INTERNET CONTROL MESSAGE PROTOCOL

OVERVIEW

Internet Control Message Protocol (ICMP)

Used by hosts & routers to communicate network-level information

- error reporting
  - unreachable host, network, port, protocol
- echo request/reply
  - used by ping
- network-layer above IP
  - ICMP msgs carried in IP pkts

ICMP message

- ICMP header: 8 bytes
- Start with type and code fields

Type	Code	Description
0	0	echo reply (ping)
3	0	dest. network unreachable
3	1	dest host unreachable
3	2	dest protocol unreachable
3	3	dest port unreachable
3	6	dest network unknown
3	7	dest host unknown
4	0	source quench (congestion control - not used)
8	0	echo request (ping)
9	0	route advertisement
10	0	router discovery
11	0	TTL expired
12	0	bad IP header

Ping Implementations

Sender

Send ICMP echo with the current timestamp

Destination

Send ICMP reply (with the original payload in ICMP echo copied)

Sender

Get the current time

Get the time carried in ICMP reply

Difference: one instance of RTT

See more details in PA2 document

NETWORK PROGRAMMING

BIT-WISE OPERATIONS IN PYTHON

Bit-wise operations on variables

x << y

- returns x with bits shifted to left by y places
  - new bits on right-hand-side are zeros
  - same as multiplying x by 2^y

x >> y

- returns x with bits shifted to right by y places
  - same as dividing x by 2^y

x & y

- does a bitwise and
  - each bit of output is 1 if corresponding bit of x AND of y is 1, otherwise 0

~ x

- returns complement of x
  - number you get by switching each 1 for 0 and each 0 for 1

E.g.,

- use to pack ip_version and ip header length into 8 bits

https://wiki.python.org/moin/BitwiseOperators
https://www.tutorialspoint.com/python3/bitwise_operators_example.htm

Traceroute and ICMP

Source sends series of UDP datagram to destination

- first set has TTL =1
- second set has TTL=2, etc.
- unlikely port number

When *n*th set arrives to nth router

- router discards and sends source ICMP message (type 11, code 0)
- ICMP message includes name of router & IP address

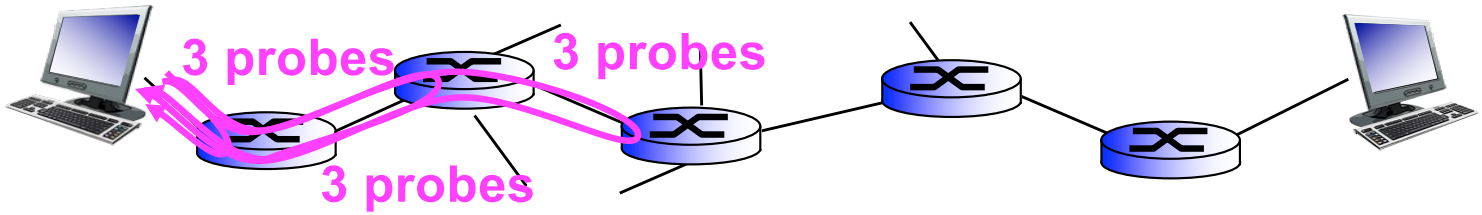
When ICMP msg arrives

- source records RTTs

Stopping criteria

UDP datagram eventually arrives at dst host

- dst returns ICMP "port unreachable" message
- source stops



Traceroute Example Implementations

Send UDP datagram

Intermediate routers

- respond with ICMP TTL expired

Final destination

- responds with ICMP “port unreachable” message

Can also use TCP segments (to pass firewalls)

Approach: similar as UDP

Send segments using ICMP echo

Intermediate routers

- respond with ICMP TTL expired

Final destination

- responds with ICMP echo reply