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"IPv6- The Next Generation Protocol"

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Introduction

- Internet Protocol version 6 (IPv6) is the most recent version of the internet protocol (IP), that provides an identification and location system for computers on networks and routes traffic across the internet.
- IPv6 was developed by the Internet Engineering Task Force (IETF) to deal with the long-anticipated problem of IPv4 address exhaustion.
- IPv6 uses a 128-bit address, theoretically allowing 2^{128} or approximately 3.4×10^{38} addresses. IPv6 provides other technical benefits in addition to a larger addressing space.

Literature Survey

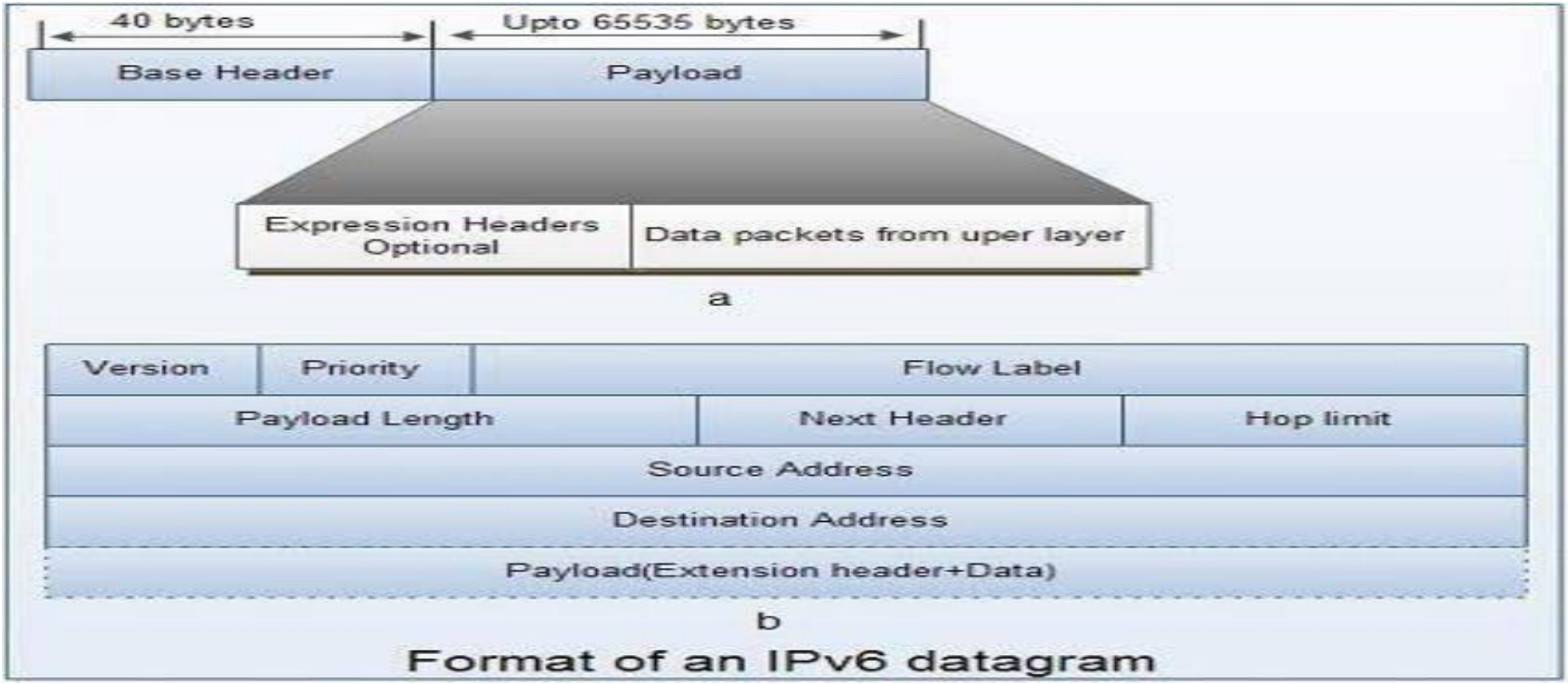
“IPv4 and IPv6 Protocols: A Comparative Performance Study”-Abubakar Zakari; Maryam Musa; Girish Bekaroo; Surayya Ado Bala; Ibrahim Abaker Targio Hashem; Saqib Hakak, 2 - 3 August 2019

- This paper aims to perform a comparative study on the performance of IPv4 and IPv6 on voice and video network traffic flow using performance metrics such as jitter, throughput, and packet loss.
- A testbed experimental environment was set-up with two hosts in client-server mode. Two scenarios (voice/video) were set-up to analyze the performance of the protocols.

