INTEGRATED TECHNICAL EDUCATION CLUSTER
AT ALAMEERIA

E-626-A
Data Communication and Industrial Networks (DC-IN)

Lecture #9
Ethernet

Instructor:
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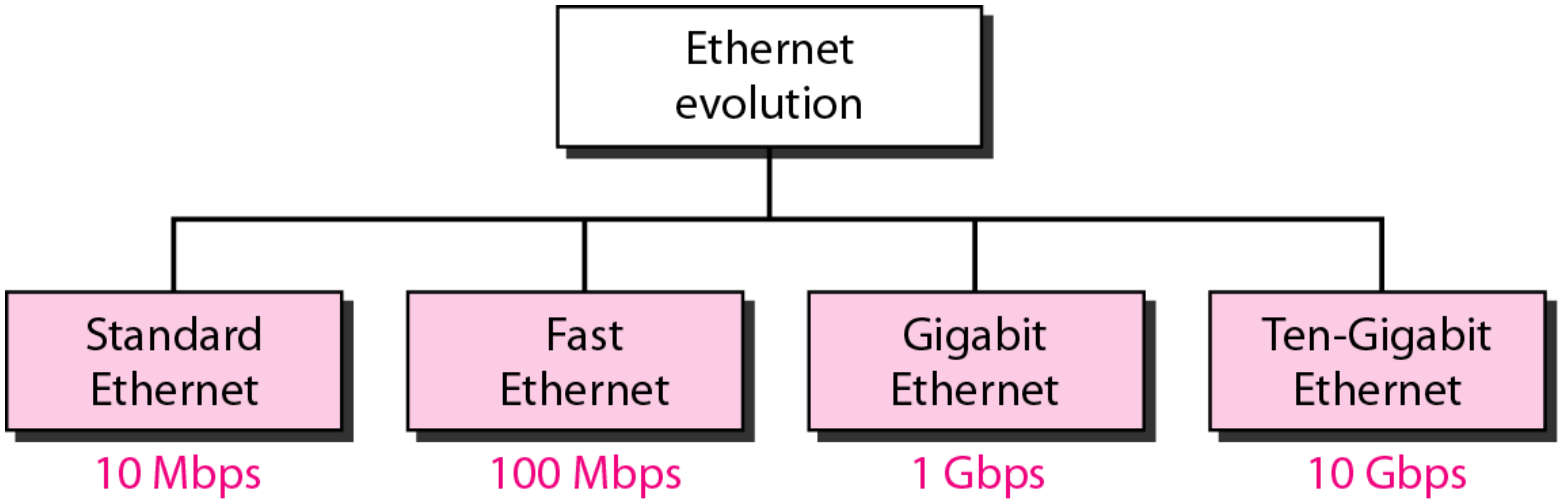
SPRING 2015

Agenda

- 10 Mbps Ethernet
- High-Speed Ethernet

Ethernet Evolution



10 MBPS ETHERNET

Ethernet

- Developed at PARC – Palo Alto Research Center
- Inspired by earlier networks
- Named “ethernet” after “ether”
  - Name used by physicists in 1800s to refer to the “substance through which electromagnetic energy traveled”
  - Thought to be everywhere but invisible
  - Networks will be universal but invisible

Ethernet Precursors

- ALOHA – packet radio network
  - Station may transmit frame at any time
  - Station listens for acknowledgement
    - time > 2 X propagation delay + fixed increment
    - If none, resend – corrupted due to noise or collision
  - Simple, but limited to about 18% efficiency
- Slotted ALOHA
  - Time divided into organized slots equal to frame
  - Increases utilization to about 37% efficiency

Ethernet Precursors

- Carrier Sense Multiple Access (CSMA)
  - Before transmit, listen to medium (Carrier Sense)
  - If medium idle, station transmits
  - Wait for acknowledgement
    - Time is longer than ALOHA to account for contention
  - If no acknowledgement, listen and retransmit
  - Utilization far exceeds ALOHA
    - Longer frames and shorter propagation delay gives best utilization

Non-Persistent CSMA

- Listen to medium
- If medium is idle, transmit
- If medium is busy, wait an amount of time randomly drawn from a probability distribution, and retry
- Disadvantage
  - Channel usually remains idle following transmission because stations are waiting

1-Persistent CSMA

- Rules
  - If medium idle, transmit
  - If medium busy, listen until idle, then transmit immediately
- Selfish strategy
  - If two or more stations are waiting, collision is guaranteed

