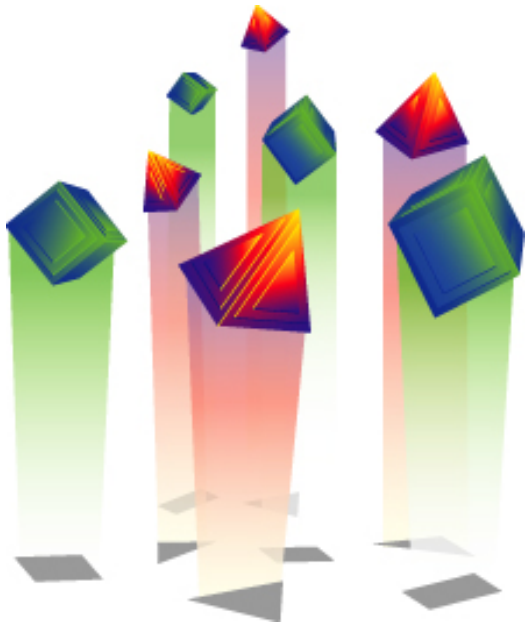
Management Changes in IPv6 : Focus on ICMPv6 Share Session Anaheim



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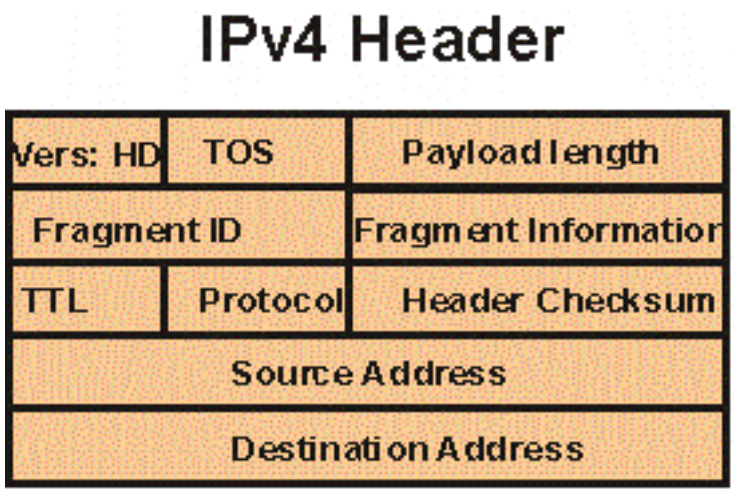
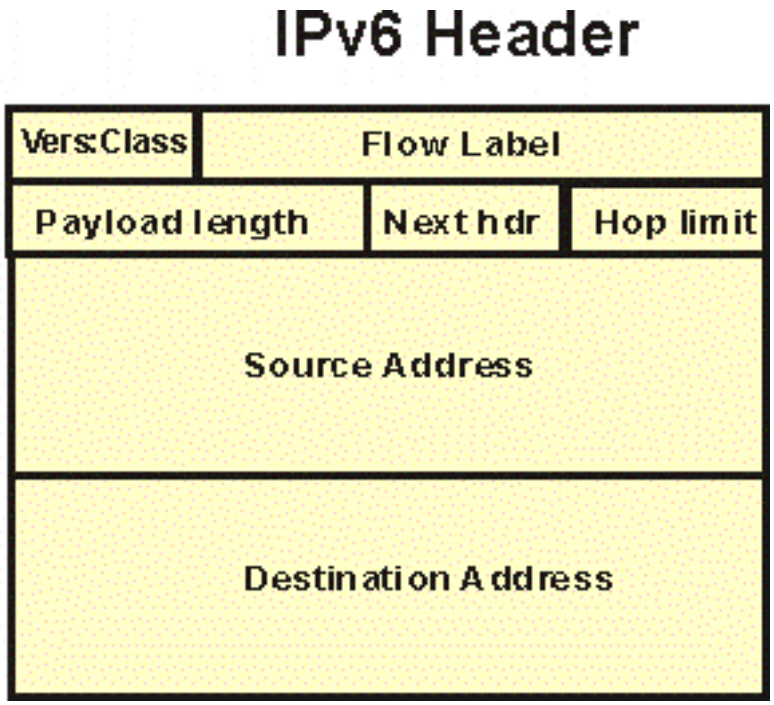
What is IPv6

Addressing	**128 bits addresses hierarchically assigned**
Routing	**Strongly hierarchical (route aggregation)**
Performance	**Simple datagram**
Extensibility	**New flexible option header format**
	Improved support for extensions and options
Multimedia	**Better support for QoS**
Multicast	**Compulsory-better scope control**
Security	**Built in security (IPSEC)**
Auto-configuration	**Stateless and state-full address configuration**
Mobility	**Better efficiency and security**

IPv6 Header





IPv4 header is 20 bytes : IPv6 header is 40 bytes
Address increased from 32 to 128 bits
Fragmentation fields moved out of base header
Header checksum
Time to Live replaced with 'Hop Limit'
Protocol replaced with 'Next Header'
TOS replaced with 'Flow Label'
Alignment changed from 32 to 64 bits

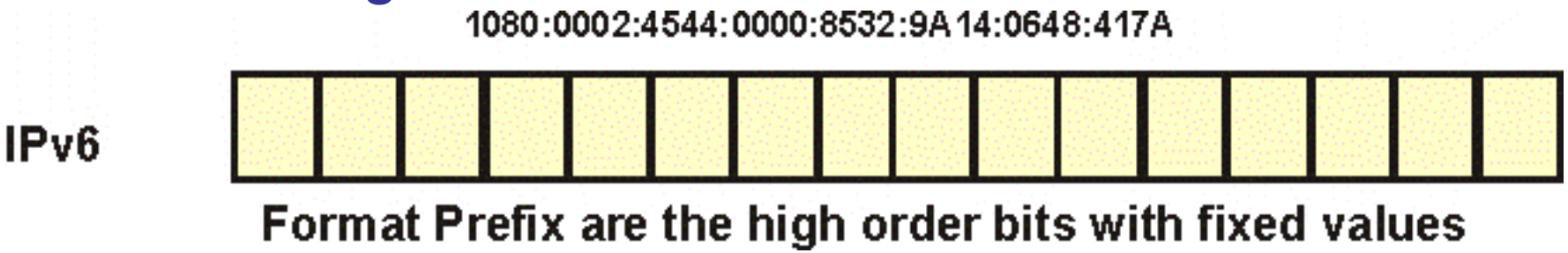
Items to Be Discussed

IP Addressing

Autoconfiguration

SNMP MIBs

Addressing Format



Defined in RFC 3513
40,282,366,920,938,463,374,607,431,768,211,456 addresses
40 trillion trillion trillion addresses

Addresses are assigned to interfaces

Multiple address can be defined to a single interface

Address structure
Ipv6 address = Prefix + Interface id

Separation of 'who you are' from 'where you are connected'

Assignments by ARIN, APNIC, RIPE

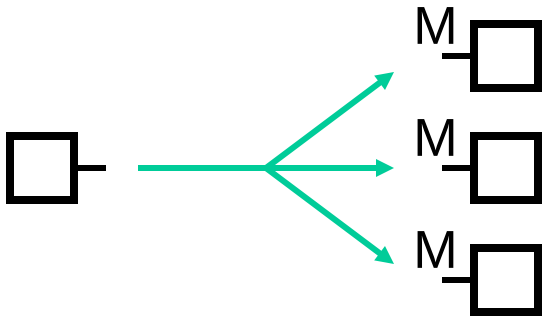
IPv6 Address Types

unicast:

for one-to-one communication

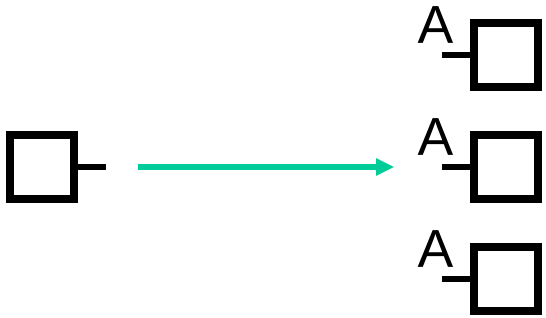
multicast:

for one-to-many communication



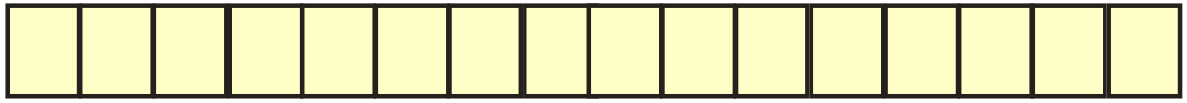
anycast:

