TEE 843 – Sistem Telekomunikasi

Teknologi Jaringan Akses

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Lhokseumawe, 2015

Jaringan Telekomunikasi:
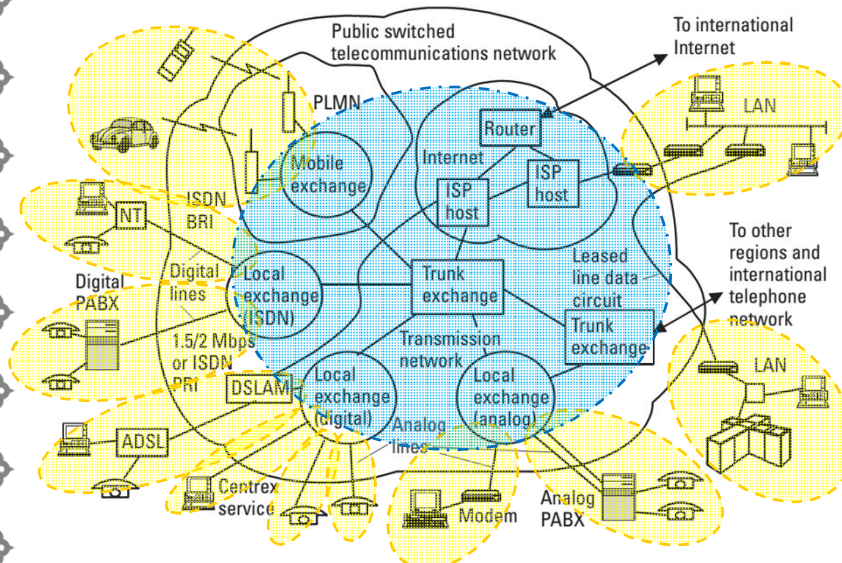## Jaringan Akses dan Jaringan Transmisi

Figure 2.20 Overview of the public switched telecommunications network.

Access Network

- The **access network** provides the connection between the subscriber's premises and the local exchange.
- This connection is commonly referred to as the *last mile*.
- Technologies used in the access network are:
  - the basic local loop, the fixed wireless local loop, and the digital subscriber loop (forming the PSTN),
  - cellular (forming the PLMN),
  - fiber-based techniques such as fiber to home (FTTH),
  - other broadband access techniques.

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Teknologi Jaringan Akses

1. *Local loop* pada PSTN
   - Leased Line
   - Voice-Band Modem
   - ISDN
   - DSL
2. Fiber Cable Access
3. Cable TV Network
4. LAN (Local Area Network)
5. Wireless Access

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Jaringan Akses pada PSTN

- Jaringan akses/lokal pada PSTN disebut *local loop* atau *subscriber loop.*
- Pada awalnya hanya menyediakan layanan komunikasi suara *(voice communications).*
- Lalu berkembang menyediakan layanan:
  - Leased Line
  - Voice-Band Modems
  - ISDN (Integrated Services Digital Network)
  - DSL (Digital Subscriber Line)
- Klasifikasi dan istilahnya di Indonesia:
  - Jarlokat (jaringan lokal akses tembaga)
  - Jarlokar (jaringan lokal akses radio)
  - Jarlokaf (jaringan lokal akses fiber)