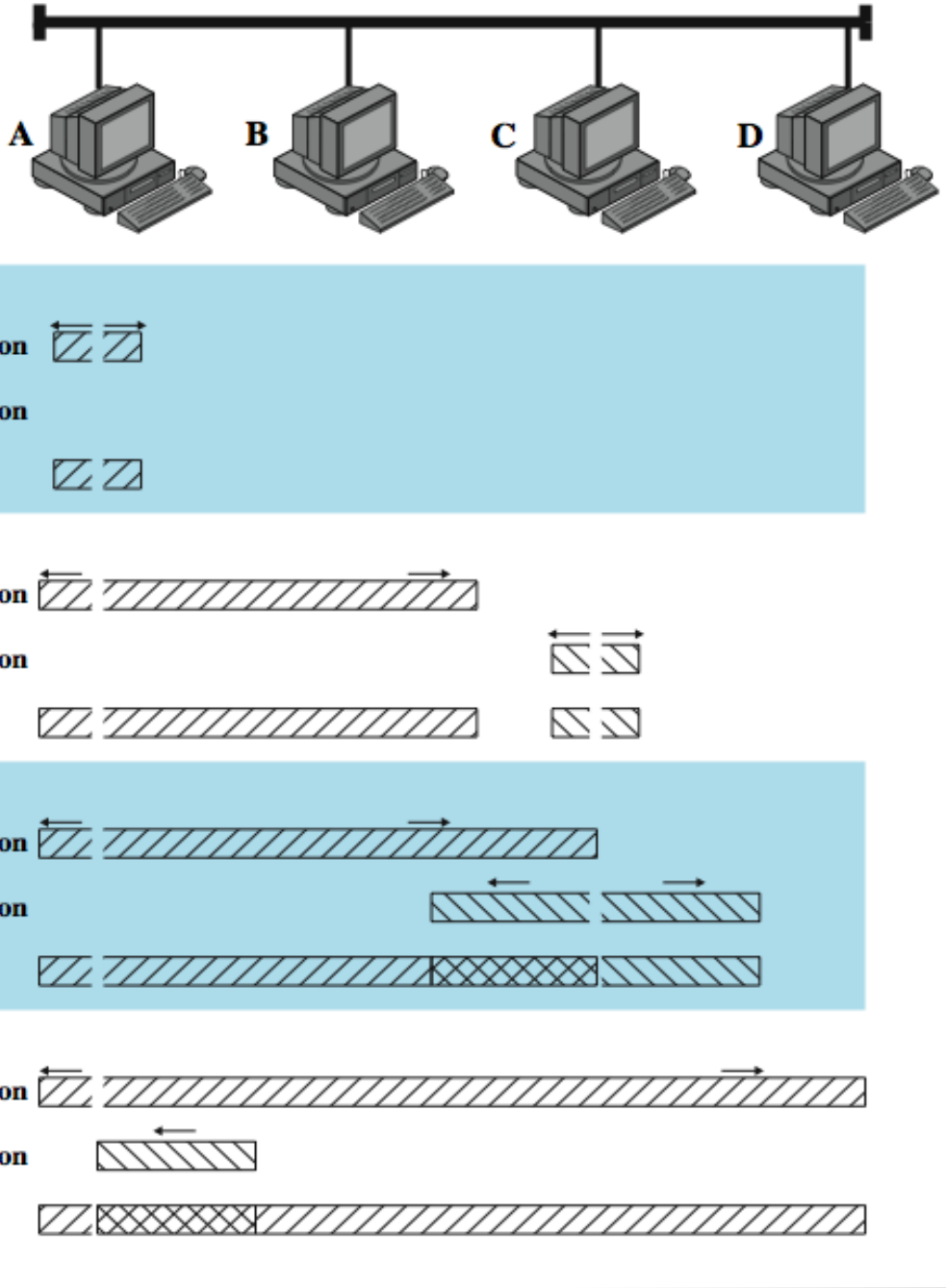
P-Persistent CSMA

- Rules
  - If medium idle, transmit with probability p or delay one time unit with probability (1-p)
  - If medium busy, listen until idle and repeat
  - If transmission is delayed one time unit, repeat from step 1
- How do we choose effective value of p?
  - Too high – everyone tries to send
  - Too low – waiting for nothing

CSMA/CD (Ethernet)

