

# TCP/IP 通訊協定及應用

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中央大學 吳曉光博士  
<http://wmlab.csie.ncu.edu.tw/course/tcp>

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## Chapter 7: Ping Program

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### Introduction

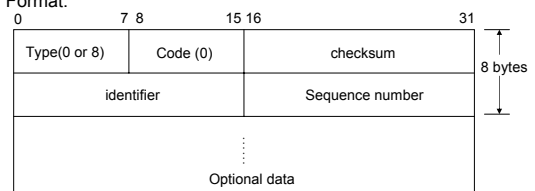
- ◆ The Ping program was written by Mike Muuss and it tests whether another host is reachable.
- ◆ The program sends an ICMP echo request message to a host, expecting an ICMP echo reply to be return.
- ◆ If you can't Ping a host, you won't be able to Telnet or FTP to that host. Conversely, if you can't Telnet to a host, Ping is often the starting point to determine what the problem is.
- ◆ Ping also measures the round-trip time to the host, giving us some indication of how "far away" that host is.

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### Ping program

- ◆ Client: the ping program that sends the echo requests  
Server: the host be pinged
- ◆ The server is not a user process.
- ◆ Format:



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- ◆ Unix implementations of ping set the *identifier* field in the ICMP message to the process ID of the sending process.
- ◆ The sequence number starts at 0 and is increased every time a new echo request is sent.
  - Ping prints the sequence number of each returned packet, allowing us to see if packets are missing, reordered, or duplicated.

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- ◆ Example: LAN Output

```
bsdi % ping svr4
PING svr4 (140.252.13.34): 56 data bytes
64 bytes from 140.252.13.34: icmp_seq=0 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=1 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=2 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=3 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=4 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=5 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=6 ttl=255 time=0 ms
64 bytes from 140.252.13.34: icmp_seq=7 ttl=255 time=0 ms
^?
--- svr4 ping statistics ---
8 packets transmitted, 8 packets received, 0% packet loss
round-trip min/avg/max = 0/0/0 ms
```

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- Shows the tcpdump output for this example:

1	0.0		bsdr-svr4: icmp: echo request
2	0.003733(0.0037)	b	bsdr-bdsi: icmp: echo reply
3	0.998045(0.99943)		bsdr-svr4: icmp: echo request
4	1.001747(0.0037)		svr4-bdsi: icmp: echo reply
5	1.997818(0.99961)		bsdr-svr4: icmp: echo request
6	2.001542(0.0037)		svr4-bdsi: icmp: echo reply
7	2.997610(0.9961)		bsdr-svr4: icmp: echo request
8	3.001311(0.0037)		svr4-bdsi: icmp: echo reply
9	3.997390(0.9961)		bsdr-svr4: icmp: echo request
10	4.001115(0.0037)		svr4-bdsi: icmp: echo reply
11	4.997201(0.9961)		bsdr-svr4: icmp: echo request
12	5.000904(0.0037)		svr4-bdsi: icmp: echo reply
13	5.996977(0.9961)		bsdr-svr4: icmp: echo request
14	6.000708(0.0037)		svr4-bdsi: icmp: echo reply
15	6.996764(0.9961)		bsdr-svr4: icmp: echo request
16	7.000479(0.0037)		svr4-bdsi: icmp: echo reply

## IP Record Route Option

- ◆ Most versions of ping provide the `-R` option that enables the record route(RR) feature.
- ◆ The big problem is the limited room in the IP header for the list of IP addresses.

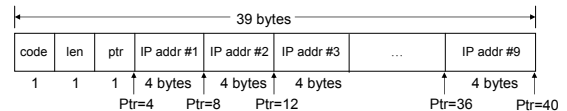
$$60 - 20 - 3 = 37$$

→ Allow up to 9 IP addresses

- RR option uses 3 bytes for overhead

the fixed size of the IP header  
 minimum IP header length

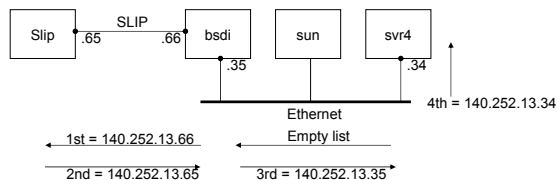
- ◆ General format:



- **Code:** a 1-byte field specifying the type of IP option.
- **Len:** the total number of bytes of the RR option.
- **Ptr:** be called the pointer field. It is a 1-based index into the 39-byte option for where to store the next IP address. Its minimum value is 4, which is the pointer to the first IP address.
- RFC 791 [Postel 1981a] specifies that the router records the outgoing IP address.

