

Wireshark Developer and User Conference

Discovering IPv6 with Wireshark

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SHARKFEST '11

Stanford University

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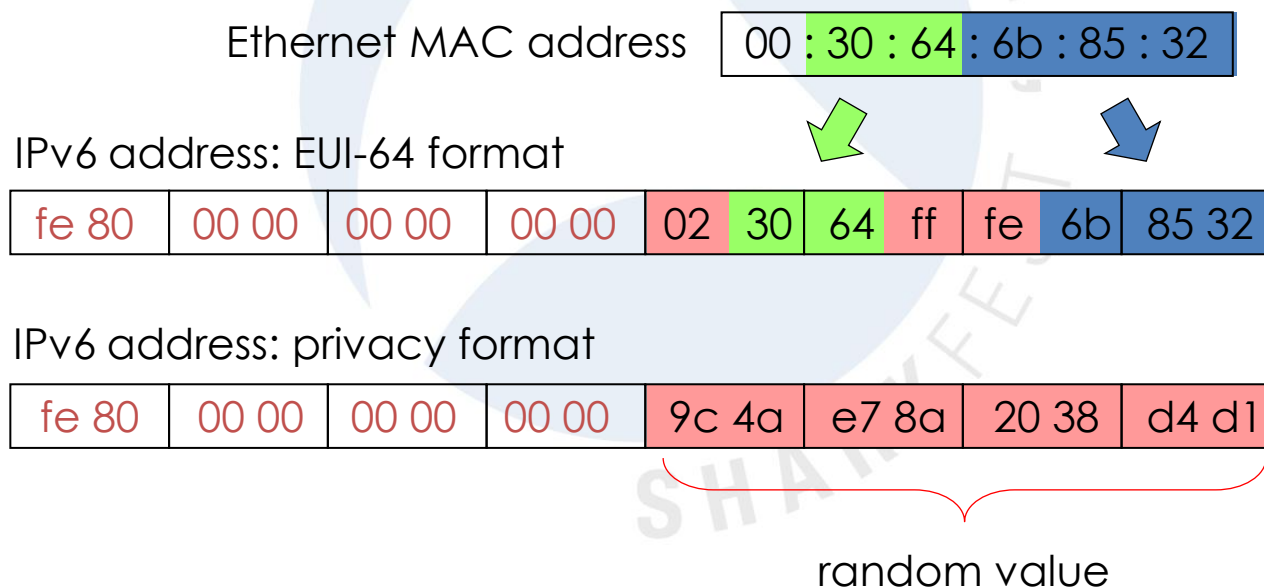
Agenda

- Address Autoconfiguration
- Neighbor discovery, Router discovery
- Host configuration with DHCPv6
- Transition technologies, ISATAP & Teredo Tunnel

Address Autoconfiguration

IPv6 Stateless Address Autoconfiguration (SLAAC)

- An IPv6 host will **autoconfigure** a link-local address for each interface
- Prefix for link-local address is **fe80::/64**
- Interface ID is either derived from **MAC address** or a **random value**

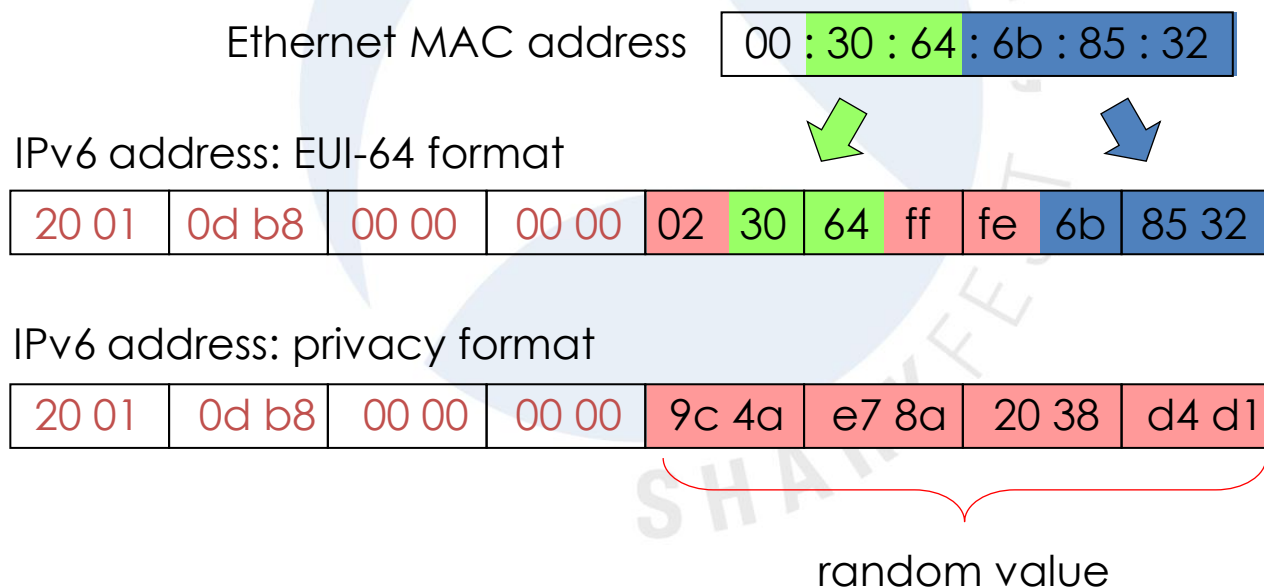


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Address Autoconfiguration

IPv6 Stateless Address Autoconfiguration (SLAAC)

- If a router is present, host will also **autoconfigure global address**
- Prefix will be obtained from router, example **2001:db8::/64**
- Interface ID is either derived from **MAC address** or a **random value**
- Router indicates in advertisement if **stateful configuration** may be used



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Address Autoconfiguration

Solicited Node Multicast Address (SNMA)

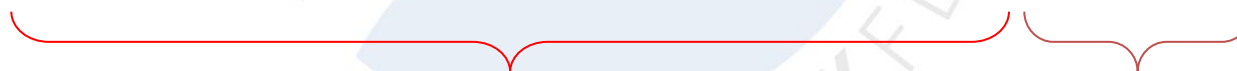
- Probably the **most strange** part of IPv6 addressing
- An IPv6 host forms a SNMA for **each own unicast address** in use
- The SNMA address is used for **Neighbor Discovery** (replacement of ARP)
- The SNMA address is **derived from** each **unicast address** in use

Hosts unicast address

20 01	0d b8	00 00	00 00	02 30	64 ff	fe 6b	85 32
-------	-------	-------	-------	-------	-------	-------	-------

Hosts SNMA address

ff 02	00 00	00 00	00 00	00 00	00 01	ff	6b	85 32
-------	-------	-------	-------	-------	-------	----	----	-------



SNMA prefix `ff02:0:0:0:0:1:ff00/104`

24 bits

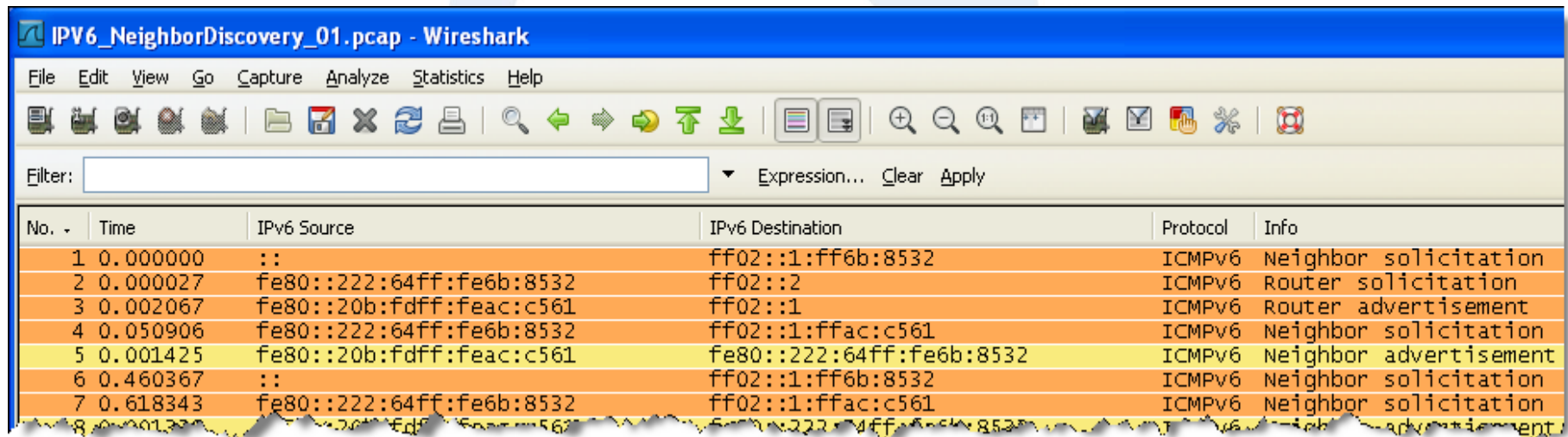
SNMA derived from unicast address: `ff02::1:ff6b:8532`

