

**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**

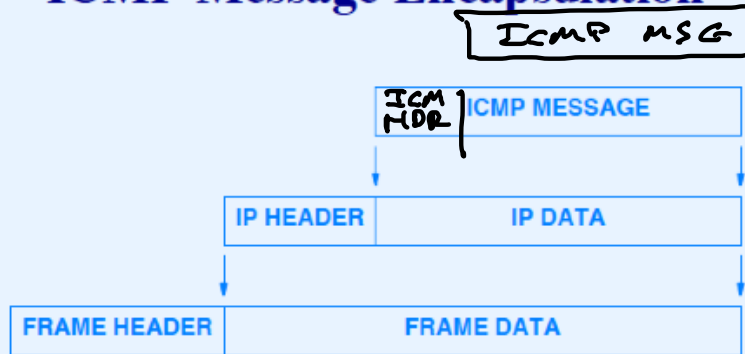
- ICMP only reports problems to original source
- Discussion question: what major problem in the Internet cannot be handled with ICMP?

## **ICMP Encapsulation**

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

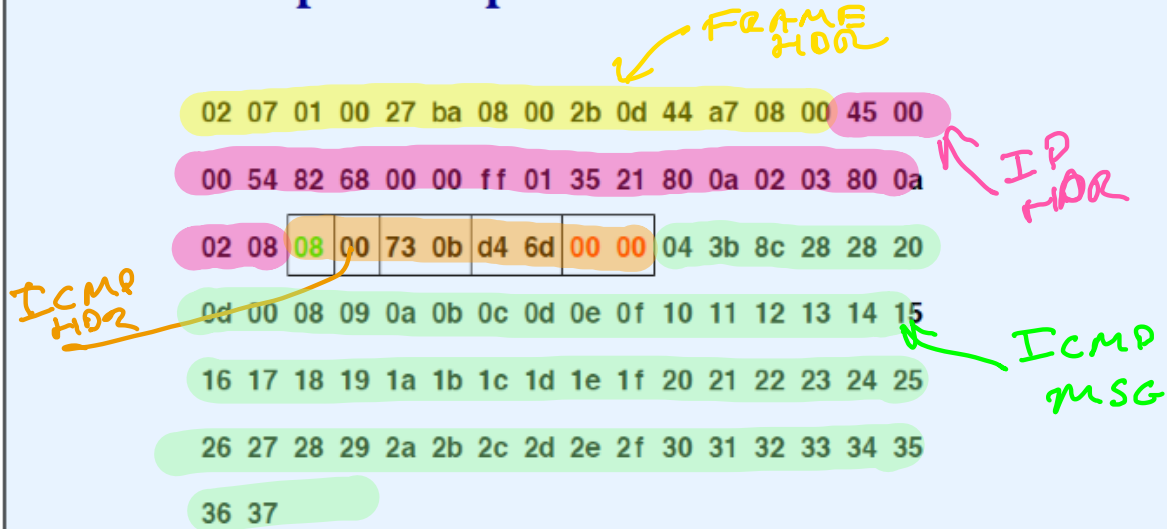


## ICMP Message Encapsulation



- 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



- 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

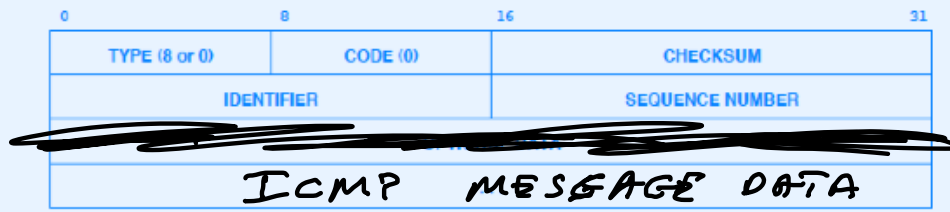
## ICMP Message Types

<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)

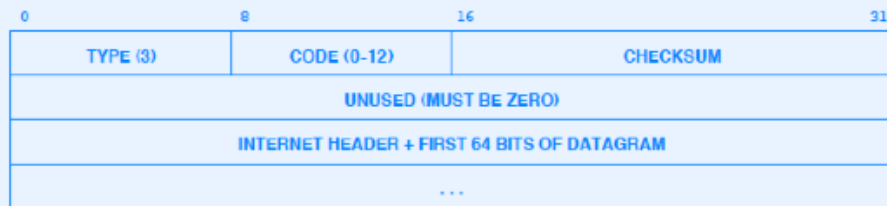
<u>Type Field</u>	<u>ICMP Message Type</u>
30	Traceroute
31	Datagram Conversion Error
32	Mobile Host Redirect
33	IPv6 Where-Are-You
34	IPv6 I-Am-Here
35	Mobile Registration Request
36	Mobile Registration Reply
37	Domain Name Request
38	Domain Name Reply
39	SKIP
40	Photuris

## Example ICMP Message (ICMP Echo Request)



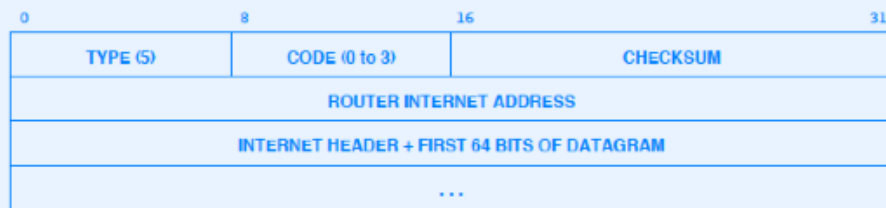
- Sent by *ping* program
- Used to test reachability

## Example ICMP Message (Destination Unreachable)



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

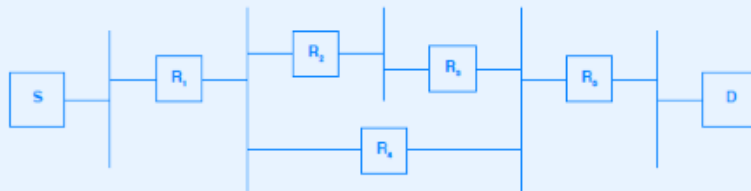
## Example ICMP Message (Redirect)



- Used to report incorrect route

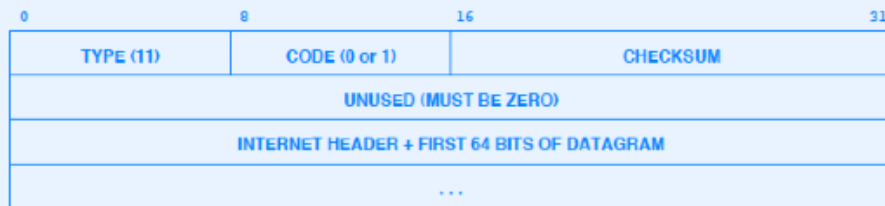


## Situation Where An ICMP Redirect Cannot Be Used



- $R_5$  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