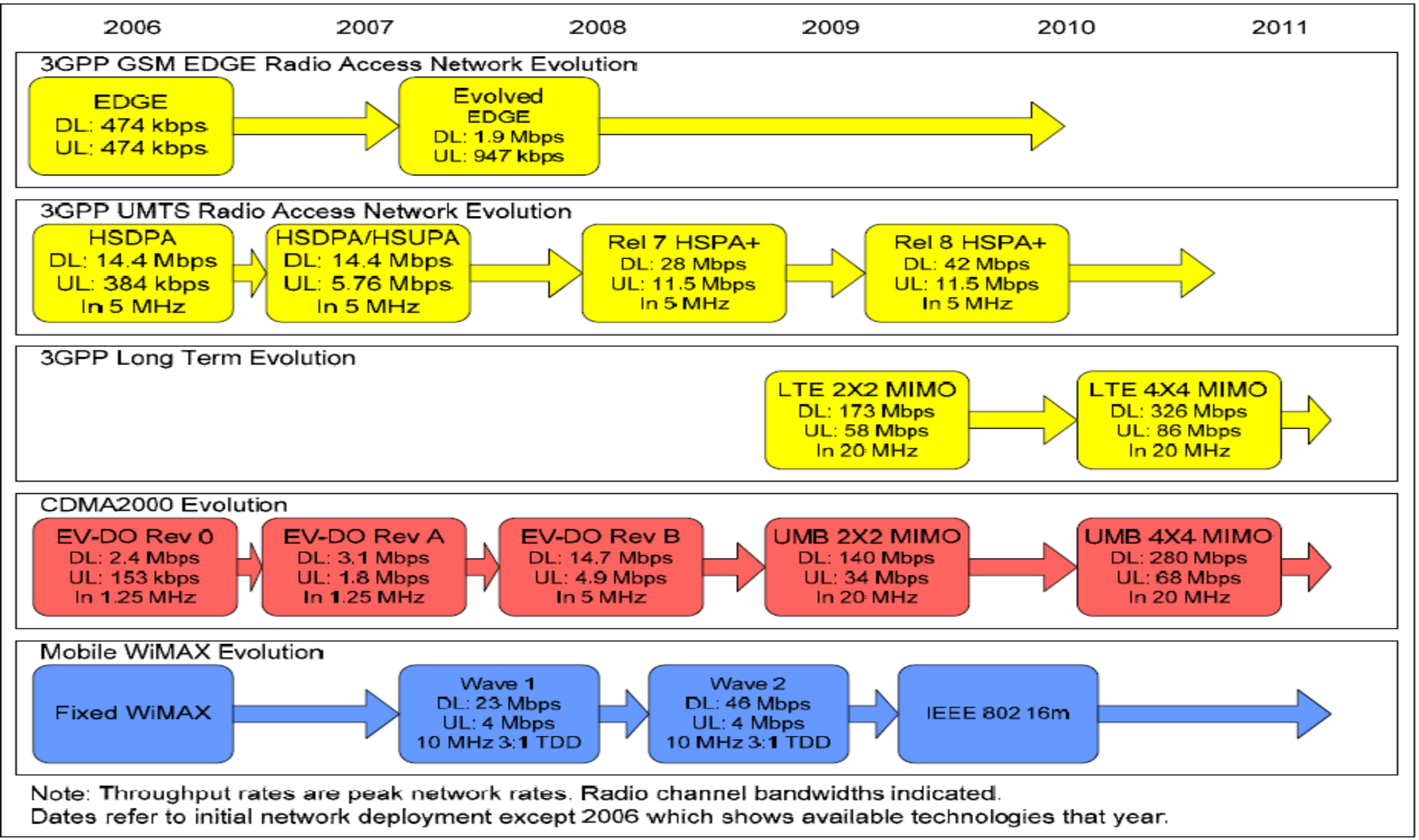
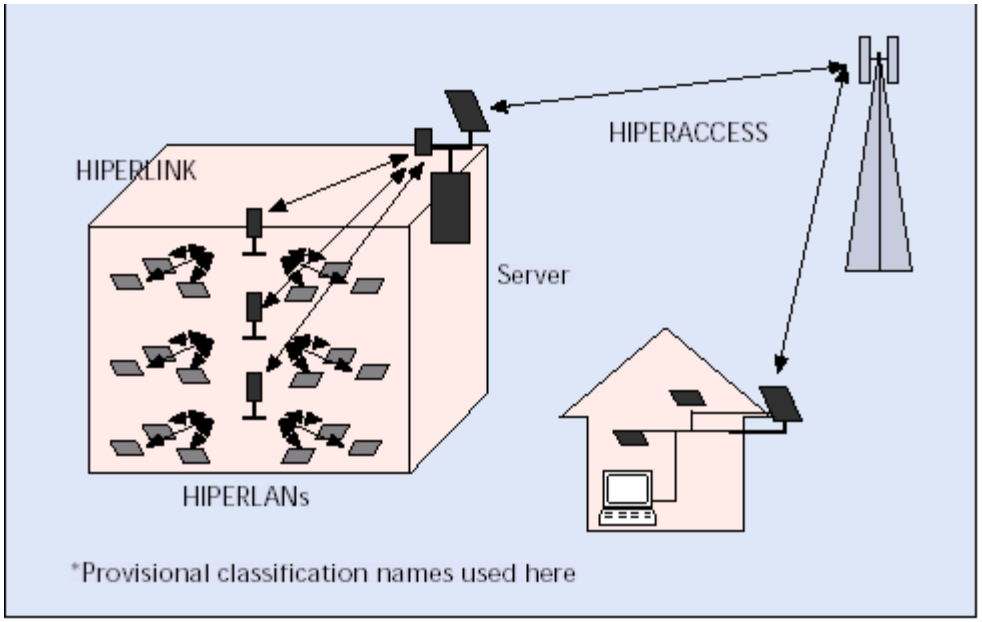


Figure 5. *Mobile communication systems evolution.*

TDMA, CDMA, OFDMA




HIPERACCESS
HIPERLINK
Server
HIPERLANs
*Provisional classification names used here

WiMAX Nomadic and Portable

Non Line of Sight
Point to Multi-point

802.16

Line of Sight
BACKHAUL

802.16

802.16e PC
Card

Laptop Connected
Through 802.16

SEEKS BEST
CONNECTION

2 to 3 Kilometers Away

Telco Core
Network or
Private (Fiber)
Network

INTERNET
BACKBONE

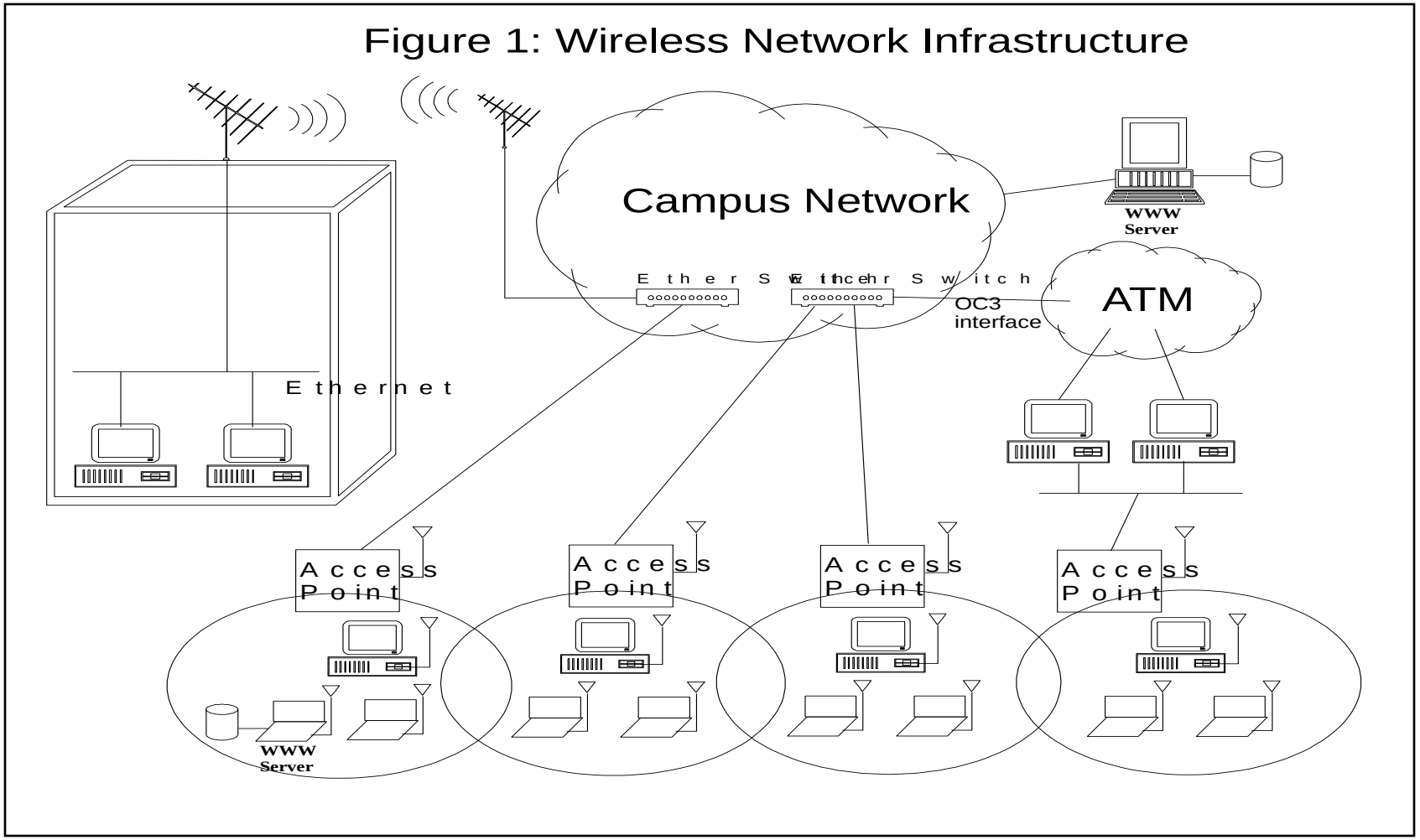
Ref: Margaret LaBrecque , "Enabling Deployments through Standards and Certification," WiMax, 2003

AIReach™ BROADBAND

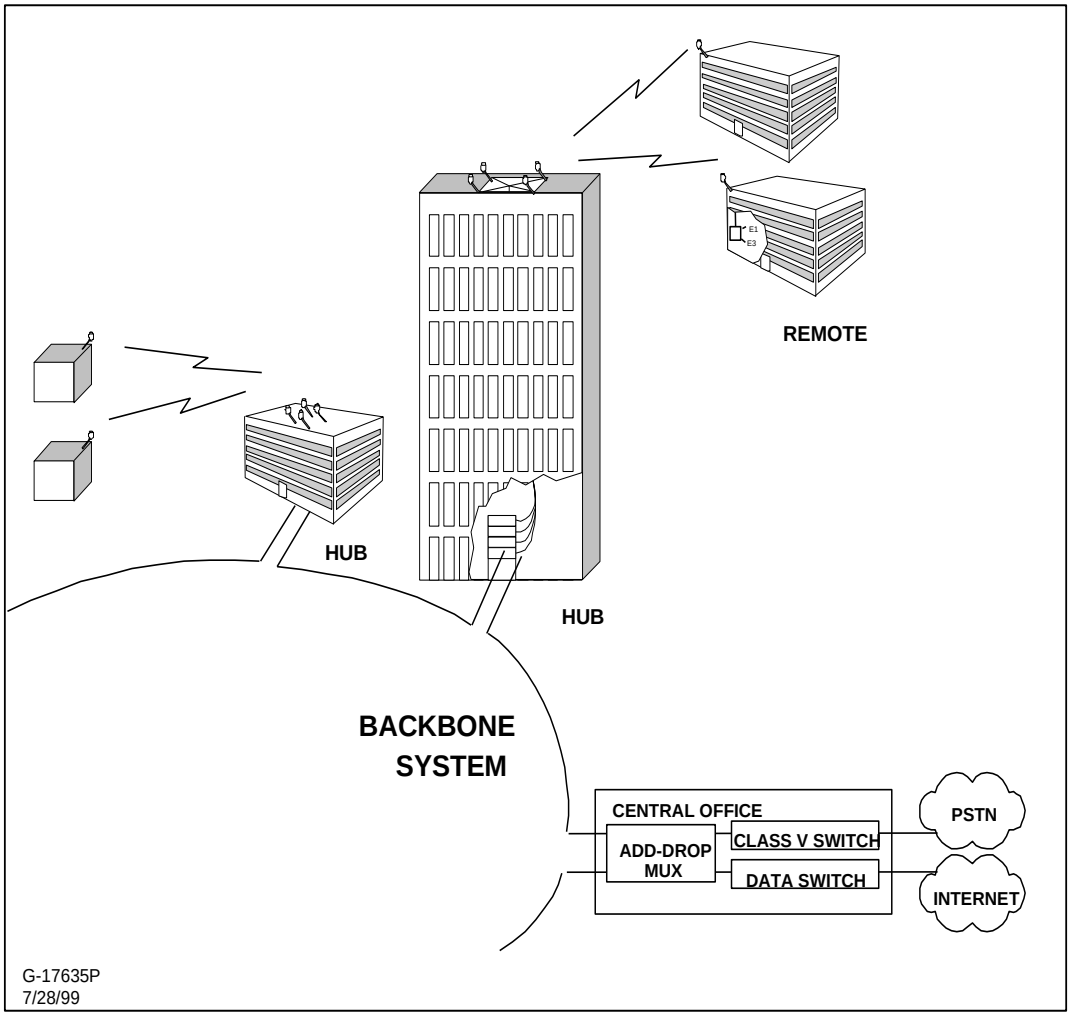
National Central University
&
Hughes Network Systems
LMDS Demo Briefing