Duplicate Address Detection (DAD)

The initial client startup process includes the following steps:

Frame #

- 1 Duplicate Address Detection after Link-Local autoconfiguration
- 2 Router Discovery
- 3 Router Advertisement and global address autoconfiguration
- 4 Neighbor Discovery (searching for Router MAC)
- 5 Neighbor Advertisement (reply from Router with MAC)
- 6 Duplicate Address Detection with acquired global address

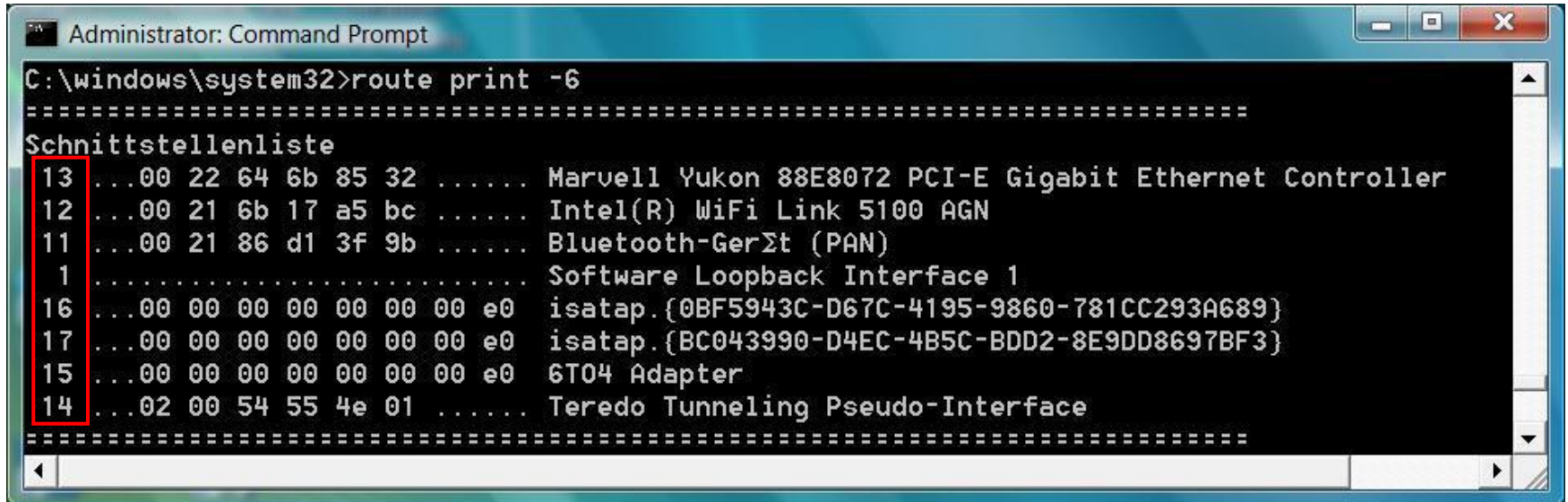


The image shows a Wireshark capture of IPv6 Neighbor Discovery protocol frames. The capture is titled "IPv6_NeighborDiscovery_01.pcap - Wireshark". The interface includes a menu bar (File, Edit, View, Go, Capture, Analyze, Statistics, Help), a toolbar with various icons, and a filter field. The main display area shows a list of frames with columns for No., Time, IPv6 Source, IPv6 Destination, Protocol, and Info. The frames are as follows:

No.	Time	IPv6 Source	IPv6 Destination	Protocol	Info
1	0.000000	::	ff02::1:ff6b:8532	ICMPv6	Neighbor solicitation
2	0.000027	fe80::222:64ff:fe6b:8532	ff02::2	ICMPv6	Router solicitation
3	0.002067	fe80::20b:fdff:feac:c561	ff02::1	ICMPv6	Router advertisement
4	0.050906	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
5	0.001425	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement
6	0.460367	::	ff02::1:ff6b:8532	ICMPv6	Neighbor solicitation
7	0.618343	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
8	0.001322	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement

IPv6 Interfaces

- In Windows Vista/7, each IPv6 interface is numbered with unique 'Zone ID'



```
Administrator: Command Prompt
C:\windows\system32>route print -6
=====
Schnittstellenliste
13 ...00 22 64 6b 85 32 ..... Marvell Yukon 88E8072 PCI-E Gigabit Ethernet Controller
12 ...00 21 6b 17 a5 bc ..... Intel(R) WiFi Link 5100 AGN
11 ...00 21 86 d1 3f 9b ..... Bluetooth-Gerät (PAN)
1 ..... Software Loopback Interface 1
16 ...00 00 00 00 00 00 00 e0 isatap.{0BF5943C-D67C-4195-9860-781CC293A689}
17 ...00 00 00 00 00 00 00 e0 isatap.{BC043990-D4EC-4B5C-BDD2-8E9DD8697BF3}
15 ...00 00 00 00 00 00 00 e0 6T04 Adapter
14 ...02 00 54 55 4e 01 ..... Teredo Tunneling Pseudo-Interface
=====
```

- A link-local address is automatically configured with the address prefix `fe80::/64` for each physical or logical IPv6 interface
- If a `router` is available, a `global address` is configured on interface

IPv6 Interfaces

```
Administrator: Command Prompt
IPv6-Routentabelle
=====
Aktive Routen:
If Metrik Netzwerkziel Gateway
13 286 ::/0 fe80::20b:fdff:feac:c560
16 281 ::/0 fe80::5efe:192.168.20.1
1 306 ::1/128 Auf Verbindung
14 18 2001::/32 Auf Verbindung
14 266 2001:0:d5c7:a2d6:281b:276f:3f57:ff32/128
Auf Verbindung
13 38 2001:cafe:0:20::/64 Auf Verbindung
13 286 2001:cafe:0:20::113/128 Auf Verbindung
13 286 2001:cafe:0:20:222:64ff:fe6b:8532/128
Auf Verbindung
13 286 2001:cafe:0:20:8d2d:33b4:5455:ad15/128
Auf Verbindung
16 33 2001:cafe:0:40::/64 Auf Verbindung
16 281 2001:cafe:0:40:0:5efe:192.168.0.205/128
Auf Verbindung
13 286 fe80::/64 Auf Verbindung
14 266 fe80::/64 Auf Verbindung
16 281 fe80::5efe:192.168.0.205/128
Auf Verbindung
17 296 fe80::5efe:192.168.10.100/128
Auf Verbindung
13 286 fe80::222:64ff:fe6b:8532/128
Auf Verbindung
14 266 fe80::281b:276f:3f57:ff32/128
Auf Verbindung
1 306 ff00::/8 Auf Verbindung
14 266 ff00::/8 Auf Verbindung
13 286 ff00::/8 Auf Verbindung
=====
```

