TCP/IP Internetworking

Chapter 8

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

現況

- 大部份公司Intranet使用多個LAN與WAN
- 大部份公司Intranet 使用 TCP/IP 標準
- 大部份個人電腦使用 TCP/IP 標準

使用Router連接不同LAN

3

Routers連接多個網路 (LANs與WANs) 到 Internet

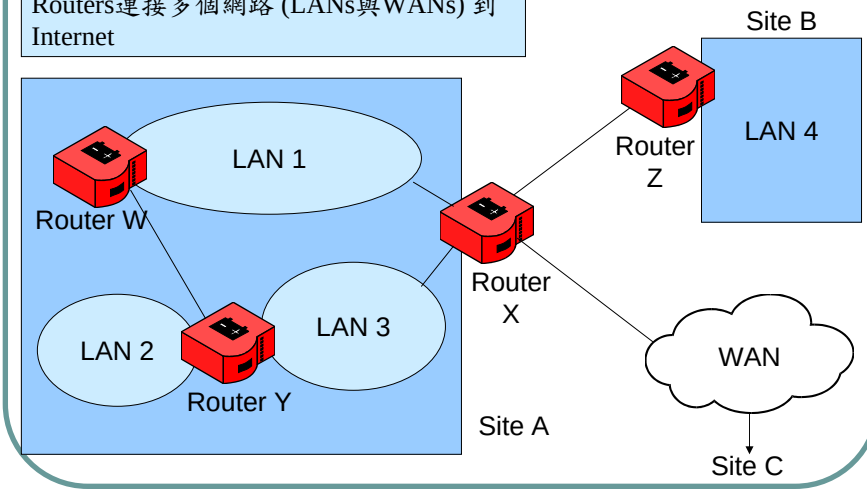


Figure 8-1: 主要的 TCP/IP 標準

4

5 Application	User Applications			Supervisory Applications		
	HTTP	SMTP	Many Others	DNS	Routing Protocols	Many Others
4 Transport	TCP			UDP		
3 Internet	IP			ICMP	ARP	
2 Data Lin						
1 Physica						

網際網路傳輸(Internetworking)必須透過 Internet與transport layers標準 這兩層只有幾個標準

Note: Shaded protocols are discussed in this chapter.

Figure 8-1: 主要的 TCP/IP 標準

5

5 Application	User Applications			Supervisory Applications		
	HTTP	SMTP	Many Others	DNS	Routing Protocols	Many Others
4 Transport	TCP			UDP		
3 Internet						
2 Data Link						
1 Physical	None: Use OSI Standards					

應用層可分使用者應用程式(user applications)與
管理者應用程式(supervisory applications)
本章將介紹兩種管理者應用程式

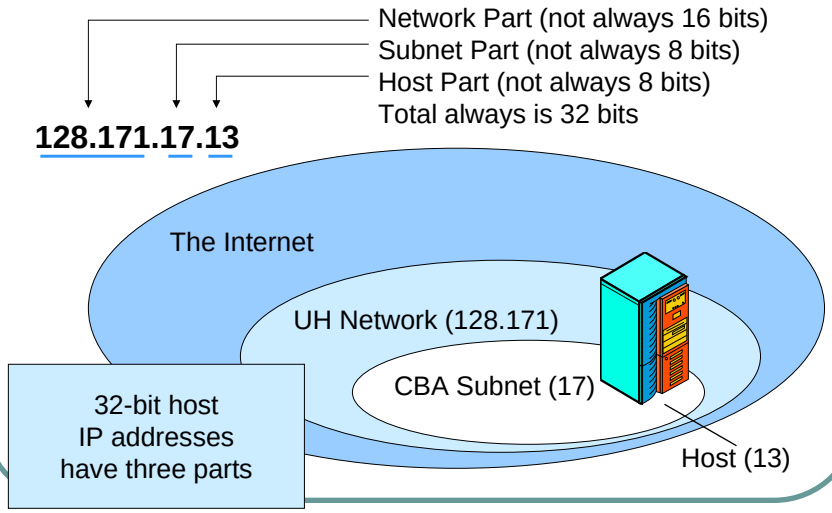
Note: Shaded protocols are discussed in this chapter.

Figure 8-2: IP, TCP, and UDP

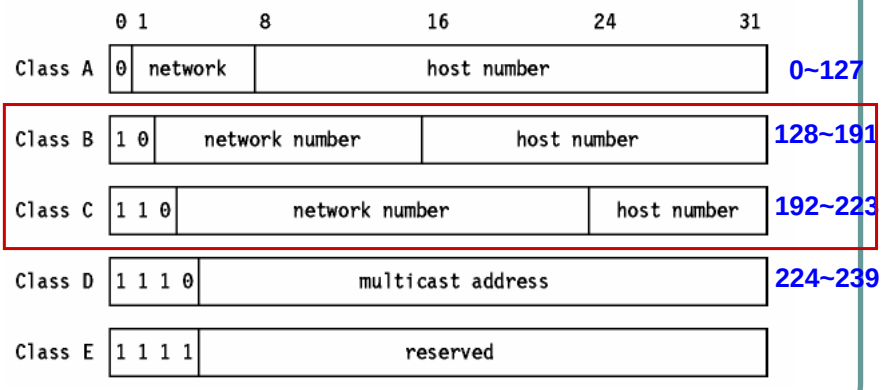
6

Layer	Protocol	Connection-Oriented?	Reliable?	Lightweight or Heavyweight?
4 (Transport)	TCP	Yes	Yes	Heavyweight
4 (Transport)	UDP	No	No	Lightweight
3 (Internet)	IP	No	No	Lightweight

Figure 8-3: 階層式 IP Address



IP Address 種類



IP Address - examples

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Class B IP位址實例

教育部 140.111.34.60=**10**001100 01101111 00100010 00111100

工研院140.96.100.40 =**10**001100 01100000 01100100 00101000

台大140.112.XX.XX

交大140.113.XX.XX

清大140.116.XX.XX

IP Address - examples

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Class C IP位址實例

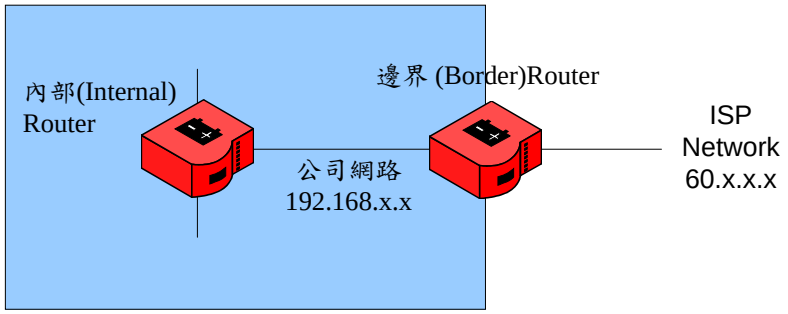
南華203.72.0.5=**110**01011 01001000 00000000 00000101

中時電子報210.65.0.2=**110**10010 01000001 00000000 00000010

奇摩202.43.195.13=**110**01010 00101011 11000011 00001101

Figure 8-4: Border Router, Internal Router, Networks, and Subnets

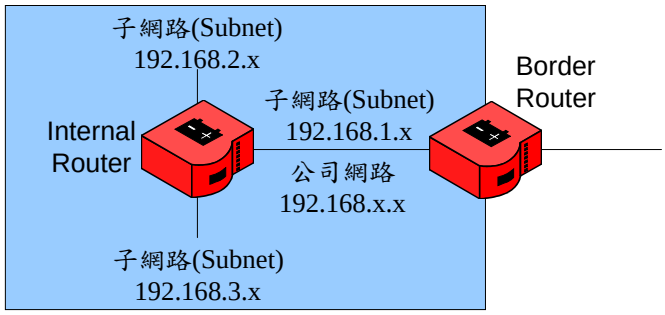
11



Border Routers 連接不同網路
通常是指連接公司內部與外部網路用的router

Figure 8-4: Border Router, Internal Router, Networks, and Subnets, Continued

12



Internal Routers連接公司內部不同子網路

公司內部網路可分成多個子網路

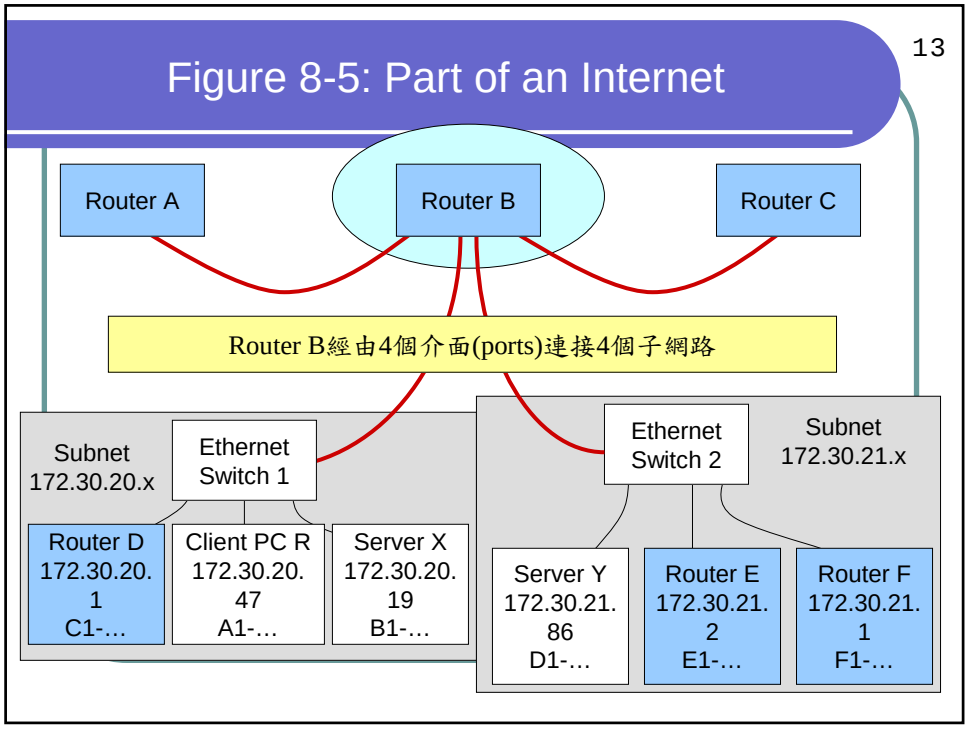


Figure 8-5: Part of an Internet
13
Router A
Router B
Router C
Router B經由4個介面(ports)連接4個子網路
Subnet
172.30.20.x
Ethernet
Switch 1
Router D
172.30.20.
1
C1-…
Client PC R
172.30.20.
47
A1-…
Server X
172.30.20.
19
B1-…
Ethernet
Switch 2
Subnet
172.30.21.x
Server Y
172.30.21.
86
D1-…
Router E
172.30.21.
2
E1-…
Router F
172.30.21.
1
F1-…

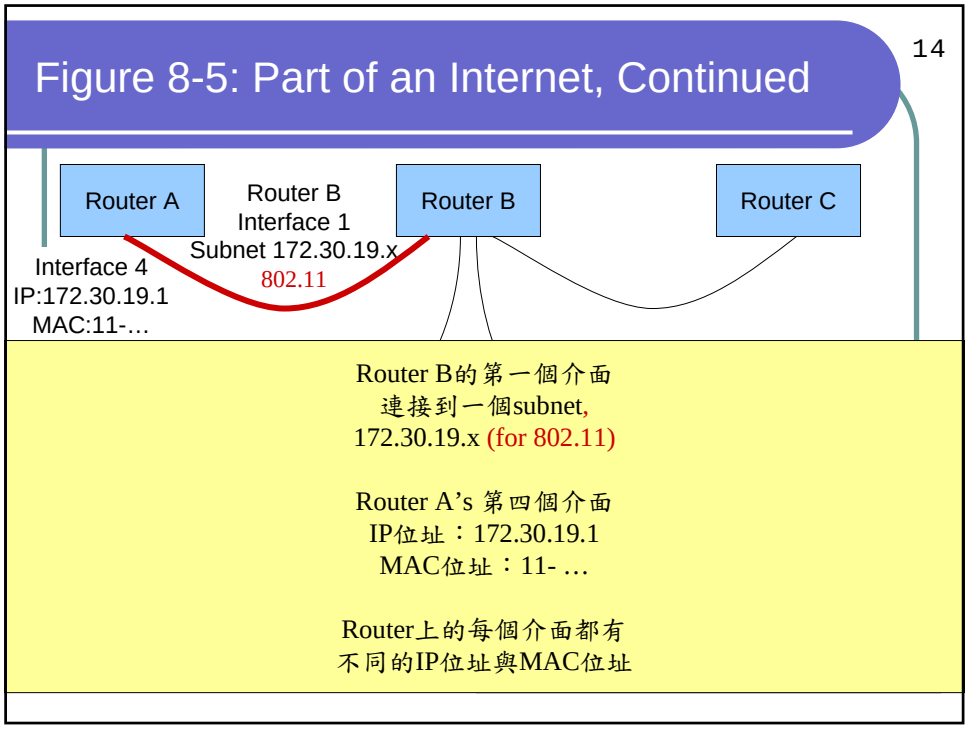


Figure 8-5: Part of an Internet, Continued
14
Router A
Router B
Interface 1
Subnet 172.30.19.x
802.11
Router B
Router C
Interface 4
IP:172.30.19.1
MAC:11-…
Router B的第一個介面
連接到一個subnet,
172.30.19.x (for 802.11)
Router A's 第四個介面
IP位址：172.30.19.1
MAC位址：11- …
Router上的每個介面都有
不同的IP位址與MAC位址