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Leased Line

- The **leased line** is connected all the time, but **dial-up** or switched lines are connected only on demand.
- Leased lines can be used for **voice** (telephone), **data** or Internet services.
- Leased lines are available at speeds of 64 kbit/s, 128 kbit/s, 256 kbit/s, 512 kbit/s, 1 Mbit/s, 2 Mbit/s, 4 Mbit/s, 8 Mbit/s, 16 Mbit/s T1(1.544 Mbit/s) or E1(2.048 Mbit/s).
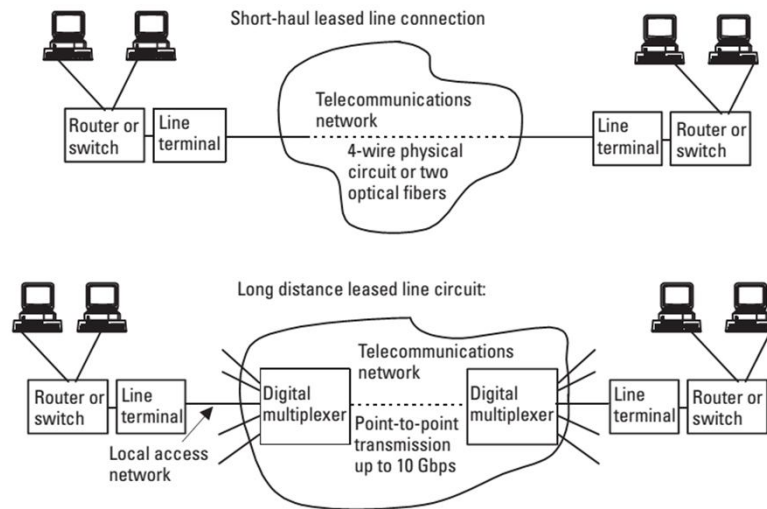
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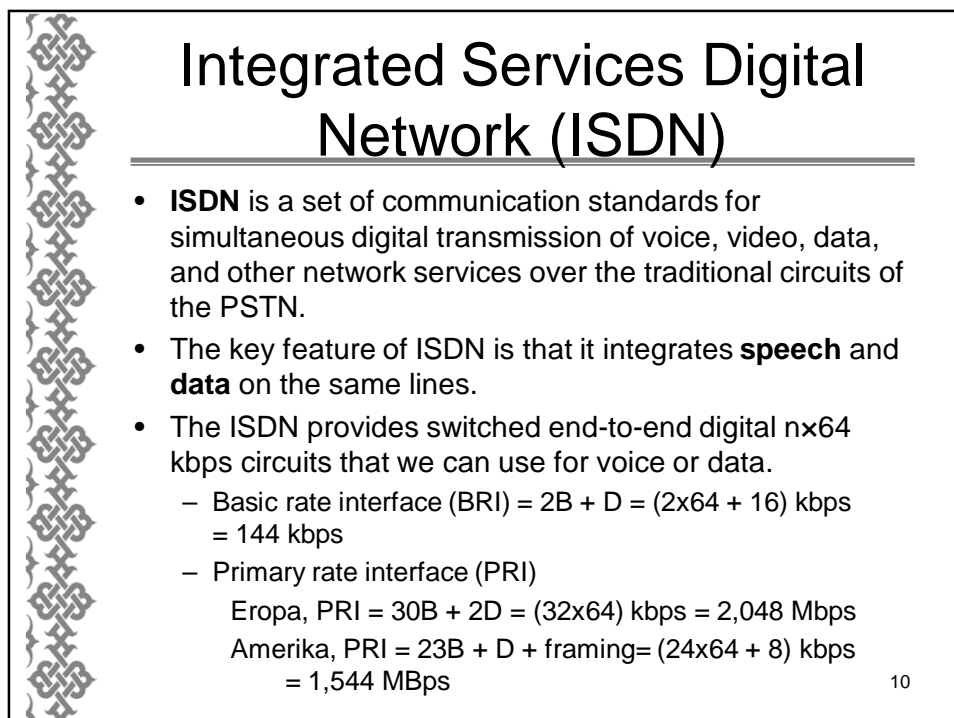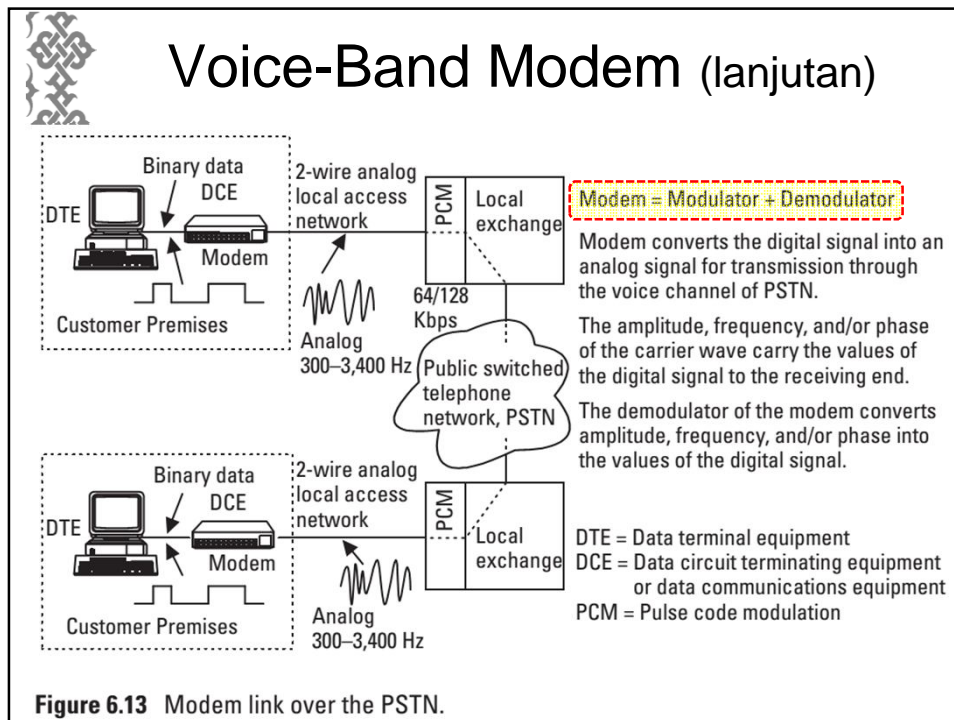
Leased Line (lanjutan)

