

Internet Protocol

The Internet Protocol or IP:

- is the Network Layer of the ARPA protocol stack.
- is connectionless.
- is a best-effort, unreliable protocol.
- is intended to operate over a store and forward switching network.
- does not include routing.
- does not include error control directly.

What's Interesting

- First introduced in 1982.
- Has undergone minor changes until 1999 with IPv6.
- The packet format
- The addressing scheme
- The switching model
- The error control model
- How it handles fragmentation

Packet Format

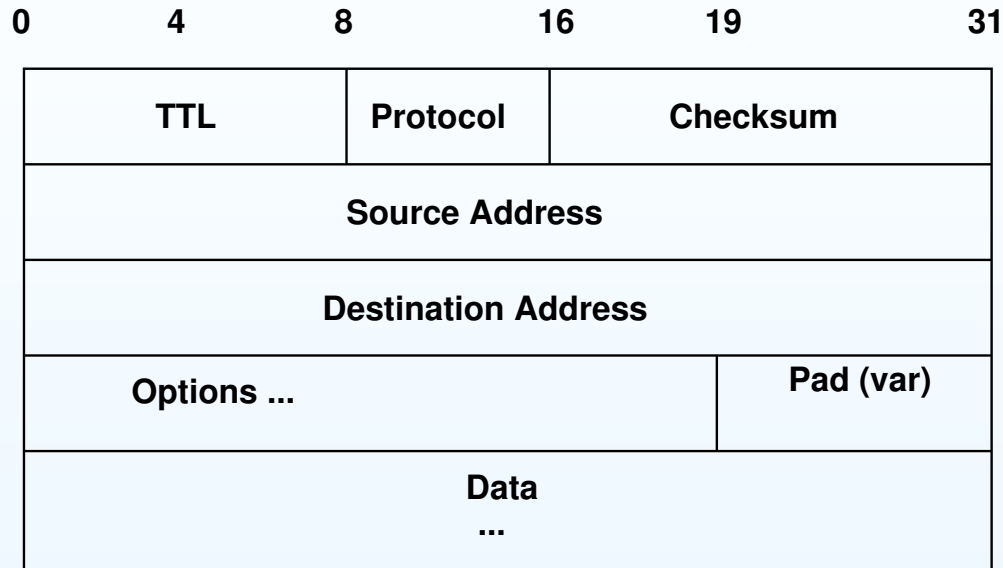
0	4	8	16	19	31
Version	Header Length	TOS	Total Length		
Identifier			Flags	Offset	
TTL		Protocol	Checksum		
Source Address					
Destination Address					
Options ...				Pad (var)	
Data ...					

Packet Format

0	4	8	16	19	31
Version	Header Length	TOS	Total Length		
Identifier			Flags	Offset	

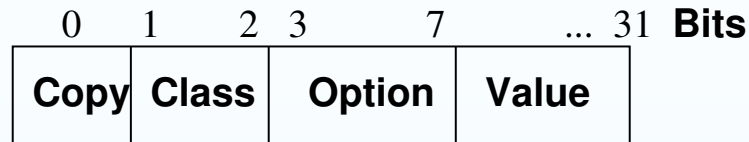
- Version for deciphering what follows.
- Header length in 32-bit words.
- TOS - Type of Service (3-bit precedence, 1-bit delay, 1-bit throughput, 1-bit reliability)
- Total length of the packet in bytes
- Identifier is a unique value for each packet
- Flags - Don't Fragments (DF), More Fragments (MF)
- Offset is the fragment offset

Packet Format



- Time To Live in hops
- Protocol is the protocol that initiated the packet (TCP, ...)
- Checksum is the ones complement of the one's complement sum of the 16-bit words in the header (without options).
- Source Address is the 32-bit IP address of the sender.
- Destination Address is the 32-bit IP address of the receiver.

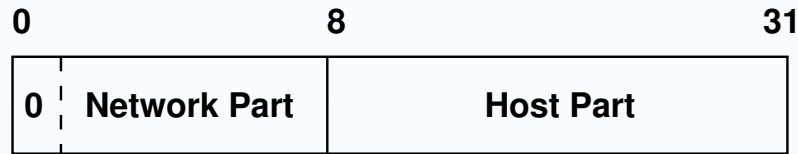
IP Options



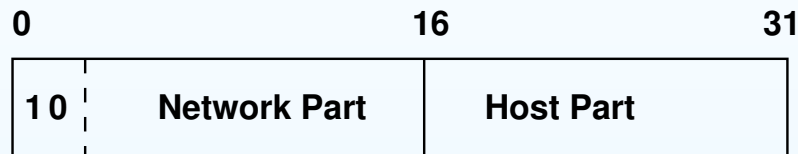
IP Option Format

Class	Option	Use	Function
0	0	End of Options	No more options
0	1	NOOP	Pad to 32-bit boundary
0	2	Security	Sets security options
0	3	Loose Source Route	Provides source route
0	7	Record Route	Record path followed
0	9	Strict Source Route	Provides source route
2	4	Timestamp	Provide timestamp