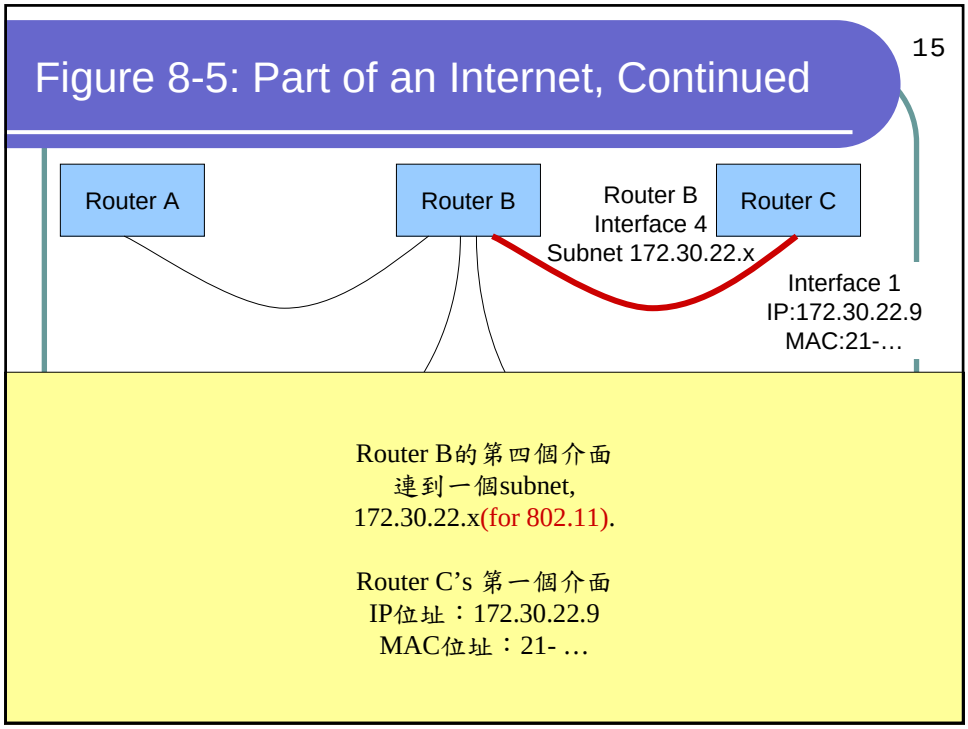


Figure 8-5: Part of an Internet, Continued
15
Router A
Router B
Router B
Interface 4
Subnet 172.30.22.x
Router C
Interface 1
IP:172.30.22.9
MAC:21-…
Router B的第四個介面
連到一個subnet,
172.30.22.x(for 802.11).
Router C's 第一個介面
IP位址：172.30.22.9
MAC位址：21- …

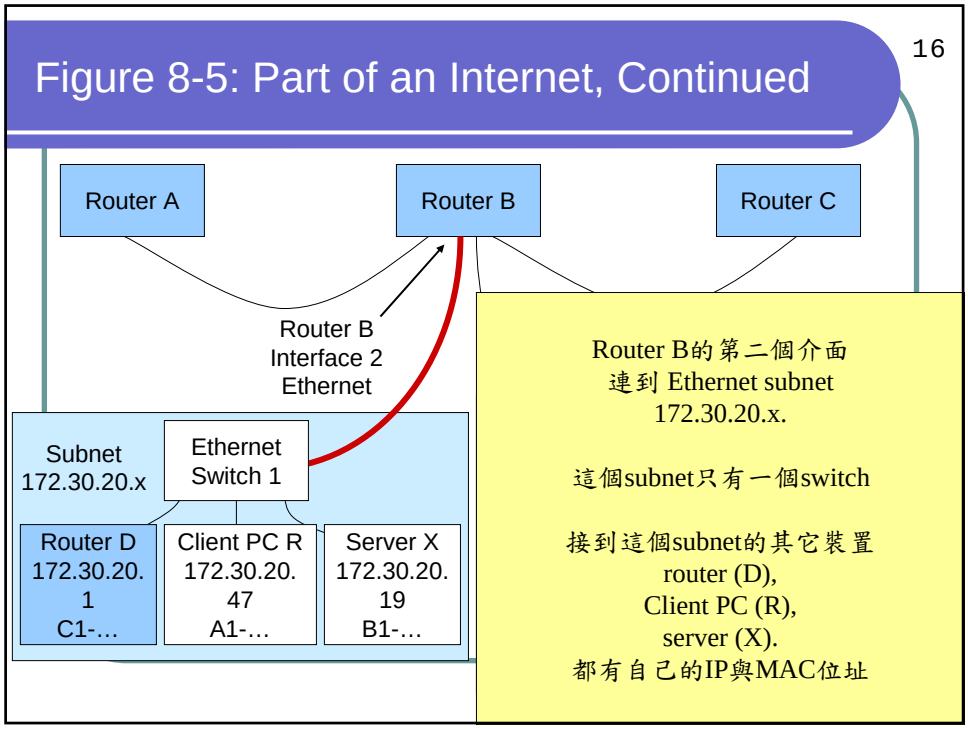
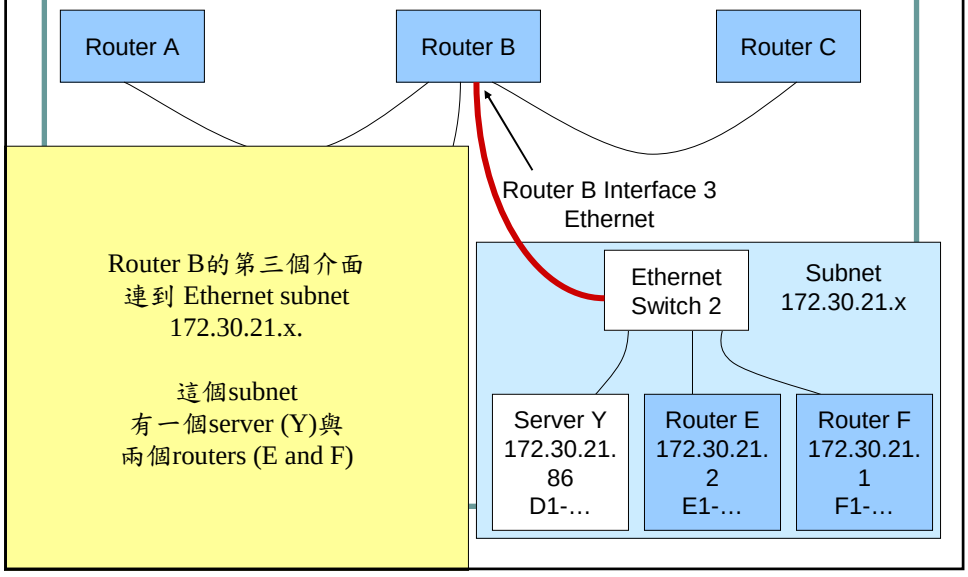


Figure 8-5: Part of an Internet, Continued
16
Router A
Router B
Router C
Router B
Interface 2
Ethernet
Subnet
172.30.20.x
Ethernet
Switch 1
Router D
172.30.20.
1
C1-…
Client PC R
172.30.20.
47
A1-…
Server X
172.30.20.
19
B1-…
Router B的第二個介面
連到 Ethernet subnet
172.30.20.x.
這個subnet只有一個switch
接到這個subnet的其它裝置
router (D),
Client PC (R),
server (X).
都有自己的IP與MAC位址

Figure 8-5: Part of an Internet, Continued

17

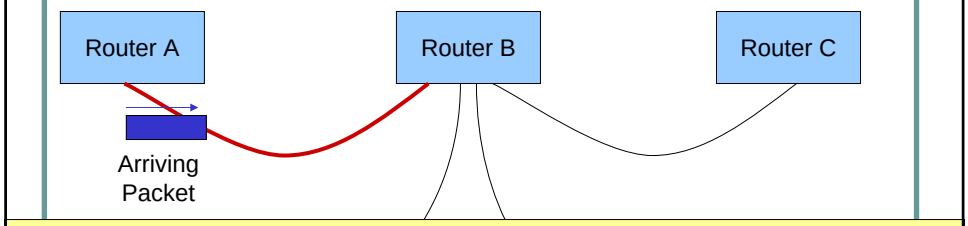


Router B的第三個介面
連到 Ethernet subnet
172.30.21.x.

這個subnet
有一個server (Y)與
兩個routers (E and F)

Figure 8-5: Part of an Internet, Continued

18



封包由Router B的第一個介面進入
Router B會將封包透過不同的介面傳出去

從哪個介面呢?

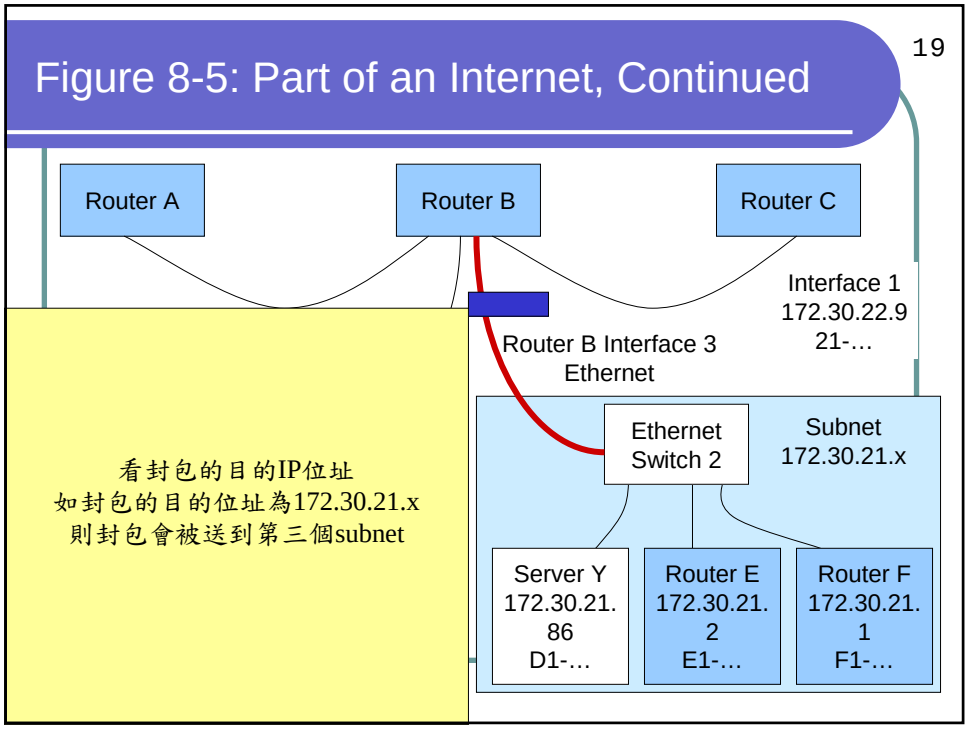


Figure 8-5: Part of an Internet, Continued
19
Router A
Router B
Router C
Interface 1
172.30.22.9
21-…
Router B Interface 3
Ethernet
Ethernet
Switch 2
Subnet
172.30.21.x
看封包的目的IP位址
如封包的目的位址為172.30.21.x
則封包會被送到第三個subnet
Server Y
172.30.21.
86
D1-…
Router E
172.30.21.
2
E1-…
Router F
172.30.21.
1
F1-…

