

# 邁向 IPv6 的時代

麟瑞科技

戴榮志

系統整合、資訊服務的第一選擇

- 
- Date  
– 2012/10/24

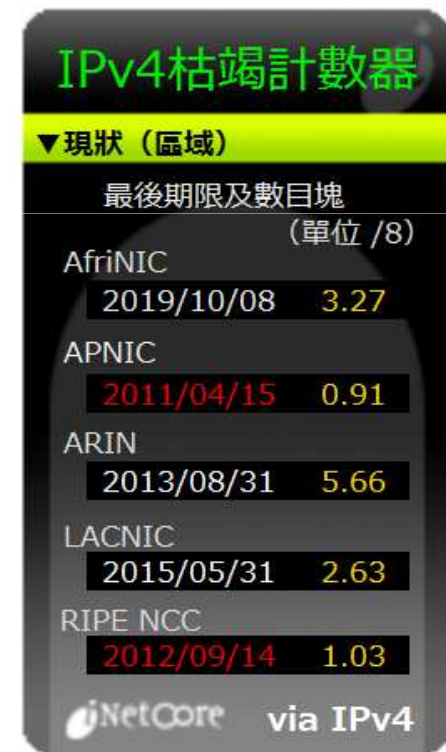
# 大綱

- IPv6 的簡介
- IPv6 的定址與位址組態
- IPv4 與IPv6 的比較
- IPv4 to IPv6 轉移技術
- Router/Windows/Linux IPv6 支援與設定



# IPv6 的發展(1/2)

- 1992年，IETF之IPv4的Address空間不足的問題開始被檢討。
- 1994年，下一代的網際網路協定開始被提案，CATNIP (Common Architecture for the Internet)、TUBA (TCP/IP with Bigger Addresses)、SIPP (Simple Internet Protocol Plus)三個提案中出線。
- 1995年，SIPP被更名為IPv6，IPv6的規範將被RFC1752(The Recommendation for the IP Next Generation Protocol)公開。



## IPv6的發展(2/2)

- 1998年，IPv6之位址架構與通訊協定之規範分別在RFC2373 (IP Version 6 Addressing Architecture)與RFC2460 (Internet Protocol Version 6(IPv6) Specification)公開。
- 1999年，全球第一個業界團體(共有42個單位加盟)成立了「IPv6 Forum」。ARIN 將全球第一個之IPv6 Prefix：2001:400::/35授予給ESnet。
- 2002年，全球各區域性的Internet Registry RIR(Regional Internet Registries)實施新的「IPv6 Address Allocation and Assignment Global Policy」。



# TWNIC IP 政策及資源會議 (June-12-14)

- APNIC
  - (1)對 IPv4 位址買賣採取中立
  - (2)對 IPv4 位址申請：最多一次 (4 個 Class C)
- MicroSoft.
  - 微軟系統轉移至 IPv6 應注意事項
- 中華電信
  - Linux 應用服務升級至 IPv6 的考慮
- Cisco Systems
  - IPv6 Ready Internet Edge
- 結論
  - (1)IPv4 位址會成為 SP, IDC 競爭的武器
  - (2)IPv4 位址的交易會普及
  - (3)應用程式的檢查服務會普及



# 政府 IPv6 全面升級發展時程



項目	建議時程	理由	說明
<b>T0: 政策聲明</b>	啓動日 (2011/12/30)	IPv4 位址發罄, 行政院業於 2011 年 12 月 30 日核定 "網際網路通訊協定升級推動方案", 並以 2011 年 12 月 30 日訂為 IPv6 之啓動日	必要
<b>Ta: 主要外部服務</b>	> 2013/12/31	(1) 調查顯示國內 ISP 之 IPv4 位址, 將於 2-3 年後面臨不足的問題, 業界將先以雙協定技術過渡, 逐步升級為 IPv6 網路	必要
<b>Tb: 次要外部服務</b>	> 2015/12/31	(1) 部分國家先行枯竭, 政府網路必須滿足居住全球各地民眾需求 (2) 參考其他國家 (美國政府對外服務 2012 年 IPv6 化, 內部網路 2014 年 IPv6 化)	必要
<b>Tc: 內部使用網路</b>	2016 <	(1) 參考相關機關規劃時程 (4 至 5 年) 建議	依需要及預算調整





- What is it?
  - [www.worldipv6launch.org](http://www.worldipv6launch.org); coordinated by the Internet Society
- **W6L: Turn it on, leave it on.**
  - **Since 6/6/12, IPv6 becomes part of a regular business!**
- Who will turn on IPv6 AAAA forever?
  - Google, Facebook, Yahoo!, Akamai, Microsoft...
  - CPE vendors – Cisco, D-Link
- Practical support: <http://www.internetsociety.org/deploy360/>
- 台灣 IPv6 全面升級活動 (Taiwan IPv6 Launch)  
<http://ipv6launch.tw/about1.html>



# World IPv6 Launch – This time its for real!

- June 6<sup>th</sup>, 2012 it is!
- 2,500 + (and counting) Website Operators, Network Operators and Home Router Vendors will turn on IPv6 (*and leave it on permanently!*)
- 截至4日為止美國參加IPv6Launch的網站已有71%可在IPv6上存取，中國則為65%左右
- <http://www.worldipv6launch.org/>

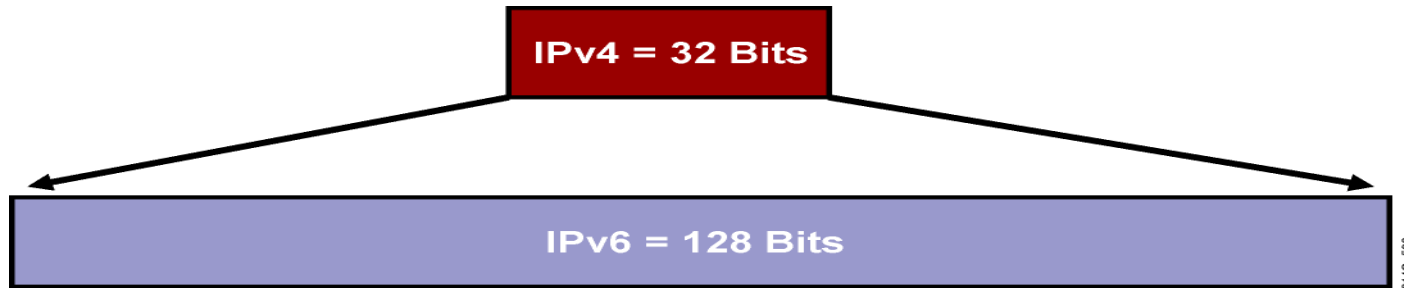




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0146\_580

版 本	位 元 數	位 址 數 量
IPv4	32	4, 294, 967, 296個
IPv6	128	340, 282, 366, 920, 938, 463, 463, 374, 607, 431, 768, 211, 456個 ( $\doteq 3.4 \times 10^{38}$ )

128bits 的定址讓IPv6位址多到地球的每粒沙都可以有一個IP使用…



# IPv6 位址格式

**16-bit fields in case insensitive colon hexadecimal representation**


- 2031:0000:130F:0000:0000:09C0:876A:130B

**Leading zeros in a field are optional:**

- 2031:0:130F:0:0:9C0:876A:130B

**Successive fields of 0 represented as ::, but only once in an address:**

- 2031:0:130F::9C0:876A:130B

 2031::130F::9C0:876A:130B

- 0:0:0:0:0:0:0:1 => ::1 => **127.0.0.1**

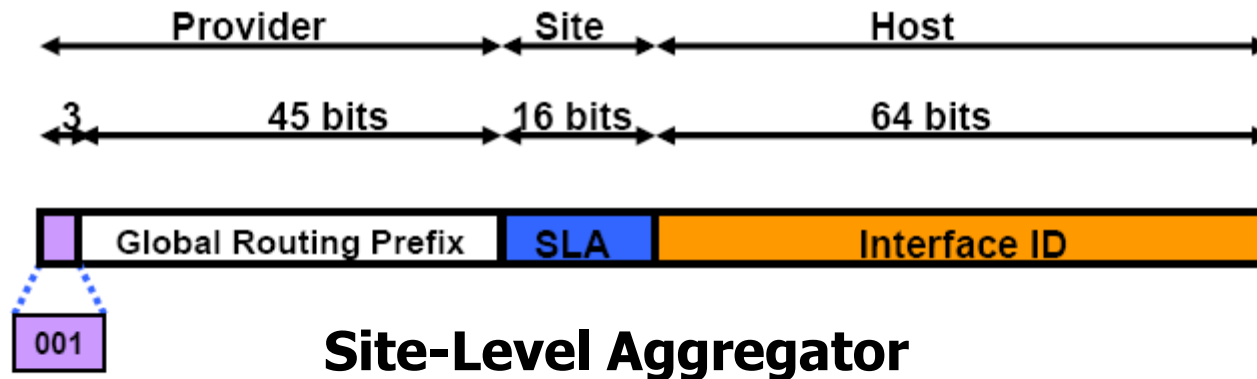
- 0:0:0:0:0:0:0:0 => :: => **0.0.0.0**

**IPv4-compatible address representation**

- 0:0:0:0:0:0:192.168.30.1 = ::192.168.30.1 = ::C0A8:1E01



# Aggregatable Global Unicast Addresses



**Aggregatable Global Unicast addresses are:**

- **Addresses for generic use of IPv6**
  - **Structured as a **hierarchy** to keep the aggregation**
- See RFC 3513**



# IPv6 Addressing

## Prefix Format (PF) Allocation

- PF = 0000 0000 : Reserved
  - PF = 001 : Aggregatable Global Unicast Address
  - PF = 1111 1110 10 : Link Local Use Addresses (FE80::/10)
  - PF = 1111 1110 11 : Unique Local Use Addresses (FEC0::/10)
  - PF = 1111 1111 : Multicast Addresses (FF00::/8)
- Other values are currently Unassigned (approx. 7/8th of total)

All Prefix Formats have to support EUI-64 bits Interface ID setting

-But Multicast



# IP Addressing

**IPv6 Addressing rules are covered by multiples RFC's**

**-Architecture defined by RFC 3513 (obsoletes RFC 2373)**

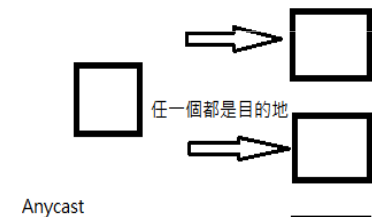
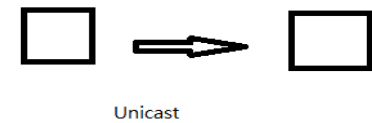
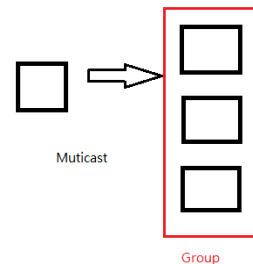
**Address Types are :**

**-Unicast : One to One (Global, Link local, Unique local , Compatible)**

**-Anycast : One to Nearest (Allocated from Unicast)**

**-Multicast : One to Many**

**-Reserved**



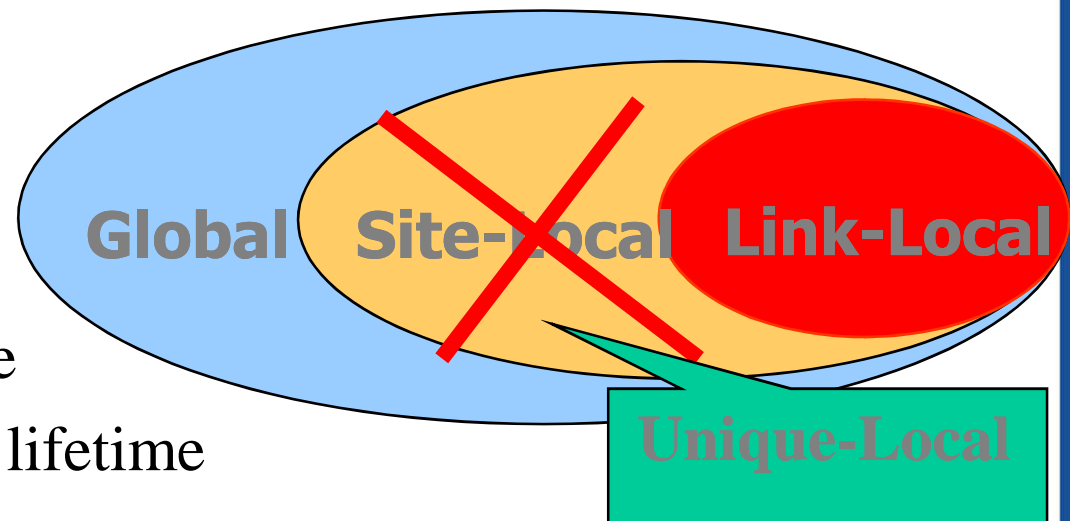
**A single interface may be assigned multiple IPv6 addresses of any type (unicast, anycast, multicast)**