for one-to-nearest communication



IPv6 Address: Site and Link

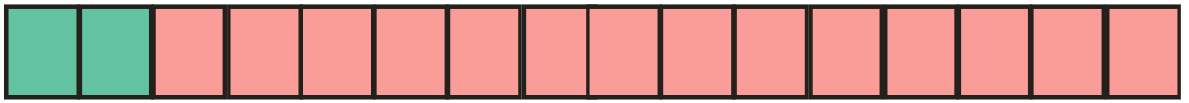
IPv6



2001:0DB8::15:219:D1FF:FE10:74EE/64

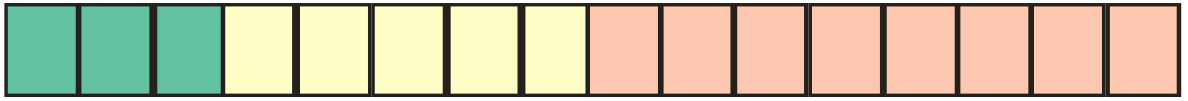
Multicast

Prefix=FF00::/8 112 bit group ID



Unicast

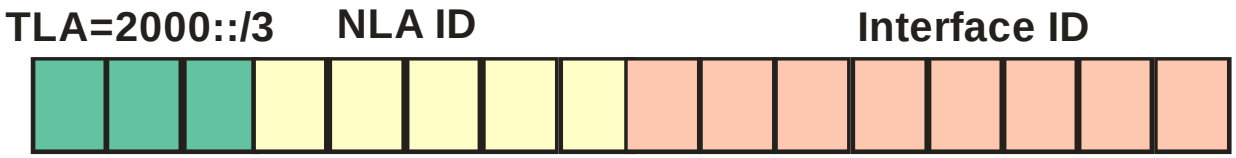
TLA=2000::/3 NLA ID Interface ID



2001:0408/32 ATT
2001:0506:0000/48 Verizon Business
2001:4840/32 Earthlink
2001:49C0/32 IBM
2001:0200--039F 12 ISPs in Korea

FC00::/7 Unique Local – Internet router will discard
FE80::/10 Link Local – Non-routeable

Global Unicast Address



TLA : Top Level Aggregation - 3 bytes (21 bits; First three bits of byte 1 are 001)
IANA allocates address blocks to the regional Internet registries
They allocate portions of their block to national registries or to ISPs

NLA : Next Level Aggregation - 5 bytes
High order part assigned to smaller or regional ISPs, large companies
Holders of an NLA block assign partsof their block to their customers
They assign middle chunks to locations
Low order numbers identify subnets

Interface ID : host interface (64 bits)
Assigned by the owning organization
IEEE has defined a 64 bit NIC address known as EUI-64
NIC driver for IPv6 will convert 48 bit NIC to 64 bit NIC

Structure greatly reduces the entries in the routing table....only one entry needed in a US router to define all the networks in a region or country

Address Type Prefixes

- Unspecified
  - used when there is no address
- Loopback
- Link Local Unicast
- Multicast
- Unicast + Anycast
  - hierarchical
  - /13 - /32 to LIR's (ISP's)
  - /48 or /56 to endusers / sites
  - "Site Local" used to exist (fec0::/10) but this has been deprecated in favor of ULA

http://www.iana.org/assignments/ipv6-address-space

0000 .... 0000 (::/128)

0000 .... 0001 (::1/128)

1111 1110 1000 0000 .... (fe80::/16)

1111 1111 .... (ffxx::/8)

The rest, 2000::/3, which is 1/8th of total IPv6 space

2001::/16 = RIRs

2001::/32 = Teredo

2002::/16 = 6to4

3ffe::/16 = 6bone*

fd00::/8 = ULA

* = 6bone shut down on 6/6/6

Items to Be Discussed

IP Addressing

Autoconfiguration

SNMP MIBs

IPv6: Autoconfiguration

Combination

ARP : ICMP router discovery : ICMP redirect

Neighbor discovery

Multicast and unicast datagrams

Establishes MAC address on same network

ICMPv6 router solicitation

ICMPv6 router advertisement

ICMPv6 neighbor solicitation

ICMPv6 redirect

ICMPv6 includes IGMP protocol for Multicast IP

Reduces impact of finding hosts

Stateless: router configures a host with IPv6 address

Stateful: DHCP for IPv6

Link Local Address: IPv6 connectivity on isolated LANs

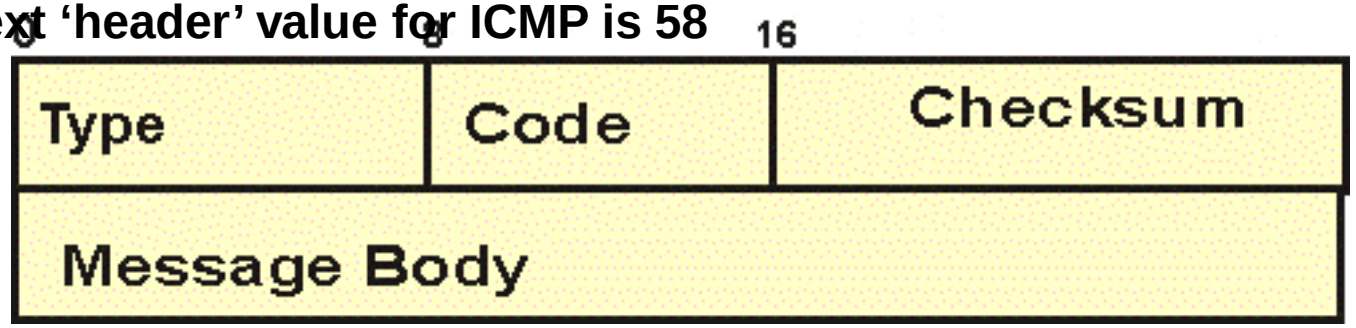
ICMPv6

ICMPv6 is used by IPv6 nodes to report errors encountered in processing packets, and to perform other internet-layer functions, such as diagnostics (ICMPv6 "ping")

ICMPv6 is an integral part of IPv6 and MUST be fully implemented by every IPv6 node

ICMPv6 messages are grouped into two classes:
- **error messages - Types 0-127**
- **informational messages - Types 128-255**

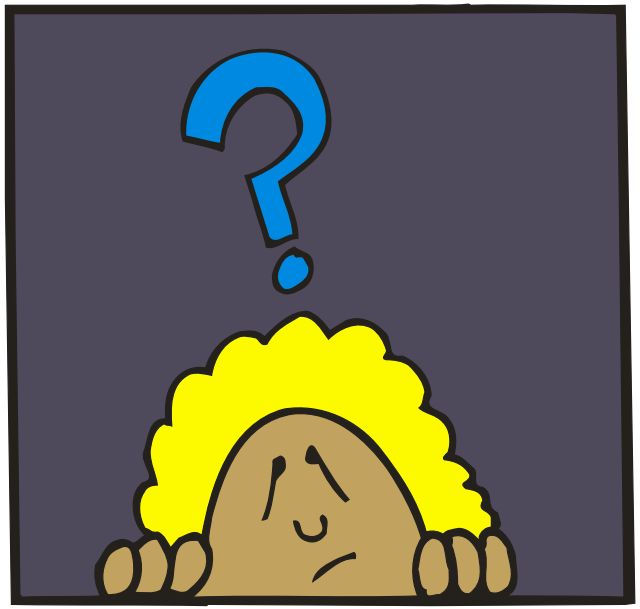
IPv6 next 'header' value for ICMP is 58



ICMPv6 Functions

Reports:

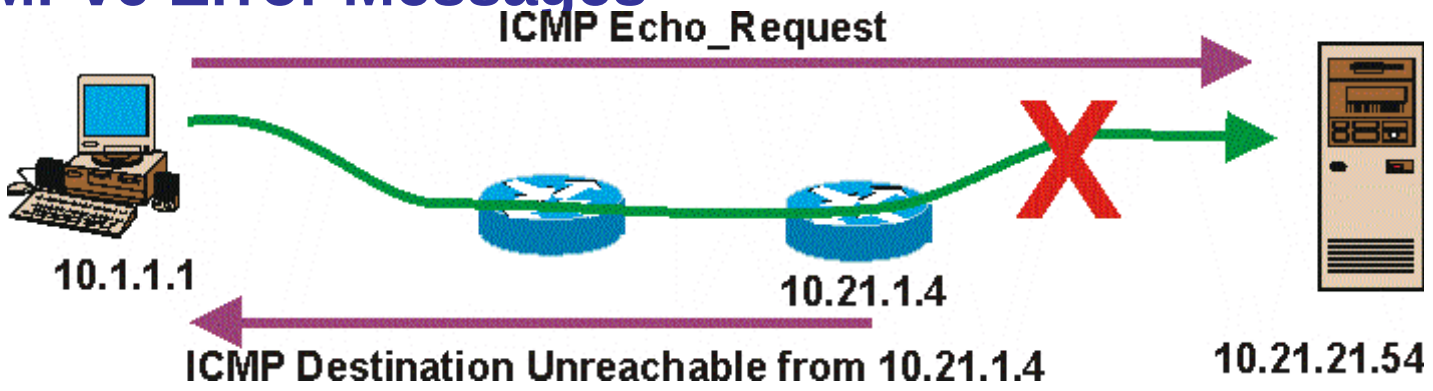
- **packet processing errors**
- **intranetwork communications path diagnosis**
- **multicast membership**



New functions:

- **Neighbor Discovery**
  - **allows nodes on the same link to discover each other**
  - **allows nodes to discover each other's addresses**
  - **finds routers for paths to other networks**
  - **determines fully qualified name of a node**
- **path MTU discovery determines the maximum path size along a path**

ICMPv6 Error Messages



ICMPv6 error messages:

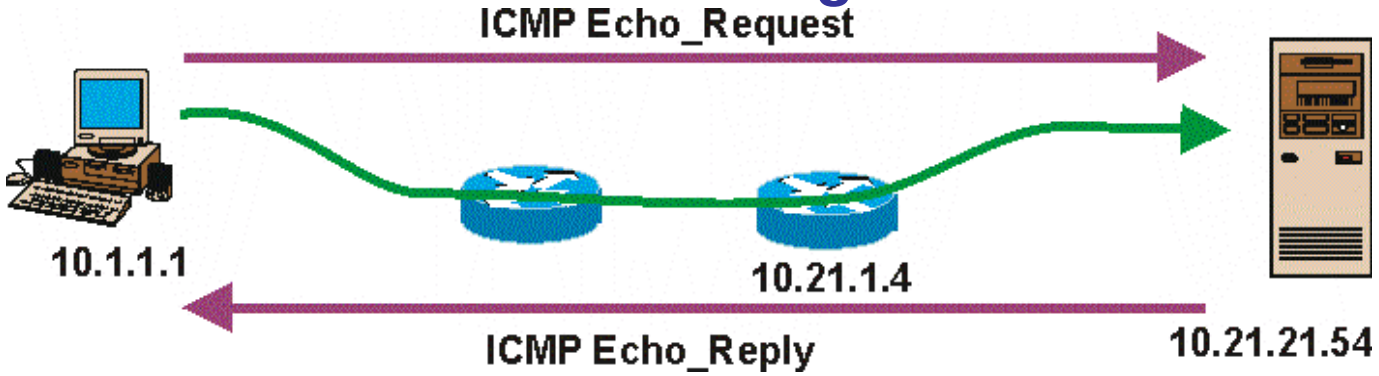
1 Destination unreachable
- **code=0 no route to destination**
- **code=1 communication with destination prohibited**
- **code=2 (not assigned)**
- **code=3 address unreachable**
- **code=4 port unreachable**

2 Packet too big
- **code=0 next byte contains the maximum transmission MTU of the next hop**

3 Time exceeded
- **code=0 hop limit exceeded in transit**
- **code=1 fragment reassembly time exceeded**

4 Parameter problem
- **code=0 erroneous header field encountered**
- **code=1 unrecognized next header type encountered**
- **code=2 unrecognized IPv6 option encountered**

ICMPv6 Informational Messages



ICMPv6 informational messages:

128 Echo request
code=0 and Identifier and sequence number carried
129 Echo reply
code=0 and identifier and sequence number carried
130 Multicast listener query
131 Multicast listener report
132 Multicast listener done
133 Router solication
134 Router advertisemenmt
135 Neighbor solicitation
136 Neighbor advertisement
137 Redirect

ICMPv6 Multicast Listener (MLD)

Took pieces from IGMP (Internet Group Management Protocol) (RFC 1112 and RFC 2236) and merged into new protocol

Defined in RFC 2710

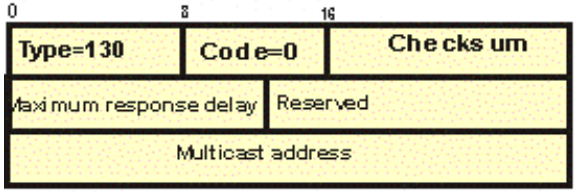
MLD is a subprotocol of ICMPv6

Allows routers to discover nodes that wish to receive multicast packets on all the routers links

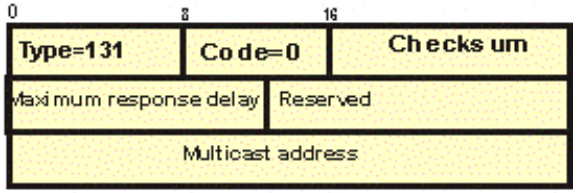
Query can be general or specific
- Tell me all nodes with multicast address x
- Tell me all nodes and their multicast addresses

Maximum response delay only is used with the Query message

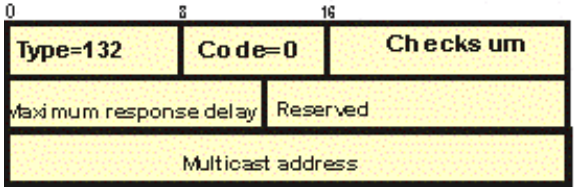
MLD Query Message



MLD Listener Report



MLD Listener Done



ICMPv6 Neighbor Discovery

Defined in RFC 2461

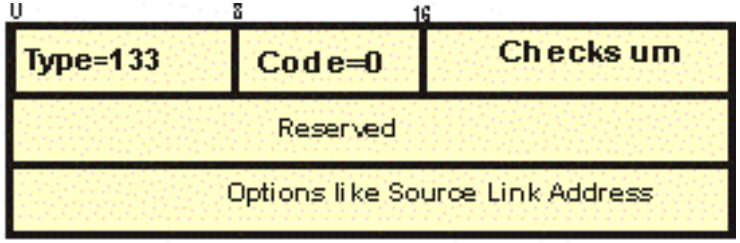
- **Combines prior IPV4 functions**
  - **ARP (RFC 826)**
  - **Router Discovery (RFC 1256)**
  - **Redirect Message (RFC 792)**

Mechanisms to:

- **Discover routers**
- **Prefix discovery for on-link**
- **Parameter discovery (i.e link MTU)**
- **Address autoconfiguration**
- **Address resolution**
- **Next hop determination**
- **Neighbor unreachable**
- **Duplicate address**
- **Redirect**

ICMPv6 Router Solicitation/Advertisement

Router Solicitation
Host to router to prompt the router to generate a Router Advertisement message quickly



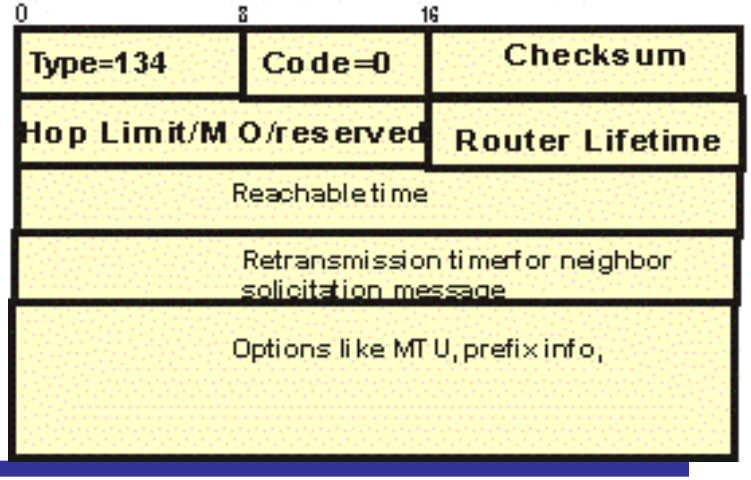
Router Advertisement

Sent on periodic basis from router to the 'all nodes address'

Hop limit should be 255

Could include security header

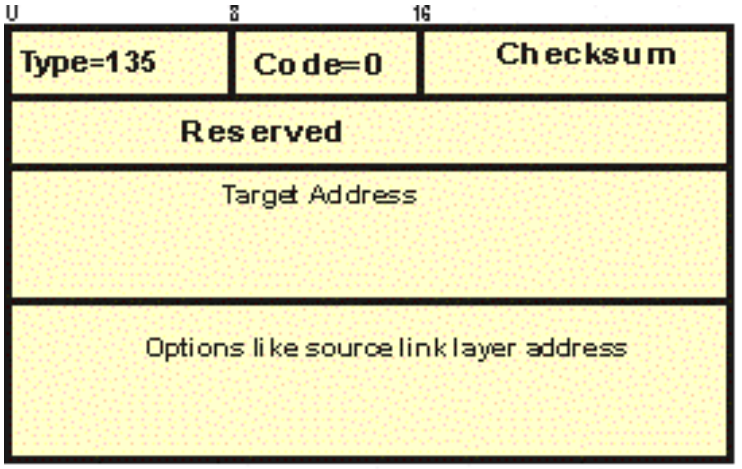
M=1 use DHCP for address configuration
O=1 use stateful protocol for address configuration



ICMPv6 Neighbor Messages

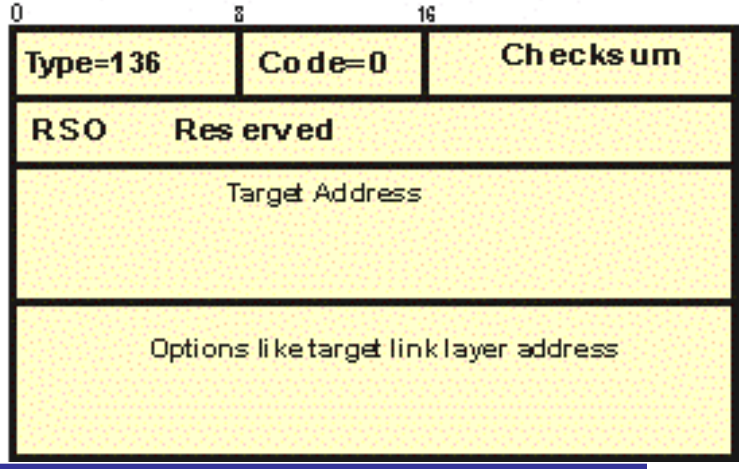
Neighbor Solicitation

- Nodes ask for link layer address of a target while providing their own link layer address to the target
- Multicast to resolve an address
- Unicast to verify the reachability of a neighbor



