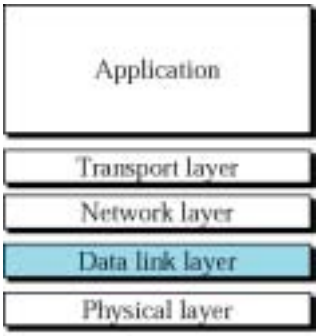
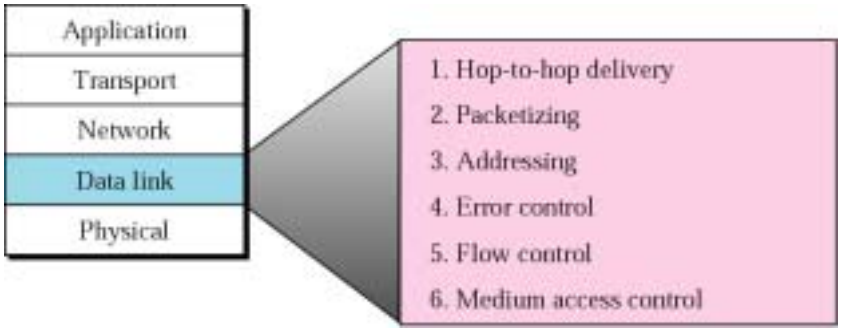
Data Link Layer

Data link layer in the Internet model

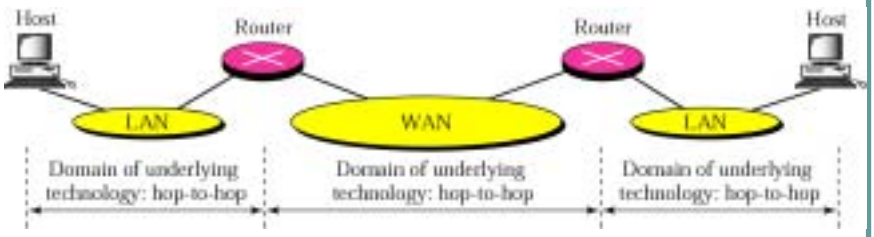


Internet Model

Data-link layer duties

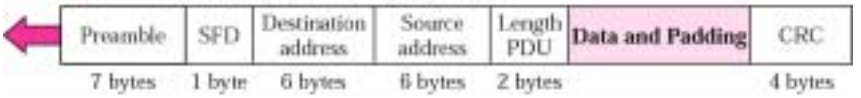


Hop-to-hop delivery



Packetizing

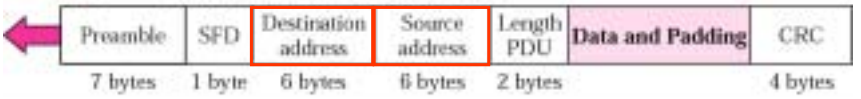
Preamble 56 bits of alternating 1s and 0s.
SFD Start field delimiter, flag (10101011)



Addressing

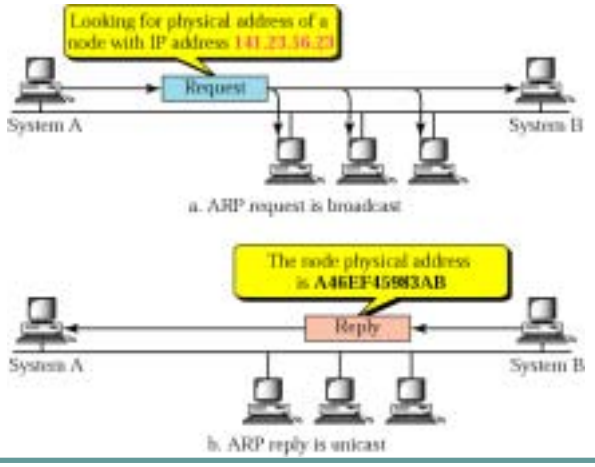
MAC address

Preamble 56 bits of alternating 1s and 0s.
SFD Start field delimiter, flag (10101011)

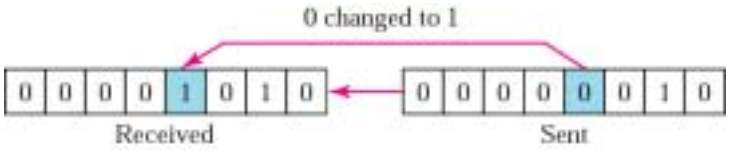


Addressing

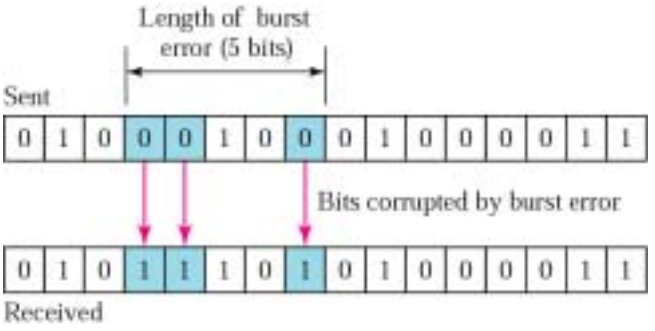
Address Resolution Protocol (ARP)



Error Control - Single-bit error

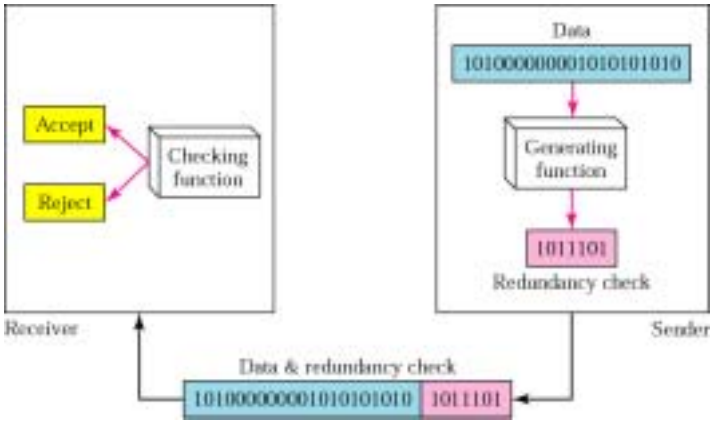


Error Control - Burst error

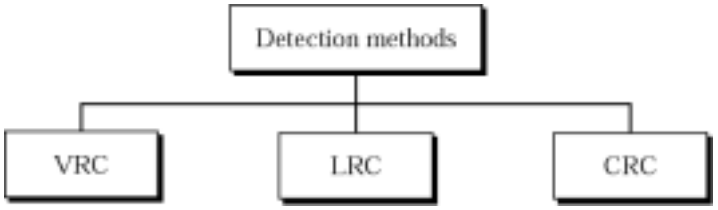


Error Control - Redundancy

使用多餘位元檢查資料的正確性

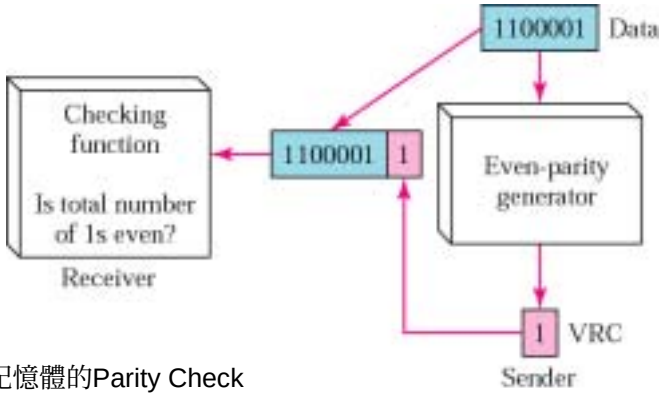


Error Control - Detection methods



VRC=Vertical Redundancy Check(直向多餘檢查)
LRC=Longitudinal Redundancy Check (縱向多餘檢查)
CRC=Cyclic Redundancy Check (循環多餘檢查)

Error Control - Even parity VRC



例:記憶體的Parity Check

Error Control - Even parity VRC

101111011的Even Parity VRC是多少

110001100的Even Parity VRC是多少

100111111的Even Parity VRC是多少

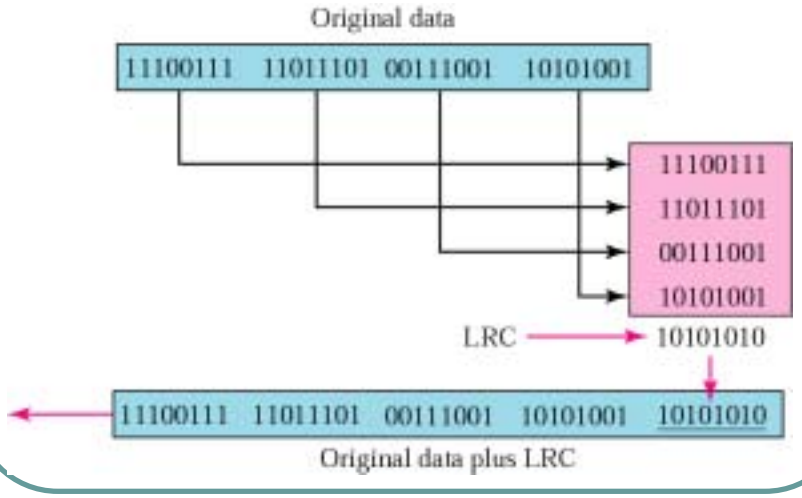
Error Control - Even parity VRC

111111011的Odd Parity VRC是多少

110011100的Odd Parity VRC是多少

101110011的Odd Parity VRC是多少

Error Control - LRC

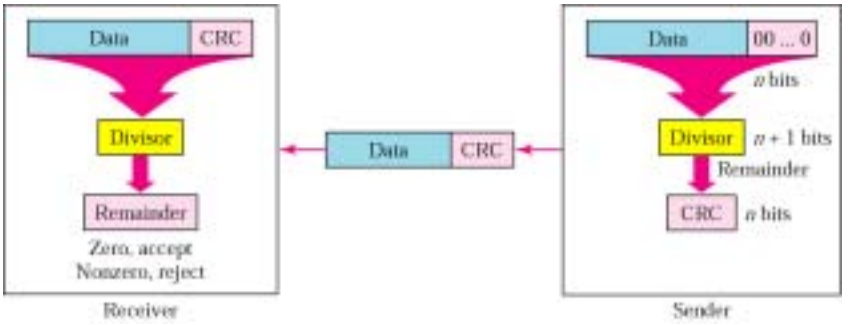


Error Control - LRC

11111101 10111101 01100001 00111000

Even Parity LRC?

