chapter 6

Voice Networks

CHAPTER OBJECTIVES

- Identify the business purpose of voice networks.
- Describe how data is transmitted over a plain old telephone system local loop.
- Identify the business purpose and features of a private branch exchange.
- Define PBX technology and discuss PBX switching topologies and design considerations.
- Define and describe voice over IP (VoIP).

인터넷 전화

대부분 PBX를 사용을 한다.

CHAPTER OBJECTIVES (cont'd)

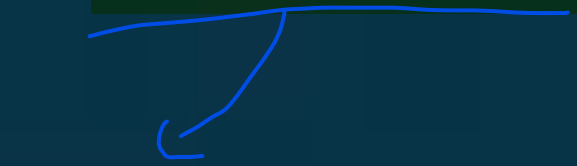
이동하면서 사용을 할 수 있도록 설계

- Discuss cellular wireless voice networks and describe the anatomy of a cellular wireless connection.

휴대전화에 사용

- List and describe three cellular wireless access methods.
- Identify and describe three cellular wireless topologies and connectivity to the PSTN.
- List and discuss cellular wireless data services.

5G LTE



음성통신을 이용하면서 하도록 만듦

VOICE NETWORKS – AN INTRODUCTION

- Voice networks convey the human voice between remote locations.
- Voice networks use electrical transmission techniques. 전송매체안에 구리선을 집어넣어서 전달 , 동출케이블 , utp
- Voice networks were in existence long before modern data networks. 데이터 네트워크 훨씬 전부터 존재 했다.
- Voice networks have traditionally used analog transmission techniques where data networks generally use digital methods. 보이스 네트워크의 시작은 아날로그 , 데이터 네트워크는 디지털
- Voice networks have traditionally been constructed and maintained separately from data networks.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- From the late 1870s – 1950s, voice networks were specifically used for the analog transmission of the human voice. 보이스 네트워크 밖에 없었다.
- In the 1960s and 1970s, organizations with mainframe computers began using telephone companies' analog voice networks to share computing resources and to transmit digital data between remote locations. 디지털을 아날로그로 아날로그를 디지털로 바꿔줘야 했다.
- Modern voice networks can be based on analog or digital techniques or a combination of both.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Earliest voice networks appeared after the introduction of the first commercial telephone in the late 1870s.
- These early telephone networks connected a person's home directly with another person's home to create a point-to-point connection.
- Subsequent connections to others' homes required the installation of additional point-to-point connections.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- All these point-to-point connections were inefficient to install and maintain.
- This led to the development in 1878 of the first telephone exchange, which is also known as a telephone central office (CO).
- A CO is a physical facility owned by the telephone company, and it acts as a hub to which all telephone subscribers in a specific geographic region connect.
- When a subscriber makes a call, the call connects to the CO, and then the call is connected to another subscriber.