- ◆ Normal Example

```
Svr4 % ping -R slip
PING slip (140.252.13.65): 56 data bytes
64 bytes from 140.252.13.65: icmp_seq=0 ttl=254 time=280 ms
RR:      bdsi      (140.252.13.66)
          slip      (140.252.13.65)
          bdsi      (140.252.13.35)
          svr4      (140.252.13.34)
64 bytes from 140.252.13.65: icmp_seq=1 ttl=254 time=280 ms (same route)
64 bytes from 140.252.13.65: icmp_seq=2 ttl=254 time=270 ms (same route)
^?
--- slip ping statistics ---
3 packets transmitted, 3 packets received, 0% packet loss
Round-trip min/avg/max = 270/276/280 ms
```



- We can watch this exchange of packets from the host sun, running tcpdump with its -v option (to see the IP options).

1	0.0	svr4>slip: icmp: echo request (ttl 32, id 35835, optlen=40 RR{39}=RR{#0.0.0.0/0.0.0.0/0.0.0.0/ 0.0.0.0/0.0.0.0/0.0.0.0/0.0.0.0/0.0.0.0/} EOL)
0.267746 (0.2677)		slip>svr4: icmp: echo reply (ttl 254, id 1976, optlen=40 RR{39}=RR{140.252.13.66/140.252.13.65/ 140.252.13.35/#0.0.0.0/0.0.0.0/0.0.0.0/0.0.0.0/ 0.0.0.0/0.0.0.0/} EOL}

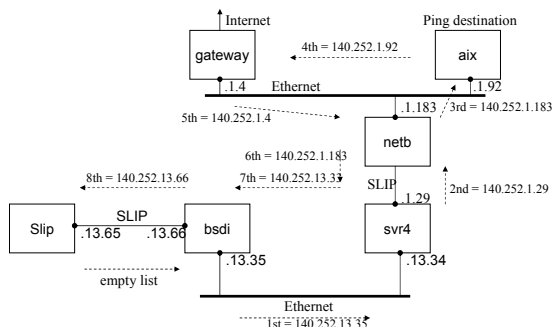
### Abnormal Output

```

Slip % ping -R aix
PING aix (140.252.1.92): 56 data bytes
64 bytes from 140.252.1.92: icmp_seq=0 ttl=251 time=650 ms
RR:
    bsd1 (140.252.13.35)
    sun (140.252.1.29)
    netb (140.252.1.183)
    aix (140.252.1.92)
    gateway (140.252.1.4)
    netb (140.252.1.183)
    sun (140.252.1.33)
    bsd1 (140.252.1.66)
    slip (140.252.1.65)

64 bytes from aix: icmp_seq=1 ttl=251 time=610 ms (same route)
64 bytes from aix: icmp_seq=2 ttl=251 time=600 ms (same route)
^?
--- aix ping statistics ---
4 packets transmitted, 3 packets received, 25% packet loss
round-trip min/avg/max = 600/652/650 ms

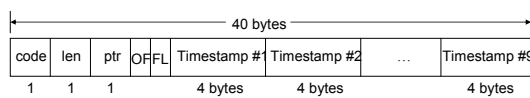
```



## IP Timestamp Option

- The IP timestamp option is similar to the record route option.

#### Format:



- len: the total length of option (normally 36 or 40)
- ptr: a pointer to the next available entry (5, 9, 13, etc.)
- OF: overflow, if a router can't add a timestamp because there's no room left, it just increments the overflow field.
- FL: flag, the operation of the timestamp option is driven by the flags field

Flags	Description
0	Record only timestamps.
1	Each router records its IP address and its timestamp. There is room for only four of these pairs in the options list.
3	The sender initializes the options list with up to four of IP address and a 0 timestamp. A router records its timestamp only if the next IP address in the list matches the router's.

## Summary

- The Ping program is the basic connectivity test between two systems running TCP/IP.
- It uses the ICMP echo request and echo reply messages and does not use a transport layer.
- The Ping server is normally part of the kernel's ICMP implementation.
- We looked at the normal ping output for a LAN, WAN, and SLIP links, and performed some serial line throughput calculations for a dedicated SLIP link.
- Ping also let us examine and use the IP record route option.
- We also looked at the IP timestamp option, but it is of limited practical use.