- Rules
  - If medium is idle, transmit
  - If medium is busy
    - Continue to listen until idle (1-persistent)
    - Transmit once idle but keep listening
  - If collision detected while transmitting, stop
  - After collision, wait a random amount of time, referred to as the "backoff", then start again

CSMA/CD Operation



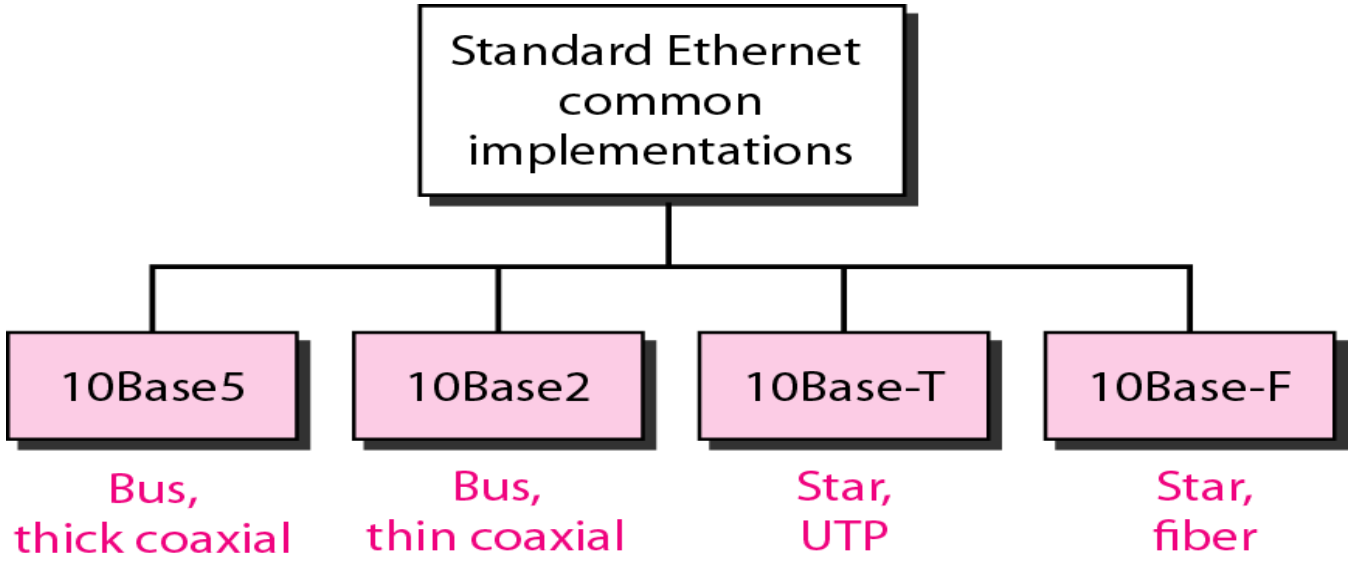
Collision Detection

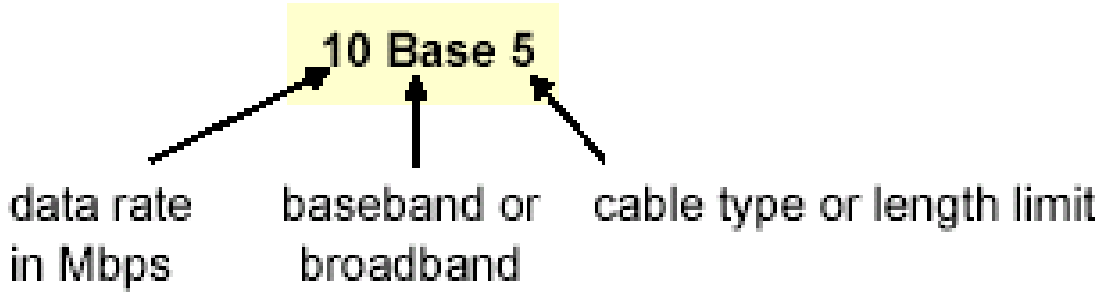
- On baseband (co-axial cable) bus
  - Collision produces higher signal voltage
  - Detected if cable signal greater than station's
- On twisted pair (star topology)
  - Activity on more than one port is collision
  - Use special collision presence signal from hub until all incoming signals end