Error Control - CRC



Problems

- Hop to Hop delivery
- Packetizing
- Addressing
- Error Control
- Flow Control
- Media Access Control

Ethernet LANs

Chapter 4

Panko's
Business Data Networks and Telecommunications, 5th edition

Ethernet History

- Ethernet
  - 是目前LAN的主要標準
  - 全錄(Xerox)公司於1970年代由位於Palo Alto 的研究中心開發出來
  - 參考夏威夷大學1970年的 Alohanet project 設計
    - 使用RF傳遞訊息

Ethernet History

- Ethernet開發者

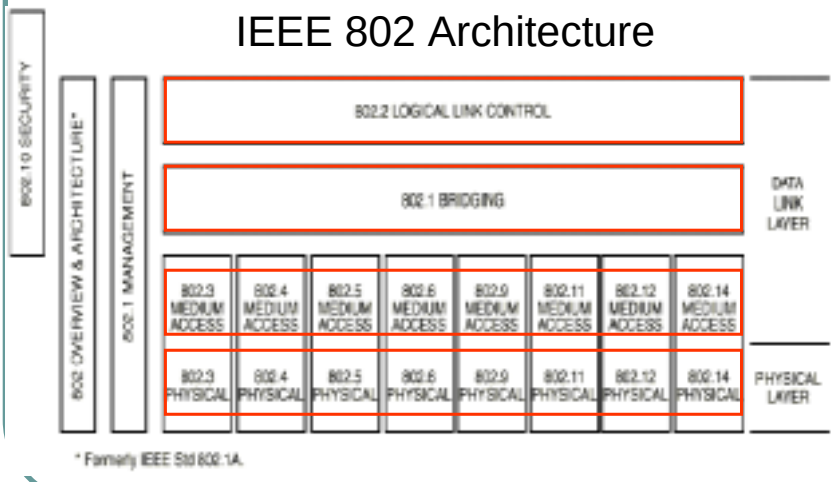
Robert M. "Bob" Metcalfe

1946 : was born in Brooklyn, New York.
1969 : Bachelor : MIT EE/Business Management.
1970 : Master : Harvard University Applied Mathematics.
1973 : Ph. D. : Harvard University Computer Science
1972 : Xerox
1973 : invented Ethernet with D.R. Boggs(his assistant).
1979 : founded 3Com Corporation in Santa Clara, California.
1990 : retired from 3Com.

Ethernet History

- 標準
  - IEEE 802 LAN/MAN標準協會
  - IEEE 802.3 Working Group負責開發Ethernet標準
  - IEEE 802的其它working groups開發其它標準

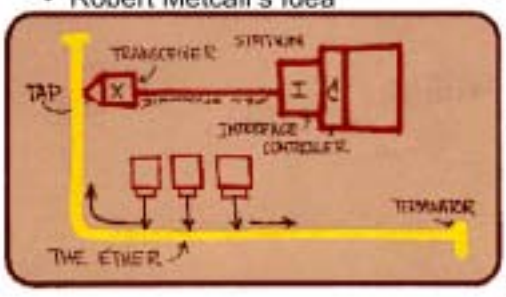
Ethernet History



802.3:Ethernet, 802.4:Token bus, 802.5:Token ring, 802.11:Wireless

Ethernet History

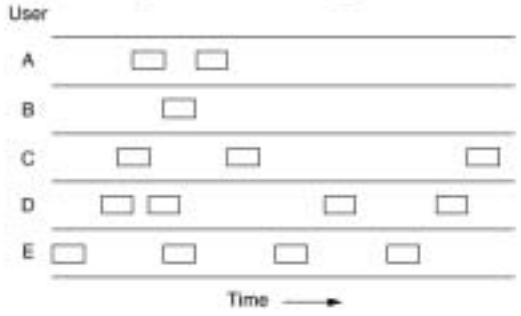
- Robert Metcalf's Idea



- Invented by Metcalf at Xerox in 1973 and patented in 1976
- Xerox convinced Digital and Intel to join in making products (hence the group called DIX)
- IEEE standard in 1989

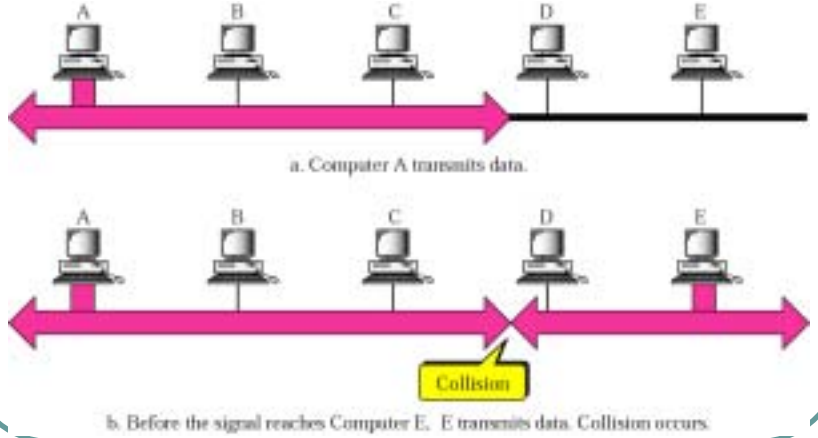
Ethernet History

- Legacy Protocol
  - Pure ALOHA
  - Transmit when you want to, regardless of others.



Ethernet History

- Collisions



a. Computer A transmits data.

b. Before the signal reaches Computer E, E transmits data. Collision occurs.

Ethernet History

- Slotted ALOHA

- Transmit only at the beginning of synchronized "slot times"
- Collision inefficiency limited to one frame transmission time

Ethernet History

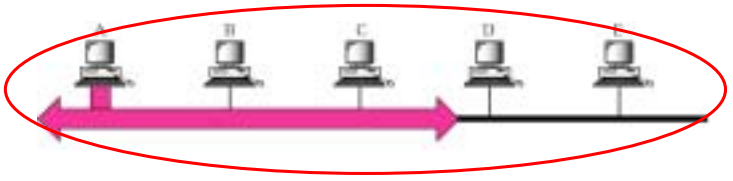
- CSMA/CD
  - Carrier Sense : listen before talk
  - Multiple Access : shared media
  - Collision Detect
  - Broadcasting
  - Half Duplex
  - non-slotted 1-persistent

Ethernet History

- CSMA/CD
  - 1.偵測網路通道有無信號,若有則等其傳完再送,否則直接傳送.
  - 2.若發生碰撞,馬上停止傳送,並等待隨機時間後重傳.
    - Binary Exponential Backoff Algorithm
    - 退讓時間單位:$0 \le r < 2^k$, k=MIN(n,10), n是傳送次數
      - r是介於1~2^k之間的整數亂數
      - 退讓時間=r*slot time
      - 最多重試15次,n最大值=16

Ethernet History

- Slot Time
  - Round Trip Time
    - 10M ethernet:到最遠一端發生碰撞再回來的時間約50 μs

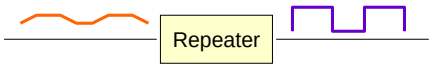


Collision Domain

51.2 μs=512 bit time for 10M ethernet
5.12 μs =512 bit time for 100M ethernet(Fast ethernet)
4.096 μs =4094 bit time for 1G ethernet

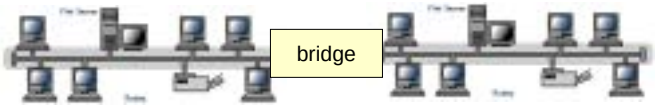
Ethernet History

- Repeater
  - 連接兩段網路
  - 一個bit一個bit傳送
  - 信號加強



Ethernet History

- Bridge
  - 連接兩段網路,通常具學習電腦位址能力
  - 將封包由一段傳送至另一段
  - 依data link address過濾封包
  - store-and-forward