November 1999

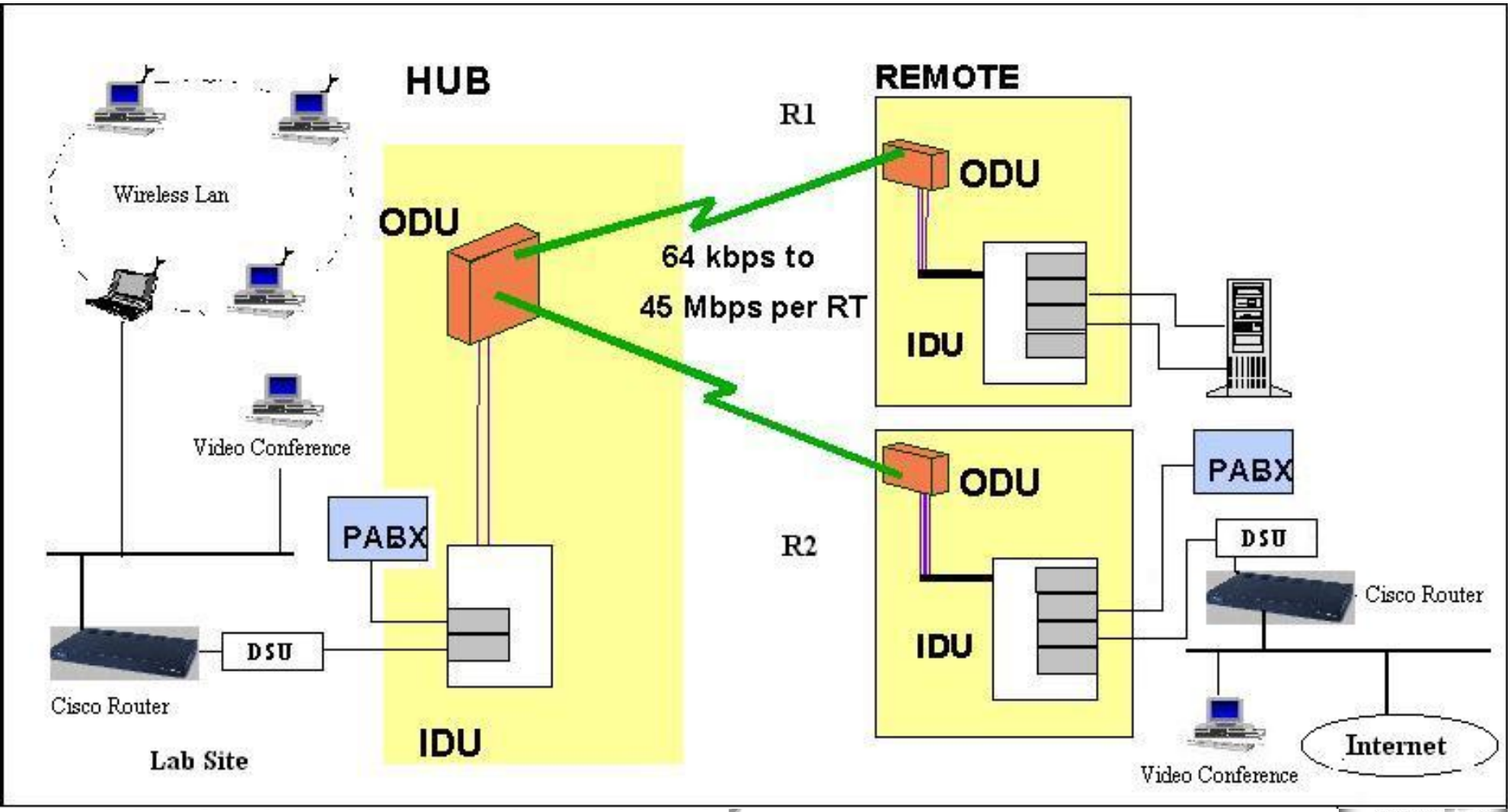
Campus Network



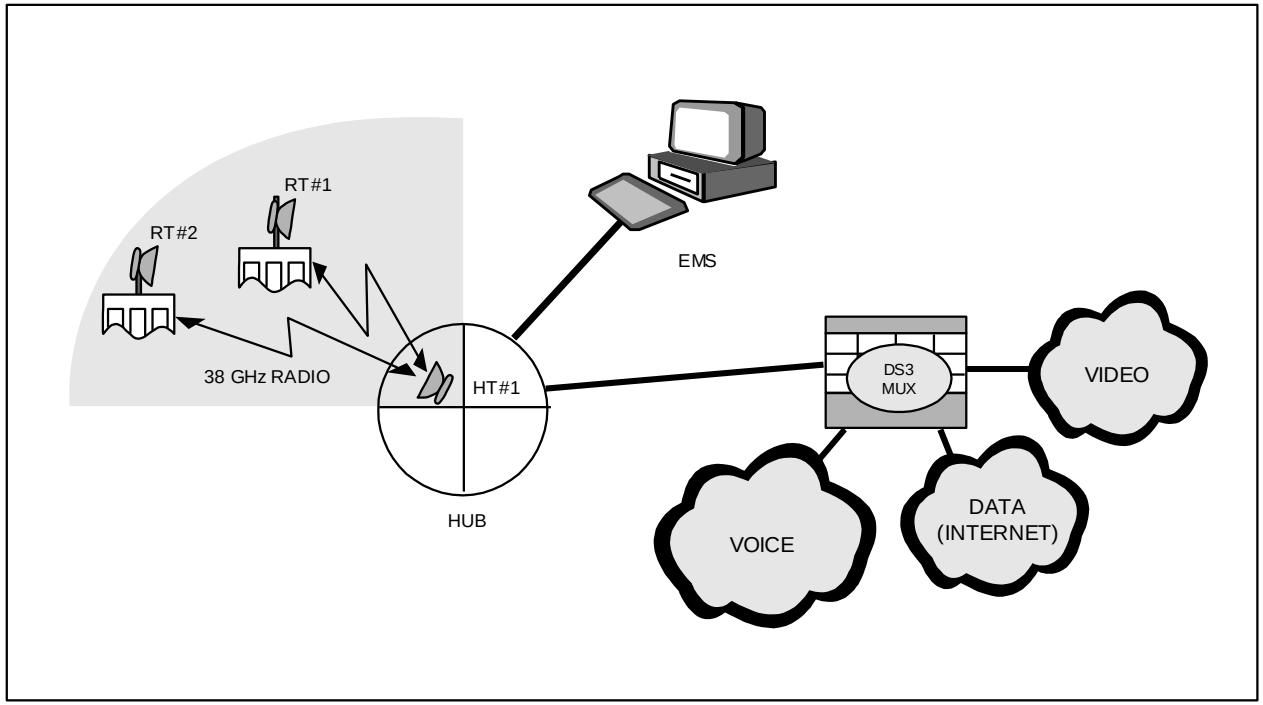
LMDS NCU Test-bench



Architecture of the Demo

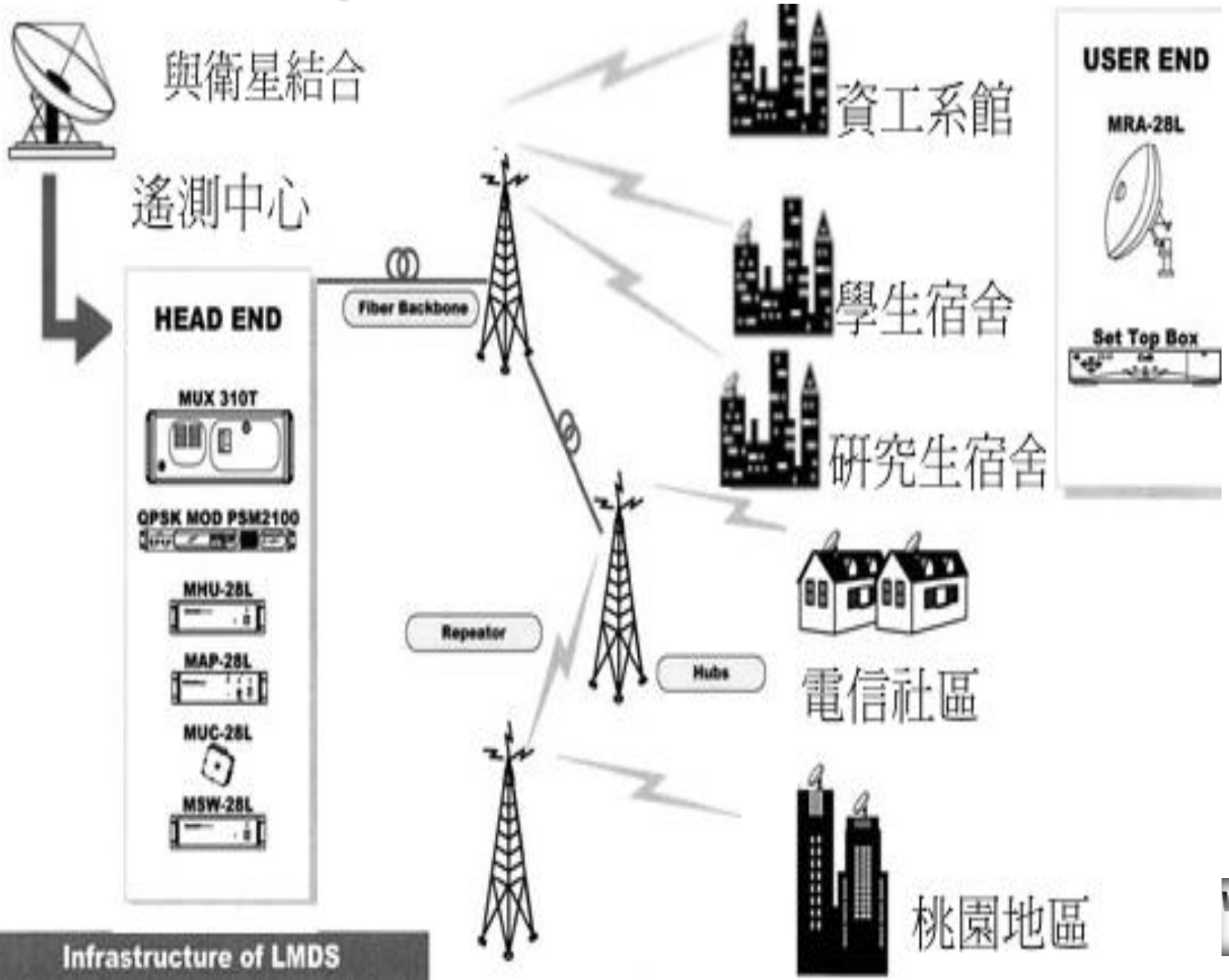


National Central University Demo Layout



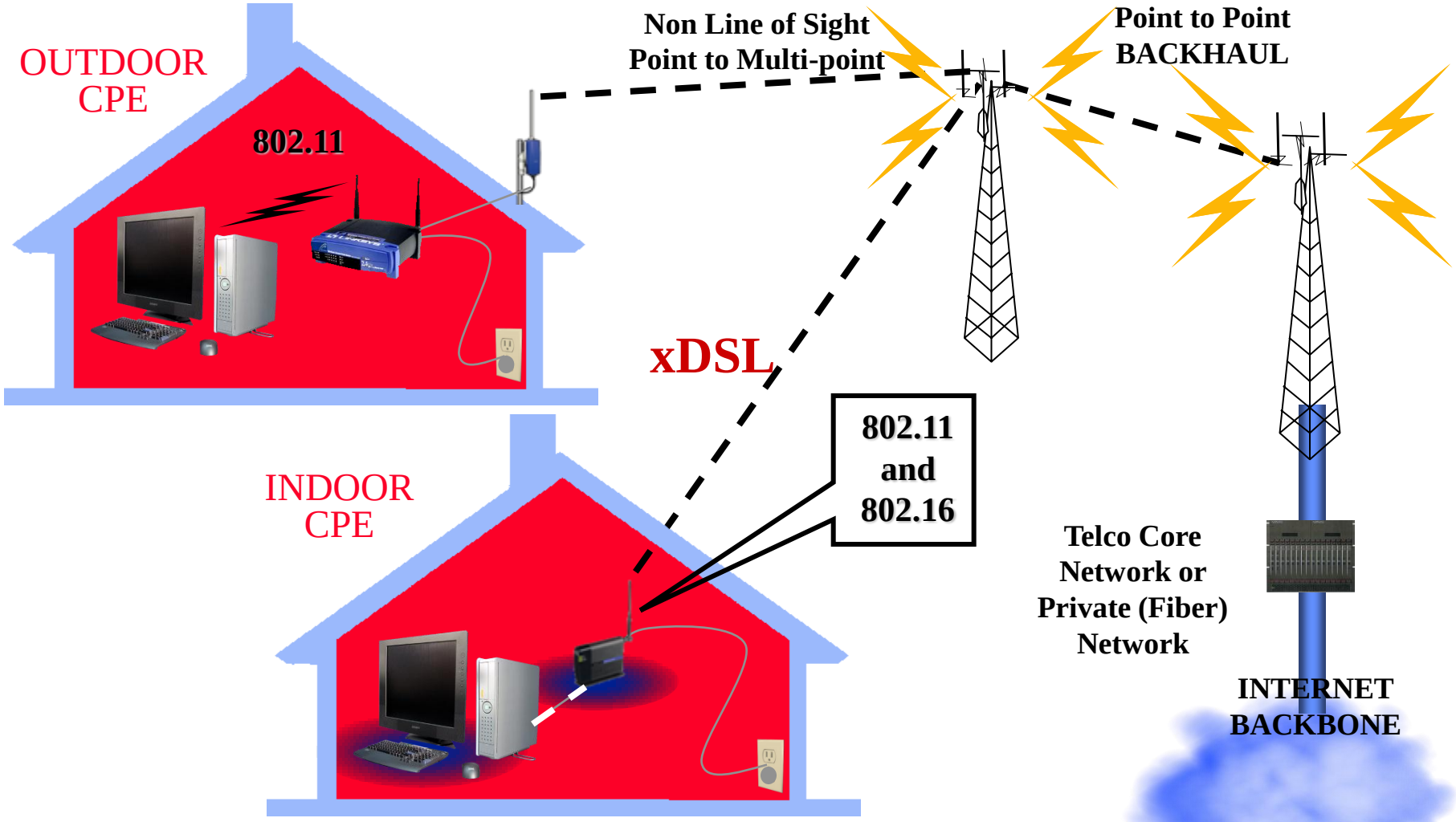
G-17833P 8/19/99

Step.1 LMDS Architecture



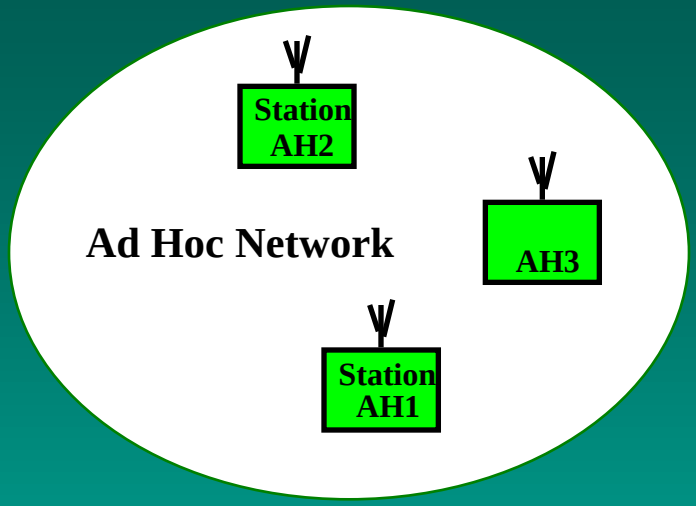
Infrastructure of LMDS

WiMAX Consumer Last Mile



Ref: Margaret LaBrecque , "Enabling Deployments through Standards and Certification," WiMax, 2003