**-No Broadcast Address -> Use Multicast**



# IPv6 Addressing

- Addresses are assigned to interfaces
  - No change from IPv4 Model
- Interface ‘expected’ to have multiple addresses
- Addresses have scope
  - Link Local
  - Unique Local
  - Global
- Addresses have lifetime
  - Valid and Preferred lifetime



# Link-Local & Unique Unicast Addresses

- Link-local addresses for use during auto-configuration and when no routers are present:

**FE80::/10**



- Site-local addresses for independence from Global Reachability, similar to IPv4 private address space

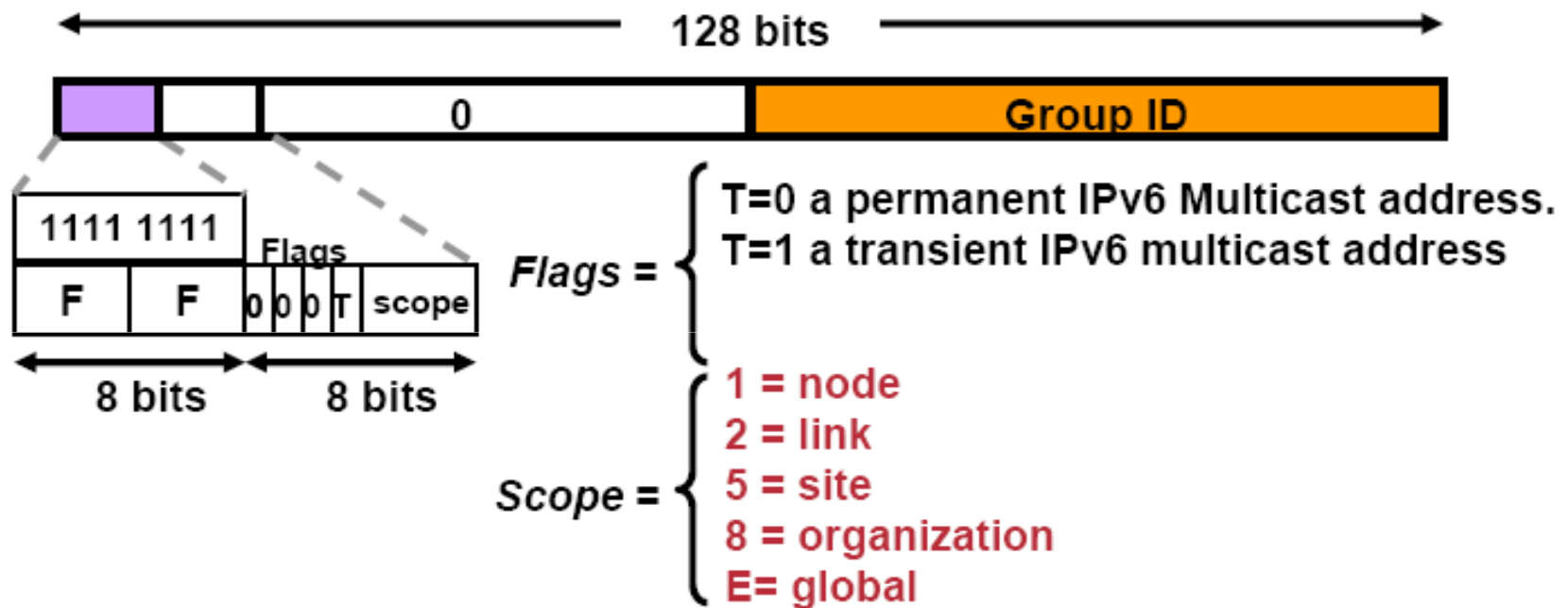
- RFC3513 specifies 54 bits for SLA field but SL may get deprecated by IPv6 WG soon

**FEC0::/10**



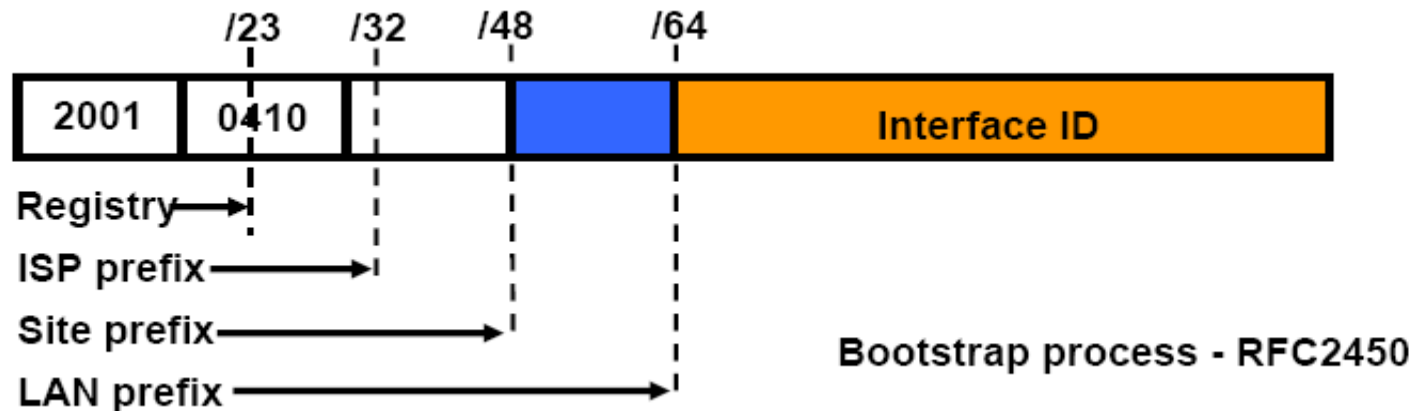


# Multicast Addresses (RFC 3513)



Multicast is used in the context of one-to-many.





The allocation process is under reviewed by the Registries:

- IANA allocates 2001::/16 to registries
- Each registry gets a /23 prefix from IANA
- Formerly, all ISP were getting a /35
- With the new policy, Registry allocates a /32 prefix to an IPv6 ISP
- Then the ISP allocates a /48 prefix to each customer (or potentially /64)
- <ftp://ftp.cs.duke.edu/pub/narten/ietf/global-ipv6-assign-2002-06-26.txt>

<http://rms.twnic.net.tw/twnic/User/Member/Search/IPv6Allocated.jsp?Order=ORG.ID>

精誠資訊股份有限公司	SYSNET-NET	2010-10-27	2405:0A00::	32
台灣大哥大股份有限公司	TAIWANMOBILE-NET	2011-11-09	2402:7500::	32
教育部	TANET-NET	2000-08-01	2001:0288::	32
大同電信股份有限公司	TATUNGINFO-NET	2010-04-12	2401:5E00::	32
台灣寬頻通訊顧問股份有限公司	TBCOM-NET	2010-12-06	2405:9200::	32



# Example (1/2)

- 區網 2001:288:7000::/36(2001:288:7000-7FFF)
- 成大連線單位

2001:288:7000::/39(2001:288:7000--71FF)

2001:0288: 7 0 0 0 :0:0:0:0

2001:0288:0111 0000 0000 | 0000

2001:0288:0111 0000 0000 | 0001

2001:0288:0111 0000 0000 | 0010

.....

2001:0288:0111 0000 FFFF | FFFF

2001:0288:0111 0001 0000 | 0000

.....

2001:0288:0111 0001 1111 | 1111



## Example (2/2)

- **2001:288:7000::/48 → 每個學校**

**2001:0288:7000: 0:0:0:0**

**2001:0288:7001:**

**2001:0288:7002:**

**2001:0288:7003:**

.....

**2001:0288:70FF:**

**2001:0288:7100:**

**2001:0288:7101:**

.....

**2001:0288:71FF:**

目前區網發放7000~7040,  
(65段/48 的網段)

512 個/48的subnet



# Interface IDs

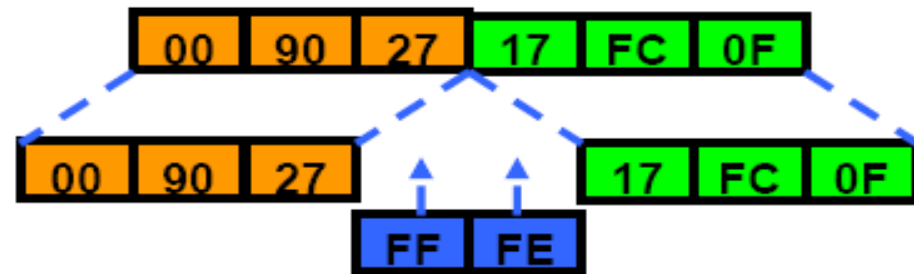
Lowest-order 64-bit field of unicast address may be assigned in several different ways:

- auto-configured from a 64-bit EUI-64, or expanded from a 48-bit MAC address (e.g., Ethernet address)
- auto-generated pseudo-random number (to address privacy concerns)
- assigned via DHCP
- manually configured



# Eui-64

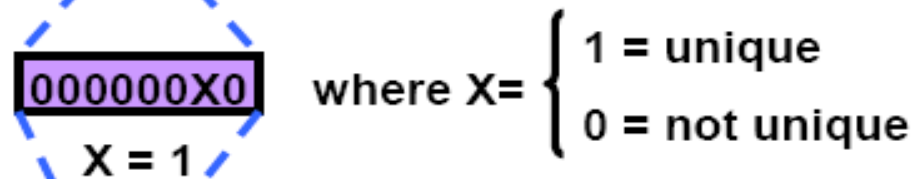
Ethernet MAC address  
(48 bits)