802.3 Medium Notation

- Notation format:
  <data rate in Mbps>
  <signaling method>
  <maximum segment length in 100s of meters>
- e.g 10Base5 provides
  10 Mbps baseband, up to 500 meters
- T and F are used in place of segment length for twisted pair and fiber

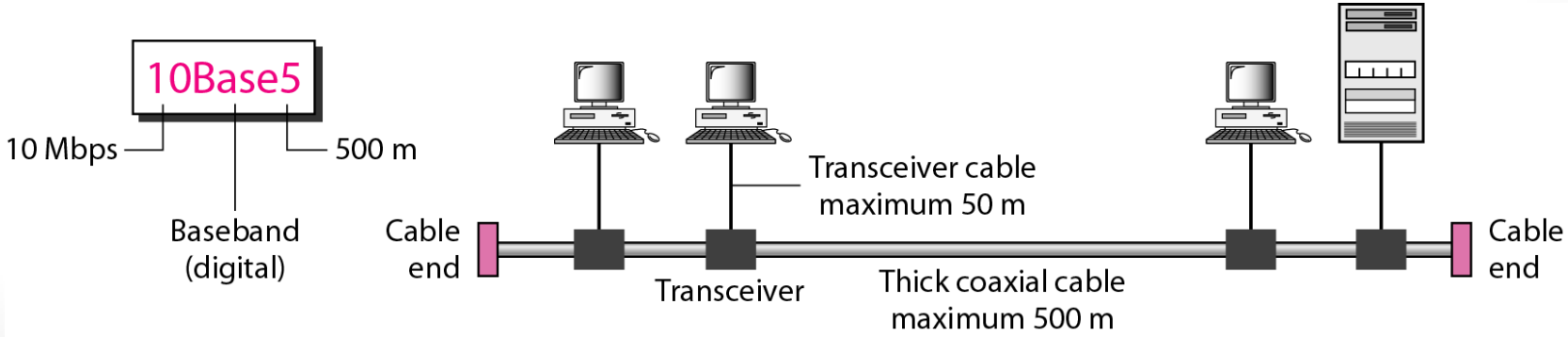
Ethernet Implementations





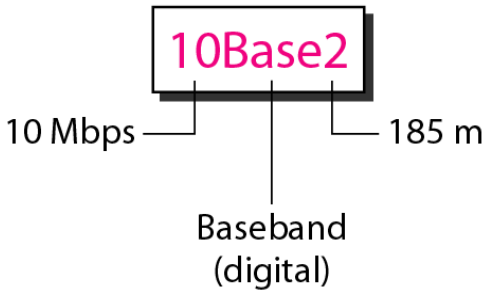
10Base5 "Thick Ethernet"

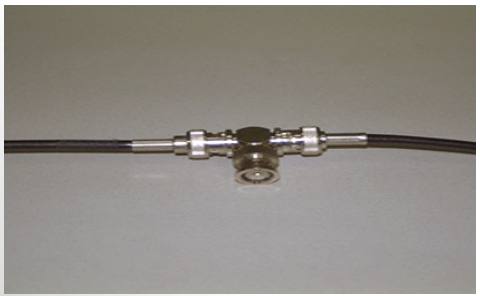
- Original 802.3 medium specification
- 50-Ω coax and Manchester signaling
- Segment length can be extended past 500m with repeaters
  - transparent at the MAC level
  - maximum of 4 allowed
- No looping allowed--one path between any two stations