Ethernet History

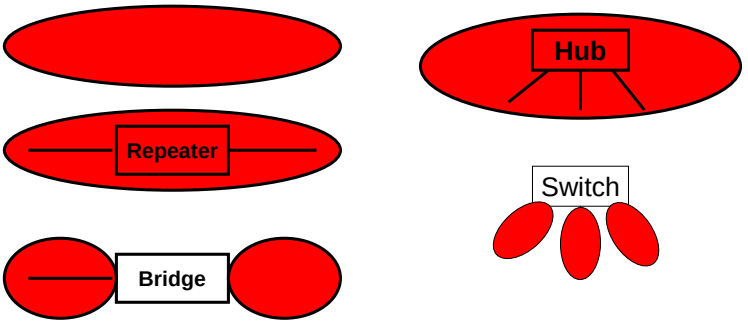
- Hub
  - 連接電腦
  - 內建一個shared bus

Ethernet History

- Ethernet Switch
  - 連接多段網路
  - 依data link address過濾及傳遞封包,功能類似bridge
  - store-and-forward 或 cut-through

Ethernet History

- Collision Domains



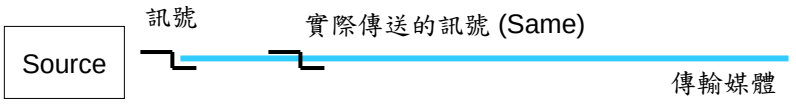
Problems

- Ethernet標準
- Collision
- Pure Aloha
- Slotted Aloha
- CSMA/CD
- Collision Domains
- Switch/Hub差異

Ethernet 實體層標準

Baseband與Broadband傳輸

Baseband傳輸

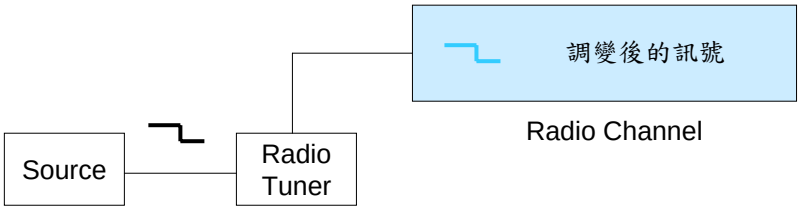


- 訊號直接注入傳輸媒體 (wire, optical fiber)
- 同一時間只能傳送一組訊號
- 成本較低, 主導整個有線LAN的傳輸

Baseband與Broadband傳輸

Ex:有線電視

Broadband傳輸



- 訊號先被調變到較高頻率
- 將調變後的訊號送到傳送媒體
- 多組訊號可同時傳送
- 成本較高,收送兩端需要調波器(Tuner)

Ethernet實體層標準

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
UTP			
10Base-T	10 Mbps*	100 meters	4-pair Category 3 or better
100Base-TX	100 Mbps	100 meters	4-pair Category 5 or better
1000Base-T	1,000 Mbps	100 meters	4-pair Category 5 or better

Base: Baseband, Broad: Broadband, T/TX:Twist Pair

Ethernet實體層標準, Continued

- 100Base-TX網路卡(NICs)與交換器
  - 通常具有自動偵測功能(autosensing)
  - 可依對方速度調整自己速度
    - 10Base-T
    - 100Base-TX
  - 通常稱為10/100 Ethernet

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
Optical Fiber			
100Base-FX	100 Mbps	2 km	62.5/125 multimode, 1300 nm, switch

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
1000Base-SX	1 Gbps	220 m	62.5/125 micron multimode, 850 nm, **160 MHz-km** modal bandwidth
1000Base-SX	1 Gbps	275 m	62.5/125 micron multimode, 850 nm, **200 MHz-km**
1000Base-SX	1 Gbps	500 m	**50**/125 micron multimode, 850 nm, **400 MHz-km**
1000Base-SX	1 Gbps	550 m	**50**/125 micron multimode, 850 nm; **500 MHz-km**

SX:for 850nm

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
1000Base-LX	1 Gbps	550 m	62.5/125 micron **multimode**, 1310 nm
1000Base-LX	1 Gbps	5 km	9/125 micron **single mode**, 1310 nm

LX:for 1310nm

現況

- Access links主要使用100Base-TX
- Trunk links主要使用1000Base-SX

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
10GBase-SR/SW	10 Gbps	65 m	62.5/125 micron multimode, 850 nm
10GBase-LX4	10 Gbps	300 m	62.5/125 micron multimode, 1300 nm, WDM with 4 lambdas

10 Gbps Ethernet, multimode
S = 850 nm, L = 1300 nm
R=LAN, W=WAN

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
10GBase-LR/LW	10 Gbps	10 km	9/125 micron single mode, 1300 nm.
10GBase-ER/EW	10 Gbps	40 km	9/125 micron single mode, 1550 nm.

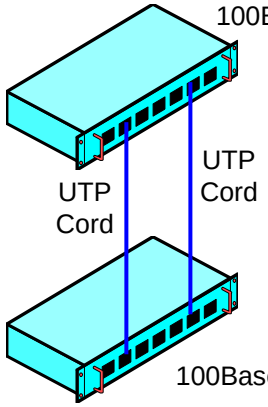
10 Gbps Ethernet, for wide area networks
L = 1300 nm, E = 1550 nm
R = LAN, W = WAN

Ethernet實體層標準, Continued

實體層標準	傳輸速度	最大傳輸距離	傳輸媒體
40 Gbps Ethernet	40 Gbps	Under Development	9/125 micron single mode.

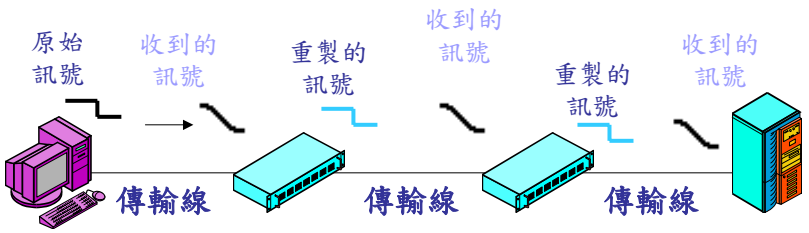
- 40 Gbps Ethernet標準還在制訂中

Link Aggregation (Trunking)



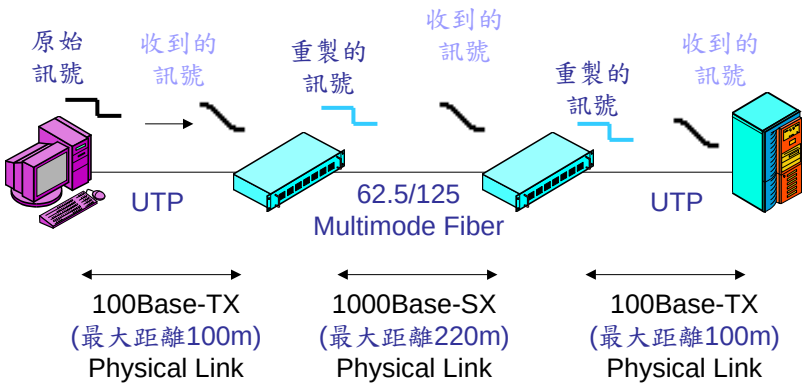
- 一條連線提供100Mbps
- n條連線提供n*100Mbps
- 提高Switch之間的傳輸速度
- Switch必須支援link aggregation

Data Link與switch的關係

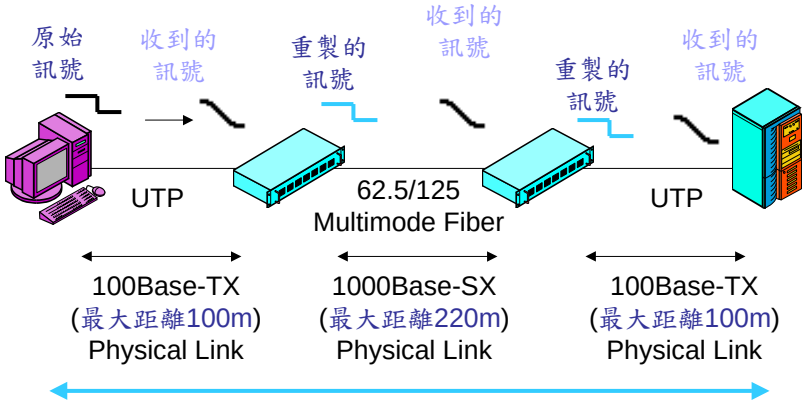


- 傳輸線有距離限制
- 交換器延長傳輸距離

Data Link與switch的關係



Data Link與switch的關係



Problems

- Baseband
- Broadband
- 100Base-TX
- 1000Base-SX
- 1000Base-LX
- 10/100 Ethernet
- Link Aggregation

Ethernet Data Link (MAC) Layer標準

802的Data Link層架構

Ethernet封包架構

交換器運作原理

錯誤控制

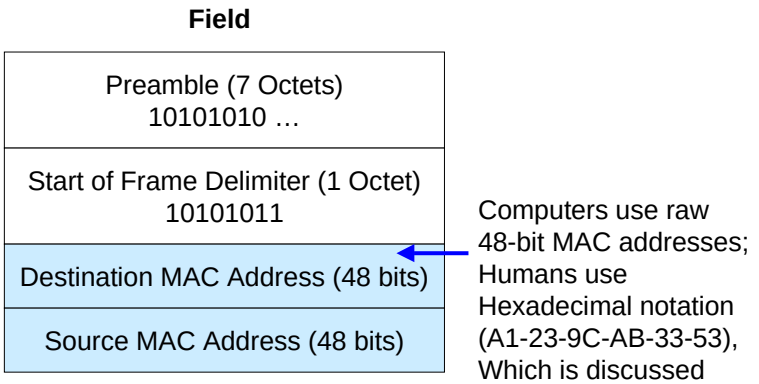
802的Data Link層架構

Internet Layer		
Data Link Layer	**Logical Link Control Layer**	管理不同LAN技術的資料傳輸, e.g., error correction. 這些功能實際上很少使用
	Media Access Control Layer	管理特定LAN技術的資料傳輸, e.g., 802.3 Ethernet, 802.11 wireless LANs, etc.
Physical Layer		

