Chapter 2
Getting Connected

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TELKOM ENGINEERING SCHOOL

Telkom University

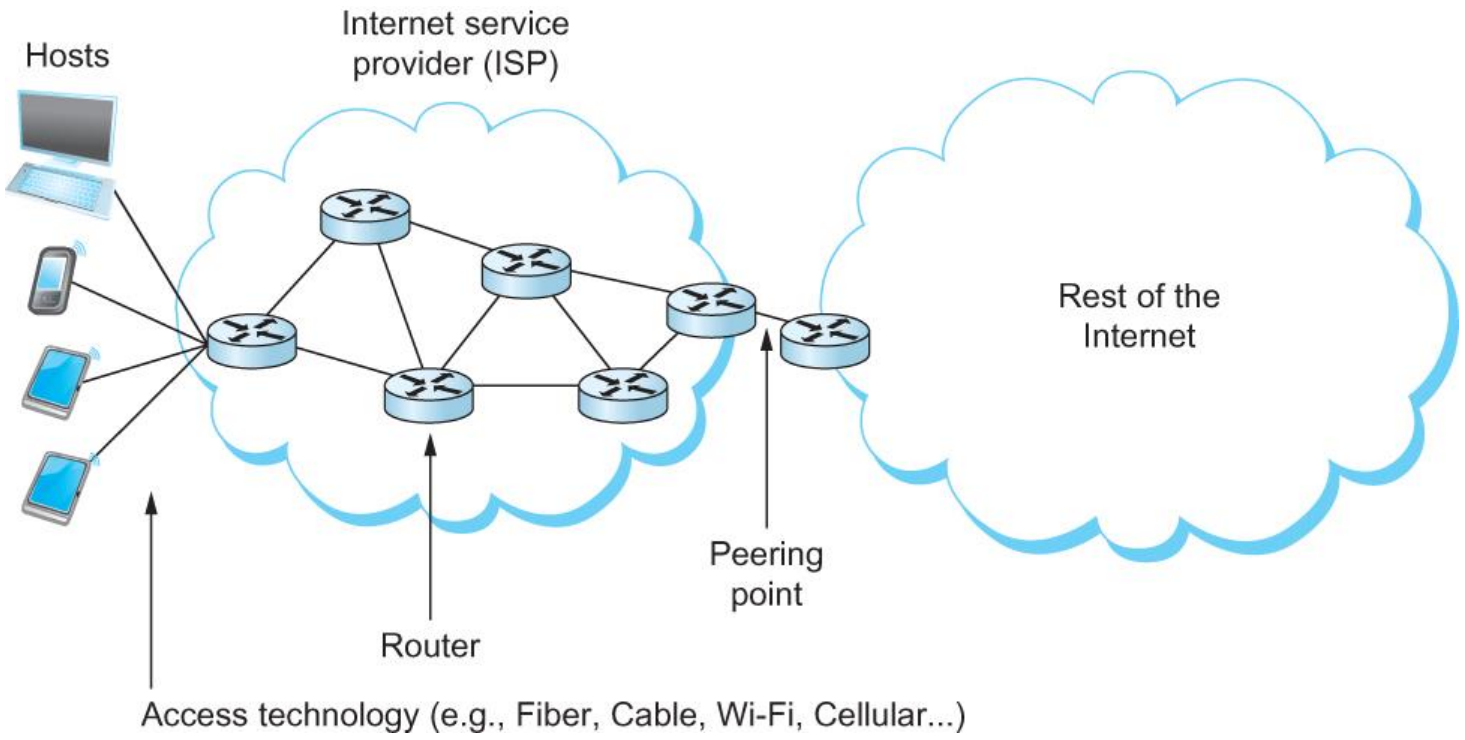
Agenda

Chapter 2. Getting Connected

2.1 Connecting
2.2 Encoding
2.3 Framing

2.4 Error Detection
2.5 Reliable
2.6 Ethernet
2.7. Wireless

Connecting



An end-user's view of the Internet

Shannon-Hartley Theorem

Signal Processing and Information Theory,

studying everything from how signals degrade over distance to how much data a given signal can effectively carry.

- **$C = B \log_2 (1+S/N)$**
  - Where B = 3300 – 300 = 3000Hz, S is the signal power, N the average noise.
  - The signal to noise ratio (S/N) is measured in decibels is related to $dB = 10 \times \log_{10}(S/N)$. If there is 30dB of noise then S/N = 1000.
  - Now **$C = 3000 \times \log_2(1001) = 30kbps$.**

Links

- All practical links rely on some sort of *electromagnetic radiation propagating* through a medium or, in some cases, through free space