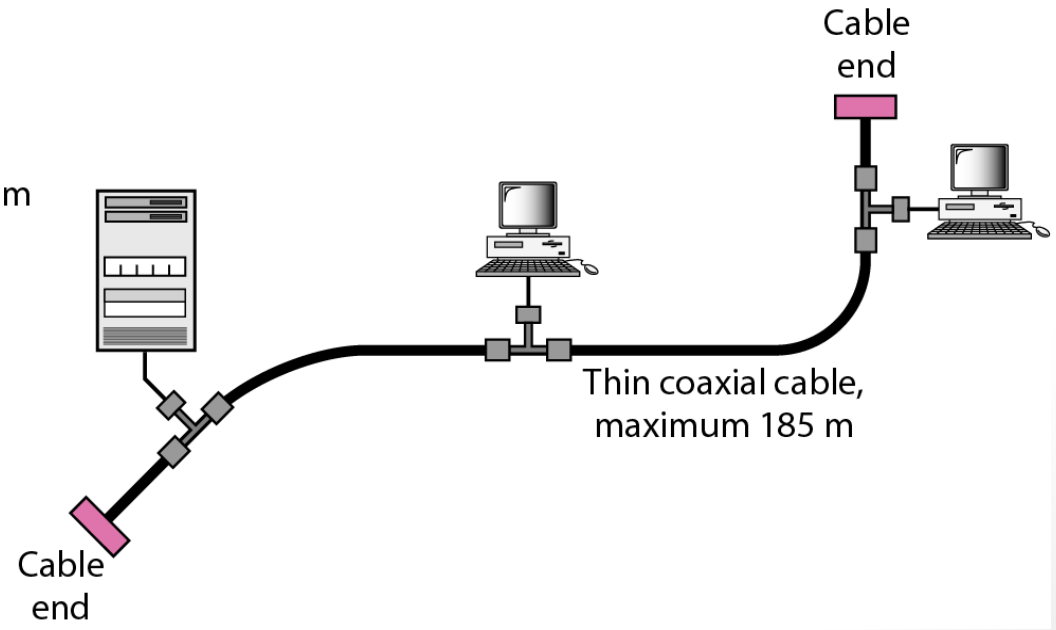


10Base2 "Thin Ethernet"

- Intended to provide lower-cost system for PC LANs
- Uses thinner cable and supports fewer taps than 10Base5
- Can combine 10BASE2 and 10BASE5 segments in the same network
  - but backbone must then be 10BASE5

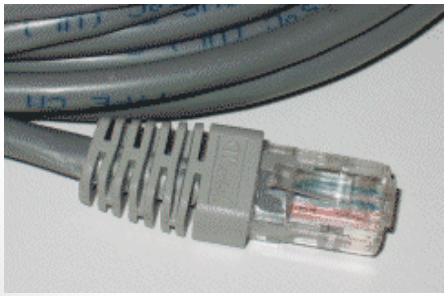


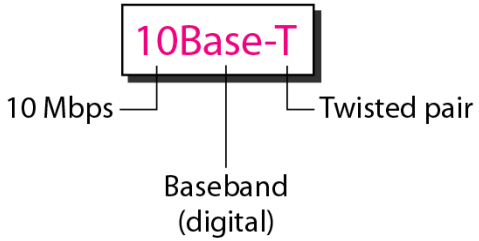


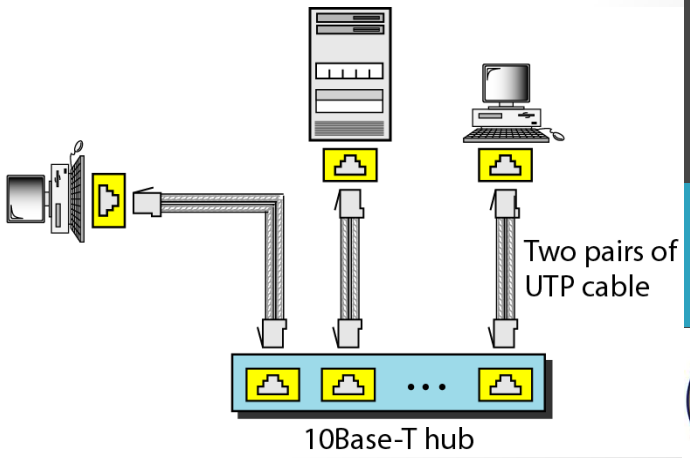


10BaseT

- Uses UTP
- Star-shaped topology is well-suited to existing wires terminating in a closet
- Stations attach to central multi-port repeater (hub) via two twisted pairs
- Hubs can be cascaded
- Physical star, but logical bus
  - all transmissions are repeated





