Network Hardware

Network Performance Issues

- Three major factors
  - Selection of high-quality hardware
  - Reasonable network design
  - Proper installation and documentation

Hardware Selection – Classification of market

- LAN
  - Local Area Network
  - Networks that exist within a building or group of buildings
  - High-speed, low-cost media
- WAN
  - Wide Area Network
  - Networks that endpoints are geographically dispersed
  - High-speed, high-cost media
- MAN
  - Metropolitan Area Network
  - Networks that exist within a city or cluster of cities
  - High-speed, medium-cost media

Hardware Selection – LAN Media (1)

- Evolution of Ethernet

Year	Speed	Common name	IEEE#	Dist	Media
1973	3 Mb/s	Xerox Ethernet	–	?	Coax
1980	10 Mb/s	Ethernet 1	–	500m	RG-11 coax
1982	10 Mb/s	DIX Ethernet (Ethernet II)	–	500m	RG-11 coax
1985	10 Mb/s	10Base5 ("Thicknet")	802.3	500m	RG-11 coax
1985	10 Mb/s	10Base2 ("Thinnet")	802.3	180m	RG-58 coax
1989	10 Mb/s	10BaseT	802.3	100m	Category 3 UTP[a] copper
1993	10 Mb/s	10BaseF	802.3	2km	MM[b] Fiber
				25km	SM Fiber
1994	100 Mb/s	100BaseTX ("100 meg")	802.3u	100m	Category 5 UTP copper
1994	100 Mb/s	100BaseFX	802.3u	2km	MM fiber
				20km	SM fiber
1998	1 Gb/s	1000BaseSX	802.3z	260m	62.5-μm MM fiber
				550m	50-μm MM fiber
1998	1 Gb/s	1000BaseLX	802.3z	440m	62.5-μm MM fiber
				550m	50-μm MM fiber
				3km	SM fiber
1998	1 Gb/s	1000BaseCX	802.3z	25m	Twinax
1999	1 Gb/s	1000BaseT ("Gigabit")	802.3ab	100m	Cat 5E and 6 UTP copper

a. Unshielded twisted pair

b. Multimode and single-mode fiber

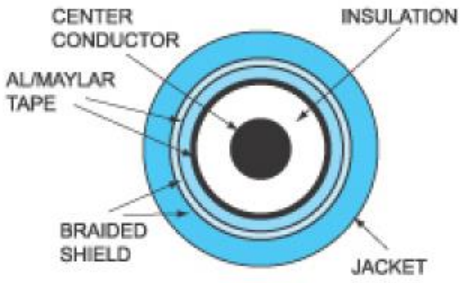
Coaxial cable

UTP

Fiber

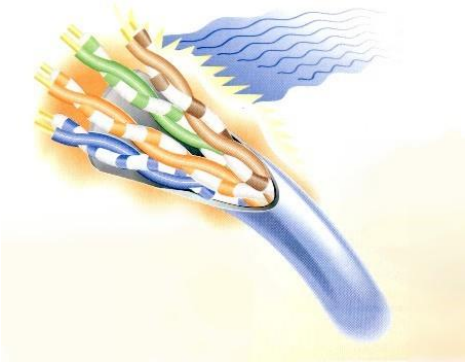
Hardware Selection – LAN Media (2)

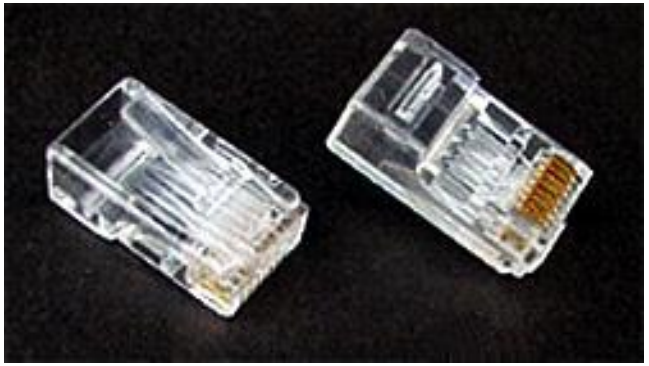
- Coaxial cable
  - Cooperated with BNC connector
  - Speed: 10 Mbps
  - Coaxial cable used in LAN
    - RG11 (10Base5, 500m)
    - RG58 (10Base2, 200m)



