

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).

CHAPTER OBJECTIVES (cont'd)

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



Voice NW 유선전화 무선전화 휴대전화

Data NW 유선인터넷 무선인터넷 (Wi-fi) 현대인터넷 (Wibro)

음성통화서비스 지원 X
수입이 줄기때문

Data NW 인터넷전화 (저렴)
Voice NW 증강제 통화

VOICE NETWORKS – AN INTRODUCTION

- Voice networks convey the human voice between remote locations.
- Voice networks use electrical transmission techniques.
- Voice networks were in existence long before modern data networks.
- Voice networks have traditionally used analog transmission techniques where data networks generally use digital methods.
- Voice networks have traditionally been constructed and maintained separately from data networks.

(과거에는)

과거에는 voice NW / Data NW가 명확히 구분

VOICE NETWORKS – AN INTRODUCTION (cont'd)

- From the late 1870s – 1950s, voice networks were specifically used for the analog transmission of the human voice. analog ⇒ digital 로 전환하고있다.
발신자번호 표시 기
- 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.
- Modern voice networks can be based on analog or digital techniques or a combination of both.

VOICE NETWORKS – AN INTRODUCTION (cont'd)

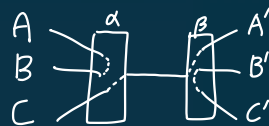
- Earliest voice networks appeared after the introduction of the first commercial telephone in the late 1870s.
- These early telephone networks connected a person's home directly with another person's home to create a point-to-point connection.
- Subsequent connections to others' homes required the installation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

n번째 사용자가 가입할 때 마다

(n-1) 개의 회선 연결 필요

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)**. (= 전화국)
- 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.



통신연결이 들어올 때 마다
연결해준다.

(초기엔 사람이 수동으로 했다)
→ 기계식 교환기 → 전자식 교환기

voice NW 특징)

이미 사용중인 회선을 이용하지 못함

= circuit switched NW
회선

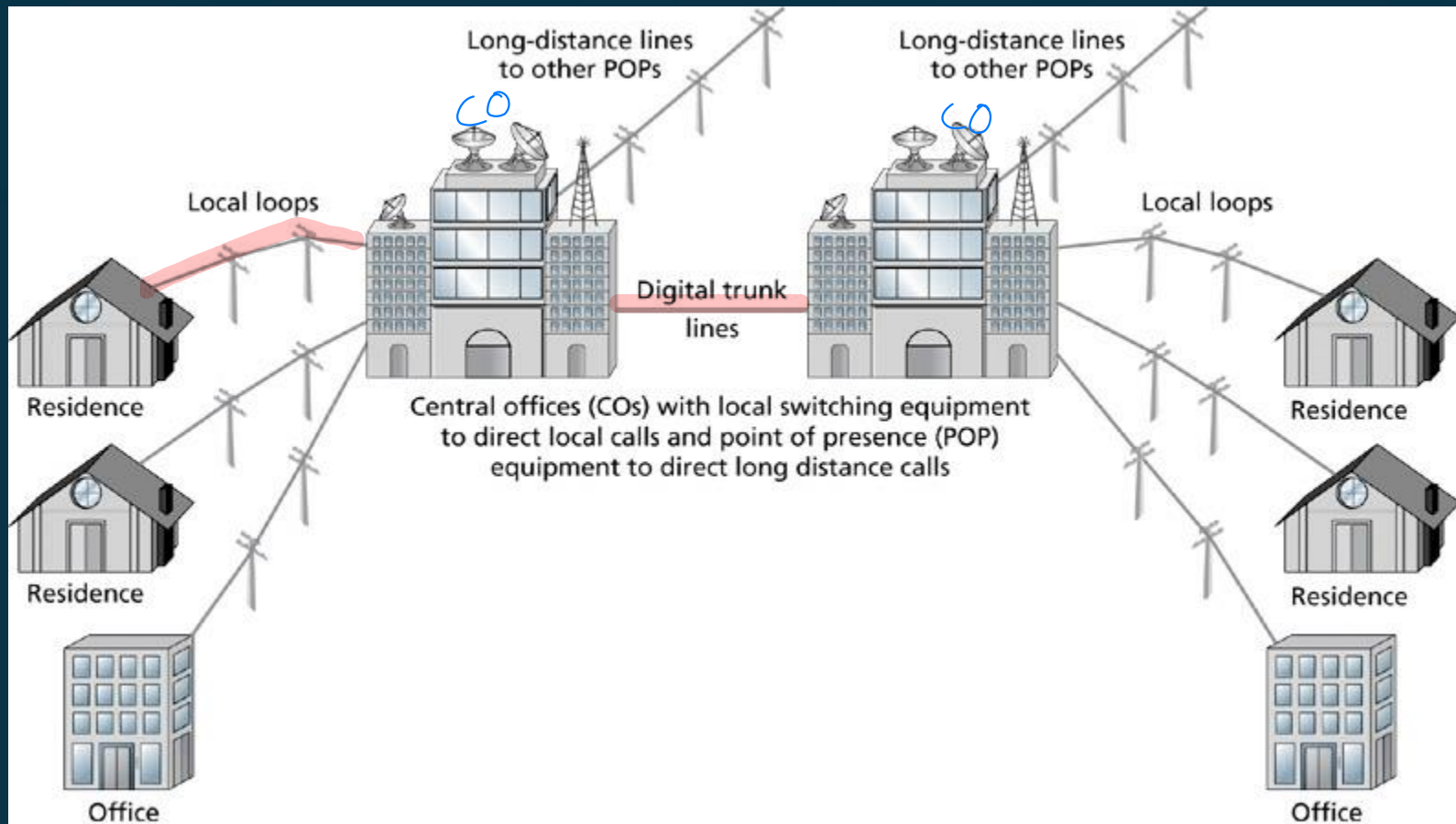
VOICE NETWORKS – AN INTRODUCTION (cont'd)