“Handling Transmission Error for IPv6 Packets over High Speed Networks”-Supriyanto Praptodiyono, Raja Kumar Murugesan, Rahmat Budiarto, Sureswaran Ramadass

- In this paper , the method was to remove error handling at the Data Link layer and handle it at the Network layer by utilizing the features of the IPv6 header especially extension header, and the characteristics of the high speed network medium.
- The proposed concept would reduce the overhead of the header at the Data Link layer resulting in increasing the data transfer rate and reducing the bandwidth utilization of IPv6 packets over high speed networks.

IPv6 Datagram Format

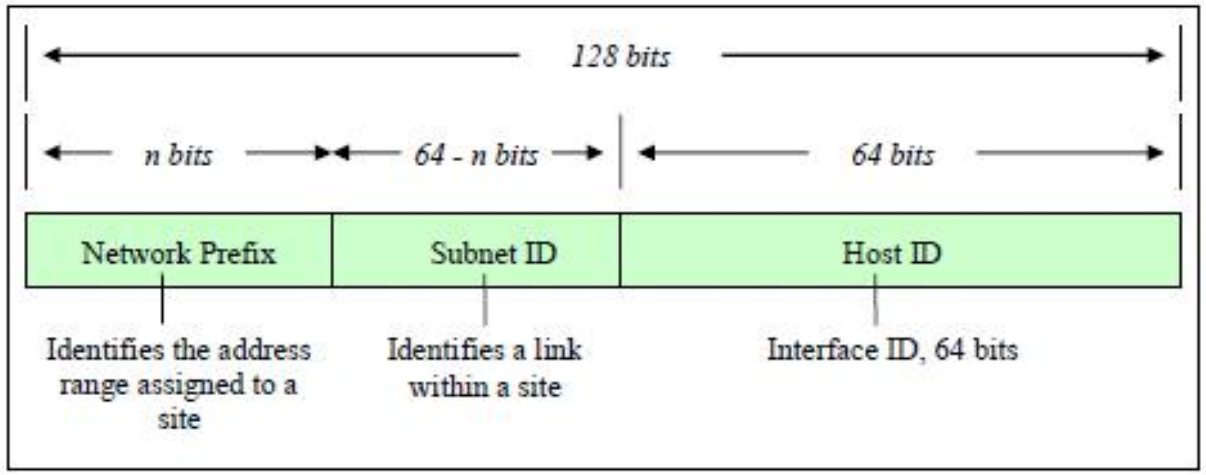


- **Extension headers-** In order to rectify the limitations of IPv4 Option Field, Extension Headers are introduced in IPv6.

Extension Header	Next Header Value	Description
Hop-by-Hop Options header	0	read by all devices in transit network
Routing header	43	contains methods to support making routing decision
Fragment header	44	contains parameters of datagram fragmentation
Destination Options header	60	read by destination devices
Authentication header	51	information regarding authenticity
Encapsulating Security Payload header	50	encryption information

Address structure

- An IPv6 address is represented as eight groups of four hexadecimal digits, each group representing 16 bits.



Representation

example: 2001:0db8:85a3:0000:0000:8a2e:0370:7334

• Leading zeroes in a group may be omitted, but each group must retain at least one hexadecimal digit.

Hence the given address is expressed as 2001:db8:85a3:0:0:8a2e:370:7334.

• One or more consecutive groups containing zeros only may be replaced with a single empty group, using two consecutive colons (::).

Hence the given address is expressed as2001:db8:85a3::8a2e:370:7334.

Types of IPv6 addresses

- **Unicast address-**Unicast addresses represent a single interface. Packets addressed to a single unicast address will be delivered to a specific network interface.
- **Anycast address-** In this addressing mode, multiple interfaces (hosts) are assigned same Anycast IP address. When a host wishes to communicate with a host equipped with an Anycast IP address, sends a Unicast message.
- **Multicast address-**Multicast addresses in IPv6 are similar to multicast addresses in IPv4. They are used to communicate with dynamic groupings of hosts.

