chapter 7

Wide Area Networks

CHAPTER OBJECTIVES

Circuit vs packet 개념 구분짓기!

- Define circuit switching, describe circuit-switched architecture, and identify and describe different types of circuit-switched carrier services.
- Define dedicated circuit, and list and describe dedicated-circuit carrier services.
- Discuss packet-switched networks, and list and describe different types of packet-switched carrier services.
- List and describe other high-speed carrier services.
- Identify and describe different types of multiplexing.

최근엔 voice NW도 packet으로 바뀌는중

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Circuit-Switched Carrier Services
  - Circuit switching is a communications method that creates a dedicated communications path between points A and B for the exclusive use of the end nodes for the duration of the connection.
  - Data rates for circuit-switched carrier services range from modem dial-up speeds of 28.8 Kbps to 56 Kbps, to low-end broadband data rates of 1.544 Mbps.
  - Businesses implement circuit-switched carrier services if data transmission requirements between remote locations are mostly text-based and don't require a continuous connection.

네트워크를 독점적으로 이용
analog 방식으로 전송

초기의 형편없는 전송속도

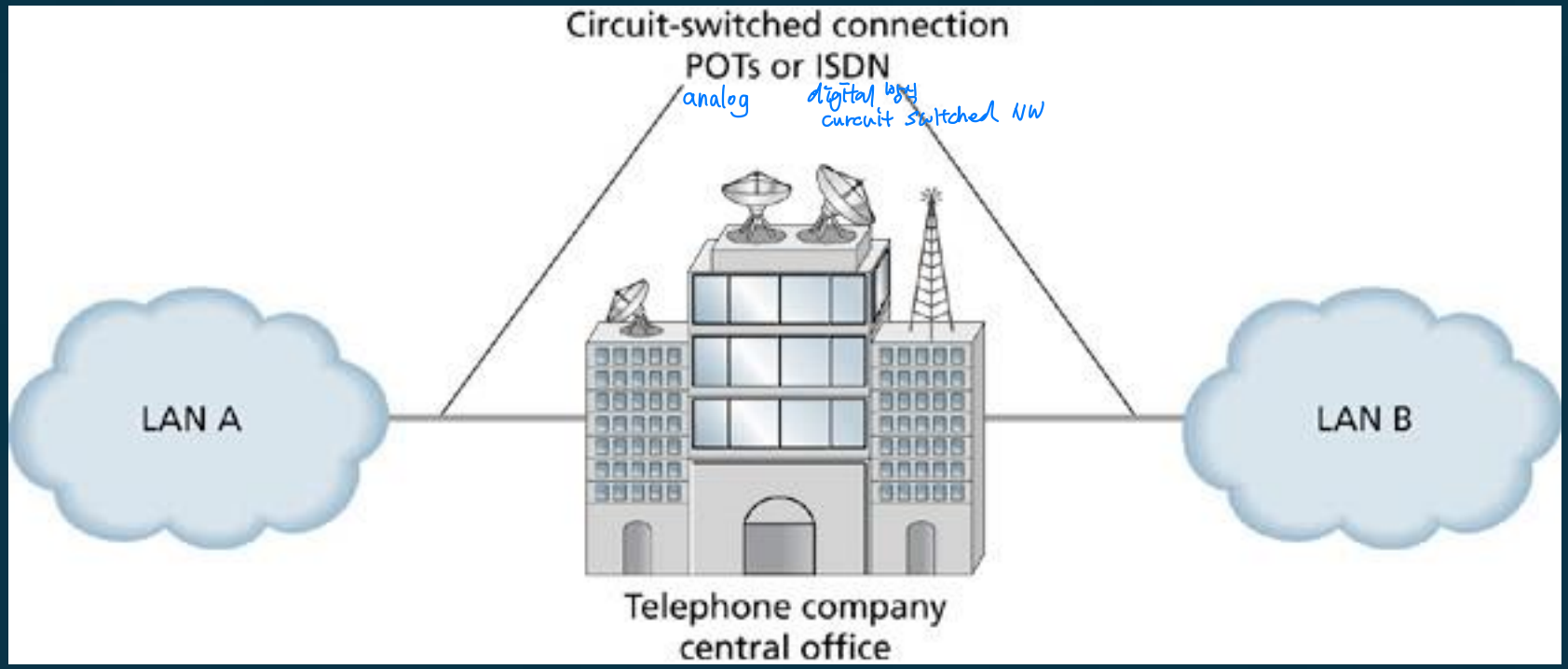
Voice NW를 위해 설계되었지만
초기 digital data 전송에도 이용되었다.
(modem 이용)

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

종량제 방식.