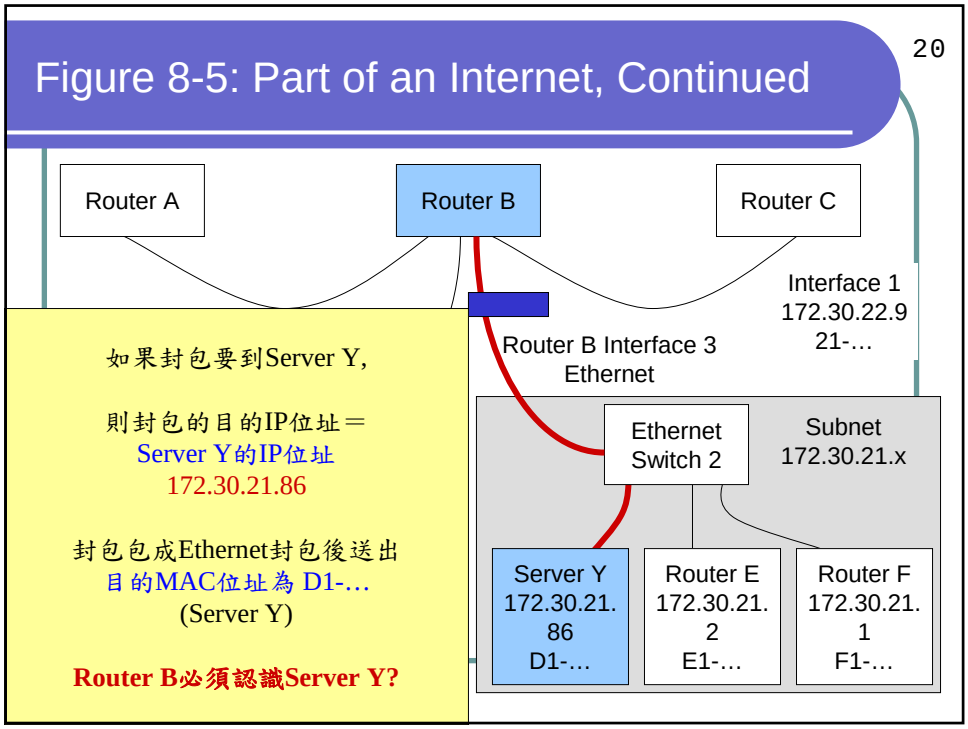
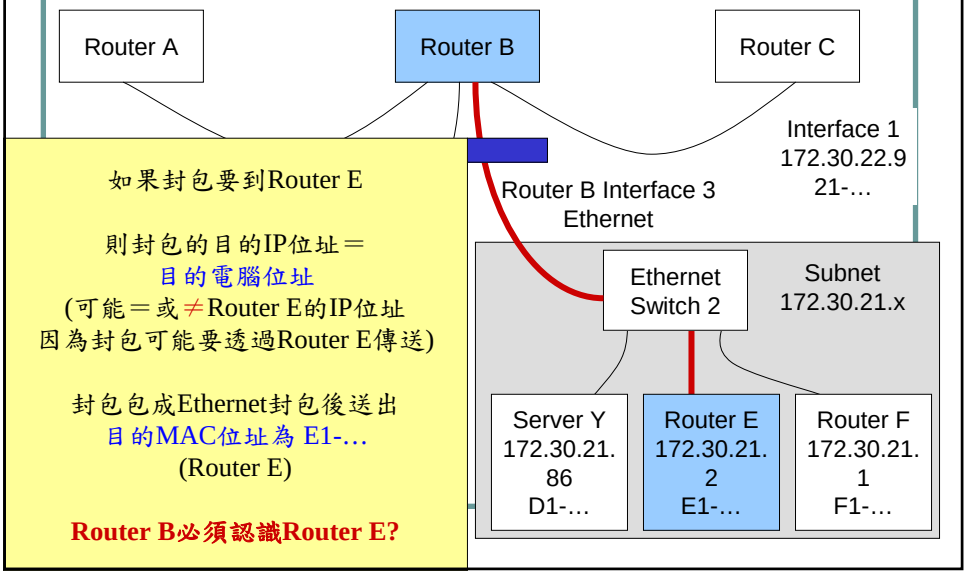


Figure 8-5: Part of an Internet, Continued
20
Router A
Router B
Router C
Interface 1
172.30.22.9
21-…
Router B Interface 3
Ethernet
Ethernet
Switch 2
Subnet
172.30.21.x
如果封包要到Server Y,
則封包的目的IP位址＝
Server Y的IP位址
172.30.21.86
封包包成Ethernet封包後送出
目的MAC位址為 D1-…
(Server Y)
Router B必須認識Server Y?
Server Y
172.30.21.
86
D1-…
Router E
172.30.21.
2
E1-…
Router F
172.30.21.
1
F1-…

Figure 8-5: Part of an Internet, Continued

21



如果封包要到Router E

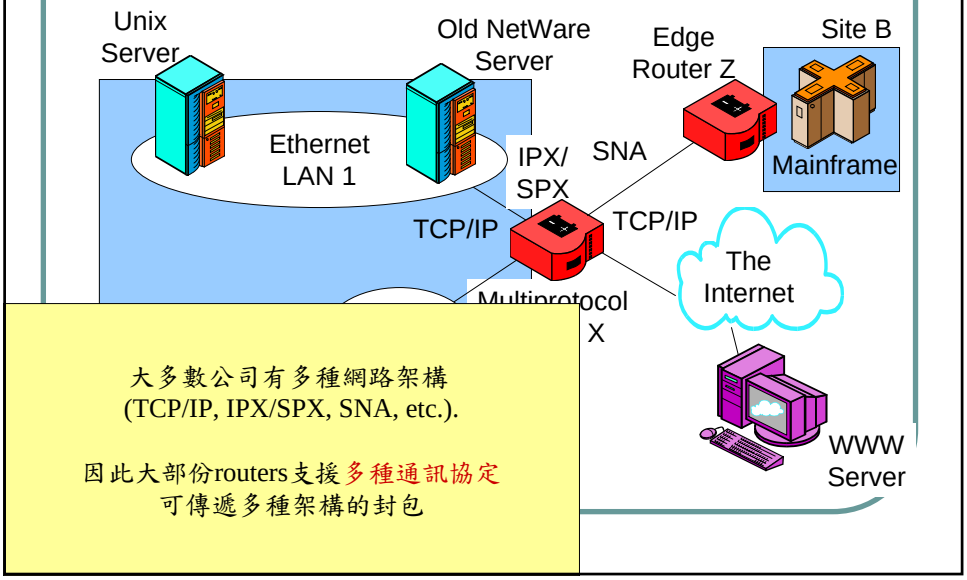
則封包的目的IP位址＝
目的電腦位址
(可能＝或≠Router E的IP位址
因為封包可能要透過Router E傳送)

封包包成Ethernet封包後送出
目的MAC位址為 E1-…
(Router E)

Router B必須認識Router E?

Figure 8-6: Multiprotocol Routing

22



大多數公司有多種網路架構
(TCP/IP, IPX/SPX, SNA, etc.).

因此大部份routers支援多種通訊協定
可傳遞多種架構的封包

Ethernet交換器與IP Router比較

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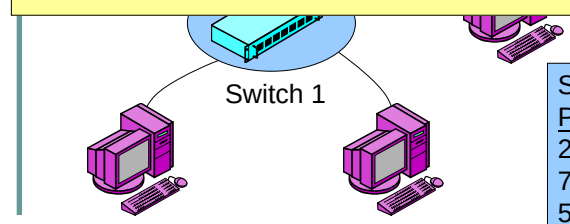
Ethernet switching
速度快且便宜
針對目的 MAC 位址
表格中只能有一個相同的MAC位址
封包依表格內MAC位址所對應的port傳送

Ethernet Switching

n Switch 2
on Switch 3



A1-44-D5-1F-AA-4C
Switch 1, Port 2

B2-CD-13-5B-E4-65
Switch 1, Port 7

Switching Table Switch 1

Port	Station
2	A1-44-D5-1F-AA-4C
7	B2-CD-13-5B-E4-65
5	C3-2D-55-3B-A9-4F
5	D4-47-55-C4-B6-9F
5	E5-BB-47-21-D3-56

Ethernet交換器與IP Router比較

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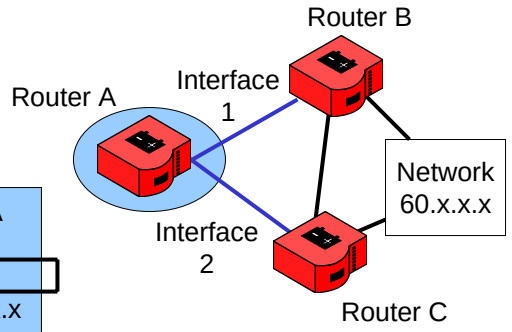

IP Routing Table Router A

Interface	Network
1	60.x.x.x
2	128.171.x.x
1	123.x.x.x
2	60.x.x.x
2	123.x.x.x

IP Routing
交換速度慢，價錢貴
存在替代路徑可用
相同目的IP可能對映多個輸出埠
從可用的輸出埠中找出最佳方案

Ethernet交換器與IP Router比較

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- Ethernet switching 相對便宜
- Router routing 相對較貴
- 可用交換器就不用router

Routing Table

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列號	目的網路 或子網路	Mask (/Prefix) 使用的Bit數	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	L
3	192.168.6.0	255.255.255.0 (/24)	12	2	G

Router 依Routing Table內容決定路徑

每一列表示到一個網路或子網路的可能路徑

針對每個進來的封包

檢查routing table上的每一列是否與封包的目的IP位址相符

從所有相符的結果中，找出一個成本最低的方案

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Figure 8.8: Routing Table, Continued

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	L
3	192.168.6.0	255.255.255.0 (/24)	12	2	G

每一列包含**一個範圍**的IP位址

可減少搜尋時間與表格大小

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如何判斷目的IP位址與routing table的項目是否相符?

Figure 8.9: Masking(使用and運算)

29

跟IP位址做and運算

and位元運算

Information bit	1	0	1	0
Mask bit	1	1	0	0
Result	1	0	0	0

Figure 8.9: Masking(使用and運算)

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常用的Mask Pattern

二進位	十進位
00000000	0
11111111	255

Figure 8.9: Masking(使用and運算)

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Example 1

IP Address	172.	30.	22.	7
Mask	255.	0.	0.	0
Result	172.	0.	0.	0

Figure 8.9: Masking(使用and運算)

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Example 2

IP Address	172.	30.	22.	7
Mask	255.	255.	0.	0
Result	172.	30.	0.	0

Figure 8.9: Masking(使用and運算)

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1. IP位址：140.96.100.10, Mask : 255.255.255.0
2. IP位址：140.134.11.4, Mask : 255.255.0.0
3. IP位址：203.72.206.123, Mask : 255.255.240.0

Figure 8.8: Routing Table, Continued

34

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	L
3	192.168.6.0	255.255.255.0 (/24)	12	2	G

Row 1
If Destination IP Address = 172. 30.33.6
Mask = 255.255. 0.0
Result = 172. 30. 0.0 ⇄ 比較
Destination Network or Subnet = 128.171. 0.0
No match!

35

Figure 8.8: Routing Table, Continued

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	L
3	192.168.6.0	255.255.255.0 (/24)	12	2	G

Row 2
If Destination IP Address = 172. 30. 33.6
Mask = 255.255.255.0
Result = 172. 30. 33.0 } 比較
Destination Network or Subnet = 172. 30. 33.0
This row is a match!

36

Figure 8.8: Routing Table, Continued

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
2	172.30.33.0	255.255.255.0 (/24)	0	1	L
3	192.168.6.0	255.255.255.0 (/24)	12	2	G

Row 3
If Destination IP Address = 172. 30. 33.6
Mask =
Result =
Destination Network or Subnet =
Is this row is a match?