64 bits version



Uniqueness of the MAC



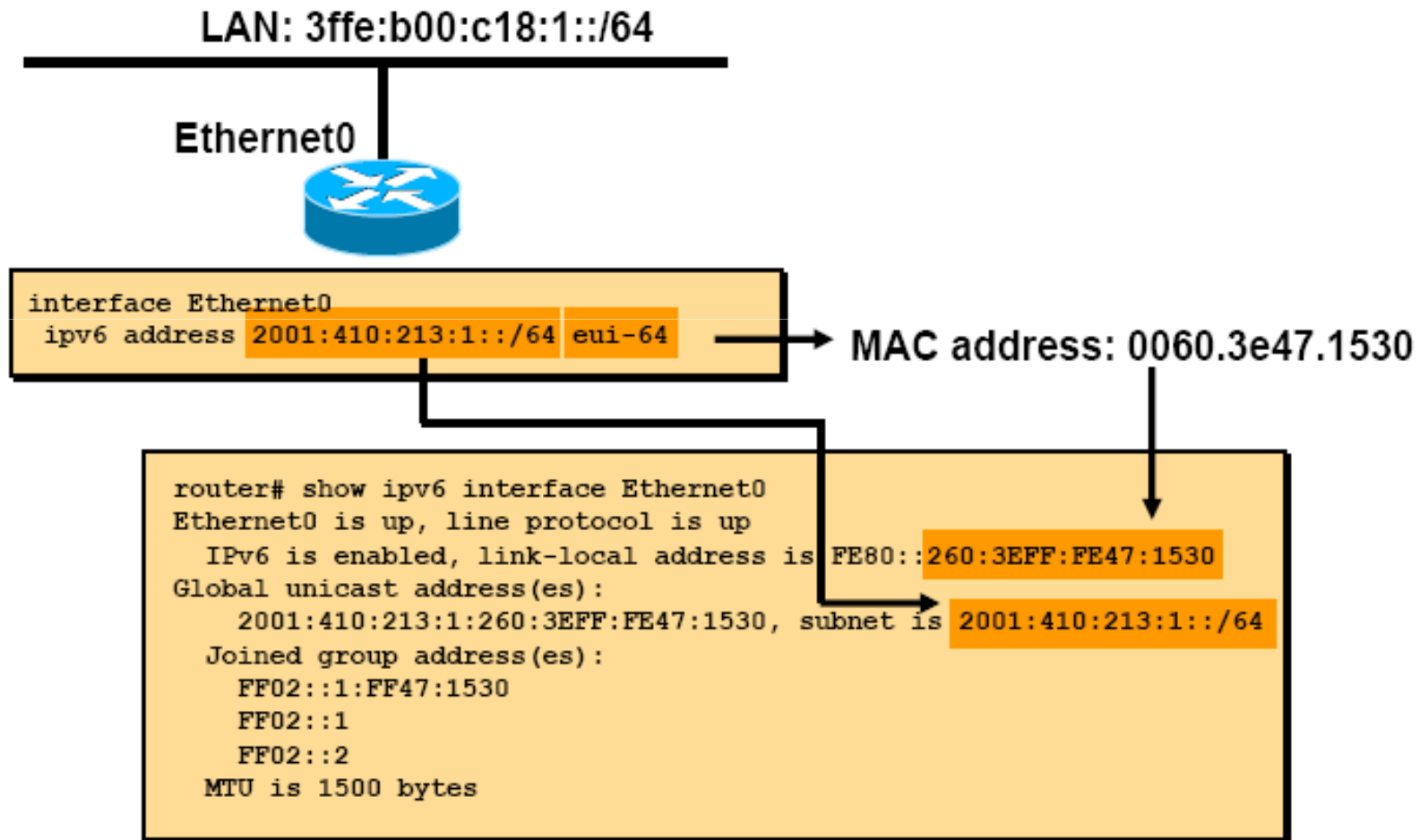
Eui-64 address



**Eui-64 address is formed by inserting "FFFE" and ORing a bit identifying the uniqueness of the MAC address.**



# IPv6 Addressing Examples



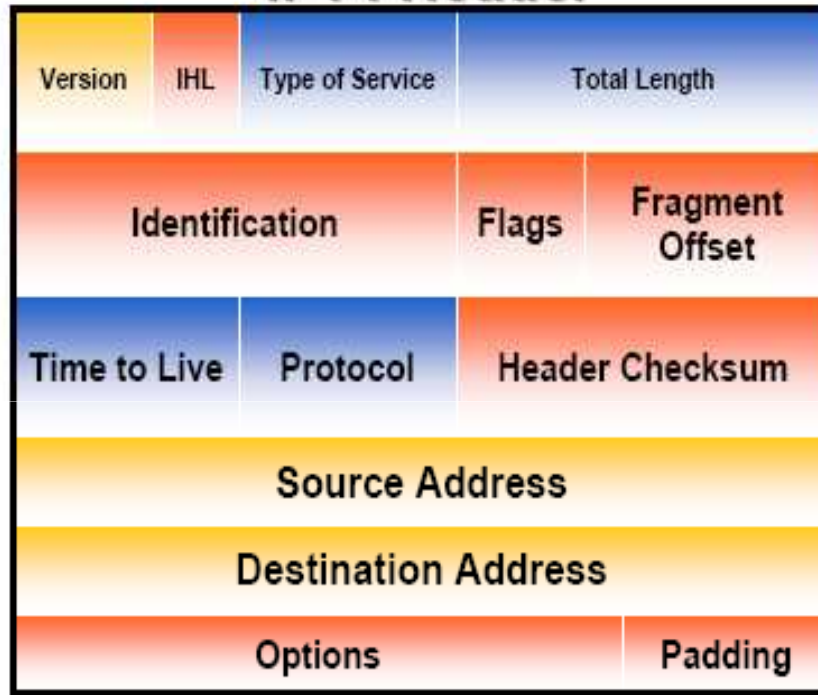
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## IPv4 Header



## IPv6 Header



- Legend**
-  - field's name kept from IPv4 to IPv6
  -  - fields not kept in IPv6
  -  - Name & position changed in IPv6
  -  - New field in IPv6

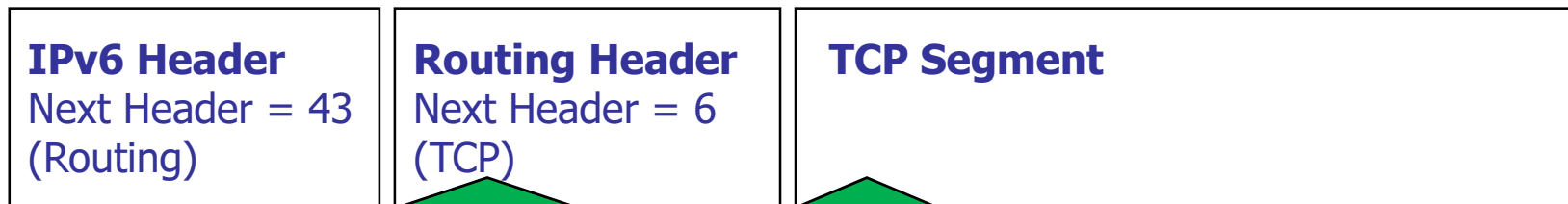
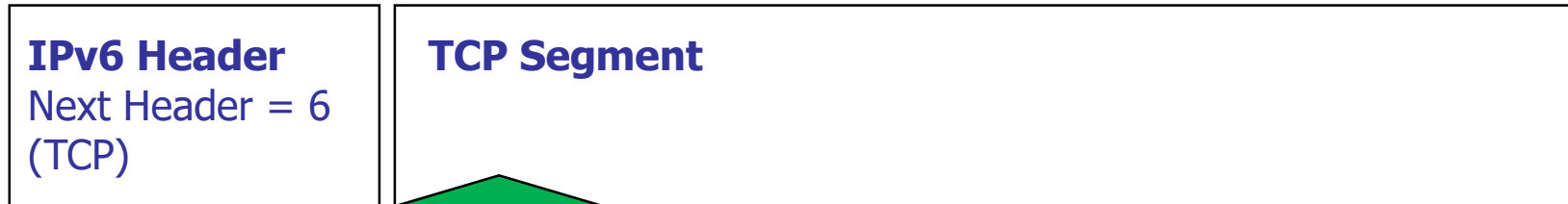


# Values of the Next Header Field

Value	Header
0	Hop-by-Hop Options Header
6	TCP
17	UDP
41	Encapsulated IPv6 Header
43	Routing Header
44	Fragment Header
50	Encapsulating Security Payload
51	Authentication Header
58	ICMPv6
59	No next header
60	Destination Options Header



# IPv6 Header Options (RFC 2460)



# IPv4 與 IPv6 比較表

Feature	IPv4	IPv6
Source and destination address	32 bits	128 bits
IPSec	Optional	required
Payload identification for QoS in the header	No identification	Using Flow label field
Fragmentation	Both router and the sending hosts	Only supported at the sending hosts
Checksum of header	included	Not included
<b>Resolve address to a link layer address</b>	broadcast ARP request	Multicast Neighbor Solicitation message



## IPv4 與 IPv6 比較表

Feature	IPv4	IPv6
<b>Determine the address of the best default gateway</b>	ICMP Router Discovery (optional)	ICMPv6 Router Solicitation and Router Advertisement (required)
Send traffic to all nodes on a subnet	Broadcast	Link-Local scope all-nodes multicast address
Payload identification for QoS in the header	No identification	Using Flow Label field
Configure address	Manually or DHCP	Autoconfiguration/DHCPv6
Map hosts name to addresses	A	AAAA
<b>Manage local subnet group membership</b>	IGMP	Multicast Listener Discovery (MLD)



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# IPv4 to IPv6 轉移技術

- IPv6/IPv4 Dual Stack
- Tunneling



# Dual Stack TCP/IP Protocol

OSI model	TCP/IP	TCP/IP protocol Suite					
Application	Application	HTTP	SMTP	FTP	TFTP	SNMP	RIP
Presentation							
Session							
Transport	Transport	TCP			UDP		
Network	Network	ICMP/IGMP/ARP IPv4			ICMPv6/MLD/ND IPv6		
Data Link	Physical	Ethernet	802.11 Wireless LAN	Frame Relay		ATM	
Physical							





# Dual Stack

- **Dual IP Layer Operation (dual stack)**

Both IPv4 and IPv6 are directly supported

- **IPv6/IPv4 nodes**

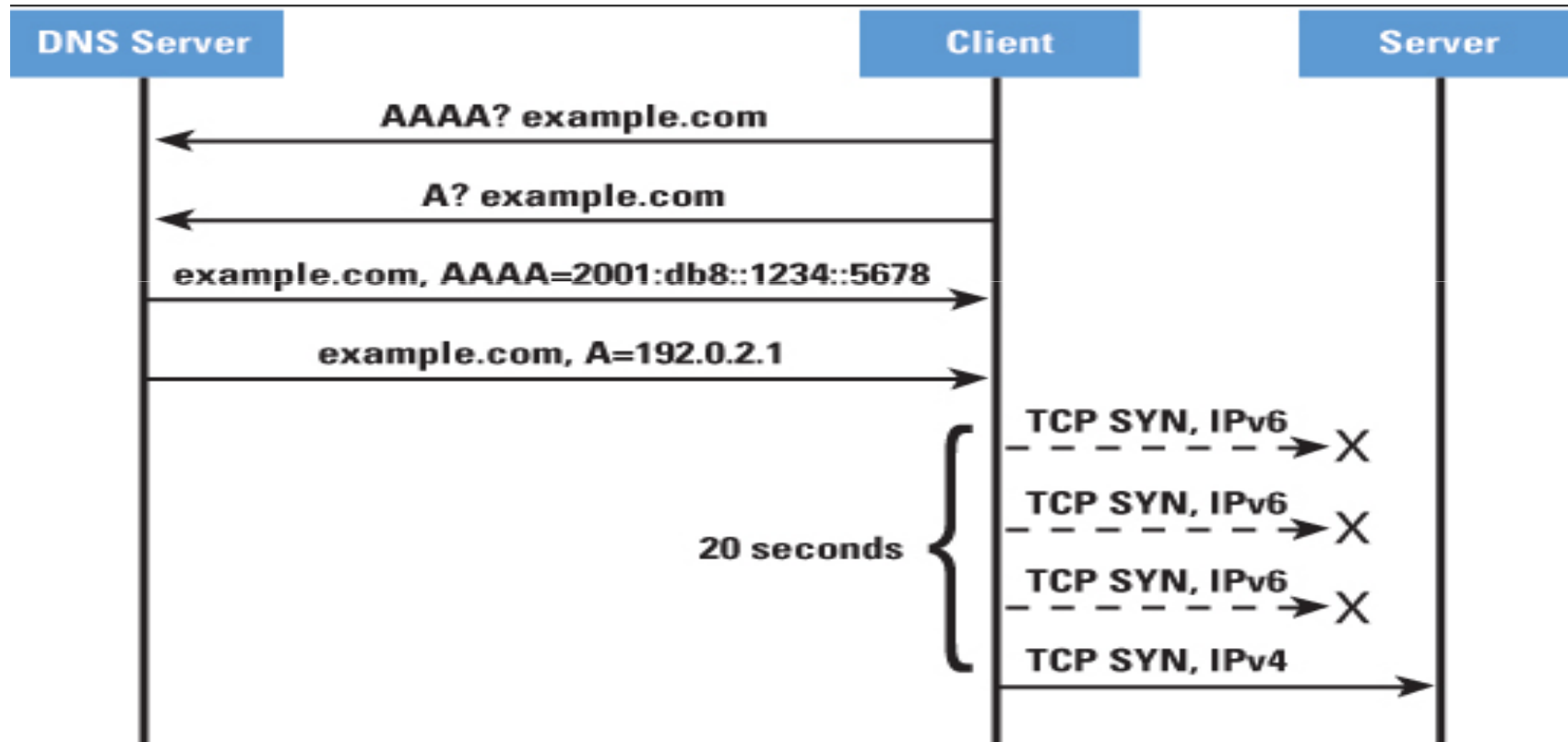
for IPv6 nodes to remain compatible with IPv4-only nodes operated in one of three modes:

- IPv4 stack enabled and IPv6 stack disabled
- IPv6 stack enabled and IPv4 stack disabled
- both stacks enabled.