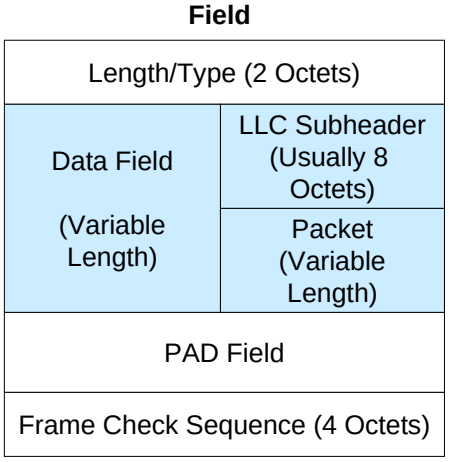
802的Data Link層架構

Internet Layer		TCP/IP Internet Layer Standards (IP, ARP, etc.)		Other Internet Layer Standards (IPX, etc.)	
Data Link Layer	**Logical Link Control Layer**	802.2			
	Media Access Control Layer	Ethernet 802.3 MAC Layer Standard			Other MAC Standards (802.5, 802.11, etc.)
Physical Layer		10Base-T	1000 Base-SX	…	Other Physical Layer Standards (802.11, etc.)

Ethernet封包架構



Ethernet封包架構



Ethernet封包架構

- 將48位元的MAC Address轉成16進位(hex)
  - 48位元的MAC Address
    - 1010000110111011 …
  - 4個位元分成一組,共12個 4-bit “nibbles”
    - 1010 0001 1101 1101 …
  - 將每個nibble轉成16進位符號
    - A 1 D D
  - 兩兩16進位符號一組寫在一齊,中間加dash符號
    - A1-DD-3C-D7-23-FF

Ethernet封包架構

- MAC address
  - VV-VV-VV-SS-SS-SS
    - VV-VV-VV:廠商代碼

000001	SuperLAN-2U	
000002	BBN (was internal usage only, no longer used)	
000009	powerpipes?	
00000C	Cisco	
00000E	Fujitsu	
00000F	NeXT	
000010	Hughes LAN Systems (formerly Sytek)	
000011	Tektronix	
000015	Datapoint Corporation	
000018	Webster Computer Corporation	Appletalk/Ethernet Gateway
00001A	AMD (?)	

…

    - SS-SS-SS:序號

Ethernet封包架構

- MAC address
  - Broadcasting address
    - FF-FF-FF-FF-FF-FF
  - Multicasting Address
    - 使用某些特殊位址

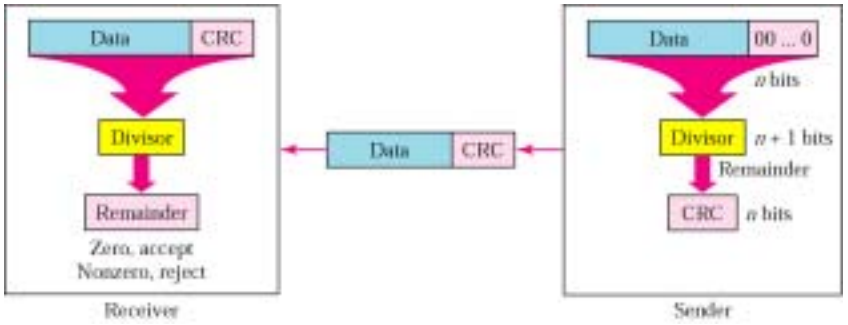
Ethernet封包架構
FCS

- Length/Type

0000-05DC	IEEE802.3 Length Field (0.:1500.)
0800	Internet Protocol (IP)
0806	Address Resolution Protocol (ARP...
814C	SNMP over Ethernet (see RFC1089)
8191	PowerLAN, NetBIOS/NetBEUI (PC)

- Data Field
  - 46~1500bytes
- Frame Check Sequence (4 Octets)
  - 錯誤檢查碼
  - 使用CRC(Cyclic Redundancy Check)

Ethernet封包架構
FCS



Ethernet封包架構
FCS

假設CRC公式 G(x) = x^4+x+1可供產生4bits CRC

計算資料串10111110011的CRC

xor 101111100110000　1.補零
　　10011

xor 1001100110000
　　10011

xor 110000
　　10011

xor 10110
　　10011

101　2.用長除法求餘數（即為CRC）

101111100110101　3.將餘數加到資料串後面

Ethernet封包架構
FCS

對方收到

```
xor  101111100110101
     10011
     ---------------
xor  1001100110101
     10011
     ---------------
xor  110101
     10011
     ---------------
xor  10011
     10011
     ---------------
     0
```


Ethernet封包架構
FCS

- **Ethernet 32位元CRC公式**

$G(x)=x^{32}+x^{26}+x^{23}+x^{22}+x^{16}+x^{12}+x^{11}+x^{10}+x^{8}+x^{7}+x^{5}+x^{4}+x^{2}+x^{1}+1$

Ethernet封包架構
FCS

假設CRC公式 G(x) = x^4+x+1

計算資料串10110010011的CRC位元

Ethernet封包架構
FCS

```
xor  101100100110000
     10011
     ---------------
xor  1010100110000
     10011
     ---------------
xor  11000110000
     10011
     ---------------
xor  1011110000
     10011
     ---------------
xor  10010000
     10011
     ---------------
     1000

101100100111000
```

Ethernet封包架構
FCS

對方收到

```
xor  1011001001111000
     10011
     ----------------
xor  1010100111000
     10011
     ----------------
xor  11000111000
     10011
     ----------------
xor  1011111000
     10011
     ----------------
xor  10011000
     10011
     ----------------
     0000
```


Ethernet封包架構
FCS

假設CRC公式 $G(x) = x^4+x+1$

計算資料串10110110011的CRC位元

Ethernet封包架構
FCS

```
101101100110000
xor 10011
    1011100110000
xor 10011
    10000110000
xor 10011
    11110000
xor 10011
    1101000
xor 10011
    100100
xor 10011
    10
```

101100100110010

Ethernet封包架構
FCS

對方收到

```
101101100110010
xor 10011
    1011100110010
xor 10011
    10000110010
xor 10011
    11110010
xor 10011
    1101010
xor 10011
    100110
xor 10011
    00
```

Figure 4-8: Multiswitch Ethernet LAN

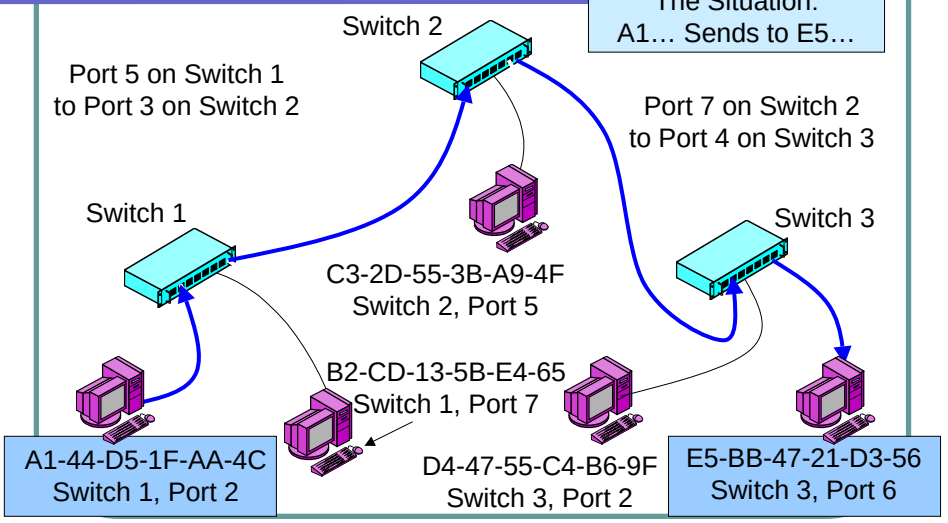
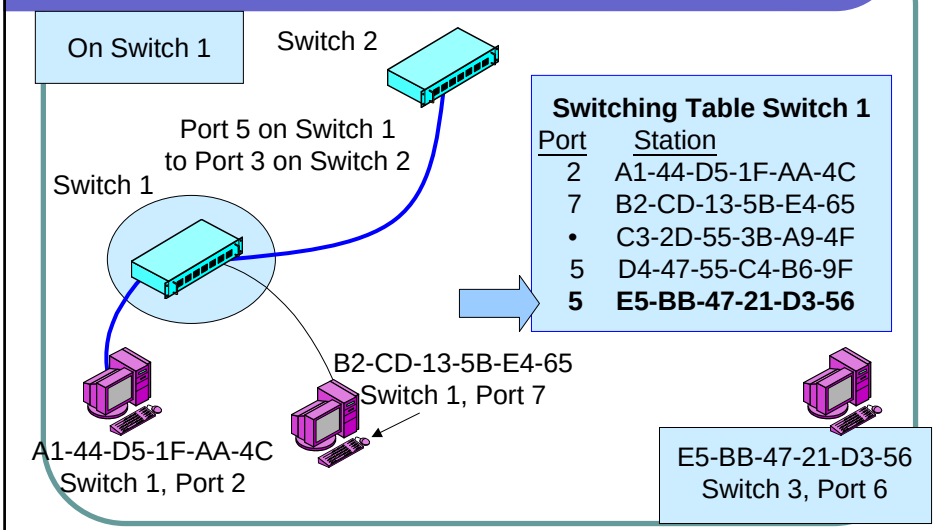