Routing(尋徑)

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- 對每個進來的IP封包
  - 找出 routing table 中與封包目的IP位址相符的項目
  - 假如 routing table有10,000列, 則每個封包都要比較 10,000 次
  - 可能找到多個相符的項目, 代表多條可用的路徑
  - **從所有可用的路徑中，找一條最好的路徑**

Figure 8.8: Routing Table, Continued

38

列號	目的網路或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
3	192.168.0.0	255.255.0.0 (/16)	12	2	G

- 如果只有一條符合，則直接選為最佳路徑
  - 目的 IP 位址 = 192.168.6.7

Figure 8.8: Routing Table, Continued

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列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
13	0.0.0.0	0.0.0.0 (/0)	5	3	H

- 內定列永遠符合
  - Mask 0.0.0.0 會將所有IP變成 0.0.0.0
  - 所以這一行永遠符合
  - Next-Hop Router = H 表示這一列是內定router

Figure 8.8: Routing Table, Continued

40

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
1	128.171.0.0	255.255.0.0 (/16)	47	2	G
7	128.171.17.0	255.255.255.0 (/24)	55	3	H

- 假如有多個列符合，則Prefix最長的被選擇
  - 例如：128.171.17.56
    - 第1列跟第7列都符合
    - 選擇第7列
  - 因為prefix較長的屬於特定子網路

Figure 8.8: Routing Table, Continued

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列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
5	172.29.8.0	255.255.255.0 (/24)	34	1	F
8	172.29.8.0	255.255.255.0 (/24)	20	3	H

- 假如多列符合且prefix長度相等，比較Metric
  - 如果metric是cost, 選最小的
  - 如果metric是speed, 選最大的

Figure 8.8: Routing Table, Continued

42

列號	目的網路 或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
5	172.29.8.0	255.255.255.0 (/24)	34	1	F

- Interface表示router上的一個輸出埠
  - 每個Interface連到一個子網路
- Next-Hop Router表下一個Router位址
- 第5列, 將封包從Interface 1送到下一站

Figure 8.8: Routing Table, Continued

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列號	目的網路或子網路	Mask (/Prefix)	Metric (Cost)	Interface	Next-Hop Router
2	172.30.33.0	255.255.255.0 (/24)	0	1	Local

- 如果下一站欄位是Local
  - 則目的IP就在這個Interface相連的子網路內
  - 此時router會直接將封包送給目的電腦,而不是送給下一個router

Figure 8-11: Interface and Next-Hop Router

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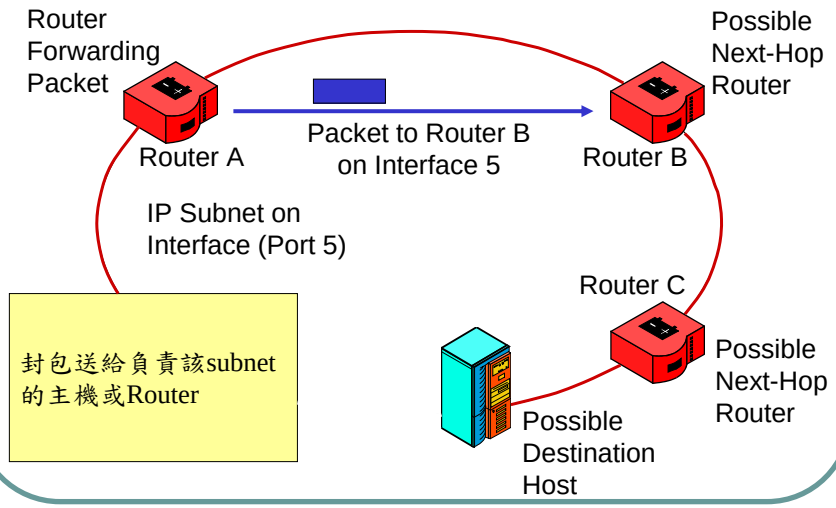

Routing(尋徑方法)

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- 1.Router找出所有符合封包目的IP位址的列
- 2.Router選出一個最適合的列
- 3.Router依interface與next-hop router欄位決定如何處理封包

Figure 8-12: Routing Protocols

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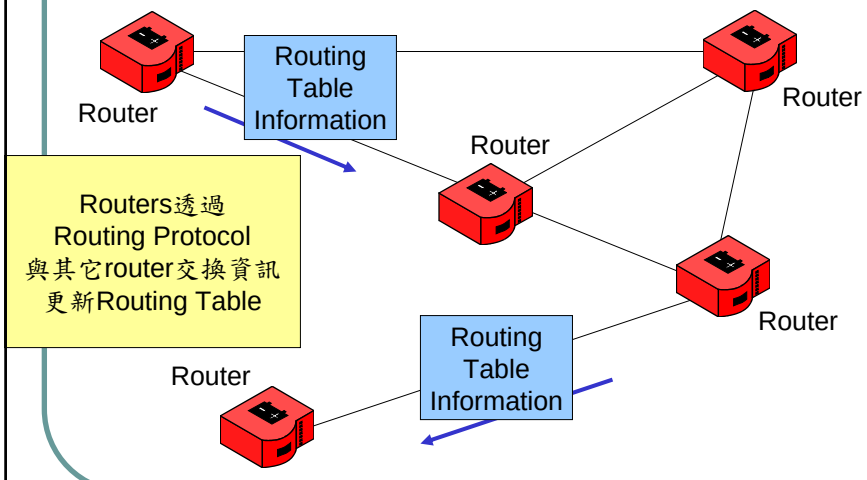


What is “Routing”?

47

- TCP/IP uses the term “routing” in two ways.
  - Router決定如何傳送封包
  - Router彼此交換routing table資訊

Figure 8-13: Multiprotocol Label Switching (MPLS)

48

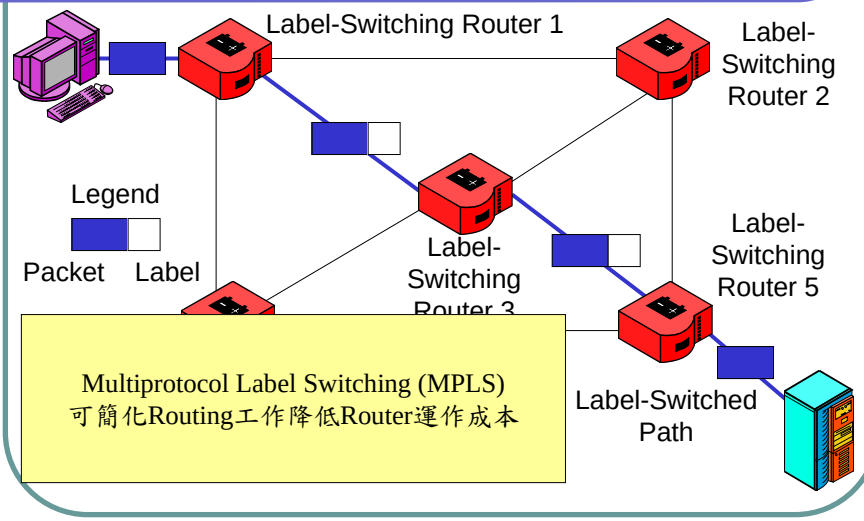


Figure 8-13: Multiprotocol Label Switching (MPLS), Continued

49

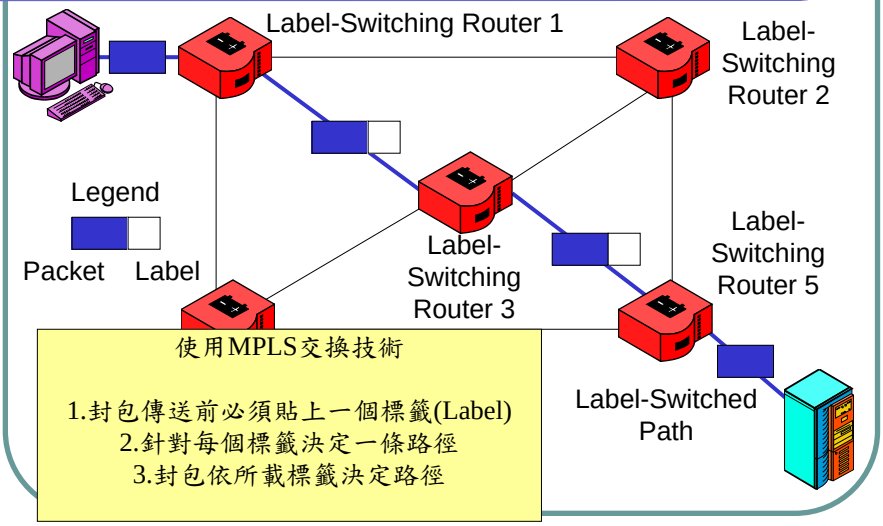


Figure 8-13: Multiprotocol Label Switching (MPLS), Continued

50

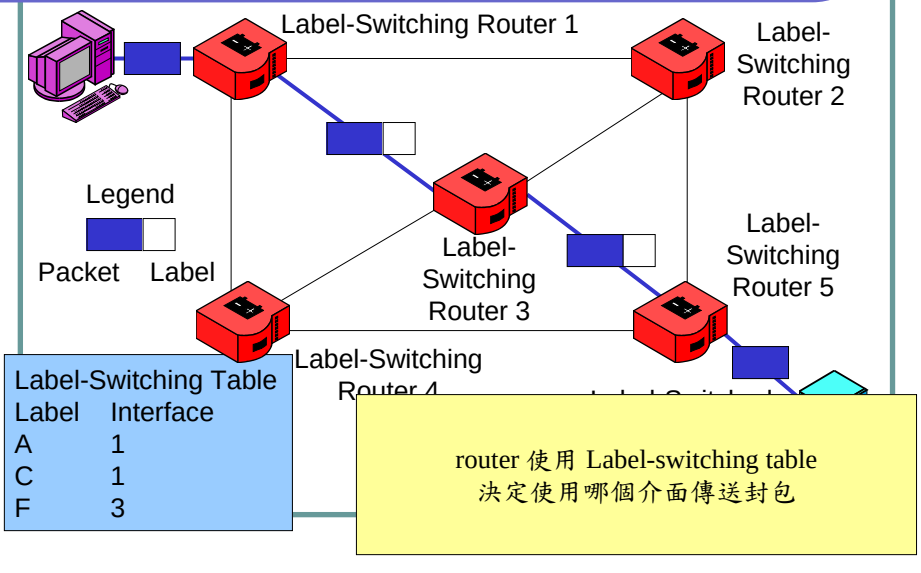


Figure 8-13: Multiprotocol Label Switching (MPLS), Continued

51

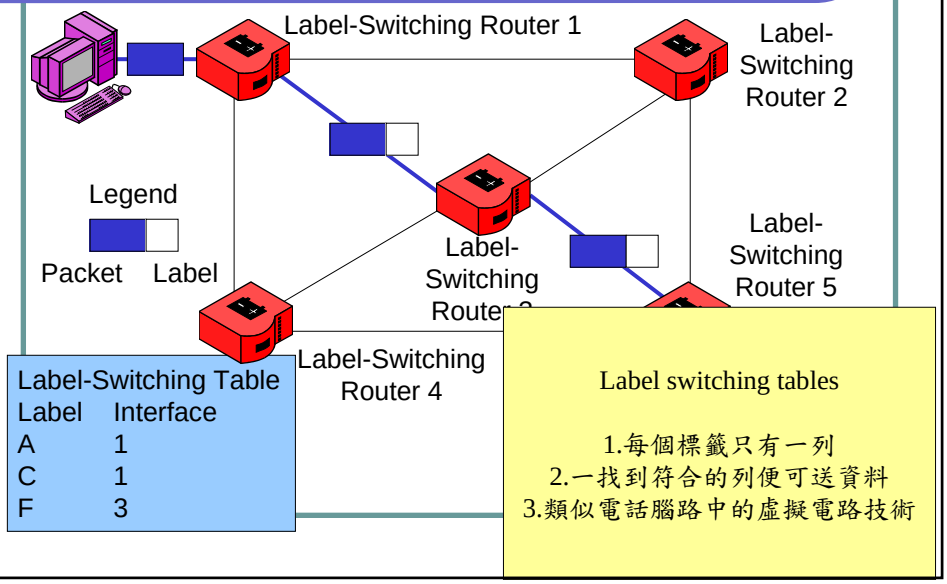


Figure 8-13: Multiprotocol Label Switching (MPLS), Continued

52

- MPLS
  - 跟Ethernet Switch交換技術類似交換速度快, 便宜
  - 不同標籤可有不同優先權
  - 可提供不同的服務品質(QoS)