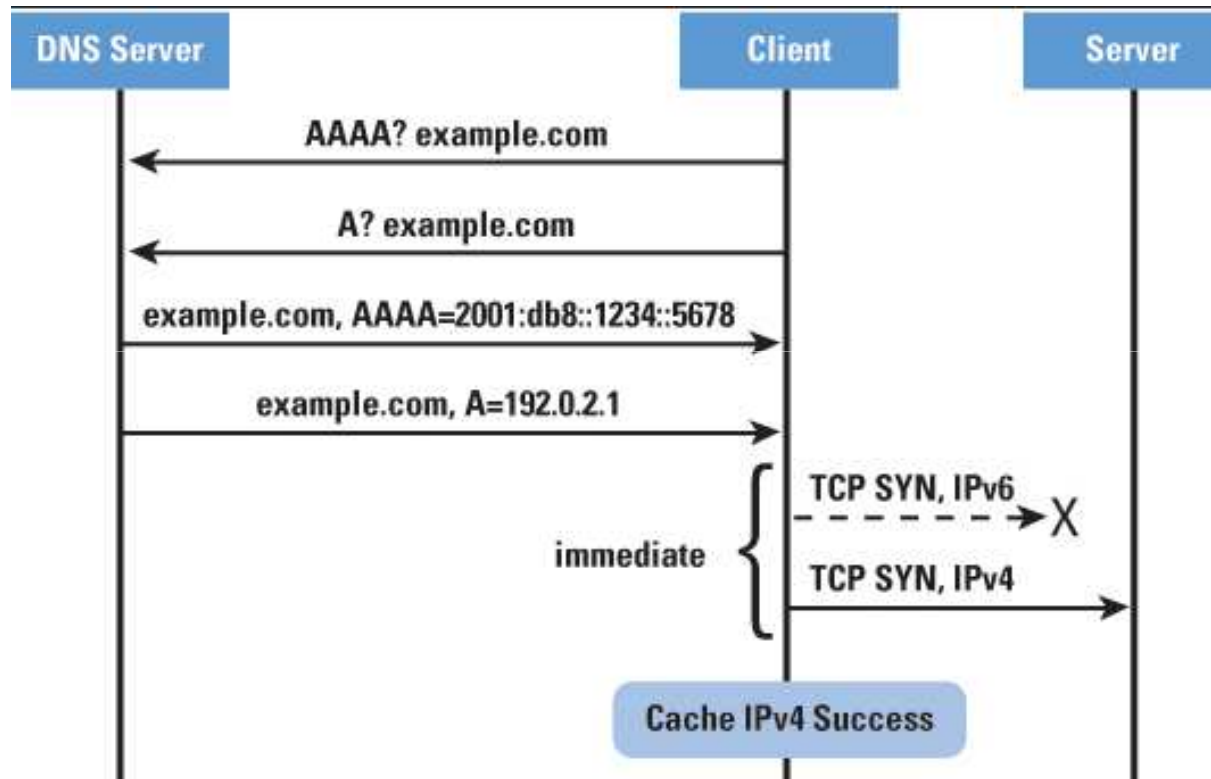
```
interface GigabitEthernet0/0
description [Inside]
ip address 172.16.6.254 255.255.255.0
ip nat inside
ip virtual-reassembly
load-interval 30
duplex auto
speed auto
ipv6 address 2001:1234:4321::254/64
ipv6 enable
no cdp enable
end
```



# Dual Stack Issues



[http://www.cisco.com/web/about/ac123/ac147/archived\\_issues/ipj\\_13-3/133\\_he.html](http://www.cisco.com/web/about/ac123/ac147/archived_issues/ipj_13-3/133_he.html)



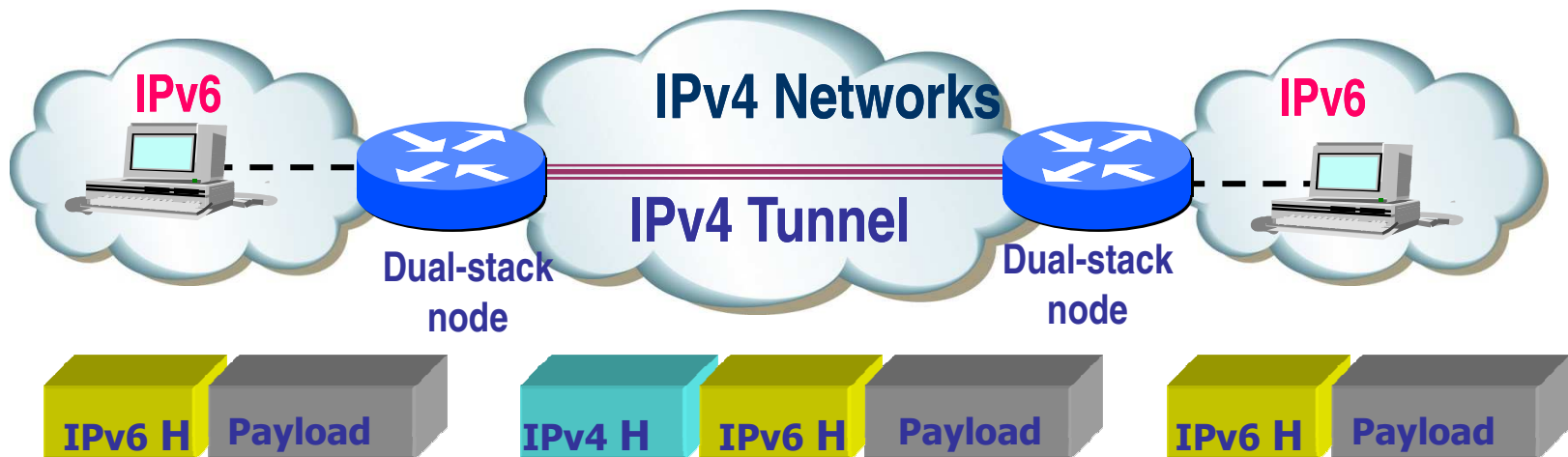
## Implementations:

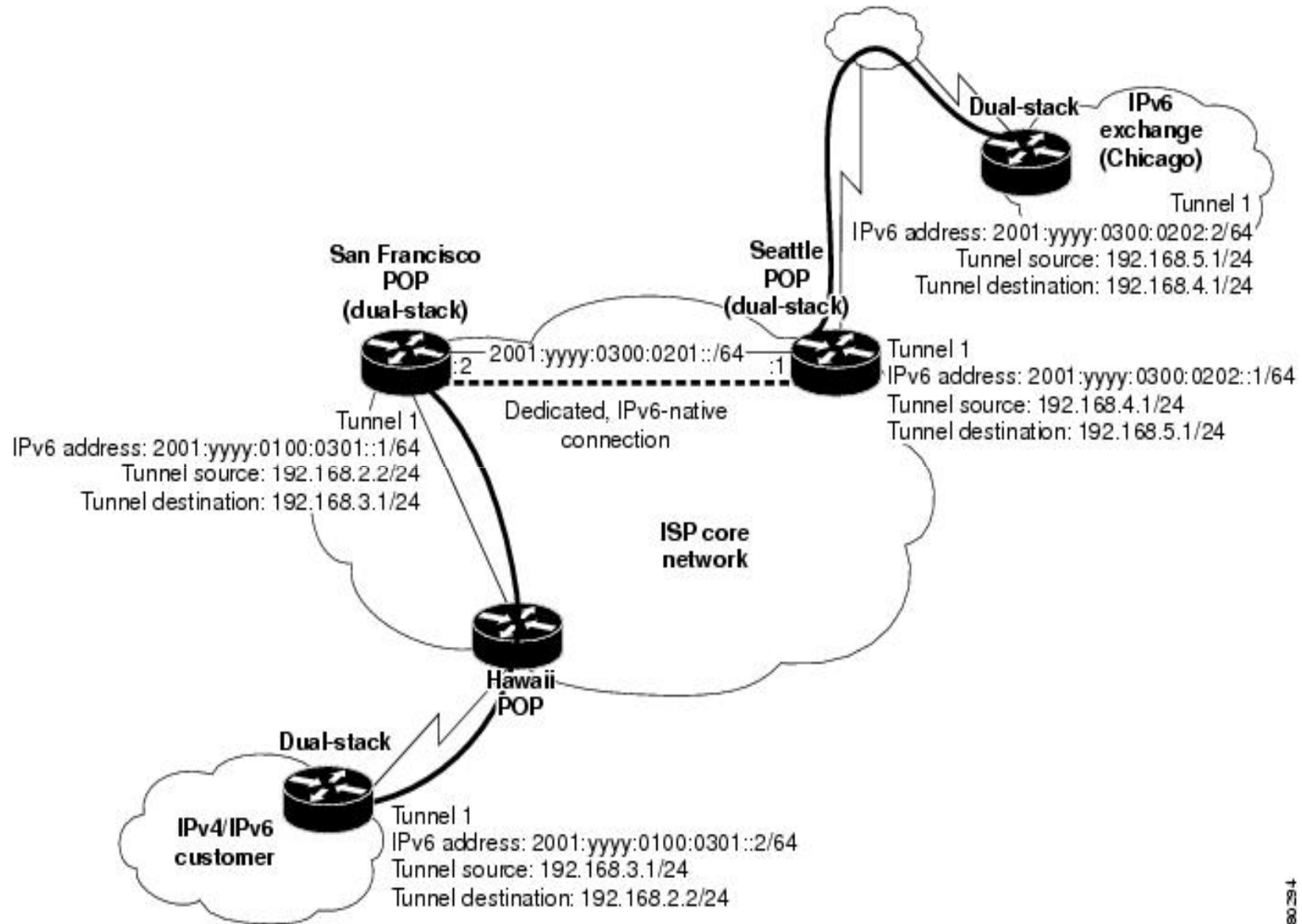
- Firefox 10
- Chrome (last stable)
- OSX 10.7 "Lion"
  - `getaddrinfo()`
  - Safari
- iPhone iOS 4.3.1



# Tunneling

- 手動設定之Tunnel
  - 適用於ISP與企業用戶間的IPv6 Tunnel連線
  - 優點:安全性高，可支援IPv6 Multicast
  - 缺點:需要site-to-site 逐點設定,管理不易





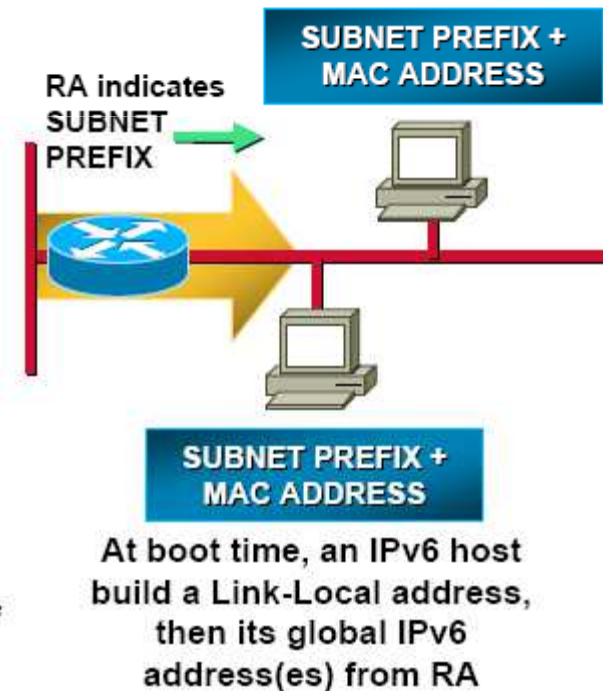
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# IPv6 Auto-Configuration

- Stateless (RFC2462)
  - Host autonomously configures its own Link-Local address
  - Router solicitation are sent by booting nodes to request RAs for configuring the interfaces.
- Stateful
  - DHCPv6 (under definition at IETF)



# Neighbor Discovery (RFC 2461)

Protocol built on top of ICMPv6 (RFC 2463)

- Combination of IPv4 protocols (ARP, ICMP,...)

Neighbor Discovery:

- Determines the link-layer address of a neighbor on the same link, Duplicate Address Detection(DAD)
- Finds neighbor routers, Keeps track of neighbors

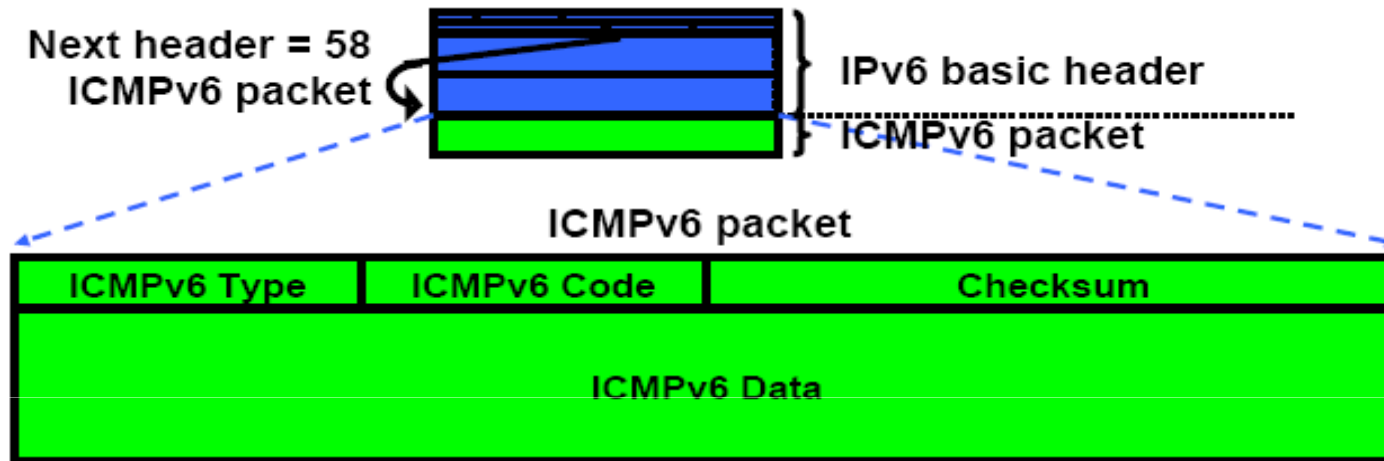
Defines 6 ICMPv6 packet types

- Router Solicitation(133)/ Router Advertisements(134)
- Neighbor Solicitation (135)/ Neighbor Advertisements(136)
- Redirect(137)
- Router Renumbering(138)





# ICMPv6



ICMPv6 is similar to IPv4:

- Provides diagnostic and error messages
- Is used for path MTU discovery



# Neighbor Discovery—Neighbor Solicitation



ICMP type = 135

Src = A

Dst = Solicited-node multicast of B

Data = link-layer address of A

Query = what is your link address?

