Internet Protocol Version 6

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Outline

- Introduction
- IPv6 Packet Format
- Addressing

Introduction

- Exhausion of the class B address space on 1993
  - Allocation in the class C address space
  - Explosion of the size of routing tables
- IANA has allocated last blocks of IPv4 address space on 2011/02/03

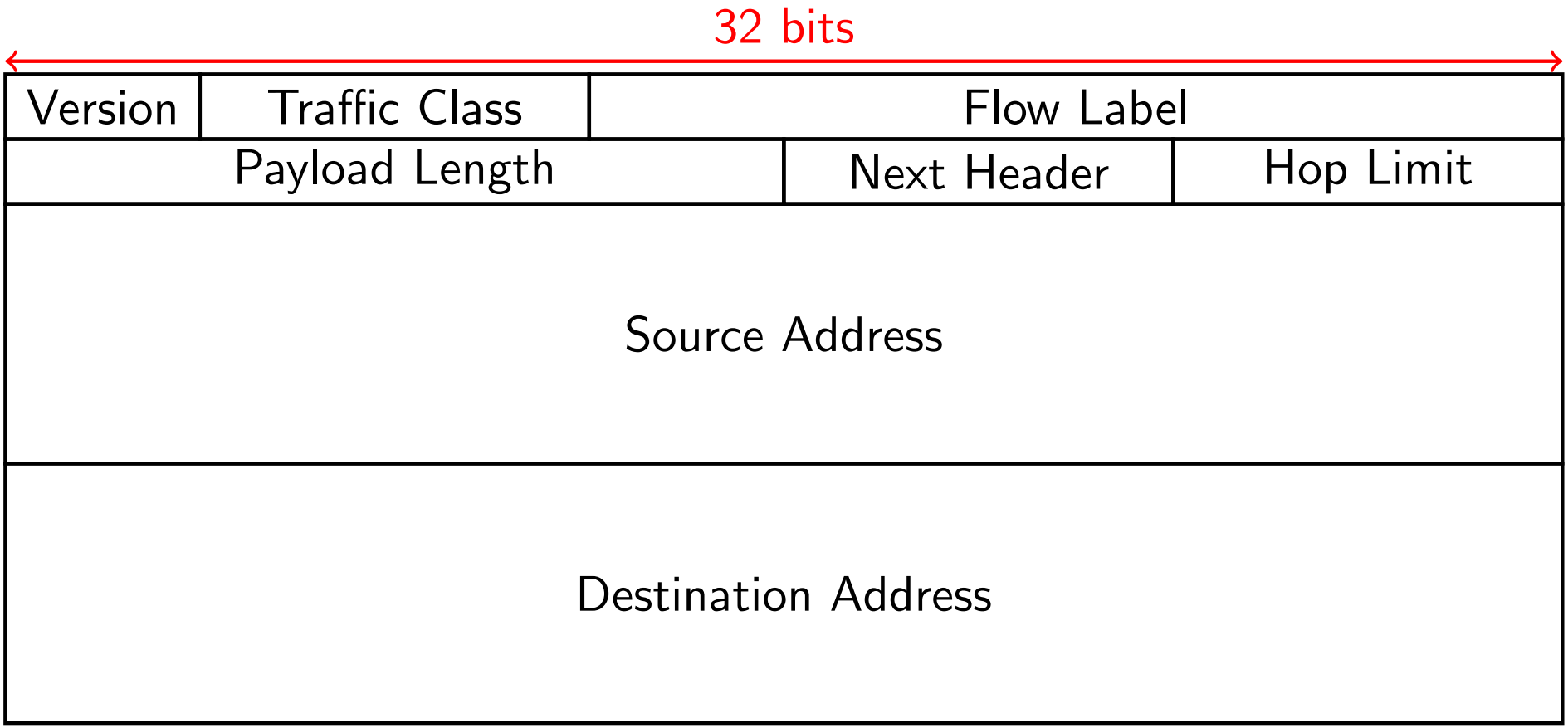
Emergency Measures

- Ask the Internet community to give back allocated prefixes (RFC 1917)
- Re-use class C address space
- CIDR (Classless Internet Domain Routing) (RFC 1519)
- Private Adressing (RFC 1918)
- These emergency measures give time to develop a new version of the IP protocol