Figure 8-14: Domain Name System (DNS) Hierarchy

53

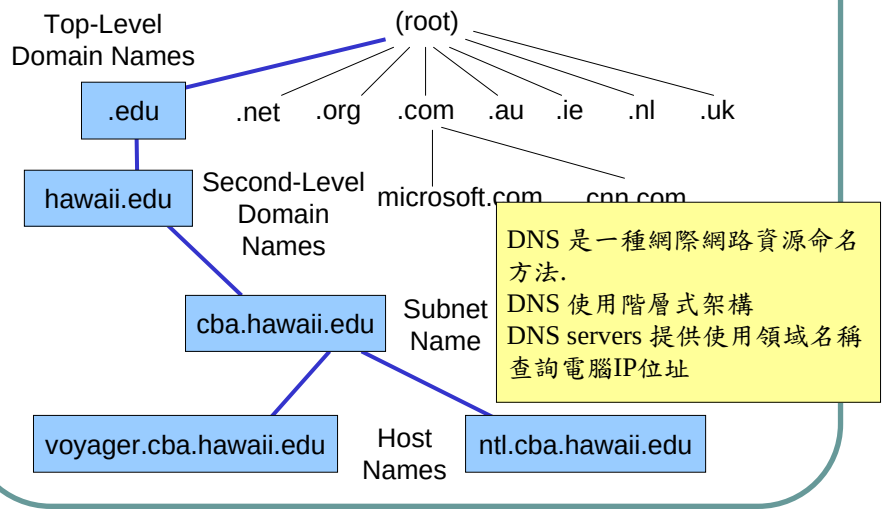


Figure 8-14: Domain Name System (DNS) Hierarchy, Continued

54

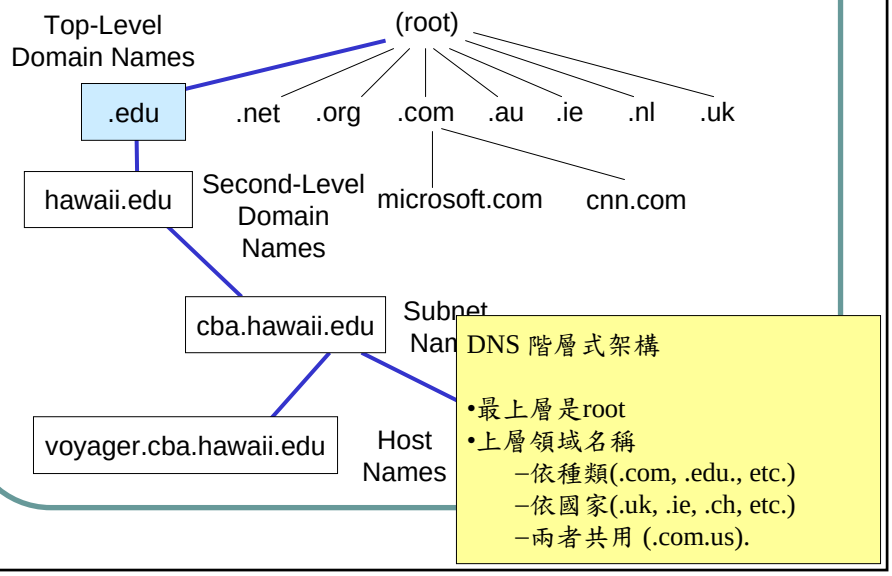


Figure 8-14: Domain Name System (DNS) Hierarchy, Continued

55

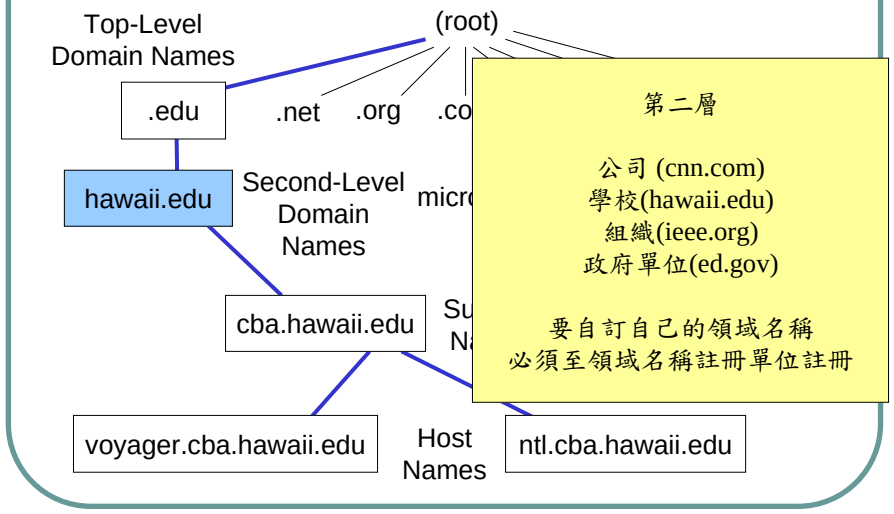
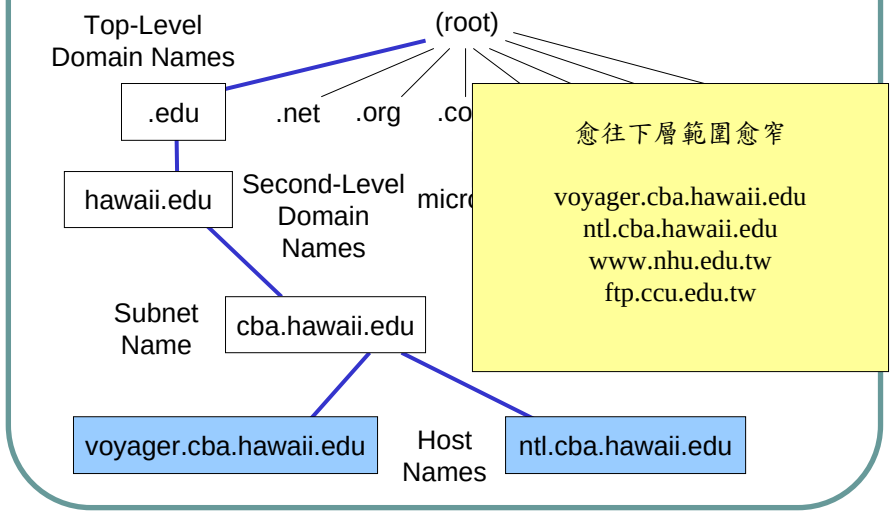


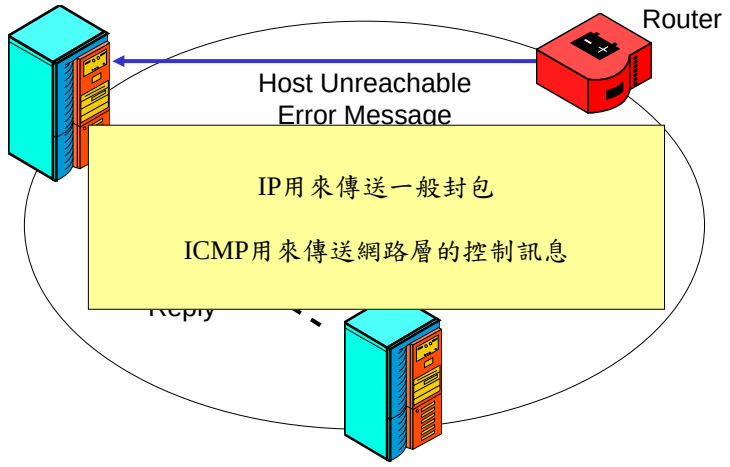
Figure 8-14: Domain Name System (DNS) Hierarchy, Continued

56



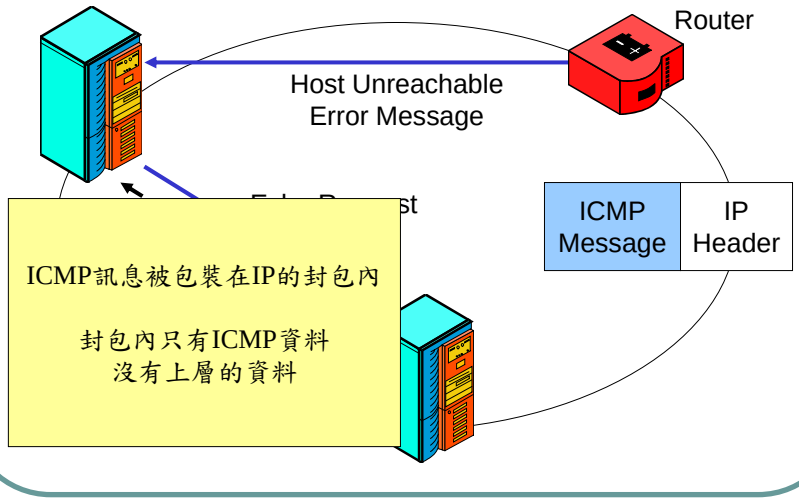
Internet Control Message Protocol (ICMP)
控制訊息傳送協定

57



Internet Control Message Protocol (ICMP)
控制訊息傳送協定

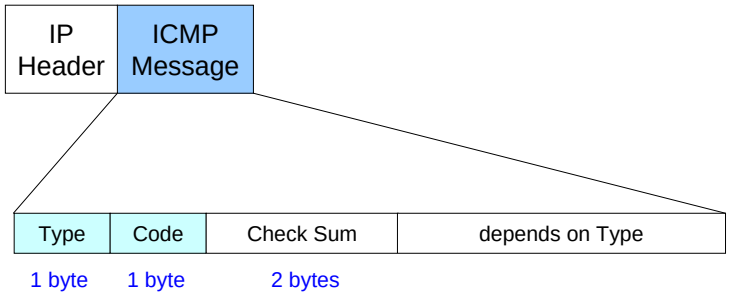
58



Internet Control Message Protocol (ICMP)
控制訊息傳送協定

59

- ICMP封包格式



Internet Control Message Protocol (ICMP)
控制訊息傳送協定

60

TYPE	CODE	Description	Query	Error
0	0	Echo Reply	x	
3	0	Network Unreachable		x
3	1	Host Unreachable		x
3	2	Protocol Unreachable		x
3	3	Port Unreachable		x
3	4	Fragmentation needed but no frag. bit set		x
3	5	Source routing failed		x
3	6	Destination network unknown		x
3	7	Destination host unknown		x
3	8	Source host isolated (obsolete)		x
3	9	Destination network administratively prohibited		x
3	10	Destination host administratively prohibited		x
3	11	Network unreachable for TOS		x
3	12	Host unreachable for TOS		x
3	13	Communication administratively prohibited by filtering		x
3	14	Host precedence violation		x
3	15	Precedence cutoff in effect		x
4	0	Source quench		

Internet Control Message Protocol (ICMP)
控制訊息傳送協定

61

5	0	Redirect for network		
5	1	Redirect for host		
5	2	Redirect for TOS and network		
5	3	Redirect for TOS and host		
8	0	Echo request	x	
9	0	Router advertisement		
10	0	Route solicitation		
11	0	TTL equals 0 during transit		x
11	1	TTL equals 0 during reassembly		x
12	0	IP header bad (catchall error)		x
12	1	Required options missing		x
13	0	Timestamp request (obsolete)	x	
14		Timestamp reply (obsolete)	x	
15	0	Information request (obsolete)	x	
16	0	Information reply (obsolete)	x	
17	0	Address mask request	x	
18	0	Address mask reply	x	

