IPv6 Overview

Issue Date:

Revision:

APNIC

Overview

- What is IPv6?
- Protocol Background
- Motivations Behind IPv6 Protocol
- New Functional Improvement
- IPv6 Extension Headers
- Protocol Header Comparison
- IPv6 Address Distribution

What is IPv6?

- IP stands for Internet Protocol which is one of the main pillars that supports the Internet today
- Current version of IP protocol is IPv4
- The new version of IP protocol is IPv6
- There was an IPv5 (Internet Stream Protocol) but it was assigned for experimental use [RFC1190]
- IPv6 was also called IPng in the early days of IPv6 protocol development stage

IPv6 Protocol Background

- August 1990
  - First wakeup call by Solensky in IETF on IPv4 address exhaustion
- December 1994
  - IPng area were formed within IETF to manage IPng effort [RFC1719]
  - List of technical criteria was defined to choose IPng [RFC1726]
- January 1995
  - IPng director recommendation to use 128 bit address [RFC1752]
- December 1995
  - First version of IPv6 address specification [RFC1883]
- December 1998
  - Updated version changing header format from 1st version [RFC2460]

Motivation Behind IPv6 Protocol

- Plenty of address space (Mobile Phones, Tablet Computers, Car Parts, etc. ☺)
- Solution of very complex hierarchical addressing need, which IPv4 is unable to provide
- End to end communication without the need of NAT for some real time application (i.e online transaction)
- Ensure security, reliability of data and faster processing of protocol overhead
- Stable service for mobile network (i.e Internet in airline, trains)

Why IPv6?

- IPv4 address exhaustion due to the decreasing supply of unallocated IPv4 addresses.
- IPv6 provides much larger IP address space than IPv4
  - IPv4 = 32 bits = 4,294,967,296 addressable devices
  - IPv6 = 128 bits = 3.4 x 10^{38} possible addressable devices
  - That's ~ 5 x 10^{28} addresses per person on the planet
- New functionality and improvement to IPv4

New Functional Improvement

- Address Space
  - Increase from 32-bit to 128-bit address space
- Management
  - Stateless autoconfiguration means no more need to configure IP addresses for end systems, even via DHCP
- Performance
  - Fixed header size (40 bytes) and 64-bit header alignment mean better performance from routers and bridges/switches
- No hop-by-hop segmentation
  - Path MTU discovery

New Functional Improvement

- Multicast/Multimedia
  - Built-in features for multicast groups, management, and new "anycast" groups
- Mobile IP
  - Eliminate triangular routing and simplify deployment of mobile IP-based systems
- Virtual Private Networks
  - Built-in support for ESP/AH encrypted/ authenticated virtual private network protocols;
- Built-in support for QoS tagging
- No more broadcast

IPv6 Extension Header

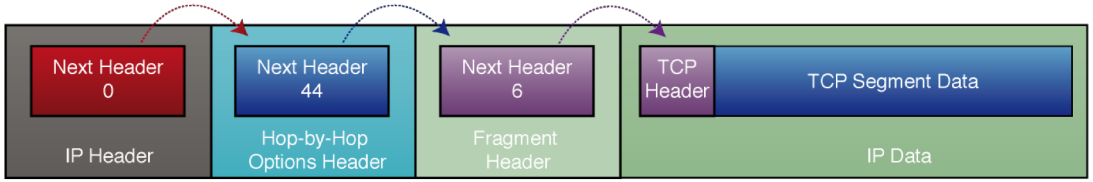
- Adding an optional Extension Header in IPv6 makes it simple to add new features in IP protocol in future without a major re-engineering of IP routers everywhere
- The number of extension headers are not fixed, so the total length of the extension header chain is variable
- The extension header will be placed in between main header and payload in an IPv6 packet

IPv6 Extension Header

- If the Next Header field value (code) is 6, it determines that there is no extension header and the next header field is pointing to TCP header which is the payload of this IPv6 packet
- Code values of Next Header field:
  - 0 Hop-by-hop option
  - 6 TCP
  - 17 UDP
  - 43 Source routing
  - 44 Fragmentation
  - 50 Encrypted security payload
  - 51 Authentication
  - 59 Null (No next header)
  - 60 Destination option

