16장. 네트워크 응용 기술과 차세대 네트워크

16-0 이동통신의 과거
Cellular Mobile Telephony

- Frequency modulation
- Antenna diversity
- Cellular concept
  - Bell Labs (1957 & 1960)
- Frequency reuse
  - typically every 7 cells
- Handoff as caller moves
- Sectors improve reuse
  - every 3 cells possible
First Generation

- Advanced Mobile Phone Service (AMPS)
  - US trials 1978; deployed in Japan (’79) & US (’83)
  - 800 MHz band – two 20 MHz bands
  - TIA-553

- Nordic Mobile Telephony (NMT)
  - Sweden, Norway, Demark & Finland
  - Launched 1981
  - 450 MHz; later at 900 MHz (NMT900)

- Total Access Communications System (TACS)
  - British design; similar to AMPS; deployed 1985
Second Generation – 2G

- Digital systems
- Leverage technology to increase capacity
  - Speech compression; digital signal processing
- Utilize/extend “Intelligent Network” concepts
- Improve fraud prevention
- Add new services
- There are a wide diversity of 2G systems
  - IS-54/ IS-136 North American TDMA; PDC (Japan)
  - iDEN
  - DECT and PHS
  - IS-95 CDMA (cdmaOne)
  - GSM
GSM

« Groupe Special Mobile », later changed to « Global System for Mobile »
- joint European effort beginning in 1982
- focus on seamless roaming across Europe

Services launched 1991
- time division multiple access (8 users per 200KHz)
- 900 MHz band; later extended to 1800MHz
- added 1900 MHz (US PCS bands)

GSM is dominant world standard today
- well defined interfaces; many competitors
- network effect (Metcalfes law) took hold in late 1990s
- tri-band GSM phone can roam the world today
Distribution of GSM Subscribers

- GSM is used by 70% of subscribers worldwide
  - 564 M subs / 800 M subs in July 2001
- Most GSM deployments in Europe (59%) and Asia (33%)
  - ATT & Cingular deploying GSM in US today

Number of subscribers in the world (Jul 2001)

- GSM 71%
- US TDMA 10%
- CDMA 12%
- PDC 7%

Source: EMC World Cellular / GSM Association
1G – Separate Frequencies

FDMA - Frequency Division Multiple Access

Frequency

30 KHz
30 KHz
30 KHz
30 KHz
30 KHz
30 KHz
30 KHz
30 KHz
30 KHz
2G – TDMA –
Time Division Multiple Access

One timeslot = 0.577 ms
One TDMA frame = 8 timeslots
2G & 3G – CDMA – Code Division Multiple Access

- Spread spectrum modulation
  - originally developed for the military
  - resists jamming and many kinds of interference
  - coded modulation hidden from those w/o the code

- All users share same (large) block of spectrum
  - one for one frequency reuse
  - soft handoffs possible

- Almost all accepted 3G radio standards are based on CDMA
  - CDMA2000, W-CDMA and TD-SCDMA
Multi-Access Radio Techniques

Courtesy of Petri Possi, UMTS World
Courtesy of Suresh Goyal & Rich Howard
3G Vision

- Universal global roaming
- Multimedia (voice, data & video)
- Increased data rates
  - 384 Kbps while moving
  - 2 Mbps when stationary at specific locations
- Increased capacity (more spectrally efficient)
- IP architecture
- Problems
  - No killer application for wireless data as yet
  - Vendor-driven
International Standardization

- **ITU (International Telecommunication Union)**
  - radio standards and spectrum

- **IMT-2000**
  - ITU’s umbrella name for 3G which stands for International Mobile Telecommunications 2000

- National and regional standards bodies are collaborating in 3G partnership projects
  - ARIB, TIA, TTA, TTC, CWTS, T1, ETSI - refer to reference slides at the end for names and links

- **3G Partnership Projects (3GPP & 3GPP2)**
  - focused on evolution of access and core networks
IMT-2000 Vision Includes LAN, WAN and Satellite Services
Migration To 3G

- **1G**: Analog Voice
  - 1984 - 1996+
  - TACS
  - NMT
  - AMPS

- **2G**: Digital Voice
  - 1992 - 2000+
  - GSM
  - TDMA
  - PHS
  - CDMA
  - iDEN
  - PDC
  - 9.6 Kbps
  - 14.4 Kbps
  - 64 Kbps

- **2.75G**: Intermediate Multimedia
  - 2001+
  - GPRS
  - EDGE
  - 115 Kbps
  - 384 Kbps

- **3G**: Multimedia
  - 2003 - 2004+
  - W-CDMA (UMTS)
  - cdma2000 (1X-EV-DV)
  - Over 2.4 Mbps
  - 2 Mbps?