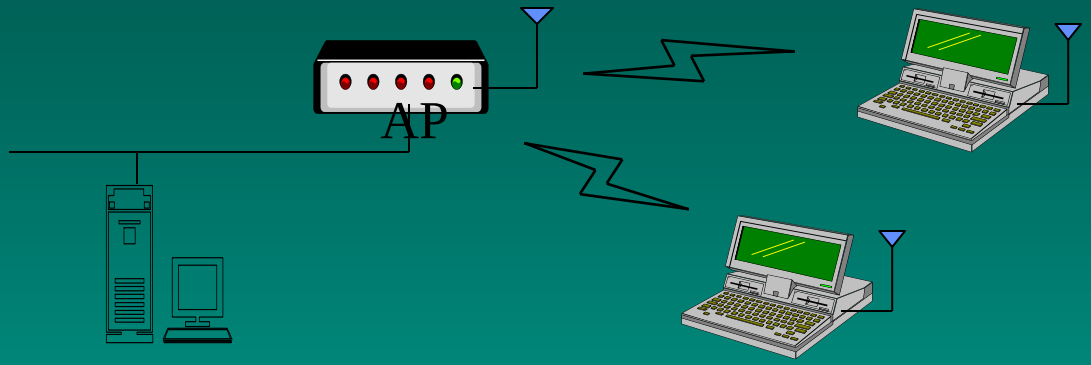
IEEE 802.11 Configurations - Independent



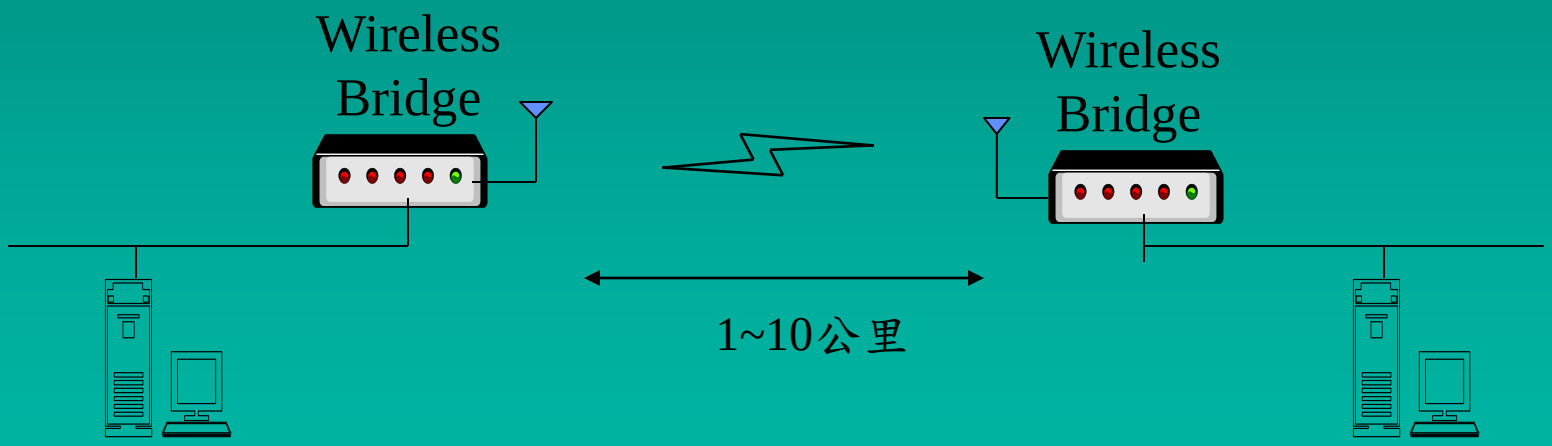
- Independent
  - one Basic Service Set - BSS
  - Ad Hoc network
  - direct communication
  - limited coverage area

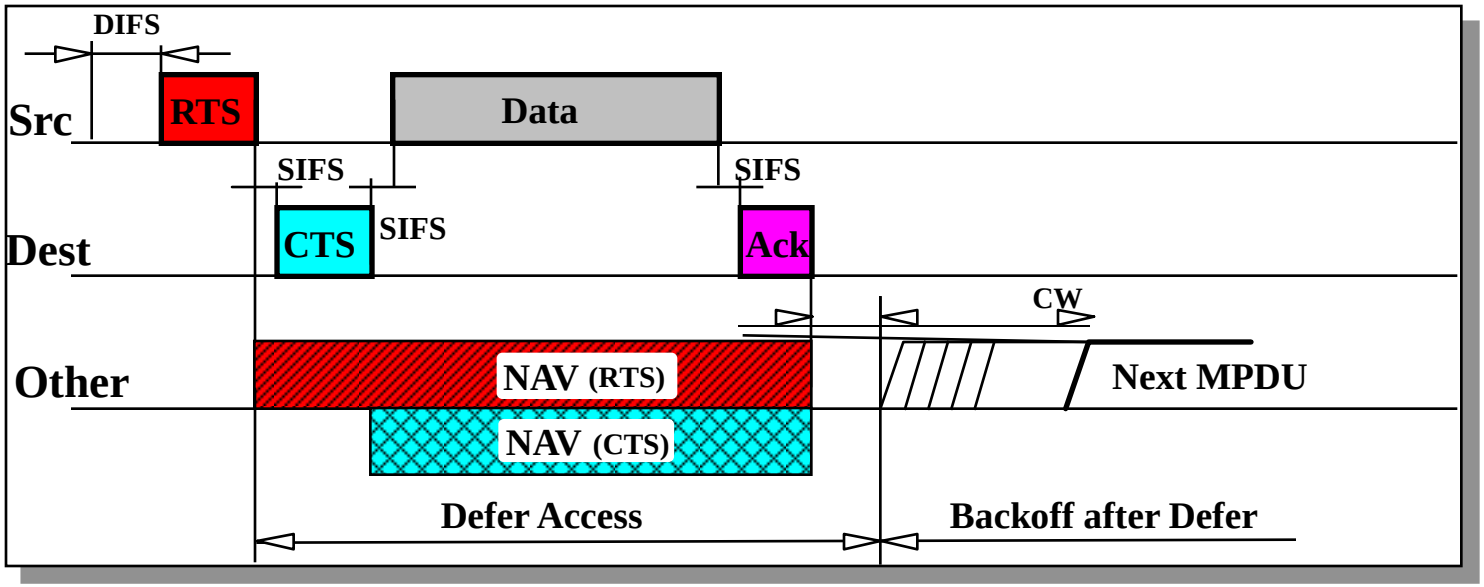
Topology of a Wireless LAN

- 進接(Access)應用: 使用者與網路的連接



- 中繼(Trunk)或骨幹(Backbone)應用: 網路與網路之間的連接. 例如,大樓與大樓之間的通訊, 或是遠方網路的連接.





- ***Duration*** **field in RTS and CTS frames distribute** ***Medium Reservation*** **information which is stored in a** ***Network Allocation Vector (NAV)*****.**
- **Defer on either NAV or "CCA" indicating** ***Medium Busy*****.**
- **Use of RTS / CTS is optional but must be implemented.**

Node Contention & Rate Adaptation

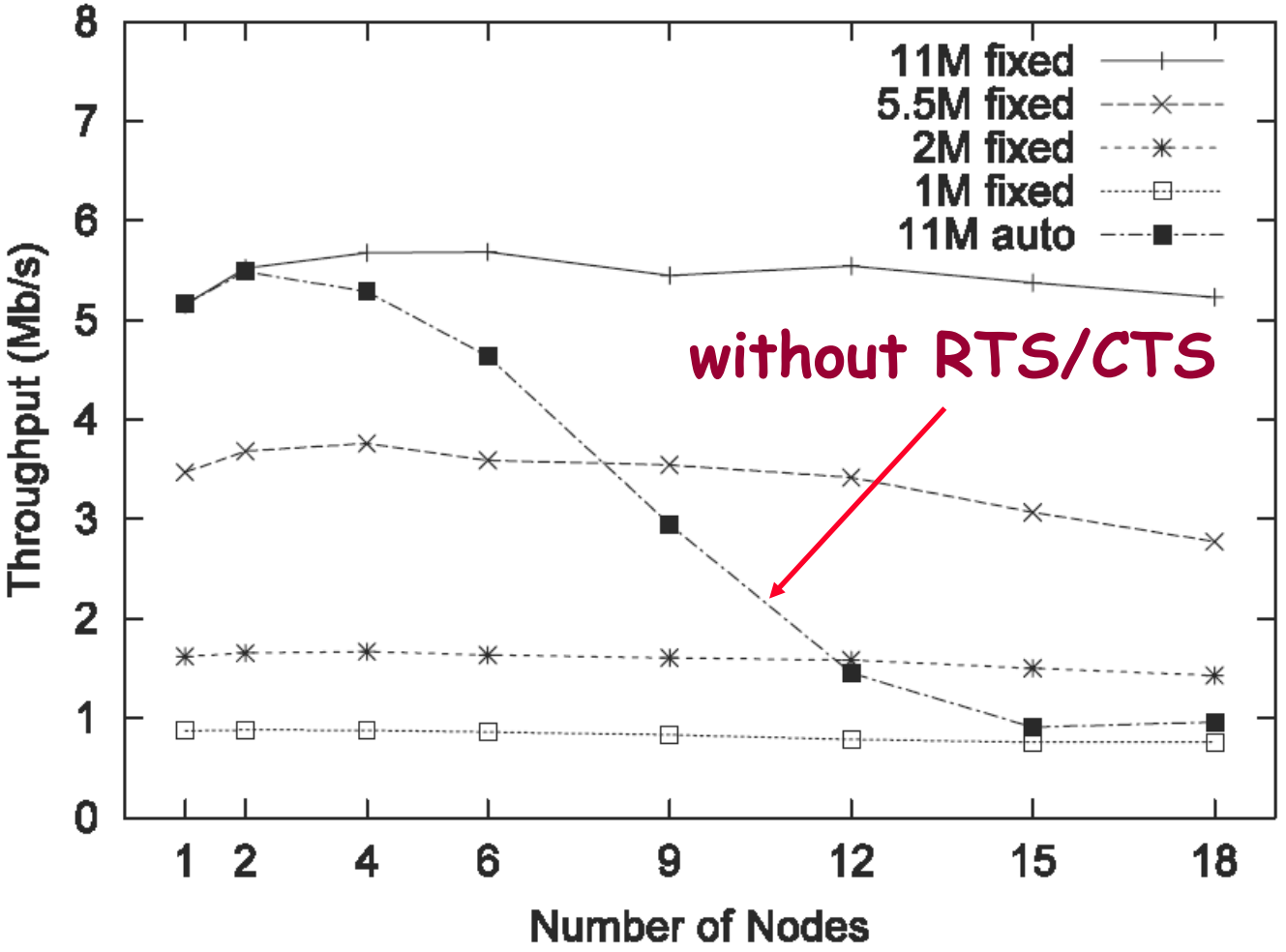
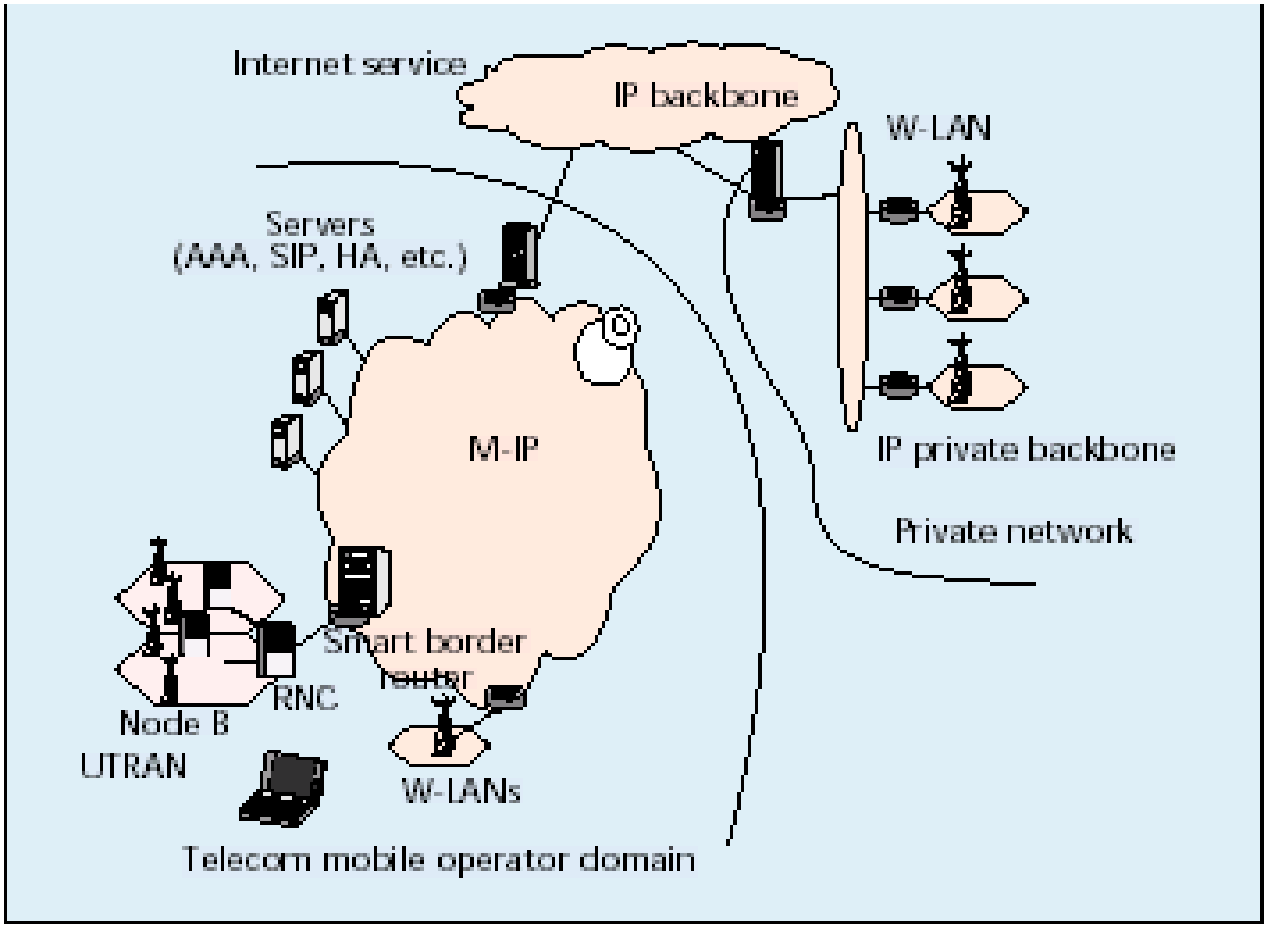


Fig. 7 Throughputs with node contentions.