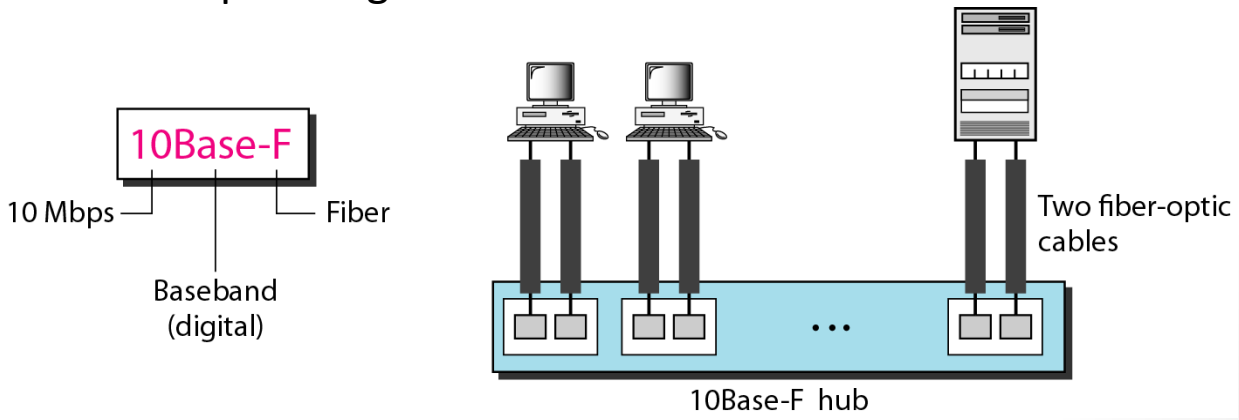


10Broad36

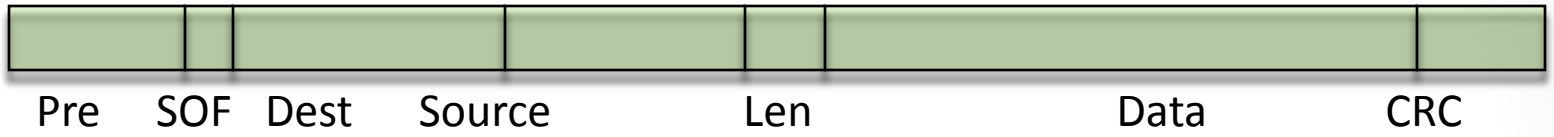
- Only 802.3 broadband specification
- Uses 75-Ω CATV (cable TV quality) coax
- Maximum length of individual segment is 1800m
- Broadband is by nature analog, so analog encoding must be used (PSK)

10Base-F

- Standard includes 3 specifications
  - 10-BASE-FP: Passive star topology, up to 1km per segment
  - 10-BASE-FL: Point-to-point link connecting stations or repeaters up to 2km
  - 10-BASE-FB: Point-to-point backbone link connecting repeaters at up to 2km
- All specs use two fibers
  - one for transmission in each direction
- Manchester encoding
  - converted to optical signal elements



Ethernet Frame Format



- Preamble - 7 byte pattern of 1's and 0's - synchronization
- Start of Frame - pattern 10101011
- Destination and source addresses - 2 or 6 bytes (12 Hex)
- Data length field - 2 byte value (<65536)
- Data field - up to 1500 bytes
- Pad field - if data field too short, padded up to 46 bytes
- Frame check sequence - 32-bit CRC error check (4 bytes)

Ethernet Maximum Distance

- 10Base5 with no more than four repeaters
  - 5 segments, max 500 m each
  - max 50 m long transceiver cables to two stations at the ends
  - Max distance station to station = 2600 m
- 10Base2 (Cheapernet)
  - max 200 m per segment, no transceivers, gives 1000 m max

Ethernet Address

- 48 bit integer (281 trillion possibilities)
- Assigned to interface card by manufacturer who purchases set of addresses from IEEE
- No two interfaces have same address, thus changing interface changes address
- Higher levels of software must accommodate address change

FAST ETHERNET

Fast Ethernet

- CSMA/CD operating at 100 Mbps
- Easy to integrate with existing systems
- 100BASE-X - two simplex links b/w nodes
- Can use UTP (100BASE-TX) but requires two lines between stations
- Can use Fiber (100BASE-FX)

Fast Ethernet Configuration

- 100BASE-T uses star-wire topology
- All stations connected to central point using multiport repeater (broadcast method)
- Repeater, not stations, detects collisions and sends jam signal on all ports
- Repeaters connected with bridges

Fast Ethernet Full-duplex Mode

- Traditional Ethernet is half-duplex
- Two links b/w stations allows full-duplex
- NICs must support full-duplex mode
- Switched hub must be used
  - determines path for frame
- No collisions ever occur

