ADVANCED COMPUTER NETWORKS

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(1) IPv6 (Internet Protocol version 6) is a network layer protocol that allows communication to take place over the network.

(*) An IPv6 consists of eight groups of 4 hexadecimal digits.

Ex: 3001: 0da8: 75a3: 0000: 0000: 8a2e: 0370: 7334

Features of IPv6

1. Expanded addressing capabilities
2. Server less autoconfiguration (plug -n- play) and reconfiguration.
3. More efficient and robust mobility mechanisms
4. Built-in, strong IP player encryption and authentication
5. Streamlined header format and flow identication
6. Improved support for options / extensions
7. simplified header
8. Anycast support
9. Enhanced priority suppoll
10. Mobility

Addressing Modes of IPv6

(*) Addresses are assigned to interfaces

1. UNICAST (one- to-one)
   - (*) global
   - (*) link-local
   - (*) site-local
   - (*) IPv4 compatible

In unicast, IPv6 is uniquely addressed and identified. IPv6 packet contains bouth source and destination IP. A host is equipped with an IP which is unique.

2. <u>MULTI CAST</u>

- ⊛ Addresses of a set of interfaces
- ⊛ Delivery to all interfaces in the set

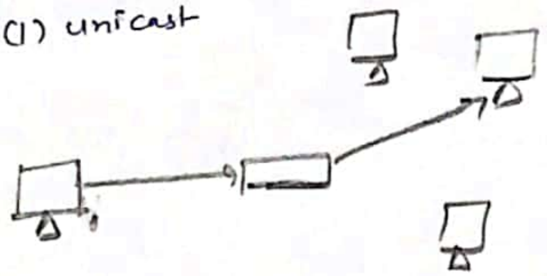
The IPV6 multicast mode is same as that of IPv4. packet destined to multiple hosts is sent on special multicast address. All the hosts interested in multicast information, need to join that multicast group.

3. <u>ANYCAST</u>

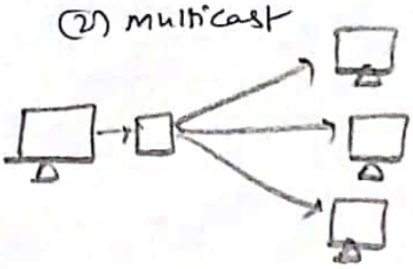
- ⊛ unicast Address of a set of interfaces
  - subnet router anycast address : subnet prefix::/n
- ⊛ Delivery to a single interface in the set

In this addressing modes, multiple interfaces (hosts) are assigned same Any cast IP. When a host wishes to communicate with a host equipped with an Anycast IP, it sends unicast message. With the help of complex routing mechanism, Unicast message is delivered to closest to sender in terms of routing cost.

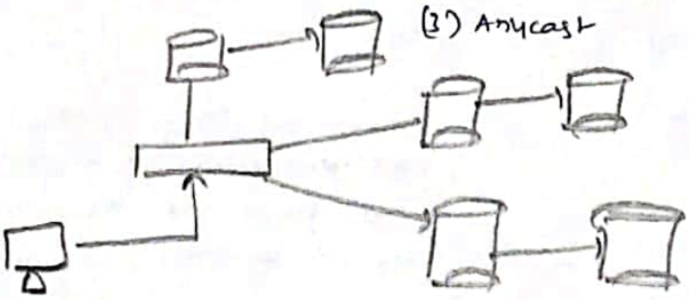
(1) unicast



(2) multicast



(3) Anycast



② IPV6 - Address Types & Formats

(a) Hexadecimal Number System

It is a positional number that uses radix (base) of 16. To represent values in readable format, this system uses 0-9 symbols, to represent values from zero to nine, uses A-F to represent values from ten to fifteen.

→ Every digit values from 0 to 15.

0 – 0	10 – A
01 – 1	11 – B
02 – 2	12 – C
03 – 3	13 – D
04 – 4	14 – E
05 – 5	15 – F
06 – 6	
07 – 7	
08 – 8	
09 – 9	

(b) Address structure

An IPV6 Address is made of 128 bits divided into 8 16-bits blocks. Each block then is converted into 4- digit Hexadecimal numbers separated by colon symbols.