Link listed Extension Header

IPv6 Datagram With No Extension Headers Carrying TCP Segment



IPv6 Datagram With Two Extension Headers Carrying TCP Segment

- Link listed extension header can be used by simply using next header code value
- Above example use multiple extension header creating link list by using next header code value i.e 0 44 6
- The link list will end when the next header point to transport header i.e next header code 6

Fragmentation Handling In IPv6

- Routers handle fragmentation in IPv4 which cause variety of processing performance issues
- IPv6 routers no longer perform fragmentation. IPv6 host use a discovery process [Path MTU Discovery] to determine most optimum MTU size before creating end to end session
- In this discovery process, the source IPv6 device attempts to send a packet at the size specified by the upper IP layers [i.e TCP/Application].
- If the device receives an □ICMP packet too big□ message, it informs the upper layer to discard the packet and to use the new MTU.
- The □ICMP packet too big□ message contains the proper MTU size for the pathway.
- Each source device needs to track the MTU size for each session.

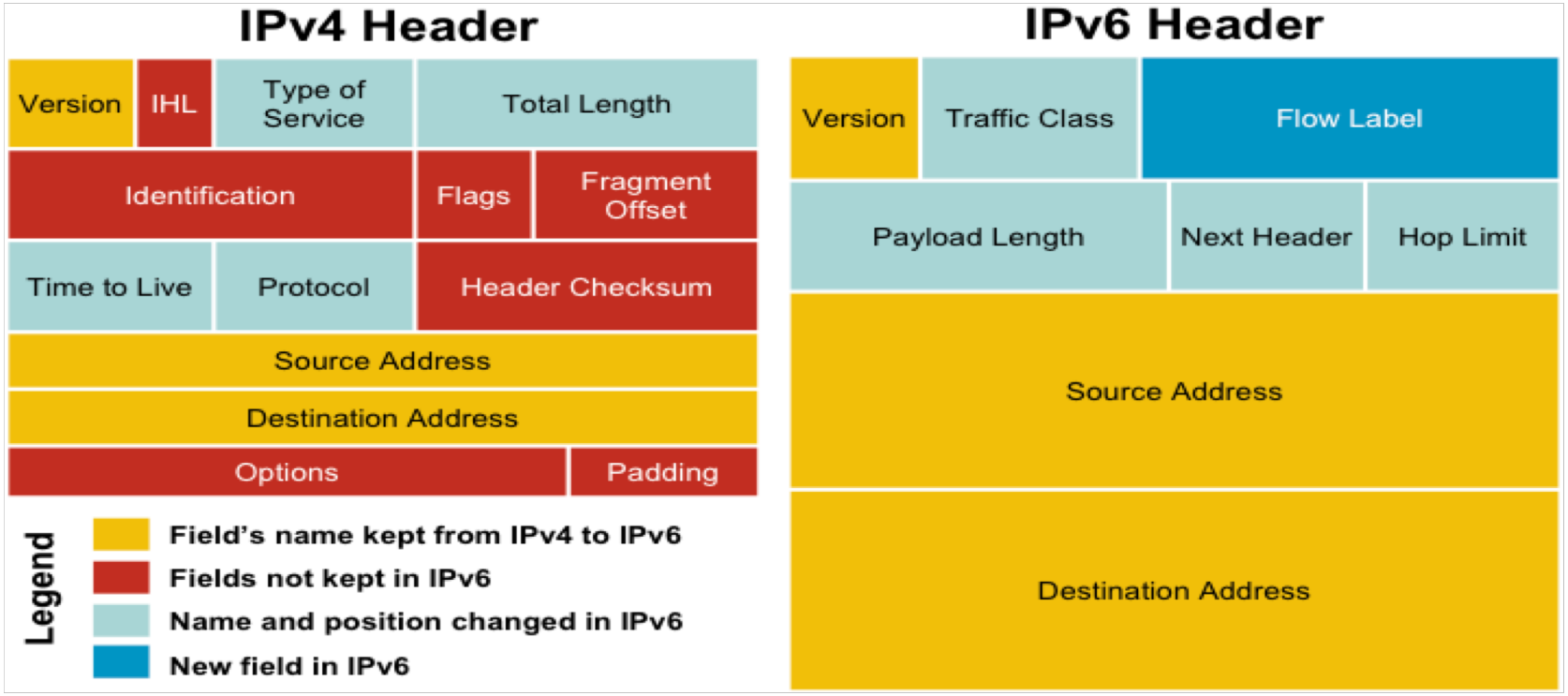
MTU Size Guideline

- MTU for IPv4 and IPv6