- Modern connections between a home or office and a CO is provided by a **local exchange carrier** (LEC).
미국 주별로 있는 전화사
- The connection between home or office and the CO is known as a **local loop**. UTP 케이블
- 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)**. 원래 analog
- Formally, POTS is better described as the **public switched telephone network (PSTN)**. 최근 digital
- 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. 음성전달목적
 - 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** **mod**ulates a simple carrier wave into different frequencies, amplitudes, and phases, and then **dem**odulates the signal at the receiving end.
- Modem development spawned the beginning of data communications over regular telephone lines.

digital data를 analog 장비로 전송할때.

digital → analog

analog → digital

동시 사용불가

PRIVATE BRANCH EXCHANGE

- A **private branch exchange** (PBX) is a private version of the PSTN central exchange.
(=사설교환장)
- 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.

전화회사: Local Loop 부담

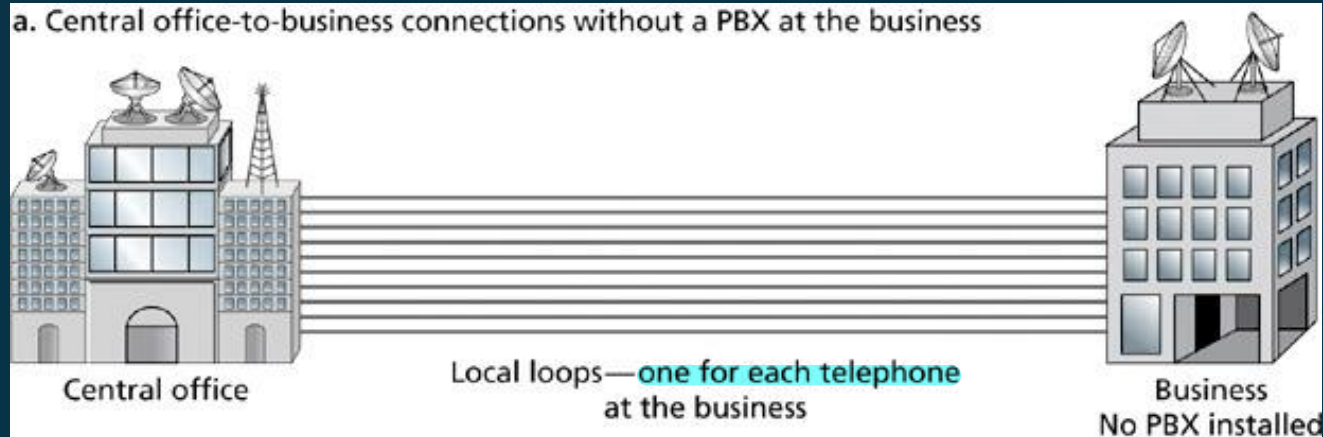
이용회사: 비용

PRIVATE BRANCH EXCHANGE (cont'd)