Internet Control Message Protocol (ICMP)
控制訊息傳送協定

62

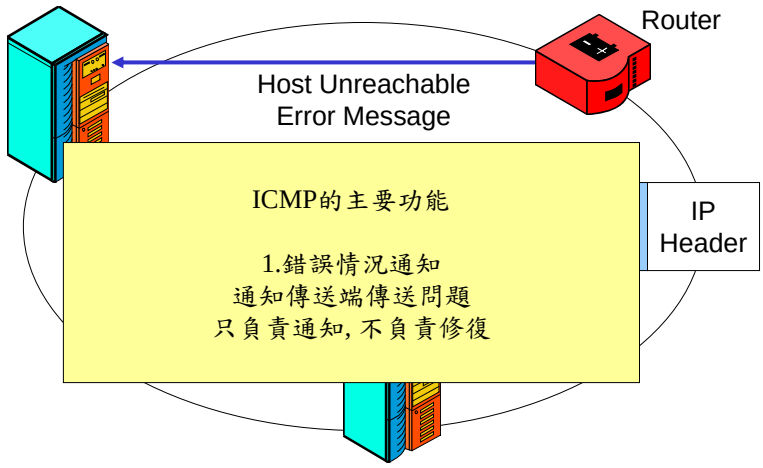
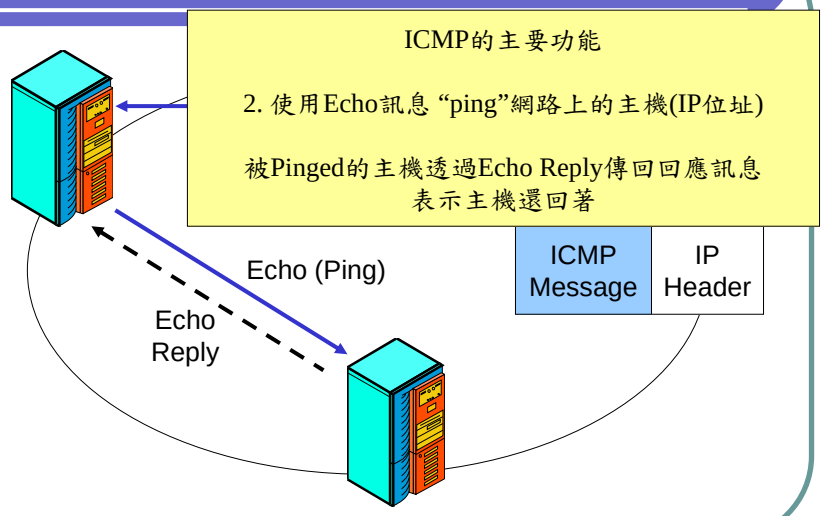


Figure 8-15: Internet Control Message Protocol (ICMP) for Supervisory Messages, Continued

63



Internet Control Message Protocol (ICMP) 控制訊息傳送協定

64

- Traceroute

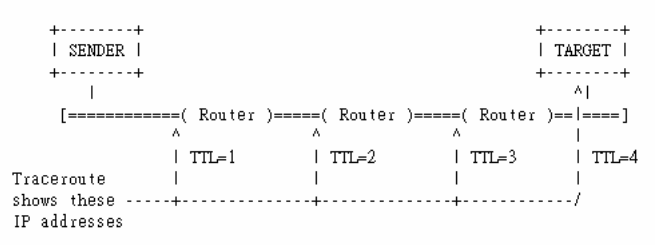


Figure 8-16: IPv4 and IPv6 Packets

65

Bit 0 **IP Version 4 Packet** Bit 31

Version (4 bits) Value is 4 (0100)	Header Length (4 bits)	Diff-Serv (8 bits)	Total Length (16 bits) Length in octets
Identificat… Unique value… IP p…		Flags	Fragment Offset (13 bits)
Time to Live (8 bits)			

Version欄位說明Internet Protocol的版本

目前主要版本是Version 4. (IPv4)

沒有更早的版本

Figure 8-16: IPv4 and IPv6 Packets, Continued

66

Bit 0 IP… 31

Version (4 bits) Value is 4 (0100)	Header Length (4 bits)	Diff-… (8 b…
Identification (16 bit… Unique value in each o… IP packet		
Time to Live (TTL) (8 bits)	Protocol (8 bits) 1=ICMP, 6=TCP, 17=UDP	Header Checksum (16 bits)

TTL可預防迷路的封包無止盡的繞圈圈

傳送端設定TTL的值

每個經過的router會將TTL的值減1

假如router減1後TTL為0,
router便將封包丟掉

Figure 8-16: IPv4 and IPv6 Packets, Continued

67

Bit 0 **IP Version 4 Packet** Bit 31

Version	Header	Diff-Serv	Total Length
IP packet			original IP fragment's data field
Time to Live (8 bits)	Protocol (8 bits) 1=ICMP, 6=TCP, 17=UDP		Header Checksum (16 bits)

Protocol欄位告訴接收端，這個封包攜帶什麼樣的資料
1 = 表示 ICMP
6 = 表示 TCP
17 = 表示 UDP
. . .

Figure 8-16: IPv4 and IPv6 Packets, Continued

68

IP Version 4 Packet Bit 31

Version (4 bits) Value is 4 (0100)			
Identification (16 bits) Unique value in each original IP packet		Flags (3 bits)	Fragment Offset (13 bits) Octets from start of original IP fragment's data field
Time to Live	Protocol (8 bits)	Header Checksum	

封包可被拆成多個 IP Packets, 每個 IP Packet 有自己的 Identification, Flags, 與 Frafment Offset 欄位資訊

接收端依IP Packets的 Identification, Flags, 與 Fragment offset 欄位內容重組封包, 通常很少使用到這個功能，Hacker有時會使用這些欄位

Figure 8-16: IPv4 and IPv6 Packets, Continued

69

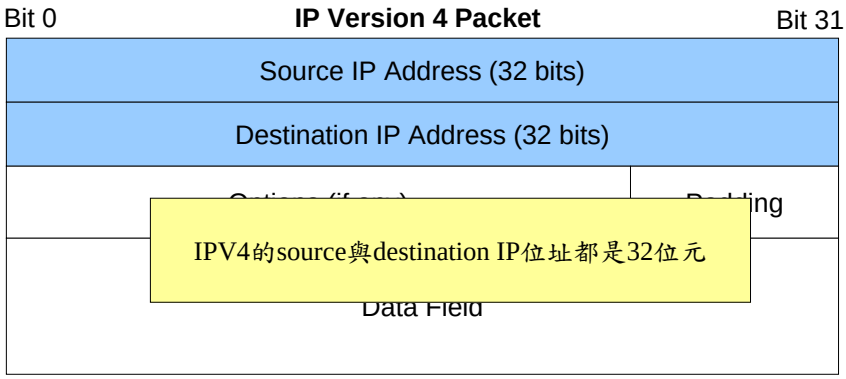


Figure 8-16: IPv4 and IPv6 Packets, Continued

70

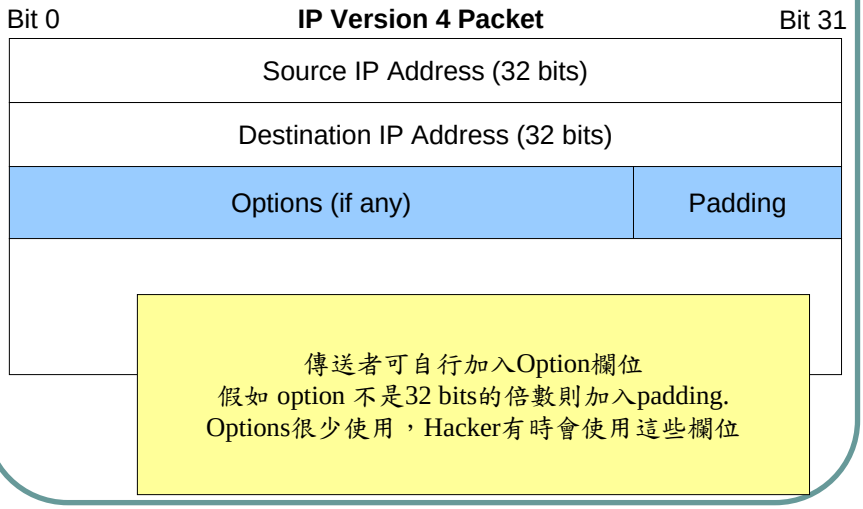


Figure 8-16: IPv4 and IPv6 Packets, Continued

71

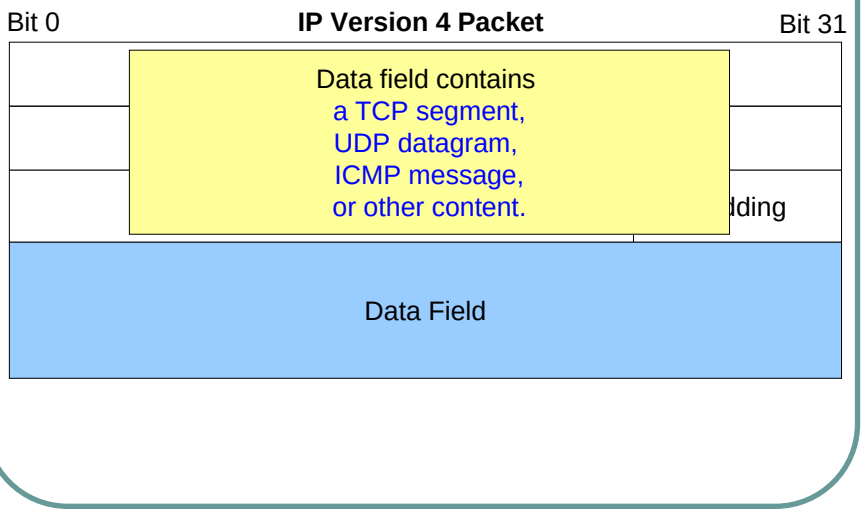


Figure 8-16: IPv4 and IPv6 Packets, Continued

72

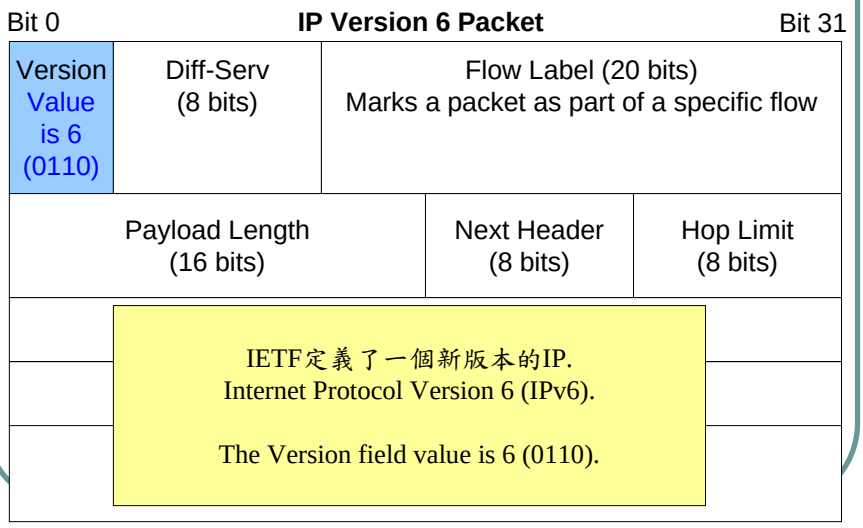


Figure 8-16: IPv4 and IPv6 Packets, Continued

73

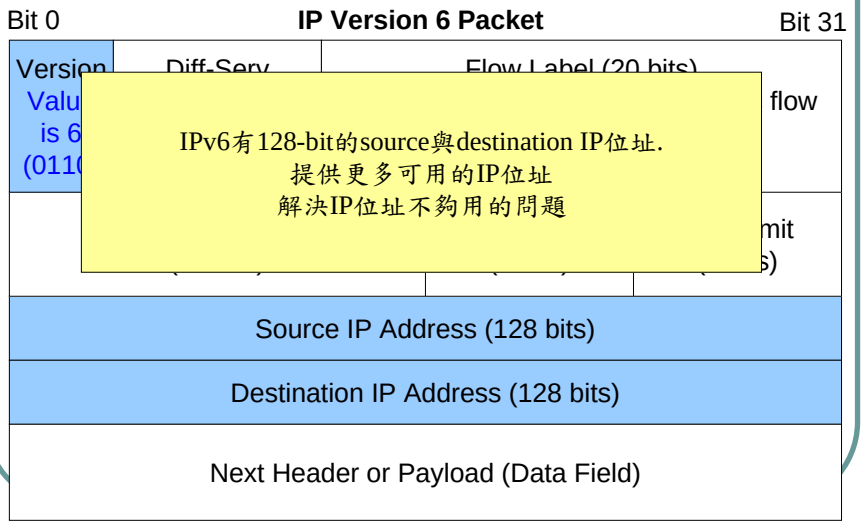
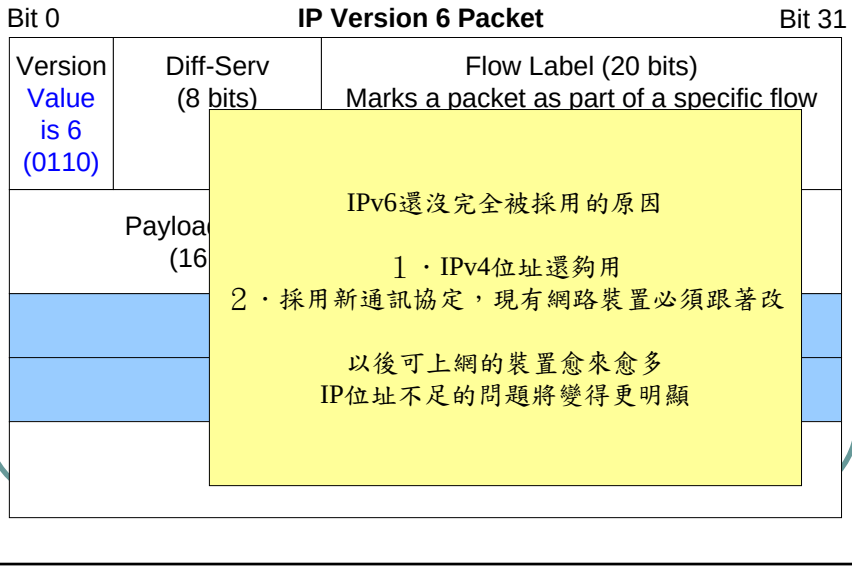