Figure 4-8: Multi-Switch Ethernet LAN, Continued



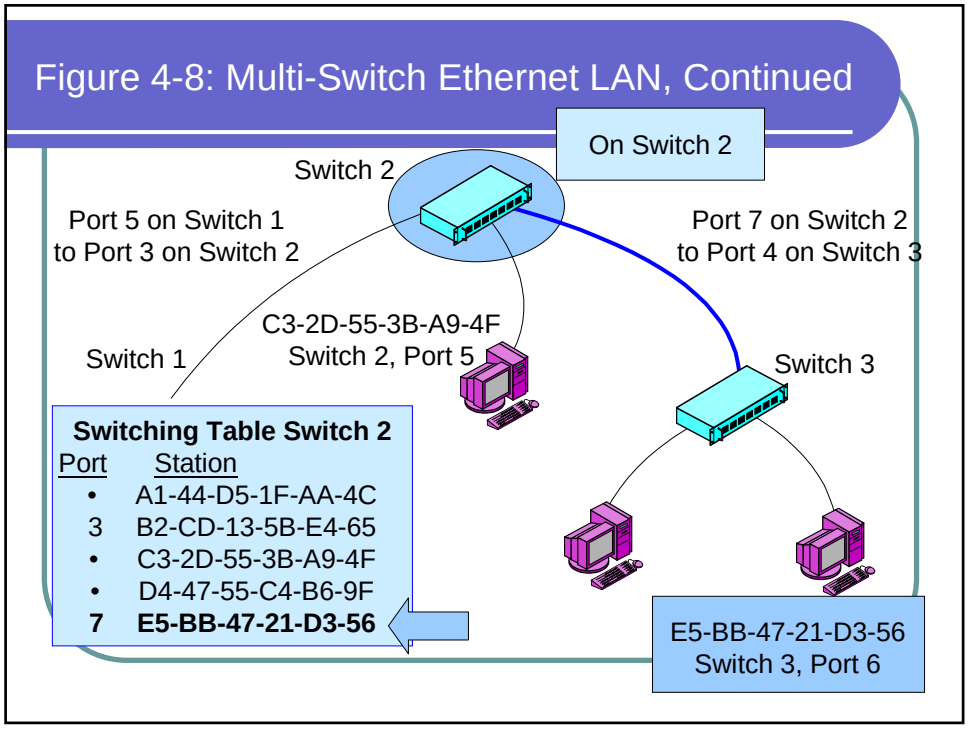


Figure 4-8: Multi-Switch Ethernet LAN, Continued
On Switch 2
Switch 2
Port 5 on Switch 1
to Port 3 on Switch 2
Port 7 on Switch 2
to Port 4 on Switch 3
C3-2D-55-3B-A9-4F
Switch 2, Port 5
Switch 1
Switch 3
Switching Table Switch 2
Port Station
• A1-44-D5-1F-AA-4C
3 B2-CD-13-5B-E4-65
• C3-2D-55-3B-A9-4F
• D4-47-55-C4-B6-9F
7 E5-BB-47-21-D3-56
E5-BB-47-21-D3-56
Switch 3, Port 6

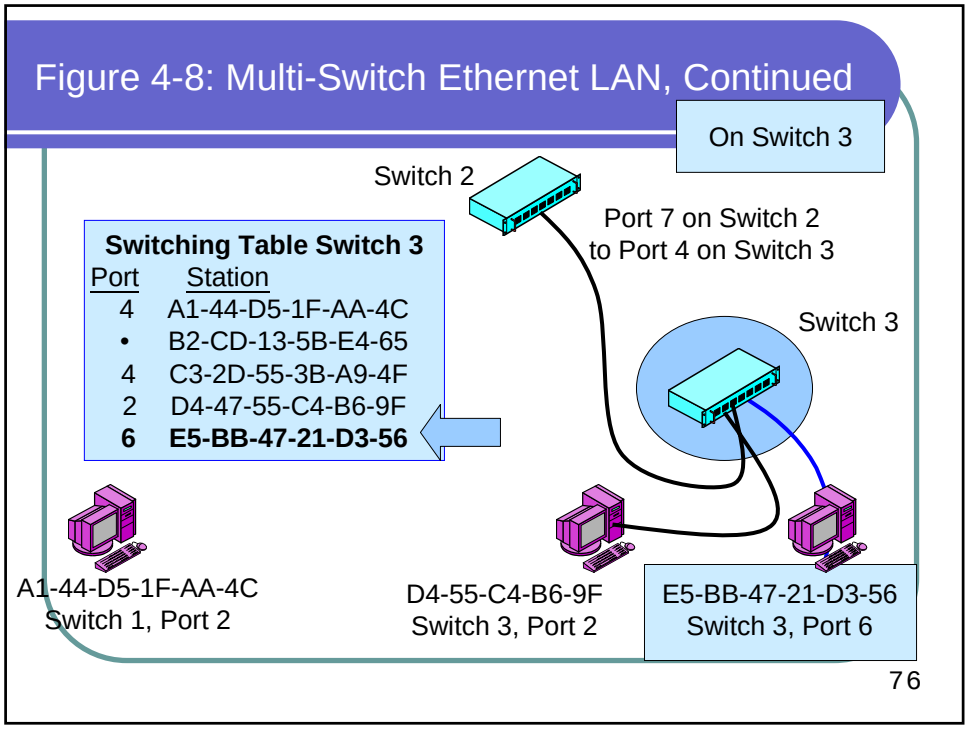
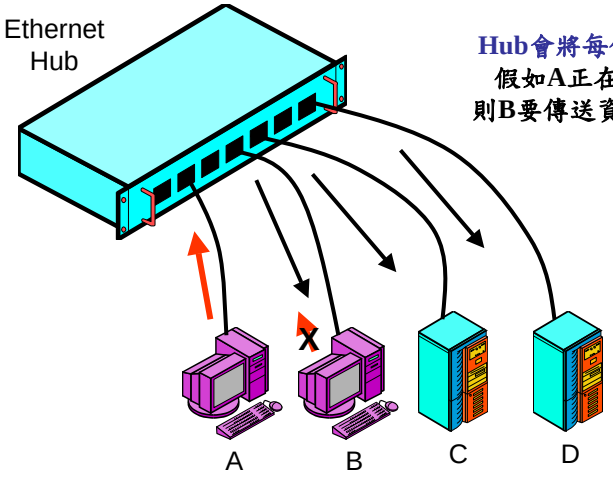


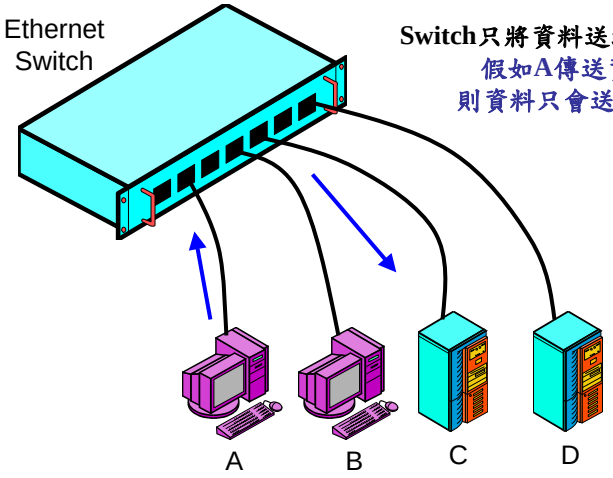
Figure 4-8: Multi-Switch Ethernet LAN, Continued
On Switch 3
Switch 2
Port 7 on Switch 2
to Port 4 on Switch 3
Switching Table Switch 3
Port Station
4 A1-44-D5-1F-AA-4C
• B2-CD-13-5B-E4-65
4 C3-2D-55-3B-A9-4F
2 D4-47-55-C4-B6-9F
6 E5-BB-47-21-D3-56
Switch 3
A1-44-D5-1F-AA-4C
Switch 1, Port 2
D4-55-C4-B6-9F
Switch 3, Port 2
E5-BB-47-21-D3-56
Switch 3, Port 6

Hub與Switch運作原理



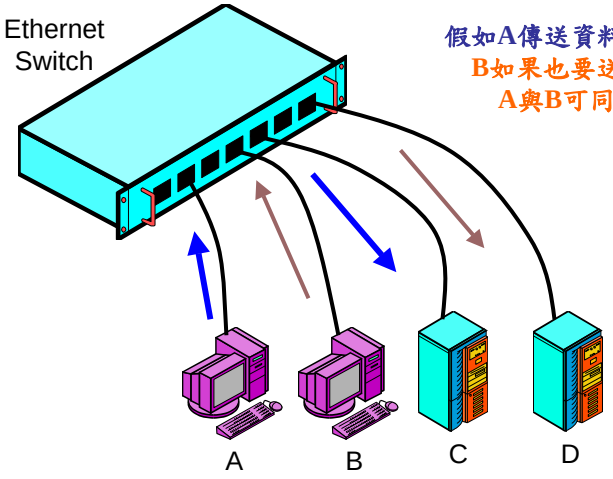
Hub會將每個位元廣播出去
假如A正在傳送資料給C,
則B要傳送資料必須等A傳完