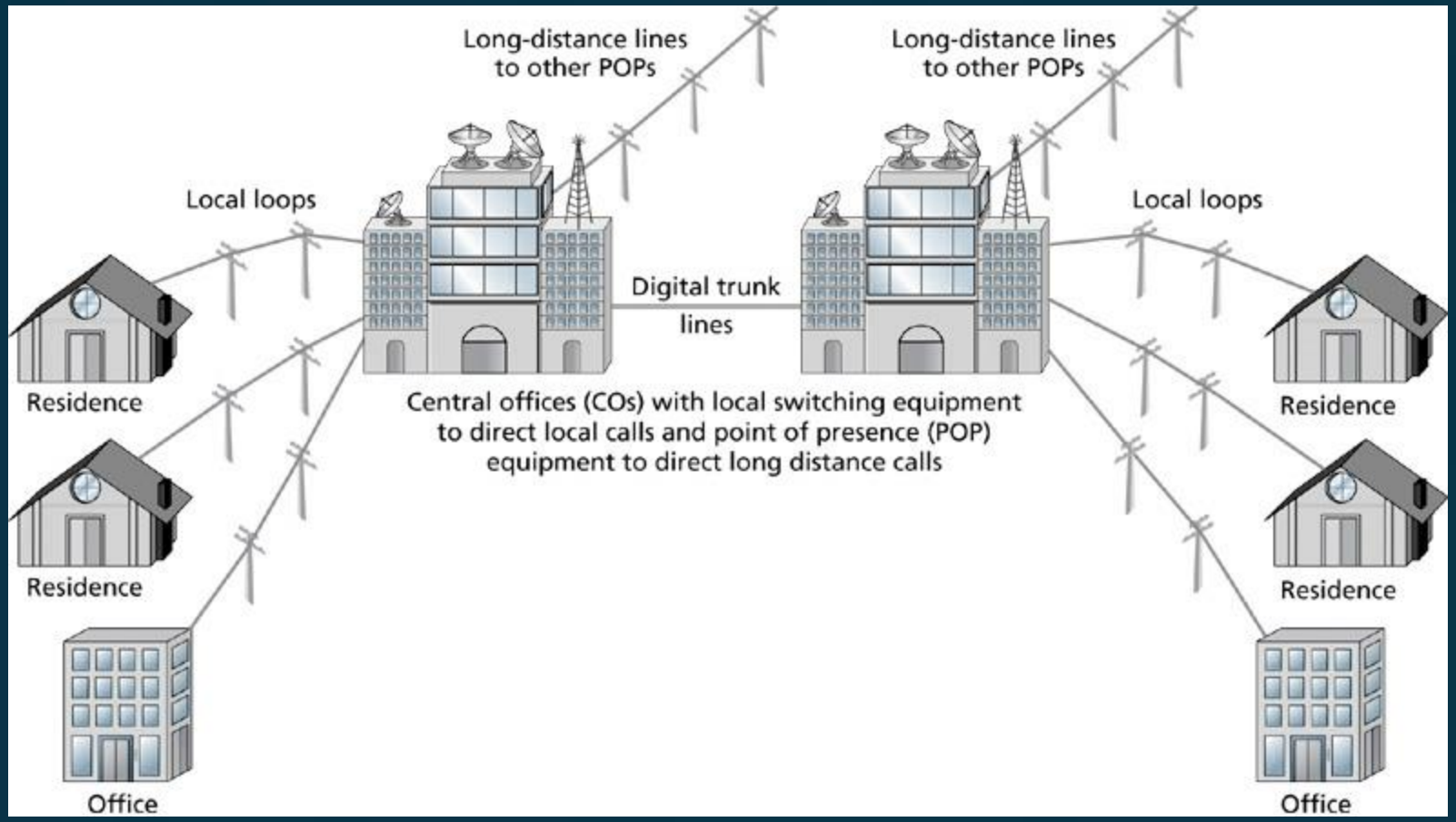
VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Modern connections between a home or office and a CO is provided by a local exchange carrier (LEC).
- The connection between home or office and the CO is known as a local loop.
- Local loops consist of a pair of twisted copper wires that are like the UTP cabling used in data networks.
- Local loops in combination with one or more COs form the basic voice network for local calls.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Local loops and COs in combination with long-distance technologies comprise a voice network that is commonly referred to as the plain old telephone system (POTS). 서킷 스위치드 네트워크 , POTS, PSTN 다 같은 내용이다.
- Formally, POTS is better described as the public switched telephone network (PSTN).
- POTS provides the basic foundation for the voice network that spans across the Korea and the entire world.
- POTS is technically that part of the PSTN that services regular analog telephones.