Ex:

2001: 3000: 3238: DFE1: 0063: 0000: 0000: FEFB.

(c) Interface ID

⊛ IPV6 has 3 different types of unicast Address scheme.

⊛ The second half of address (last 64 bits) is always used for Interface ID.

⊛ MAC address of system is composed of 48 bits (Hexa decimal)

⊕ A host can auto-configure its interface ID by IEEE's Extended unique identifier (EUI-64) format.

OUI			NIC specific		
00	11	22	AB	CD	EF

↓

00	11	22	FF	FE	AB	CD	EF

(d) Global unicast Address

This address type is equivalent to IPv4's public address. Global unicast addresses in IPv6 are globally identified and are uniquely addressable.

Global Routing prefix	subnet ID	Interface ID
48	16	64

(e) Link Local Address

Auto configured IPv6 address is known as Link local address. This address always starts with FE80. 1st 16 bits of this address is always set to 1111 1110 1000 0000 (FE80). The next 48 bits are set to 0.

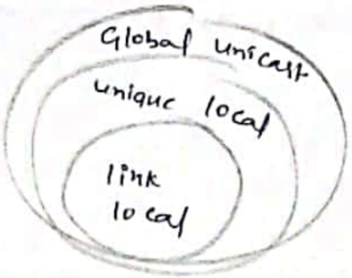
Data	Interface ID

(f) unique Local Address

This type of IPv6 address is globally unique. It should be used in local communication. The second half of this address has interface ID, 1st half is divided among prefix, local bit, global ID and subnet ID.

Prefix	L	Global ID	subnet ID	Interface ID
	1	40	16	64

Prefix is alway set to 1111 110.



IPv6 unicast Address scope

3) IPv6 headers have one fixed header and zero or more optional (Extension) headers. All necessary information that is essential for a router is kept in fixed header. Extension header has optional information that helps router to understand how to handle packet/flow.

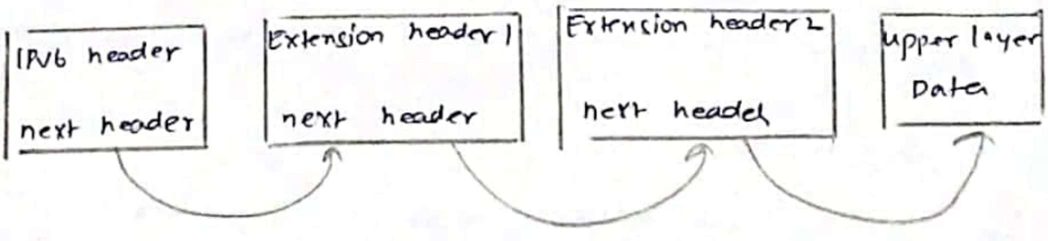
Fixed Header

		4-11	12-31		
0-3	Version	Traffic class	Flow label		
32-47	Payload length		Next header	Hop limit	56-63
64-191	Source Address				
192-288	Destination Address				

IPv6 Fixed header

Extension Header

Each extension header is identified by distinct value. When extension headers are used, IPv6 fixed header's next header field points to first extension header. If there is one more extension header, then 1st extension header's 'next-header' field points to second one and so on...



Extension header connected format

The following extension headers must be supported as per RFC 2460.

	Extension header	Next header Value
1.	Hop by hop options header	0
2.	Routing header	43
3.	Fragment header	44
4.	~~Destination~~ Destination options header	60
5.	Authentication header	51
6.	Encapsulating security payload header	50

These headers:

- should be processed by first, subsequent destinations
- should be processed by final destination.

Communication in IPv6

- In IPv6, there are no broadcast messages/mechanisms. It is not must for an IPV6 enable host to obtain IP address from DHCP or manually configured, it can auto -configure its own IP.
- ARP has been replaced by ICMPV6 neighbour discovery protocol.

Neighbour Discovery Protocol

A host in IPV6 network is capable of auto configuring itself with unique link local address. As soon as its gets IPv6, it joins multicast groups.