Global Addresses

Link Local Addresses

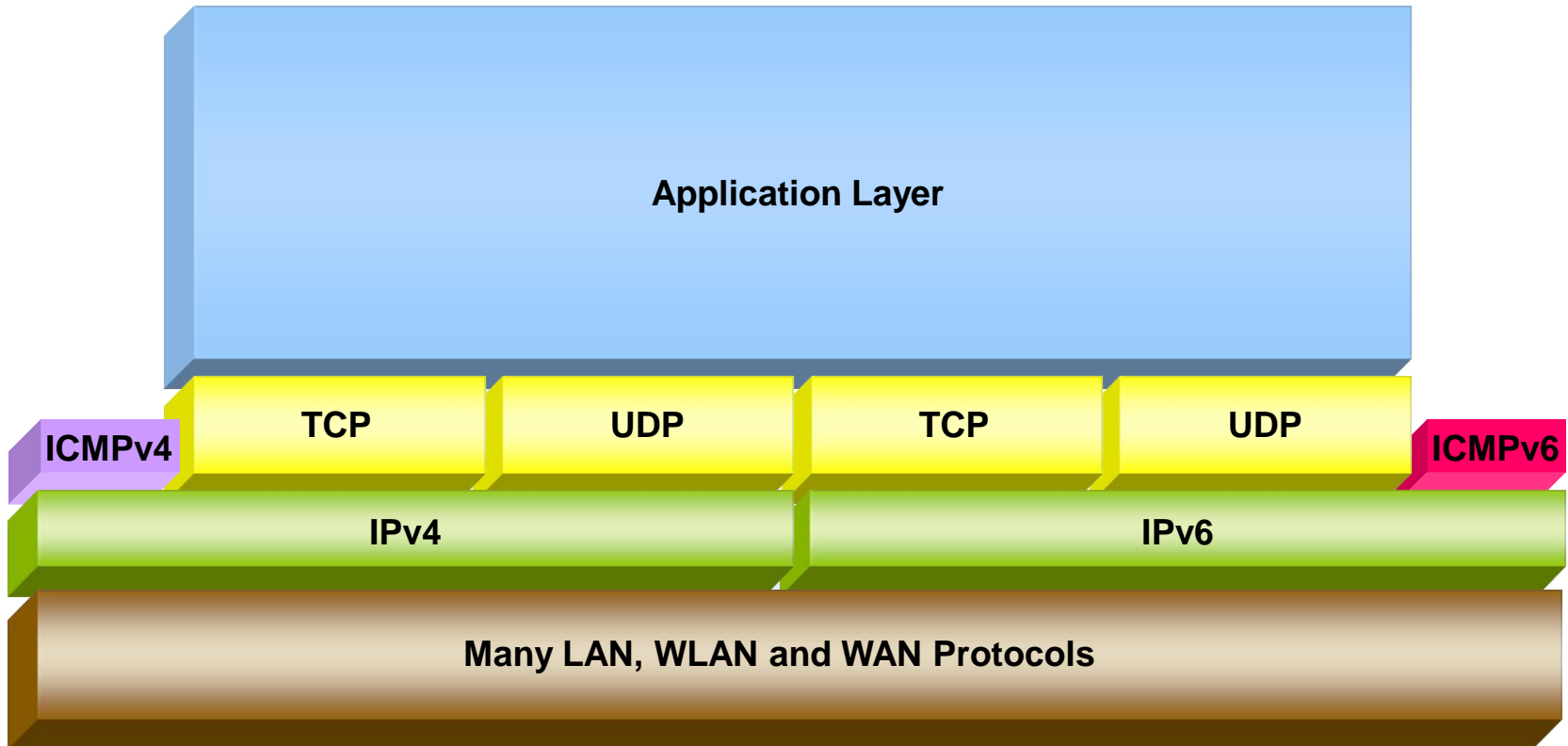
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TCP/IP Protocol Family

Dual stack implementation



- **Internet Control Message Protocol v6** (ICMPv6) plays an important role
- Many new ICMPv6 messages have been defined

ICMPv6 Messages

Error
and Control
Messages

Multicast Listener
Discovery (MLD)
Messages

Neighbor
Discovery (ND)
Messages

Echo Request/Reply
Destination unreachable
Time exceeded
Redirect
Parameter Problem
Packet too big

Multicast Listener Query
Multicast Listener Report
Multicast Listener Done

Neighbor Solicitation
Neighbor Advertisement
Router Solicitation
Router Advertisement

ICMPv6

IPv6

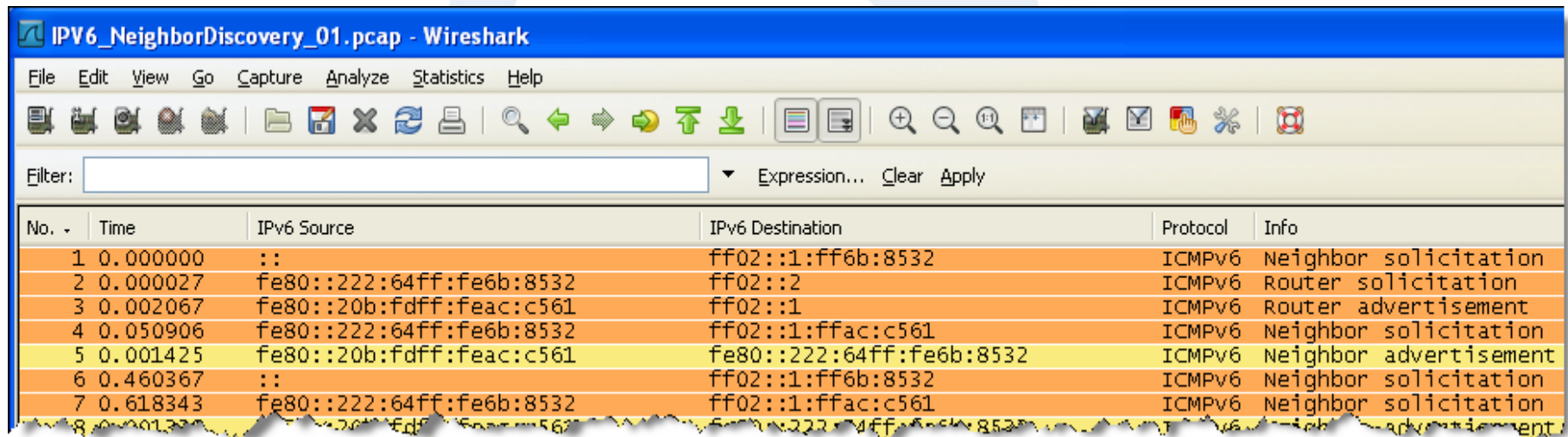
LAN, WLAN and WAN Protocols

Neighbor Discovery (ND)

The initial client startup process includes the following steps:

Frame

- 1 Duplicate Address Detection after Link-Local autoconfiguration
- 2 Router Discovery
- 3 Router Advertisement and global address autoconfiguration
- 4 Neighbor Discovery (searching for Router MAC)
- 5 Neighbor Advertisement (reply from Router with MAC)
- 6 Duplicate Address Detection with acquired global address



The image shows a Wireshark capture of IPv6 Neighbor Discovery frames. The capture is titled "IPV6_NeighborDiscovery_01.pcap - Wireshark". The interface includes a menu bar (File, Edit, View, Go, Capture, Analyze, Statistics, Help), a toolbar with various icons, and a filter field. The main display area shows a list of frames with columns for No., Time, IPv6 Source, IPv6 Destination, Protocol, and Info. The frames are as follows:

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4	0.050906	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
5	0.001425	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement
6	0.460367	::	ff02::1:ff6b:8532	ICMPv6	Neighbor solicitation
7	0.618343	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
8	0.001322	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement

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Host configuration with DHCPv6

Despite Address Autoconfiguration, DHCP plays an important role in IPv6 environment. It is required to provide clients with additional parameters like DNS server address and many other options.

DHCPv6 offers different level of control over the workstations:

Client parameters	Stateless Auto Address Config. RFC2462	Stateless DHCP Service for IPv6 RFC3736	Stateful DHCPv6 RFC3315
Subnet Prefix & Mask	From Router Advertisements (O-Flag=0 M-Flag=0)	From Router Advertisements (O-Flag=1 / M-Flag=0)	From Router Advertisements (O-Flag=1 / M-Flag=1)
Interface Identifier	Auto Configuration	Auto Configuration	From DHCPv6 Server
DNS, NTP address etc.	Manual Configuration	From DHCPv6 Server	From DHCPv6 Server