[Choi, ACM SIGMETRICS'05]

IP integration

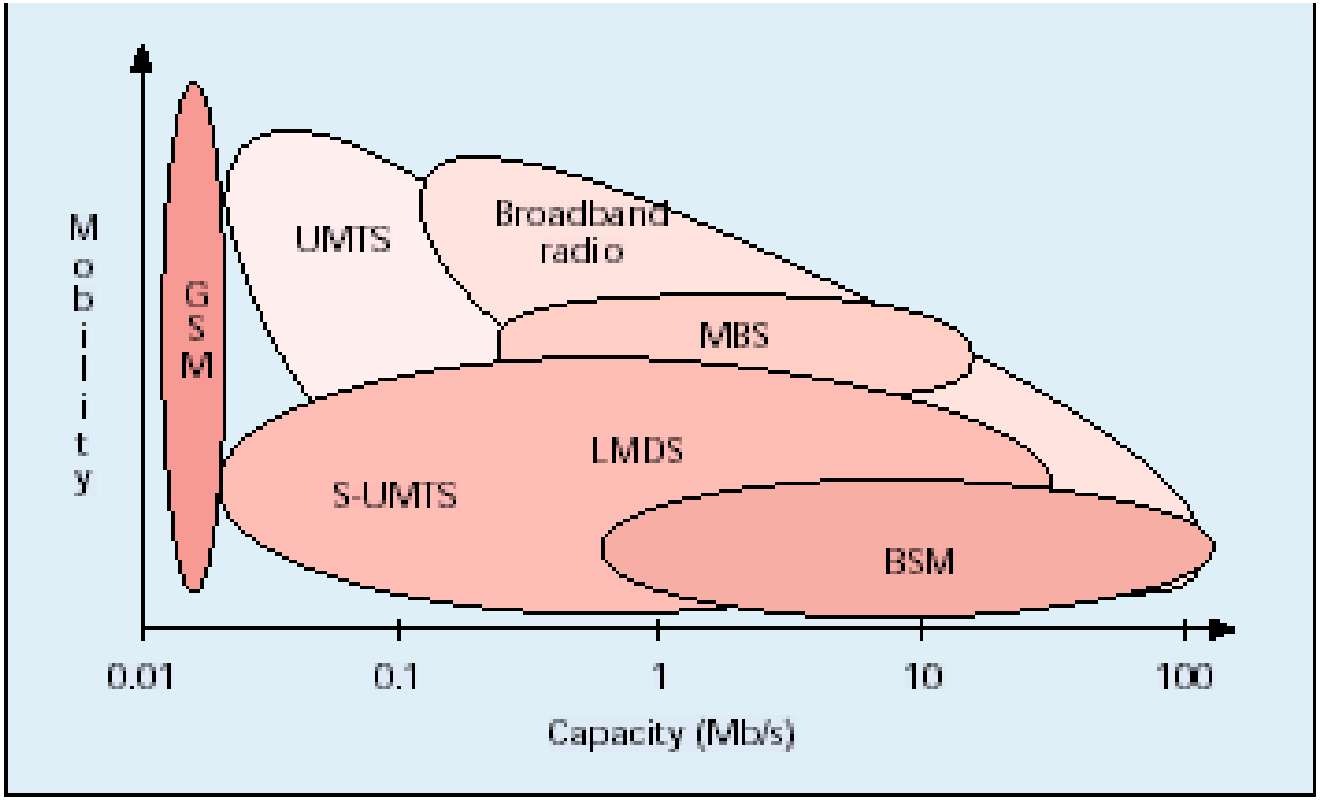


WiMedia Solutions – Simple Usage

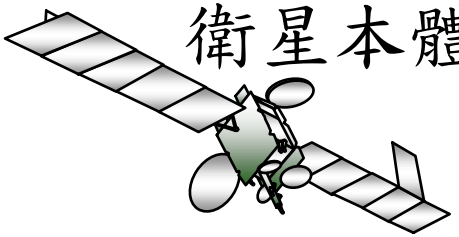
Video Stream (e.g., MPEG2)

Discovery, Channel Management
and other Control Signaling

Capacity and Mobility



地球村的建立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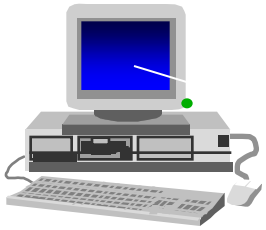

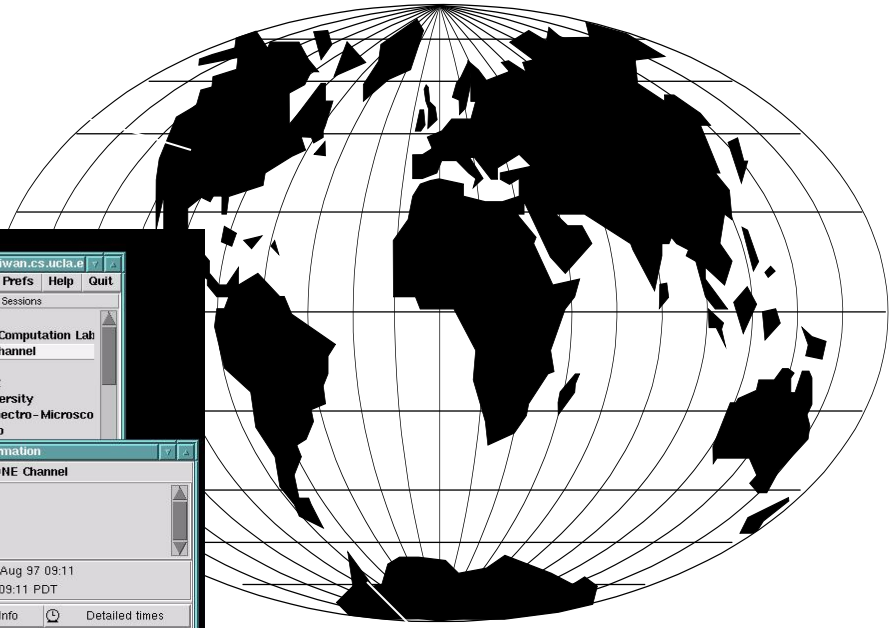

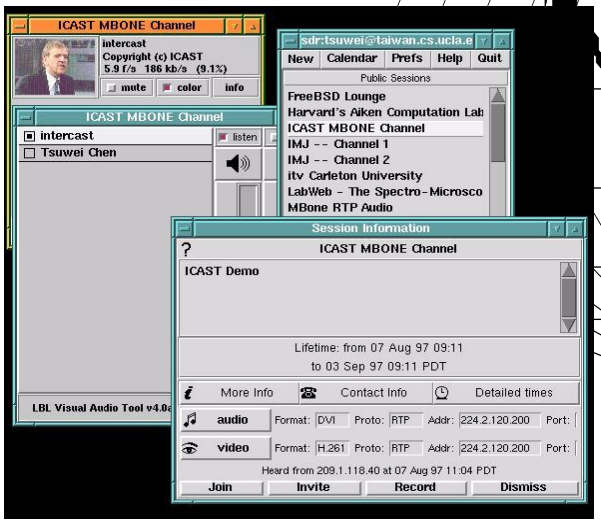
ICAST MBONE Channel
intercast
Copyright (c) ICAST
5.9 f/s 186 kb/s (9.1%)
mute
color
info
ICAST MBONE Channel
intercast
Tsuwei Chen
listen
LBL Visual Audio Tool v4.0a
sdr:tsuwei@taiwan.cs.ucla.e
New
Calendar
Prefs
Help
Quit
Public Sessions
FreeBSD Lounge
Harvard's Aiken Computation Lab
ICAST MBONE Channel
IMJ -- Channel 1
IMJ -- Channel 2
itv Carleton University
LabWeb - The Spectro-Microsco
MBone RTP Audio
Session Information
ICAST MBONE Channel
ICAST Demo
Lifetime: from 07 Aug 97 09:11
to 03 Sep 97 09:11 PDT
More Info
Contact Info
Detailed times
audio
Format: DVI
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Addr: 224.2.120.200
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video
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Port:
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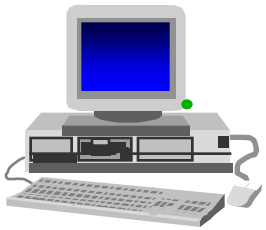
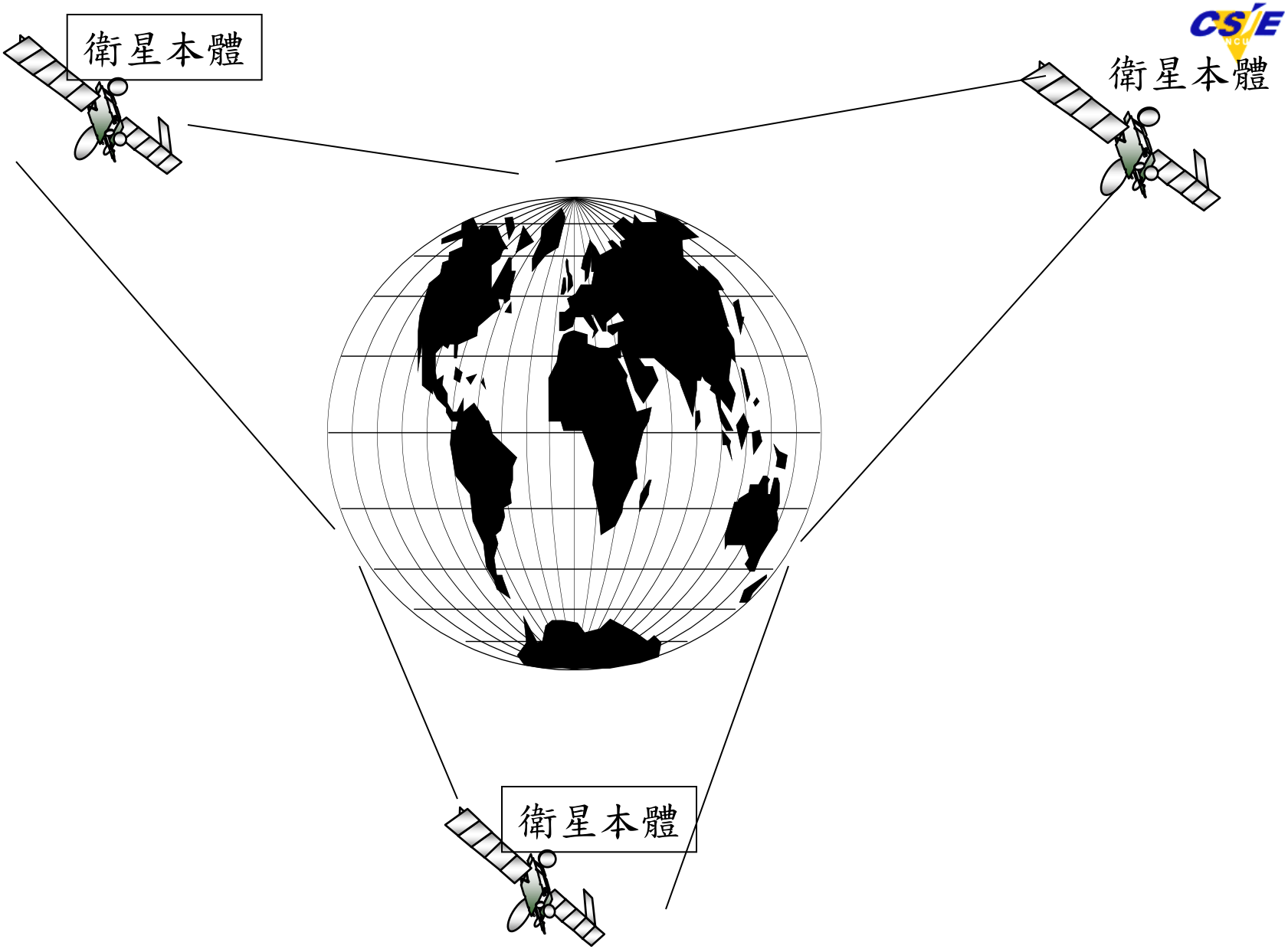
Join
Invite
Record
Dismiss