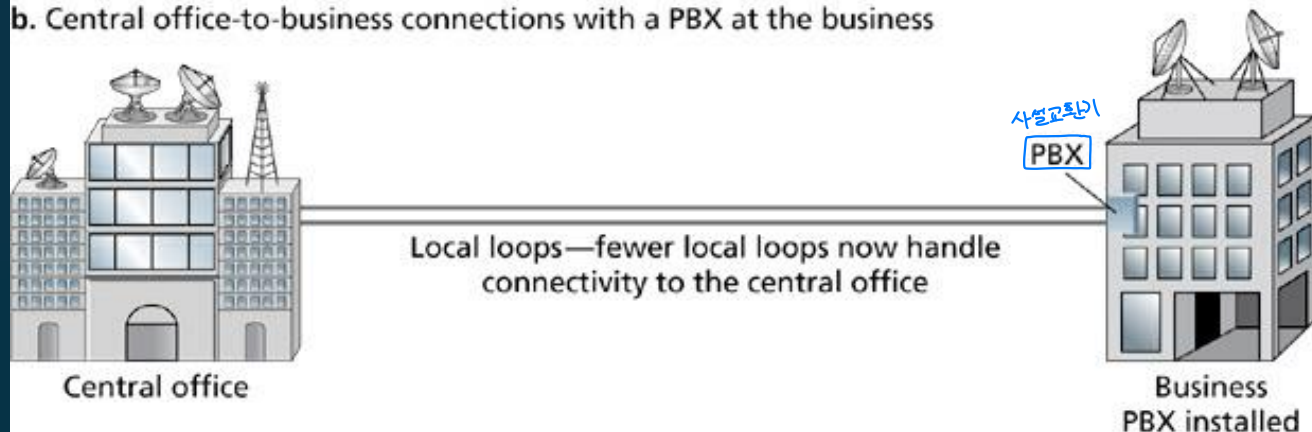
- PBX Business Purpose and Features
 - PBXs have existed for over 100 years. *em*
 - First PBXs were switchboards installed at business locations in the late 1800s and early 1900s.
 - Business subscribers and the telephone company both benefited with the installation of a PBX.
 - Businesses could reduce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

Connectivity to Central Office Exchange

a. Central office-to-business connections without a PBX at the business



b. Central office-to-business connections with a PBX at the business



PRIVATE BRANCH EXCHANGE (cont'd)

01
27>1

- 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)

2/27/11

- 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)

(= VoIP)

- **Voice over IP** is the combination of hardware, software, and protocols that support voice communications over IP networks.