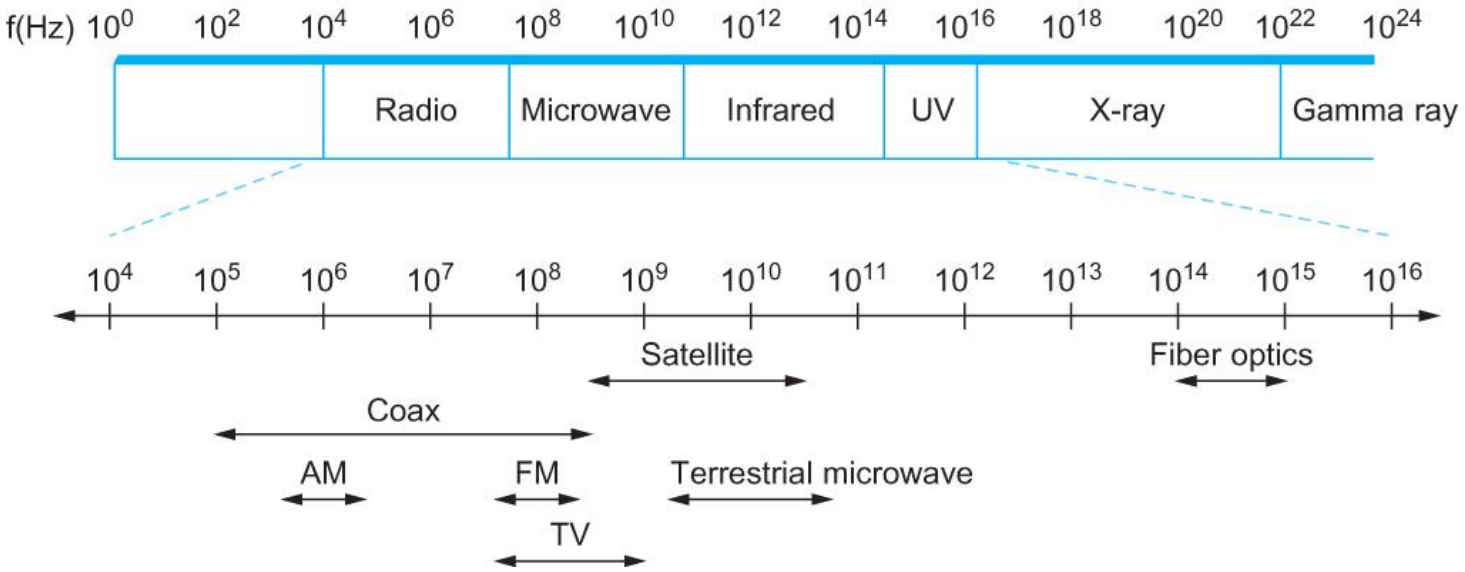
- One way to characterize links, then, is by the medium they use
  - Typically **copper wire** in some form (as in Digital Subscriber Line (DSL) and coaxial cable),
  - **Optical fiber** (as in both commercial fiber-to-the home services and many long-distance links in the Internet's backbone), or
  - **Air/free space** (for wireless links)

Links

- Another important link characteristic is the *frequency*
  - Measured in hertz, with which the electromagnetic waves oscillate
- Distance between the adjacent pair of maxima or minima of a wave measured in meters is called *wavelength*
  - Speed of light divided by frequency gives the wavelength.
  - Frequency on a copper cable range from 300Hz to 3300Hz; Wavelength for 300Hz wave through copper is speed of light on a copper / frequency
  - $2/3 \times 3 \times 10^8 / 300 = 667 \times 10^3$ meters.

- Placing binary data on a signal is called *encoding*.
- Modulation involves modifying the signals in terms of their frequency, amplitude, and phase.

