INTERNET PROTOCOL VERSION 6 (IPv6)

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Introduction

- IPv6 is Internet protocol version 6. Following are its distinctive features as compared to IPv4.
  - Header format simplification
  - Expanded routing and addressing capabilities
  - Improved support for extensions and options
  - Flow labeling (for QoS) capability
  - Auto-configuration and Neighbour discovery
  - Authentication and privacy capabilities
  - Simple transition from IPv4

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WHY IPv6?

❖Larger address space

❖Simplified header

❖Support for route aggregation

❖Security, QoS, Auto-configuration, Mobility etc.

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LARGER ADDRESS SPACE

IPv4

32 bits
= 4,294,967,296 possible addressable devices

IPv6

128 bits: 4 times the size in bits
= 3.4×10^{38} possible addressable devices
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340,282,366,920,938,463,463,374,607,431,768,211,456
$\sim 5 \times 10^{28}$ addresses per person on the planet

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Header Changes between IPv4 & IPv6

Version	HLen	TOS	Length		
Id			Flags		Offset
TTL		Protocol	Checksum		
Source Addr					
Destination Addr					
Options (variable)					Pad (variable)

IPv4

Version	Traffic Class	Flow Label	
Payload Length		Next Header	Hop Limit
SourceAddr (4 words)			
DestinationAddr (4 words)			

IPv6

Removed (6)

- ID, flags, flag offset
- TOS, hlen
- header checksum

Changed (3)

- total length => payload
- protocol => next header
- TTL => hop limit

Added (2)

- traffic class
- flow label

Expanded

- address 32 to 128 bits

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IPv6 Packet Format

version	Traffic Class	Flow Label	
Payload Length		Next Header	Hop Limit
Source Address (128 bits)			
Destination Address (128 bits)			

Summary of Fields

- *Version* **(4 bits)** -The constant 6 (bit sequence 0110).

- *Traffic Class* **(8 bits)** -This field allows for differentiated services. Hosts or routers can set this field to indicate that certain packets require priority forwarding over others.

- *Flow Label* **(20 bits)** - Flow Label specifications and minimum requirements are described. Allows intermediate routers to identify flows in an efficient and fast manner.

Summary of Fields

● *Payload Length* **(16 bits)** -The size of the payload in octets, including any extension headers. The length is set to zero when a *Hop-by-Hop* extension header carries a Jumbo Payload option.
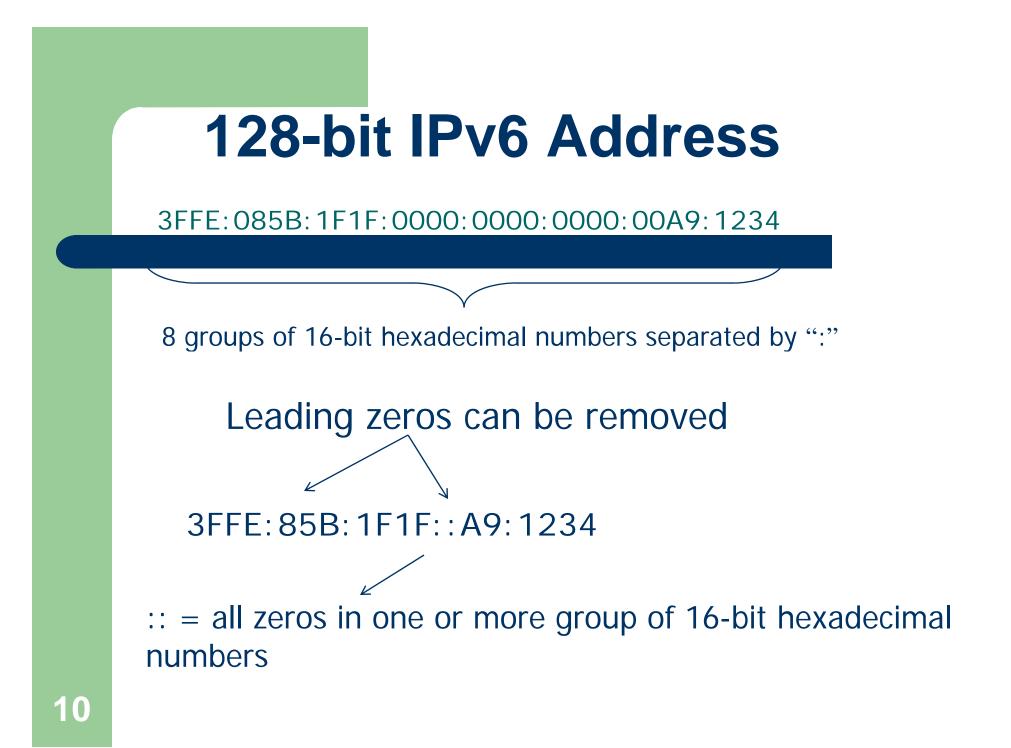
● *Next Header* **(8 bits)** -Specifies the type of the next header. This field usually specifies the transport layer protocol used by a packet's payload.