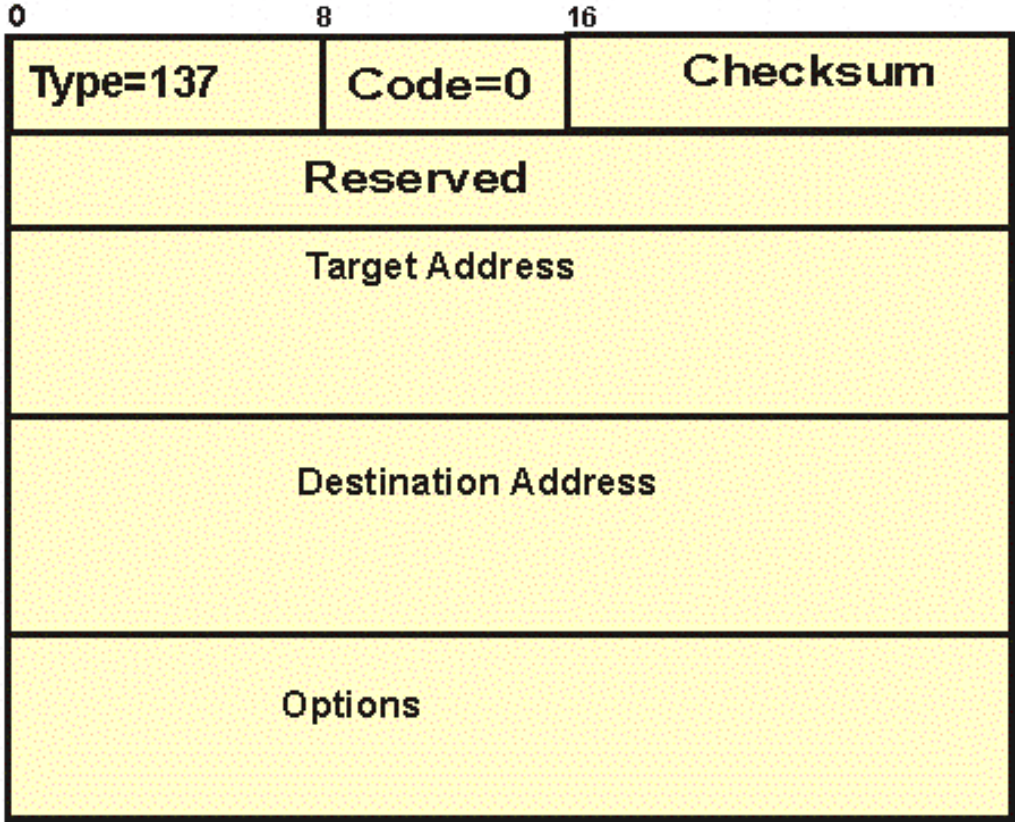
Neighbor Advertisement

- Sent by nodes in response to Neighbor solicitation messages
- Can be sent unsolicited to quickly ask for information
- Identify sender as router (r), destination address (s) response, or should over-ride existing cache (o)



ICMPv6 Redirect

Redirect messages are sent by routers to tell a host of a better first-hop node

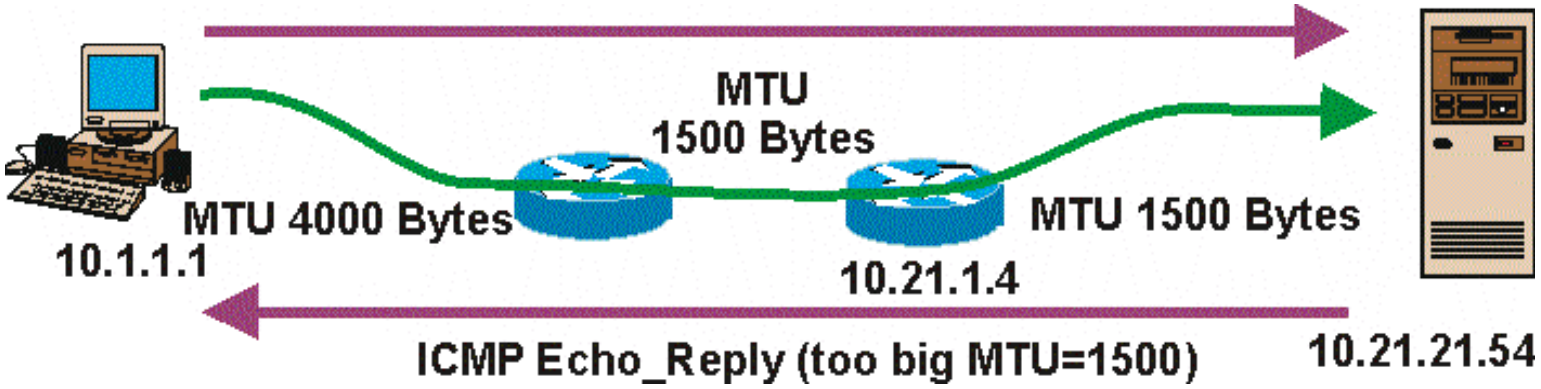


ICMPv6 Neighbor Discovery Options

Five options

- **type=1 Source link layer option used by**
  - **Neighbor Solicitation**
  - **Router Solicitation**
  - **Router Advertisement**
- **type=2 Target link layer option used by**
  - **Neighbor Advertisement**
  - **Redirect messages**
- **type=3 Prefix information**
  - **How many bits in prefix are valid**
- **type=4 Redirected header used by**
  - **Redirect messages**
  - **Makes sure the message does not exceed 1280 octets**
- **type=5 Recommended MTU used by**
  - **Router Advertisement**
  - **All nodes use same MTU**

ICMPv6 Path MTU Discovery



RFC 1981

Since fragmentation is a host function the host most have an idea of the route topology

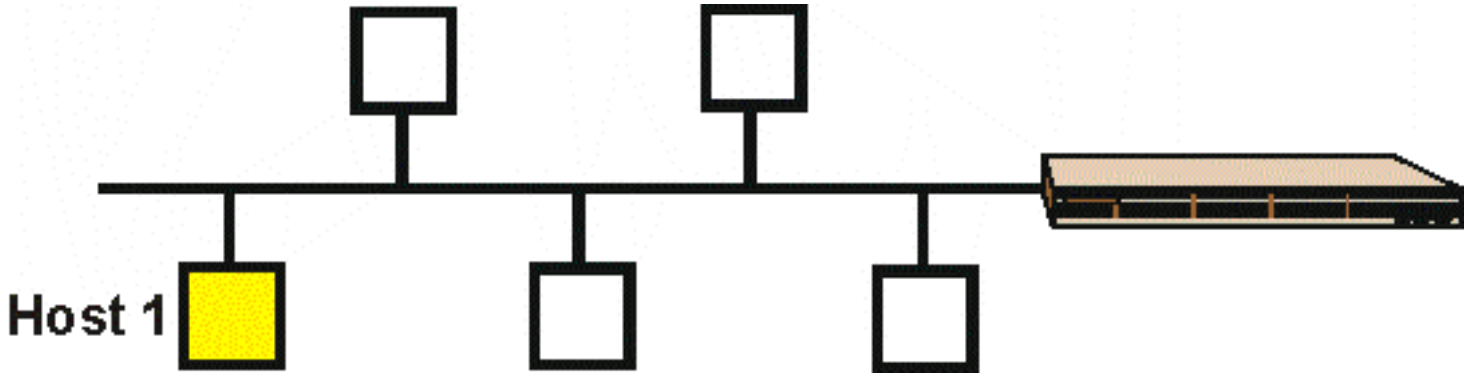
Assume that the MTU of the path is the same as your local link

Source node transmits a packet and sees if ICMPv6 ‘packet too big’ is returned

If ICMPv6 ‘packet too big’ is returned reset PMTU is reduced

Repeat the test

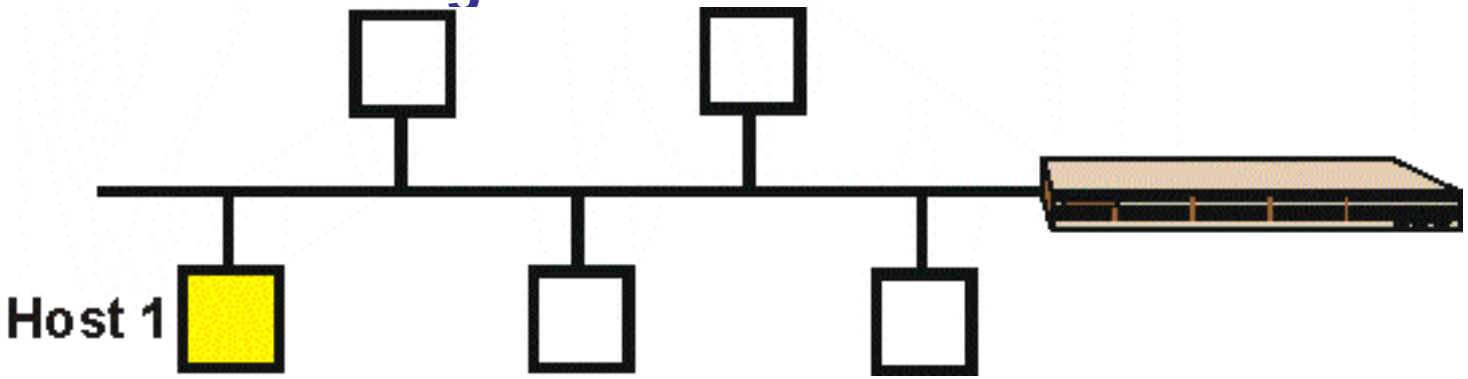
ICMPv6 Model Host



Each host is to maintain the following:

- **Neighbor Cache**
- **Destination Cache**
- **Prefix List**
- **Default Router List**
- **LinkMTU**
- **CurHopLimit**
- **BaseReachable Time**
- **Reachable Time**
- **Retransmit Timer**

IPv6 Auto-configuration



Host 1 comes on line and generates a link local address

Host 1 sends out a query called neighbor discovery to the same address to verify uniqueness. If there is a positive response a random number generator is used to generate a new address

Host 1 multicasts a router solicitation message to all routers

Routers respond with a router advertisement that contains an aggregatable global address (AGA) prefix and other information

Host 1 automatically configures its global address by appending its interface

ID to the AGA

Host 1 can now communicate

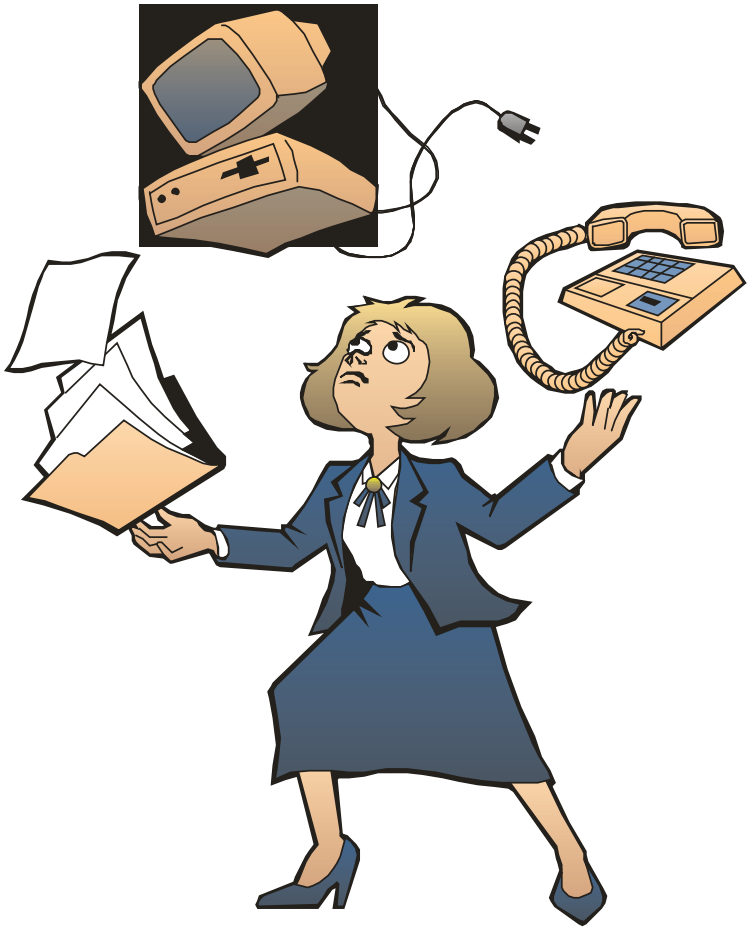
Changes Needed to Implement IPv6

Hosts
- Implement IPv6 code in operating system
- TCP/UDP aware of IPv6
- Sockets/Winsock library updates for IPv6
- Domain Name Server updates for IPv6

Domain Name Server (DNS)
- Many products already support 128 bit addresses
- Uses ‘AAAA’ records for IPv6
- IP6.INT (in_addr_arpa in IPv4)

Routers
- IPv6 forwarding protocols
- Routing protocols updated to support IPv6
- Management needs to support ICMPv6
- Implement transition mechanisms

IPv6 Protocol Status
- RIPv6 - Same as RIPv2
- OSPFv6 - Updated for IPv6
- EIGRP - Extensions implemented
- IDRP - Recommended for exterior protocol over BGP4
- BGP4+ - Preferred implementation in IPv6 today