Links



Electromagnetic spectrum

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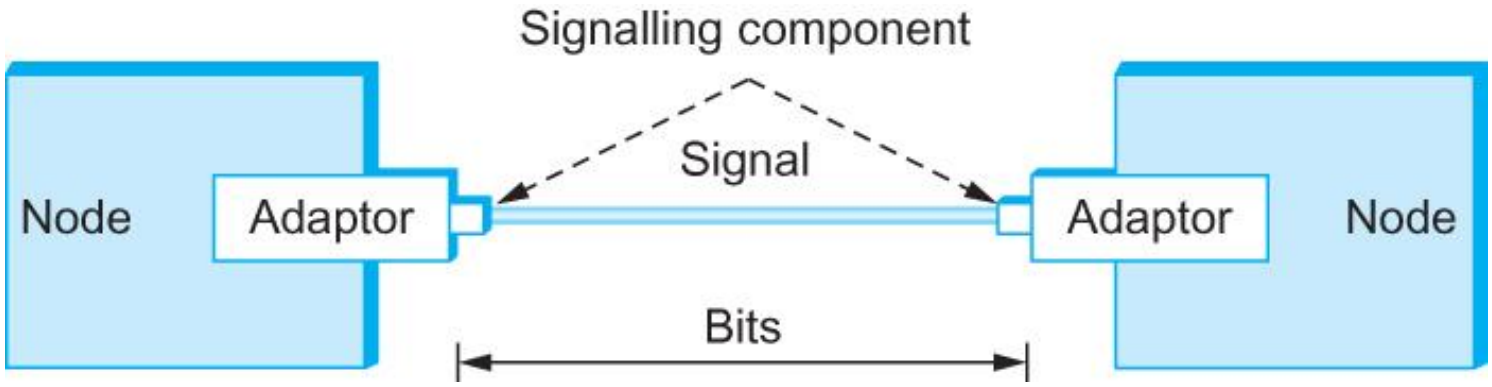
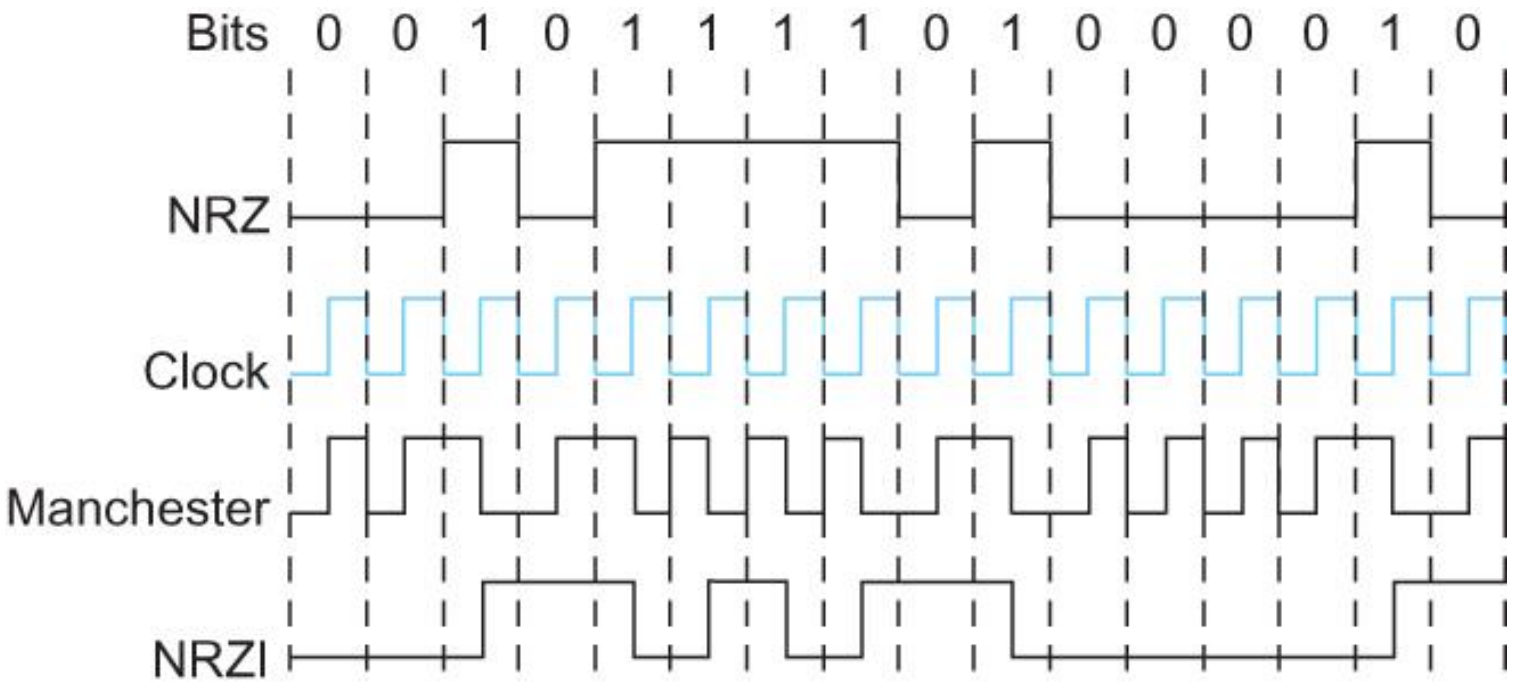
Encoding

- Placing binary data on a signal is called *encoding*.



- Signals travel between signaling components; bits flow between adaptors

Encoding



Task 1 : no.1

Jelaskan kelebihan dan kekurangan dari Encoding

a. NRZ
b. Clock
c. Manchester
d. NRZI
e. 4B/5B

Tulis Tangan

Batas akhir kamis 19/9/13

12.01pm, Lab Telematika (F223)

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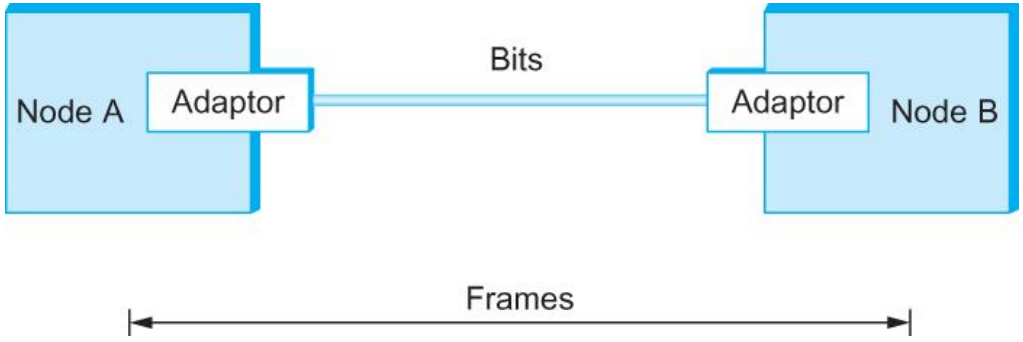
Framing

- We are focusing on ***packet-switched networks***, which means that blocks of data (called *frames* at this level), not bit streams, are exchanged between nodes.
- It is the network adaptor that enables the nodes to *exchange* frames.