Figure 6.24 Regional and long-distance leased lines.

Voice-Band Modem

- The word **modem** comes from the combination of the two devices, modulator and demodulator.
- **Modulation** converts a digital signal into an analog signal for transmission through a channel, and **demodulation** performs the conversion back to the original digital baseband data signal.
- **Voice-band modems** are needed when an analog voice channel of the telephone network is used for **data transmission**.
- The **frequency band** of the voice channel is 300 to 3,400 Hz and the baseband digital information is transferred to this band through CW modulation.

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Voice-Band Modem (lanjutan)

Modem = Modulator + Demodulator

Modem converts the digital signal into an analog signal for transmission through the voice channel of PSTN.
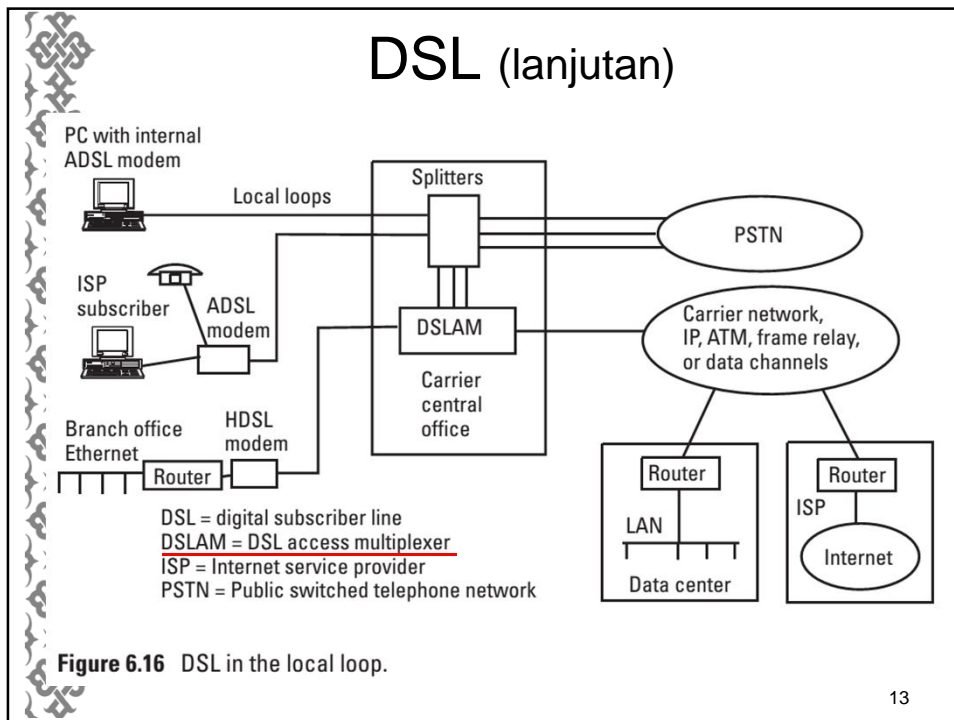
The amplitude, frequency, and/or phase of the carrier wave carry the values of the digital signal to the receiving end.

The demodulator of the modem converts amplitude, frequency, and/or phase into the values of the digital signal.

DTE = Data terminal equipment
DCE = Data circuit terminating equipment or data communications equipment
PCM = Pulse code modulation

Figure 6.13 Modem link over the PSTN.