- Circuit-Switched Carrier Services (cont'd)
  - All circuit-switched services use the PSTN, which provides the carrier-service infrastructure between remote locations.
  - Circuit-switched connections provide flexibility in connecting to remote locations – you dial a number to connect to a remote computer or network, and the connection is maintained until you hang up.
  - Circuit-switched connections charge for every minute of connection time.

LAN-to-LAN Connectivity through the PSTN



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

음성품질 개선, 더 큰 용량의 정보 전송 목적

- Integrated Services Digital Network

PSTN의 digital ver.

circuit < PSTN (analog) / ISDN (digital)

  - ISDN is a digital circuit-switched service.
  - Was originally developed in the 1960s as a digital replacement for analog phone lines.
  - ISDN has many of the same features as regular analog phone lines.
  - ISDN can accommodate voice and data traffic, graphics, video, audio, and any other data that can be converted to digital.

ISDN 상용화 못함 ⇒ AT&T 분할에 크게 작용

  - It was never widely deployed because of the cost of telephone replacement at every home in the U.S. in the days when AT&T held a telephone monopoly.

실제로 상용화되진 않았다.

↳ (50개로 쪼개졌던)

AT&T 와 MCI 가 국제전화 경쟁했다

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

동기적 전송 광케이블 NW

- SONET (Synchronous Optical Network)
  - It's an ANSI standard for high-speed data communications over fiber-optic cables.
  - It's defined in terms of optical carrier levels (OC-X).
  - SONET is deployed as redundant rings for fault tolerance.

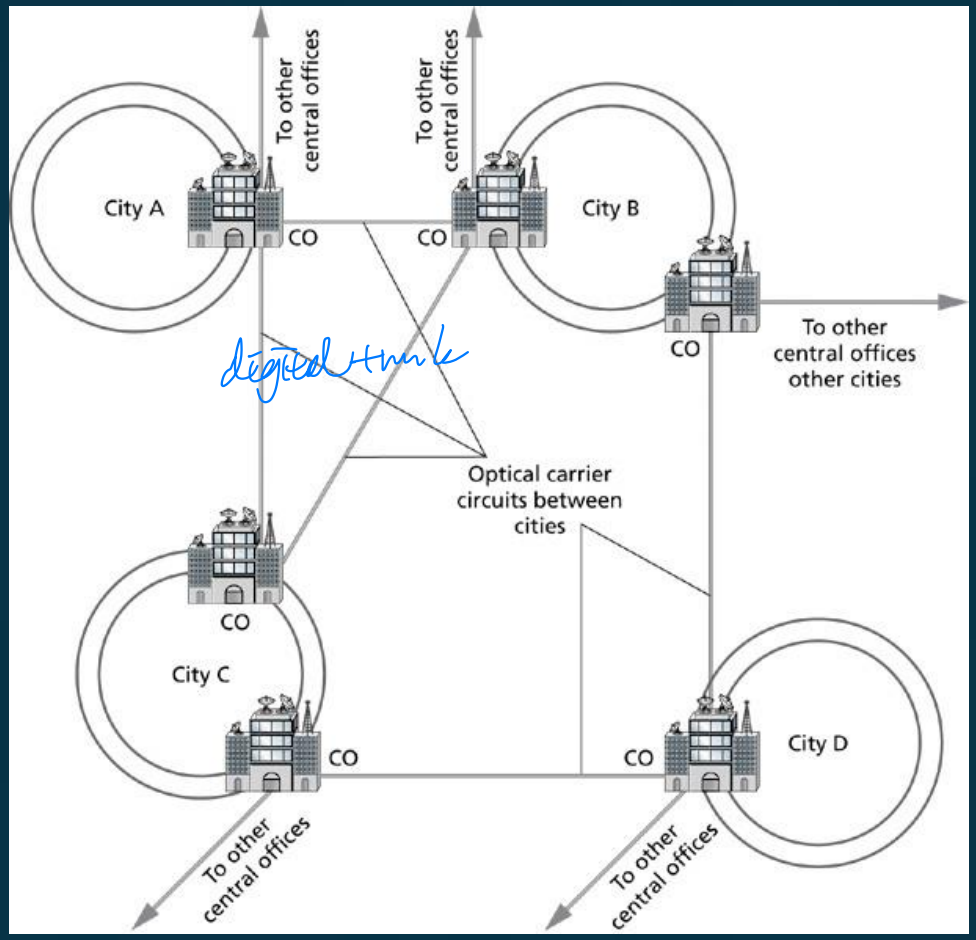
미국 표준협회

뒤로갈수록 회선

용어 road valancing
fault tolorance

현에라 : packet

SONET Ring Infrastructure



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

기존의 voice NW 개선 목적 "idle time을 줄인다."