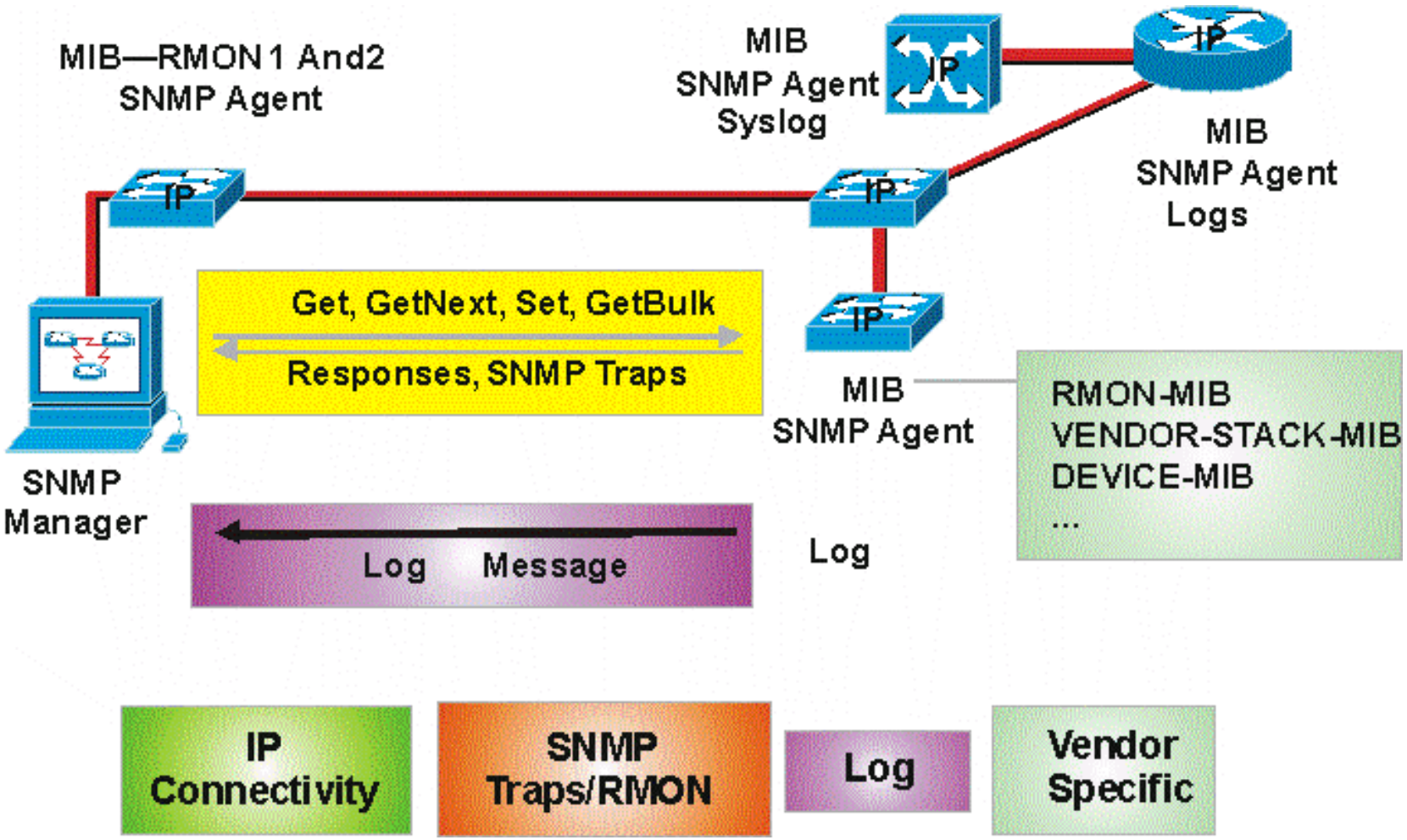
Items to Be Discussed

IP Addressing

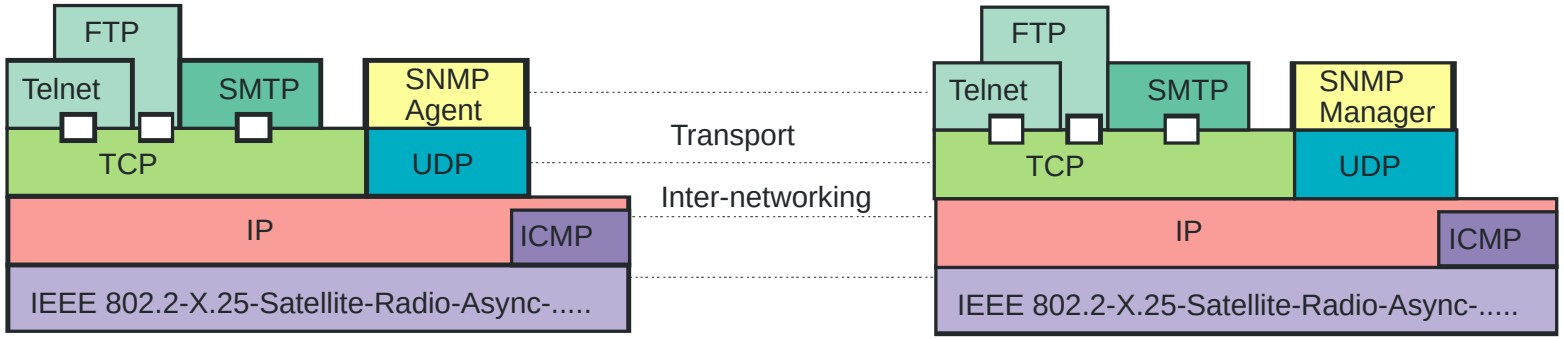
Autoconfiguration

SNMP MIBs

SNMP Technology Base



SNMP Deficiencies



SNMP version 1 and 2

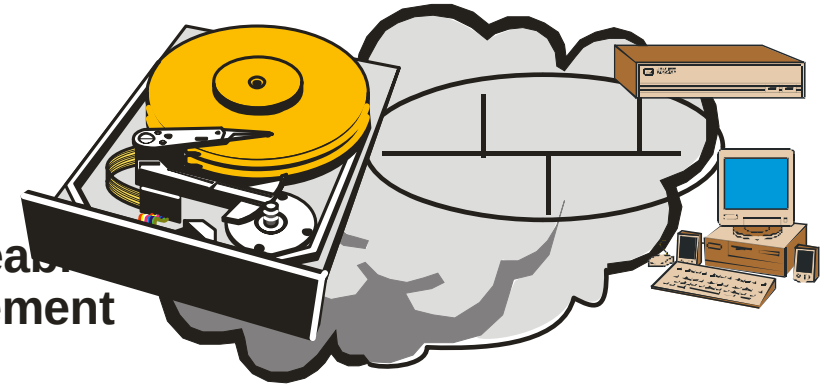
- Version 1 showing age
- Large counters
- Limited security
- Poor WAN protocol
- No bulk data retrieval

SNMP version 3

- User Security Module (USM)
- Authenticates users
- Multiple administrative levels
- Multiple user levels
- Encrypts PDUs
- Distributes management
- Confirmed notifications
- 64 bit counters
- Bulk data retrieval

Management Information Base - MIB

How do the agents keep the information ?



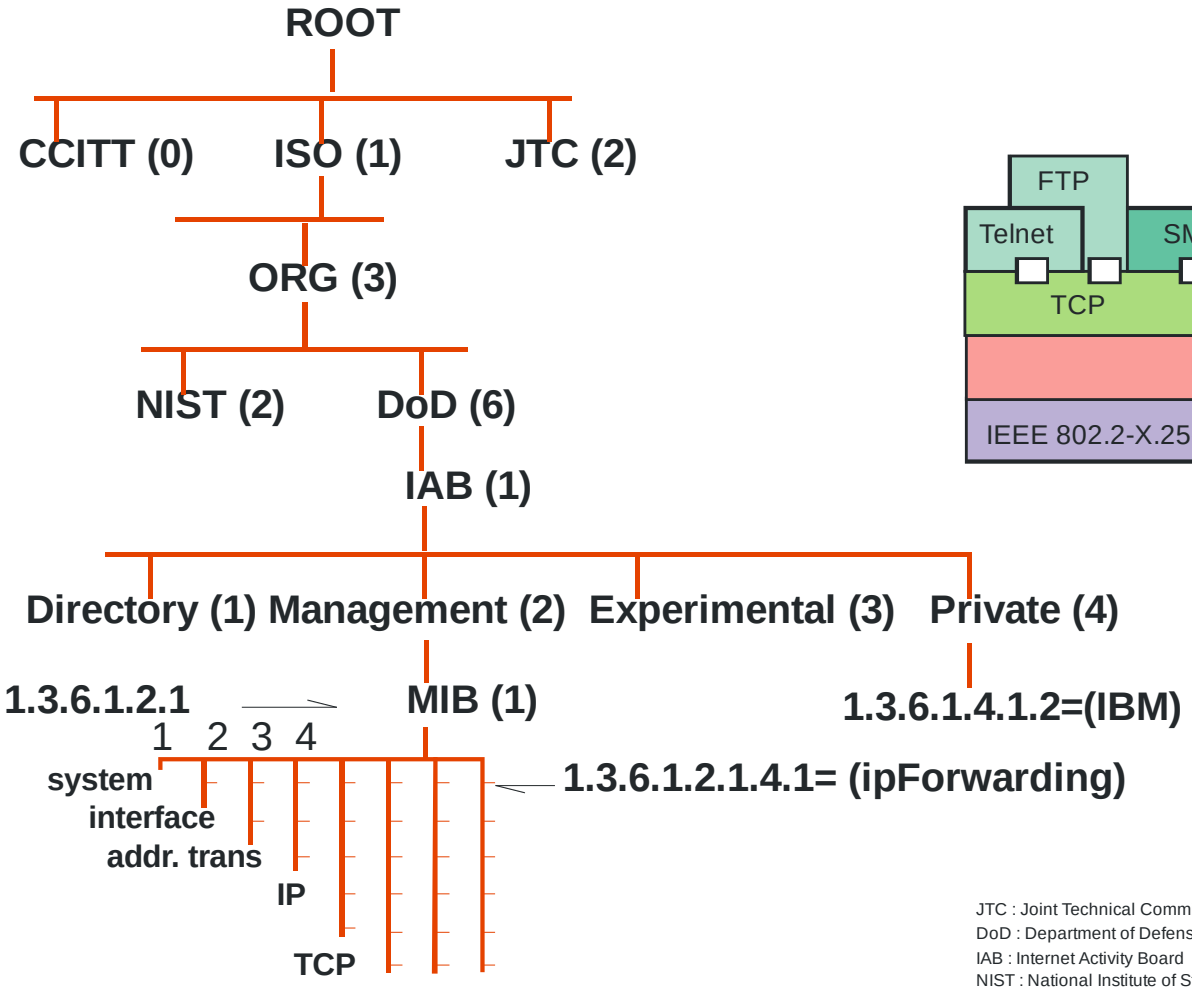
Universe of network manageable objects is called the Management Information Base (MIB).

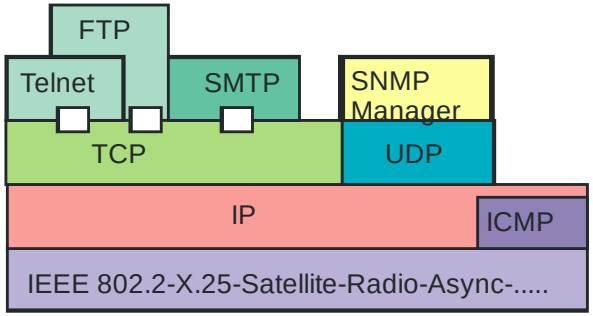
Items within the network elements which are manageable are called managed objects

Objects within the MIB are organized into the following groups:

MIB ....(114)	MIB-2 ....(171)
1) System	1) System
2) Interface	2) Interface
3) Address Translation	3) Address Translation
4) IP	4) IP
5) ICMP	5) ICMP
6) TCP	6) TCP
7) UDP	7) UDP
8) EGP	8) EGP
	9) CMOT
	10) Transmission
	11) SNMP I

Object Registration Hierarchy





JTC : Joint Technical Committee
DoD : Department of Defense (U.S.)
IAB : Internet Activity Board
NIST : National Institute of Standards and Technology (U.S.)

