Best Effort Delivery

- IP uses best-effort delivery
  - IP makes an attempt to deliver
  - IP does not guarantee delivery
- In an internet, gateways become overrun or change routes, meaning that:
  - Datagrams can be lost
  - Datagrams can be duplicated
  - Datagrams can arrive out of order or scrambled
- Motivation: allow IP to operate over the widest possible variety of physical networks
- In practice
  - Errors are the exception, not the rule
  - IP is designed to *tolerate* errors in the underlying hardware; it does not introduce them

IP Error Detection And Reporting Mechanisms

- As we've seen, the IP Header checksum detects transmission errors
- Other errors can occur
  - Packets sent to invalid IP address
  - Packets discarded due to errors
  - Packets sent to host that is unreachable
- Higher level protocols (such as TCP) must handle problems
- We need a mechanism to report the errors

ICMP Error Reporting Mechanism

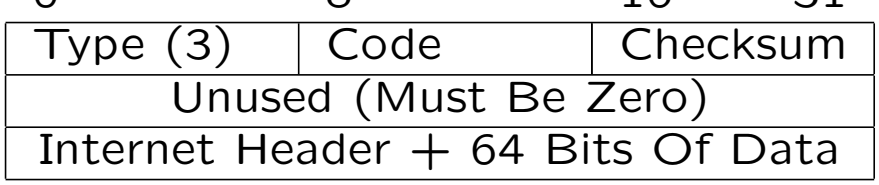
- Called Internet Control Message Protocol (ICMP)
- ICMP is an integral part of IP
- Used mostly by gateways to report delivery or routing problems to original source
- Uses IP to carry control messages
- No error messages about error messages

ICMP Message Types

Type Field	ICMP Message Type
0	Echo reply
3	Destination unreachable
4	Source quench
5	Redirect (change a route)
8	Echo request
9	Router advertisement
10	Router solicitation
11	Time exceeded for a datagram
12	Parameter problem on a datagram
13	Timestamp request
14	Timestamp reply
15	Information request (obsolete)
16	Information reply (obsolete)
17	Address mask request
18	Address mask reply

Example ICMP Message Format Destination Unreachable

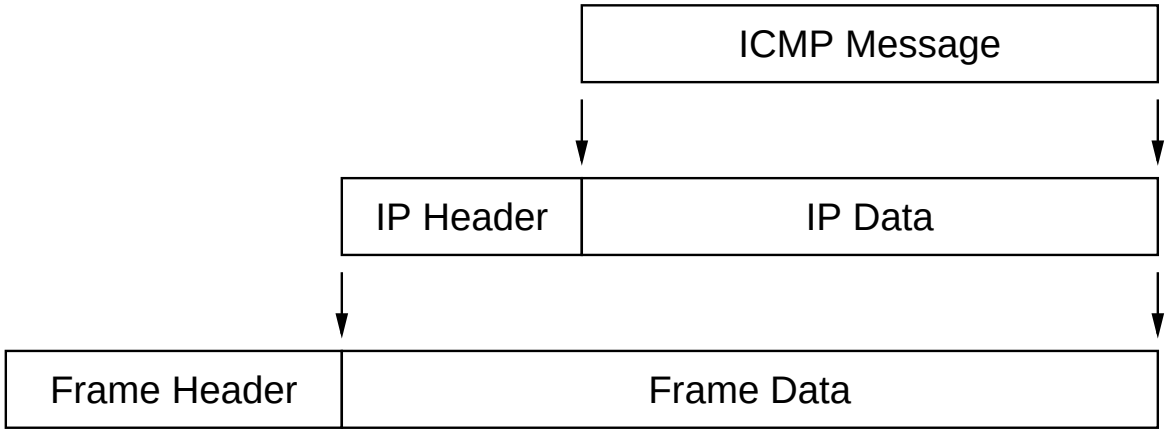
- Example Format - Destination Unreachable



- Types of destination unreachable

Code Field	Meaning
0	Network unreachable
1	Host unreachable
2	Protocol unreachable
3	Port unreachable
4	Fragmentation needed and DF set
5	Source route failed
6	Destination network unknown
7	Destination host unknown
8	Source host isolated
9	Communication with destination network administratively prohibited
10	Communication with destination host administratively prohibited
11	Network unreachable for type of service
12	Host unreachable for type of service

ICMP Message Encapsulation



- ICMP message has header and data areas
- Complete ICMP message is treated as data in IP datagram
- Complete IP datagram is treated as data in physical network frame

Example Of ICMP Encapsulation In An Ethernet Frame

```
02 07 01 00 27 ba 08 00 2b 0d 44 a7 08 00 45 00
00 54 82 68 00 00 ff 01 35 21 84 eb 01 01 84 eb
01 02 08 00 73 0b d4 6d 00 00 04 3b 8c 28 28 20
0d 00 08 09 0a 0b 0c 0d 0e 0f 10 11 12 13 14 15
16 17 18 19 1a 1b 1c 1d 1e 1f 20 21 22 23 24 25
26 27 28 29 2a 2b 2c 2d 2e 2f 30 31 32 33 34 35
36 37
```

- ICMP header follows IP header, and contains eight bytes
- ICMP type field specifies echo request message (08)
- ICMP sequence number is zero