

Best-Effort Delivery

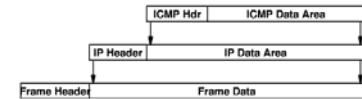
- IP datagrams may be lost, duplicated, delayed, delivered out of order, or delivered with corrupted data.
- The Internet Protocol does not attempt to correct problem packets.
- Higher layers of protocol software are required to handle each of these errors.

Internet Control Message Protocol

- **ICMP** is an error reporting and network management system.
- ICMP attempts to keep the Internet running as efficiently as possible.
- ICMP works to correct network problems, although does not try to correct individual packet problems.

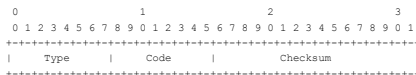
ICMP Packets

- ICMP packets are sent in IP Datagrams. They have no special priority, although an error in an IP packet never creates an error message.



- * Two levels of encapsulation that occur when an ICMP message is sent.
- * The ICMP message is encapsulated in a datagram, which is encapsulated in a frame for transmission across a physical network.

ICMP Header



- The **Type** field indicates the type of ICMP message.
- The **Code** field provides data specific to the type.
- The **Checksum** detects errors in the ICMP packet.

Type	Name
0	Echo Reply
1	Unassigned
2	Unassigned
3	Destination Unreachable
4	Source Quench
5	Redirect
6	Alternate Host Address
7	Unassigned
8	Echo
9	Router Advertisement
10	Router Selection
11	Time Exceeded
12	Parameter Problem
13	Timestamp
14	Timestamp Reply
15	Information Request
16	Information Reply
17	Address Mask Request
18	Address Mask Reply
19	Reserved (for Security)
20-29	Reserved (for Robustness Experiment)
30	Traceroute
31	Datagram Conversion Error
32	Mobile Host Redirect
33	IPv6 Where-Are-You
34	IPv6 I-Am-Here
35	Mobile Registration Request
36	Mobile Registration Reply
37-255	Reserved

ICMP Message Types

- Each message is identified by an 8-bit type field.

Some Uses for ICMP

1. Echo (ping)
2. Tells the source a packet exceeded the TTL.
3. Tell the source that a packet had to be fragmented.
4. Redirect the host to a better router.
5. Controls the rate at which a host sends packets. (Source Quench)
6. Tell the source the destination is unreachable. Either the network or the host is down.
7. Request subnet mask.

Ping

- The ping utility sends ICMP packets with the echo function to a remote computer.
- When a computer receives an ICMP echo packet, it sends it back to the host that sent it.
- Ping times how long it takes to get a reply to make a simple measure of network performance.

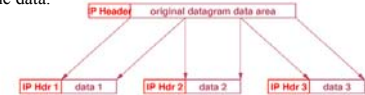
Traceroute

- Traceroute measures the number of hops required to reach a destination.
- Traceroute sends an IP packet with the Time To Live (TTL) value set to 1.
- When a router decrements the TTL to zero, it discards the packet and sends an ICMP packet to the source to inform it of the problem.
- Traceroute repeats this with increasing numbers TTL values.

MTU

(Maximum Transmission Unit)

- When a router receives a datagram that is larger than the MTU of the network over which it is to be sent, the router divides the datagram into smaller pieces called fragments.
- Each fragment uses the IP datagram format, but carries only part of the data.

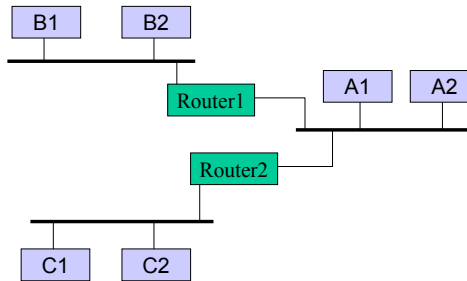


An IP datagram divided into three fragments. Each fragment carries some data from the original datagram, and has an IP header similar to the original datagram.

MTU

- ICMP can be used to determine maximum the MTU along a path.
- Sending packets with the “do not fragment” flag will cause a node to send an ICMP message back to the source when a packet needs to be fragmented. The ICMP message includes the maximum packet size allowed at that point.
- IP can adjust to sending packets that won't fragment along the way.

Multiple Router Network



Router Redirection

- If A1 wants to send a packet to a computer on network B, it will have to send the packet to a router.
- If A1 sends the packet to router 2, router 2 will send the packet to router 1 and will send an ICMP message to the source to inform it of the correct router to use.