ICMPv6 MIB Modules

IPv6 General Group
RFC 2465
ipv6ifTable - interface information
ipv6IfStatsTable - traffic statistics on interfaces
ipv6AddrPrefixTable - Address prefixes associated with interfaces
ipv6AddrTable - Addressing information on interfaces
ipv6RouteTable - Table for all valid unicast routes
ipv6NetToMediaTable - Address translation

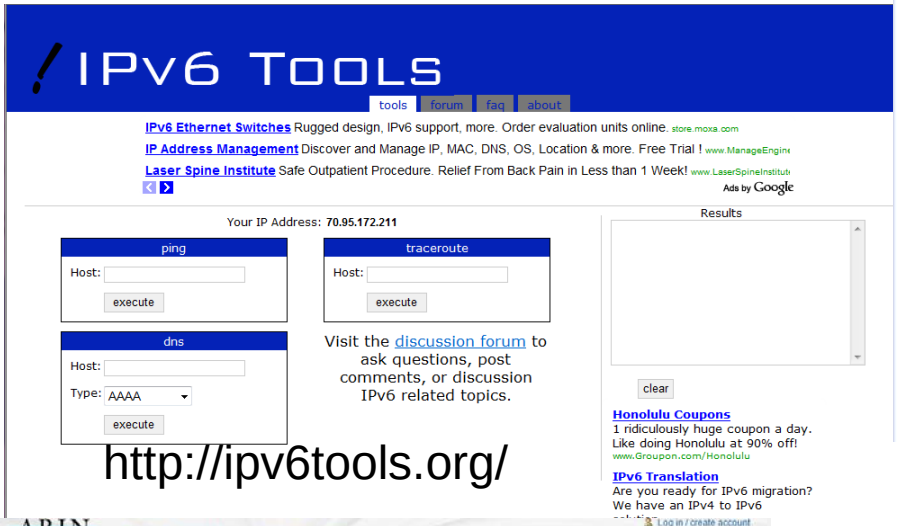
IPv6 ICMPv6 Group
RFC 2466
ipv6IcmpTable - Statistics on both incoming and outgoing messages on a per interface basis

IPv6 Multicast Listinere MIB
RFC 3019

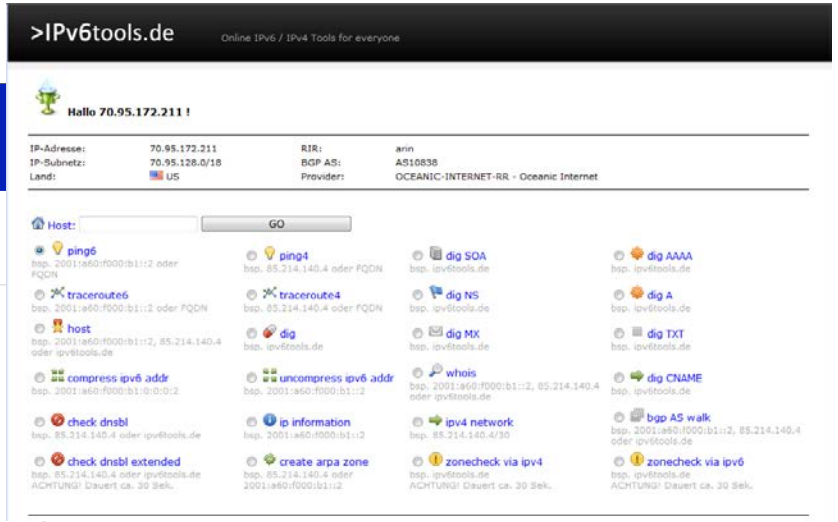
IPv6 UDP Group
RFC 2454 and RFC 2013
ipv6UdpTable - UDP listeners using Ipv6
ipv6UdpMIB - Work in progress

IPv6 TCP Group
RFC 2452
ipv6TcpConnTable - TCP connections between IPv6 endpoints
ipv6TcpMIB - Work in progress

Adhoc Tools



http://ipv6tools.org/



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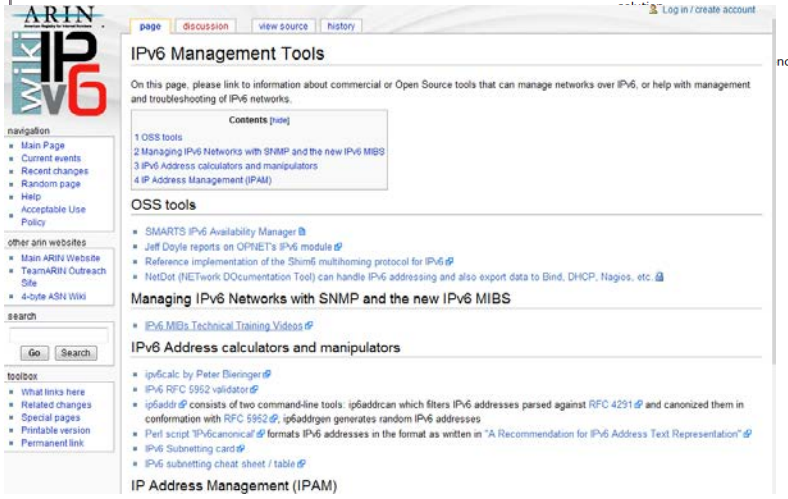