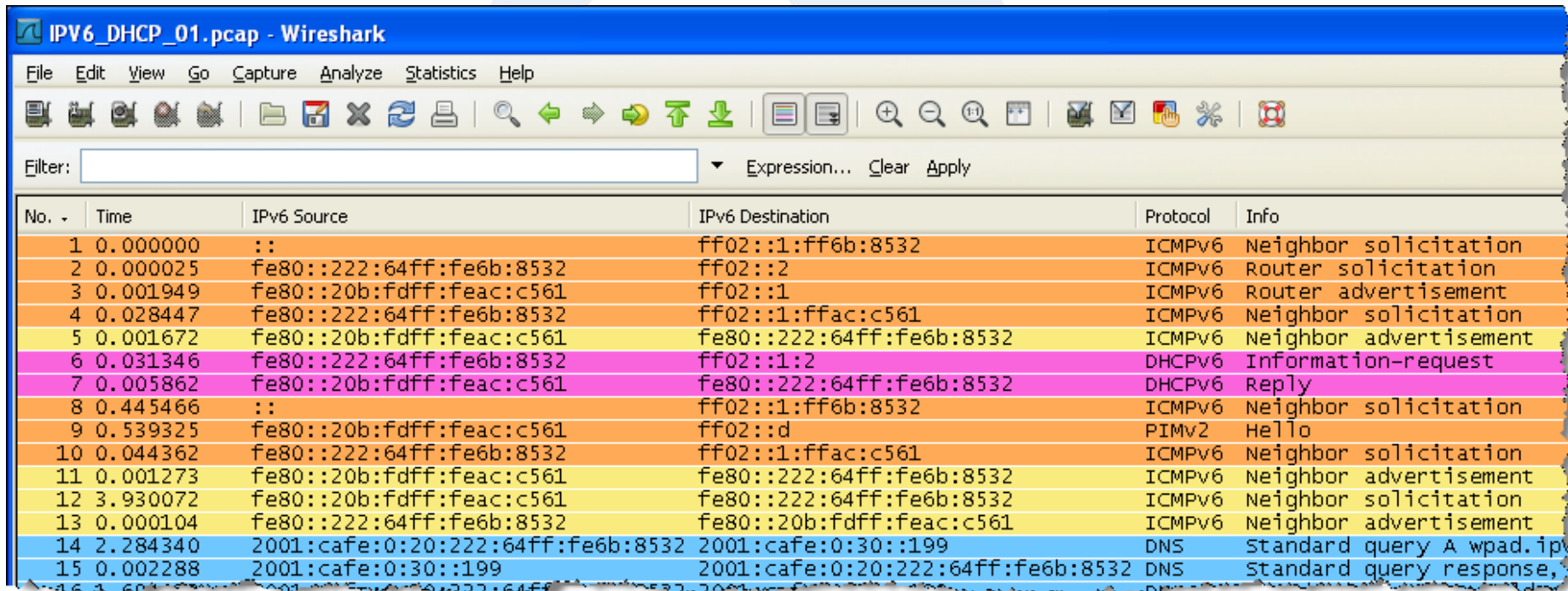
O = Other Flag / M = Managed Flag

Host configuration with DHCPv6

During this phase, the client is supplied with additional parameters:

Frame #

- 2 Router Discovery
- 3 Router Advertisement with 'Other Flag' set
- 6 Client contacts DHCP server
- 7 DHCP server delivers additional parameter like DNS, suffixes etc.

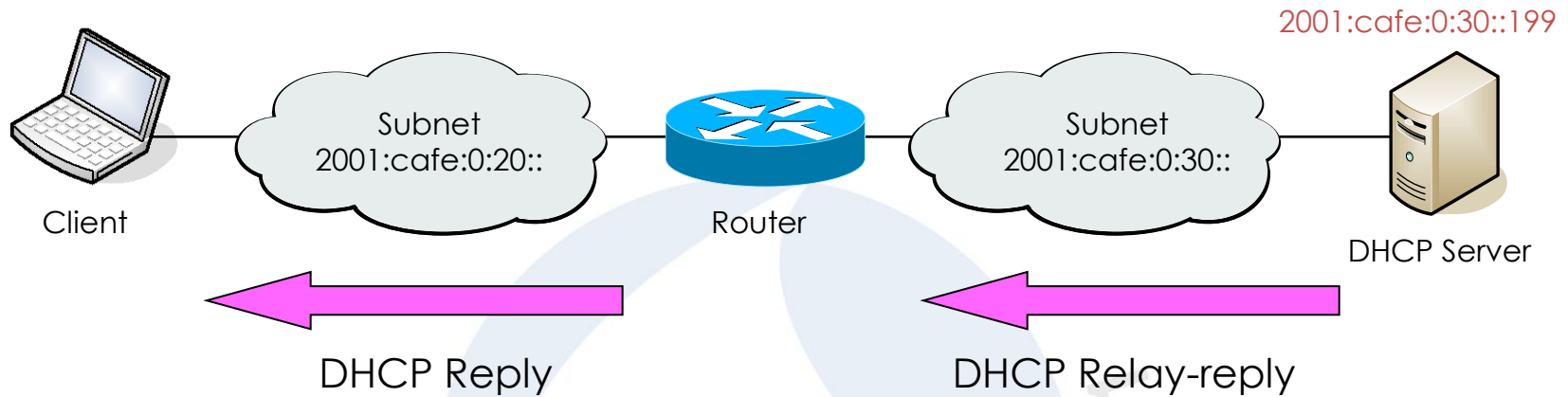


The image shows a Wireshark capture of IPv6 DHCPv6 traffic. The interface includes a menu bar (File, Edit, View, Go, Capture, Analyze, Statistics, Help), a toolbar with various icons, and a filter field. The main display area shows a list of packets with columns for No., Time, IPv6 Source, IPv6 Destination, Protocol, and Info. The packets are color-coded: orange for ICMPv6, yellow for ICMPv6, pink for DHCPv6, and blue for DNS.

No.	Time	IPv6 Source	IPv6 Destination	Protocol	Info
1	0.000000	::	ff02::1:ff6b:8532	ICMPv6	Neighbor solicitation
2	0.000025	fe80::222:64ff:fe6b:8532	ff02::2	ICMPv6	Router solicitation
3	0.001949	fe80::20b:fdff:feac:c561	ff02::1	ICMPv6	Router advertisement
4	0.028447	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
5	0.001672	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement
6	0.031346	fe80::222:64ff:fe6b:8532	ff02::1:2	DHCPv6	Information-request
7	0.005862	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	DHCPv6	Reply
8	0.445466	::	ff02::1:ff6b:8532	ICMPv6	Neighbor solicitation
9	0.539325	fe80::20b:fdff:feac:c561	ff02::d	PIMv2	Hello
10	0.044362	fe80::222:64ff:fe6b:8532	ff02::1:ffac:c561	ICMPv6	Neighbor solicitation
11	0.001273	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor advertisement
12	3.930072	fe80::20b:fdff:feac:c561	fe80::222:64ff:fe6b:8532	ICMPv6	Neighbor solicitation
13	0.000104	fe80::222:64ff:fe6b:8532	fe80::20b:fdff:feac:c561	ICMPv6	Neighbor advertisement
14	2.284340	2001:cafe:0:20:222:64ff:fe6b:8532	2001:cafe:0:30:199	DNS	Standard query A wpad.ip
15	0.002288	2001:cafe:0:30:199	2001:cafe:0:20:222:64ff:fe6b:8532	DNS	Standard query response,

Host configuration with DHCPv6

DHCP server reply



IPV6_DHCP_Relay_01.pcap - Wireshark

File Edit View Go Capture Analyze Statistics Help

Filter: Expression... Clear Apply

No.	Time	IPv6 Source	IPv6 Destination	Protocol	Info
1	0.000000	2001:cafe:0:30::3	2001:cafe:0:30::199	DHCPv6	Relay-forw
2	0.000676	2001:cafe:0:30::199	ff02::1:ff00:3	ICMPv6	Neighbor solicitation
3	0.001176	2001:cafe:0:30::3	2001:cafe:0:30::199	ICMPv6	Neighbor advertisement
4	0.000041	2001:cafe:0:30::199	2001:cafe:0:30::3	DHCPv6	Relay-reply
5	4.998115	fe80::20b:fdff:feac:c560	2001:cafe:0:30::199	ICMPv6	Neighbor solicitation
6	0.000245	fe80::20ea:d4cf:1963:571f	ff02::1:ffac:c560	ICMPv6	Neighbor solicitation
7	0.001134	fe80::20b:fdff:feac:c560	fe80::20ea:d4cf:1963:571f	ICMPv6	Neighbor advertisement
8	0.000051	2001:cafe:0:30::199	fe80::20b:fdff:feac:c560	ICMPv6	Neighbor advertisement
9	2.248004	2001:cafe:0:20:222:64ff:fe6b:8532	2001:cafe:0:30::199	DNS	Standard query A wpad.i
10	0.000274	2001:cafe:0:30::199	2001:cafe:0:20:222:64ff:fe6b:8532	DNS	Standard query response
11	1.696142	2001:cafe:0:20:222:64ff:fe6b:8532	2001:cafe:0:30::199	DNS	Standard query SRV _ldap

Host configuration with DHCPv6

At this state, the client is configured with all required parameters:



```
C:\windows\system32>ipconfig /all
```

```
Ethernet-Adapter LAN-Verbindung:
```

```
Verbindungsspezifisches DNS-Suffix: ipv6.ch
Beschreibung. . . . . : Marvell Yukon 88E8072 PCI-E Gigabit Ethernet
Physikalische Adresse . . . . . : 00-22-64-6B-85-32
DHCP aktiviert. . . . . : Ja
Autokonfiguration aktiviert . . . . : Ja
```

```
IPv6-Adresse. . . . . : 2001:cafe:0:20:222:64ff:fe6b:8532 (Bevorzugt)
Verbindungslokale IPv6-Adresse . : fe80::222:64ff:fe6b:8532%13 (Bevorzugt)
```

```
Lease erhalten. . . . . : Samstag, 21. Februar 2009 11:46:04
Lease läuft ab. . . . . : Sonntag, 1. März 2009 11:46:03
```

```
Standardgateway . . . . . : fe80::20b:fdff:feac:c561%13
```

```
DHCPv6-IAID . . . . . : 251667044
```

```
DHCPv6-Client-DUID. . . . . : 00-01-00-01-10-D2-B9-65-00-22-64-6B-85-32
```

```
DNS-Server . . . . . : 2001:cafe:0:30::199
```

```
Suchliste für verbindungsspezifische DNS-Suffixe:
    yourdomain.ch
    ipv6.ch
    dummy.ch
```