- Packet-Switched Carrier Services

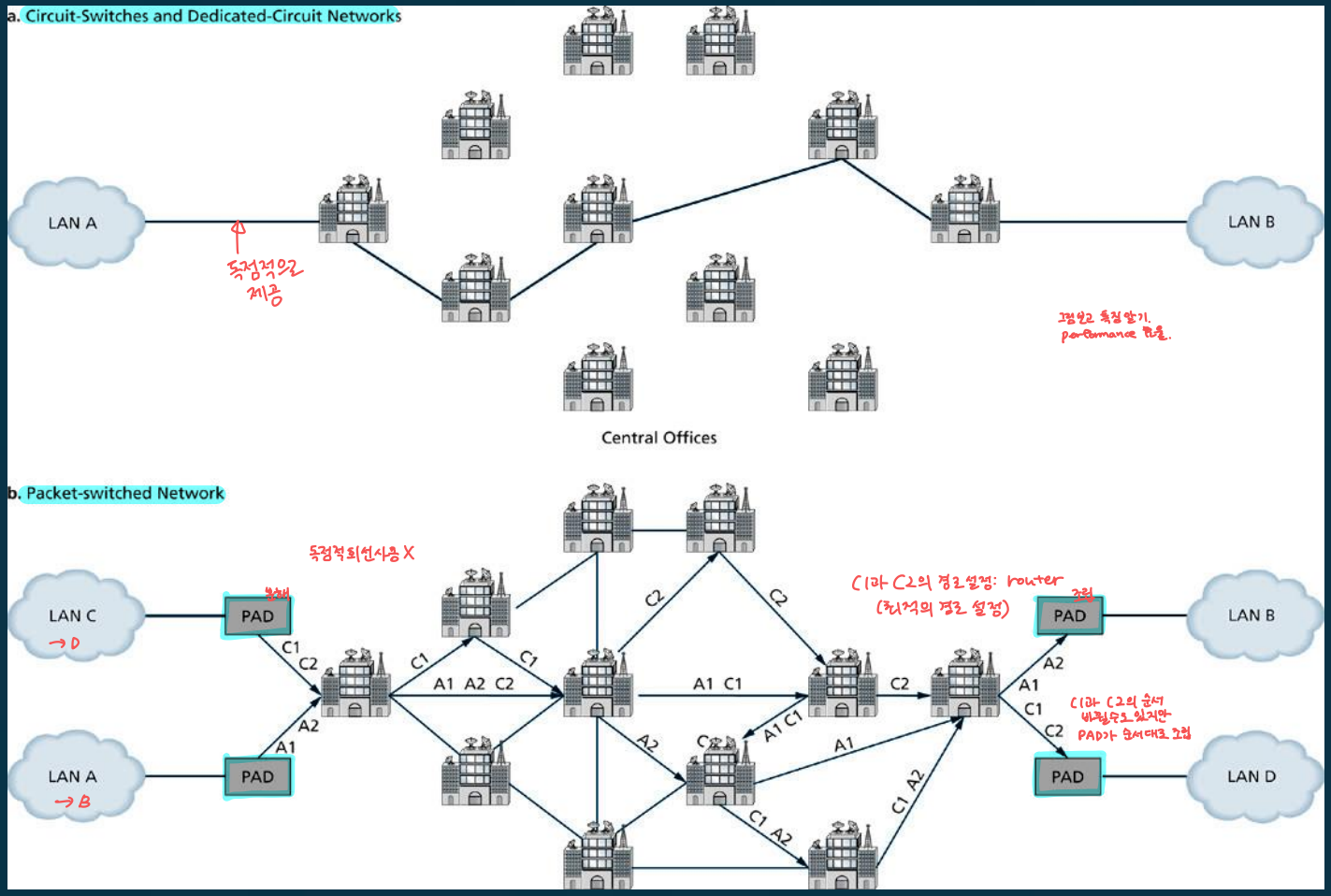
  독점 x, 비어있는 노선 이용 ⇒ 노선장비 절임

  - Were developed as more efficient data and voice transmission services – packet switching reduced idle time on transmission circuits.
  - Are always on and ready to transmit. call-setup 불필요.
  - There's no call setup with packet-switched services.
  - There's no wasted capacity when the connection is not in use.

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Packet-Switched Carrier Services (cont'd)
  - Are represented as a cloud in diagrams.
  - Are referred to as the Public Data Network (PDN). → (data를) packet 단위로 주고받음
  - Packets must pass through a packet assembler/disassembler (PAD) to reach the PDN.