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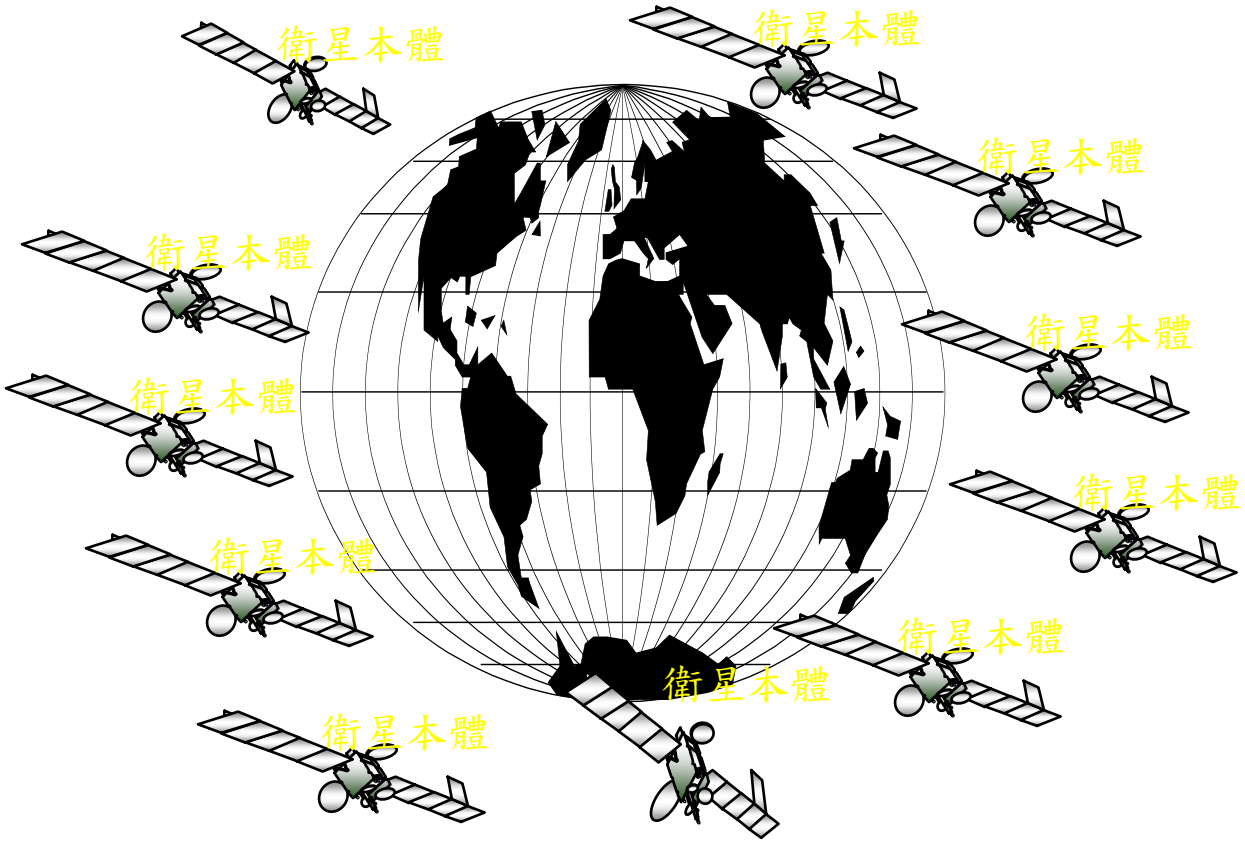
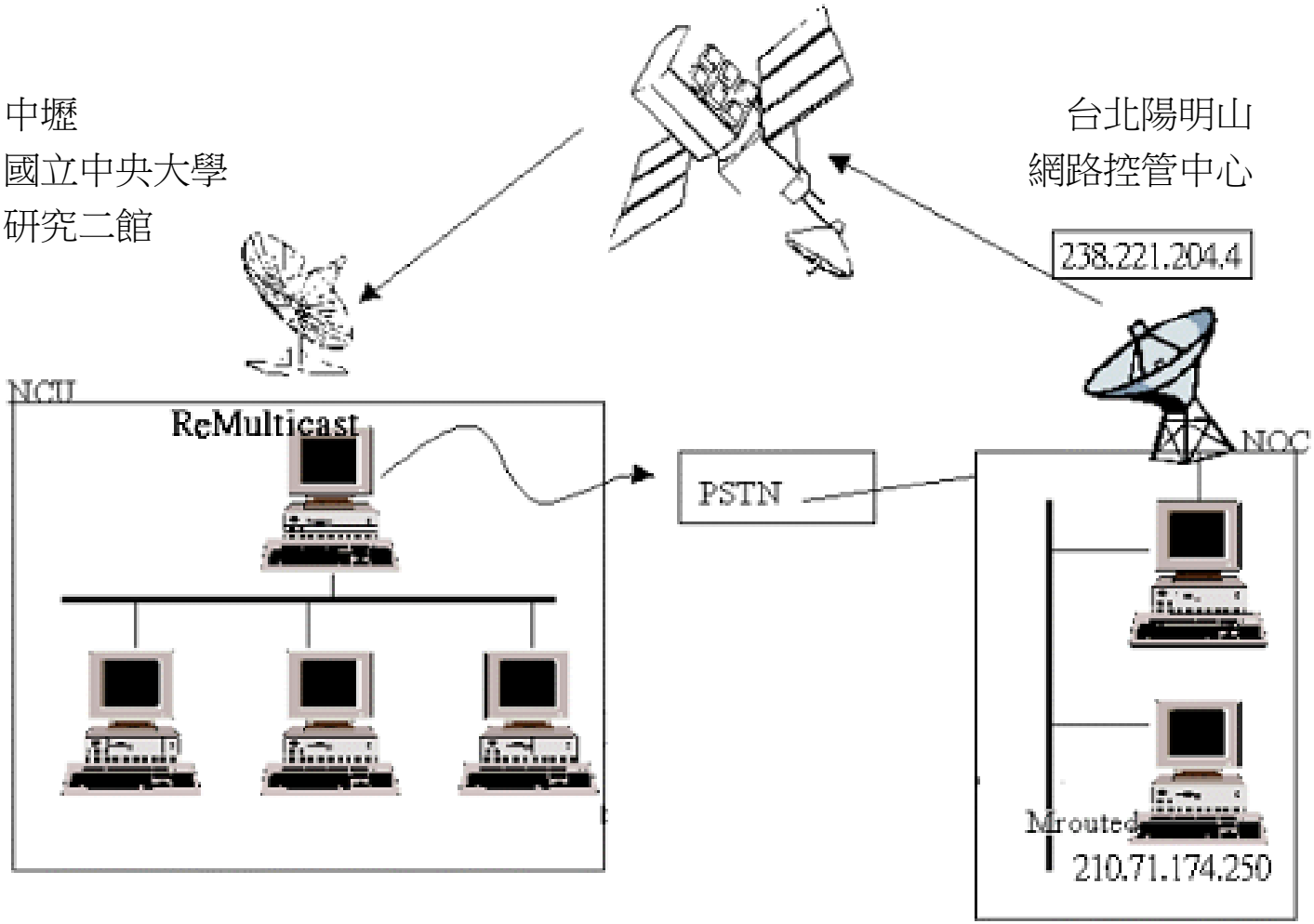
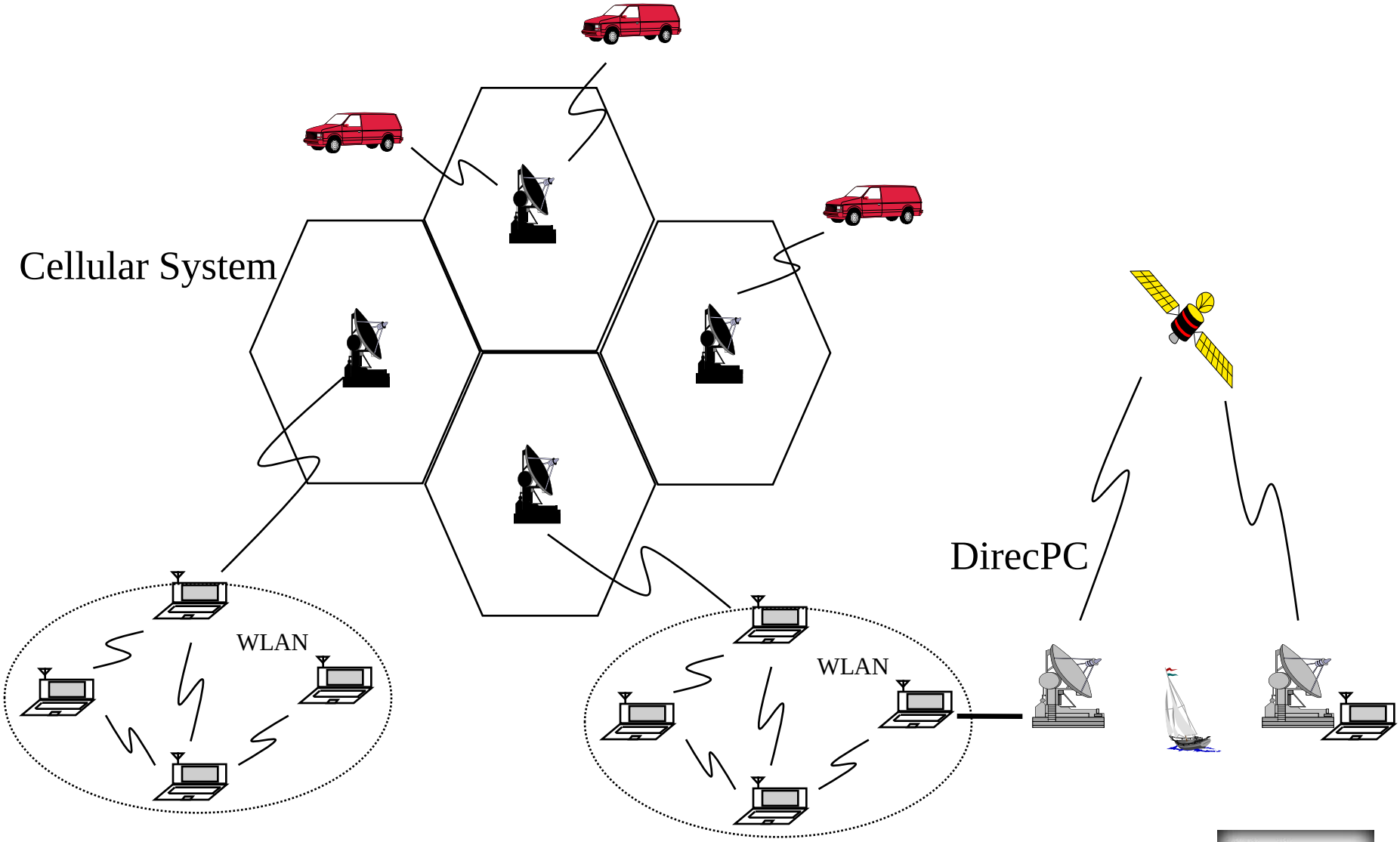
Sky of Satellites