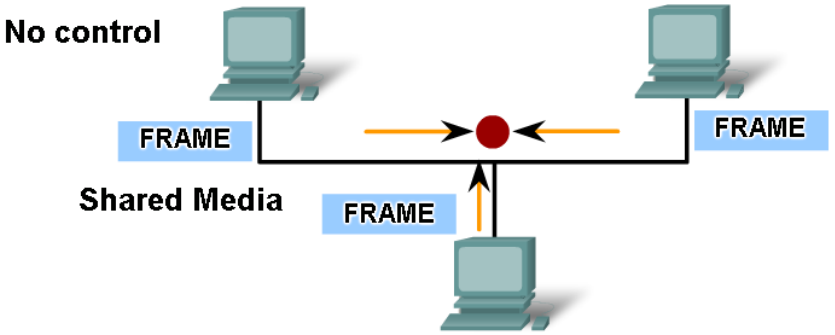


Bits flow between adaptors, frames between hosts

Framing

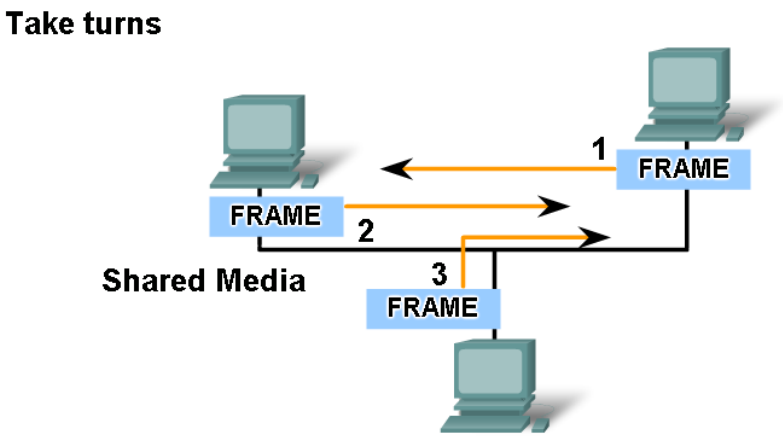
Media Access Control Methods

No control at all would result in many collisions. Collisions cause corrupted frames that must be resent.



Methods that enforce a high degree of control prevent collisions, but the process has high overhead.

Methods that enforce a low degree of control have low overhead, but there are more frequent collisions.



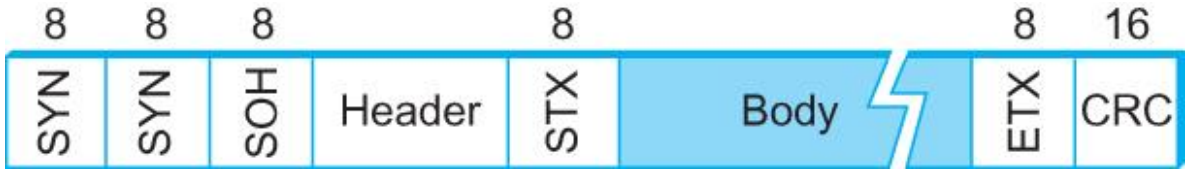
Framing

There are several ways to address the framing problem. This section uses several different protocols to illustrate the various points in the design space.

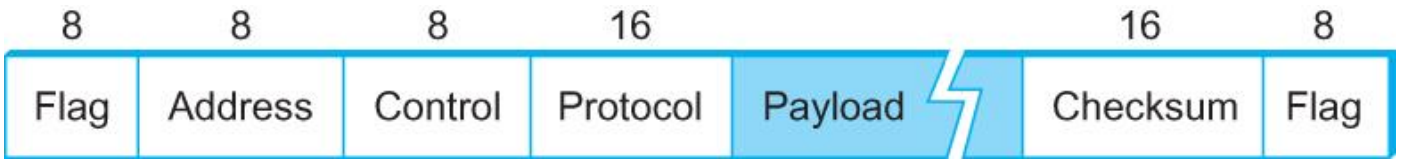
1) Byte-Oriented Protocols (BISYNC, PPP, DDCMP)
2) Bit-Oriented Protocols (HDLC)
3) Clock-Based Framing (SONET)

Byte Oriented Protocols

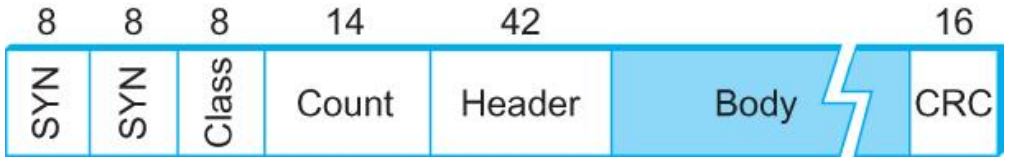
- BISYNC Frame Format (SYN,STX, ETX)



- PPP Frame Format (Flags, Checksum)



- DDCMP Frame Format (Count)