http://www.getipv6.info/index.php/IPv6_Management_Tools

IPv6 Migration Plans

Define topology and functions on hosts, routers, and service machines

Upgrade DNS, DHCP, ARP servers to handle IPv6 addresses

Introduce dual stack systems that support IPv4 and IPv6

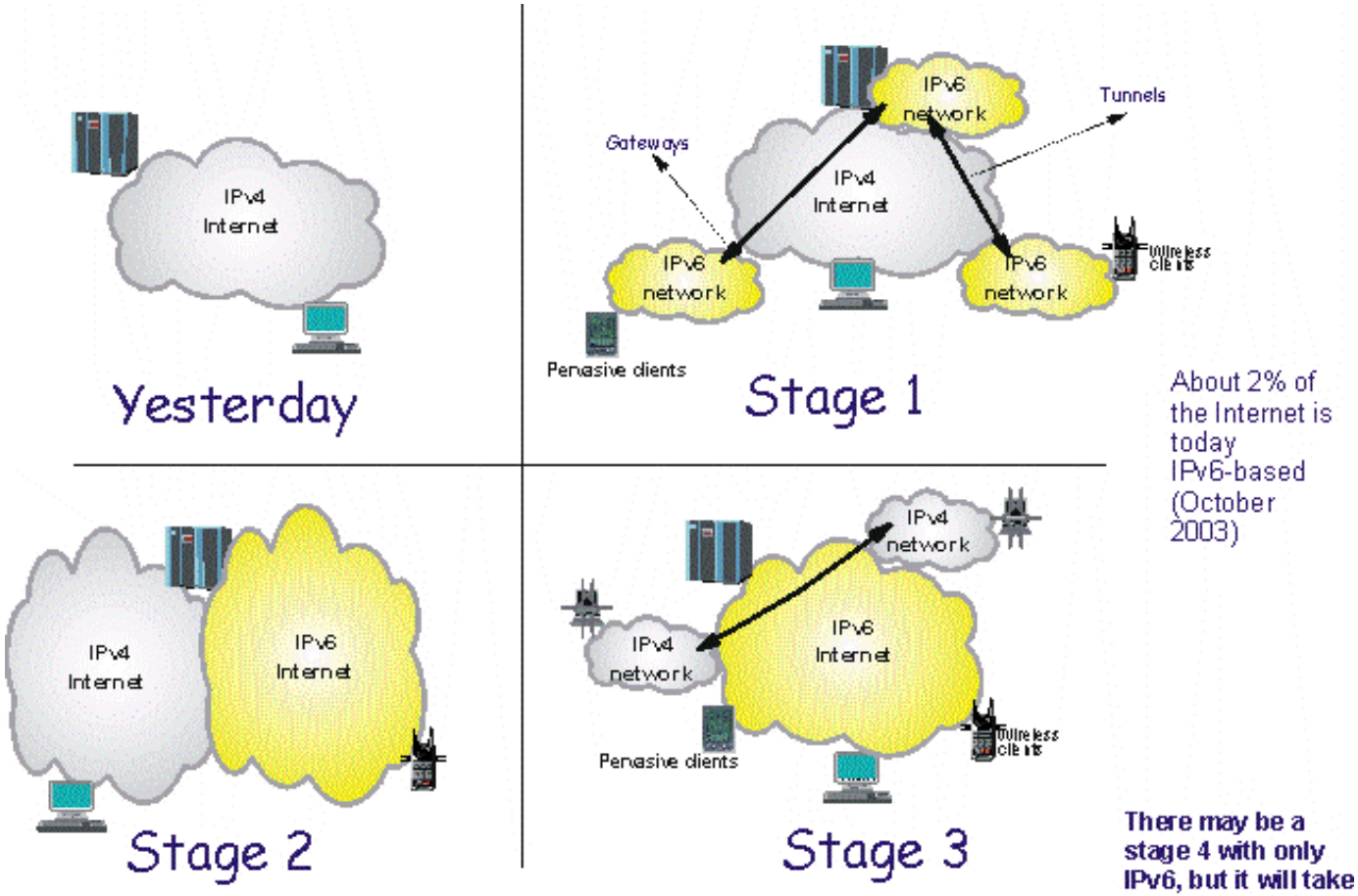
Configure to Internet using IPv6

Rely on tunnels to connect IPv6 islands separated by IPv4 networks

Gradually remove IPv4 from systems

Work closely with ISP for connections to the Internet

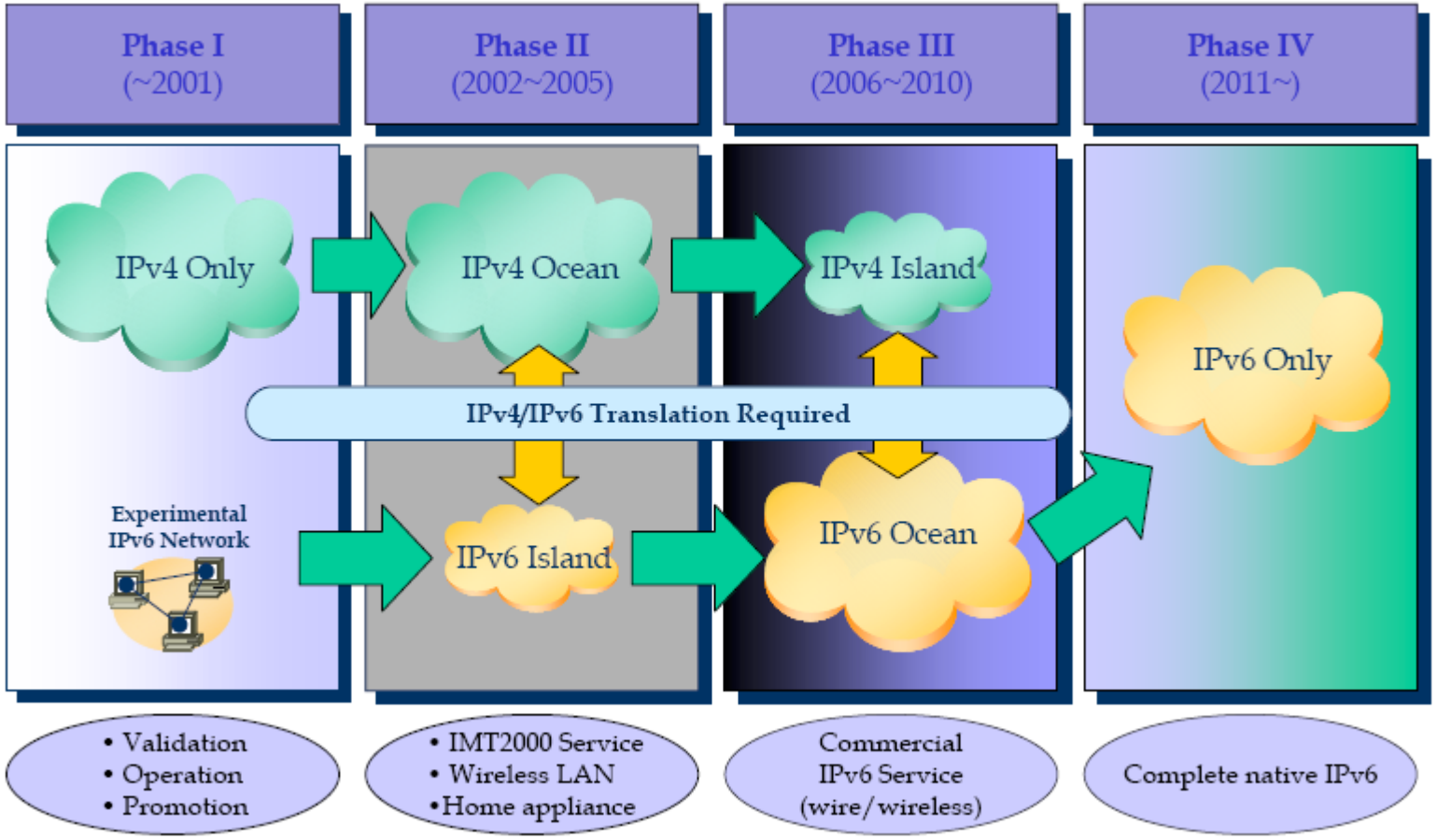
IPv6 Transition Paths



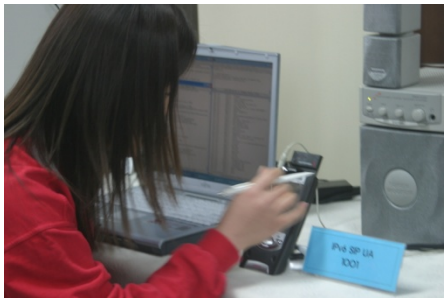
About 2% of the Internet is today IPv6-based (October 2003)

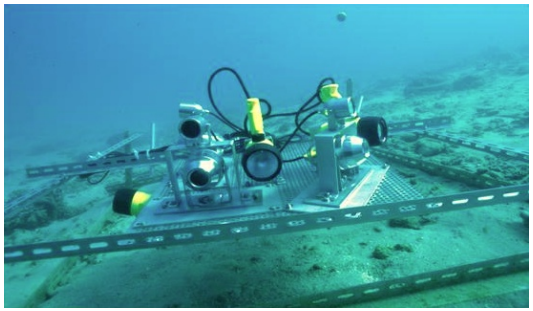
There may be a stage 4 with only IPv6, but it will take some years to get there.

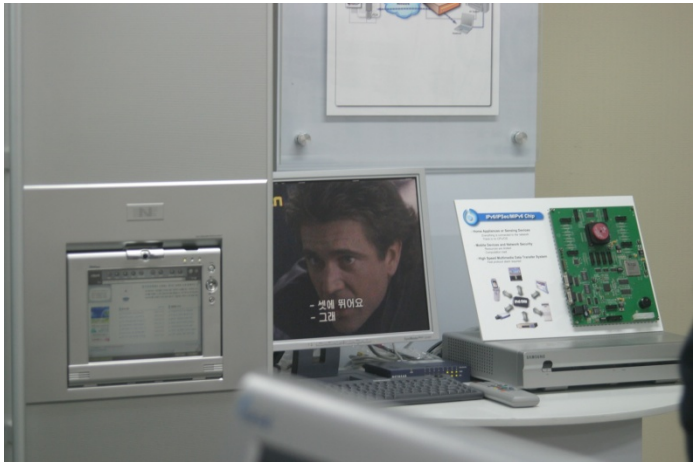
IPv6 Transition Roadmap – Leading Korean ISP



IPv6 Toys: Home automation, fridges, sensors, etc







For more:

google(IPv6 toys)

google(IPv6 cool)

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1825 Security Architecture
1826 IPv6 Authentication
1827 IPv6 Encapsulating Security Payload
1881 IPv6 Address allocation Management
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1886 DNS extensions to support
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1888 OSI NSAPs and IPv6
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1933 Transition Mechanism for IPv6 Hosts
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2450 TLA and NLA Assignment Rules
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2454 IPv6 MIB for UDP
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2553 Basic Socket Extensions
2675 IPv6 Jumbograms
2732 URL format

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2928 IPv6 TLA Assignments
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3056 Connection of IPv6 Domains via IPv4 Clouds
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3831 Support of IPv6 over Fiber Channel
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4218 Threats Relating to IPv6 Multihoming Solutions
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4225 Mobile IPv6 Route Optimization Security
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4338 Transmission of IPv6 over Fiber Channel
4339 IPv6 Host Configuration of DNS Server Info
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4584 Extension to Sockets API for Mobile IPv6

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4640 Problem Statement for Bootstrapping Mobile IPv6
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4669 RADIUS Server MIB for IPv6
4670 RADIUS Accounting Client MIB for IPv6
4671 RADIUS Accounting Server MIB for IPv6
4672 RADIUS Dynamic authorization client MIB for IPv6
4673 RADIUS Dynamic Authorization server MIB for IPv6
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4727 Experimental Value in IPv6 headers
4779 ISP IPv6 Deployment Scenarios in Broadband access Networks
4798 Connecting IPv6 islands over IPv4 MPLS using IPv6 Provider Edge Routers
4843 An IPv6 Prefix for ORCHID
4852 IPv6 Enterprise Network Analysis
4861 Neighbor Discovery for IPv6
4862 IPv6 Stateless Address Autoconfiguration
4877 Mobile IPv6 Operation with IKEv2
4882 IP Address Location Privacy nd Mobile IPv6
4891 Using IPsec to secure IPv6-in-IPv4 tunnels
4919 IPv6 over Low-Power Wireless PON
4941 Privacy Extensions for Stateless Address Autoconfiguration in IPv6
4942 IPv6 Transition/co-existence security considerations
4943 IPv6 Neighbor Discovery on-link assumption
4944 Transmission of IPv6 Packets over 802.15.4 Networks
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5096 MIPv6 Experimental Messages

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5121 Transmission of IPv6 via IPv6 Convergence Sublayer over IEEE 802.16
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5157 IPv6 Implications for Network Scanning
5158 6to4 Reverse DNS Delegation Specification
5172 Negotiation of IPv6 Datagram Compression using IPv6 Control Protocol
5175 IPv6 Router Advertisement Flags Options
5180 IPv6 Benchmarking Methodology for Network Interconnect Devices
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5270 MIPv6 Fast Handovers over IEEE 802.16e Networks
5271 MIPv6 Fast Handovers for 3G CDM
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5447 Diameter MIPv6
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5454 Dual Stack MIPv6
5460 DHCPv6 Bulk Leasequery
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5534 Failure Detection and Locator Pair Exploration Protocol for IPv6 Multihoming
5555 MIPv6 support for Dual stacks and routers
5568 MIPOv6 Fst Handovers
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Questions?

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Tuesday, 3:00 pm - 4:00 pm: Performance Management in a Virtualized Environment
Wednesday 3:00 pm – 4:00 pm: Management Changes in IPv6 – Focus on ICMPv6
Thursday 9:30 am – 10:30 am: Hot Topics in Networking and Security
Thursday 1:30 pm – 2:30 pm: Network Problem Diagnosis with OSA Examples
Thursday 3:00 pm – 4:00 pm: TCP/IP Forensics
Friday 8:00 am – 9:00 pm: Keeping Your Network at Peak Performance as you Virtualize the Data Center
Friday 9:30 am – 10:30 am: Virtualization: New Technologies and Methods to Assure the Health of the Infrastructure