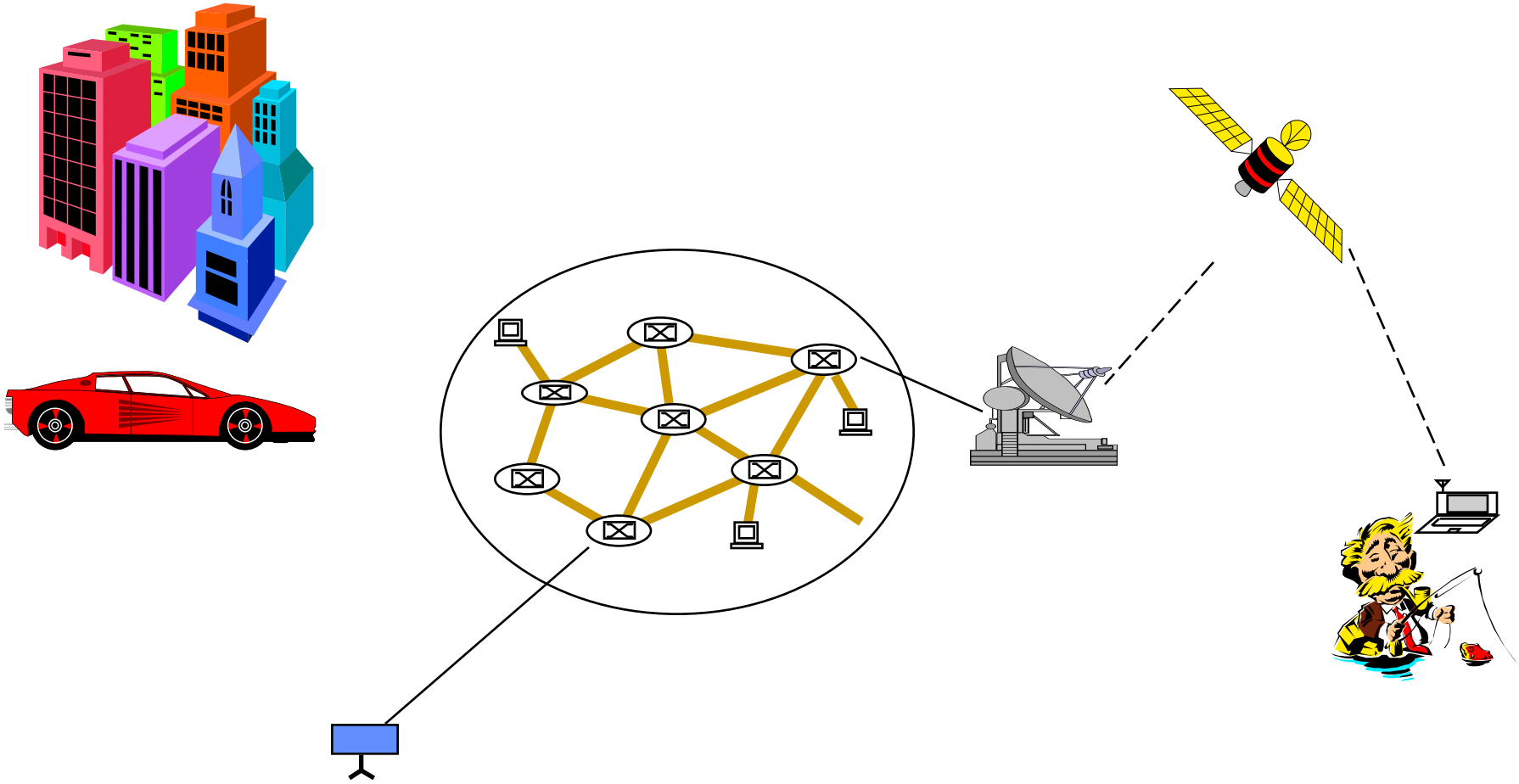
DirecPC Satellite Experiments



Ubiquitous Access

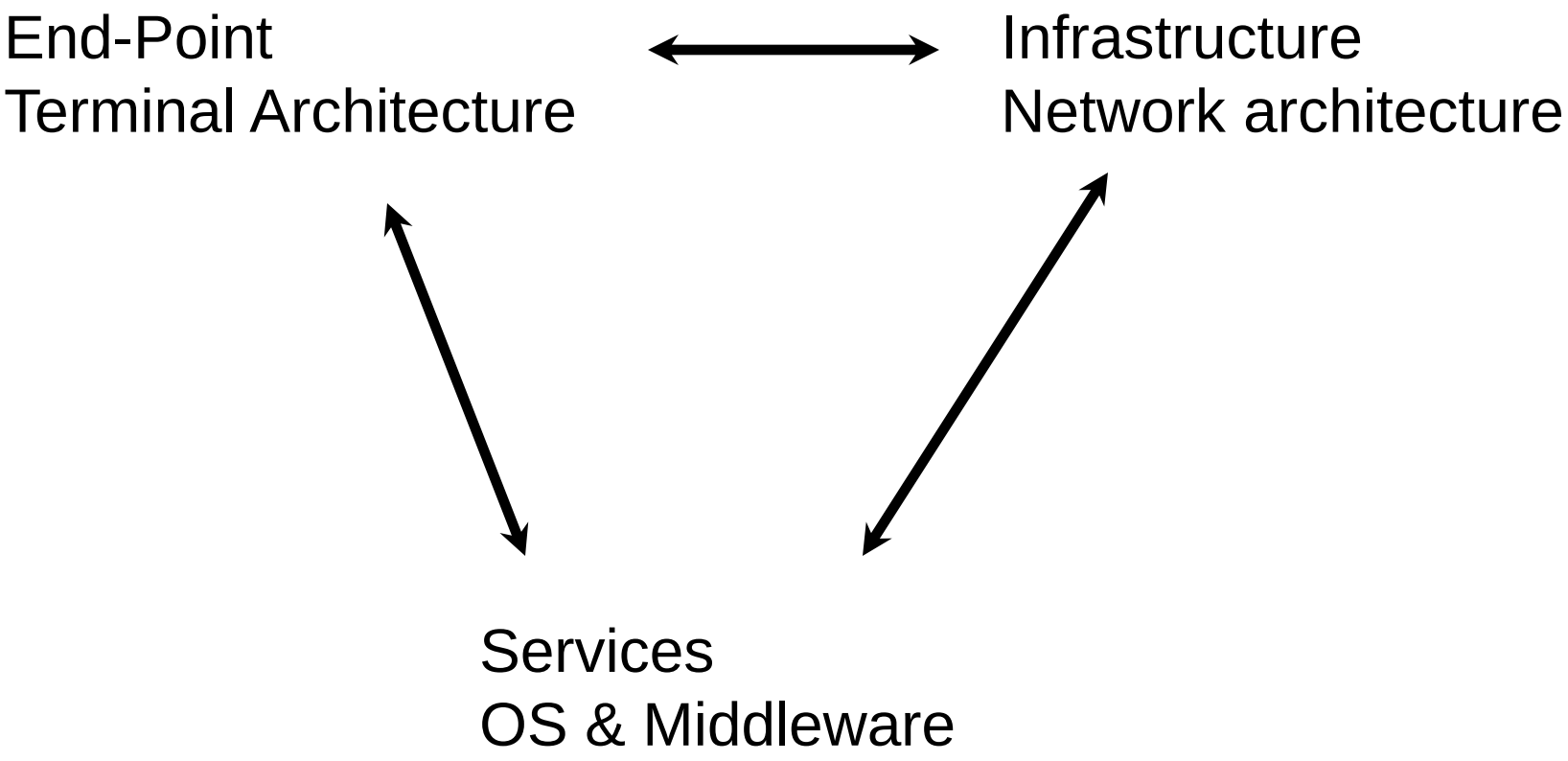


“Anytime Anywhere ” Information System



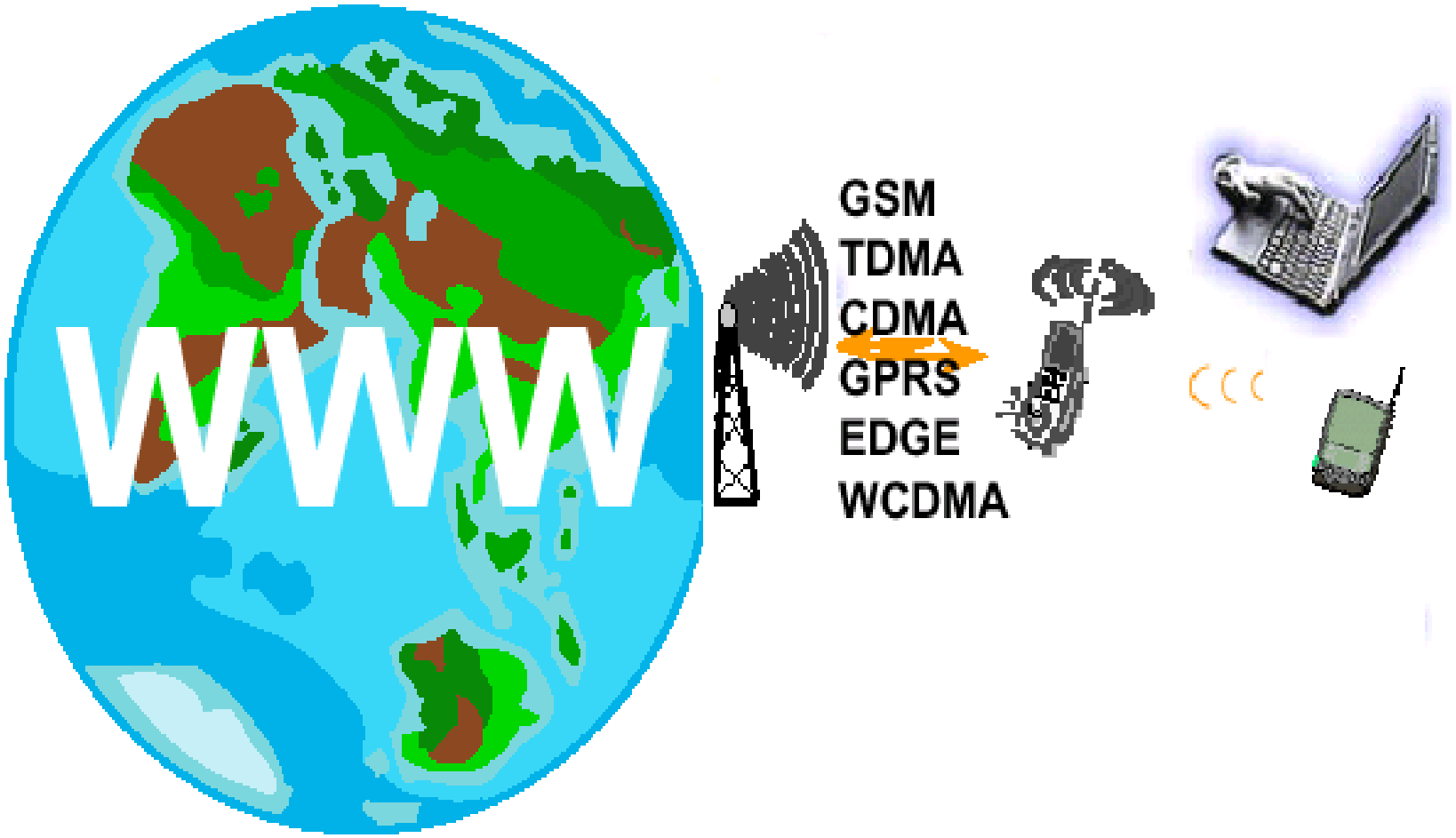
Fundamental Issues

Three System Components

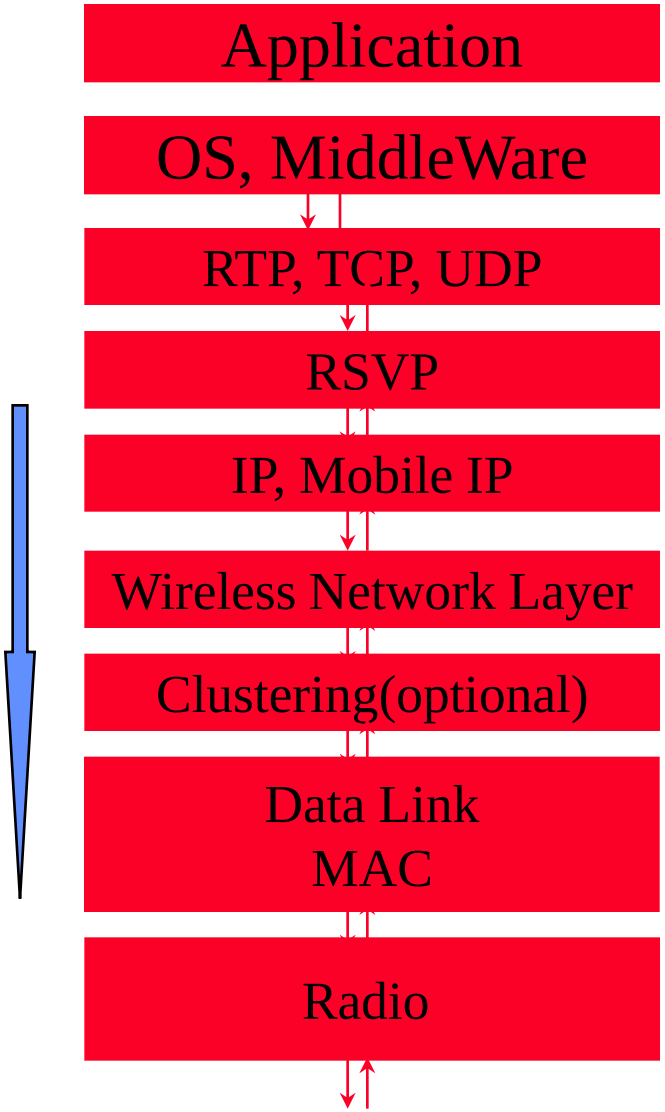


Personal area network

Connect devices to internet on the mobile infrastructure world wide



QoS and Multimedia Traffic Support



Adaptive Algorithm

by QoS Requirement

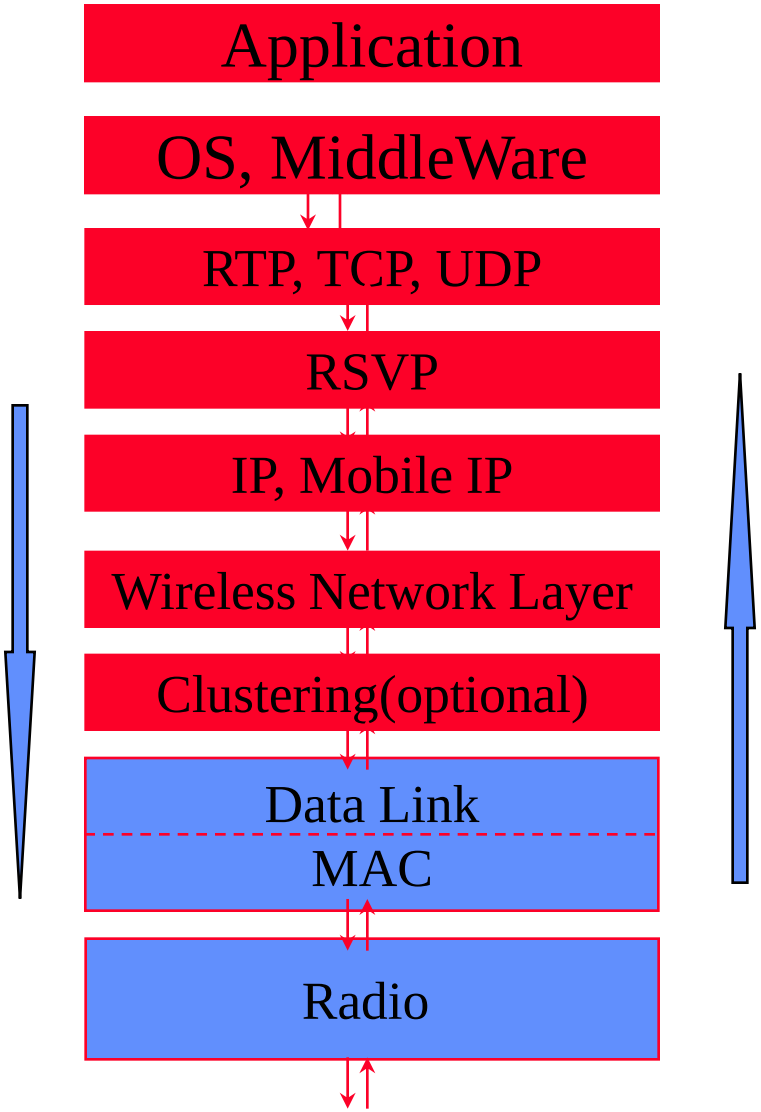
Mobility Unpredictable channel

by QoS Information

QoS and Multimedia Traffic Support

Adaptive Algorithm

by QoS Requirement



Mobility Unpredictable channel

by QoS Information

Channel Propagation and Fading

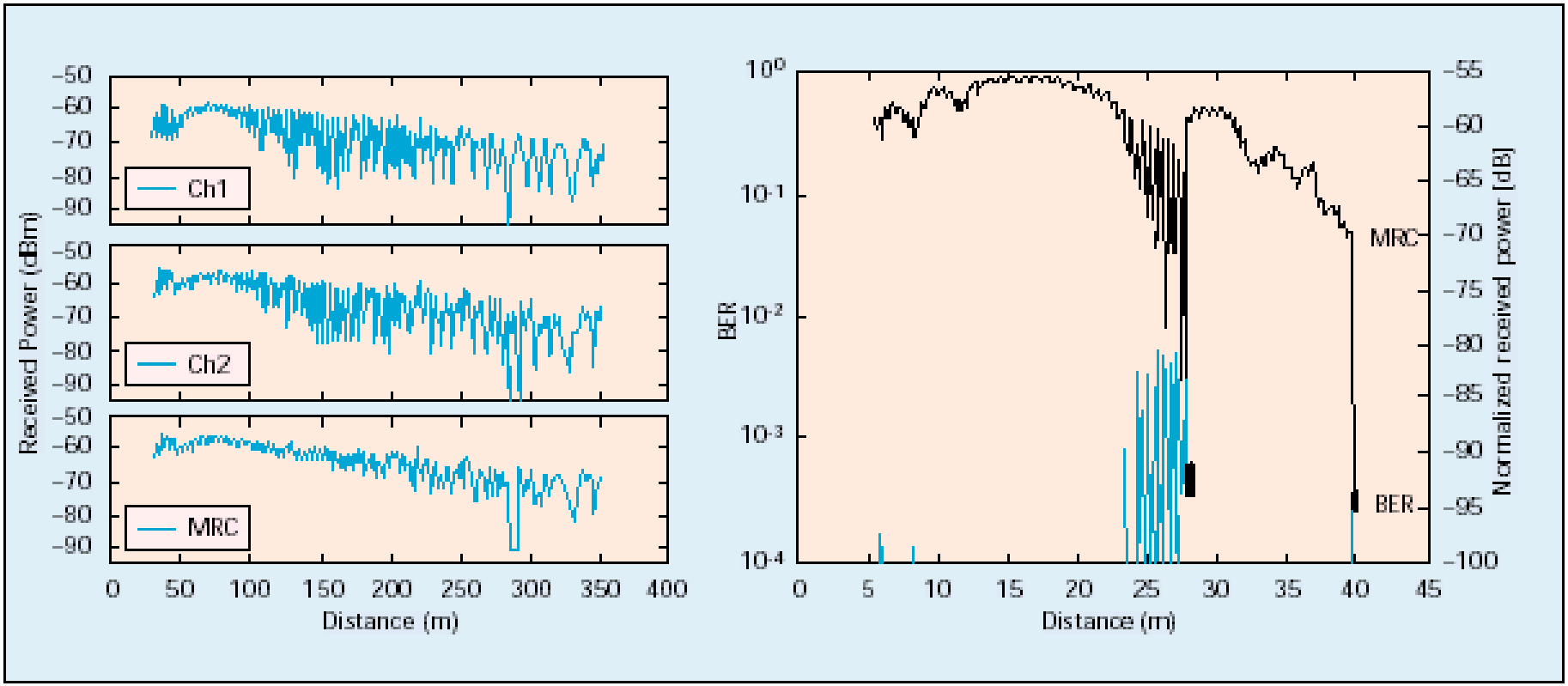
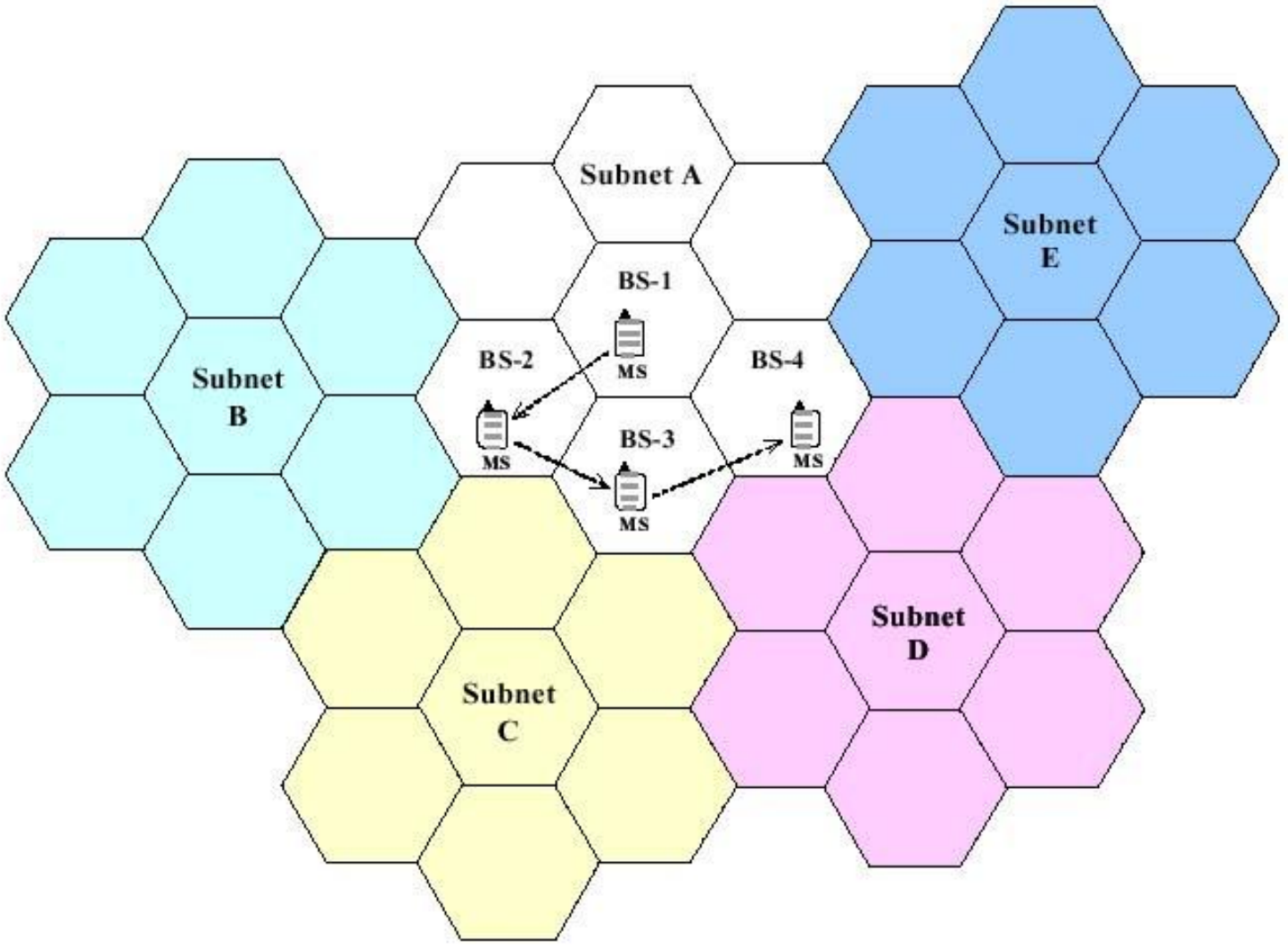


Figure 4. *Received power as a function of distance: in a street (left), in a pavilion (right); BER and handover (right).*

Intra-Domain Handoff

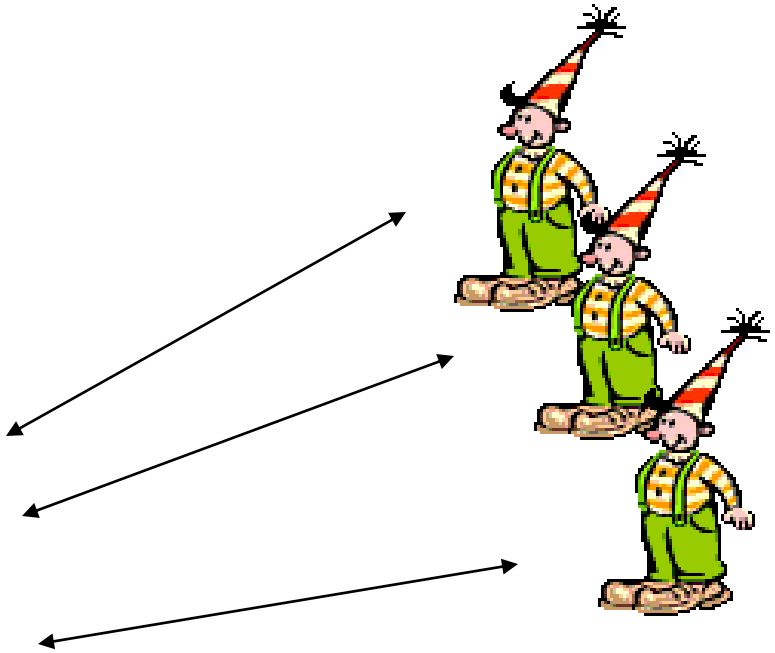