Circuit-Switched and Dedicated-Circuit Networks vs. Packet-Switched Networks



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Packet-Switched Services ⟷ SONET
  - X.25 specifies data communications across the PSTN between remote computers with a maximum data rate of 64 Kbps.
  - Frame Relay provides data rates ranging from 56 Kbps to 45 Mbps
  - Asynchronous Transfer Mode (ATM) is the widely accepted standard of cell relay technology.

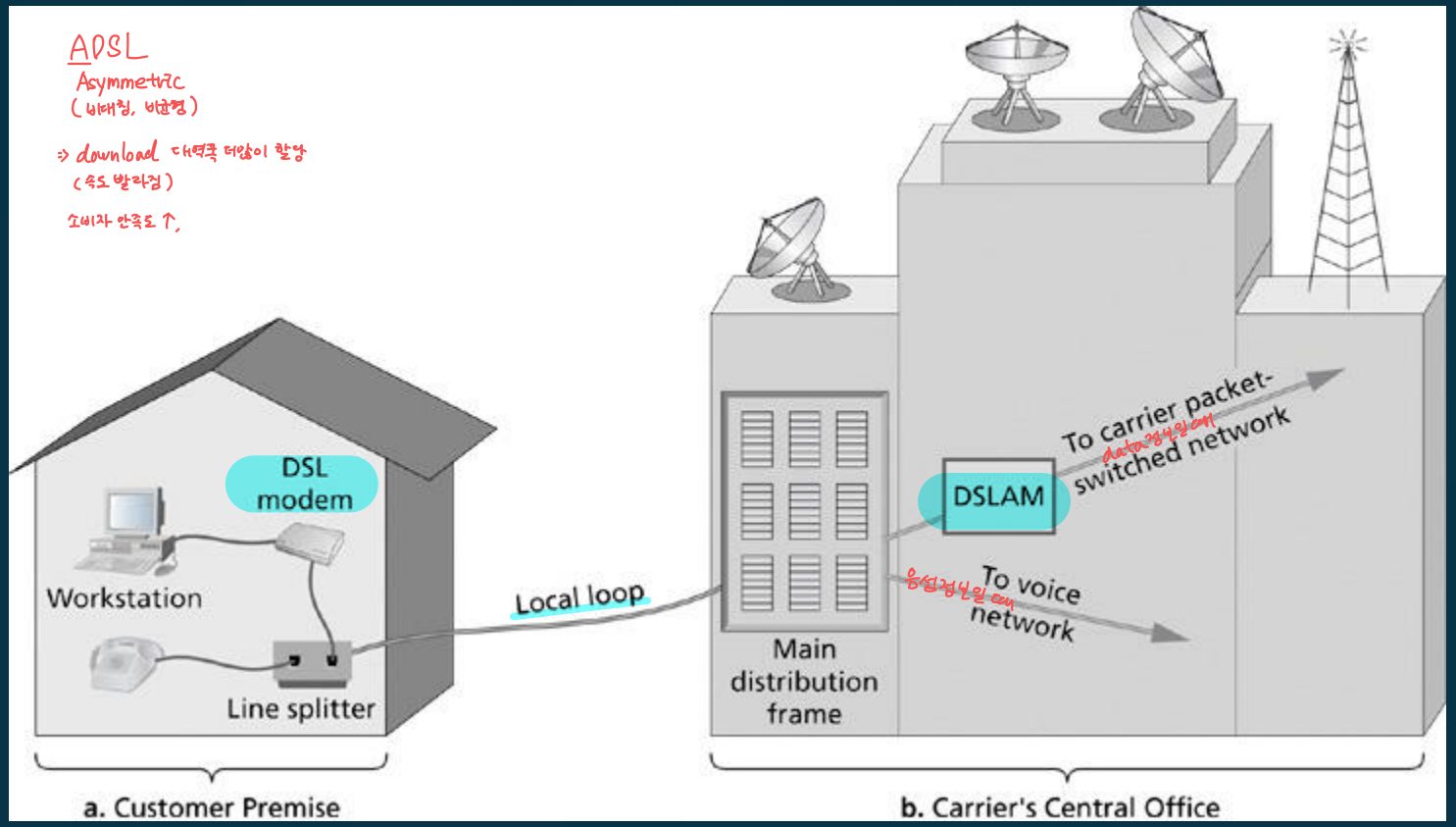
CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Other High-Speed Carrier Services

voice NW를 이용해서 voice, data 동시 이용가능하고, 속도↑

  - Digital Subscriber Line Technologies (DSL) use existing telephone lines for high-speed Internet access and data communications.
  - DSL requires extra equipment at both the customer location and at the carrier's central office.
  - Customers require a DSL modem and a line splitter.
  - The carrier's central office (CO) requires a main distribution frame to separate incoming voice and data traffic.
  - The carrier's CO also requires a digital subscriber line access multiplexer (DSLAM) to convert DSL data streams into ATM cells.

