

OSI Reference Model, Layer 3

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IPv4 datagram format

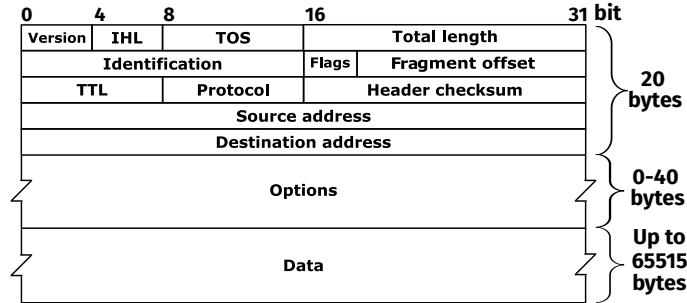


Figure 1: IP is an unreliable, connectionless protocol.

Header section	Size	Description
Identification	2-byte	Identifies fragments of the same datagram.
Flags	03-bit	Please, refer to the next table.
Fragment Offset	13-bit	Packet must be a multiple of 8-bytes.
Options	var	Header must be a multiple of 4-bytes.
Data	var	One of the these: ICMP, TCP, UDP, ESP, AH.

Flags	Size	Description
DF	1-bit	Useful for testing link-layer MTU.
MF	1-bit	Are there any more fragments left?

IPv4 reassembly

To prevent link-layer fragmentation, which significantly increases the chance of a fragment going missing, the source node typically tests the path first by sending the datagram with the DF flag, using the MTU of its local physical link. If the datagram needs to be fragmented along the way to reach its destination, it'll instead get disregarded and an ICMPv4 message "Destination Unreachable" will be returned. At this point, the source node tries again using a smaller datagram size, and continues until it finds the largest MTU that can be used on the path.

Reassembly of fragments is performed by initializing a buffer and a timer specific to fragments of the same datagram. Each time a fragment arrives, it gets offset and put inside the buffer: once the buffer is fully filled and the last fragment with the MF flag unset arrives, its content can be read. If the timer expires or one fragment goes missing, the entire datagram ends up being disregarded.

IPv4 addressing

Table 3: Total networks: 2,113,662. Total hosts: 16,843,002.

Class	Subnet mask	Decimal	Binary	Networks	Hosts
A	255.0.0.0	0-127	0xxx xxxx	$2^7 - 2$	$2^{24} - 2$
B	255.255.0.0	128-191	10xx xxxx	2^{14}	$2^{16} - 2$
C	255.255.255.0	192-224	110x xxxx	2^{21}	$2^8 - 2$

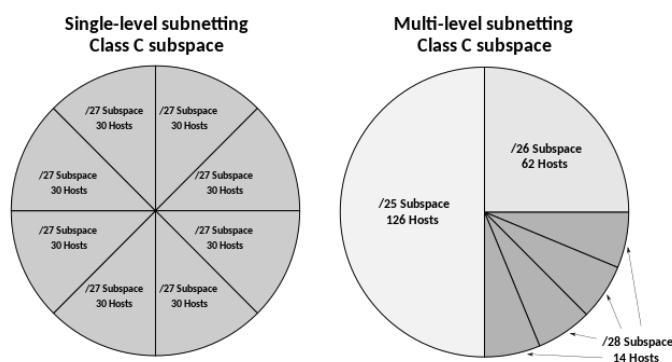


Figure 2: Classless addressing is multi-level subnetting extended to the entire internet.

ICMPv4 header format

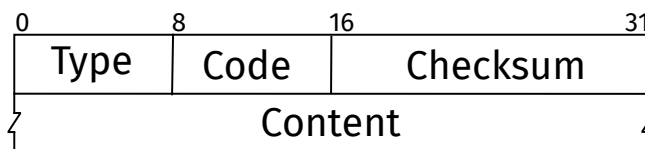


Figure 3: ICMP is IP's complementary protocol for when things don't go as expected.

Error message	Type	Description
Destination Unreachable	3	<ul style="list-style-type: none"> Network/Host/Protocol/Port Unreachable Communication Administratively Prohibited
Redirect	5	<ul style="list-style-type: none"> Network/Host Redirect Datagrams
Parameter Problem	12	<ul style="list-style-type: none"> Pointer To Error In The Original Datagram Missing Required Option Or Bad Length

NAT, private addresses

Inside/Outside address	Local/Global address
It refers to the location of the address.	It refers to the instance of the address.