ICMP type = 136

Src = B

Dst = A

Data = link-layer address of B

A and B can now exchange  
packets on this link



# Neighbor Discovery—Router Advertisements



RA packet definitions:

ICMP Type = 134

Src = Router Link-local Address

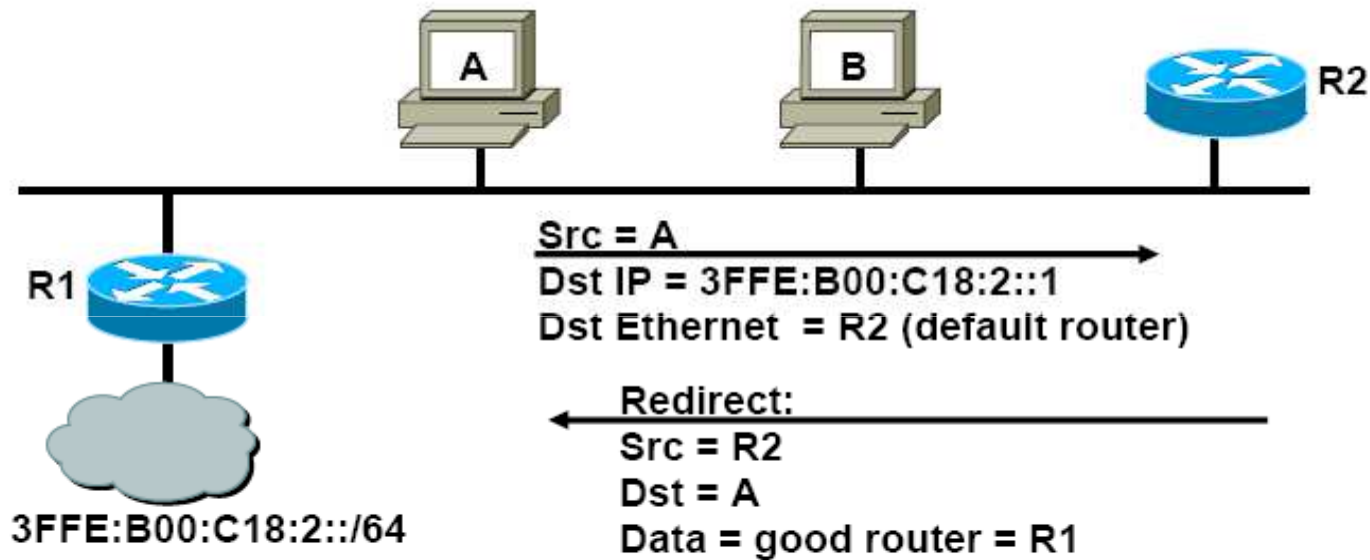
Dst = All-nodes multicast address

Data= options, prefix, lifetime, autoconfig flag

**Routers send periodic Router Advertisements (RA) to the all-nodes multicast address.**



# Neighbor Discovery—Redirect



Redirect is used by a router to signal the reroute of a packet to a better router.



# Duplicate Address Detection



ICMP type = 135

Src = 0 (::)

Dst = Solicited-node multicast of A

Data = link-layer address of A

Query = what is your link address?



Duplicate Address Detection (DAD) uses neighbor solicitation to verify the existence of an address to be configured.



# Router Solicitation and Advertisement



**1—ICMP Type = 133 (RS)**

**Src = link-local address (FE80::1/10)**

**Dst = all-routers multicast address (FF02::2)**

**Query = please send RA**

**2—ICMP Type = 134 (RA)**

**Src = link-local address (FE80::2/10)**

**Dst = all-nodes multicast address (FF02::1)**

**Data = options, subnet prefix, lifetime, autoconfig flag**

- Router Solicitations (RS) are sent by booting nodes to request RAs for configuring the interfaces
- Routers send periodic Router Advertisements (RA) to the all-nodes multicast address



# Router Solicitation and Advertisement

```
Ro_a#sh ipv6 int
FastEthernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::218:B9FF:FECC:75B6
No Virtual link-local address(es):
No global unicast address is configured
Joined group address(es):
  FF02::1
  FF02::2
  FF02::1:FFCC:75B6
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP redirects are enabled
ICMP unreachable are sent
ND DAD is enabled, number of DAD attempts: 1
ND reachable time is 30000 milliseconds (using 16816)
ND advertised reachable time is 0 (unspecified)
ND advertised retransmit interval is 0 (unspecified)
ND router advertisements are sent every 200 seconds
ND router advertisements live for 1800 seconds
ND advertised default router preference is Medium
Hosts use stateless autoconfig for addresses.
Ro_a#
```

```
NetBIOS over Tcpip . . . . . : 啟用
乙太網路卡 區域連線:
  媒體狀態 . . . . . : 媒體已中斷連線
  連線特定 DNS 尾碼 . . . . . :
  描述 . . . . . : Intel(R) 82566MM Gigabit Network Connecti
on
  實體位址 . . . . . : 00-16-D3-C6-16-FF
  DHCP 已啟用 . . . . . : 是
  自動設定啟用 . . . . . : 是
```



# Router Solicitation and Advertisement

```

Ro_1#
*Mar 4 06:32:49.451: ICMPv6-ND: REACH -> STALE: FE80::216:D3FF:FEC6:16FF
Ro_1#
*Mar 4 06:33:00.359: ICMPv6-ND: STALE -> DELAY: FE80::216:D3FF:FEC6:16FF
Ro_1#
*Mar 4 06:33:01.859: ICMPv6-ND: Received RS on FastEthernet0/0 from FE80::216:D3FF:FEC6:16FF
*Mar 4 06:33:01.859: ICMPv6-ND: Sending solicited RA on FastEthernet0/0
*Mar 4 06:33:01.859: ICMPv6-ND: Request to send RA for FE80::218:B9FF:FECC:75B6
*Mar 4 06:33:01.859: ICMPv6-ND: Sending RA from FE80::218:B9FF:FECC:75B6 to FF02::1 on FastEthernet
0/0
*Mar 4 06:33:01.859: ICMPv6-ND: MTU = 1500
Ro_1#
*Mar 4 06:33:05.359: ICMPv6-ND: DELAY -> PROBE: FE80::216:D3FF:FEC6:16FF
*Mar 4 06:33:05.359:
*Mar 4 06:33:05.359:
80::216:D3FF:FEC6:16FF
*Mar 4 06:33:05.359:
Ro_1#
*Mar 4 06:33:09.363:
80::216:D3FF:FEC6:16FF
*Mar 4 06:33:09.363:
Ro_1#
*Mar 4 06:33:46.011:
Ro_1#
*Mar 4 06:33:55.355:

```

Intel(R) 82566MM Gigabit Network Connection: Capturing - Wireshark

File Edit View Go Capture Analyze Statistics Telephony Tools Help

Filter: ipv6 Expression... Clear Apply

	Source	Destination	Protocol	Info
14:26:56.04	fe80::216:d3ff:fec6:16ff	ff02::1:ffcc:75b6	ICMPv6	Neighbor solicitation
14:26:56.40	::	ff02::1:ffc6:16ff	ICMPv6	Neighbor solicitation
14:26:56.40	fe80::216:d3ff:fec6:16ff	ff02::2	ICMPv6	Router solicitation
14:26:56.40	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:56.55	fe80::216:d3ff:fec6:16ff	ff02::1:ffcc:75b6	ICMPv6	Neighbor solicitation
14:26:56.90	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:57.39	fe80::216:d3ff:fec6:16ff	ff02::1:ffcc:75b6	ICMPv6	Neighbor solicitation
14:26:57.41	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:57.91	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:58.41	fe80::216:d3ff:fec6:16ff	ff02::1:ffcc:75b6	ICMPv6	Neighbor solicitation
14:26:58.74	::	ff02::1:ffcc:75b6	ICMPv6	Neighbor solicitation
14:26:59.41	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:59.43	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:59.73	fe80::218:b9ff:fecc:75b6	ff02::1	ICMPv6	Neighbor advertisement
14:26:59.73	fe80::218:b9ff:fecc:75b6	ff02::1	ICMPv6	Router advertisement
14:26:59.73	fe80::218:b9ff:fecc:75b6	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:59.73	fe80::218:b9ff:fecc:75b6	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:26:59.91	fe80::216:d3ff:fec6:16ff	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:27:00.42	fe80::218:b9ff:fecc:75b6	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:27:00.67	fe80::218:b9ff:fecc:75b6	ff02::16	ICMPv6	Multicast Listener Report Message v2
14:27:15.79	fe80::218:b9ff:fecc:75b6	ff02::1	ICMPv6	Router advertisement
14:27:17.57	fe80::216:d3ff:fec6:16ff	fec0:0:0:ffff::3	DNS	Standard query A teredo.ipv6.microsoft
14:27:17.57	fe80::218:b9ff:fecc:75b6	fe80::216:d3ff:fec6:16ff	ICMPv6	unreachable (Route unreachable)



# Neighbor Solicitation and Advertisement



## Neighbor Solicitation

ICMP type = 135

Src = A

Dst = Solicited-node multicast of B

Data = link-layer address of A

Query = what is your link address?



## Neighbor Advertisement

ICMP type = 136

Src = B

Dst = A

Data = link-layer address of B



**A and B Can Now Exchange  
Packets on this Link**



A large black double-headed arrow pointing left and right, indicating bidirectional communication between A and B.



# Contents of NS

- ⊕ Frame 36 (86 bytes on wire, 86 bytes captured)
- ⊖ Ethernet II, Src: D-Link\_ac:fe:56 (00:50:ba:ac:fe:56), Dst: IPv6-Neighbor-Discovery\_ff:84:18:d9 (33:33:ff:84:18:d9)
  - ⊖ Destination: IPv6-Neighbor-Discovery\_ff:84:18:d9 (33:33:ff:84:18:d9)
    - Address: IPv6-Neighbor-Discovery\_ff:84:18:d9 (33:33:ff:84:18:d9)
    - .... ..1 .... = Multicast: This is a MULTICAST frame
    - .... ..1. .... = Locally Administrated Address: This is NOT a factor
  - ⊖ Source: D-Link\_ac:fe:56 (00:50:ba:ac:fe:56)
    - Address: D-Link\_ac:fe:56 (00:50:ba:ac:fe:56)
    - .... ..0 .... = Multicast: This is a UNICAST frame
    - .... ..0. .... = Locally Administrated Address: This is a FACTORY DEFAULT address
  - Type: IPv6 (0x86dd)
- ⊖ Internet Protocol version 6
  - Version: 6
  - Traffic class: 0x00
  - Flowlabel: 0x00000
  - Payload length: 32
  - Next header: ICMPv6 (0x3a)
  - Hop limit: 255
  - Source address: fe80::250:baff:feac:fe56
  - Destination address: ff02::1:ff84:18d9
- ⊖ Internet Control Message Protocol v6
  - Type: 135 (Neighbor solicitation)
  - Code: 0
  - Checksum: 0xc92d [correct]
  - Target: fe80::20e:cff:fe84:18d9
- ⊖ ICMPv6 options
  - Type: 1 (source link-layer address)
  - Length: 8 bytes (1)
  - Link-layer address: 00:50:ba:ac:fe:56

**L2 Destination:  
L2 Multicast Address  
Corresponding to Target  
IPv6 Solicited Node Address**

**L3 Source:  
IPv6 Link-Local Address of Source**

**L3 Destination:  
Solicited Node Address  
Corresponding to Target  
IPv6 Address of Destination**

**IPv6 Link-Local Address of Destination**



# Contents of NLA

```

+ Frame 37 (86 bytes on wire, 86 bytes captured)
- Ethernet II, Src: Intel_84:18:d9 (00:0e:0c:84:18:d9), Dst: D-Link_ac:fe:56 (00:50:ba:ac:fe:56)
  - Destination: D-Link_ac:fe:56 (00:50:ba:ac:fe:56)
    Address: D-Link_ac:fe:56 (00:50:ba:ac:fe:56)
    .... 0... = Multicast: This is a UNICAST frame
    .... 0... = Locally Administrated Address: This is a FACTORY DEFAULT address
  - Source: Intel_84:18:d9 (00:0e:0c:84:18:d9)
    Address: Intel_84:18:d9 (00:0e:0c:84:18:d9)
    .... 0... = Multicast: This is a UNICAST frame
    .... 0... = Locally Administrated Address: This is a FACTORY DEFAULT address
  Type: IPv6 (0x86dd)
- Internet Protocol Version 6
  Version: 6
  Traffic class: 0x00
  Flowlabel: 0x00000
  Payload length: 32
  Next header: ICMPv6 (0x3a)
  Hop limit: 255
  Source address: fe80::20e:cff:fe84:18d9
  Destination address: fe80::250:baff:feac:fe56
- Internet Control Message Protocol v6
  Type: 136 (Neighbor advertisement)
  Code: 0
  Checksum: 0xed8b [correct]
- Flags: 0x60000000
  0... = Not router
  .1.. = Solicited
  ..1. = Override
  Target: fe80::20e:cff:fe84:18d9
- ICMPv6 options
  Type: 2 (Target link-layer address)
  Length: 8 bytes (1)
  Link-layer address: 00:0e:0c:84:18:d9
  