Integrated Services Digital Network (ISDN)

- **ISDN** is a set of communication standards for simultaneous digital transmission of voice, video, data, and other network services over the traditional circuits of the PSTN.
- The key feature of ISDN is that it integrates **speech** and **data** on the same lines.
- The ISDN provides switched end-to-end digital n×64 kbps circuits that we can use for voice or data.
  - Basic rate interface (BRI) = 2B + D = (2x64 + 16) kbps = 144 kbps
  - Primary rate interface (PRI)

    Eropa, PRI = 30B + 2D = (32x64) kbps = 2,048 Mbps

    Amerika, PRI = 23B + D + framing= (24x64 + 8) kbps = 1,544 MBps

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ISDN (lanjutan)

64 Kbps
Network terminal
NT
ISDN telephone
S-interface
Fax (group 4)
Office A
U-interface

ISDN-Basic rate interface unit

Transmission network

ISDN exchange

64 Kbps

Ordinary 2-wire subscriber line with bidirectional 160 Kbps digital transmission

NT
ISDN telephone
S-interface
Fax (group 4)
Office B

ISDN-Basic rate interface unit

ISDN exchange

Basic rate interface, BRI, 2B+D: Two bearer channels (B) at 64 Kbps and one signaling channel (D) at 16 Kbps, 2B+D, totally 144 Kbps. The framing information increases data rate on a subscriber line to 160 Kbps.

Maximum 8 subscriber devices may be connected to NT and two of them may communicate at the same time

Primary rate interface, PRI: European PRI: 30 bearer channels, one signaling channel and framing, all at 64 Kbps make up data rate of 2.048 Mbps. Framing structure is the same as in ordinary 2 Mbps PCM. American PRI: 23B+D plus framing, 1.544 Mbps.

Digital Subscriber Line (DSL)

- In the DSL (*digital subscriber line* or *digital subscriber loop*) techniques, **data** and **speech** are separated at the local exchange site.
- The **speech** portion is connected to the switching (PSTN).
- The **data** portion is connected to the data network for Internet access.
- **Applications of DSL**: remote access to data center, Internet access, and interconection of LANs.
- Term **xDSL** refers to different variations of DSL, such as ADSL, HDSL, and RADSL.

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DSL (lanjutan)

PC with internal
ADSL modem

Local loops

Splitters

PSTN

ISP subscriber

ADSL modem

DSLAM

Carrier central office

Carrier network, IP, ATM, frame relay, or data channels

Branch office Ethernet

HDSL modem

Router

Router

LAN

Data center

Router

ISP

Internet

DSL = digital subscriber line
DSLAM = DSL access multiplexer
ISP = Internet service provider
PSTN = Public switched telephone network

Figure 6.16 DSL in the local loop.

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DSL (lanjutan)

Table 6.1
DSL Technologies, Access Distances, and Service Rates

DSL Technology	Reach (km)	Downstream Data Rate	Upstream Data Rate	Analog Phone	Market
IDSL	8	144 Kbps	144 Kbps	No	Residential
G.lite ADSL	5	1.5 Mbps	640 Kbps	Yes	Residential
HDSL	4	2/1.5 Mbps	2/1.5 Mbps	No	SME*
SDSL, G.shdsl	5–6	2.3 Mbps	2.3 Mbps	No	SME
G.dmt ADSL	3	...8 Mbps	...1.5 Mbps	Yes	Residential SME
VDSL	0.1–2	...52 Mbps (34 Mbps)	6 Mbps (34 Mbps)	Yes	Residential SME

*SME = small and medium size enterprises.

DSL (lanjutan)

Technology	Transmission	No. of Pairs	Maximum Bandwidth		
			Upstream	Downstream	
SDSL – Symmetric DSL	Symmetric	1 to 3	2 Mbps	2 Mbps	1st Generation Broadband
HDSL – High Speed DSL	Symmetric	1	2 Mbps	2 Mbps	
ADSL – Asymmetric DSL	Asymmetric	1	640 kbps	8 Mbps	
ADSL 2 – Asymmetric DSL	Asymmetric	1	640 kbps	12 Mbps	2nd Generation Broadband
**ADSL 2+ – Asymmetric DSL	Asymmetric	1	1.2 Mbps	25 Mbps	
VDSL – Very High Speed DSL	Symmetric	1	52 Mbps	52 Mbps	
	Asymmetric	1	16Mbps	52 Mbps	
VDSL2	Symmetric	1	100 Mbps	100 Mbps	
	Asymmetric	1	16 Mbps	100 Mbps	

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Teknik Modulasi pd DSL

- Baseband transmission
  - Pulse amplutude modulation (PAM), misalnya 2B1Q coding.
- Passband transmission
  - Single carrier mudulation:
    - Quadrature amplitude modulation (QAM)
    - Carrierless amplitude and phase (CAP)
  - Multicarrier modulation (MCM):
    - Discrete multitone (DMT)
    - Discrete wavelet multitone (DWMT)