음성은 data로 보내는 것 (= 인터넷 전화)
(회선교환방식 패킷교환방식) ⇒ 통신요금도 낮아짐

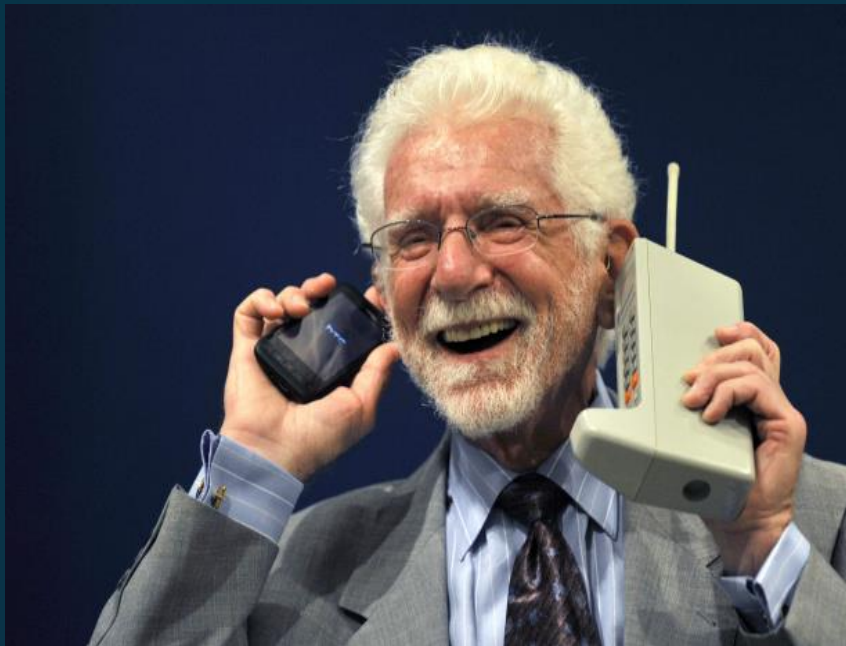
but, 정정되면 통화불가
network 속도가 증가해서 지연됨.
- Client/server IP-PBX topologies are an example of VoIP.
- VoIP protocols fall into two levels of functionality: call signaling and call transport.

통화 발기전 과정 protocol

음성 데이터 전송 protocol

FATHER OF THE CELL PHONE

주파수 무선통신 전문
⇓
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.

단말기엔 ESN이 있다 = electronic serial number
(= 휴대폰의 MAC Address)

MSC DB에서 ID의 위치를 찾아서 휴대폰을 올려준다
가입자수가 많아지면 MSC 추가설, 역할분리

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

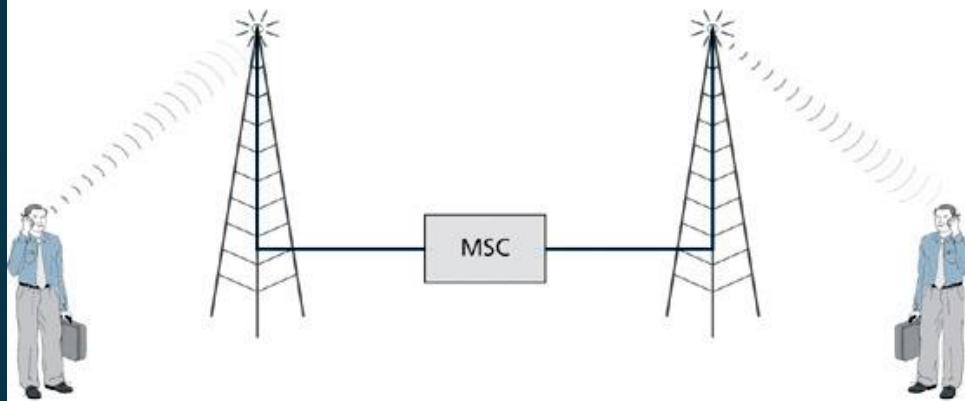
- Anatomy of a Cellular Wireless Connection (cont'd)
 - When a caller dials a number and presses Send, the number is transmitted across the control channel to the cell tower. *device → cell tower → MSC → cell tower → device* *이동이 잦으면 handoff도 많이...*
 - The cell tower relays the call to a **mobile switching center** (MSC). *단말기 위치 파악이 핵심!!* *// 근처의 cell tower 서비스가능지역 벗어나면 handoff*
 - 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)