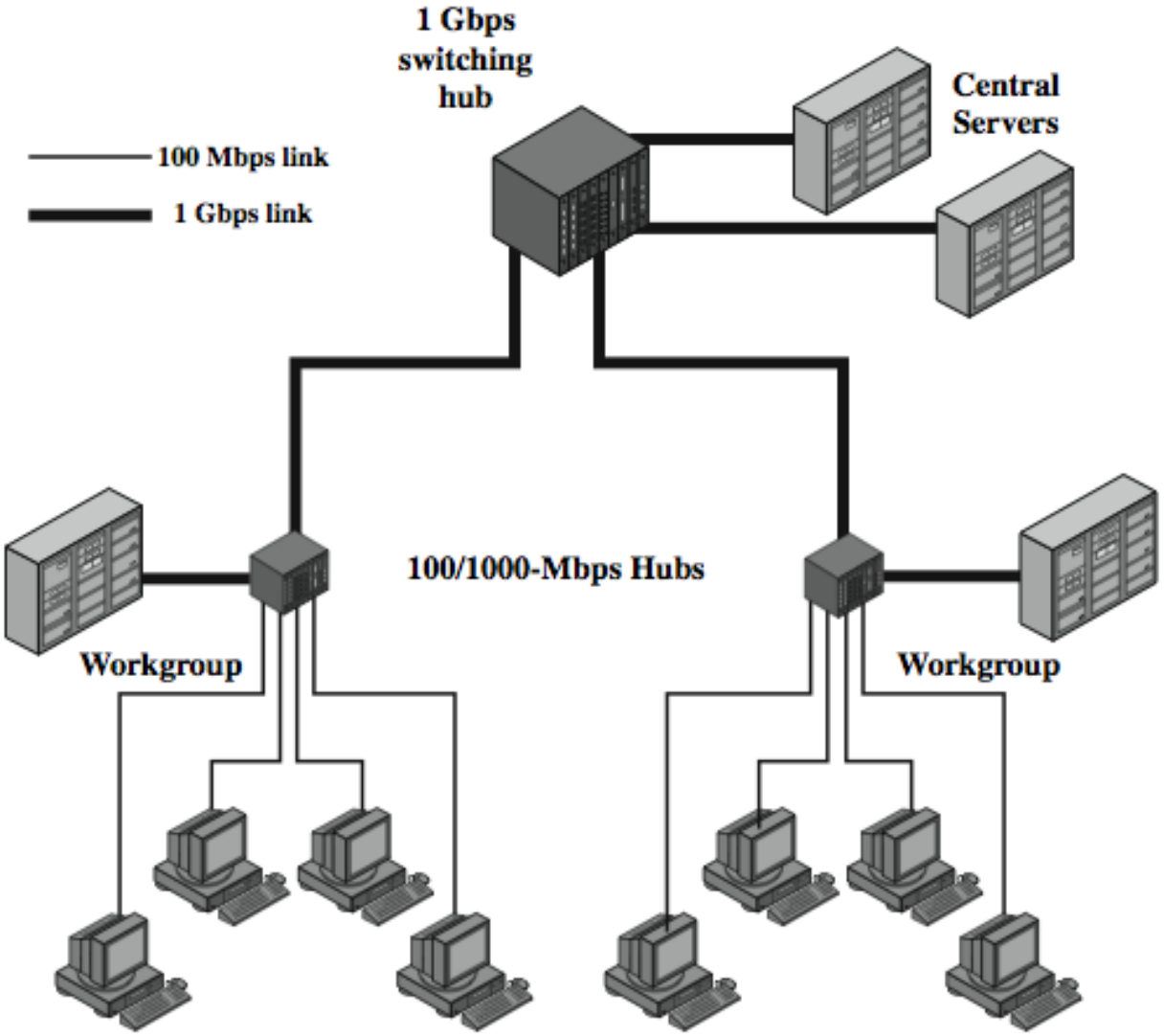
Mixed Ethernet

- Can mix 10-Mbps and 100-Mbps LANs
- Slow stations attach to 10-Mbps hubs
- Hubs connected to 100-Mbps hubs
- High-speed servers connected to 100-Mbps

Gigabit Ethernet

- Retains CSMA/CD protocol and Ethernet format, ensuring smooth upgrade path
- Uses optical fiber over short distances
- 1-Gbps switching hub provides backbone connectivity for central servers and high-speed workgroup hubs
- Now moving to 10-Gbps, 40-Gbps, and even 100-Gbps backbones

Gigabet Ethernet Configuration



- For more details, refer to:
  - Chapters 16 , W. Stallings, **Data and Computer Communications**, 8th ed.
- The lecture is available online at:
- Lecture notes are found at:
  - http://bu.edu.eg/staff/ahmad.elbanna-courses/12133
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