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Spektrum Sinyal ADSL
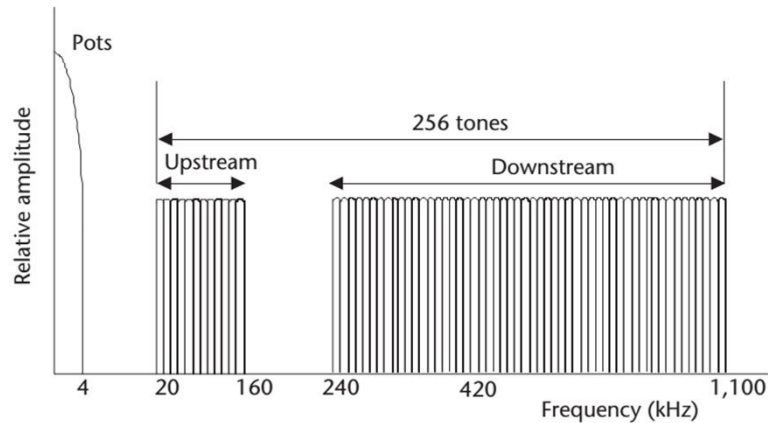
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Cable TV Network

- Jaringan TV kabel adlh jaringan televisi berbayar yg layanan utamanya menyediakan layanan siaran televisi.
- Dpt dipakai utk akses komunikasi data.
- Medium transmisinya utk distribusi siaran TV ke pelanggan-pelanggan biasanya berupa fiber optik dan kabel coaxial.
- Link satelit dipakai oleh provider utk menerima siaran TV dari stasiun televisi.
- Namun, di lapangan televisi berbayar yg pelanggannya langsung menerima siaran dari satelit terkadang juga disebut TV kabel.

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Jaringan TV Kabel

Figure 6.22 Traditional cable TV plant.

Jaringan TV Kabel plus Komunikasi Data

Figure 6.23 Cable TV plant modified for cable modem service.
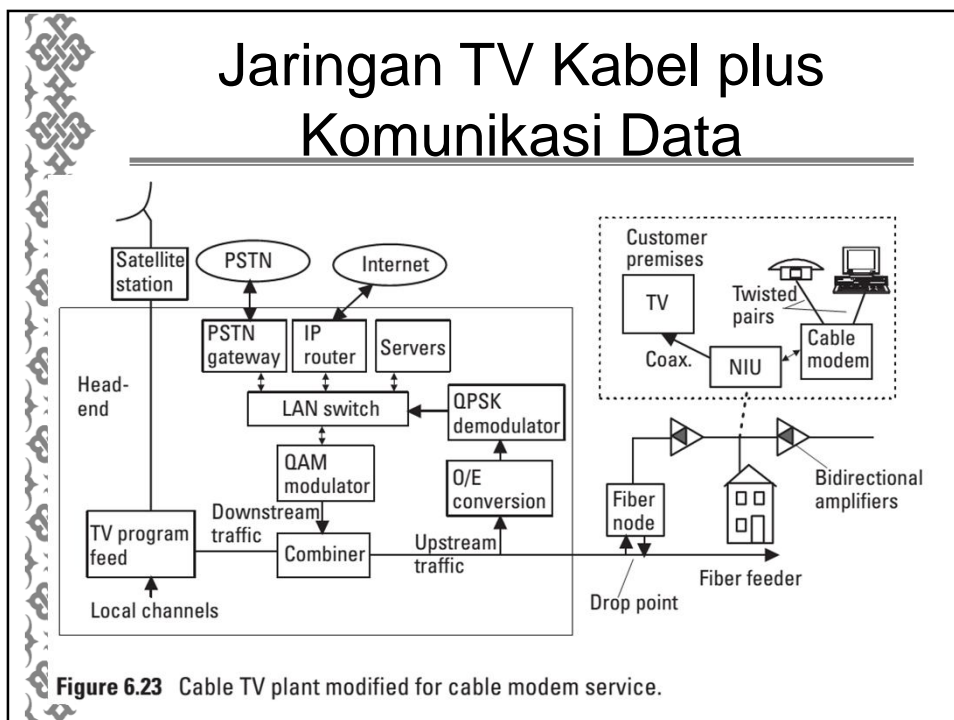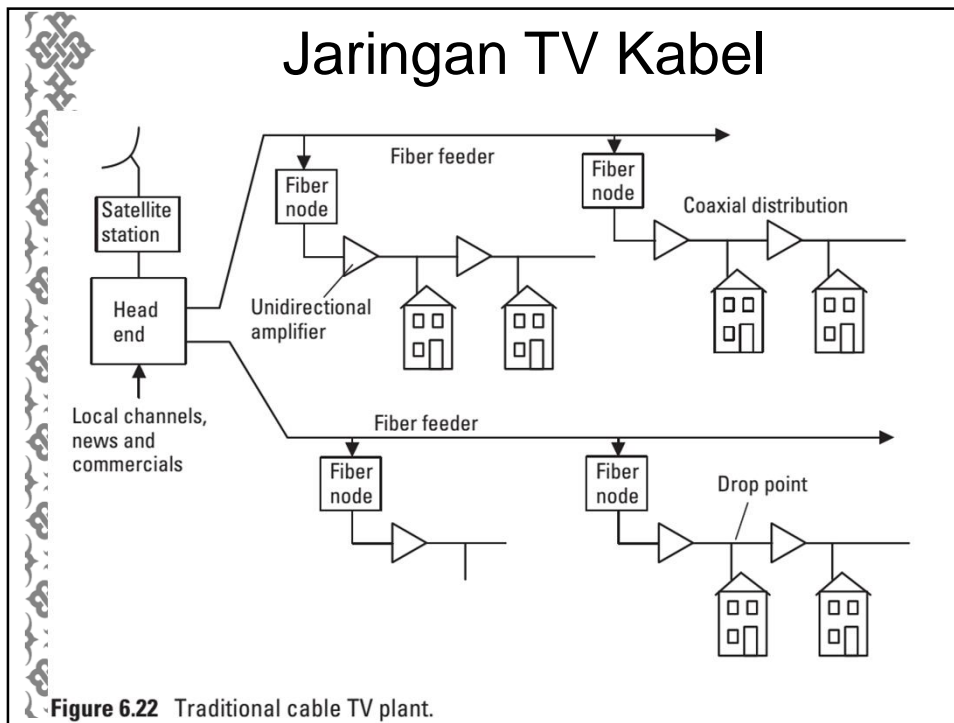
Local Area Network (LAN)