Hardware Selection – LAN Media (3)

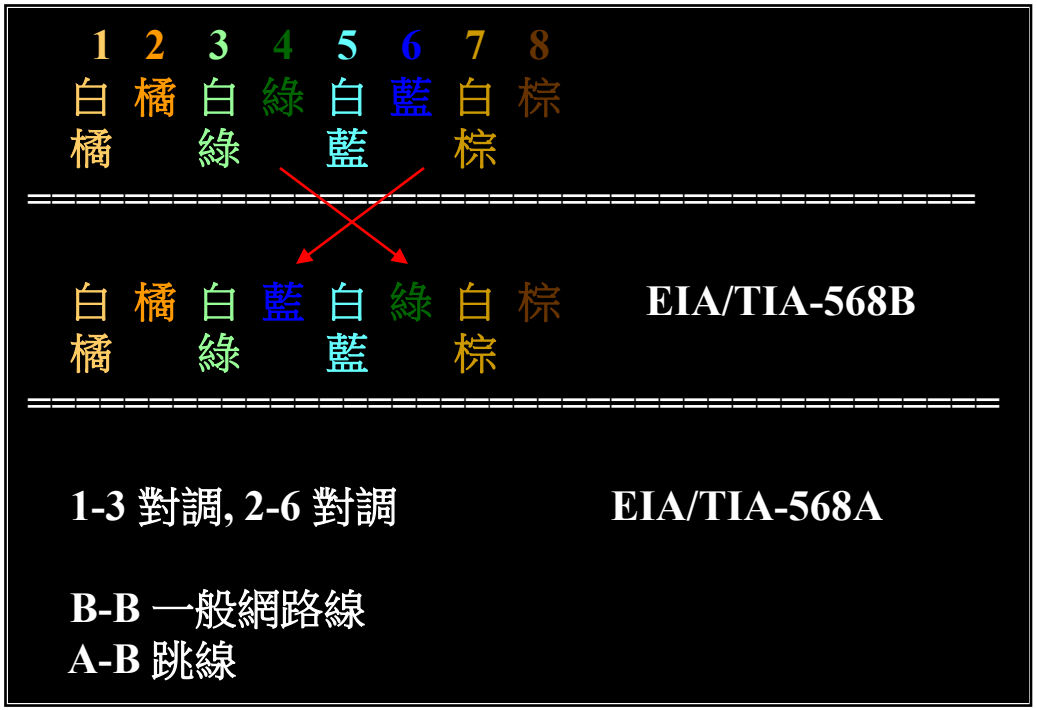
- Twisted Pair Cable
  - UTP (Unshielded) and STP (Shielded)
    - STP has conductive shield
      - More expensive but good in resisting cross talk
  - Cooperated with RJ45 connector
  - Categories
    - From CATEGORY-1 ~ CATEGORY-7, CATEGORY-5E
      - Cat3 up to 10Mbps (10BaseT, 100m)
      - Cat5 up to 100Mbps (100BaseTX, 100m)
      - Cat5e / Cat6 up to 1000Mbps (1000BaseT, 100m)





Hardware Selection – LAN Media (4)