Hub與Switch運作原理



Switch只將資料送給有需要的Port
假如A傳送資料給C,
則資料只會送給C的port

Hub與Switch運作原理

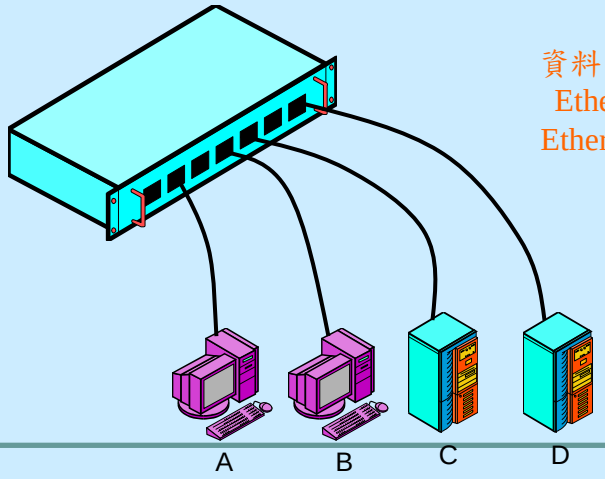


假如A傳送資料給C的同時
B如果也要送資料給D
A與B可同時傳送

Problems

- IEEE 802將Data Link Layer分成哪兩層?
- MAC位址包含哪兩個部份?
- 廣播用的MAC位址多少?
- Switching Table內存放什麼資料

Problems



資料由A傳到C
Ethernet Hub
Ethernet switch

進階Ethernet考量

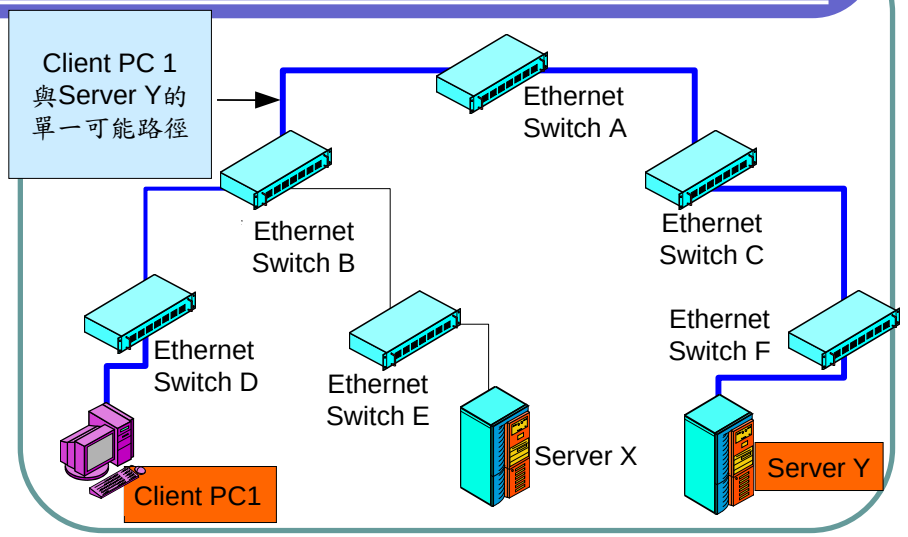
Spanning Tree Protocol

Virtual LANs(虛擬LAN)

Momentary Traffic Peaks(短暫的交通尖峰)

IEEE 802.1D Spanning Tree Protocol

階層式的Ethernet LAN

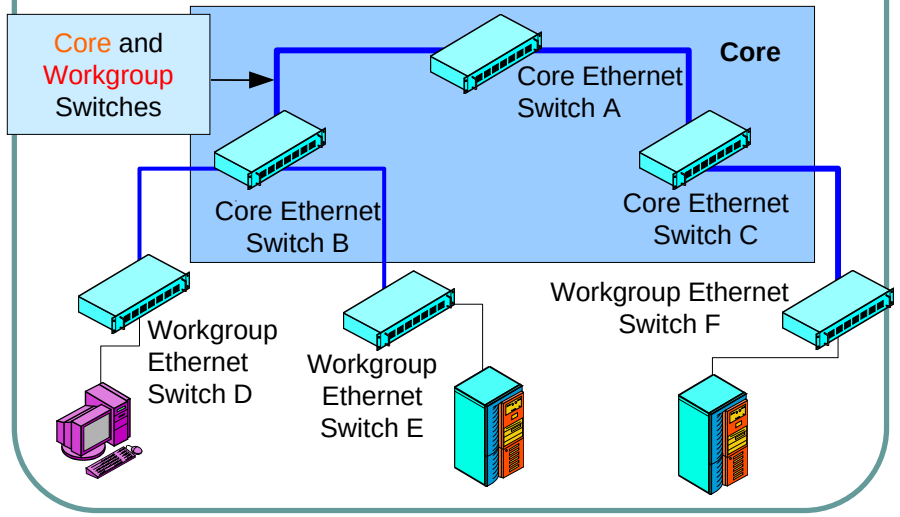


階層式的Ethernet LAN

- 兩台電腦之間只有一個可能的路徑
  - 在switch的switching table中,每個MAC address只有一份資料
  - switch可快速找到位址
  - switch成本低
  - switch是Ethernet的主要連接裝置

Port	Station
2	A1-44-D5-1F-AA-4C
7	B2-CD-13-5B-E4-65
5	**E5-BB-47-21-D3-56**

階層式的Ethernet LAN

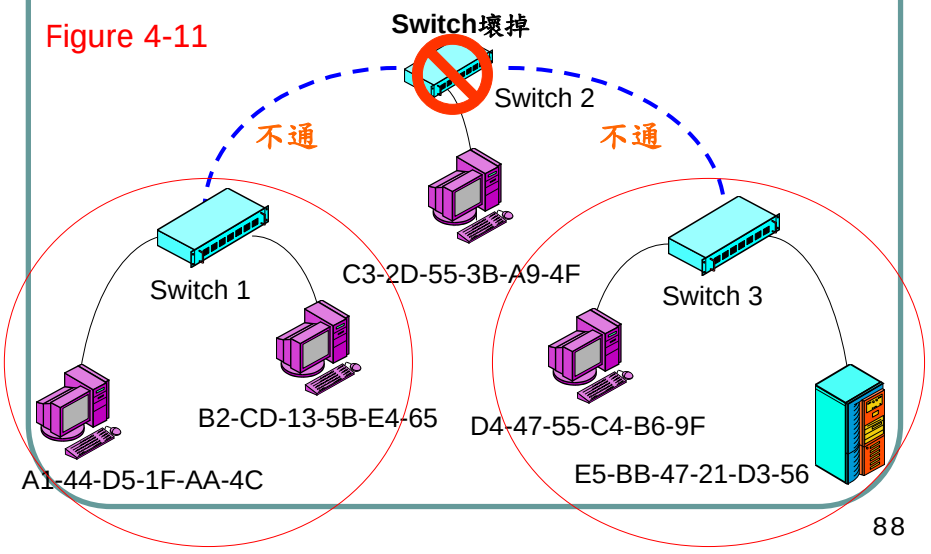


階層式的Ethernet LAN

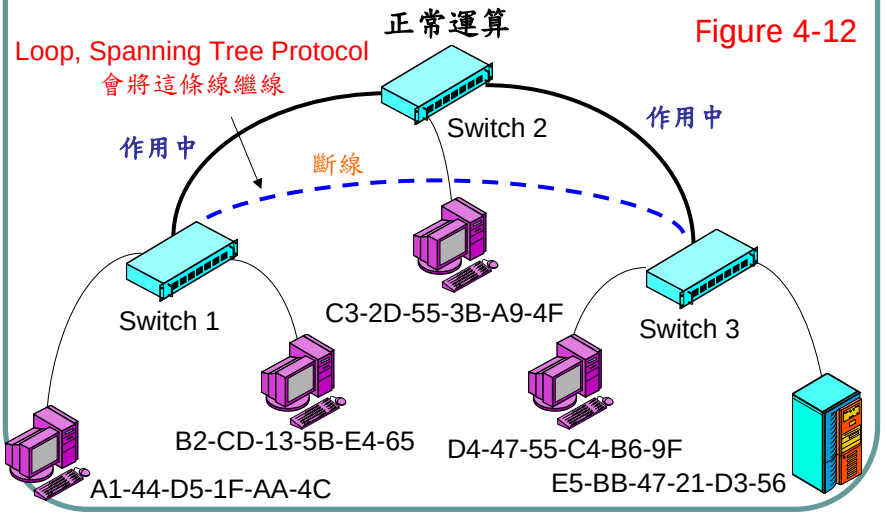
- Workgroup switches
  - 透過access line直接連到電腦
- Core switches
  - 透過trunk lines連到其它switches
  - 需具備較高傳輸容量
- Core 是指所有core switches的集合