- **LANs** provide **high-data-rate communications between computers**, for example, inside one building.
- Because of the high transmission capacity (10 Mbps or higher) only **short distances** are allowed. The typical maximum transmission distance is a few hundred meters.
- **LANs can be interconnected** to make up a wide-area corporate network using switching devices (switches or bridges) or routers.
- The **bridges** or **switches** interconnect separate LAN segments and switch frames from one segment to another with the help of a local hardware address that is stored in the interface unit of each computer.
- **Routers** are devices that use network layer addresses for the routing of packets and they are used to connect LANs to other networks, for example, to the Internet. Routers can also be used to interconnect LANs that use different technologies.

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Two Basic Structures of LANs
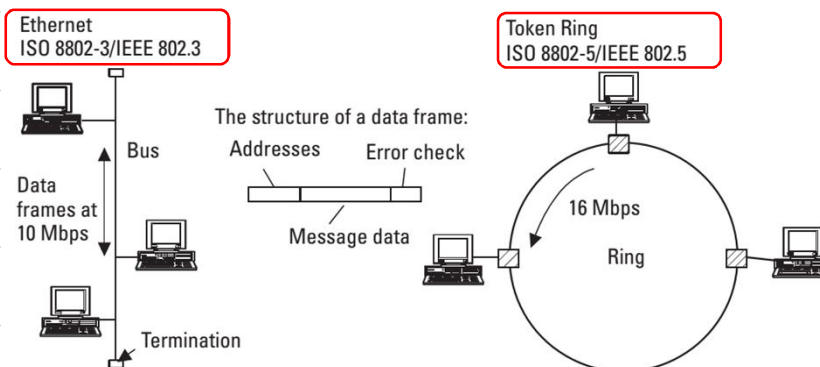
Figure 6.25 LAN structure.

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LANs Protocols

- Special protocols are standardized to make sure that only one computer transmits at a time.
- The complex standards of LANs specify OSI **layer 1**, the physical layer, and the so-called medium access sublayer (MAC) of **layer 2** (the data link layer).
- The basic task of these protocols is to connect acomputer to another via a shared medium as if they were connected by a point-to-point cable.
- The most common LAN is the **Ethernet**, which has been standardized as ISO 8802-3 or ANSI/IEEE 802-3.
- An Ethernet LAN is logically a **bus** although its physical structure is often a **star** where all stations are connected to wiring center called a **hub**.