Source: U.S. Bancorp Piper Jaffray
**Typical 2G Architecture**
Network Planes

- Like PSTN, 2G mobile networks have one plane for voice circuits and another plane for signaling.
- Some elements reside only in the signaling plane.
  - HLR, VLR, SMS Center, …
PSTN-to-Mobile Call

Signaling over SS7
- MAP/IS41 (over TCAP)
- ISUP

Where is the subscriber?

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>IAM (SSP)</td>
</tr>
<tr>
<td>2</td>
<td>IAM (SSP)</td>
</tr>
<tr>
<td>3</td>
<td>Routing Info</td>
</tr>
<tr>
<td>4</td>
<td>Where is the subscriber?</td>
</tr>
<tr>
<td>5</td>
<td>Provide Roaming</td>
</tr>
<tr>
<td>6</td>
<td>IAM (SSP)</td>
</tr>
</tbody>
</table>

MS - BSS - VLR - VMSC - (STP) - HLR - (SCP) - (SSP) - GMSC - PSTN

514 581 ...
GSM 2G Architecture

BSS  Base Station System
BTS  Base Transceiver Station
BSC  Base Station Controller
MS  Mobile Station
NSS  Network Sub-System
MSC  Mobile-service Switching Controller
VLR  Visitor Location Register
HLR  Home Location Register
AuC  Authentication Server
GMSC  Gateway MSC

PSTN  Public Switched Telephone Network
SS7  Signalling System 7
GPRS - 2.5G for GSM

- General packet radio service
  - first introduction of packet technology
- Aggregate radio channels
  - support higher data rates (115 Kbps)
  - subject to channel availability
- Share aggregate channels among multiple users
- All new IP-based data infrastructure
- No changes to voice network
2.5G / 3G Adds IP Data
No changes for Voice Calls

3G Network Layout

- Base Station

- Radio Network Controller
2.5G Architectural Detail

BSS  Base Station System
BTS  Base Transceiver Station
BSC  Base Station Controller

NSS  Network Sub-System
MSC  Mobile-service Switching Controller
VLR  Visitor Location Register
HLR  Home Location Register
AuC  Authentication Server
GMSC  Gateway MSC

SGSN  Serving GPRS Support Node
GGSN  Gateway GPRS Support Node

GPRS  General Packet Radio Service
GSM Evolution for Data Access

- GSM: 9.6 kbps
- GPRS: 115 kbps
- EDGE: 384 kbps
- UMTS: 2 Mbps

Timeline:
- 1997: GSM
- 2000: GPRS
- 2003: EDGE
- 2003+: UMTS

GSM evolution → 3G
3G rel99 Architecture (UMTS) - 3G Radios

BSS  Base Station System
BTS  Base Transceiver Station
BSC  Base Station Controller
RNS  Radio Network System
RNC  Radio Network Controller
CN  Core Network
MSC  Mobile-service Switching Controller
VLR  Visitor Location Register
HLR  Home Location Register
AuC  Authentication Server
GMSC  Gateway MSC

2G MS (voice only)
BTS

2G+ MS (voice & data)
BTS

3G UE (voice & data)
Node B

RNC

GBS

MSC

VLR

HLR

AuC

GMSC

SGSN

GGSN

PSTN

PSDN

UMTS  Universal Mobile Telecommunication System

목포해양대 해양컴퓨터공학과
3G rel4 Architecture (UMTS) - Soft Switching

BSS  Base Station System
BTS  Base Transceiver Station
BSC  Base Station Controller

RNS  Radio Network System
RNC  Radio Network Controller

CN  Core Network
MSC  Mobile-service Switching Controller
VLR  Visitor Location Register
HLR  Home Location Register
AuC  Authentication Server
GMSC  Gateway MSC

SGSN  Serving GPRS Support Node
GGSN  Gateway GPRS Support Node

PSTN  Public Switched Telephone Network
PSDN  Packet Switched Data Network

2G MS (voice only)
2G+ MS (voice & data)
3G UE (voice & data)