Plain Old Telephone System (POTS)



VOICE NETWORKS – AN INTRODUCTION (cont'd)

- If a call is long-distance, point of presence (POP) equipment owned by an inter-exchange carrier (IXC or IEC) transmits the call along the appropriate long-distance communications path.
- Long-distance calls are received at a remote POP, switched to the destination LEC, and then connected to the remote subscriber.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Business Purpose of Voice Networks
  - Transmission of human voice as well as data between point A and point B. 처음에는 사람에 음성만 옮기는 거였지만 이젠 데이터도 옮긴다.
  - Organizations use POTS and the PSTN for simple analog voice and data communications over POTS to switched digital services such as ISDN.
  - The PSTN services voice and data transmission across trunks to organizations' private branch exchange (PBX) systems.
  - Cellular wireless also relies on the PSTN for connecting voice and data transmissions between points A and B.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Digital data transmissions across POTS use modems.
- A modem modulates a simple carrier wave into different frequencies, amplitudes, and phases, and then demodulates the signal at the receiving end.
- Modem development spawned the beginning of data communications over regular telephone lines.

PRIVATE BRANCH EXCHANGE

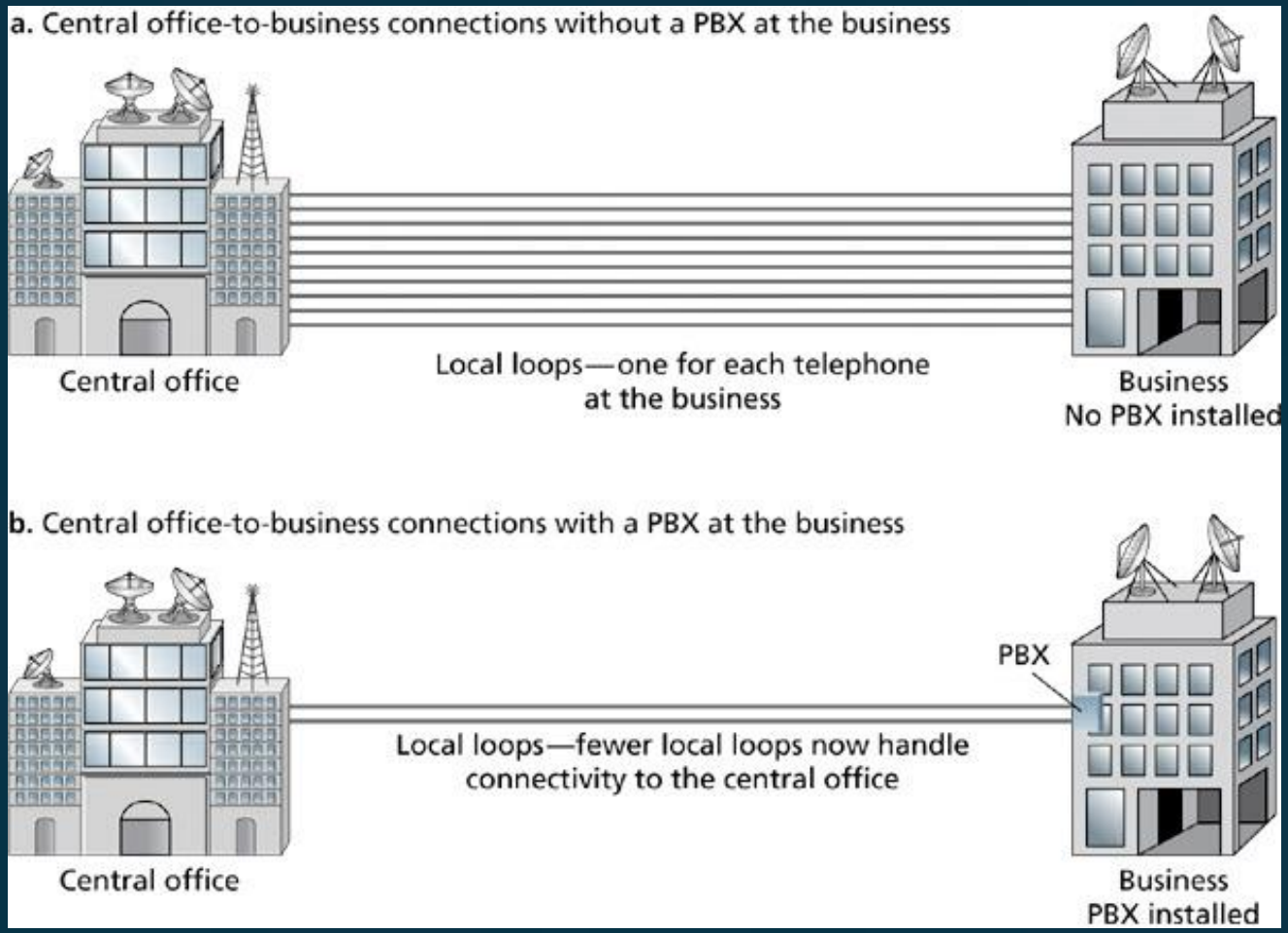
- A private branch exchange (PBX) is a private version of the PSTN central exchange.
- A PBX can be implemented by an organization to control and manage voice network use, functionality, and costs.
- With PBX implementation, control, management, and cost of a substantial part of an organization's voice network passes from the telephone company to the organization itself.