IPv6

- RFC 2460
- Keep good things that where successful in IPv4
  - Fixed header
  - Fixed address size
- Change bad things
  - Expanded Addressing Capabilities
  - Header Format Simplification
  - Improved Support for Extensions and Options

IPv6 Packet Format



IPv6 Header

- Version
  - 4 bits
  - IP version number
  - IPv6: 6
- Traffic Class
  - 8 bits
  - To distinguish between different classes or priorities
  - May be used to encode DSCP
- Flow Label
  - 20 bits
  - Used to identify a flow of packets sent from a source to a destination
  - May be used for resource reservation

IPv6 Header

- Payload Length
  - 16 bits
  - Length of the IPv6 payload
  - The size of the rest of the packet following this header in bytes
- Next Header
  - 8 bits
  - Identifies the type of header immediately following the IPv6 header
  - Uses the same values as the IPv4 Protocol field
- Hop Limit
  - 8 bits
  - Decremented by 1 by each node that forwards the packet
  - The packet is discarded if Hop Limit is decremented to zero
  - Similar to TTL in IPv4

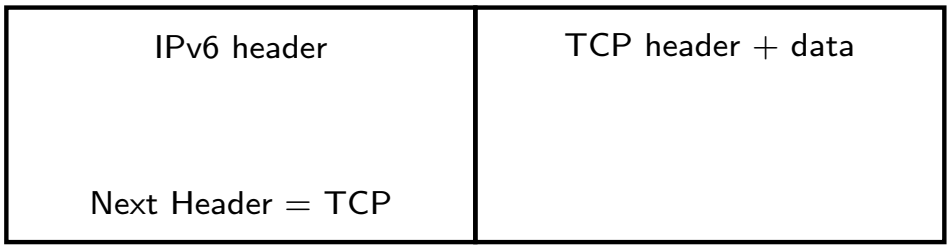
IPv6 Header

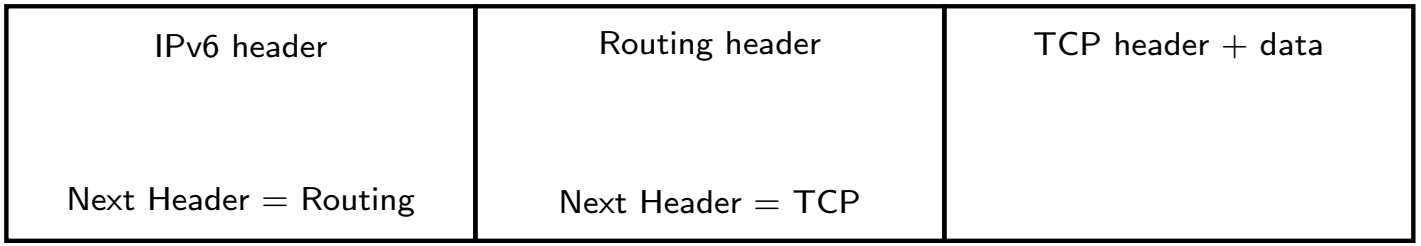
- Source Address
  - 128 bits
  - Source address of the packet
  - Unicast address
- Destination Address
  - 128 bits
  - Destination address of the packet
  - Unicast/Multicast/Anycast address