階層式Ethernet LAN的單一錯誤

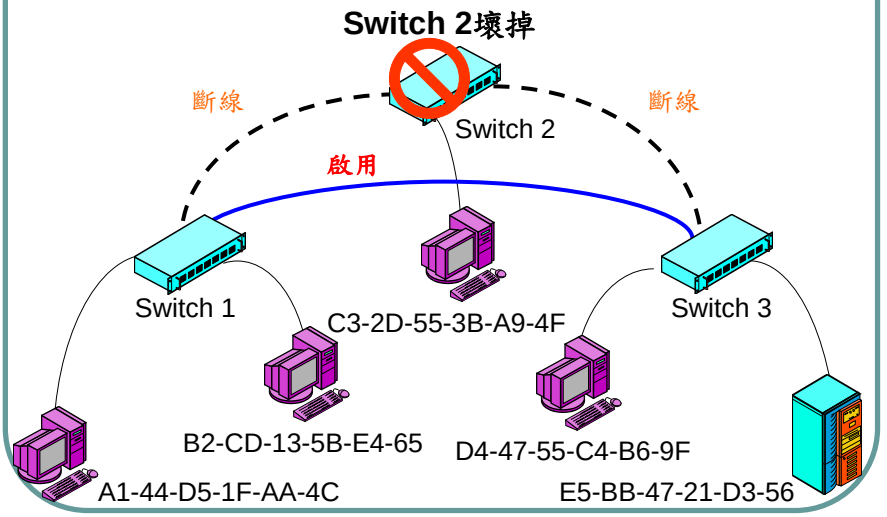
Figure 4-11



IEEE 802.1D Spanning Tree Protocol



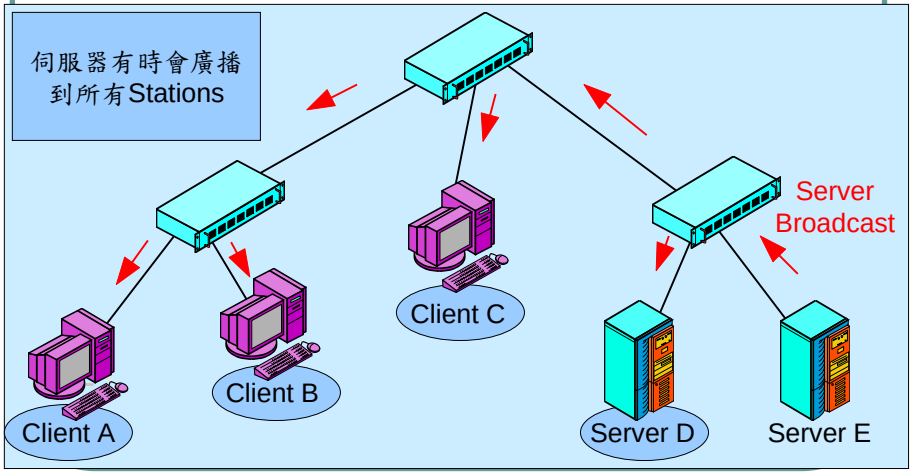
IEEE 802.1D Spanning Tree Protocol



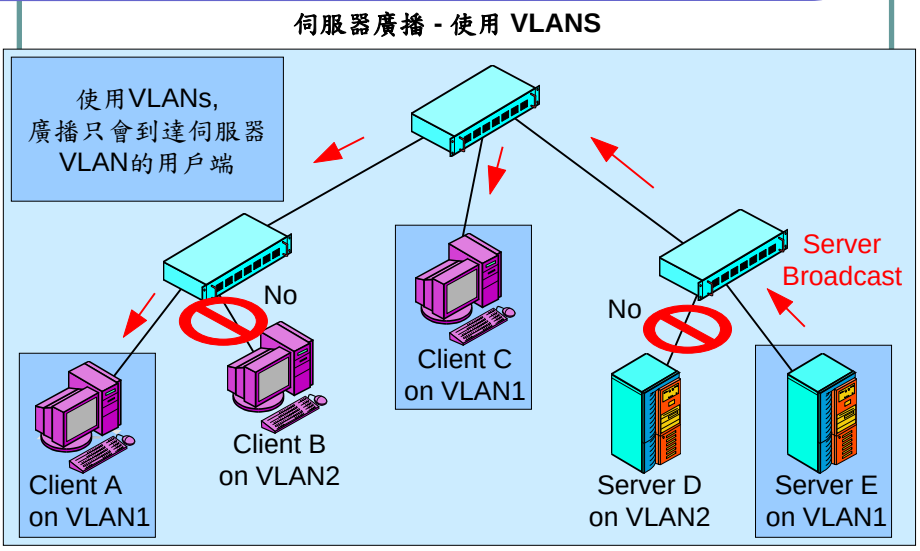
IEEE 802.1Q Virtual LAN

Virtual LAN (VLAN) with Ethernet Switches

Figure 4-13 伺服器廣播 - 沒有用 VLANS



Virtual LAN (VLAN) with Ethernet Switches



Tagged Ethernet Frame (802.1Q)
貼標籤的Ethernet封包

Basic 802.3 MAC Frame	Tagged 802.3 MAC Frame
Preamble (7 octets)	Preamble (7 octets)
Start-of-Frame Delimiter (1 Octet)	Start-of-Frame Delimiter (1 Octet)
Destination Address (6 Octets)	Destination Address (6 Octets)
Source Address (6 Octets)	Source Address (6 Octets)
Length (2 Octets)	Tag Protocol ID (2 Octets) 81-00 hex

Tagged Ethernet Frame (802.1Q)
貼標籤的Ethernet封包

Basic 802.3 MAC Frame

Data Field (variable)
PAD (If Needed)
Frame Check Sequence (4 Octets)

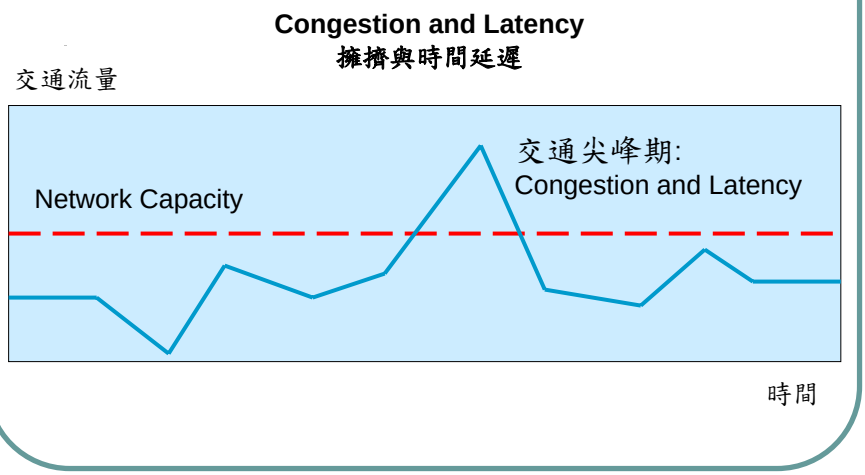
Packet size:64bytes~1518bytes

Tagged 802.3 MAC Frame

Tag控制資訊:2個位元組 Priority Level (0-7):3個位元 VLAN ID:12個位元 1個其它位元	4 bytes
Length (2 Octets)	
Data Field (variable)	
PAD (If Needed)	
Frame Check Sequence (4 Octets)	

Packet size:68bytes~1522bytes

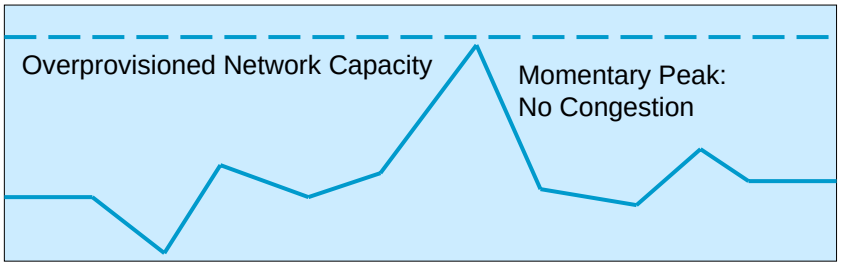
交通尖峰期的處理方式



交通尖峰期的處理方式

提供較多的交通容量

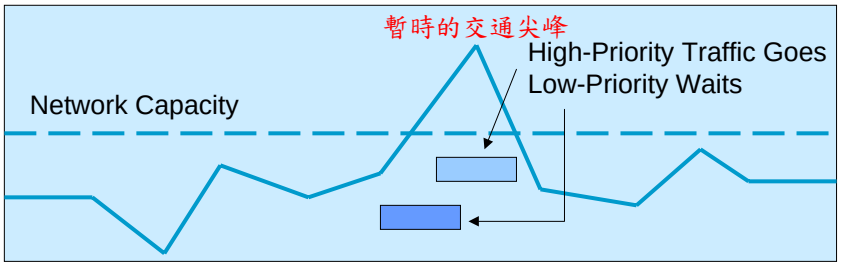
交通流量



交通尖峰期的處理方式

在Ethernet中使用不同的優先權(Priority)

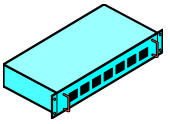
交通流量



購買交換器

購買交換器的主要考量

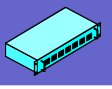
- Port數與傳輸速度
  - 決定每個交換器的port數與傳輸速度
  - 通常有現成的交換器可供挑選
  - 模組化交換器可在需要時隨時調整交換器