DSL Configuration



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Other High-Speed Carrier Services (cont'd)
  - VDSL is very-high-data-rate DSL.
  - Upload speeds approach 16 Mbps.
  - Download speeds approach 52 Mbps.
  - Distance between customer premise and central office must be 4,000 feet or less.
  - VDSL has competing standards that are not compatible with each other.

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

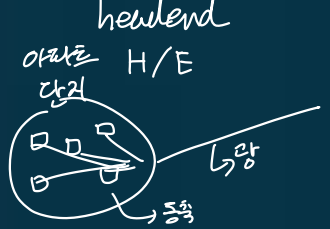
multiple SO 로 관리 ⇐ 망 자체연 자체망사업자 ↓ 유선케이블방송 사업자 SO system operator ⟷ No network operator 망을 가진사업

- Other High-Speed Carrier Services (cont'd)
  - Cable Television (CATV) is marketed toward home users, home offices, and small businesses.
  - Upload transmission rates of 3 Mbps and download rates in the 27-56 Mbps range are achievable.
  - Customer equipment includes a cable modem and an Ethernet NIC or USB port.
  - The CATV company provides the hybrid fiber coax (HFC) network, the cable headend transmitter, and the cable modem termination system (CMTS).

보안역할로 시작되었다 (지상파가 닿지않는 지역)

광 동축. 회선방송망

Internet service 제공자 컨트롤 장비



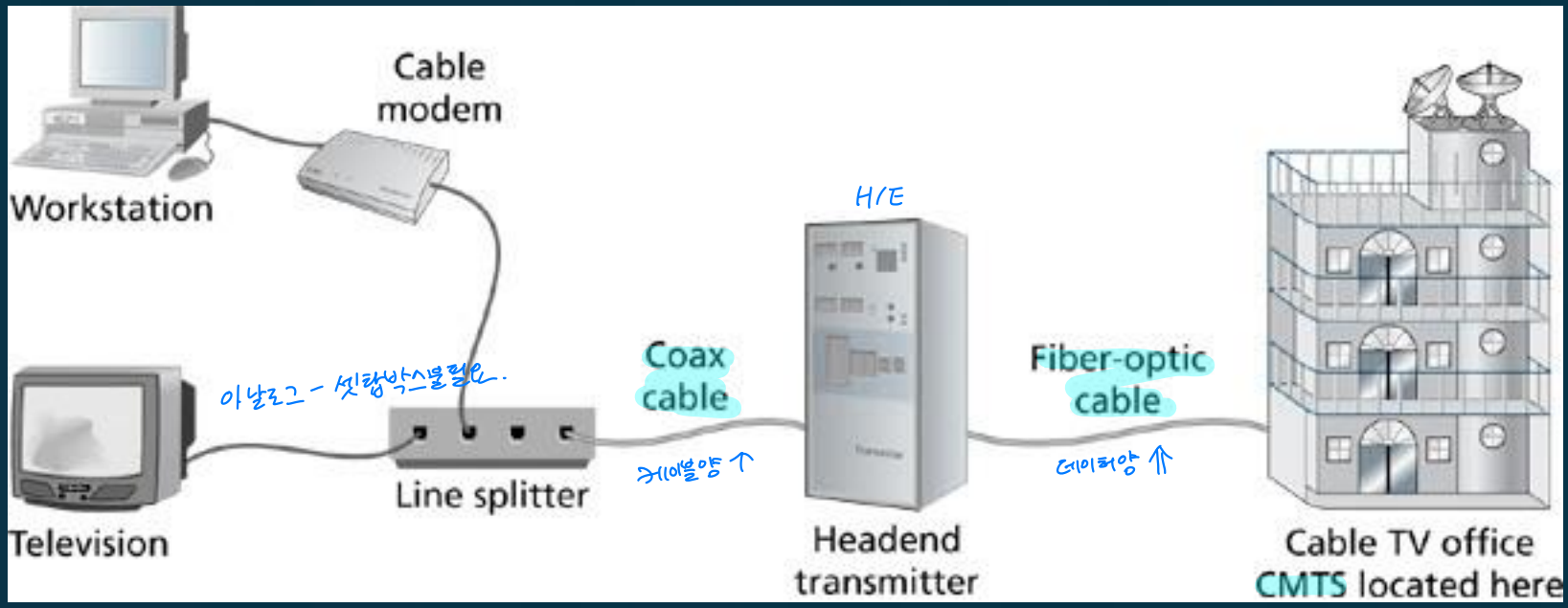
SO가 H/E → 셋탑박스로 모든 채널 신호보냄. (망이 좋기때문에 가능) = multicast