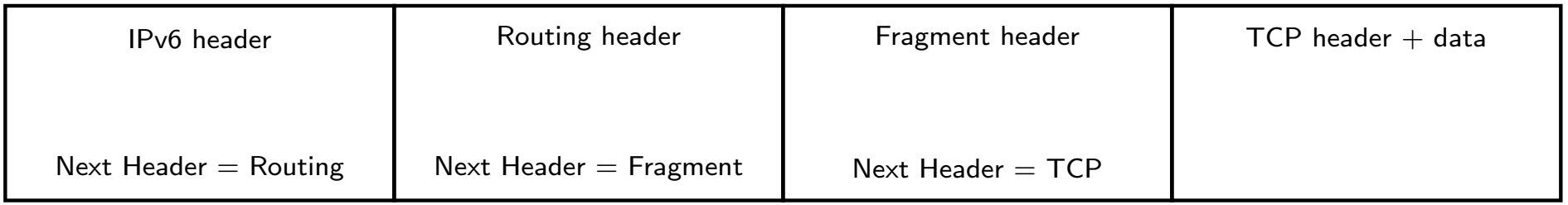
IPv6 Extension Headers

- Optional internet-layer information is encoded in separate headers
- Extension headers are placed between the IPv6 header and the upper-layer header
- Each extension header is identified by a distinct Next Header value
- An IPv6 packet may carry zero, one, or more extension headers
- Each header is identified by the Next Header field of the preceding header

IPv6 Extension Headers







Extension Headers

Order	Header Type	Next Header Code
1	Basic IPv6 Header	-
2	Hop-by-Hop Options	0
3	Destination Options	60
4	Routing	43
5	Fragment	44
6	Authentication	51
7	Encapsulation Security Payload	50
8	Destination Options	60
9	Mobility	135
-	No next header	59
Upper Layer	TCP	6
Upper Layer	UDP	17
Upper Layer	ICMPv6	58

Options

- Hop by Hop Options and Destination Options carry a variable number of options
- Options are encoded using TLV encoding
- Option Type: 8 bits
- Option Data Length: 8 bits
- Option Data: variable length field
- Options are processed in the order they appear in the header

Options

- Option Type:
  - Two highest-order bits specify the action that must be taken if the Option Type was not recognized
    - 00: skip over this option and continue processing the header
    - 01: discard the packet
    - 10: discard the packet and notify the sender by an ICMP message
    - 11: discard the packet and only notify the sender by an ICMP message if the destination is unicast
  - Third highest-order bit
    - 0: Option Data does not change en-route
    - 1: Option Data may change en-route
- Pad1 Option
  - Option Type: 0
  - It is used to insert 1 byte of padding into the Options area of a header
  - No Option Data Length and Option Data fields
- PadN Option
  - Option Type: 1
  - It is used to insert two or more (N) bytes of padding into the Options area of a header
  - Option Data Length has the value N-2

Hop by Hop Options Header

- It is used to carry optional information that must be examined by every node along a packet delivery path
- If present, this type of header must immediately follow the IPv6 header
- Next Header Code: 0
- It carries variable number of options field
- Options are encoded using TLV encoding

Destination Options Header

- The only header that may appear twice in the same packet
- For options to be processed by all nodes whose address appears in the IPv6 Destination Address field and in the Routing header.
- For options that must be processed only by the final destination of the packet.
- Next Header Code: 60

Routing Header

- Similar to Explicit Route Option in IPv4
- Next Header Code: 43

Fragment Header

- Fragmentation is done only the source node
- Next Header Code: 44

IPv6 Address Text Representation

- RFC 5952
- Leading Zeros in a 16-Bit Field must be suppressed
- :: Usage
  - Shorten as Much as Possible
  - Do not use it for handling One 16-Bit 0 Field
  - Choice in Placement of ::
- Lowercase

Addressing Architecture

- Prefix Notation
- Net-id (n bits)
- Subnet-id (m bits)
- n + m = 64 bits
- interface id (64 bits)
  - May be generated automatically from the MAC address
  - Insert 0xFFFE between vendor-id and serial number
  - Invert u bit

Addressing Architecture

- Unspecified Address
  - 0/128
- Loopback Address
  - ::1/128
- Link-local Address
  - FE80::/64
- Global Unicast Address
  - 2000::/3
- Multicast Address
  - FF00::/8