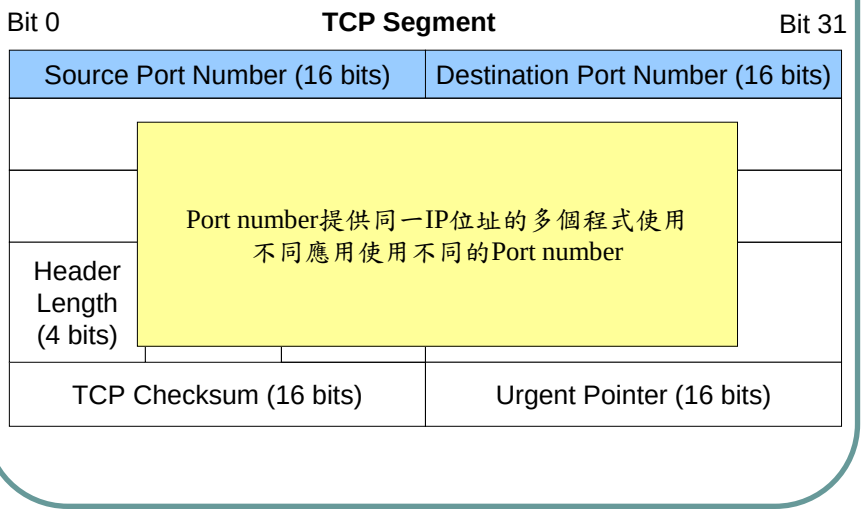
Figure 8-16: IPv4 and IPv6 Packets, Continued

74



TCP封包格式

75



TCP (and UDP) Port Number

76

- 伺服器主要應用程式使用約定的port numbers
  - Port 80 = HTTP
  - Ports 20, 21 = FTP
    - Port 21 for supervisory information
    - Port 20 for file transfers
  - Port 23 = Telnet
  - Port 25 = SMTP (E-mail)

TCP (and UDP) Port Number

77

- 有註冊的Port Numbers
  - Ports 1024 through 49151.
  - 針對非主要的應用程式
  - Unix沒有遵循這個規則
    - 可能使用這個範圍的port number做為臨時的 port number

TCP (and UDP) Port Number

78

- 用戶端使用臨時的隨機Port Numbers.
  - By IETF rules, Ports 49153 to 65535.
    - Windows follows the rules.
    - Unix programs usually do not.

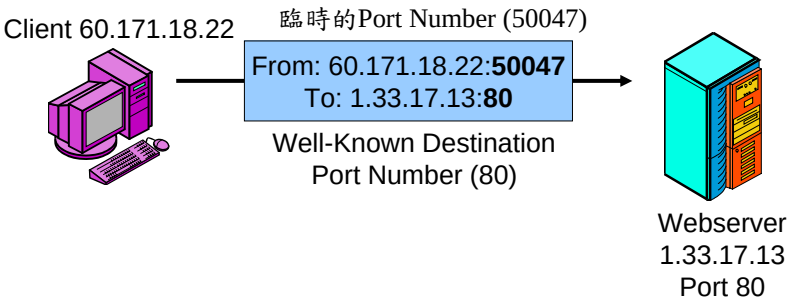
TCP (and UDP) Port Number

79

- Socket
  - 一個socket由IP位址、冒號、與port number組成
    - Example: 128.171.17.13:80
  - 對伺服器而言，每個網路應用程式都有一個特定的socket
  - 對用戶端而言，使用臨時的socket與伺服器socket建立連線

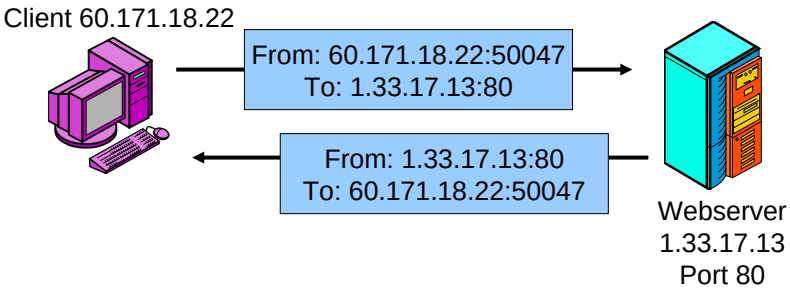
TCP (and UDP) Port Number

80



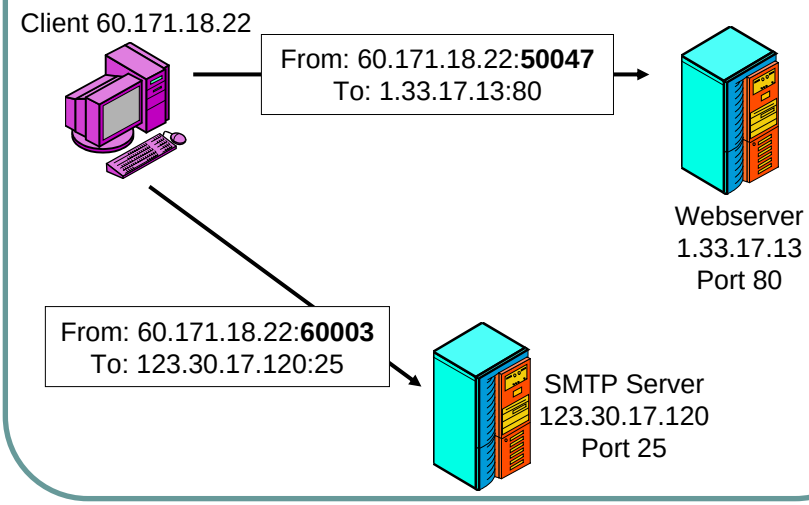
TCP (and UDP) Port Number

81



TCP (and UDP) Port Number

82



83

TCP封包格式

Bit 0 **TCP Segment** Bit 31

Source Port Number (16 bits)	Destination Port Number (16 bits)
Sequence Number (32 bits)	
Acknowledgement Number (32 bits)	
Heade Length (4 bits)	
TCP Checksum (16 bits)	Urgent Pointer (16 bits)

將每個封包編號
封包到達時可利用序號重新排列封包

84

TCP封包格式

Bit 0 **TCP Segment** Bit 31

Source Port Number (16 bits)	Destination Port Number (16 bits)
Header Length (4 bits)	Reserved (6 bits)
TCP Checksum (16 bits)	Urgent Pointer (16 bits)

URG
表示內含緊急資料
Urgent Pointer指到緊急資料存放位置

Flag Fields: URG ACK PSH RST SYN FIN

Window Size (16 bits)

85

TCP封包格式

Bit 0 **TCP Segment** Bit 31

Source Port Number (16 bits)			Destination Port Number (16 bits)
Sequence Number (32 bits)			
Acknowledgement Number (32 bits)			
Header Length (4 bits)	Reserved (6 bits)	Flag Fields: URG ACK PSH RST SYN FIN	Window Size (16 bits)
TC			its)

ACK
用於確認已收到對方封包
Acknowledgement Number表示被確認的封包序號

86

TCP封包格式

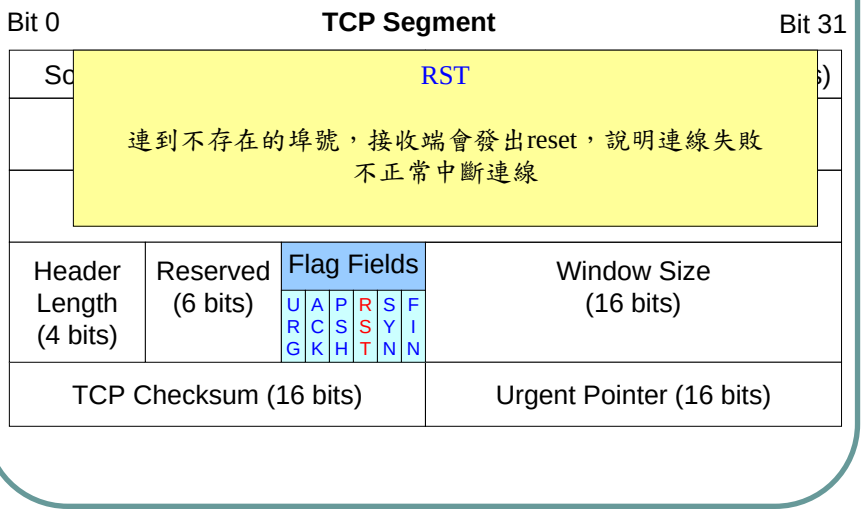
Bit 0 **TCP Segment** Bit 31

Source Port Number (16 bits)			Destination Port Number (16 bits)
Sequence Number (32 bits)			
Acknowledgement Number (32 bits)			
Header Length (4 bits)	Reserved (6 bits)	Flag Fields: URG ACK PSH RST SYN FIN	Window Size (16 bits)
TCP C			its)