IP Addressing



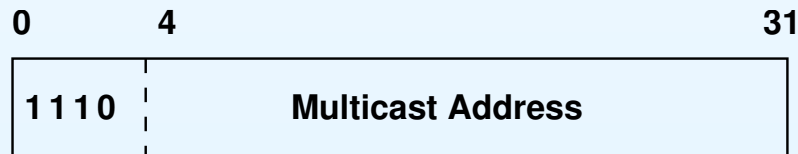
Class A IP Address



Class B IP Address



Class C IP Address



Class D IP Address

An address of all ones in the host or network indicates all recipients.

An address of all zeros is the self address.

Address Masking

- The IP address has only two levels of hierarchy which is often insufficient.
- The host part can be used any way that the local network wants.
- The address mask indicates which part of the address is network.

For example, if the address mask is 255.255.248.0 (FF.FF.F8.0),

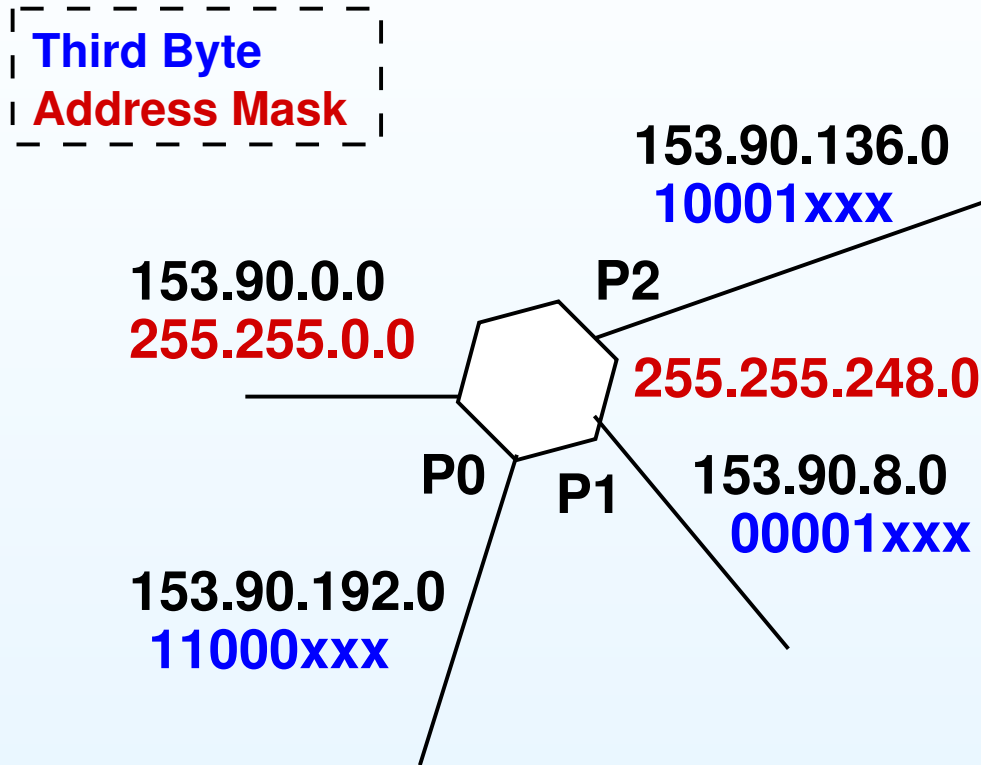
153.90.199.47 = 99.5A.C7.2F

99.5A.C7.2F & 255.255.248.0 = 99.5A.C0.00

Address Masking

- Backbone routers assume the standard address masks of:
 - 255.0.0.0 for class A
 - 255.255.0.0 for class B
 - 255.255.255.0 for class C
- Local routers use the local address mask which extends the network part.
- In a domain, the routers can have different address masks, although this is not necessary nor necessarily a good idea.