- Neighbour solicitation
- DAD (Duplicate Address Detection)
- Neighbour Advertisement

} Host state's in IPV6

- ⊛ Router solicitation
- ⊛ Router advertisement
- ⊛ Redirect

} Once host is done with config. of IPv6. It does these things

(4) IPv6 uses 128 bits to represent an address which includes bits to be used for subnetting. The second half of address (least significant 64 bits) is always used for hosts only.

Thus, there is no compromise if we subnet network.

⊢ 48 bits →	⊢ 16 bits ⊣	⊢ 64 bits →
Routing prefix	subnet ID	Interface ID

IPv6 subnetting.

⊛ 16 bits of subnet ≃ IPv4's class B network. using this, an organisation can have 65,000 of subnets.

∴ Routing prefix is 164, host portion is 64 bits.

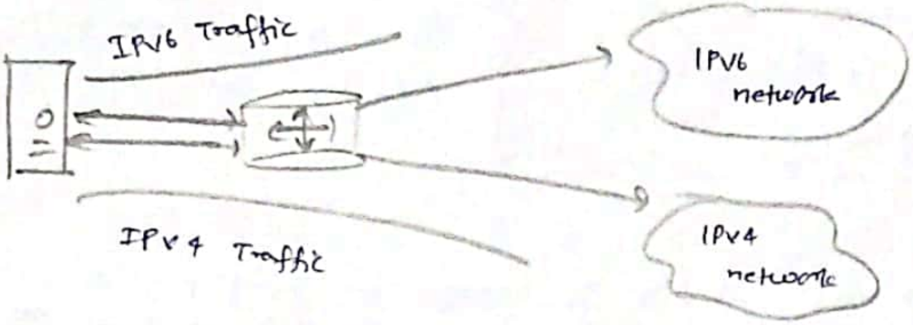
⊛ IPv6 works on same concept as Variable length subnet masking in IPv4.

Transition from IPv4 to IPv6.

There are few technologies to ensure smooth transisition from IPv4 to IPv6.

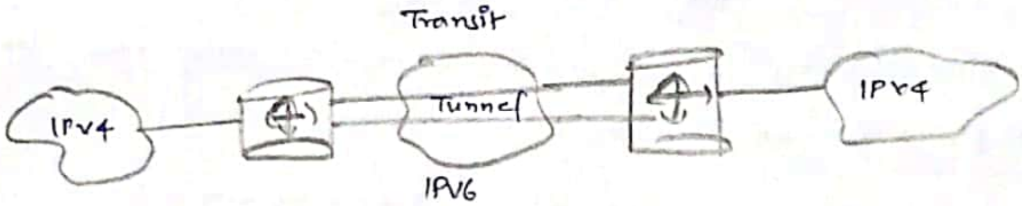
(1) Dual stack Routers

A router can be installed with both IPv4 and IPv6 addresses configured on its interfaces, pointing to network of relevant IP scheme.



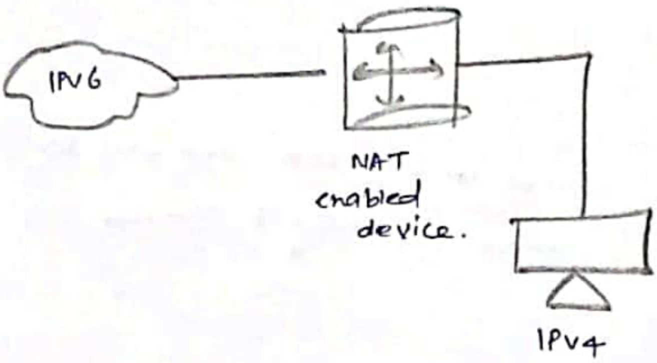
② Tunneling

Different IP versions exist on intermediate path or Transit network. It provides better solution where users data can pass through non supported IP version



③ NAT protocol Translation

NAT-PT uses devices that are NAT enabled. With the help of NAT-PT devices, actual Transition can take place between IPv4 and IPv6 and vice-verca.



⑤ IPV6 Mobility

⊛ a mobile host has one or more home addresses(es)

⊛ Relatively stable, associated with host name in DNS.

⊛ When it discovers it is in foreign subnet, it acquires foreign address.

→ uses auto configuration to get address

→ registers foreign address with home agent i.e. router on its home subnet

⊛ packets sent to mobile's home address(es) are intercepted by home agent and forwarded to foreign address using encapsulation.