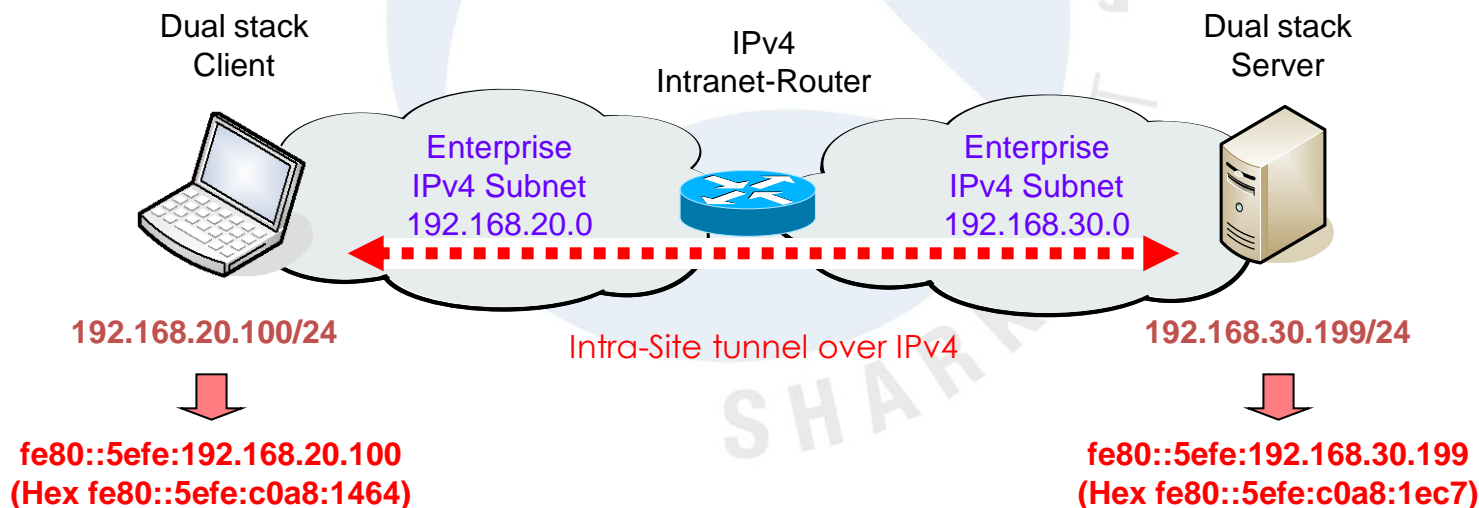
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IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

- ISATAP enables easy deployment of IPv6 in existing IPv4 infrastructure
- ISATAP hosts do not require any manual configuration
- IPv6 address contains an embedded IPv4 source or destination address
- ISATAP clients uses locally assigned IPv4 address (public or private) to create the 64-bit interface identifier

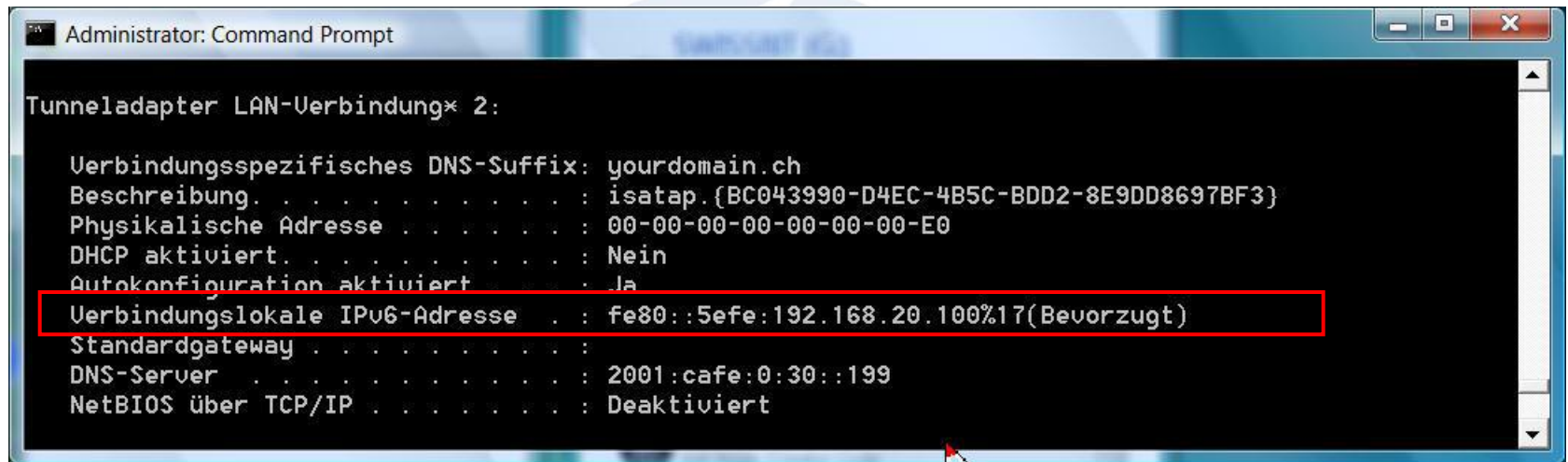


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IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

- ISATAP interface is **created at the same time the IPv6 stack is installed**



```
Administrator: Command Prompt

Tunneladapter LAN-Verbindung* 2:

Verbindungsspezifisches DNS-Suffix: yourdomain.ch
Beschreibung . . . . . : isatap.{BC043990-D4EC-4B5C-BDD2-8E9DD8697BF3}
Physikalische Adresse . . . . . : 00-00-00-00-00-00-00-E0
DHCP aktiviert. . . . . : Nein
Autokonfiguration aktiviert . . . . . : Ja
Verbindungslokale IPv6-Adresse . . . . . : fe80::5efe:192.168.20.100%17(Bevorzugt)
Standardgateway . . . . . :
DNS-Server . . . . . : 2001:cafe:0:30::199
NetBIOS über TCP/IP . . . . . : Deaktiviert
```

- Local interface ID # (**%17**) must be appended to **destination address**

Ping fe80::5efe:192.168.30.199%17

IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

The image shows a Wireshark capture window titled "IPv6_Ping_through_ISATAP_tunnel.pcap - Wireshark". The filter is set to "vlan.id == 20". The packet list shows several ICMPv6 Echo request and reply packets. The packet details pane is expanded to show the structure of an ICMPv6 Echo request.

