Lecture 16
INTERNET PROTOCOL VERSION 6 (IPv6)

Topics Covered

- WHY IPv6?
- LARGER ADDRESS SPACE
- IPv6 Packet Format
- 128-bit IPv6 Address
- Text Representation of Addresses
- Differences Between IPv4 & IPv6
- Types of IPv6 Addresses
- Applications

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 Neighbor discovery
  - Authentication and privacy capabilities
  - Simple transition from IPv4

WHY IPv6?

- Larger address space
- Simplified header
- Support for route aggregation
- Security, QoS, Auto-configuration, Mobility etc.

LARGER ADDRESS SPACE

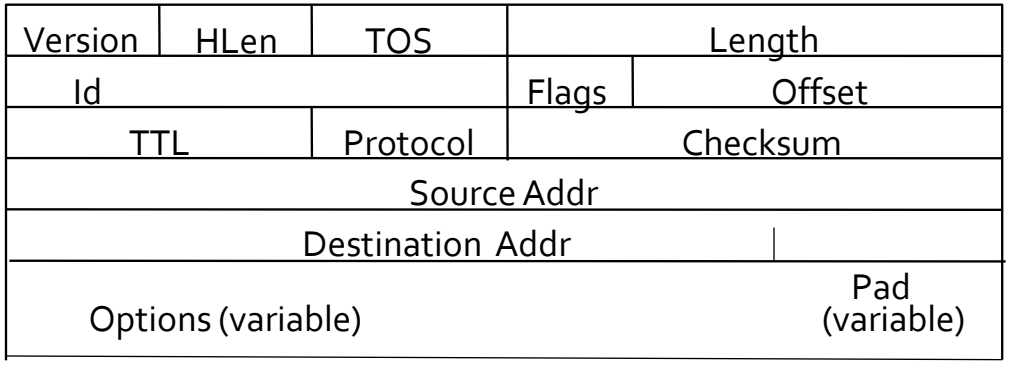
IPv4

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

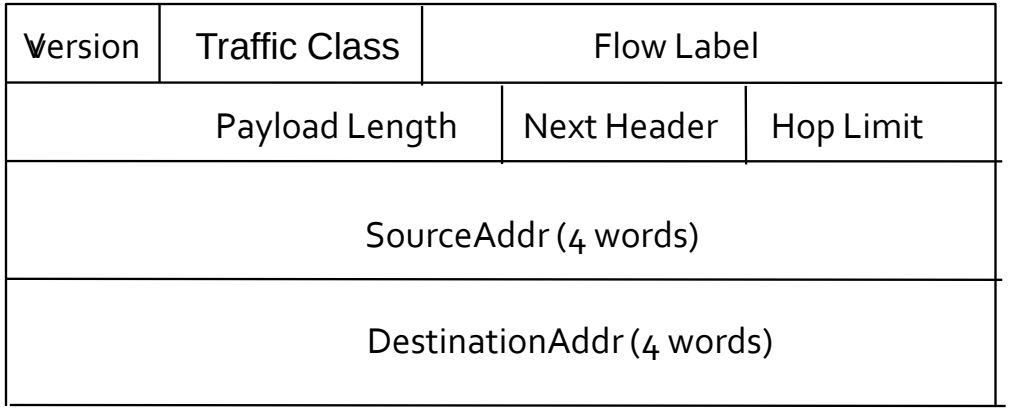
IPv6

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

Header Changes between IPv4 & IPv6



IPv4



IPv6

Removed (6)

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

Changed (3)