Traditional NAT	Overloading NAT	Overlapping NAT
Dynamically translates inside addresses.	Dynamically translates inside sockets.	Dynamically translates inside/outside addresses.

IPSEC transport/tunnel

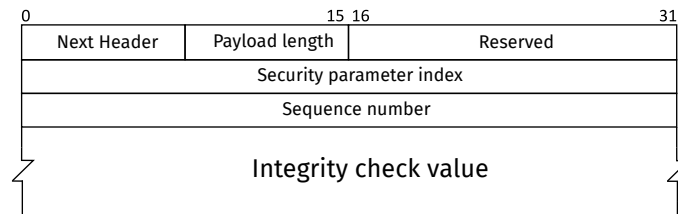


Figure 4: AH guarantees the authenticity of a datagram.

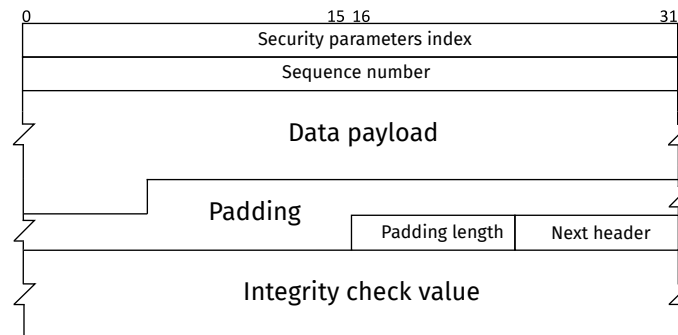


Figure 5: ESP guarantees the secrecy of a datagram.

Security policies	Security associations	Security parameter index
Set of rules built into the protocol itself.	Set of algorithms and keys between devices.	Identifies a particular connection using SA.

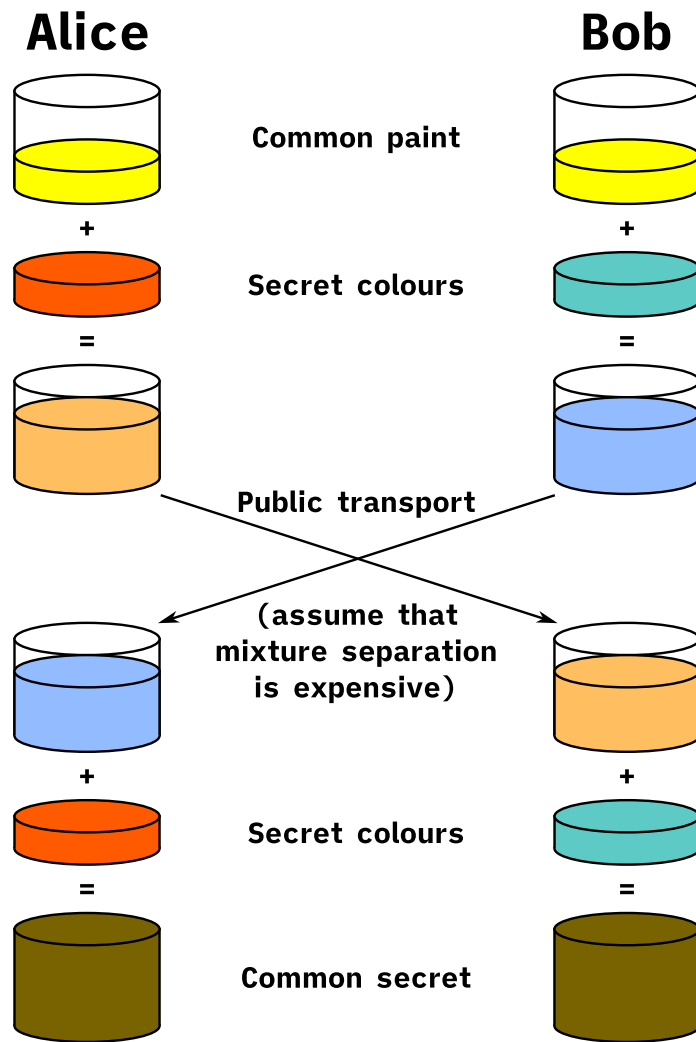


Figure 6: IKE's phase 1 generates a shared secret using Diffie-Hellman, used in phase 2 for symmetric-key derivation.