⇕

IPTV는 요청한채널의 정보가 H/E로 전송됨. → H/E에서 요청채널정보 전송 = broadcast

→ 초기의 대응. (IPTV도 지금은 upgrade)

Cable TV Network for Data Transmission



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

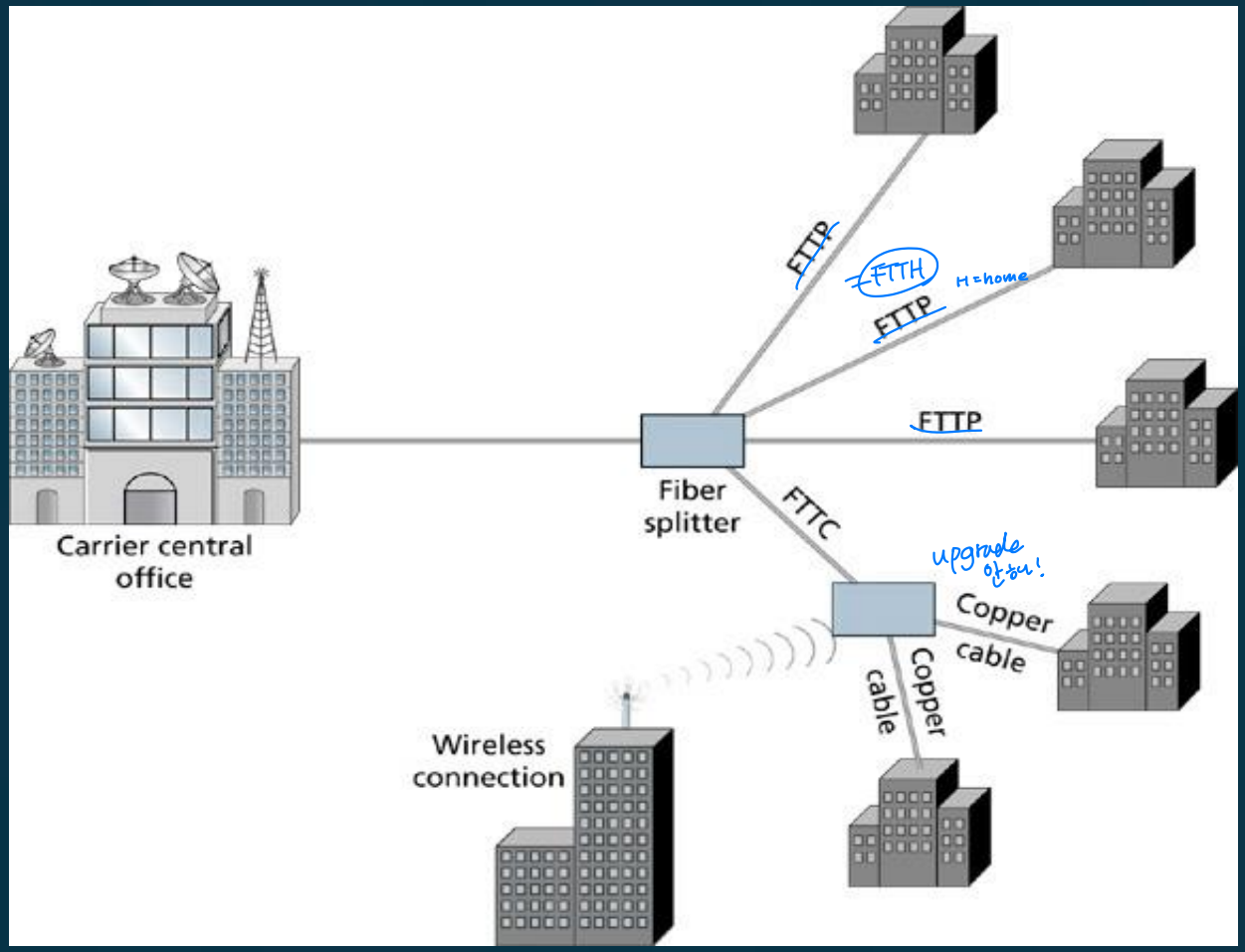
FTTH

- Other High-Speed Carrier Services (cont'd)
  - Metropolitan Ethernet networks (MENs) provide high-speed Ethernet connectivity beyond the physical boundaries of an organizations' campus.
  - 100 Mbps Ethernet, 1 Gbps Ethernet, or 10 Gbps Ethernet can be specified with the carrier.
  - The Metro Ethernet Forum (MEF) oversees the development of the metro Ethernet standards.

CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Other High-Speed Carrier Services (cont'd)
  - A passive optical network (PON) is a fiber optic network in which all active components have been removed between the customer and the carrier's CO.
  - Optical splitters distribute optical signals to multiple customers.
  - ATM-based PONs (APONs) provide 155 Mbps or 622 Mbps downstream and 155 Mbps upstream.
  - Ethernet PONs (EPONs) and Gigabit Ethernet PONs (GPONs) are in development.

Passive Optical Network



CONNECTIVITY TO REMOTE NETWORKS (cont'd)

- Other High-Speed Carrier Services (cont'd)
  - Wireless MAN/WAN services provide shared bandwidth of up to 70 Mbps over a 30-mile non-line-of-sight range.
  - Wireless MAN/WAN services are commonly known as WiMAX.
  - WiMAX follows the IEEE 802.16 standards.

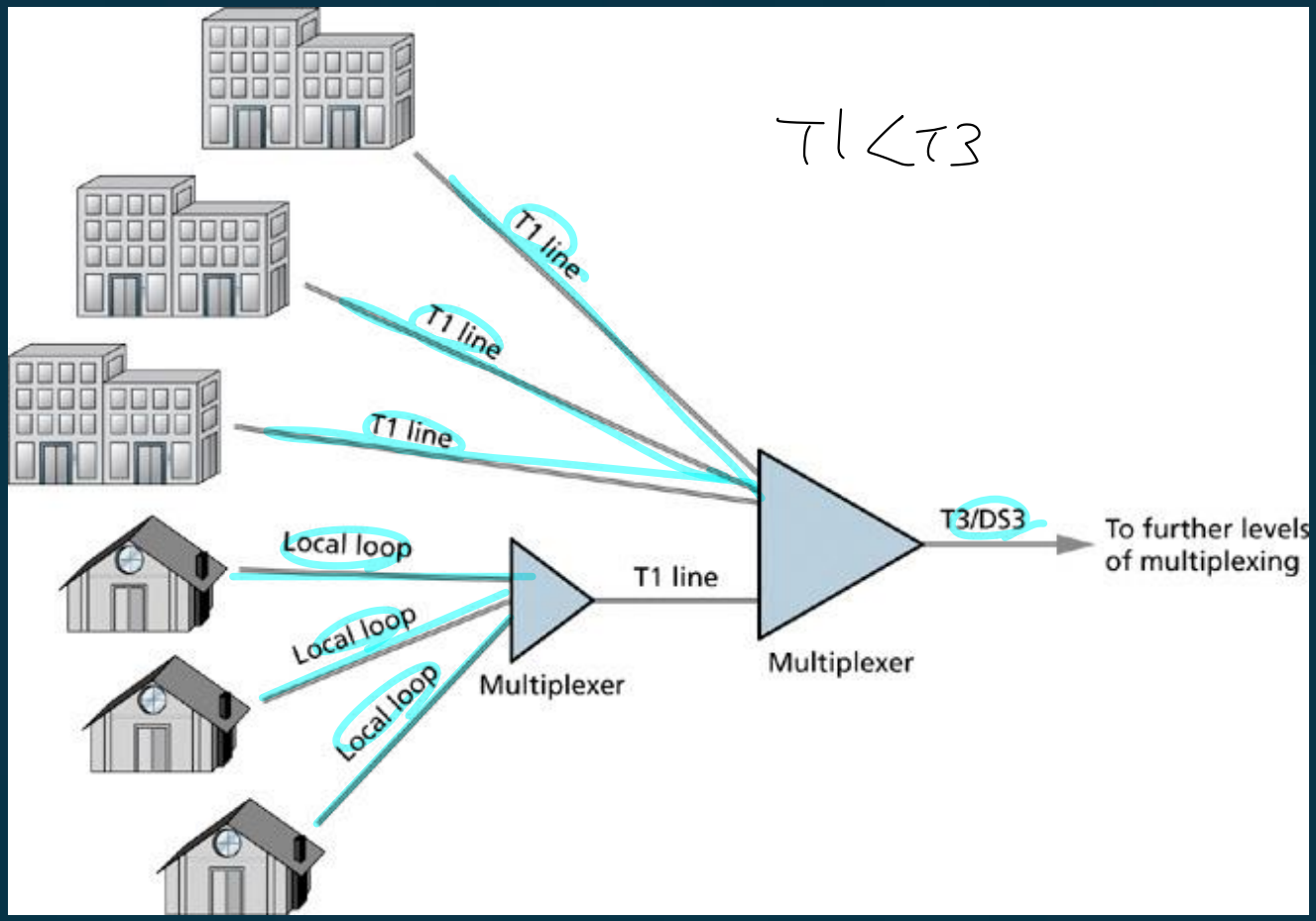
DATA COMMUNICATION THROUGH THE CARRIER

- Multiplexing (= 다중화) 하수도