  - MTU is the largest size datagram that a given link layer technology can support [i.e HDLC]
  - Minimum MTU 68 Octet [IPv4] 1280 Octet [IPV6]
  - Most efficient MTU 576 [IPv4] 1500 [IPv6]
- Important things to remember:
  - Minimum MTU for IPv6 is 1280
  - Most efficient MTU is 1500
  - Maximum datagram size 64k
  - With IPv6 in IPv4 tunnel 1560 [Tunnel Source Only]

IPv6 Security Features

- IPsec is mandatory in IPv6
- Since IPsec became part of the IPv6 protocol, all node can secure their IP traffic if they have required keying infrastructure
- In build IPsec does not replace standard network security requirement but introduce added layer of security with existing IP network

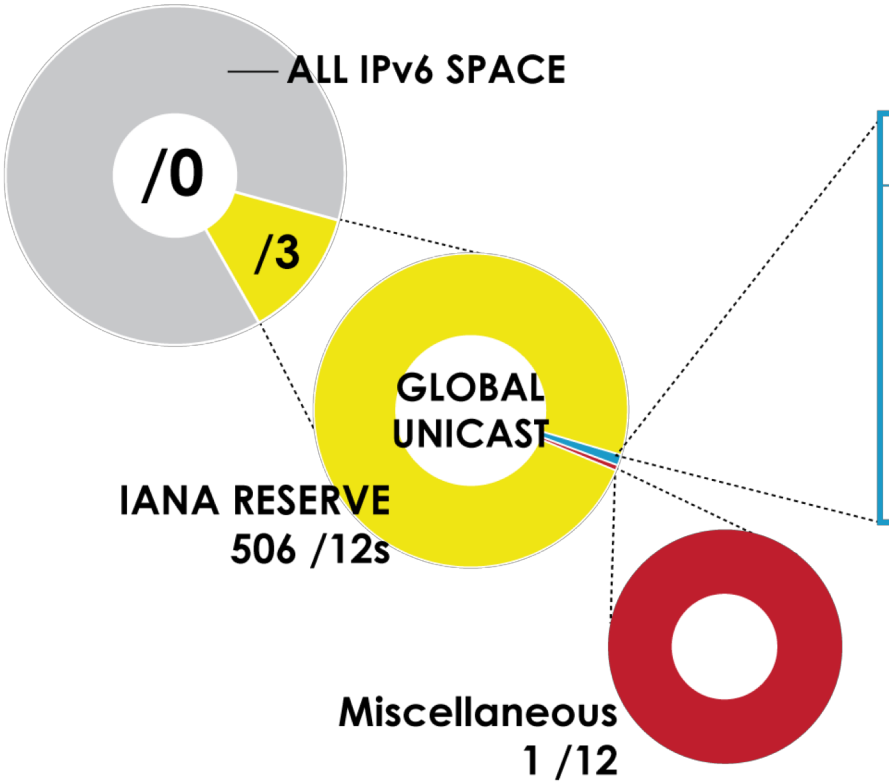
Protocol Header Comparison



- IPv4 contains 10 basic header fields
- IPv6 contains 6 basic header fields
- IPv6 header has 40 octets in contrast to the 20 octets in IPv4
- So a smaller number of header fields and the header is 64-bit aligned to enable fast processing by current processors

Diagram Source: www.cisco.com

IPv6 Address Space



RIRs 5 /12s (October 2006)

RIR	IPv6 ADDRESS
AfriNIC	2C00:0000::/12
APNIC	2400:0000::/12
ARIN	2600:0000::/12
LACNIC	2800:0000::/12
RIPE NCC	2A00:0000::/12

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Get Your IPv6 Address

Kickstart your IPv6 network!