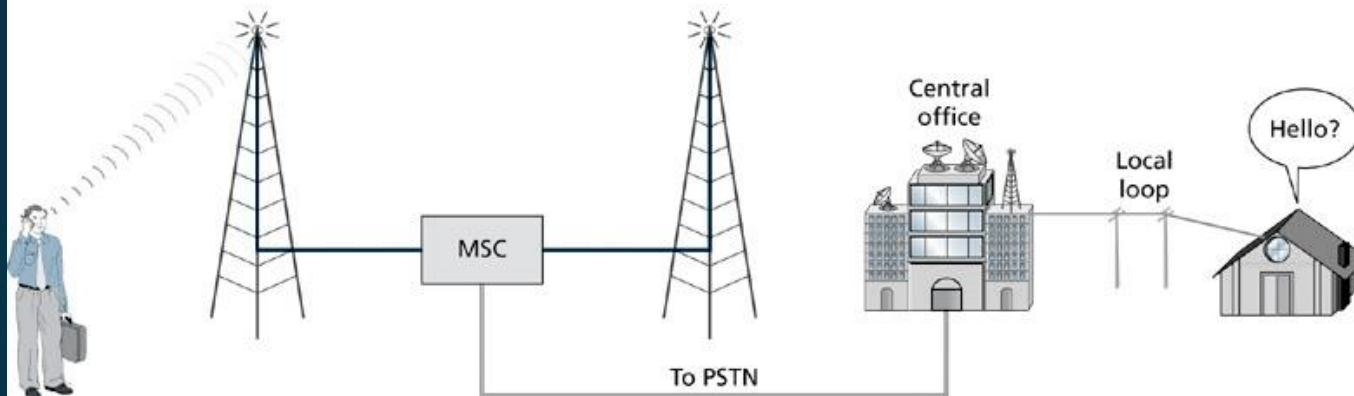
- Anatomy of a Cellular Wireless Connection (cont'd)
 - The MSC also scans its database to see whether the number being called is within the MSC's cellular network or part of another wireless system.
 - Mobile-to-mobile calls that are within the same cell or group of cells that is connected to the same 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

a. Mobile-to-mobile calls within the same group of cells (무선-무선)



b. Mobile-to-landline calls (무선-유선)



CELLULAR WIRELESS VOICE NETWORKS (cont'd)

- Cellular Wireless Access Methods
 - Wireless access methods are also known as ^{CSMA/CD} air interfaces. 주파수 이용하기 때문에..
 - 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.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

• FDMA (1세대)

analog

90s digital 휴대전화기 널리 사용

이제 소프트웨어 때문에 드래핑

공정 업무에 지미서 -
인사이드 2000 (1세대!)

(지금은 4세대+5세대)

- 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**)

data 주권반기 → 2세대부터 가능.

FDMA = analog, 1세대, AMPS.

CELLULAR WIRELESS VOICE NETWORKS (cont'd)

• TDMA

time division

digital

90년대 중반부터

FDMA + 시간축

⇒ 효율적

한개의
cell tower에서
서비스가능
단말기수 ↑

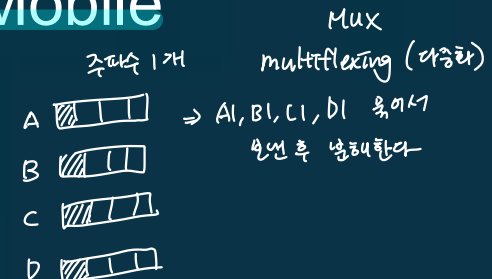
- TDMA adds a time dimension to FDMA to make more efficient use of the radio frequency bandwidth.
- With TDMA, multiple calls are multiplexed across the same frequency.
- TDMA requires less power consumption than FDMA.
- TDMA is offered as an air interface by some cellular carriers, but it is generally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

1세대에 비해

전력소모 ↓

TDMA 기반 구조

디지털유러
소프트웨어
조작가능



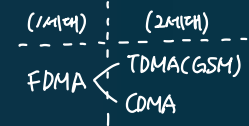
CELLULAR WIRELESS VOICE NETWORKS (cont'd)

TDMA보다 상위기술 : handoff 잘됨, 보안호, 전력소모 ↓

⇒ TDMA보다 기지국 열세워도 된다

• CDMA

code division 군사용



- 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.

기술이 복잡 ⇒ 상용화에 부적합
(단말기 무게와 크기 ↑)

⇒ 보통 TDMA (2G로라 등)

TDMA보다 주파수 효율적으로 쓰고

Handoff에서 더 효율적인 동작

⇒ CDMA 단말기의 배터리 사용시간 ↑

but, 한국에서 CDMA 단말기 상용화한다!

그래서 2G로라도 CDMA로 선택

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.

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.

(속도에 따라 세레 나뉨)