Bit Oriented Protocols

HDLC : High Level Data Link Control

Beginning and Ending Sequences **0 1 1 1 1 1 1 0**

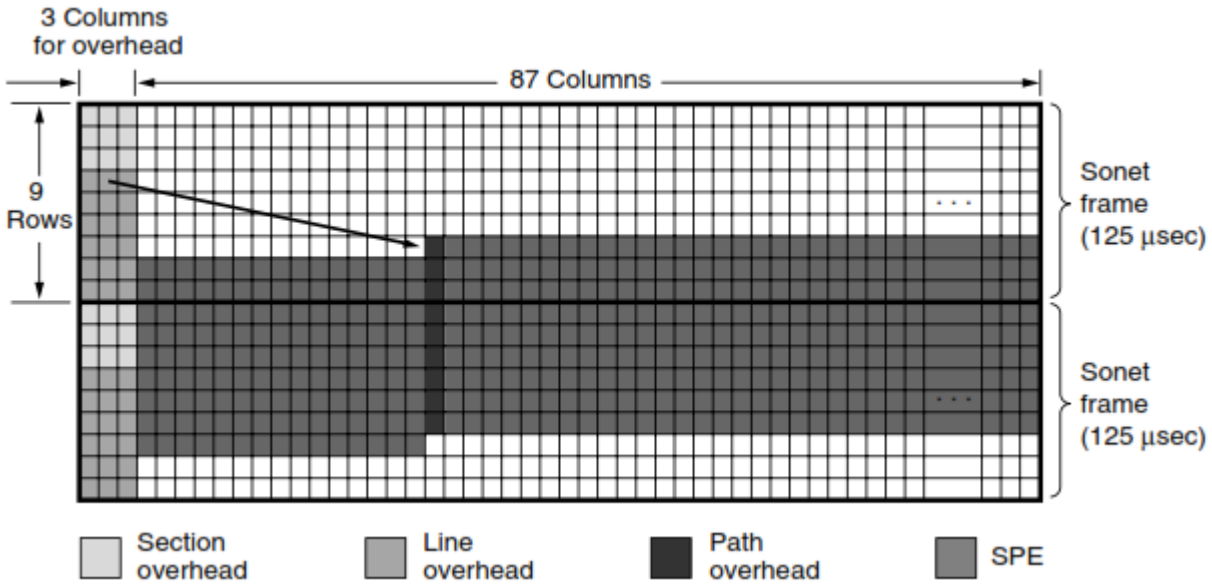
Clock Based Framing

- *Synchronous Optical Network (SONET)*

- SONET was first proposed by Bell Communications Research (Bellcore), and then developed under the American National Standards Institute (ANSI) for digital transmission over optical fiber; it has since been adopted by the ITU-T.
- SONET has been for many years the dominant standard for *long-distance transmission of data over optical networks*.

Clock Based Framing

- *Synchronous Optical Network (SONET)*



Tanenbaum , 2011.

SONET and SDH

SONET		SDH	Data rate (Mbps)		
Electrical	Optical	Optical	Gross	SPE	User
STS-1	OC-1		51.84	50.112	49.536
STS-3	OC-3	STM-1	155.52	150.336	148.608
STS-12	OC-12	STM-4	622.08	601.344	594.432
STS-48	OC-48	STM-16	2488.32	2405.376	2377.728
STS-192	OC-192	STM-64	9953.28	9621.504	9510.912
STS-768	OC-768	STM-256	39813.12	38486.016	38043.648

Tanenbaum , 2011.

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Error Detection

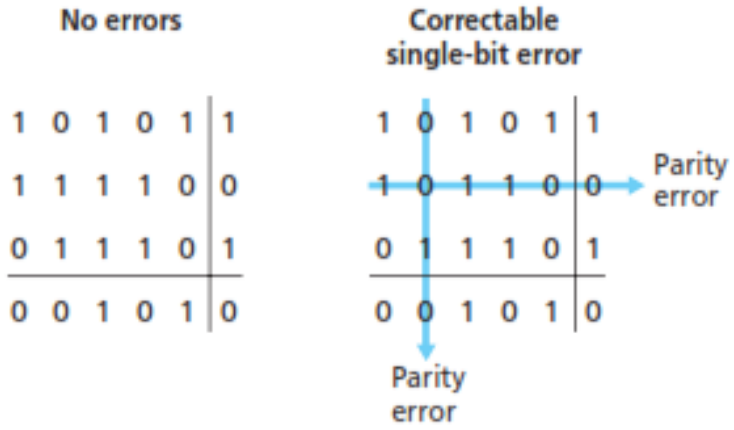
- Bit errors are introduced into frames
  - Because of **electrical interference** and **thermal noises**
- Detecting Error
- Correction Error

- Two approaches when the recipient detects an error
  - Notify the sender that the message was corrupted, so the sender can send again.
    - If the error is rare, then the retransmitted message will be error-free
  - Using some error correct detection and correction algorithm, the receiver reconstructs the message