```

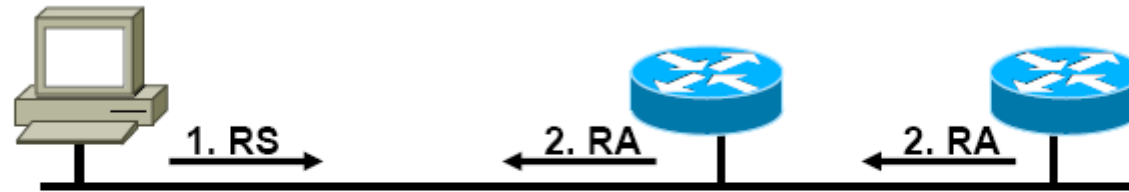
**L3 Source:  
IPv6 Link-Local Address of Source**

**L3 Destination:  
IPv6 Link-Local Address  
of Destination**

**Link-Layer Address Requested  
In the NS Message**



# Stateless Autoconfiguration



**1 - ICMP Type = 133 (RS)**

Src = ::

Dst = All-Routers multicast Address

query= please send RA

**2 - ICMP Type = 134 (RA)**

Src = Router Link-local Address

Dst = All-nodes multicast address

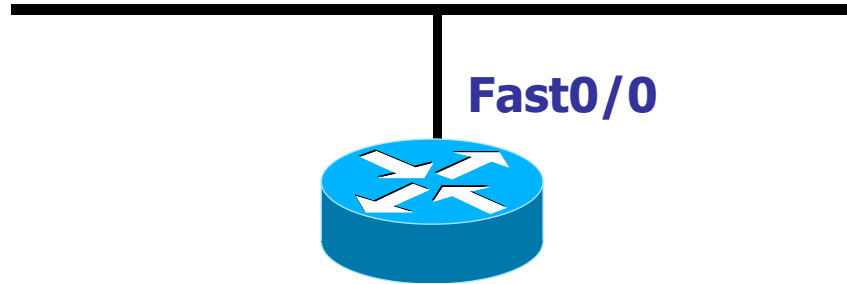
Data= options, prefix, lifetime,  
autoconfig flag

Router solicitations are sent by booting nodes to request RAs for configuring the interfaces



# IOS IPv6 Addressing (1)

## Manual Interface Identifier



```
ipv6 unicast-routing
!  
interface FastEthernet0/0  
 ip address 10.151.1.1 255.255.255.0  
 ipv6 address 2006:1::1/64  
 ipv6 enable  
 ipv6 nd prefix 2006:1::/64 300 300  
!
```



## Manual Interface Identifier

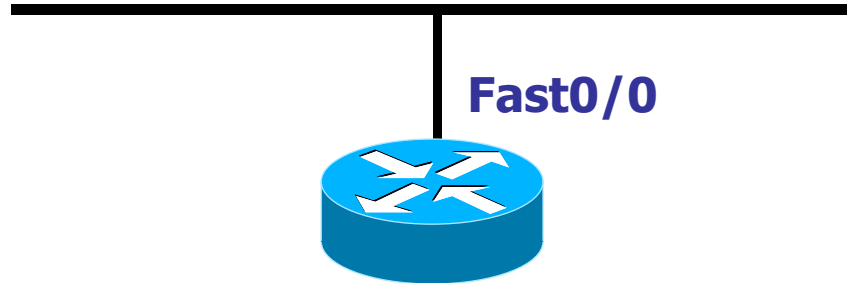
```
r1#sh ipv6 int fast0/0
FastEthernet0/0 is up, line protocol is up
  IPv6 is enabled, link-local address is FE80::207:50FF:FE5E:9460
  Global unicast address(es):
    2001:1::1, subnet is 2001:1::/64
  Joined group address(es):
    FF02::1
    FF02::2
    FF02::1:FF00:1
    FF02::1:FF5E:9460
  MTU is 1500 bytes
  ICMP error messages limited to one every 100 milliseconds
  ICMP redirects are enabled
N1#r1#sh int fast0/0
N1#FastEthernet0/0 is up, line protocol is up
N1#  Hardware is AmdFE, address is 0007.505e.9460 (bia 0007.505e.9460)
ND advertised retransmit interval is 0 milliseconds
ND router advertisements are sent every 30 seconds
ND router advertisements live for 1800 seconds
Hosts use stateless autoconfig for addresses.
r1#
```

**MAC Address : 0007.505e.9460**



# IOS IPv6 Addressing (2)

## EUI-64 Interface Identifier



```
ipv6 unicast-routing
!  
interface FastEthernet0/0  
 ip address 10.151.1.1 255.255.255.0  
 ipv6 address 2006:1::/64 eui-64  
 ipv6 enable  
 ipv6 nd prefix 2006:1::/64 300 300  
!
```



# IOS IPv6 Addressing Examples (2)

## EUI-64 Interface Identifier

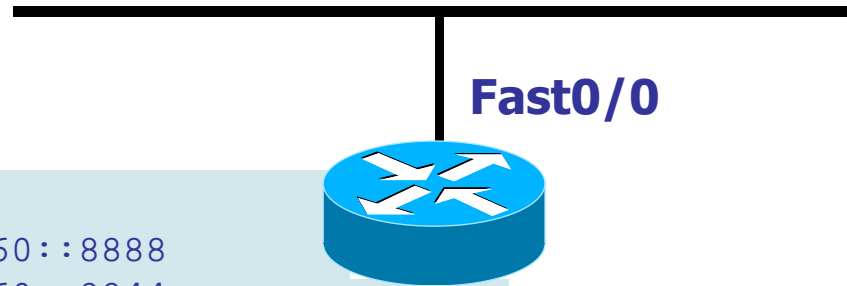
```
r1#sh ipv6 int fast0/0
FastEthernet0/0 is up, line protocol is up
IPv6 is enabled, link-local address is FE80::207:50FF:FE5E:9460
Global unicast address(es):
  2006:1::207:50FF:FE5E:9460, subnet is 2006:1::/64
Joined group address(es):
  FF02::1
  FF02::2
  FF02::1:FF5E:9460
MTU is 1500 bytes
ICMP error messages limited to one every 100 milliseconds
ICMP
r1#sh int fast0/0
ND FastEthernet0/0 is up, line protocol is up
ND Hardware is AmdFE, address is 0007.505e.9460 (bia 0007.505e.9460)
ND advertised reachable time is 0 milliseconds
ND advertised retransmit interval is 0 milliseconds
ND router advertisements are sent every 30 seconds
ND router advertisements live for 1800 seconds
Hosts use stateless autoconfig for addresses.
r1#
```

MAC Address : 0007.505e.9460





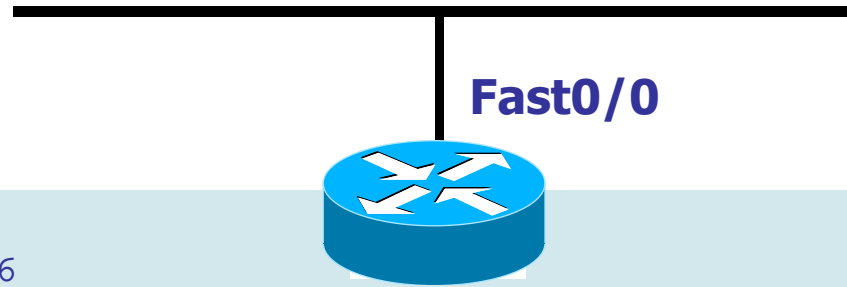
## Stateless



```
ipv6 dhcp pool DHCPv6
  dns-server 2001:4860:4860::8888
  dns-server 2001:4860:4860::8844
!
ipv6 unicast-routing
!
interface FastEthernet0/0
  ip address 10.151.1.1 255.255.255.0
  ipv6 address 2006:1::/64 eui-64
  ipv6 enable
  ipv6 nd other-config-flag
  ipv6 dhcp server DHCPv6
end
!
```



## Stateful



```
!  
ipv6 dhcp pool STATEFUL-DHCPv6  
  address prefix 2006:1::/64 lifetime 180000 172800  
  link-address 2006:1::/64  
  dns-server 2001:4860:4860::8888  
  dns-server 2001:4860:4860::8844  
!  
ipv6 unicast-routing  
!  
interface FastEthernet0/0  
  ip address 10.151.1.1 255.255.255.0  
  ipv6 address 2006:1::/64 eui-64  
  ipv6 enable  
  ipv6 nd other-config-flag  
  ipv6 dhcp server DHCPv6  
  ipv6 nd prefix 2006:1::/64 172800 172800 no-autoconfig  
  ipv6 nd managed-config-flag  
  ipv6 dhcp server STATEFUL-DHCPv6  
!
```



# Windows / Linux IPv6 的設定

- Windows IPv6 網路設定
  - Windows 95/98/Me/NT not support
  - Windows 2000/XP/Vista/Server 2003、2008 support
- Linux IPv6 網路設定



# WinXP enable ipv6

- install/uninstall ipv6  
-ipv6 install/uninstal
- 測試 → ping6 ::1



```
C:\>ipconfig /all
```

```
Windows IP Configuration
```

```
Host Name . . . . . : rzdai-xp2
Primary Dns Suffix . . . . . :
Node Type . . . . . : Unknown
IP Routing Enabled. . . . . : No
WINS Proxy Enabled. . . . . : No
DNS Suffix Search List. . . . . : localdomain
```

```
Ethernet adapter 區域連線:
```

```
Connection-specific DNS Suffix . : localdomain
Description . . . . . : VMware Accelerated AMD PCNet Adapter
Physical Address. . . . . : 00-0C-29-D9-CD-D7
Dhcp Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IP Address. . . . . : 172.16.251.129
Subnet Mask . . . . . : 255.255.255.0
Default Gateway . . . . . : 172.16.251.2
DHCP Server . . . . . : 172.16.251.254
DNS Servers . . . . . : 172.16.251.2
Lease Obtained. . . . . : 2009年5月18日 下午 01:38:51
Lease Expires . . . . . : 2009年5月18日 下午 02:08:51
```



```
C:\>ipv6 install
```

```
正在安裝...
```

```
執行成功。
```

```
C:\>ipconfig /all
```

```
Windows IP Configuration
```

```
Host Name . . . . . : rzdai-xp2
Primary Dns Suffix . . . . . :
Node Type . . . . . : Unknown
IP Routing Enabled. . . . . : No
WINS Proxy Enabled. . . . . : No
DNS Suffix Search List. . . . . : localdomain
```

```
Ethernet adapter 區域連線:
```

```
Connection-specific DNS Suffix . : localdomain
Description . . . . . : VMware Accelerated AMD PCNet Adapter
Physical Address. . . . . : 00-0C-29-D9-CD-D7
Dhcp Enabled. . . . . : Yes
Autoconfiguration Enabled . . . . : Yes
IP Address. . . . . : 172.16.251.129
Subnet Mask . . . . . : 255.255.255.0
IP Address. . . . . : fe80::20c:29ff:fed9:cdd7%5
Default Gateway . . . . . : 172.16.251.2
DHCP Server . . . . . : 172.16.251.254
DNS Servers . . . . . : 172.16.251.2
                          fec0:0:0:ffff::1%2
                          fec0:0:0:ffff::2%2
                          fec0:0:0:ffff::3%2
Lease Obtained. . . . . : 2009年5月18日 下午 01:38:51
Lease Expires . . . . . : 2009年5月18日 下午 02:08:51
```



# XP ipv6 設定範例 (1/3)

- 檢測指令

ipv6

- ipv6 if

netsh

- netsh interface ipv6 show interface





```
C:\>netsh interface ipv6 show interface
```

```
正在查詢使用中的狀態...
```

索引	公制	MTU	狀態	名稱
6	0	1500	已中斷連線	區域連線 6
5	0	1500	已連線	區域連線
4	2	1280	已中斷連線	Teredo Tunneling Pseudo-Interface
3	1	1280	已連線	6to4 Pseudo-Interface
2	1	1280	已連線	Automatic Tunneling Pseudo-Interface
1	0	1500	已連線	Loopback Pseudo-Interface

```
C:\>ipv6 if 5
```

```
介面 5: Ethernet: 區域連線
```

```
GUID {9611E3D1-CE93-448D-BD23-E0CA082BED97}
```

```
區域: link 5 site 2
```

```
使用 Neighbor Discovery
```

```
使用路由器探索
```

```
連結層位址: 00-0c-29-d9-cd-d7
```

```
preferred link-local fe80::20c:29ff:fed9:cdd7, 存留 infinite
```

```
多點傳送 interface-local ff01::1, 1 refs, 無法報告
```

```
多點傳送 link-local ff02::1, 1 refs, 無法報告
```

```
多點傳送 link-local ff02::1:ffd9:cdd7, 1 refs, 上次報告者
```

```
連結 MTU 1500 (true 連結 MTU 1500)
```

```
目前的躍點限制 128
```

```
可以連線的時間 17000ms (基本 30000ms)
```

```
重新傳輸間隔 1000ms
```

```
DAD 傳輸 1
```

```
預設站台首碼長度 48
```