PRIVATE BRANCH EXCHANGE (cont'd)

- PBX Business Purpose and Features
  - PBXs have existed for over 100 years.
  - First PBXs were switchboards installed at business locations in the late 1800s and early 1900s.
  - Business subscribers and the telephone company both benefited with the installation of a PBX.
  - Businesses could reduce the rental costs of having multiple local loops.
  - Telephone company could reduce the expense of installing and supporting additional local loops for businesses.

전자식은 대부분 아날로그 이다. 전자제품이라고 하잖아 냉장고 세탁이 그거 아날로그잖아.

Connectivity to Central Office Exchange



PRIVATE BRANCH EXCHANGE (cont'd)

- Early PBX Systems
  - Were manually operated switchboards.
  - They were installed, owned, and maintained by the telephone company for a fee.
  - Business subscriber enjoyed the benefits of internal call switching and control.
  - Business subscriber also enjoyed a cost structure that was offset by reduced local loop charges.

PRIVATE BRANCH EXCHANGE (cont'd)

- Modern PBX Systems
  - Include the features of early PBXs such as efficiencies of internal call switching and control as well as cost savings.
  - Include services that are designed to improve voice network performance and communications efficiency.

Common Features of Modern PBXs

TABLE 7.1

Feature	Description
Automated attendant	Answers incoming calls and instructs callers how to dial to reach an internal extension.
Voice mail	Storage location on the PBX for incoming callers to leave messages.
Call coverage	Allows users to program their phones to direct calls to one or more alternative phones connected to the PBX system. A user's voice mail answers the call only if no one in the call coverage path answers.
Hoteling	Allows users who move from desk to desk to access the phone system and forward their regular phone numbers to their temporary phones as well as associate their regular phone preferences with their temporary phones.
Find-me	Allows users to program their phones to redirect calls sequentially to one or more external telephone numbers.
Interactive voice response	Initiates calling actions within the PBX system based on a caller's telephone Touch-Tone inputs.
System administration	The PBX system administrator sets overall system calling parameters using PBX system commands.

PBX Components

PRIVATE BRANCH EXCHANGE (cont'd)

- PBXs and Wireless Communications
  - Regular cell phones can be partially integrated with PBX systems.
  - Users' cell phone numbers can be programmed into the PBX database to take advantage of PBX features.
  - Regular cell phones do not receive their dial tone, call processing, or switching functions from the PBX – the cellular service company provides those functions.
  - Wireless PBX phones usually sell at a significant premium over regular cell phones.

