

PART VIII

**ERROR AND CONTROL
MESSAGES
(ICMP)**

Errors In Packet Switching Networks

- Causes include
 - Temporary or permanent disconnection
 - Hardware failures
 - Router overrun
 - Routing loops
- Need mechanisms to detect and correct

Error Detection And Reporting Mechanisms

- IP header checksum to detect transmission errors
- Error reporting mechanism to distinguish between events such as lost datagrams and incorrect addresses
- Higher level protocols (i.e., TCP) must handle all other problems

Error Reporting Mechanism

- Named *Internet Control Message Protocol (ICMP)*
- Required and integral part of IP
- Used primarily by routers to report delivery or routing problems to original source
- Also includes informational (nonerror) functionality
- Uses IP to carry control messages
- No error messages sent about error messages

ICMP Purpose

The Internet Control Message Protocol allows a router to send error or control messages to the source of a datagram, typically a host. ICMP provides communication between the Internet Protocol software on one machine and the Internet Protocol software on another.

Error Reporting Vs. Error Correction

- ICMP does not
 - Provide interaction between a router and the source of trouble
 - Maintain state information (each packet is handled independently)
- Consequence

When a datagram causes an error, ICMP can only report the error condition back to the original source of the datagram; the source must relate the error to an individual application program or take other action to correct the problem.

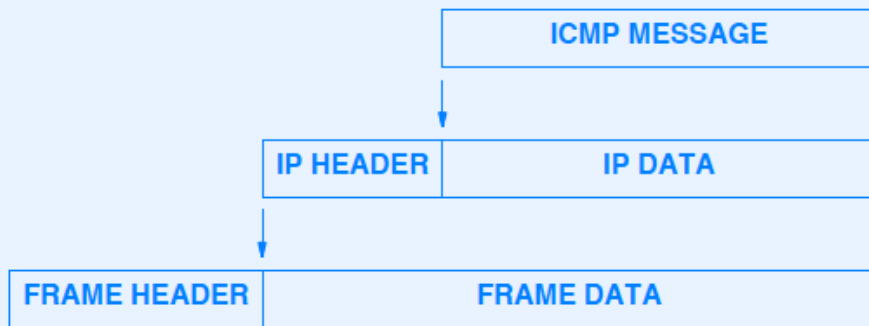
Important Restriction

- ICMP only reports problems to original source
- Discussion question: what major problem in the Internet cannot be handled with ICMP?

ICMP Encapsulation

- ICMP message travels in IP datagram
- Entire ICMP message treated as data in the datagram
- Two levels of encapsulation result

ICMP Message Encapsulation



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

Example Encapsulation In Ethernet

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 80 0a 02 03 80 0a
02 08 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

ICMP Message Format

- Multiple message types
- Each message has its own format
- Messages
 - Begin with 1-octet TYPE field that identifies which of the basic ICMP message types follows
 - Some messages have a 1-octet CODE field that further classifies the message
- Example
 - TYPE specifies destination unreachable
 - CODE specifies whether host or network was unreachable

ICMP Message Types

| <u>Type Field</u> | <u>ICMP Message Type</u> |
|-------------------|---------------------------------|
| 0 | Echo Reply |
| 3 | Destination Unreachable |
| 4 | Source Quench |
| 5 | Redirect (change a route) |
| 6 | Alternate Host Address |
| 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 |
| 16 | Information Reply |
| 17 | Address Mask Request |
| 18 | Address Mask Reply |

ICMP Message Types (continued)

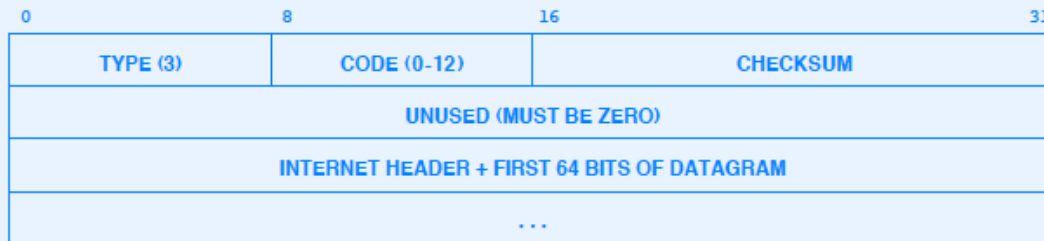
| <u>Type Field</u> | <u>ICMP Message Type</u> |
|-------------------|-----------------------------|
| 30 | Traceroute |
| 31 | Datagram Conversion Error |
| 32 | Mobile Host Redirect |
| 33 | IPv6 Where-Are-You |
| 34 | IPv6 I-Am-Here |
| 35 | Mobile Registration Request |
| 36 | Mobile Registration Reply |
| 37 | Domain Name Request |
| 38 | Domain Name Reply |
| 39 | SKIP |
| 40 | Photuris |