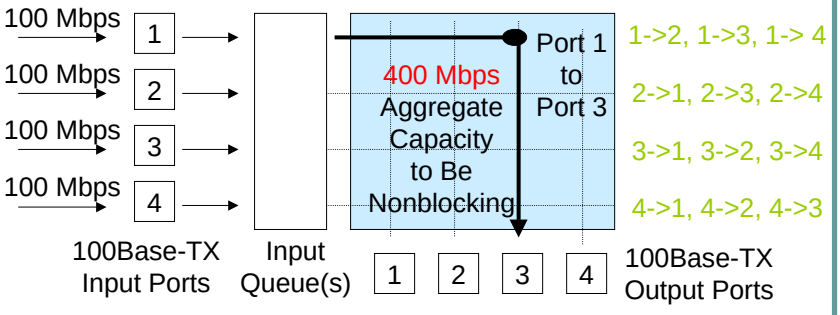
購買交換器的主要考量

- 交換器矩陣的處理能力(Throughput) (Figure 4-17)
  - Aggregate throughput
    - 交換器矩陣的整體速度
  - Nonblocking capacity
    - 交換器矩陣最大可處理的資料量(含所有port資料量)
    - 資料量低於nonblocking capacity可正常運作
      - 針對core switches, 最少要有總資料量的80%
      - 針對workgroup switches,最少要有總資料量的20%

Figure 4-17: Switching Matrix

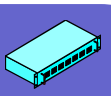


四個port的交換器



Note: Input Port 1 and Output Port 1 are the same port

購買交換器的主要考量



- Store-and-Forward與Cut-Through交換技術
  - Store-and-forward乙太交換器
    - 傳送前需讀入整個封包
  - Cut-through乙太交換器
    - 傳送前只需讀入部份欄位
  - Cut-through乙太交換器速度快(latency低), 但較不普遍

Store-and-Forward與Cut-Through交換技術

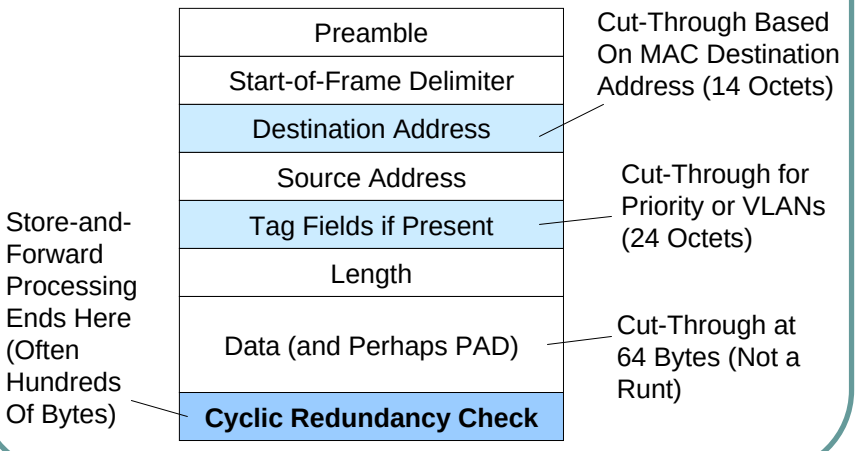
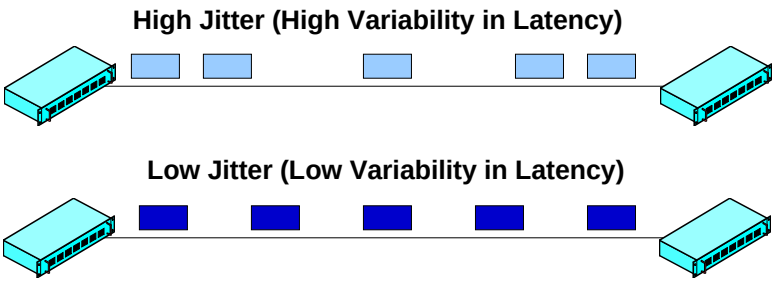


Figure 4-19: Jitter

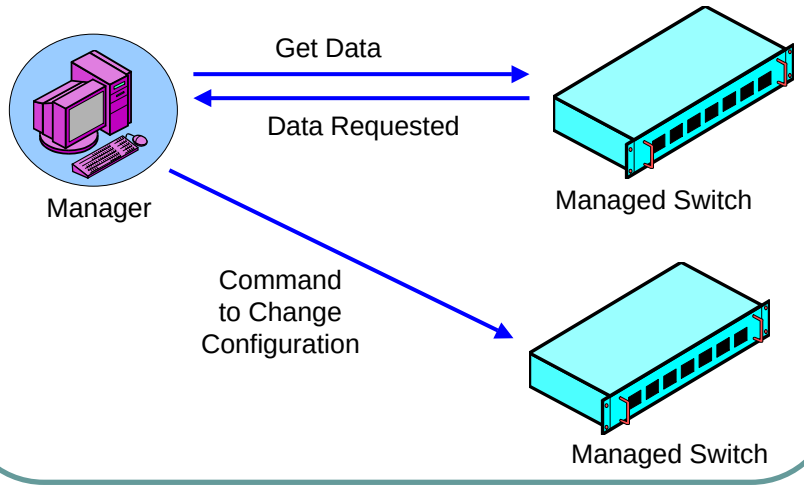
- Jitter
  - Variability in latency from cell to cell. Makes voice sound jittery



購買交換器的主要考量

- 控管能力
  - 管理者控制許多交換器
  - 利用詢問(Polling)的方式搜集資料與問題診斷
  - 利用改變設定值 - 遠端修復交換器
  - 提供網路管理者效能資訊
    - 網路流量, 封包數量, bit error rate, ...

Figure 4-20: Managed Switches

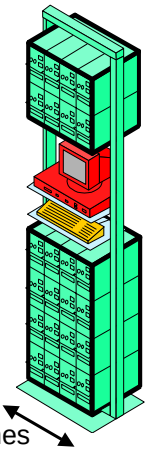


購買交換器的主要考量

- 控管能力
  - Managed switches成本較高
    - 取得成本與運作成本
  - 對較大的網路而言,可節省人力且反應快速

實體與電氣特性

- 外觀
  - 適用標準19吋(48公分)寬的架子或櫃子
  - 交換器高度單位:1U=1.75英吋(或4.4公分)



實體與電氣特性

- Port的彈性度
  - 固定port數交換器
    - 沒有彈性, port數固定
    - 高度:1U或2U
    - 大部份的workgroup switches屬於此類

實體與電氣特性

- Port的彈性度
  - Stackable (可疊式) Switches
    - 每個交換器port數固定
    - 高度:1U或2U
    - 利用高速互連滙流排(bus)連接交換器
    - Port數可增加
      - 如一台交換器12 port
      - 兩台24 port
      - n台=n*12 port

實體與電氣特性

- Port的彈性度
  - 模組式交換器
    - 高度:1U或2U
    - 包含一或多個插槽
    - 每個插槽可插一個模組
    - 每個模組內含多個port

實體與電氣特性

- Port的彈性度
  - Chassis switches
    - 高度:多個U
    - 內含多個擴充板
    - 每個擴充板包含6到12個插
    - 大部份core switches屬此類

實體與電氣特性

- UTP上傳埠(Uplink Ports)
  - 正常乙太網路交換器RJ-45接頭
    - 使用第3與第6條線傳送資料
    - 使用第1與第2條線接收資料
    - 與網路卡相反
  - 連接兩台交換器的兩個埠將無法通訊
  - 大部份交換器有上傳埠(uplink port)
    - 使用第1與第2條線傳送資料
    - 可供連到上一層的交換器

實體與電氣特性

- 802.3af可透過一般 UTP線供電
  - 最多12.95 watts (at 48 volts)
  - 可供wireless access points使用
  - 可供IP telephones使用
  - 不夠供電腦使用
  - 自動偵測相容裝置

Topics Covered

- Who develops Ethernet standards?
- Many physical layer standards (100Base-TX, 1000Base-SX, etc.)
- Baseband versus broadband transmission
- Link aggregation
- Switch signal regeneration allows maximum distances spanning several UTP and fiber links

Topics Covered

- MAC and LLC layers
- Ethernet Frame
  - Preamble and Start of Frame Delimiter fields
  - 48-bit Source and Destination Address fields
  - Length field (length of data field)
  - Data field
    - LLC subheader
    - Packet
  - PAD if needed to make data field + PAD 64 bits long

Topics Covered

- Ethernet Frame
  - Frame check sequence field
    - Discard if detect error: unreliable
- Hexadecimal Notation
  - For humans, not computers
- Multi-Switch LAN Operation with Switching Tables

Topics Covered

- Hubs versus Switches
- Hierarchical Topology
  - Only one possible path between any two end stations
  - Makes switching decisions easy and fast
  - This makes the cost per frame handled low
  - Key to Ethernet's LAN dominance
- Core and Workgroup Switches

Topics Covered

- VLANs to reduce congestion due to server broadcasting
- Handling Momentary Traffic Peaks
  - Overprovisioning—least expensive Ethernet choice today
  - Priority is more efficient but more expensive to do
- Tagged Frames for VLANs and Priority

Topics Covered

- Switch Purchasing Decisions
  - Number and speeds of ports
  - Switch matrix capacity and nonblocking switches
  - Store-and-forward versus cut-though switches
  - Jitter
  - Manageability
  - Form factor (U)
  - Port flexibility
  - UTP uplink ports
  - 802.3af for electrical power