Resource Sharing

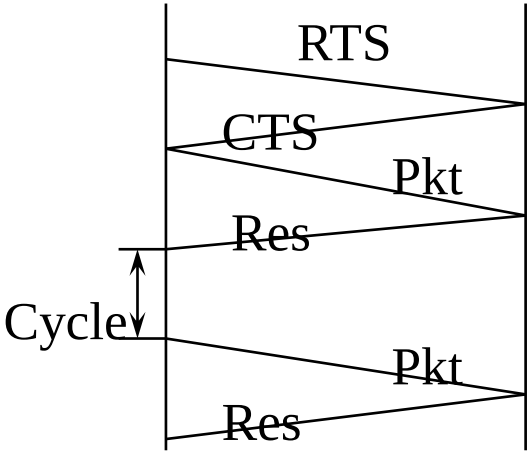
- Reservation Approaches
  - Centralized Control
  - token (round robin)
- Collision Approaches
  - fight for resource
  - distributed control

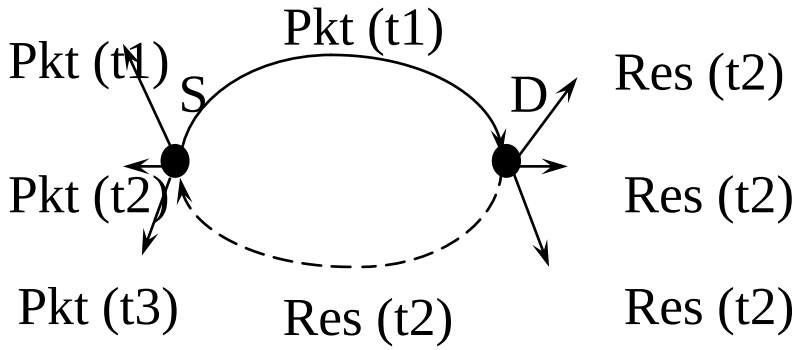
Through A Centralized Control

- TDMA, FDMA, CDMA

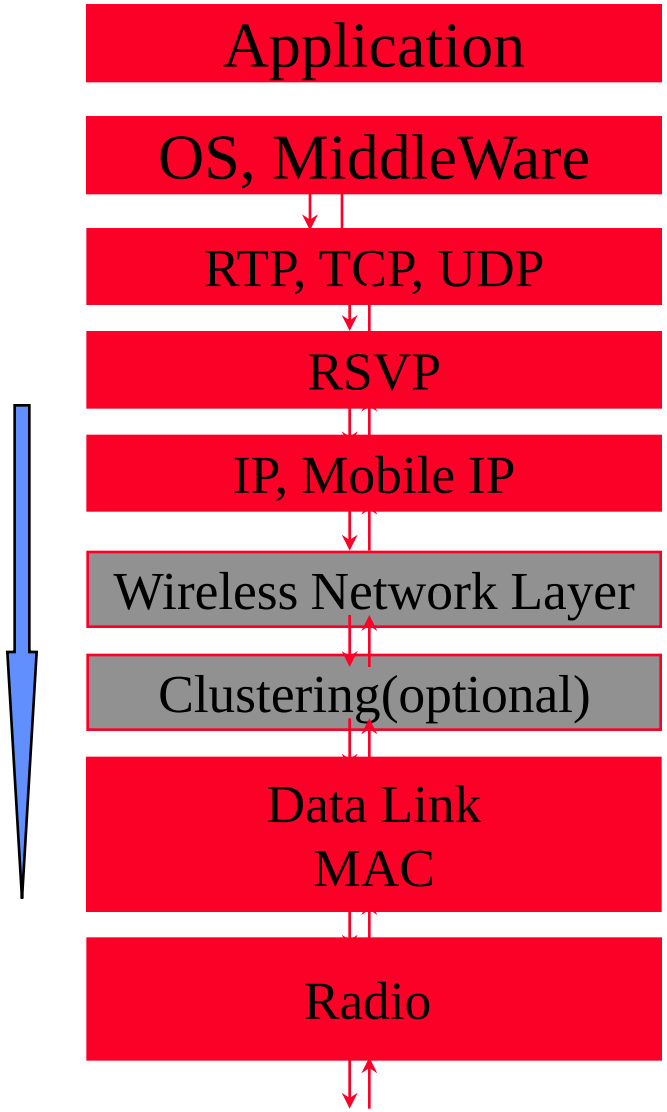


MACA/PR


RTS
CTS
Pkt
Res
Cycle
Pkt
Res


Pkt (t1)
Pkt (t1)
S
D
Res (t2)
Pkt (t2)
Res (t2)
Pkt (t3)
Res (t2)
Res (t2)

QoS and Multimedia Traffic Support



Adaptive Algorithm

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Mobility Unpredictable channel

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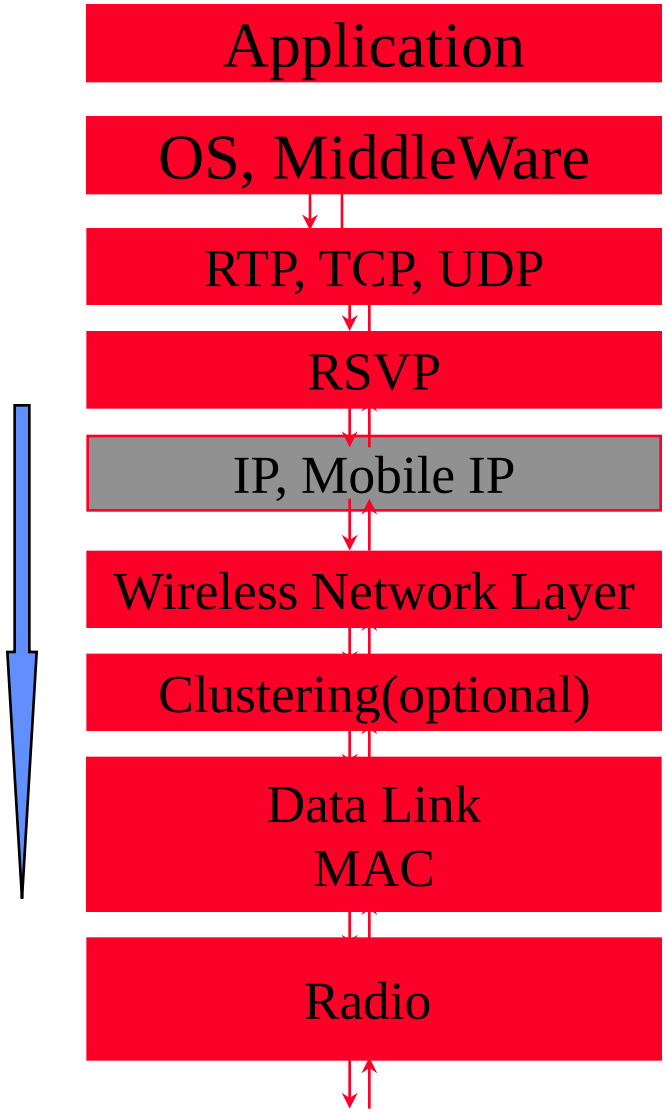
QoS and Multimedia Traffic Support



Adaptive Algorithm

by QoS Requirement

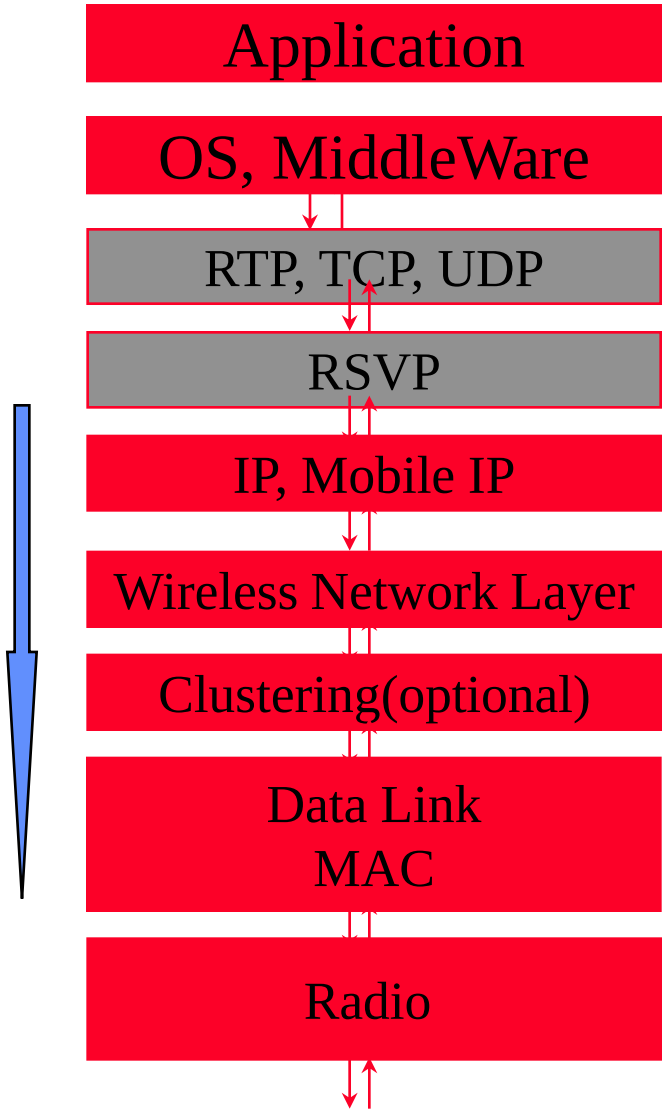
Mobility Unpredictable channel

by QoS Information

Internetworking, IP, Mobile

- Internetworking
  - roaming through different networks
  - supporting IP format
  - supporting IP portability