IP-PRIVATE BRANCH EXCHANGE (cont'd)

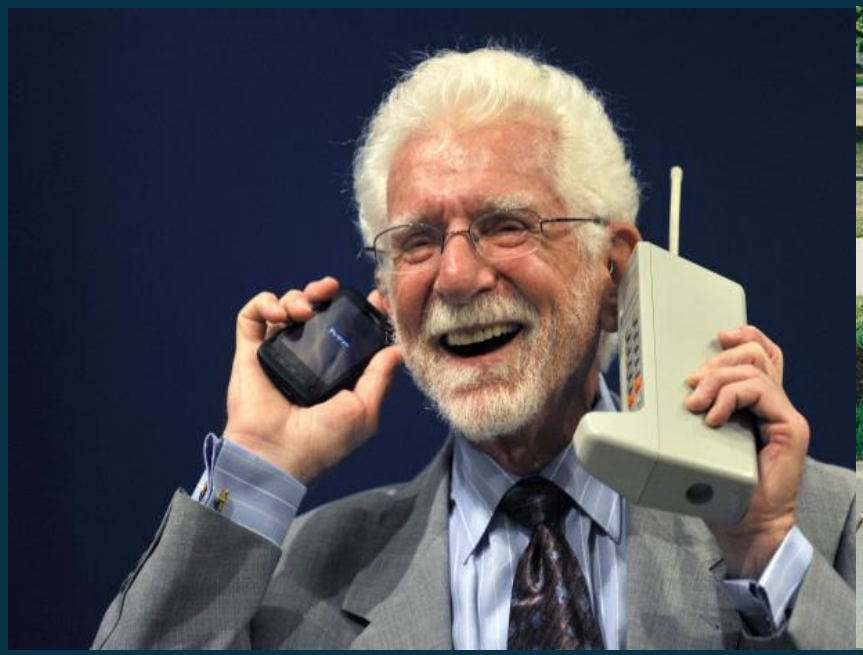
- Voice over IP is the combination of hardware, software, and protocols that support voice communications over IP networks.
- Client/server IP-PBX topologies are an example of VoIP.
- VoIP protocols fall into two levels of functionality: call signaling and call transport.

대화 하는 내용을 주고 받는 것

FATHER OF THE CELL PHONE

Martin Cooper

Motorola / Illinois Institute of Technology



CELLULAR WIRELESS VOICE NETWORKS

- Anatomy of a Cellular Wireless Connection
  - When a cellular wireless device is powered on, it transmits its identity signal to the nearest cell tower.
    - The transmission takes place using a radio frequency.
  - The cell tower responds, providing cell network information.
    - This transmission takes place using a different radio frequency that establishes a control channel between the cell phone and the cellular network.

핸드폰마다 고유의 식별번호가 msc로 날아간다.
핸드폰은 위치가 항상 변함으로 위치등록을 하게끔 만든다
얘가 내 셀에 있다고 DB에 등록을 한다.