Example ICMP Message (ICMP Echo Request)

| | | | |
|---------------|---|-----------------|----------|
| 0 | 8 | 16 | 31 |
| TYPE (8 or 0) | | CODE (0) | CHECKSUM |
| IDENTIFIER | | SEQUENCE NUMBER | |
| OPTIONAL DATA | | | |
| ... | | | |

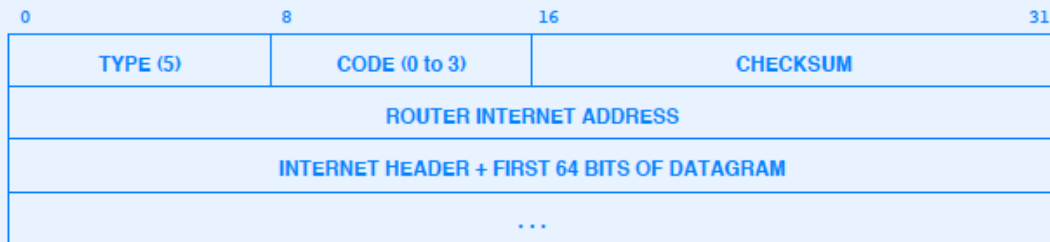
- Sent by *ping* program
- Used to test reachability

Example ICMP Message (Destination Unreachable)



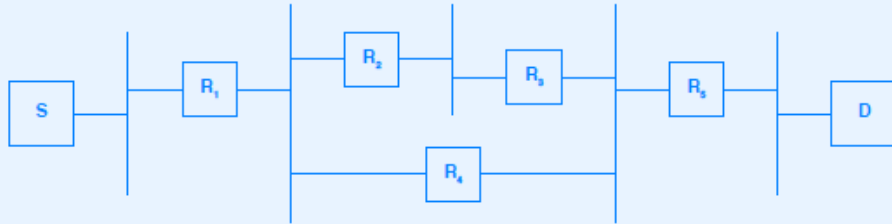
- Used to report that datagram could not be delivered
- Code specifies details

Example ICMP Message (Redirect)



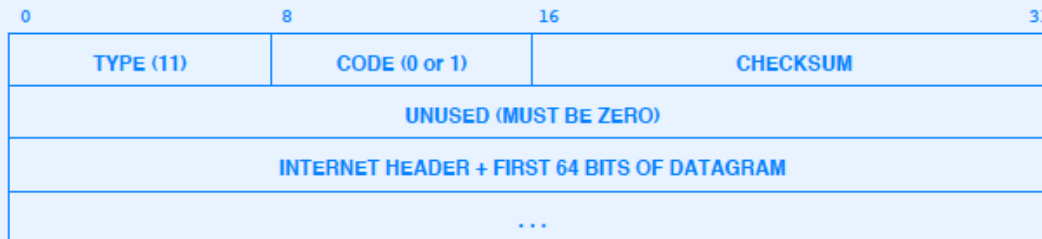
- Used to report incorrect route

Situation Where An ICMP Redirect Cannot Be Used



- R_5 cannot redirect R_1 to use shorter path

Example ICMP Message (Time Exceeded)



- At least one fragment failed to arrive, or
- TTL field in IP header reached zero

ICMP Trick

- Include datagram that caused problem in the error message
 - Efficient (sender must determine how to correct problem)
 - Eliminates need to construct detailed message
- Problem: entire datagram may be too large
- Solution: send IP header plus 64 bits of data area (sufficient in most cases)

Summary

- ICMP
 - Required part of IP
 - Used to report errors to original source
 - Reporting only: no interaction or error correction
- Several ICMP message types, each with its own format
- ICMP message begins with 1-octet TYPE field
- ICMP encapsulated in IP for delivery