QoS and Multimedia Traffic Support



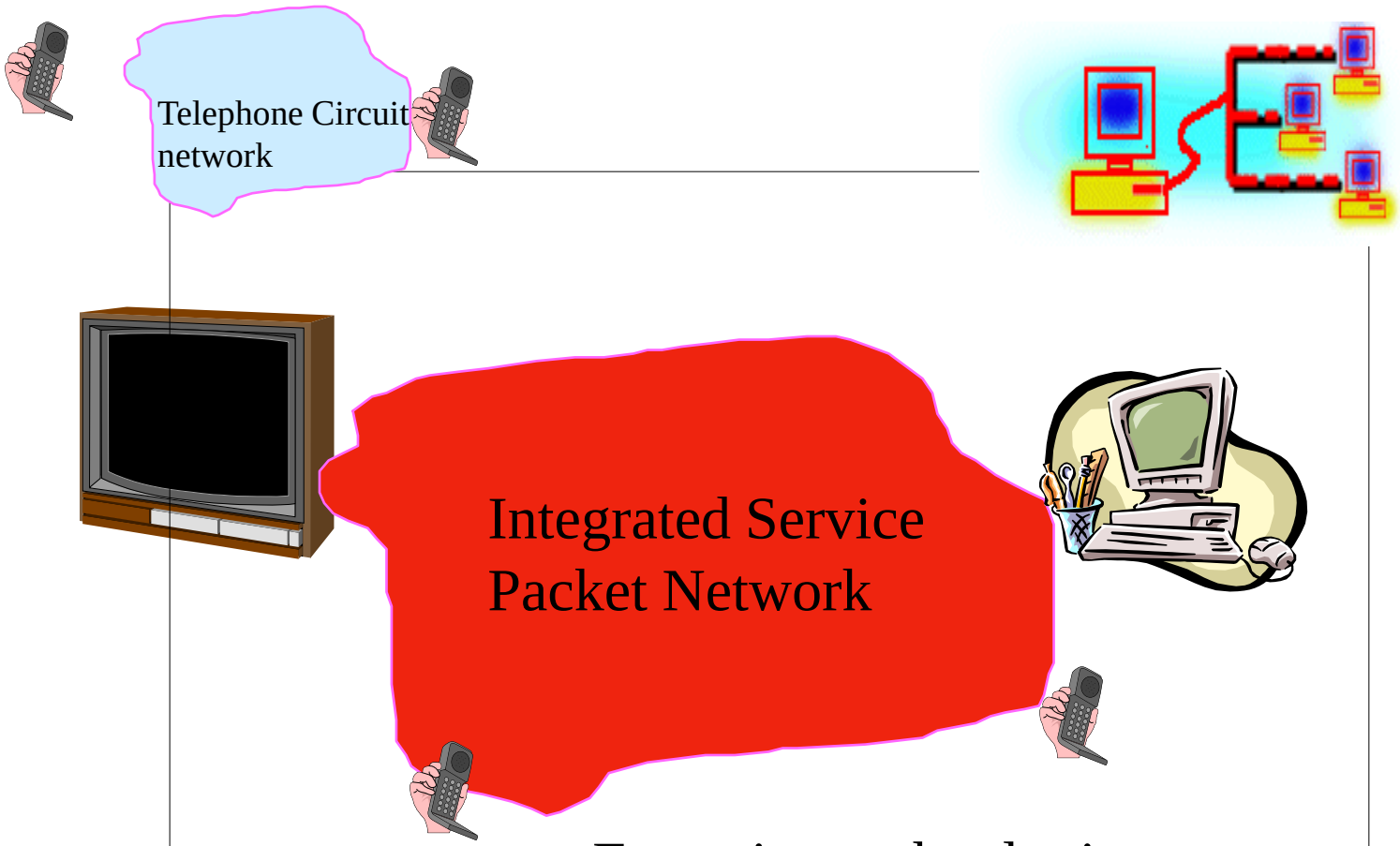
Adaptive Algorithm

by QoS Requirement

Mobility Unpredictable channel

by QoS Information

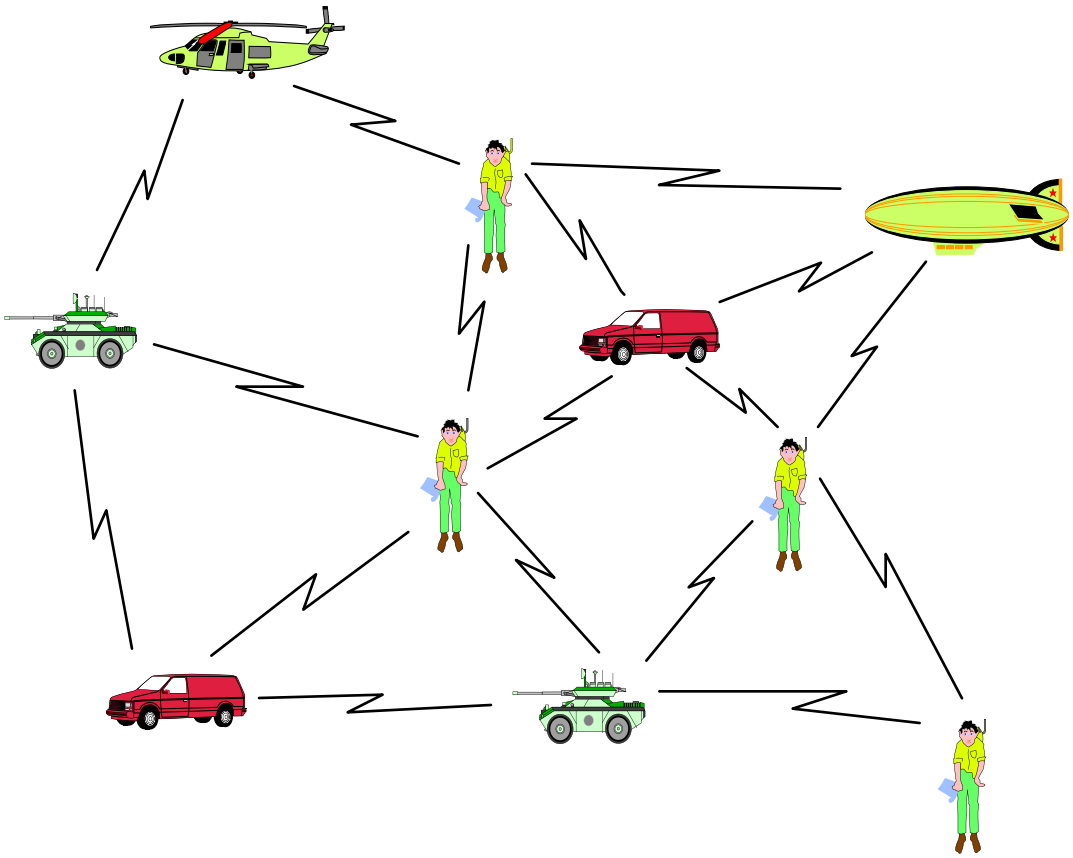
What problem does Multimedia Bring?



Emerging technologies:

1. “Datagrams” + “Flows” IPv6
2. “Virtual Circuits” (ATM)

Ad Hoc Wireless Network



Tight and Loose Internetworking

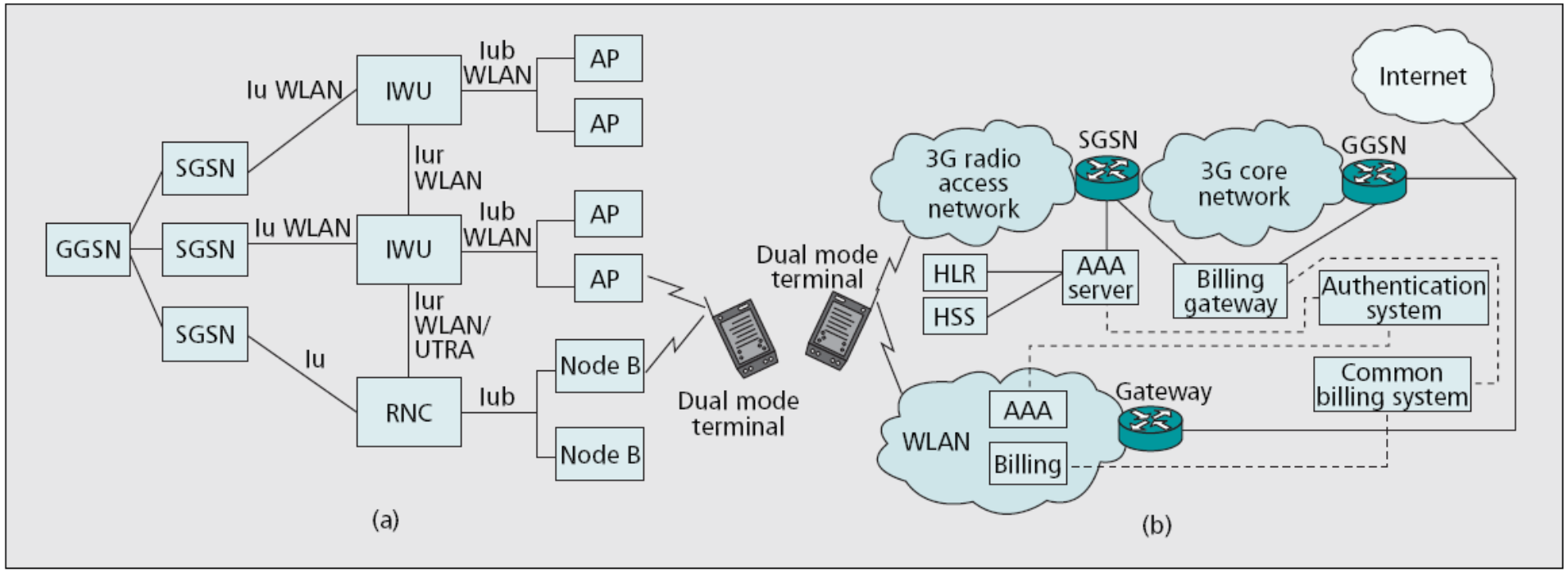


Figure 1. *a) Tight and b) loose interworking architecture of 3G /WLAN networks.*

Limited & Variable Bandwidth

- Low bandwidth compared to wired
- Highly variable bandwidth
- High latency

Wireless Communication

- More difficult than wired communication
- Dis-connections

Mobility

- Address migration
- Location-dependent information
- Migration locality

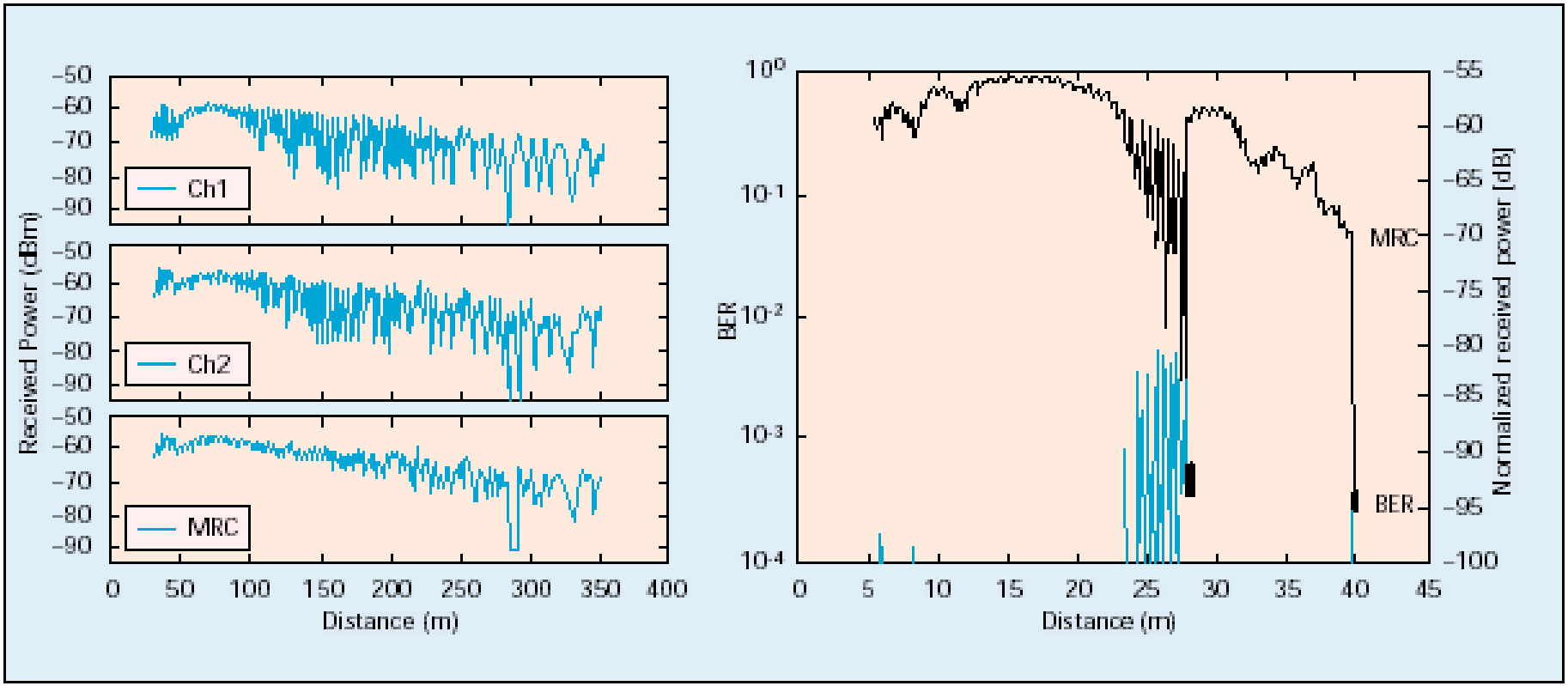
Portability

- Light weight power
- Risks to data
- Small user interface
- Small storage capacity

Challenges in Mobile Multimedia Infor-System

- Portable end-points
- End-to-end Quality of Services
- Seamless operation under context (location) changes
- Context-aware operation
- Secure operation

Channel Propagation and Fading



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