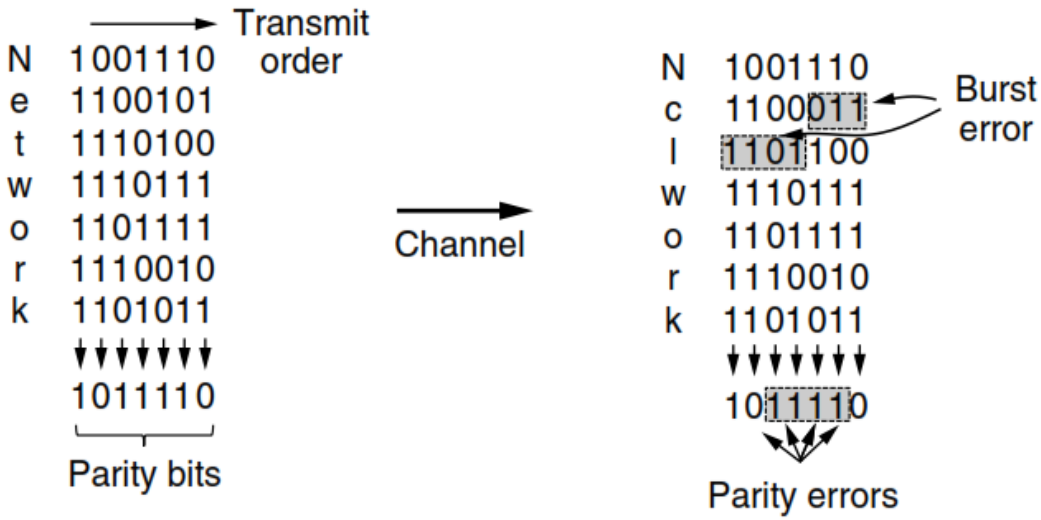
Error Detection

- Common technique for detecting transmission error
  - CRC (Cyclic Redundancy Check)
    - Used in HDLC, DDCMP, CSMA/CD, Token Ring
  - Other approaches
    - Two Dimensional Parity (BISYNC)
    - Checksum (IP)

Two Dimensional Parity



Kurose, 2013.



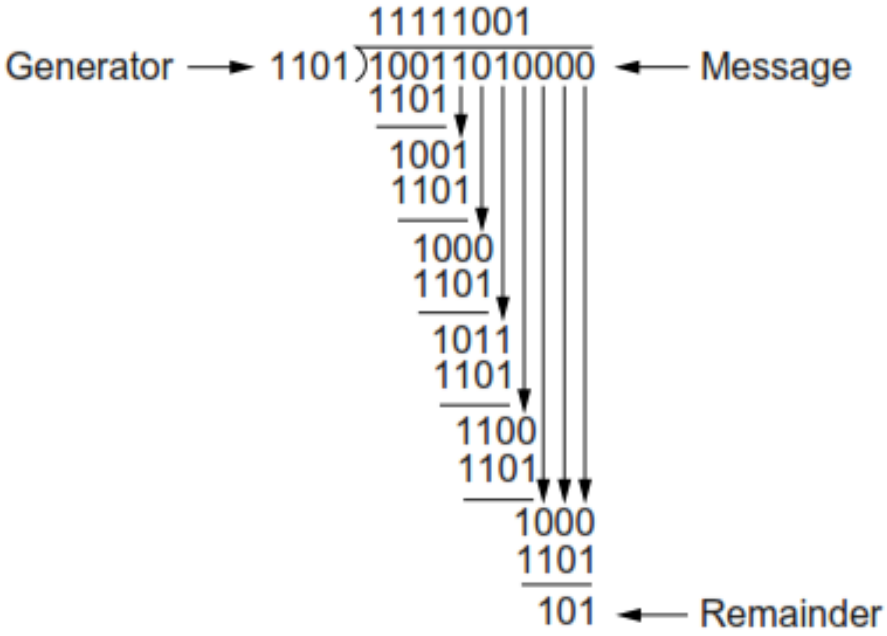
Tanenbaum , 2011.

Internet Checksum

- The idea behind the **Internet checksum** is very simple—you add up all the words that are transmitted and then transmit the result of that sum.
- The result is the checksum. The receiver performs the *same calculation* on the received data and *compares* the result with the received checksum.
- One example of a checksum is the **16-bit Internet checksum** used on all Internet packets as part of the IP protocol (Braden et al., 1988).

CRC (Cyclic Redundancy Check)

- ***CRC***, also known as a ***Polynomial Code***.
  M(x) = $X^7+X^4+X^3+X$ and G(x) = X^3+X^2+1



- So, **T(x) = 10011010101**

Tanenbaum , 2011.