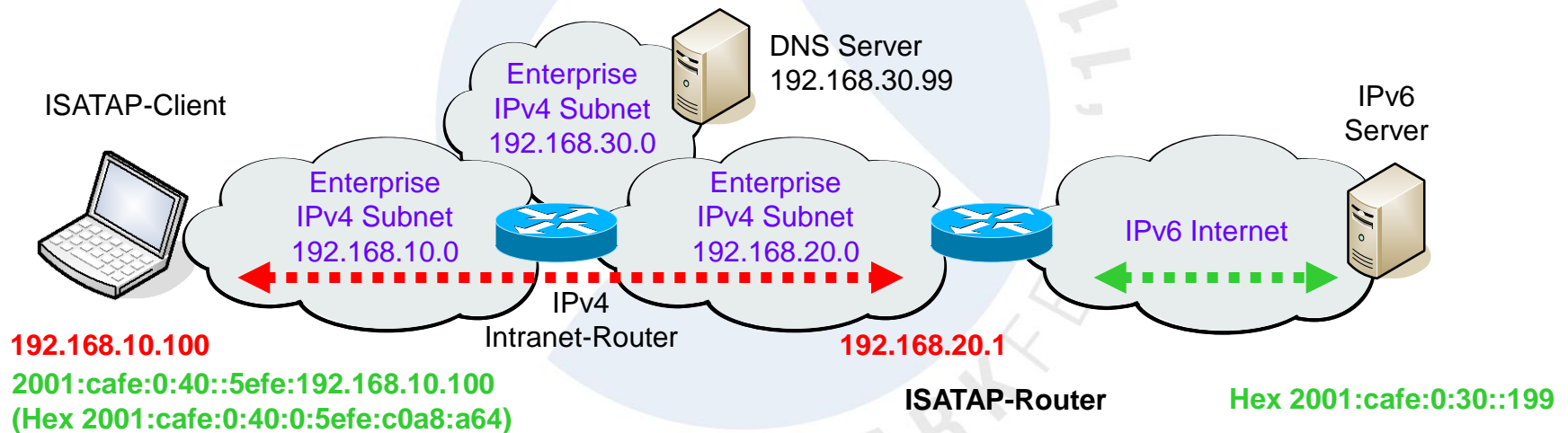
No.	Time	IPv6 Source	IPv6 Destination	IPv4 Source	IPv4 Destination	Protocol	Info
1	0.000000	fe80::5efe:c0a8:1464	fe80::5efe:c0a8:1ec7	192.168.20.100	192.168.30.199	ICMPv6	Echo request
4	0.000819	fe80::5efe:c0a8:1ec7	fe80::5efe:c0a8:1464	192.168.30.199	192.168.20.100	ICMPv6	Echo reply
5	1.002117	fe80::5efe:c0a8:1464	fe80::5efe:c0a8:1ec7	192.168.20.100	192.168.30.199	ICMPv6	Echo request
8	0.000794	fe80::5efe:c0a8:1ec7	fe80::5efe:c0a8:1464	192.168.30.199	192.168.20.100	ICMPv6	Echo reply
9	1.013203	fe80::5efe:c0a8:1464	fe80::5efe:c0a8:1ec7	192.168.20.100	192.168.30.199	ICMPv6	Echo request
12	0.000811	fe80::5efe:c0a8:1ec7	fe80::5efe:c0a8:1464	192.168.30.199	192.168.20.100	ICMPv6	Echo reply
13	1.013145	fe80::5efe:c0a8:1464	fe80::5efe:c0a8:1ec7	192.168.20.100	192.168.30.199	ICMPv6	Echo request
16	0.000854	fe80::5efe:c0a8:1ec7	fe80::5efe:c0a8:1464	192.168.30.199	192.168.20.100	ICMPv6	Echo reply

Frame 1 (118 bytes on wire, 118 bytes captured)
Ethernet II, Src: HewlettP_6b:85:32 (00:22:64:6b:85:32), Dst: Cisco_ac:c5:60 (00:0b:fd:ac:c5:60)
802.1Q Virtual LAN, PRI: 0, CFI: 0, ID: 20
Internet Protocol, src: 192.168.20.100 (192.168.20.100), dst: 192.168.30.199 (192.168.30.199)
Internet Protocol version 6
0110 = version: 6
.... 0000 0000 = Traffic class: 0x00000000
.... 0000 0000 0000 0000 0000 = Flowlabel: 0x00000000
Payload length: 40
Next header: ICMPv6 (0x3a)
Hop limit: 128
Source: fe80::5efe:c0a8:1464 (fe80::5efe:c0a8:1464)
Destination: fe80::5efe:c0a8:1ec7 (fe80::5efe:c0a8:1ec7)
Internet Control Message Protocol v6

IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

- ISATAP can also be used to access **native IPv6 destinations**
- Client resolves **ISATAP router** IPv4 address through internal **DNS**
- Client request **IPv6 global unicast** prefix from ISATAP router
- Client sends **IPv6 in IPv4 embedded packets** to ISATAP router



- ISATAP router **unpacks embedded packets** and forwards them

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IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

IPV6_Ping_through_ISATAP_router.pcap - Wireshark

Filter: Expression... Clear Apply

No.	Time	IPv6 Source	IPv6 Destination	IPv4 Source	IPv4 Destination	Protocol	Info
3	0.610461	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199	192.168.10.100	192.168.20.1	ICMPv6	Echo requ
4	0.001282	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199			ICMPv6	Echo requ
5	0.000339	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64			ICMPv6	Echo repl
6	0.001015	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64	192.168.20.1	192.168.10.100	ICMPv6	Echo repl
7	0.996878	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199	192.168.10.100	192.168.20.1	ICMPv6	Echo requ
8	0.001323	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199			ICMPv6	Echo requ
9	0.000266	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64			ICMPv6	Echo repl
10	0.000992	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64	192.168.20.1	192.168.10.100	ICMPv6	Echo repl
11	0.995744	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199	192.168.10.100	192.168.20.1	ICMPv6	Echo requ
12	0.001326	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199			ICMPv6	Echo requ
13	0.000317	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64			ICMPv6	Echo repl
14	0.000933	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64	192.168.20.1	192.168.10.100	ICMPv6	Echo repl
15	0.995771	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199	192.168.10.100	192.168.20.1	ICMPv6	Echo requ
16	0.001304	2001:cafe:0:40:0:5efe:c0a8:a64	2001:cafe:0:30::199			ICMPv6	Echo requ
17	0.000288	2001:cafe:0:30::199	2001:cafe:0:40:0:5efe:c0a8:a64			ICMPv6	Echo repl

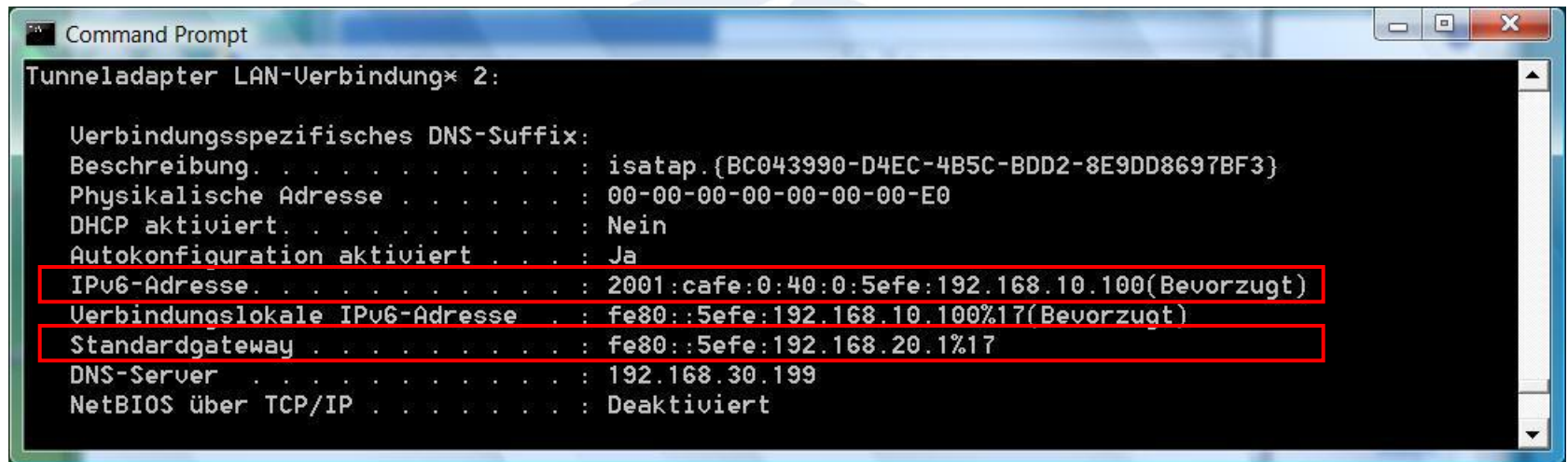
Frame 3 (118 bytes on wire, 118 bytes captured)

- Ethernet II, Src: HewlettP_6b:85:32 (00:22:64:6b:85:32), Dst: Cisco_ac:c5:60 (00:0b:fd:ac:c5:60)
- 802.1Q Virtual LAN, PRI: 0, CFI: 0, ID: 10
- Internet Protocol, Src: 192.168.10.100 (192.168.10.100), Dst: 192.168.20.1 (192.168.20.1)
- Internet Protocol Version 6
- Internet Control Message Protocol v6

IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

- Client received prefix **2001:cafe:0:40::** from ISATAP router



```
Command Prompt
Tunneladapter LAN-Verbindung* 2:

Verbindungsspezifisches DNS-Suffix:
Beschreibung . . . . . : isatap.{BC043990-D4EC-4B5C-BDD2-8E9DD8697BF3}
Physikalische Adresse . . . . . : 00-00-00-00-00-00-00-E0
DHCP aktiviert . . . . . : Nein
Autokonfiguration aktiviert . . . : Ja
IPv6-Adresse . . . . . : 2001:cafe:0:40:0:5efe:192.168.10.100(Bevorzugt)
Verbindungslokale IPv6-Adresse . . : fe80::5efe:192.168.10.100%17(Bevorzugt)
Standardgateway . . . . . : fe80::5efe:192.168.20.1%17
DNS-Server . . . . . : 192.168.30.199
NetBIOS über TCP/IP . . . . . : Deaktiviert
```