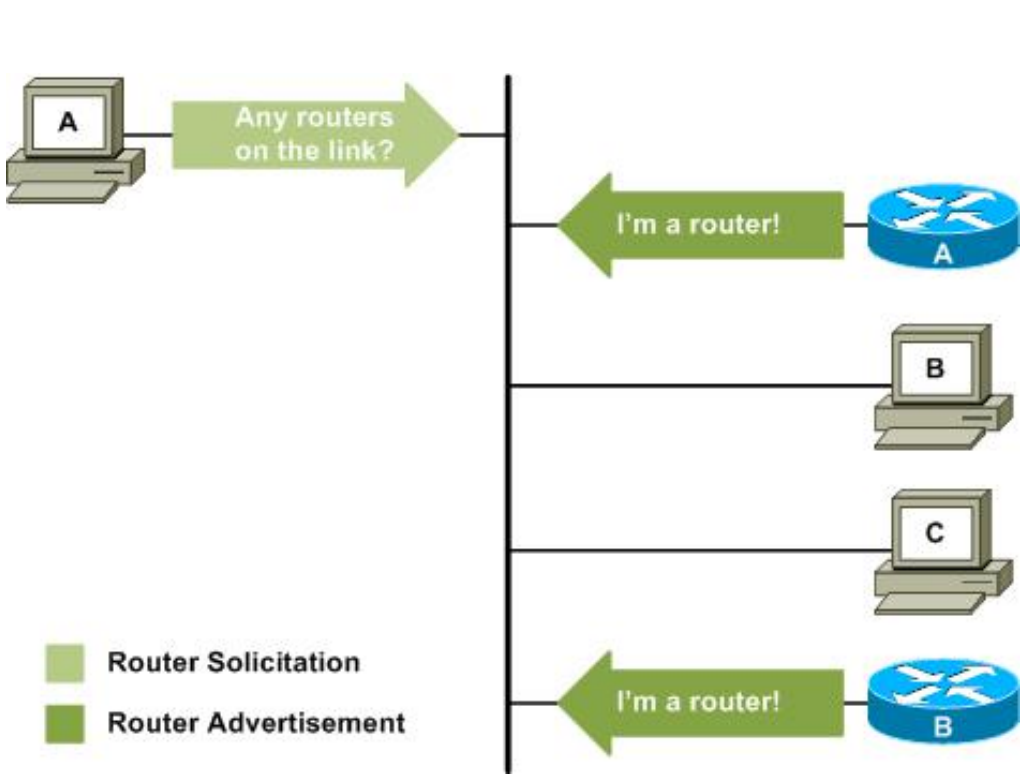
Types of Unicast address

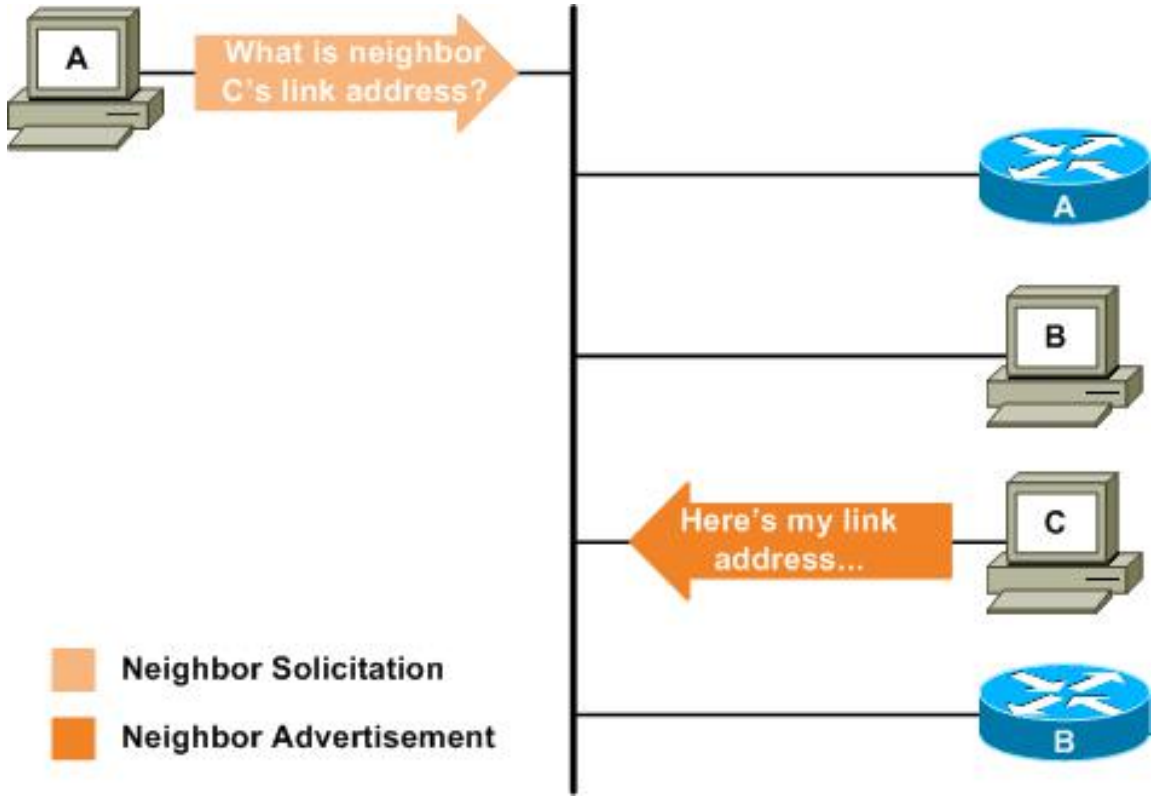
- **Global unicast address:** They have prefix of 2000::/3. Similiar to IPv4 public address.These are assigned by IANA and used on public networks.
- **Unique local address:** They have a prefix of FD00::/8. Similiar to IPv4 private address.They are used in private networks and aren't routable on internet.
- **Link-local address:** They have prefix of FE80::/10. These addresses are used for sending packets over the other subnets.

Protocols Changed to Support IPv6

- **ICMPv6-**Internet Control Message Protocol version 6 is an upgraded implementation of ICMP to accommodate IPv6 requirements.
- **DHCPv6-**Dynamic Host Configuration Protocol version 6 is an implementation of DHCP. IPv6 enabled hosts do not require any DHCPv6 Server to acquire IP address as they can be auto-configured.