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LANs Protocols (lanjutan)

- Another common LAN is the **token ring**, developed by IBM, and it is standardized as ISO 8802-5 or IEEE 802-5.
- The typical data rate of this LAN is 16 Mbps.
- In a token ring network, only a computer holding a special short frame called a **token** is able to transmit to the ring.
- Physically the token ring is always built as a **star** although logically it still makes up a ring.
- The token ring has some technical **advantages** over the Ethernet (no collisions, better bandwidth utilization, and deterministic operation) but it is much more complicated because of the token management and thus more expensive.
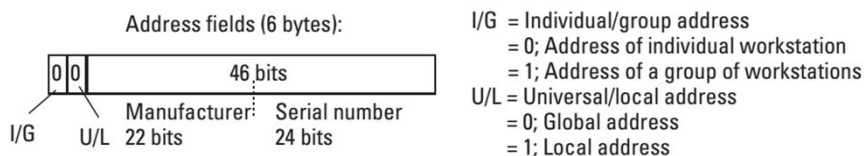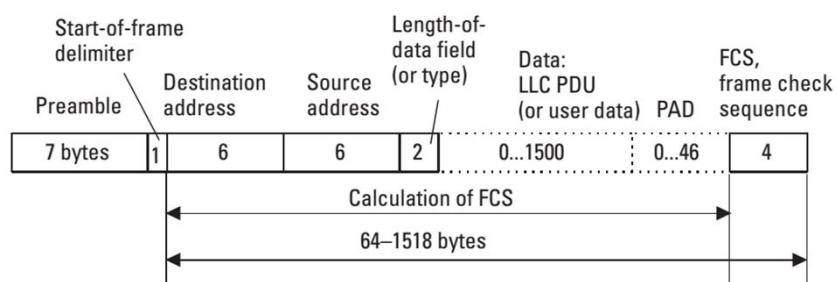
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Multiple-Access Scheme of the Ethernet

- The MAC layer in the **Ethernet** is defined in ISO 8802-3/IEEE 802.3 and this access method is called **CSMA/CD**.
- **Carrier sense (CS)** means that a workstation senses the channel and does not transmit if it is not free.
- **Multiple access (MA)** means that many workstations share the same channel.
- **Collision detection (CD)** means that each station is capable of detecting a collision that occurs if more than one station transmits at the same time. In the case of a collision, the workstation that detects it immediately stops transmitting and transmits a burst of random data to ensure that all other stations detect the collision as well.

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Frame Structure of the Ethernet

Figure 6.27 Frame structure of the Ethernet (MAC).

Switched Ethernet

Twisted pair, 100m or
fiber connection 10Base-F
up to 2 km

Hub — Hub

One collision domain

Switch

Hub — Hub

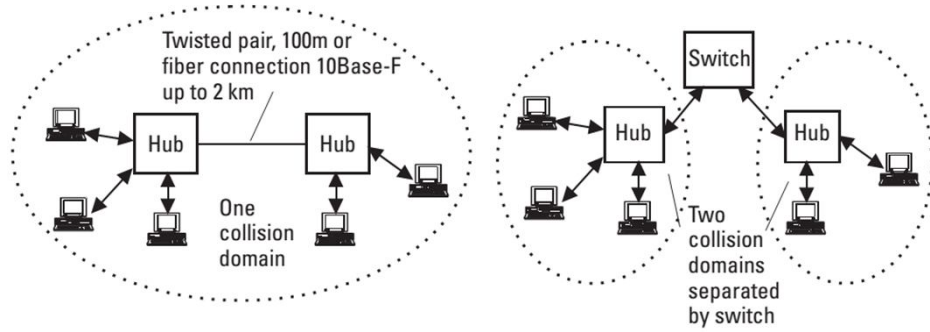Two collision domains separated by switch

Figure 6.32 Network extension with and without a switch.

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Switched Ethernet (lanjutan)

Switching table is updated if the source address in a received frame is unknown or binded to a different port. If no frames from the host are received for a certain period of time, its address is cleared from the table.