- UTP cable wiring standard
  - TIA/EIA-568A, 568B

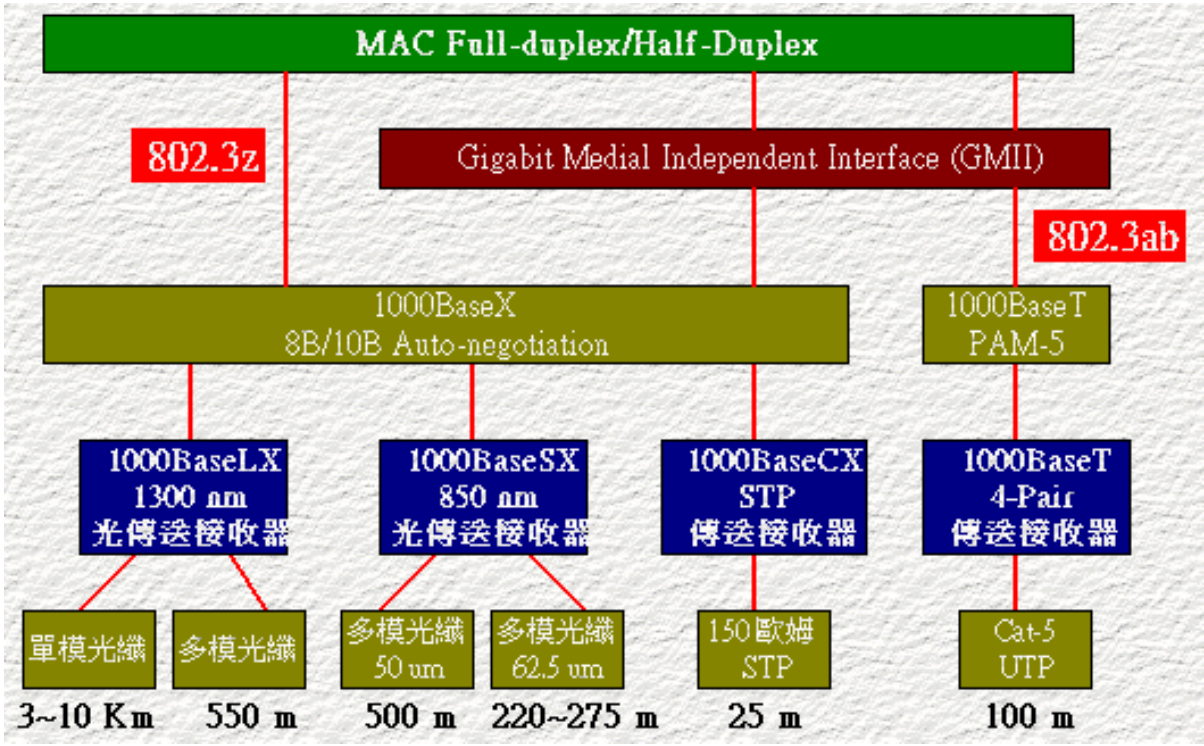


Hardware Selection – LAN Media (5)

- Fiber Optical Cable
  - Mode
    - Bundle of light rays that enter the fiber at particular angle
  - Two mode
    - Single-mode (exactly one frequency of light)
      - One stream of laser-generated light
      - Long distance, cheaper
    - Multi-mode (allow multiple path in fiber)
      - Multiple streams of LED-generated light
      - Short distance, more expensive
  - Wavelength
    - 0.85, 1.31, 1.55 μm
- Connector
  - ST, SC, MT-RJ

Hardware Selection – LAN Media (6)

- 1000BaseLX (Long wavelength, 1.31μm)
  - Single mode
  - Multi mode
- 1000BaseSX (Short wavelength, 0.85 μm)
  - Multimode



Hardware Selection – LAN Media (7)

- Fiber connector

Hardware Selection – LAN Media (8)

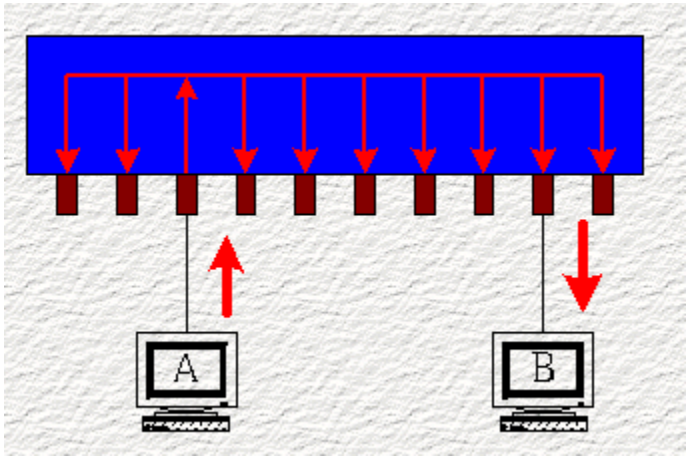
- Wireless
  - 802.11a
    - 5.4GHz
    - Up to 22Mbps
  - 802.11b
    - 2.4GHz
    - Up to 11Mbps
  - 802.11g
    - 2.4GHz
    - Up to 54Mbps
  - 802.11n
    - Development from 2002/09 to 2009/10 (finalize)
    - 2.4GHz & 5GHz
    - Up to 300Mbps
    - MIMO

Hardware Selection – LAN Device (1)

- Connecting and expanding Ethernet
  - Layer1 device
    - Physical layer
    - Repeater, Transceiver, HUB
      - Does not interpret Ethernet frame
  - Layer2 device
    - Data-link layer
    - Switch, Bridge
      - Transfer Ethernet frames based on hardware address
  - Layer3 device
    - Network layer
    - Router
      - Route message based on IP address