합칠 수 있는 신호는 합쳐서 보낸다

  - Multiplexing combines multiple signals from multiple sources into a single, composite signal.
  - The composite signal traverses the carrier's and other carriers' networks.
  - Multiplexing makes more efficient use of carriers' available infrastructure and allows delivery of high-speed WAN services at affordable rates.

Multiplexing at the Carrier



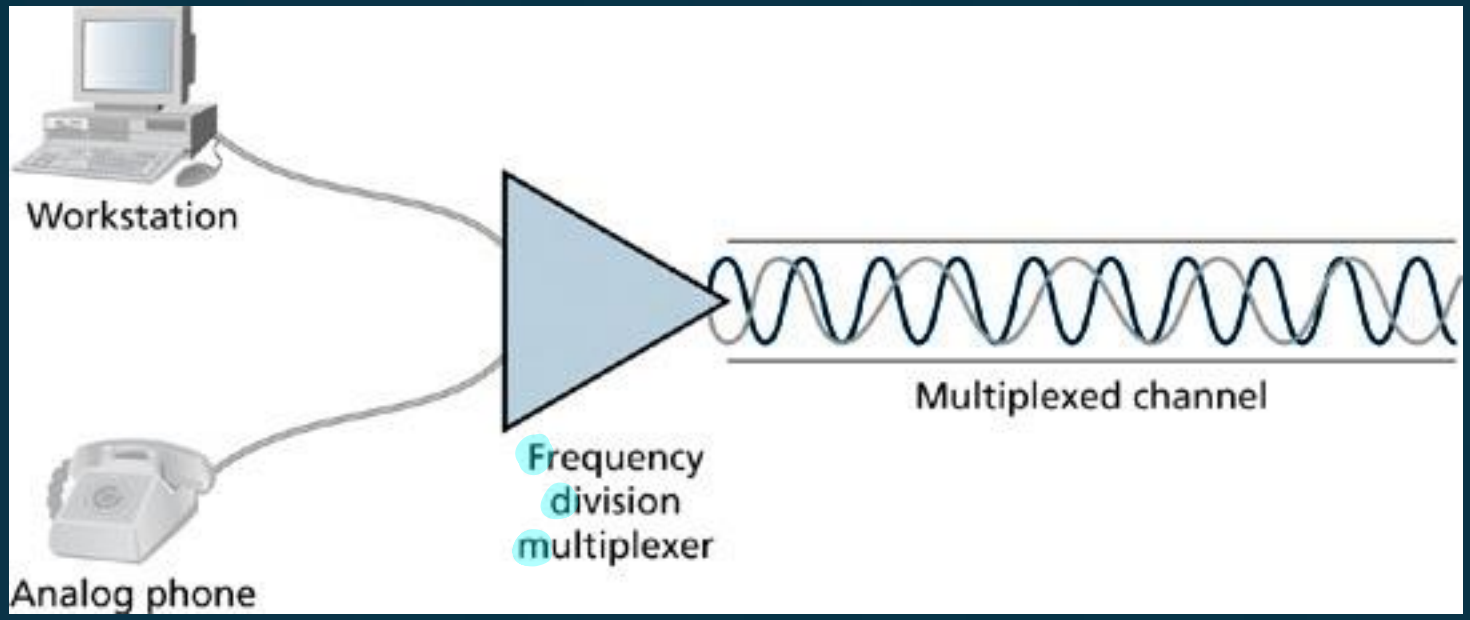
DATA COMMUNICATION THROUGH THE CARRIER (cont'd)

Multiplexing (cont'd)

- Several types of multiplexing are implemented by carriers to create these combined, complex signals:
  - Frequency division multiplexing (FDM)
  - Time-division multiplexing (TDM)
  - Statistical time-division multiplexing (STDM)
  - Wavelength division multiplexing (WDM)
  - Dense wavelength division multiplexing (DWDM)
  - Inverse multiplexing (IMUX)

FDMA
TDMA
etc
of multiplexing

Frequency Division Multiplexing



Time-Division Multiplexing