● *Hop Limit* **(8 bits)** -Replaces the time to live field of IPv4. This value is decremented by one at each intermediate node the packet visits. When the counter reaches 0 the packet is discarded.

Summary of Fields

- ***Source Address* (128 bits)** -The IPv6 address of the sending node.

- ***Destination Address* (128 bits)** -The IPv6 address of the destination node(s).

128-bit IPv6 Address

3FFE:085B:1F1F:0000:0000:0000:00A9:1234

8 groups of 16-bit hexadecimal numbers separated by ":"

Leading zeros can be removed

3FFE:85B:1F1F::A9:1234

:: = all zeros in one or more group of 16-bit hexadecimal numbers

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Text Representation of Addresses

- HEX in blocks of 16 bits

  BC84 : 25C2 : 0000 : 0000 : 0000 : 55AB : 5521 : 0018

- leading zero suppression

  BC84 : 25C2 : 0 : 0 :55AB : 5521 : 18

- Compressed format removes strings of **0**s

  BC84 : 25C2 :: 55AB : 5521 : 18

  :: can appear only once in an address.

  can also be used to compress leading or trailing **0**s

- Mixed Notation (X:X:X:X:X:X:d.d.d.d)

  e.g., ::144.16.162.21

Text Representation of Addresses

- **Link local address**

10 bits	54 bits	64 bits
1111111010	0	Interface ID

- **Site-local address**

10 bits	38 bits	16 bits	64 bits
1111111011	0	subnet ID	Interface ID

Differences Between IPv4 & IPv6

Feature	IPv4	IPv6
Address length	32 bits	128 bits
Header size	20-60 bytes	40 bytes
IPSec support	Optional	Required
QoS support	Some	Better
Fragmentation	Hosts and routers	Hosts only
Checksum in header	Yes	No
Options in header	Yes	No
Link-layer address resolution	ARP (broadcast)	Multicast Neighbor Discovery messages
Router Discovery	Optional	Required
Uses broadcasts?	Yes	No
Configuration	Manual, DHCP	Automatic, DHCP

Types of IPv6 Addresses

- **Unicast**
  - One address on a single interface
  - Delivery to single interface

- **Multicast**
  - Address of a set of interfaces
  - Delivery to all interfaces in the set

- **Anycast**
  - Address of a set of interfaces
  - Delivery to a single interface in the set
- **No broadcast addresses**

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IPv6 Extension Headers

Extension headers are defined to encode certain options that are needed for processing of the IPv6 packet.

❖Hop by Hop options header

❖Authentication header

❖Fragmentation header

❖Routing header

❖Destination options header

Applications

- Transition from IPv4
- Plug-n-play feature for devices in network
- Devices can auto configure themselves in network using IPv6
- Provides larger address space so that it can support more than trillions of devices in networks

Scope of Research

- IPv6 support for mobile devices
- Route optimization in IPv6

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Assignment

- Which of the following addresses are valid IPv6 addresses?
    1. ::
    2. 123:A23F::AAAA:CA12
    3. FE80:12:23:145:0:0:0:1
    4. 123A:FFFF:0::