## XP ipv6 設定範例(2/3)

- 新增/移除 ipv6 address

ipv6 adu ifindex/address

-ipv6 adu 5/2001:1234:4321::1

netsh

-netsh interface ipv6 add address 5 2001:1234:4321::1



```
C:\>ip6 adu 5/2001:1234:4321::1
```

```
C:\>ip6 if 5
```

```
介面 5: Ethernet: 區域連線
```

```
GUID {9611E3D1-CE93-448D-BD23-E0CA082BED97}
```

```
區域: link 5 site 2
```

```
使用 Neighbor Discovery
```

```
使用路由器探索
```

```
連結層位址: 00-0c-29-d9-cd-d7
```

```
preferred global 2001:1234:4321::1, 存留 infinite <手動>
```

```
preferred link-local fe80::20c:29ff:fed9:cdd7, 存留 infinite
```

```
多點傳送 interface-local ff01::1, 1 refs, 無法報告
```

```
多點傳送 link-local ff02::1, 1 refs, 無法報告
```

```
多點傳送 link-local ff02::1:ffd9:cdd7, 1 refs, 上次報告者
```

```
多點傳送 link-local ff02::1:ff00:1, 1 refs, 上次報告者, 5 秒後才報告
```

```
連結 MTU 1500 (true 連結 MTU 1500)
```

```
目前的躍點限制 128
```

```
可以連線的時間 17000ms (基本 30000ms)
```

```
重新傳輸間隔 1000ms
```

```
DAD 傳輸 1
```

```
預設站台首碼長度 48
```





## XP ipv6 設定範例(3/3)

### 新增/移除 ipv6 routing

- add a default route to 2001:1234:4321::254
  - ipv6 rtu ::/0 5/2001:1234:4321::254
  - netsh interface ipv6 add route ::/0 5/2001:1234:4321::254
- add/remove a route
  - ipv6 rtu 2001:1234:4321::64 5
  - netsh interface ipv6 add route 2001:1234:4321::/64 5

### 查看 routing table

-ipv6 rt



```
C:\>ipv6 rtu ::/0 5/2001:1234:4321::254
```

```
C:\>ipv6 rt
```

```
::/0 -> 5/2001:1234:4321::254 pref 0 存留 infinite <手動>
```

```
C:\>
```

```
C:\>ipv6 rtu 2001:1234:4321::/64 5
```

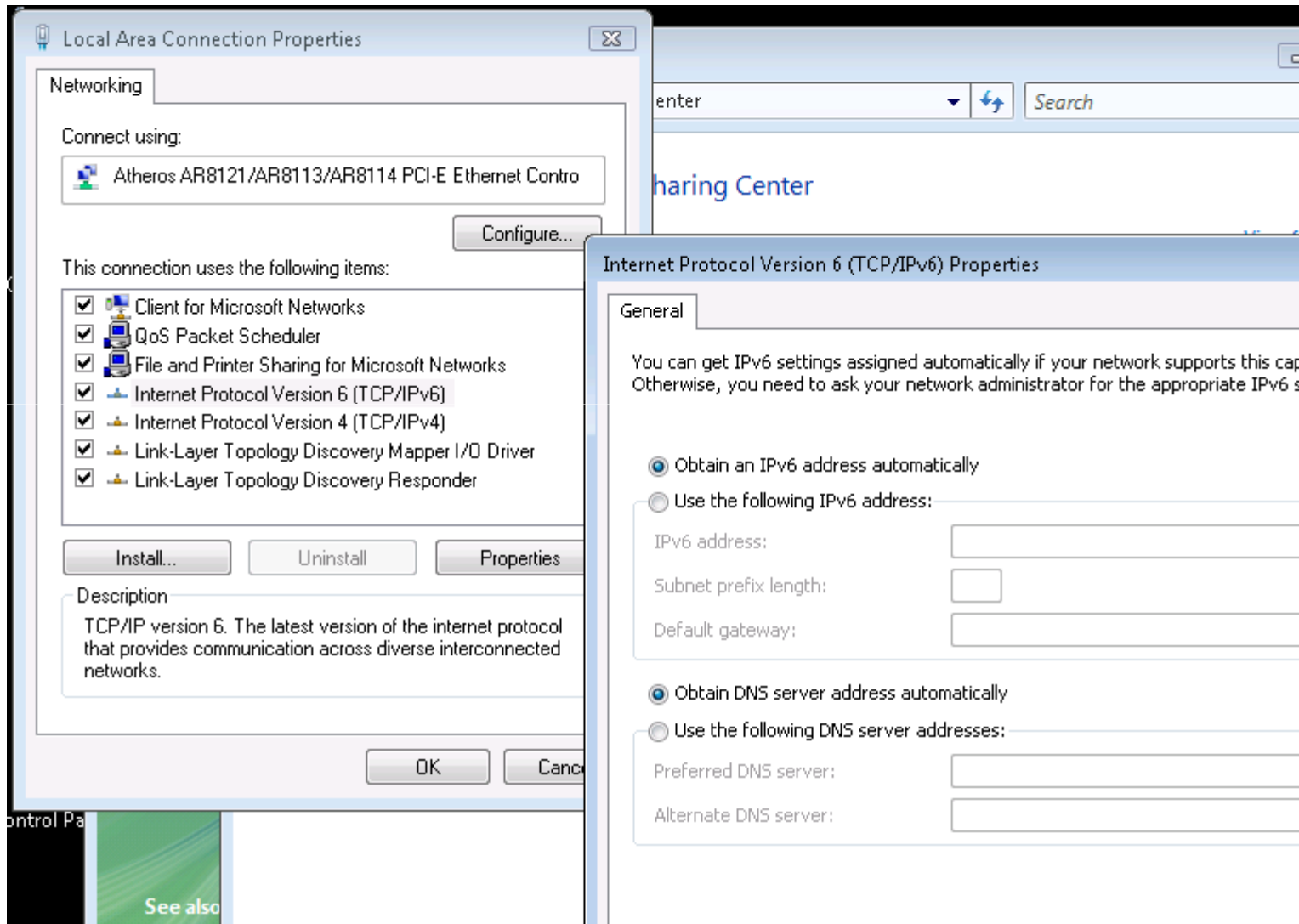
```
C:\>ipv6 rt
```

```
2001:1234:4321::/64 -> 5 pref 0 存留 infinite <手動>
```

```
::/0 -> 5/2001:1234:4321::254 pref 0 存留 infinite <手動>
```



# Windows Vista / 7 設定範例



The screenshot displays two overlapping windows from the Windows Vista/7 network configuration interface. The background window is the 'Local Area Connection Properties' dialog, showing a list of installed network protocols. The foreground window is the 'Internet Protocol Version 6 (TCP/IPv6) Properties' dialog, showing the 'General' tab with automatic settings selected.

**Local Area Connection Properties**

Connect using:  
Atheros AR8121/AR8113/AR8114 PCI-E Ethernet Contro

This connection uses the following items:

- Client for Microsoft Networks
- QoS Packet Scheduler
- File and Printer Sharing for Microsoft Networks
- Internet Protocol Version 6 (TCP/IPv6)
- Internet Protocol Version 4 (TCP/IPv4)
- Link-Layer Topology Discovery Mapper I/O Driver
- Link-Layer Topology Discovery Responder

Buttons: Install... Uninstall Properties

Description:  
TCP/IP version 6. The latest version of the internet protocol that provides communication across diverse interconnected networks.

Buttons: OK Cancel

**Internet Protocol Version 6 (TCP/IPv6) Properties**

General

You can get IPv6 settings assigned automatically if your network supports this cap  
Otherwise, you need to ask your network administrator for the appropriate IPv6 s

Obtain an IPv6 address automatically

Use the following IPv6 address:

IPv6 address:

Subnet prefix length:

Default gateway:

Obtain DNS server address automatically

Use the following DNS server addresses:

Preferred DNS server:

Alternate DNS server:



```
C:\Windows\system32\cmd.exe
C:\Users\nos>ipconfig

Windows IP 設定

無線區域網路介面卡 無線網路連線:

    媒體狀態 . . . . . : 媒體已中斷連線
    連線特定 DNS 尾碼 . . . . . : ringline.com.tw

乙太網路卡 區域連線:

    連線特定 DNS 尾碼 . . . . . :
    IPv6 位址 . . . . . : 2001:db8:1234:0:216:d3ff:fec6:16ff
    臨時 IPv6 位址 . . . . . : 2001:db8:1234:0:4ddf:f9f8:3783:2769
    連結-本機 IPv6 位址 . . . . . : fe80::216:d3ff:fec6:16ff%11
    自動設定 IPv4 位址 . . . . . : 169.254.183.11
    子網路遮罩 . . . . . : 255.255.0.0
    預設閘道 . . . . . : fe80::218:b9ff:fecc:75b6%11

通道介面卡 isatap.ringline.com.tw:

    媒體狀態 . . . . . : 媒體已中斷連線
    連線特定 DNS 尾碼 . . . . . :
```



```

C:\Windows\system32\cmd.exe

C:\Users\mos>netsh interface ipv6 show address

介面 1: Loopback Pseudo-Interface 1
位址類型  DAD 狀態  有效存留期  慣用存留期  位址
-----
其他      偏好的      infinite    infinite    ::1
介面 12: 無線網路連線
位址類型  DAD 狀態  有效存留期  慣用存留期  位址
-----
其他      已過時      infinite    infinite    fe80::21c:bfff:fe2d:20ca%12
介面 11: 區域連線
位址類型  DAD 狀態  有效存留期  慣用存留期  位址
-----
公用      偏好的      29d23h58m54s  6d23h58m54s  2001:b021:28:2226:216:d3ff:f
ec6:16ff
暫存      偏好的      6d21h42m50s  6d21h42m50s  2001:b021:28:2226:fca3:9270:d
cdf:71fc
其他      偏好的      infinite     infinite     fe80::216:d3ff:fec6:16ff%11
介面 49: isatap.ringline.com.tw
位址類型  DAD 狀態  有效存留期  慣用存留期  位址
-----
其他      已過時      infinite     infinite     fe80::5efe:172.16.226.54%49
介面 46: Teredo Tunneling Pseudo-Interface
位址類型  DAD 狀態  有效存留期  慣用存留期  位址
-----
其他      已過時      infinite     infinite     fe80::100:7f:fffe%46

C:\Users\mos>
  
```





```

C:\Windows\system32\cmd.exe

C:\Users\mos>netsh interface ipv6 show route

發佈      類型      計量  首碼      Idx  閘道/介面名稱
-----
否        手動      256  ::/0      11  fe80::222:55ff:fece:95
49
否        手動      256  ::1/128    1  Loopback Pseudo-Interf
ace 1
否        手動      8    2001:b021:28:2226::/64  11  區域連線
否        手動      256  2001:b021:28:2226:216:d3ff:fec6:16ff/128  11  區域連
線
否        手動      256  2001:b021:28:2226:fca3:9270:dcdf:71fc/128  11  區域
連線
否        手動      256  fe80::/64  46  Teredo Tunneling Pseud
o-Interface
否        手動      256  fe80::/64  11  區域連線
否        手動      256  fe80::/64  12  無線網路連線
否        手動      256  fe80::100:7f:fffe/128  46  Teredo Tunneling Pseud
o-Interface
否        手動      256  fe80::5efe:172.16.226.54/128  48  isatap.ringline.co
m.tw
否        手動      256  fe80::216:d3ff:fec6:16ff/128  11  區域連線
否        手動      256  fe80::21c:bfff:fe2d:20ca/128  12  無線網路連線
否        手動      256  ff00::/8  1  Loopback Pseudo-Interf
ace 1
否        手動      256  ff00::/8  46  Teredo Tunneling Pseud
o-Interface
否        手動      256  ff00::/8  11  區域連線
否        手動      256  ff00::/8  12  無線網路連線

C:\Users\mos>
  