Data link layer address table

MAC address:	Port
080020000001	1
080020000002	1
080020000003	1
080020000008	2
080020000007	3

MAC address:
080020000001

Hub   P1   Switch   P3

080020000002

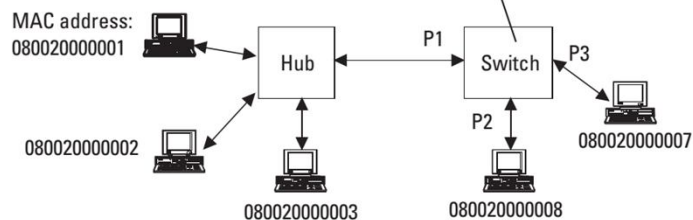080020000003   P2   080020000007

080020000008

Figure 6.33 Address or switching table of an autolearning switch.

Twisted Pair Cables for Ethernet

Table 6.2
Preferential Order of Ethernet Technologies on Twisted Pair

| Technology	Mode	Throughput/ Connection	Media
1000BaseTX	Full duplex	2 × 1 Gbps	4p UTP 5
1000BaseTX	Half duplex	1 Gbps	4p UTP 5
100BaseTX	Full duplex	2 × 100 Mbps	2p UTP 5/STP
100BaseT2	Half duplex	100 Mbps	2p UTP 3/4/5
100BaseT4	Half duplex	100 Mbps	4p UTP 3/4/5
100BaseTX	Half duplex	100 Mbps	2p UTP 5/STP
10BaseT	Full duplex	2 × 10 Mbps	2p UTP 3/4/5
10BaseT	Half duplex	10 Mbps	2p UTP 3/4/5

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Ethernet networking
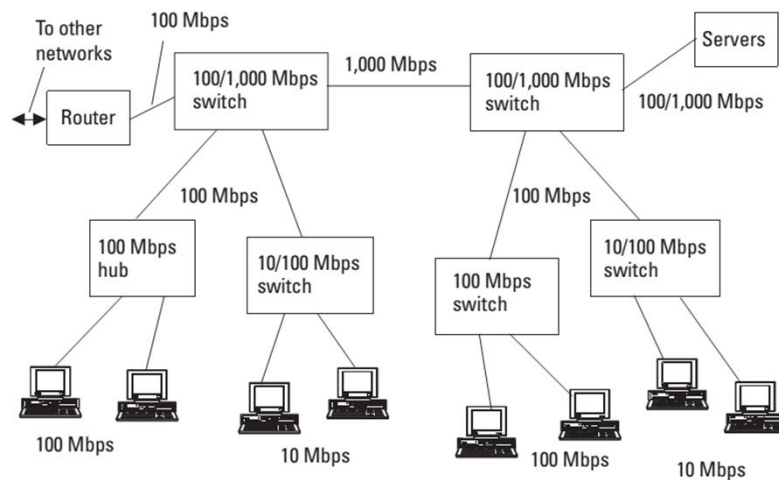
Figure 6.35 Ethernet network operating at 10, 100, and 1,000 Mbps.

Wireless Access

Jaringan Akses Nirkabel dpt berupa:

- Radio access network on PLMN (cellular systems)
- Mobile Satellites for Communications
- Wireless LAN
- WLL (Wireless Local Loop)
- WiMAX (Worldwide Interoperability for Microwave Access)

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Pengumuman
(Ralat Pengumuman Pekan Lalu)

- Berhubung hari Kamis tgl 14 Mei 2015 dan juga hari Sabtu tgl 16 Mei 2015 adlh hari libur nasional, maka rencana **kuliah pengganti** pd hari **Jum'at** tgl 15 Mei 2015 **dibatalkan**.
- Insya ALLAH, **kuliah pengganti** bagi kelas **A4 dan A1** akan dilaksanakan pd **hari Jum'at tgl 22 Mei 2015 jam 8.00–10.30 WIB**. Bagi peserta yg tdk bisa hadir pd jadwal ini, boleh masuk ke kelas A3 pd hari **Senin tgl 18 Mei 2015 jam 10.30 WIB**.
- Adapun kuliah hari Kamis tgl 21 Mei 2015 tetap seperti biasa. Lebih jelasnya perhatikan skema berikut ini:

Ahad 10/5	Senin 11/5 Materi-11	Selasa 12/5	Rabu 13/5	Kamis 14/5	Jumat 15/5	Sabtu 16/5

Ahad 17/5	Senin 18/5 Materi-12	Selasa 19/5	Rabu 20/5	Kamis 21/5 Materi-11	Jumat 22/5 Materi-12	Sabtu 23/5

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- Demikian diumumkan utk dilaksanakan. Terima kasih.

Sekian, ada pertanyaan?
Terima kasih, semoga berkah.

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