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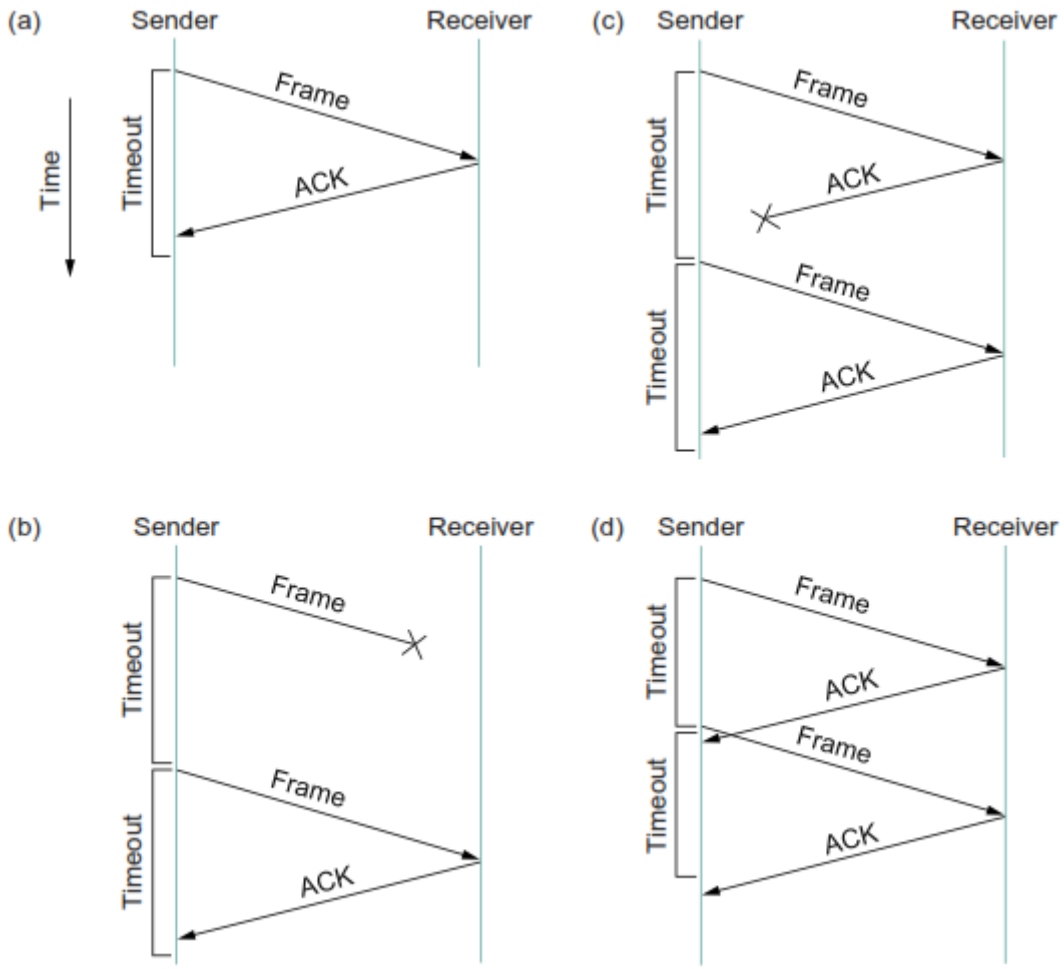
Reliable Transmission

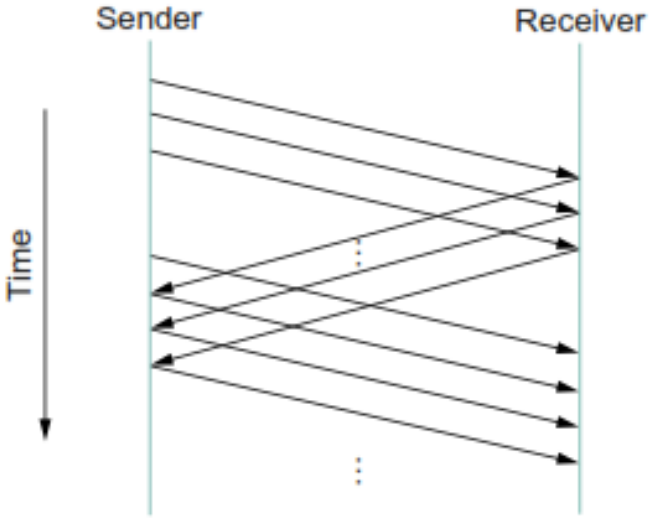
- CRC is used to **detect errors**.
- Some error codes are strong enough to correct errors.
- The overhead is typically too high.
- **Corrupt frames** must be discarded.
- A link-level protocol that wants to deliver frames reliably must recover from these discarded frames.

- This is accomplished using a combination of two fundamental mechanisms
  - ***Acknowledgements*** *and* ***Timeouts***
- The general strategy of using acknowledgments and timeouts to implement reliable delivery is sometimes called ***Automatic Repeat reQuest*** *(ARQ).*

1. STOP and WAIT



2. SLIDING WINDOWS



3. Concurrent Logical Channels

- The data link protocol used in the ARPANET provides an interesting alternative to the sliding window protocol, in that it is able to keep the pipe full while still using the simple stop-and-wait algorithm.

- The idea underlying the ARPANET protocol, which we refer to as *concurrent logical channels, is to multiplex several logical channels onto a* single point-to-point link and to run the stop-and-wait algorithm on each of these logical channels.

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Ethernet

- Developed in the mid-1970s by researchers at the Xerox Palo Alto Research Centers (PARC).

- Uses CSMA/CD technology
  - Carrier Sense Multiple Access with Collision Detection.
  - A set of nodes **send** and **receive** frames over a shared link.
  - Carrier sense means that all nodes *can distinguish between an idle and a busy link*.
  - Collision detection means that *a node listens* as it transmits and can *therefore detect when a frame it is transmitting has collided* with a frame transmitted by another node.