```



```
C:\Windows\system32\cmd.exe

C:\Users\mos>ping 2001:db8:1234::1

Ping 2001:db8:1234::1 <使用 32 位元組的資料>:
回覆自 2001:db8:1234::1: 時間=2ms
回覆自 2001:db8:1234::1: 時間=1ms
回覆自 2001:db8:1234::1: time<1ms
回覆自 2001:db8:1234::1: 時間=1ms

2001:db8:1234::1 的 Ping 統計資料:
    封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
    大約的來回時間 (毫秒):
        最小值 = 0ms, 最大值 = 2ms, 平均 = 1ms

C:\Users\mos>
```

```
C:\Windows\system32\cmd.exe

C:\Users\mos>ping 2001:c50:ffff:1:21a:92ff:fe43:d665

Ping 2001:c50:ffff:1:21a:92ff:fe43:d665 <使用 32 位元組的資料>:
回覆自 2001:c50:ffff:1:21a:92ff:fe43:d665: 時間=44ms
回覆自 2001:c50:ffff:1:21a:92ff:fe43:d665: 時間=45ms
回覆自 2001:c50:ffff:1:21a:92ff:fe43:d665: 時間=45ms
回覆自 2001:c50:ffff:1:21a:92ff:fe43:d665: 時間=44ms

2001:c50:ffff:1:21a:92ff:fe43:d665 的 Ping 統計資料:
    封包: 已傳送 = 4, 已收到 = 4, 已遺失 = 0 (0% 遺失),
    大約的來回時間 (毫秒):
        最小值 = 44ms, 最大值 = 45ms, 平均 = 44ms

C:\Users\mos>
```

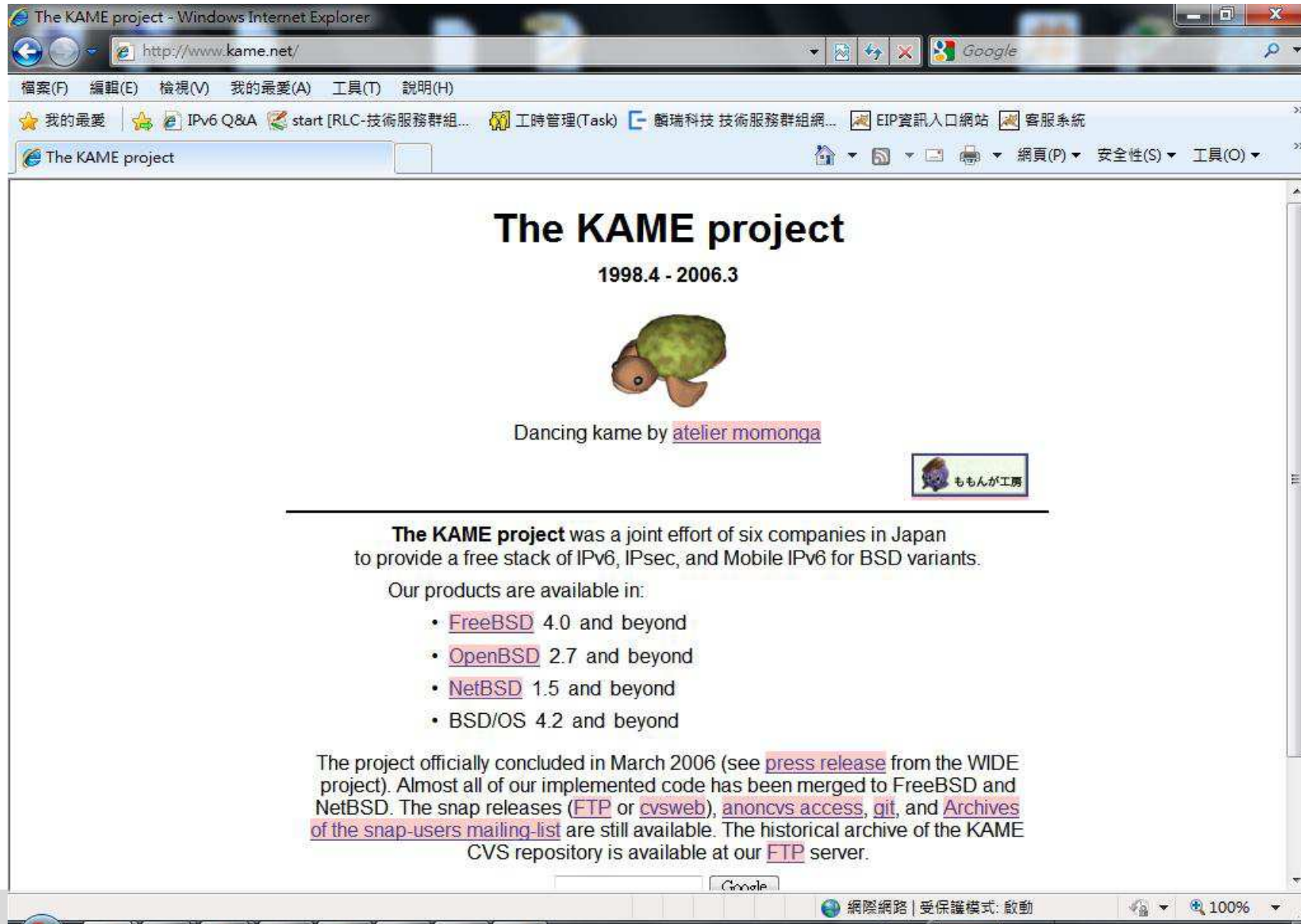


# tracert 測試

```
C:\Windows\system32\cmd.exe
最小值 = 0ms , 最大值 = 2ms , 平均 = 1ms
C:\Users\mos>tracert 2001:c50:ffff:1:21a:92ff:fe43:d665
在上限 30 個躍點上追蹤 2001:c50:ffff:1:21a:92ff:fe43:d665 的路由
  1  <1 ms    <1 ms    <1 ms    2001:b021:28:2226::
  2  44 ms    44 ms    44 ms    2001:b02a:0:3b::1
  3  44 ms    44 ms    46 ms    2001:b000::20d:bcff:feeb:aa9
  4  46 ms    45 ms    46 ms    2001:c08:7f::ed
  5  46 ms    46 ms    45 ms    2001:c08:7f::2d
  6  47 ms    45 ms    45 ms    2001:c08:7f:10::9
  7  45 ms    45 ms    45 ms    2001:288:3b0:4::2
  8  47 ms    46 ms    46 ms    2001:288:3b0:5::4747:2
  9  47 ms    47 ms    49 ms    2001:c50:ffff:1:21a:92ff:fe43:d665
追蹤完成。
C:\Users\mos>
```

```
C:\Windows\system32\cmd.exe
C:\Users\mos>tracert www.ipv6.org.tw
在上限 30 個躍點上
追蹤 www.ipv6.org.tw [2001:c50:ffff:1:21a:92ff:fe43:d665] 的路由:
  1   1 ms    <1 ms    <1 ms    2001:b021:28:2226::
  2  87 ms   157 ms   161 ms   2001:b02a:0:3b::1
  3 140 ms   158 ms   160 ms   2001:b000::20d:bcff:feeb:aa9
  4 113 ms    82 ms   161 ms   2001:c08:7f::ed
  5  93 ms   168 ms   162 ms   2001:c08:7f::2d
  6  93 ms   162 ms   176 ms   2001:c08:7f:10::9
  7 105 ms   162 ms   162 ms   2001:288:3b0:4::2
  8  92 ms   162 ms   161 ms   2001:288:3b0:5::4747:2
  9 100 ms   160 ms   182 ms   2001:c50:ffff:1:21a:92ff:fe43:d665
追蹤完成。
C:\Users\mos>
```



<http://www.kame.net/>

The KAME project - Windows Internet Explorer

http://www.kame.net/


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我的最愛 | IPv6 Q&A | start [RLC-技術服務群組... | 工時管理(Task) | 麟瑞科技 技術服務群組網... | EIP資訊入口網站 | 客服系統


The KAME project

# The KAME project

1998.4 - 2006.3



Dancing kame by [atelier momonga](#)



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**The KAME project** was a joint effort of six companies in Japan to provide a free stack of IPv6, IPsec, and Mobile IPv6 for BSD variants.

Our products are available in:

- [FreeBSD](#) 4.0 and beyond
- [OpenBSD](#) 2.7 and beyond
- [NetBSD](#) 1.5 and beyond
- BSD/OS 4.2 and beyond

The project officially concluded in March 2006 (see [press release](#) from the WIDE project). Almost all of our implemented code has been merged to FreeBSD and NetBSD. The snap releases ([FTP](#) or [cvsweb](#)), [anoncvs access](#), [git](#), and [Archives of the snap-users mailing-list](#) are still available. The historical archive of the KAME CVS repository is available at our [FTP](#) server.

Google

網際網路 | 受保護模式: 啟動 | 100%

# Linux 上的 IPv6 設定

Linux 設定參考網站

<http://www.linux.org.tw/CLDP/OLD/Linux-IPv6-HOWTO.html#toc14>



# Config IPv6 address

顯示目前的IPv6位址

```
# /sbin/ip -6 addr show dev <interface>
```

```
# /sbin/ifconfig <interface>
```

增加IPv6位址

```
# /sbin/ip -6 addr add <ipv6address>/<prefixlength> dev <interface>
```

```
# /sbin/ifconfig <interface> inet6 add <ipv6address>/<prefixlength>
```

移除IPv6位址

```
# /sbin/ip -6 addr del <ipv6address>/<prefixlength> dev <interface>
```

```
# /sbin/ifconfig <interface> inet6 del <ipv6address>/<prefixlength>
```



# 支援 IPv6 網路

## IPv6 Ping

-ping6 < ipv6address >

## IPv6 traceroute6

-traceroute6 <ipv6 address>

## DNS 支援 IPv6 的解析能力

-host -t AAAA ipv6-domainname



# Neighbor Discovery

Neighbor Discovery的訊息

```
# ip -6 neigh show [dev <device>]
```

增加一個entry

```
# ip -6 neigh add <IPv6 address> lladdr <link-layer address> dev <device>
```

移除一個entry

```
# ip -6 neigh del <IPv6 address> lladdr <link-layer address> dev <device>
```





# Config IPv6 route

顯示目前的IPv6路由

```
# /sbin/ip -6 route show [dev <device>]
```

```
# /sbin/route -A inet6
```

設定IPv6路由通過的閘道

```
# /sbin/ip -6 route add <ipv6network>/<prefixlength> via <ipv6address> [dev <device>]
```

```
# /sbin/route -A inet6 add <ipv6network>/<prefixlength> gw <ipv6address> [dev <device>]
```



# Config IPv6 route

## 移除IPv6路由通過的閘道

```
# /sbin/ip -6 route del <ipv6network>/<prefixlength> via <ipv6address> [dev <device>]  
# /sbin/route -A inet6 del <network>/<prefixlength> [dev <device>]
```

## 增加IPv6路由到interface

```
# /sbin/ip -6 route add <ipv6network>/<prefixlength> dev <device> metric 1  
# /sbin/route -A inet6 add <network>/<prefixlength> dev <device>
```



# Config IPv6 route

從interface移除IPv6路由

```
# /sbin/ip -6 route del <ipv6network>/<prefixlength> dev <device> metric 1
```

```
# /sbin/route -A inet6 del <network>/<prefixlength> dev <device>
```



# Use Script

```
/etc/sysconfig/network
```

```
NETWORKING=yes
```

```
NETWORKING_IPV6=yes
```

```
IPV6FORWARDING=no (default)
```

```
IPV6_AUTOCONF=yes (default)
```

```
IPV6_DEFAULTGW="<ipv6address>[%interface]" [optional]
```

```
/etc/sysconfig/network-scripts/ifcfg-<device>
```

```
IPV6INIT=yes
```

```
IPV6ADDR="<ipv6address>/<prefix>"
```



# IPv6 DNS Query

- nslookup
- set type=aaaa

```
rzdai@rzdai:~$ nslookup
> set type=aaaa
> ftp.twaren.net
Server:          168.95.192.1
Address:         168.95.192.1#53
```

```
Non-authoritative answer:
ftp.twaren.net  has AAAA address 2001:e10:5c00:5::9
```

```
Authoritative answers can be found from:
twaren.net      nameserver = nstt.twaren.net.
twaren.net      nameserver = nshc.twaren.net.
nstt.twaren.net internet address = 211.79.61.4
nstt.twaren.net has AAAA address 2001:e10:5c00:1::4
nshc.twaren.net internet address = 211.79.59.242
nshc.twaren.net has AAAA address 2001:e10:3c00:1::3
```



# IPv6 Query 方式 1

若Server 具有 IPv6 AAAA record，Host 端

- OS啓用IPv6
- 使用Application 連往www.abc.com
- DNS Client 經由IPv4 送出 Q=AAAA www.abc.com Query
- DNS Server 回應 AAAA record
- Application 判斷對方位置爲IPv6，並使用IPv6與對方建立連線



## IPv6 Query 方式 2

若Server尚未有IPv6 AAAA record，Host端

- OS啓用IPv6
- 使用Application 連往www.abc.com
- DNS Client 經由IPv4 送出Q=AAAA www.abc.com query
- DNS Server 回應 No Name Error 訊息
- DNS Client 收到 No Name Error 訊息後，經由IPv4送出Q=A www.abc.com
- DNS Server 回應 www.abc.com 位址
- Application 判斷對方位置爲IPv4，並使用IPv4與對方建立連線



# FAQ

Thank You!