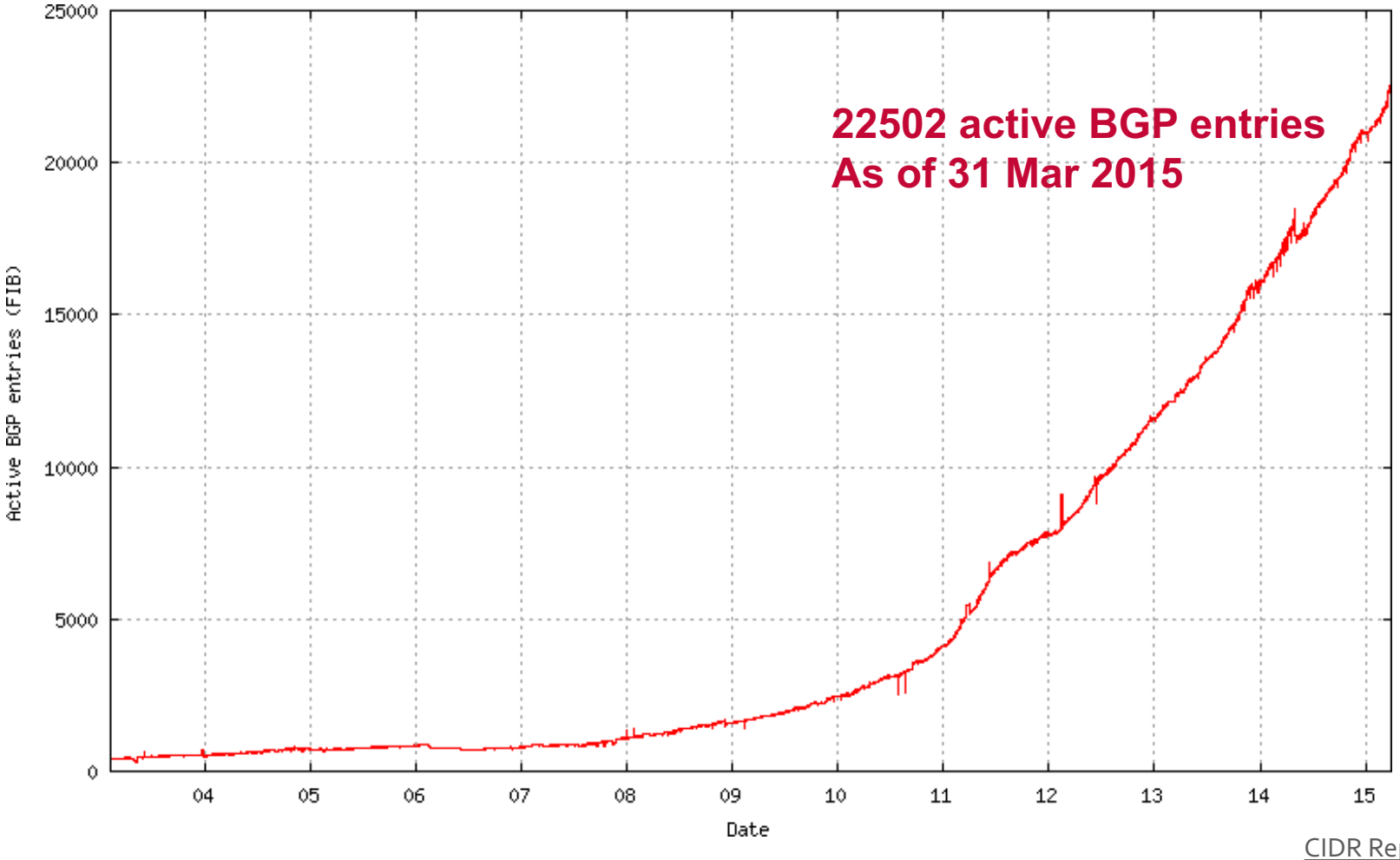
Already a Member account holder? Have IPv4 addresses and want IPv6 resources?

Members: **Login** and receive IPv6 addresses via MyAPNIC.

New to APNIC? Only want to apply for IPv6 resources?

Find out how easy it is to get IPv6 addresses.

IPv6 BGP Routing Table



CIDR Report