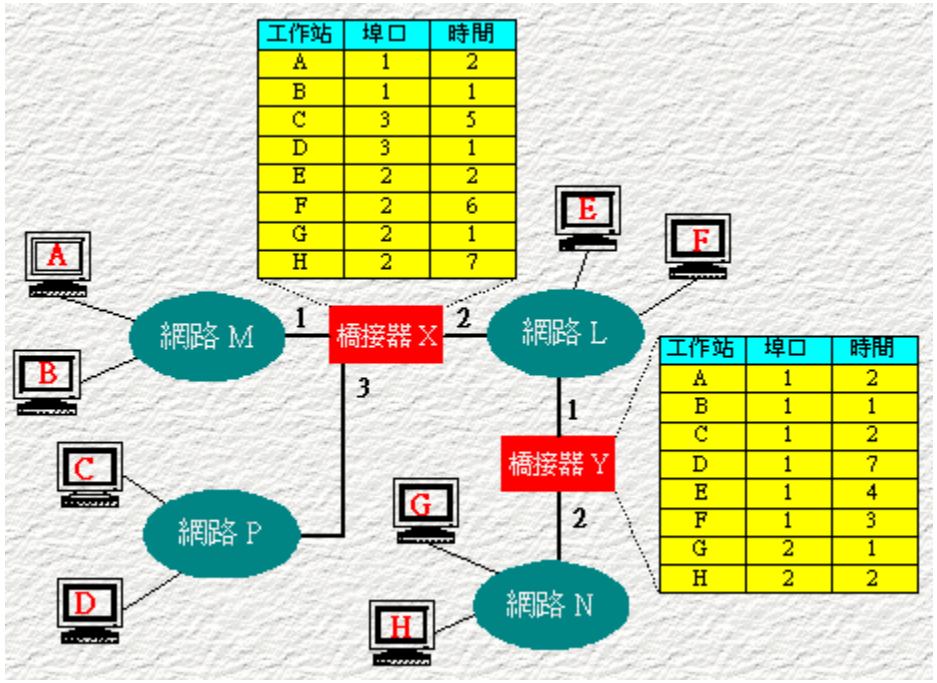
Hardware Selection – LAN Device (2)

- HUB
  - Layer1 device
  - Multi-port repeater
  - Increasing collision domain size
  - MDI and MDI-X ports
    - (Media Dependent Interface Crossover)
    - Auto-sense now
  - 5-4-3 rules in 10Mbps
    - More severe in 100Mbps ~
- Switching HUB
  - Layer1 device but forward to required port



Hardware Selection – LAN Device (3)

- Bridge
  - Layer2 device
  - Forward Ethernet frames among different segments
  - Bridge table
    - Fewer collisions
  - STP (Spanning Tree Protocol)
    - Loop avoidances
    - Including
      - STA (Spanning Tree Algorithm)
      - BPDUs (Bridge Protocol Data Units)



Hardware Selection – LAN Device (4)

- Switch (layer2)
  - Layer2 device
  - Multi-port bridge
    - Each port is a single collision domain
    - Learning
      - Each port can learn 1024 Ethernet Address
    - Store-and-Forward
  - Port Trunks
    - Aggregate multi-ports to form a logical one
      - Bandwidth
      - Reliability

VLAN – Virtual LAN

- VLAN
  - Spilt a physical switch into several logical switches
  - Static VLAN
    - Administratively assign which port to which VLAN
  - Trunking
    - IEEE 802.1Q Tagging
    - Cisco's Inter-Switch Link Tagging
    - 3COM's VLT Tagging

Last Mile Solution

- xDSL
  - Digital Subscriber Line
  - ADSL for asymmetric DSL
  - Use ordinary telephone wire to transmit data
- Cable Modem
  - Use TV cable to transmit data
- Dedicated phone connection
  - T1 (DS1 line)
    - 1.544Mbps, 24 channels, each channel 64Kbps
  - T2 (DS2 line)
    - 6.1Mpbs, 96 channels, each channel 64Kbps
  - T3 (DS3 line)
    - 43Mbps, 672 channels, each channel 64Kbps
- FTTx (Fiber To The "x")
  - FTTH for home, FTTB for building, FTTC for Curb