Exploration: IPv6

Introduction

We begin our final week on the Network Layer with a discussion of IPv6. The original motivation for IPv6 was that IPv4 was going to run out of addresses. People started predicting this in the early 90s, but this turned out not to be an issue, mainly because of NAT. There were other issues that the IETF wanted to address, and so they started a project called IP next Generation and solicited input from around the world on how IP addressing could be improved.

These are the major changes:

- The address space was increased (a lot!)
- Better support was added for audio and video
- Fragmentation was no longer allowed at the router (packet just dropped if too big)
- The checksum was removed (there's already a checksum at transport layer and the link layer, so its not needed)
- Options in IPv4 were added by increasing the length of the header. In IPv6, options were added by adding new headers. This makes it much easier to include new kinds of options.
- Also there is a new version of ICMP, with new message types and better cooperation between routers

Addresses

The most notable change with IPv6, is the increase in the address size. With an increase to 128 bits there should be enough addresses for several billion planets with the population of Earth that will last for the next million years. 3.4 x 10^38 addresses to be exact.

Colon Hex: IPv6 represents addresses in colon hexadecimal (colon hex), with /bits to specify the netmask (in the same way as IPv4). For example:

`69DC:8864:FFFF:FFFF:0:1280:8C0A:FFFF /64`

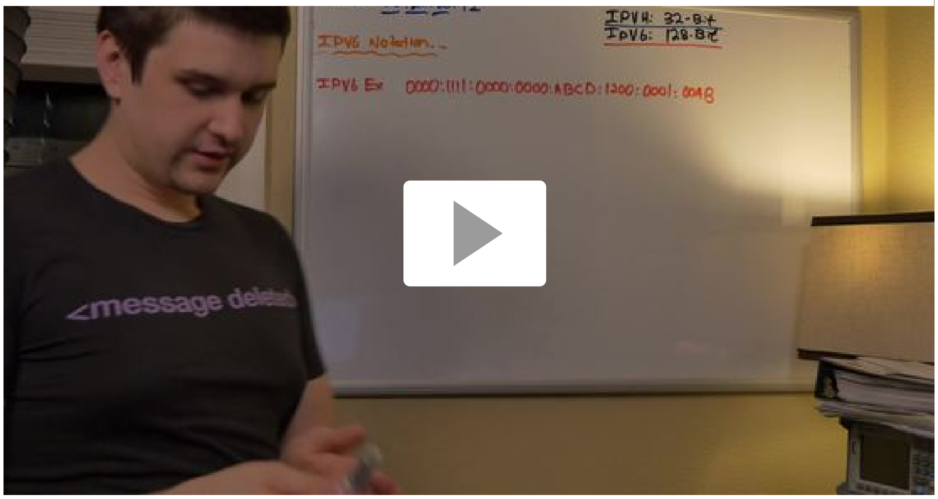
Zero-compression: With an IPv6 address, a series of zeroes can be indicated by two colons. For example:

`FF0C:0:0:0:0:0:0:B1 → FF0C::B1`

IPv4 addresses in IPv6: An IPv6 address with bits 1-80 set to 0, and bits 81-96 to 1, indicate that the remaining 32 bits contain an IPv4 address should be interpreted as an IPv4 address.

OSU student demonstration video

IPV4 and IPV6 truncations and conversions by Bradley Heenk



0:00 / 3:26

IPv6 Header

Base header (40 Bytes)

<table>
<tr><td>VERS</td><td>TRAFFIC CLASS</td><td colspan="2">FLOW LABEL</td></tr>
<tr><td colspan="2">PAYLOAD LENGTH</td><td>NEXT HEADER</td><td>HOP LIMIT</td></tr>
<tr><td colspan="4">SOURCE ADDRESS</td></tr>
<tr><td colspan="4">DESTINATION ADDRESS</td></tr>
</table>

The IPv6 header is always 40 bytes in length. The payload length, unlike IPv4, always refers to the length of the data EXCLUDING the 40-byte header. It contains the following fields:

VERSION (4 bits)
TRAFFIC CLASS (8 bits)
specifies the traffic class (used to specify priority)
FLOW LABEL (20 bits)
used to associate datagrams belonging to a flow or communication between two applications (helps packets to arrive in order)
PAYLOAD LENGTH (16 bits)
indicates the length of data (i.e. payload) excluding header
NEXT HEADER (8 bits)
type of first extension header
HOP LIMIT (8 bits) (old TTL)
specifies the maximum number of hops a packet can transit before being discarded

SOURCE ADDRESS (128 bits)
DESTINATION ADDRESS (128 bits)

The next header field specifies the type of the first extension header (if any). Headers are chained in this manner, in a very flexible format reminiscent of a linked-list.

IP Fragmentation

IPv6 fragmentation information is contained in a fragmentation extension header. This might seem inefficient, but in IPv6 the source (not intermediate routers) is responsible for fragmentation. The source determines the path MTU by sending probe messages of various sizes, and receiving return ICMP messages until the destination is reached. This information enables the source to construct datagrams that can fit within the path MTU.

Routers will simply drop datagrams larger than path MTU. If a datagram is dropped, an ICMP message will be sent to the source, and the source can update its MTU appropriately for the path.

Tunneling

The transition from IPv4 to IPv6 will be a slow one, taking many years. Our current internet technology is working well. Router upgrades are costly and it is out of the question that all routers would be upgraded at once.

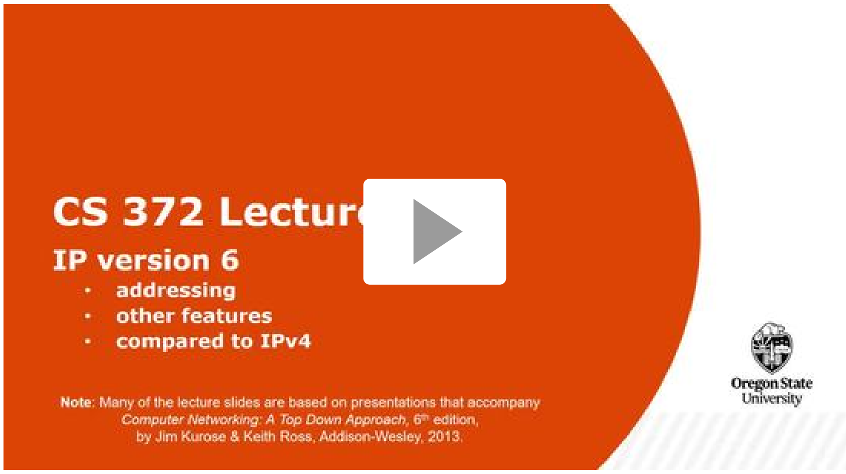
For now, IPv6, as it is adopted, will have to run on IPv4 routers. It does this by a process known as tunneling. IPv6 datagrams are carried (among IPv4 routers) as payload in an IPv4 datagram. This seems inefficient, and it is inefficient.

If an IPv4 router is in the way, then the entire IPv6 datagram will be placed in the payload of an IPv4 datagram. It may even be fragmented in IPv4, and not reassembled until it reaches the destination host or another IPv6 router. For now, this seems to be the best way to make the transition.

For more on IPv6 including more information on the header fields, be sure to view the video lecture, then test your knowledge with the Self-Check exercises.

Video Lecture

IP version 6



0:00 / 11:30 1x

(PDF (https://oregonstate.instructure.com/courses/1798856/files/83165273/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165273/download?wrap=1) |PPT (https://oregonstate.instructure.com/courses/1798856/files/83165048/download?wrap=1) (https://oregonstate.instructure.com/courses/1798856/files/83165048/download?wrap=1))

Self-Check Exercises

What are three significant changes from IPv4 to IPv6?

Turn

Card 1 of 6

Reuse <> Embed