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

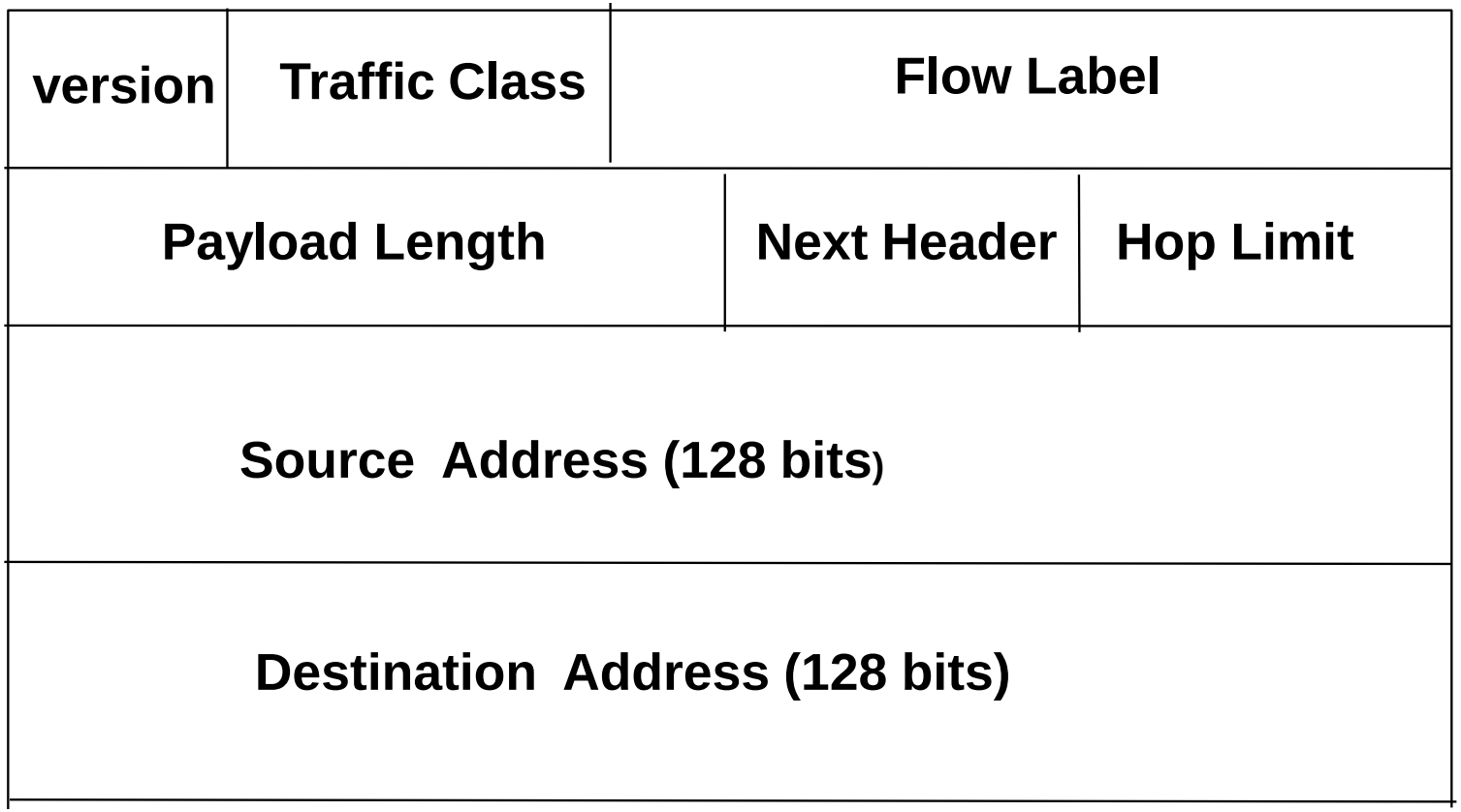
Added (2)

- traffic class
- flow label

Expanded

- address 32 to 128 bits

IPv6 Packet Format



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

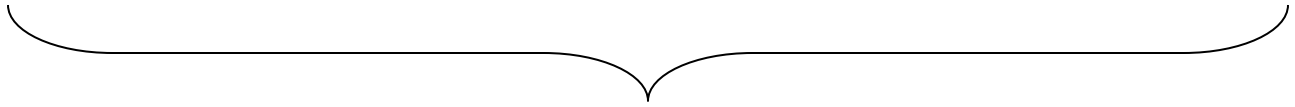
- ***Payload Length*** **(16 bits)** -The size of the payload in octets, including any extension headers. The length is set to zero when a *Hop-by-Hop* extension header carries a Jumbo Payload option.
- ***Next Header*** **(8 bits)** -Specifies the type of the next header. This field usually specifies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

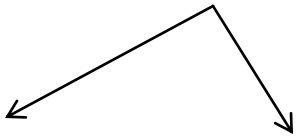
128-bit IPv6 Address

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

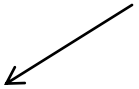


8 groups of 16-bit hexadecimal numbers separated by “:”

Leading zeros can be removed



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



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

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**

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