IPV6 Routing

⊛ uses same longest-prefix match routing as IPV4 CIDR

⊛ straightforward changes to existing IPV4 routing protocols to handle bigger addresses.

unicast: OSPF, RIP-II, IS-IS, BGP4+

multicast: MOSPF, PIM

⊛ can use routing header with anycast addresses to route packets through particular regions.

ex: for provider selection, policy, peformance etc.

⑥ Multicast Routing Protocols

They enable a collection of multicast routing devices to build distribution trees when a host on a directly attached subnet, typically a LAN wants to recieve traffic from a certain multicast group, prune branches, locate soures and groups and prevent routing loops.

1. DVMRP: Distance vector Multicast Routing protocol

2. MOSPF: Multicast OSPF:
   - ⊛ extends OSPF for dense mode.

3. Bidirectional PIM mode
   - ⊛ variation of PIM, builds bidirectional shared trees that are rooted at RP address.

4. PIM dense mode:
   - ⊛ All possible subnets have at least one receiver wanting to receive multicast traffic from source.

5. PIM sparse mode

6. CBT: Core Based Trees

7. PIM Source specific multicast (SSM)

8. IGMPv1

9. IGMPv2

10. IGMPv3

11. Bootstrap Router (BSR) and Auto-Rendezevous point (RP)

12. Multicast source Discovery protocol (MSDP)
    - ⊛ Allows groups located in one multicast routing domain to find RPs.

13. Session Announcement Protocol (SAP) and session Description Protocol (SDP).

14. Pragmatic General Multicast (PGM):

⊛ special protocol layer for multicast traffic that can be used b/w IP and multicast.

⑦ BGP

⊛ Border Gateway Protocol is postal service of Internet.

⊛ When someone drops a letter into mailbox, postal service processes that mail and chooses a fast, efficient route to deliver letter to its ~~recipient~~. recipient.

⊛ BGP does it in the same way, it is responcible for looking at all of the available paths that data could travel and picking best route, which usually means hopping b/w autonomous system.

⊛ BGP is the protocol that makes internet work. It does this by enabling data routing on internet.

⊛ The Internet is a network of networks, it's broken up into hundreds of thousands of smaller network known as AS (Autonomous systems). Each of these network is essentially a large pool of routers run by a single organisation.

IGP

⊛ IGP, Interior Gateway protocol is a type of routing protocol used for distributing routing information within AS in large internetworks based on TCP/IP protocol.

⊛ A Type of routing protocol used for TCP/IP. IGP specify how routers within an AS exchange routing information with other routers within same AS.

Examples of IGPs for TCP/IP

⊛ RIP for IP which is based on distance-vector algorithm. RIP is popular protocol for small to medium-sized networks.

⊛ open shortest path first (OSPF) protocol, which is based on link state algorithm. OSPF is used mainly on medium to large sized internetworks.

⊛ IGRP, Interior Gateway Routing protocol, a distance-vector protocol developed by CISCO systems.

⑧ MPLS Network

⊛ Multiprotocol label switching (MPLS) is data forwarding technology that increases speed and controls traffic. With MPLS, data is directed through a path via labels instead of requiring complex lookups in routing table at every stop.

⊛ Scalable and protocol independent, this technique works with IP and ATM (Asynchronous Transport Mode) based on MPLS Network.

Advantages of MPLS networks.

1. Improved Network utilisation:

⊛ lets you pool the spare bandwidth on every link.

2. consistent network perfomance:

⊛ Allows different class of services classifications to be applied to packets.

⊛ 2 fold perfomance.

3. Obscures network complexity:

⊛ hides underlying complexity of network from devices and users that don't need to know about it.

⊛ Heterogenous, pragmatic approach is used.

4. Easier global changes:

⊛ Makes it easy to apply setting across an entire WAN at once.

5. Reduced Network Congestion:

⊛ supports traffic engineering.

⊛ frees up capacity on quicker overcrowded paths

6. Increased uptime:

⊛ potential to increase uptime.

⊛ reduces downtime by reducing human scope for ~~error~~.

7. scalable IP VPNs

⊛ you can create IP VPNs without having to set up complex mesh of tunnels.