Ethernet

- Uses ALOHA (packet radio network) as the root protocol
- DEC and Intel joined Xerox to define a 10-Mbps Ethernet standard in 1978.
- This standard formed the basis for IEEE standard 802.3

Ethernet					
8	6	6	2	46 to 1500	4
Preamble	Destination Address	Source Address	Type	Data	Frame Check Sequence

IEEE 802.3						
7	1	6	6	2	46 to 1500	4
Preamble	Start of Frame delimiter	Destination Address	Source Address	Length/ Type	802.2 Header and Data	Frame Check Sequence

Ethernet

Physical Media - Characteristics

Ethernet Media

	10BASE-T	100BASE-TX	100BASE-FX	1000BASE-CX	1000BASE-T	1000BASE-SX	1000BASE-LX	1000BASE-ZX	10GBASE-ZR
Media	EIA/TIA Category 3, 4, 5 UTP, two pair	EIA/TIA Category 3, 4, 5 UTP, two pair	50/62.5 µm multi mode fiber	STP	EIA/TIA Category 3, 4, 5 UTP, four pair	62.5/50 micron multimode fiber	50/62.5 micron multimode fiber or 9 micron single mode fiber	9µm single mode fiber	9µm single mode fiber
Maximum Segment Length	100m (328 feet)	100m (328 feet)	2 km (6562 ft)	25 m (82 feet)	100 m (328 feet)	Up to 550 m (1,804 ft) depending on fiber used	550 m (MMF)10 km (SMF)	Approx. 70 km	Up to 80 km
Topology	Star	Star	Star	Star	Star	Star	Star	Star	Star
Connector	ISO 8877 (RJ-45)	ISO 8877 (RJ-45)		ISO 8877 (RJ-45)	ISO 8877 (RJ-45)				

Ethernet

- Any signal placed on the Ethernet by a host is broadcast over the entire network
  - **Signal** is propagated in both directions.
  - **Repeaters** forward the signal on all outgoing segments.
  - **Terminators** attached to the end of each segment absorb the signal.

- **Ethernet** uses **Manchester encoding scheme**.

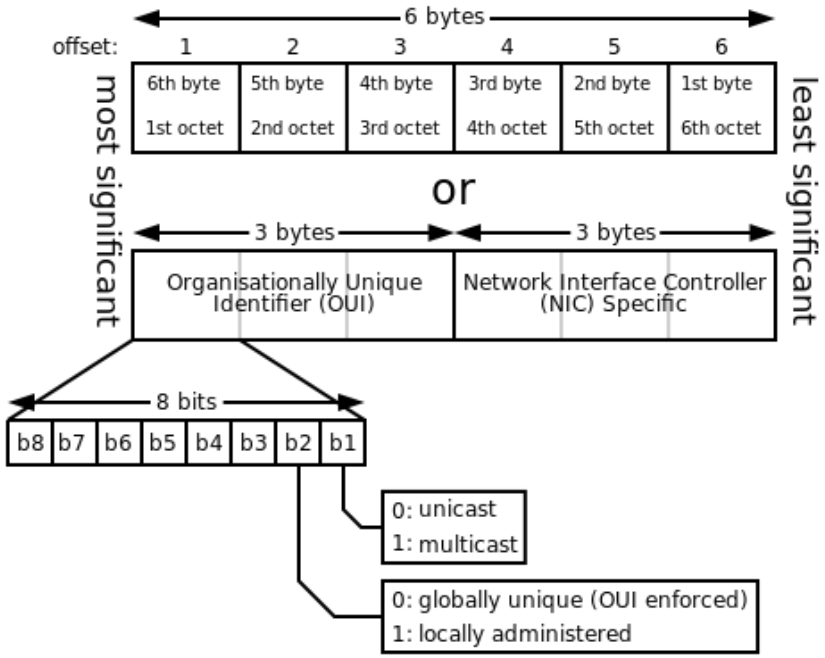
Ethernet Address

- Each host on an Ethernet (in fact, every Ethernet host in the world) has a unique Ethernet Address.
- The address belongs to the adaptor, not the host.
  - It is usually burnt into ROM.

- The first three octets (in transmission order) identify the organization that issued the identifier and are known as the Organizationally Unique Identifier (OUI) and The Last three octets identify Network Interface Controller (NIC)

Ethernet Address

Wikipedia, 2013.



MAC	Vendor
001E37	Universal Global Scientific Industrial Co., Ltd.

Example :

Ethernet adapter Local Area Connection:

Media State . . . . . : Media disconnected

Description . . . . . : Intel(R) 82579LM Gigabit Network Connection

Physical Address. . . . . : **00-1E-37-25-A6-9B**

DHCP Enabled. . . . . : No

Autoconfiguration Enabled . . . . . : Yes

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Wireless Technology

	Bluetooth (802.15.1)	Wi-Fi (802.11)	3G Cellular
Typical link length	10 m	100 m	Tens of kilometers
Typical data rate	2 Mbps (shared)	54 Mbps (shared)	Hundreds of kbps (per connection)
Typical use	Link a peripheral to a computer	Link a computer to a wired base	Link a mobile phone to a wired tower
Wired technology analogy	USB	Ethernet	DSL

Task 1 : no.2

Jelaskan karakteristik dari masing-masing jenis WiFi yang anda ketahui hingga teknologi paling terkini serta perbedaannya!

(hint : 802.11a,… … … … …)

Tulis Tangan

Batas akhir kamis 19/9/13

12.01pm, Lab Telematika (F223)

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THANK YOU

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