- Client installs address of **Default Gateway**

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IPv6 Transition Technologies

ISATAP (Intra-Site Automatic Tunnel Addressing Protocol)

- Command 'route print -6' displays clients routing table

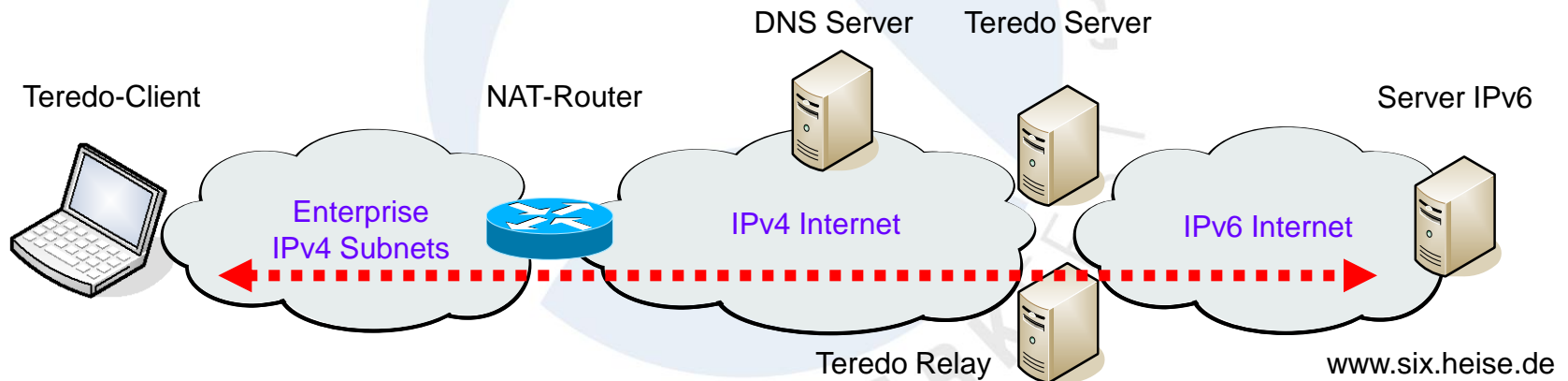
```
C:\Users\Rolf>route print -6
=====
Schnittstellenliste
 13 ...00 22 64 6b 85 32 ..... Marvell Yukon 88E8072 PCI-E Gigabit Ethernet Controller
 12 ...00 21 6b 17 a5 bc ..... Intel(R) WiFi Link 5100 AGN
  1 ..... Software Loopback Interface 1
 16 ...00 00 00 00 00 00 00 e0 isatap.{0BF5943C-D67C-4195-9860-781CC293A689}
 17 ...00 00 00 00 00 00 00 e0 isatap.{BC043990-D4EC-4B5C-BDD2-8E9DD8697BF3}
 15 ...00 00 00 00 00 00 00 e0 6T04 Adapter
 14 ...02 00 54 55 4e 01 ..... Teredo Tunneling Pseudo-Interface
=====

IPv6-Routentabelle
=====
Aktive Routen:
If Metrik Netzwerkziel Gateway
17 296 ::/0 fe80::5efe:192.168.20.1
 1 306 ::1/128 Auf Verbindung
14 18 2001::/32 Auf Verbindung
14 266 2001:0:d5c7:a2d6:24d9:1e15:3f57:f59b/128
Auf Verbindung
14 266 2001:8a8:20::23/128 Auf Verbindung
17 48 2001:cafe:0:40::/64 Auf Verbindung
17 296 2001:cafe:0:40:0:5efe:192.168.10.100/128
Auf Verbindung
13 286 fe80::/64 Auf Verbindung
```

IPv6 Transition Technologies

Teredo Tunnel

- Tunneling method named after **Teredo Navalis** (shipworm)
- Teredo **encapsulates IPv6** packets within **UDP/IPv4 datagram**
- Most **NAT Routers** can **forward** these packets properly
- Teredo allows a client to communicate with a **native IPv6 server**
- Teredo **Server** and Teredo **Relay** in the Internet care for transitions



- Teredo **tunnels** are set up **automatically**, no configuration is needed.

+

IPv6 Transition Technologies

Teredo Tunnel interface

- In WIN Vista clients, the Teredo Tunneling I/F is **created automatically**
- The IPv6 prefix of all Teredo clients is **2001:0::/32**

```
Administrator: Eingabeaufforderung

Tunneladapter Teredo Tunneling Pseudo-Interface:

Verbindungsspezifisches DNS-Suffix:
Beschreibung: Teredo Tunneling Pseudo-Interface
Physikalische Adresse . . . . . : 00-00-00-00-00-00-E0
DHCP aktiviert . . . . . : Nein
Autokonfiguration aktiviert . . . . . : Ja
IPv6-Adresse . . . . . : 2001:0:5ef5:79fd::3c37:1e2b:acb2:7e97(Bevorzugt)
Verbindungslokale IPv6-Adresse . . . . . : fe80::3c37:1e2b:acb2:7e97%21(Bevorzugt)
Standardgateway . . . . . : ::
NetBIOS über TCP/IP . . . . . : Deaktiviert
```

- The client resolves **teredo.ipv6.microsoft.com** to build the /64 prefix
- The value **5ef5:79fd** is the IPv4 Teredo **server** address: **94.245.121.253**
- **Miredo** is the open-source Teredo tunneling software for **Linux, BSD** etc. +

IPv6 Transition Technologies

Teredo Tunnel initialization (File IPV6_Teredo_www_six_heise_de)

The image shows a Wireshark capture of a Teredo tunnel initialization process. The packet list pane displays the following key packets:

No.	Time	Source Address	Destination Address	Protocol	Info
1	0.000000	192.168.0.201	192.168.0.1	DNS	Standard query A teredo.ipv6.microsoft.com
2	0.020750	192.168.0.1	192.168.0.201	DNS	Standard query response CNAME teredo.ipv6.microsoft.com.nsatc.net A 94.245.121.253
3	0.867437	192.168.0.201	192.168.0.1	DNS	Standard query A www.six.heise.de
4	0.023322	192.168.0.1	192.168.0.201	DNS	Standard query response
5	0.001338	192.168.0.201	192.168.0.1	DNS	Standard query AAAA www.six.heise.de
6	0.004647	192.168.0.1	192.168.0.201	DNS	Standard query response AAAA 2a02:2e0:3fe:100::6
7	0.015022	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	Teredo	Direct IPv6 Connectivity Test id=0x65d6, seq=36125
8	0.076991	fe80::24ac:fa35:f9ed:545c	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	IPv6	IPv6 no next header
9	0.981557	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	fe80::24ac:fa35:f9ed:545c	IPv6	IPv6 no next header
10	0.020733	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	ICMPv6	Echo (ping) reply id=0x7dfe, seq=56827
11	3.917426	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	50592 > http [SYN] Seq=0 win=8192 Len=0 MSS=1220 SACK_PERM=1
12	0.022013	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	http > 50592 [SYN, ACK] Seq=0 Ack=1 win=5760 Len=0 MSS=1440 SACK_PERM=1
13	0.000368	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	50592 > http [ACK] Seq=1 Ack=1 win=17080 Len=0
14	0.002041	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	HTTP	GET / HTTP/1.1
15	0.027842	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	http > 50592 [ACK] Seq=1 Ack=391 win=6432 Len=0
16	0.148421	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	[TCP segment of a reassembled PDU]
17	0.002209	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	[TCP segment of a reassembled PDU]
18	0.000233	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	50592 > http [ACK] Seq=391 Ack=2441 win=15860 Len=0
19	0.003756	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	[TCP window update] 50592 > http [ACK] Seq=391 Ack=2441 win=17080 Len=0
20	0.018471	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	50593 > http [SYN] Seq=0 win=8192 Len=0 MSS=1220 SACK_PERM=1
21	0.005230	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	[TCP segment of a reassembled PDU]
22	0.001451	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	[TCP segment of a reassembled PDU]
23	0.000174	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	50592 > http [ACK] Seq=391 Ack=4881 win=15860 Len=0
24	0.002851	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	2a02:2e0:3fe:100::6	TCP	[TCP window update] 50592 > http [ACK] Seq=391 Ack=4881 win=17080 Len=0
25	0.000200	2a02:2e0:3fe:100::6	2001:0:5ef5:79fd:2801:1e2b:acb2:6c85	TCP	[TCP segment of a reassembled PDU]

The packet details pane for the selected packet (No. 25) shows the following structure:

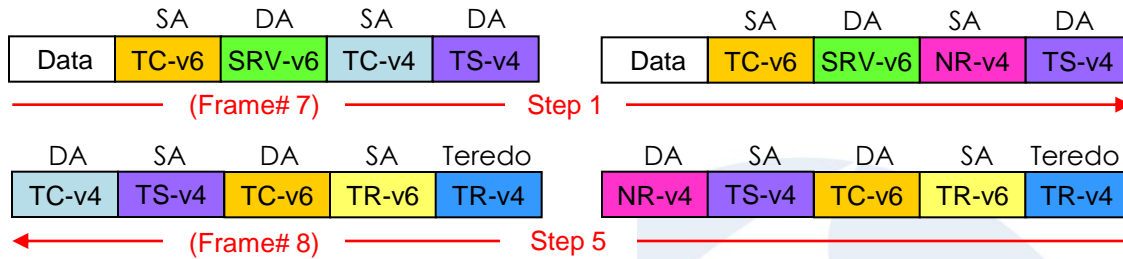
- Frame 14: 492 bytes on wire (3936 bits), 492 bytes captured (3936 bits)
- Ethernet II, Src: QuantaCo_6d:6c:e0 (00:23:8b:6d:6c:e0), Dst: Avm_bb:c1:0b (00:1a:4f:bb:c1:0b)
- Internet Protocol, Src: 192.168.0.201 (192.168.0.201), Dst: 216.66.80.238 (216.66.80.238)
- User Datagram Protocol, Src Port: 57812 (57812), Dst Port: 37070 (37070)
- Teredo IPv6 over UDP tunneling
 - Internet Protocol Version 6, Src: 2001:0:5ef5:79fd:2801:1e2b:acb2:6c85 (2001:0:5ef5:79fd:2801:1e2b:acb2:6c85), Dst: 2a02:2e0:3fe:100::6 (2a02:2e0:3fe:100::6)
 - Transmission Control Protocol, Src Port: 50592 (50592), Dst Port: http (80), Seq: 1, Ack: 1, Len: 390
 - Hypertext Transfer Protocol

The packet bytes pane shows the raw data for the selected packet, including the Hypertext Transfer Protocol section:

```
0020 50 ee e1 d4 90 ce 01 ca ec 7d 60 00 00 00 01 9a P.....}
0030 06 80 20 01 00 00 5e f5 79 fd 28 01 1e 2b ac b2 P.....y(.+.
0040 6c 85 2a 02 02 0e 03 fe 01 00 00 00 00 00 00 1*.....
0050 00 06 c5 a0 00 50 87 23 05 81 69 8a 0f c2 50 18 .....P.#.!.P.
0060 42 b8 ad 8b 00 00 47 45 54 20 2f 20 48 54 54 50 B.....GE T / HTTP
0070 0f 31 2a 21 0d 03 48 6f 72 74 73 20 77 77 77 20 /d.!.Ho.5f.ww
```

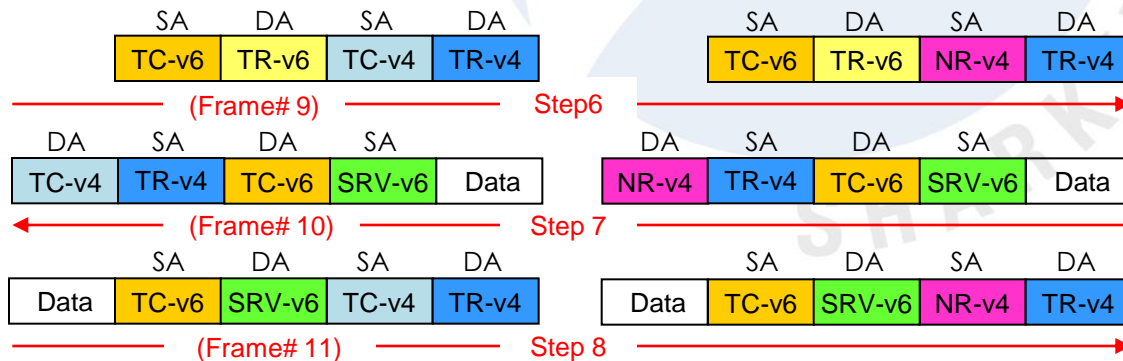
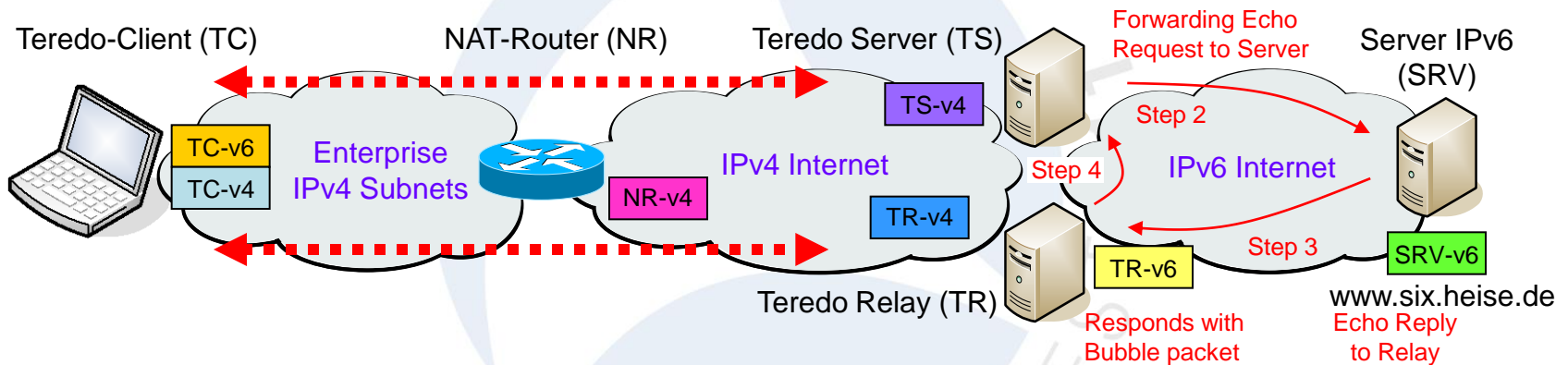
IPv6 Transition Technologies

Teredo Tunnel initialization (File IPV6_Teredo_www_six_heise_de)



ICMP Echo Request

Bubble Packet (with IP and UDP Port of Teredo Relay)



Bubble Packet (Tunnel init.)

ICMP Echo Reply

TCP SYN +

IPv6 Transition Technologies

Teredo Tunnel

- When starting, a Windows-based computer using Teredo resolves the IPv4 address of the Teredo server teredo.ipv6.microsoft.com
- By the Router solicitation/advertisement dialog through Teredo, the client receives a **valid IPv6 prefix**
- When activated, the Teredo client contacts Teredo server to obtain information such as the **type of NAT** that the client is behind
- If the client has only link-local or Teredo IPv6 addresses assigned, then the DNS Client will send **only queries for A records**
- The client needs at least **one valid IPv6 address** configured (may be manually) in order to query for AAAA records
- Windows Vista Client computers will always use **IPV6 over IPV4**
- A default route may have to be configured on Teredo interface:
netsh interface ipv6 add route ::/0 14 ← Teredo Interface ID

IPv6 Transition Technologies

Teredo commands & settings

- netsh interface teredo show state
- netsh interface teredo set state disabled
- netsh interface teredo set state client
- netsh interface teredo set state enterpriseclient
- netsh int ipv6 set teredo client teredo.remlab.net
- netsh int ipv6 set teredo client teredo.ipv6.microsoft.com
- netsh interface ipv6 show address
- netsh interface ipv6 add address "Local Area Connection 2" fd00:0:0:1::1
- netsh interface ipv6 add route ::/0 14
- Windows firewall must be activated to enable Teredo!

SHARKFEST '11

IPv6 Session Summary

- Verify IPv6 readiness of your suppliers
- Verify IPv6 readiness of your applications
- IPv6 can perfectly coexist with IPv4
- Start experimenting using ISATAP and Teredo
- Network migration can be done smoothly
- Train yourself and your people
- Wireshark is the perfect tool to learn and train
- Interesting IPv6 references:

How to get



www.sixxs.net IPv6 Deployment and IPv6 Tunnel Broker, helping to deploy IPv6 around the world, IPv6 monitoring, IPv6 routing monitoring, IPv6 coordination.

www.ipv6forum.com World-wide consortium of Internet vendors aiming to promote IPv6. Includes mailing lists, event listings, technical information, and links

www.ipv6tf.org The IPv6 Portal. IPv6 Deployment and Support, IPv6 trainings, IPv6 workshops, IPv6 labs.

Thanks for visiting



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