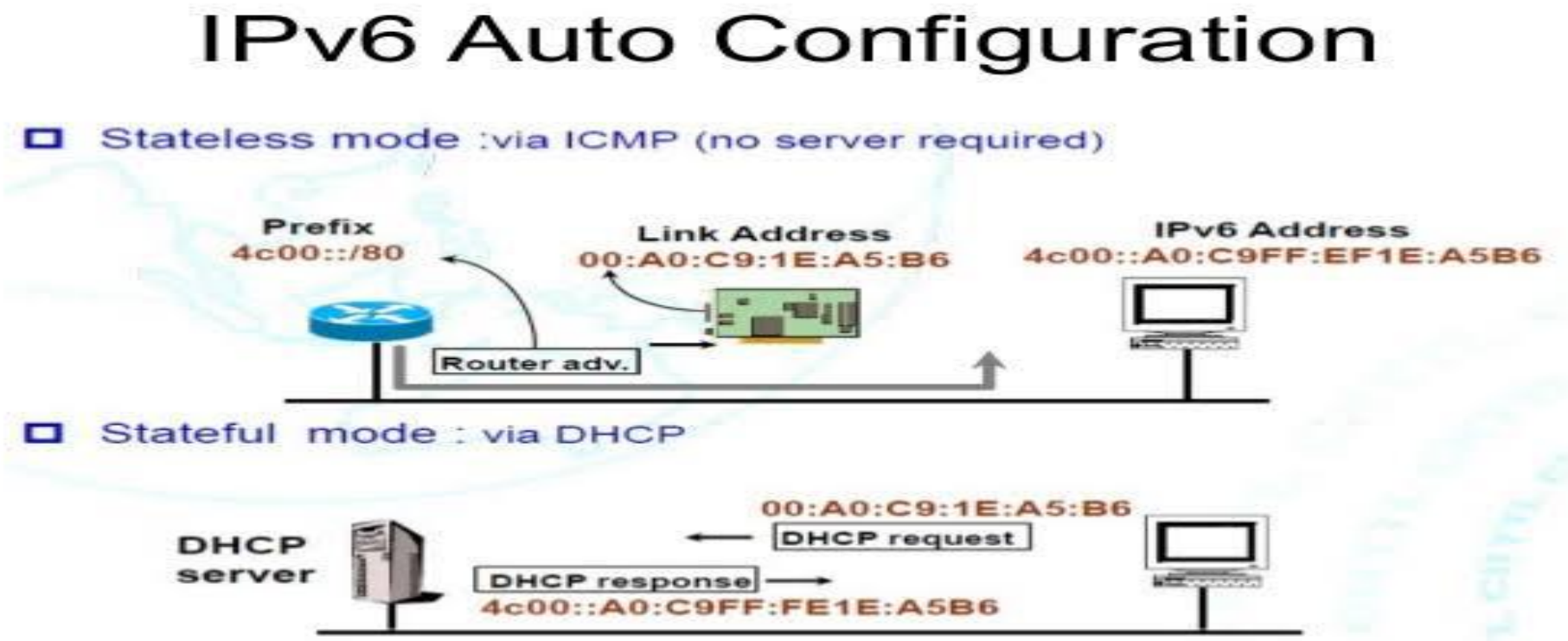
IPv6 Neighbour Discovery Protocol





- **Router solicitation:** When interface becomes enabled, hosts may send out router solicitation that request to generate router advertisements.
- **Router Advertisement:** Routers advertise their presence together with various links and internet parameters in response to router solicitation message.
- **Neighbour Solicitation:** Sent by a node to determine the link layer address of a neighbour or to verify if a neighbour is reachable via link-layer address.
- **Neighbour Advertisement:** A response to neighbour solicitation message.
- **Redirect:** Used by routers to inform hosts of a better first hop for a destination.

Autoconfiguration



Stateless Address Autoconfiguration

- Enable
- Configure terminal
- Interface type number
- IPv6 address config

Stateful Autoconfiguration

- Hosts obtain interface addresses or configuration information from servers.
- Server maintains a database that checks which addresses has been assigned to which hosts

Transition Mechanism

- **Dual stack routers-**A server having IPv4 as well as IPv6 address configured for it can now speak with all the hosts on both the IPv4 as well as the IPv6 networks with the help of a Dual Stack Router.