PSH
要求儘快將此封包傳給應用程式

87

TCP封包格式

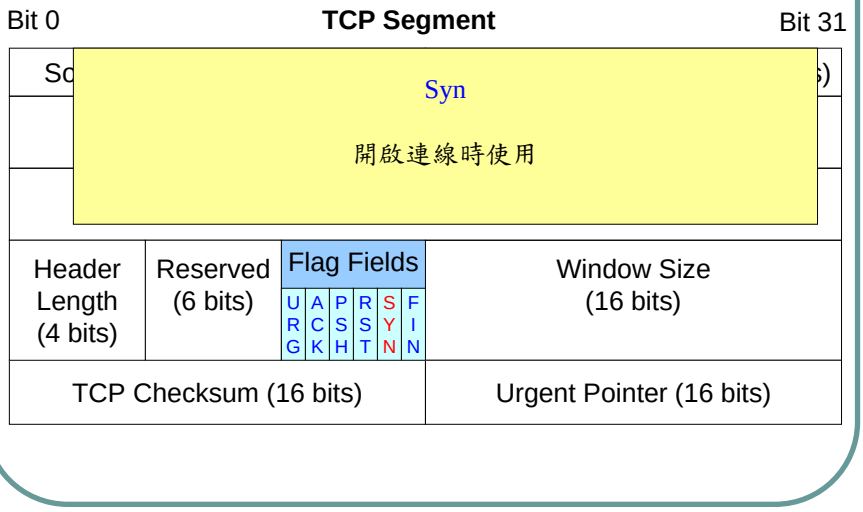


88

不正常中斷連線

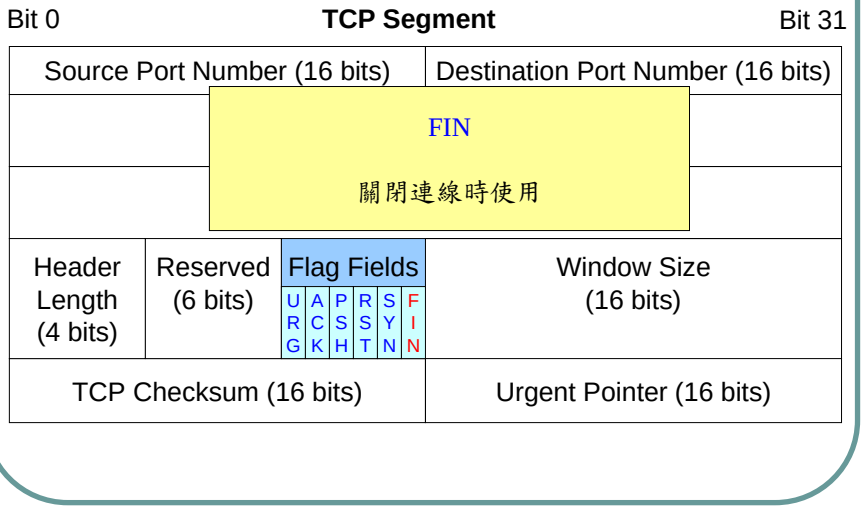
89

TCP封包格式



90

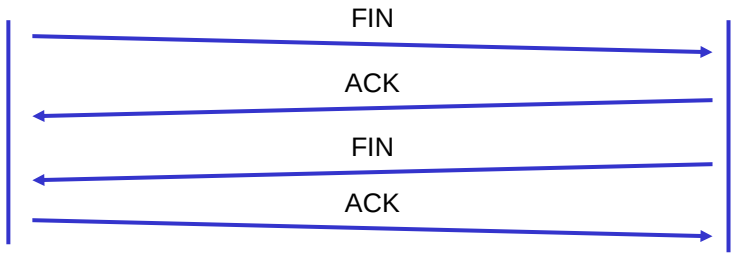
TCP封包格式



正常關閉連線

91

Normal Four-Way Close



A normal TCP close is a 4-way close.

TCP封包格式

92

Bit 0 **TCP Segment** Bit 31

			bits)
	流量控制用		
Header Length (4 bits)	Reserved (6 bits)	Flag Fields (6 bits)	Window Size (16 bits)
TCP Checksum (16 bits)			Urgent Pointer (16 bits)

TCP封包格式

93

Bit 0 **TCP Segment** Bit 31

Source Port Number (16 bits)	Destination Port Number (16 bits)
H L (	
TCP Checksum (16 bits)	Urgent Pointer (16 bits)

用來檢查封包內容是否有錯

假如有錯，將封包丟掉

否則，傳回ACK.

TCP封包格式

94

TCP Segment

Options (if any)	Padding
Data Field	

UDP封包格式

95

Bit 0 **UDP Datagram** Bit 31

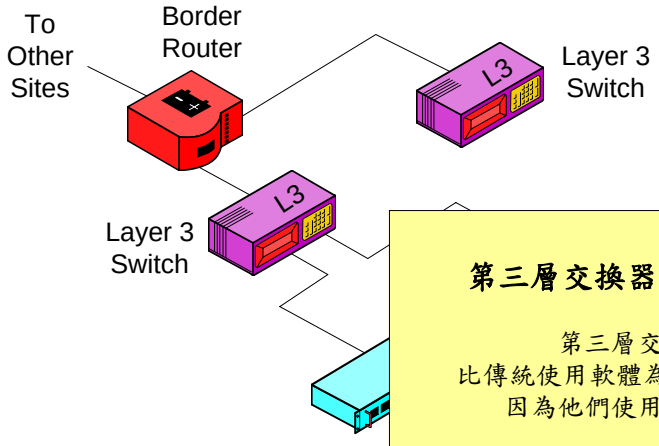
Source Port Number (16 bits)	Destination Port Number (16 bits)
UDP Length (16 bits)	UDP Checksum (16 bits)
Data Field	

UDP封包

使用port numbers
不提供連線管理(connections), 錯誤修正(error correction),
流量控制(flow control), 以及其它管理功能

第三層交換器

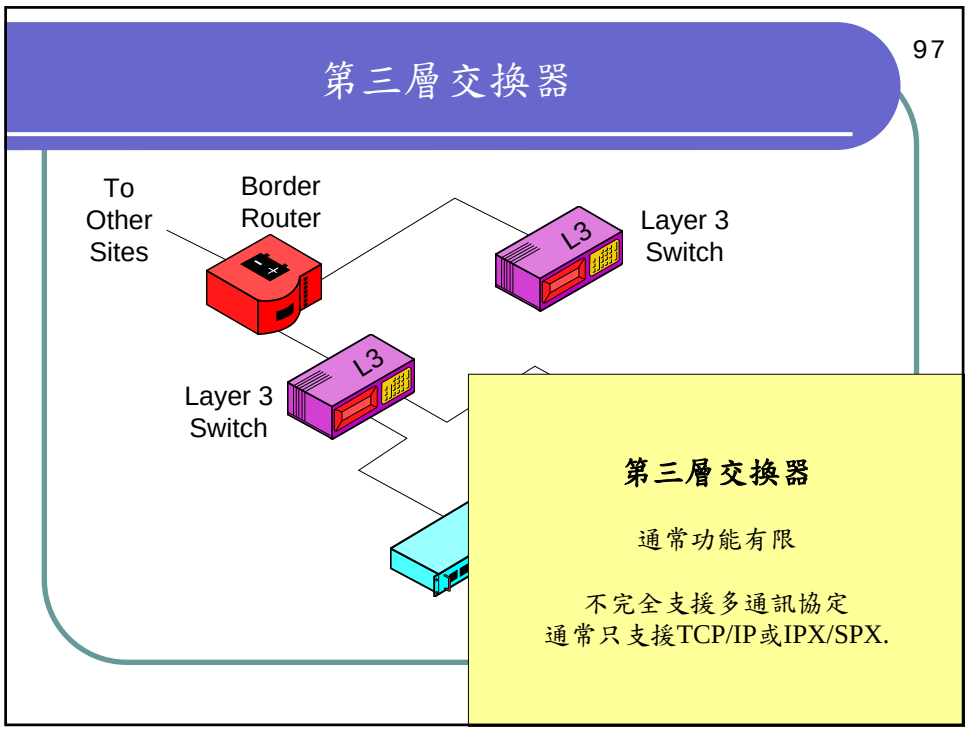
96

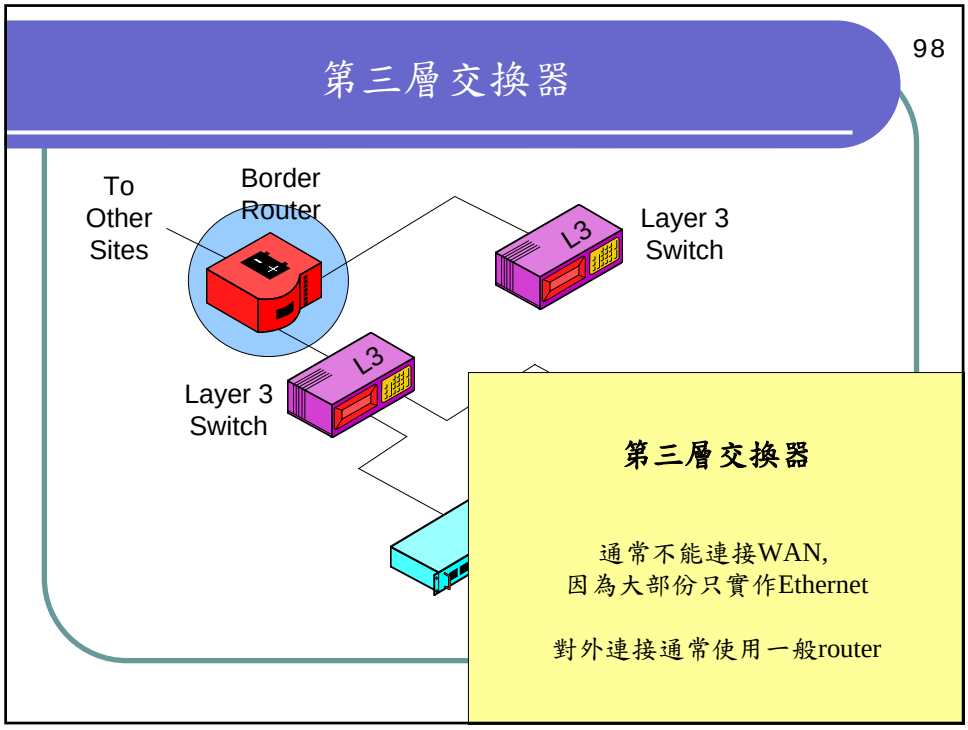


第三層交換器就是router

第三層交換器
比傳統使用軟體為主的router快,
因為他們使用硬體處理

交換器比router快,
所以市場開發第三層交換器


97
第三層交換器
To Other Sites
Border Router
Layer 3 Switch
Layer 3 Switch
L3
L3
第三層交換器
通常功能有限
不完全支援多通訊協定
通常只支援TCP/IP或IPX/SPX.

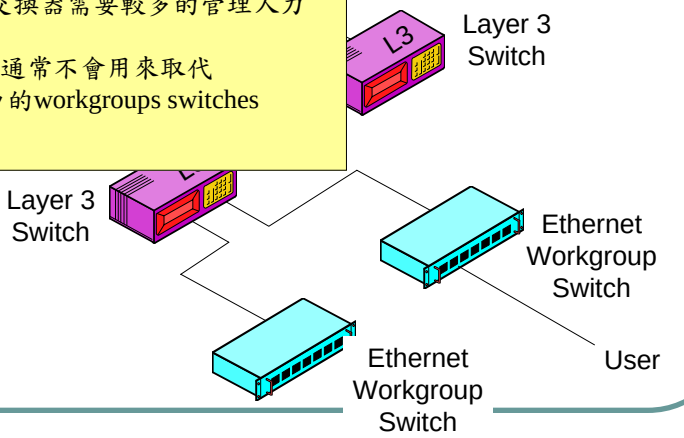

98
第三層交換器
To Other Sites
Border Router
Layer 3 Switch
Layer 3 Switch
L3
L3
第三層交換器
通常不能連接WAN,
因為大部份只實作Ethernet
對外連接通常使用一般router

第三層交換器

99

跟傳統router一樣
第三層交換器需要較多的管理人力

通常不會用來取代
底層的workgroups switches



Topics Covered

100

- IP
  - 階層式IP位址
    - 32位元
    - Network, subnet, and host parts
    - Parts vary in length, but the total is always 32 bits

Topics Covered

101

- IP
  - Router運作原理
    - 比較目的IP位址找出所有符合的列
    - 由所有符合的列中找一個最佳的列
    - 將封包送給目的機器或下一站
  - Multiprotocol routers可處理多種協定的封包

Topics Covered

102

- IP
  - Routing Protocols
    - 允許routers分享路徑資訊，更新routing tables
  - Multiprotocol Label Switching (MPLS)
    - 依label決定路徑
    - 同資料流的封包使用相同label
    - 降低工作量及處理成本

Topics Covered

103

- Domain Name System (DNS)
  - 網路裝置命名系統
  - 階層式的命名架構
  - 提供領域名稱與IP位址轉換功能
- ICMP
  - 傳遞網路層管理訊息的通訊協定
  - 可供回報多種錯誤情況
  - 可供檢查網路裝置或router是否在線上

Topics Covered

104

- IPv4 Fields
  - Version
  - Time to live (TTL)
  - Protocol
  - Options (rare and suspicious)
  - Data field
- IPv6
  - 128-bit address fields to allow many more hosts on the Internet

Topics Covered

105

- TCP封包格式
  - ACK
  - 封包重組
  - 錯誤處理
  - 流量控制
- UDP封包格式

Topics Covered

106

- Layer 3 Switches
  - 一種特殊的Router
  - 類似switch,
    - 較Router便宜, 快速
    - 成本及維護成本較switch高
  - 通常只針對特定通訊協定而非多通訊協定
  - 網路架設原則
    - 可用Ethernet switch就不要用第三層switch
    - 可用第三層switch就不要用router