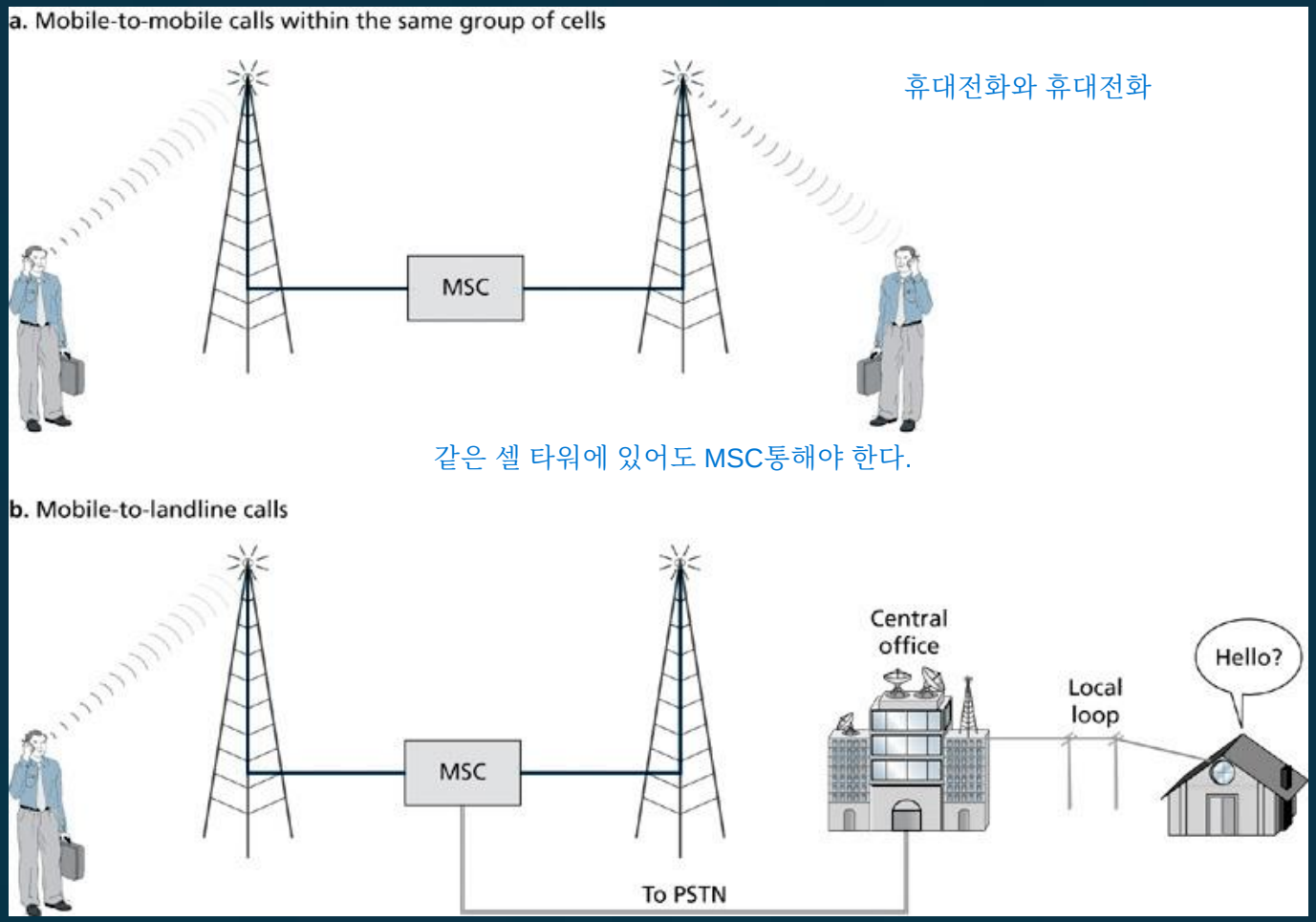
CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- Anatomy of a Cellular Wireless Connection (cont'd)
  - When a caller dials a number and presses Send, the number is transmitted across the control channel to the cell tower.
  - The cell tower relays the call to a mobile switching center (MSC).
  - The MSC instructs the cellular device that's making the call to use a specific set of frequencies known as the traffic channel for voice and data communication between the cell device and the cell tower.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- Anatomy of a Cellular Wireless Connection (cont'd)
  - The MSC also scans its database to see whether the number being called is within the MSC's cellular network or part of another wireless system.
  - Mobile-to-mobile calls that are within the same cell or group of cells that is connected to the same MSC are switched at the MSC to their destination.
  - Mobile-to-land calls or mobile calls to other cell networks must be routed through the MSC to the PSTN.

Anatomy of a Cellular Wireless Call



휴대전화와 휴대전화

같은 셀 타워에 있어도 MSC통해야 한다.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- Cellular Wireless Access Methods
  - Wireless access methods are also known as air interfaces.
  - The most common air interfaces today are Time Division Multiple Access (TDMA) and Code Division Multiple Access (CDMA)
  - Frequency Division Multiple Access (FDMA) was prevalent in the 1980s.

소프트웨어가 중요하다.
하드웨어 회사를 전부 소프트웨어 회사가 인수했다 .
하드웨어는 마진이 잘 안남는다.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- FDMA

거리가 멀어질 수록통화 품질이 좀 떨어진다.
원상복구가 100퍼센트 안되기 때문에 .
신호가 잘 안가서 강하게 보내야 했다(배터리가 빨리 단다).