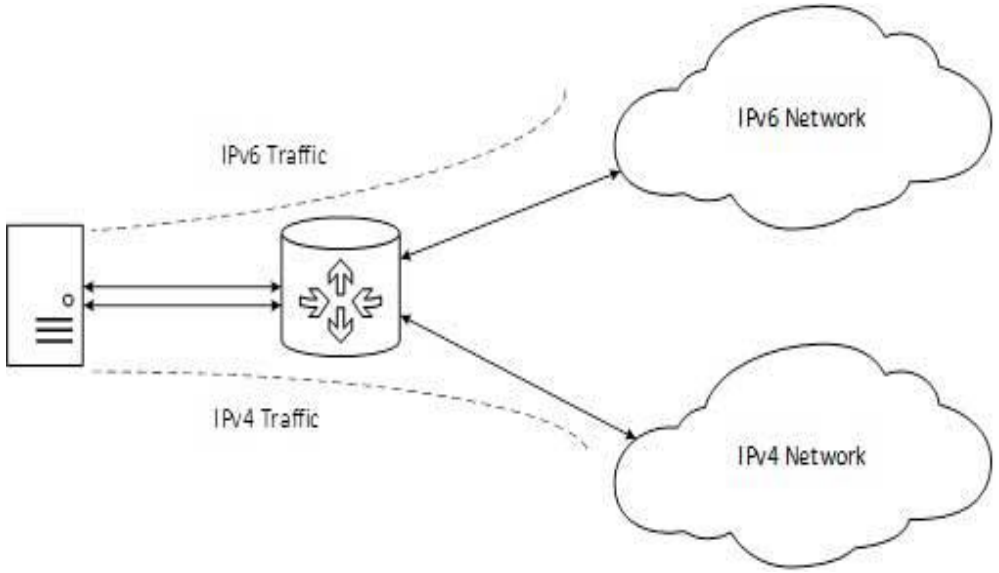
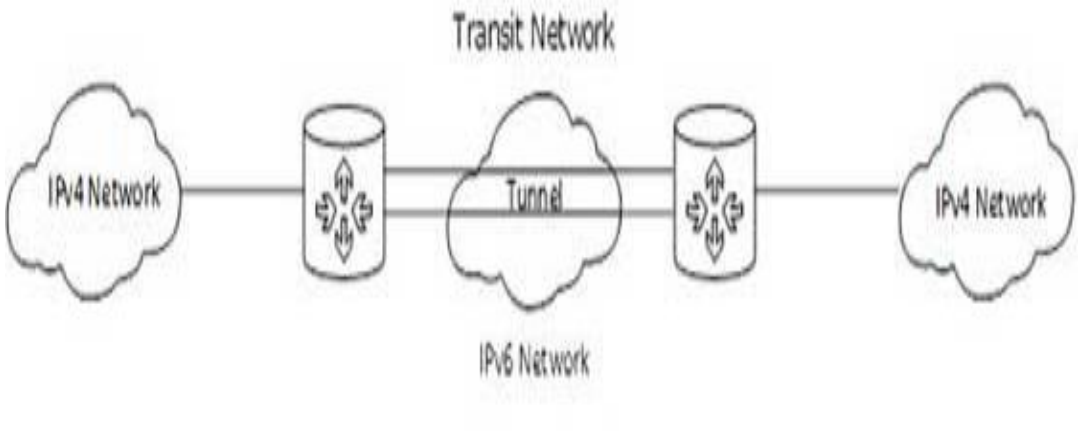
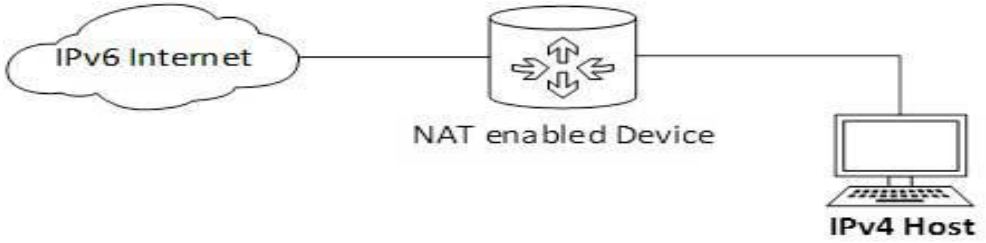


Fig: Dual stack routers

- **Tunneling-** Two IPv4 networks communicate via tunnel where transit network is on IPv6.



- **NAT Protocol Translation-** A host with IPv4 address sends a request to an IPv6 enabled server on Internet that does not understand IPv4 address



Security

- **Mandatory use of IPSec:** It provides two security headers, Authenication Header(AH) and Encapsulating Payload(ESP). IPSec operates in two modes: Transport mode and Tunnel mode
- **Transport mode:** IPv6 header of original packet is used, followed by AH or ESP header, then the payload.
- **Tunnel mode:** IPv6 header encapsulates the AH or ESP header and original IP header and payload.
- Extension headers immediately follow IP headers, except for destination options.

Applications

- Mobile IP
- Internet-enable Appliances
- Internet-enable Automobiles
- Internet-enable ATMs
- Smart sensor

Conclusion

- IPv6 overcomes many of the limitations of IPv4 while introducing new features and functionality to make the job of the network administrator easier.
- The transition techniques significantly attenuate the performance of the network.
- IPv6 presents drawbacks from security point of view.
- The Address Resolution Protocol and Router Discovery Protocol was replaced by Neighbour Discovery Protocol.

References

[1] Feng Xiaorong; Jia Shizhun, “Security Analysis for IPv6 Neighbor Discovery Protocol”,2013 2nd International Symposium on Instrumentation and Measurement, Sensor Network and Automation (IMSNA)

[2] Asif Iqbal; Muhammad Bilal, “Demonstrating the Mobility feature in the Next Generation of the Internet Protocol (IPng / IPv6)”,ECAI 2017 - International Conference – 9th Edition Electronics, Computers and Artificial Intelligence 29 June -01 July, 2017

Thank You