

# Exploration: IP Header and Address Format

## Introduction



In this lecture we will be looking at IP addressing and the IP datagram format. The Internet Protocol is THE internet's network layer protocol. Here is the IP datagram header, attached to every datagram sent through the network:

- **VER** - version of IP (currently 4)
- **HEAD. LEN** - header length (number of 32-bit "lines")
- **SERVICE TYPE** - sender's preference for low latency, high reliability
- **LENGTH** - total bytes in datagram (including header)
- **IDENT, FLAGS, FRAG OFFSET** - used with fragmentation (later)
- **TTL** - *time to live*
  - decremented in each router
  - datagram discarded when TTL = 0
- **UPPER LAYER** - type of protocol carried in datagram
  - e.g., TCP, UDP
- **HEADER CHECKSUM** - 1s-complement of sum
- **SOURCE IP ADDRESS** - IP address of *original* source
- **DESTINATION IP ADDRESS** - IP address of *ultimate* destination
- **OPTIONS** – added in multiples of 32 bits (padded if necessary)
  - e.g., record route, timestamp
  - If no options, **HEAD LEN** = 5
- **DATA** – TCP or UDP segment (includes segment header)

### Datagram overhead

#### At least:

20 bytes of TCP/UDP  
20 bytes of IP  
= 40 bytes for every packet

ver	head. len	service type	length	
16-bit identifier			flgs	fragment offset
time to live		upper layer	header checksum	
32 bit source IP address				
32 bit destination IP address				
Options (if any)				
data (variable length, typically a TCP or UDP segment)				

Note that every datagram carries the source and destination address. A key aspect of a virtual network is a single, uniform address format. The address format must be independent of any particular hardware, because different technologies have different address formats. Addresses must be globally unique for all hosts and systems that are directly connected to the internet core.

Let's talk about IP address notation. The common "dotted address" is really just a 32 bit number, so each range is a byte. Recall a byte can go from 0 – 255. That's 00 to FF hex. Or 00000000 to 11111111 in binary.

A 32 bit number can hold 0 to 4,294,967,295, or about 4 billion addresses. Is that enough?

IP addresses have a hierarchy. Every ISP network in the internet is assigned a network address that is unique within the internet. This address includes an indicator for the number of bits used for network identification. In the address 128.193.35.0 / 24, the /24 indicates that 24 bits of the address will identify the ISP network. The /24 is known as the network prefix for reasons that we will see later. What are the remaining bits for?

Every host in a specific network is assigned a host number that is unique within that network. For example, 0.0.0.123.

The host's IP address is the *combination of the network address and host address*. If we take the ISP's network address 128.193.35.0 / 24 and the host number 0.0.0.123 and put them together, we have the full IP address of that host: 128.193.35.123 / 24. The full IP address is unique within the entire internet. This hierarchical addressing format enables efficient routing.

For more on IP addressing, including a closer look at address notation, be sure to watch the video lecture, and then test your knowledge with the Self-Check exercises below.

## Video Lecture


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### IP datagram IP addressing



([PDF \(https://oregonstate.instructure.com/courses/1798856/files/83165070/download?wrap=1\)](https://oregonstate.instructure.com/courses/1798856/files/83165070/download?wrap=1)) 

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## Self-Check Exercises

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What reliability services does the IP network-layer protocol implement?

- ☐ Acknowledgement and Retransmission
- ☐ Header Checksum
- ☐ Congestion Control
- ☐ Flow Control




**Theoretically, what is the maximum number of bytes of “payload” (actual application data) that can be transmitted in an IP datagram carrying a TCP segment?**

 Turn

Card 1 of 7



 Reuse     Embed



## Resources

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- **[More on IP fragmentation](https://networkengineering.stackexchange.com/questions/39643/ip-fragmentation-and-packet-headers)** [\\_\(https://networkengineering.stackexchange.com/questions/39643/ip-fragmentation-and-packet-headers\)](https://networkengineering.stackexchange.com/questions/39643/ip-fragmentation-and-packet-headers).
- **[More on the datagram structure](https://www.inetdaemon.com/tutorials/internet/ip/datagram_structure.shtml)** [\\_\(https://www.inetdaemon.com/tutorials/internet/ip/datagram\\_structure.shtml\)](https://www.inetdaemon.com/tutorials/internet/ip/datagram_structure.shtml)