  - Is an analog cellular wireless access method.
  - It was implemented in test markets in the late 1970s in the U.S.
  - It became the air interface for the first widely deployed cellular wireless network in the early 1980s.
  - This early analog cellular network became known as Advanced Mobile Phone Service (AMPS)

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- TDMA

디지털 방식의 억세스 메소드중 가장 많이 사용되는 방식 (시분할 방식)
라디오 주파수의 대역폭을 좀 더 효율적으로 쓸 수 있다.(셀안에서 서비스 할 수 있는 디바이스 수가 늘어난다.)
같은 네트워크를 구축하고 돈을 더 많이 벌 수 있다.

  - TDMA adds a time dimension to FDMA to make more efficient use of the radio frequency bandwidth.
  - With TDMA, multiple calls are multiplexed across the same frequency.
  - TDMA requires less power consumption than FDMA.
  - TDMA is offered as an air interface by some cellular carriers, but it is generally deployed as the underlying air interface for the Global System for Mobile Communications (GSM)

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- CDMA
  - It's an air interface that was developed for the US military in the 1960s.
  - CDMA eliminates some of the inefficiencies associated with FDMA and TDMA by spreading a call or data transmission across multiple frequencies.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- CDMA (cont'd)
  - Bandwidth efficiency is also improved by spreading a transmission across multiple frequencies – the number of callers that can simultaneously use a range of radio frequencies for call transmission is increased with CDMA.
  - CDMA offers a better method of call handoff and call signal reflection management so that CDMA phones consume less power than their TDMA or FDMA counterparts.

기술적으로 CDMA가 TDMA가 우월하다 . 셀안에서 서비스 할 수 있는 디바이스수가 크다.
핸드오프 지형을 넘어갈 때 서비스 퀄리티가 낮아지는 경우가 굉장히 낮아지는 장점이 있다.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- Wireless Data Services
  - Provide a wireless carrier connection between individual remote users and parent organization networks.
  - Data rates range from about 100 Kbps to 20Gbps.
  - Wireless data services are classified in terms of 2G, 2.5G, 3G, 4G and 5G wireless data communications technologies.