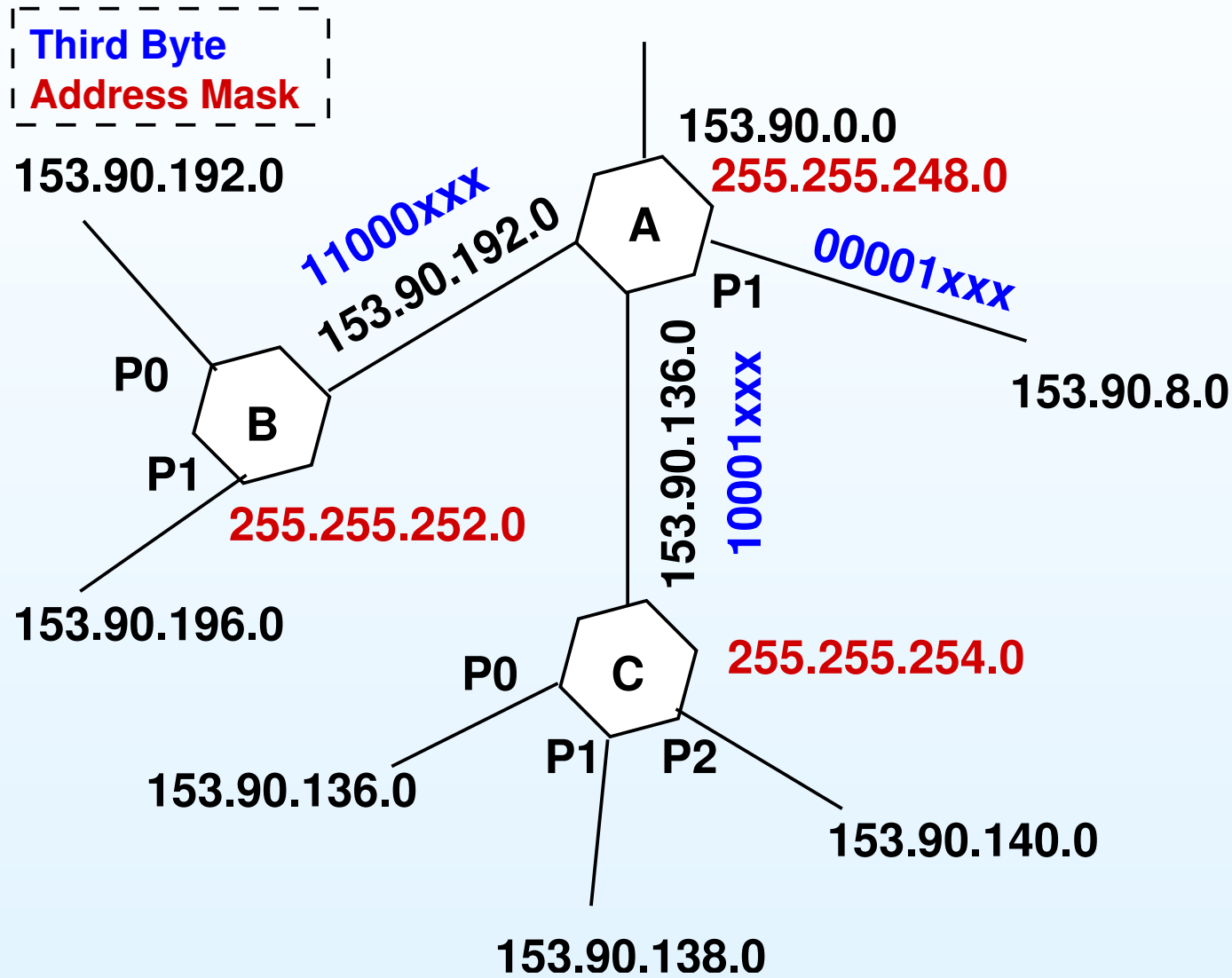
Address Masking Example



Routing Table

153.90.192.0	255.255.248.0	P0
153.90.8.0	255.255.248.0	P1
153.90.136.0	255.255.248.0	P2

Address Masking Example



Address Masking Example

Table for Router A

153.90.192.0	255.255.248.0	A
153.90.8.0	255.255.248.0	P1
153.90.136.0	255.255.248.0	C

Table for Router B

153.90.192.0	255.255.252.0	P0
153.90.196.0	255.255.252.0	P1

Table for Router B

153.90.136.0	255.255.254.0	P0
153.90.138.0	255.255.254.0	P1
153.90.140.0	255.255.254.0	P2