1G-3G Migration Path

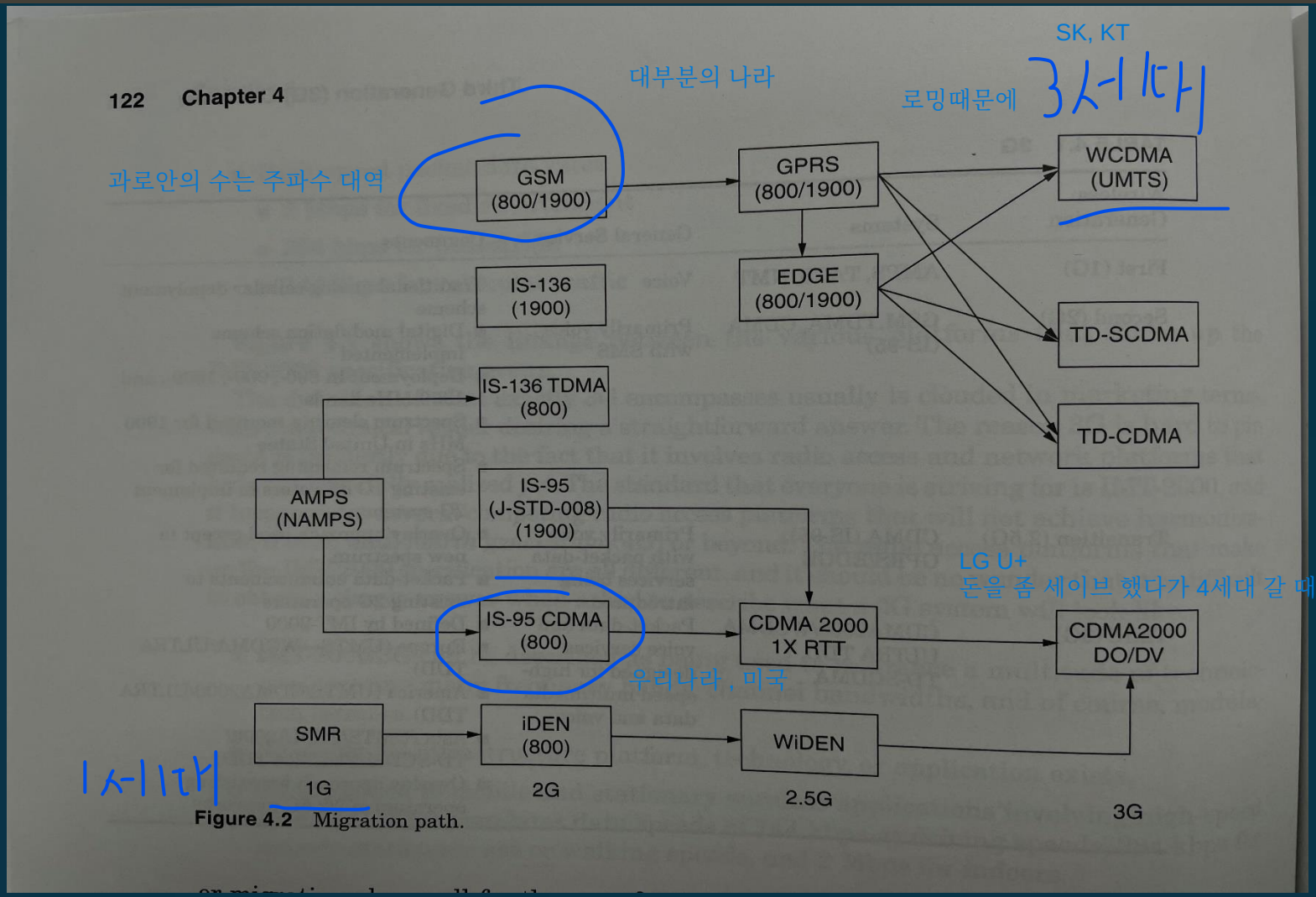


Figure 4.2 Migration path.

2G, 2.5G, and 3G Comparison

기술이 확연하게 달라져야
세대가 바뀜

TABLE 4.2 2G, 2.5G, and 3G Comparison

2G Technology	Data Capability	Spectrum Required	Comment
GSM	9.6 or 14.4 kbps	200 kHz	Circuit-switched data
IS-136	9.6 kbps	30 kHz	Circuit-switched data
iDEN	9.6 kbps	25 kHz	Circuit-switched data
CDMA (IS-95A/ J-STD-008)	9.6 bps/14.4 kbps, 64 bps (IS-95B)	1.25 MHz	Circuit-switched data
2.5G Technology	**Data Capability**	**Spectrum Required**	**Comment**
HSCSD	28.8/56 kbps	200 kHz	Circuit/packet data
GPRS	128 kbps	200 kHz	Circuit/packet data
Edge	384 kbps	200 kHz	Circuit/packet data
CDMA2000-1XRTT	153 kbps	1.25 MHz	Circuit/packet data
3G Technology	**Data Capability**	**Spectrum Required**	**Comment**
WCDMA	144 kbps vehicular 384 kbps outdoors 2 Mbps indoors	5 MHz	Packet data
CDMA2000-DO/EV	144 kbps vehicular 384 kbps outdoors 2 Mbps indoors	1.25 MHz	Packet data
TD-CDMA (Ultra TDD)	144 kbps vehicular 384 kbps outdoors 2 Mbps indoors	5 MHz	Packet data
TD-SCDMA	144 kbps vehicular 384 kbps outdoors 2 Mbps indoors	1.6 MHz	Packet data

Note: TD-SCDMA and TD-CDMA are TDD and are unpaired.

Fig 4.2, Table 4.2 Source