CS321: Computer Networks

IP, ICMP

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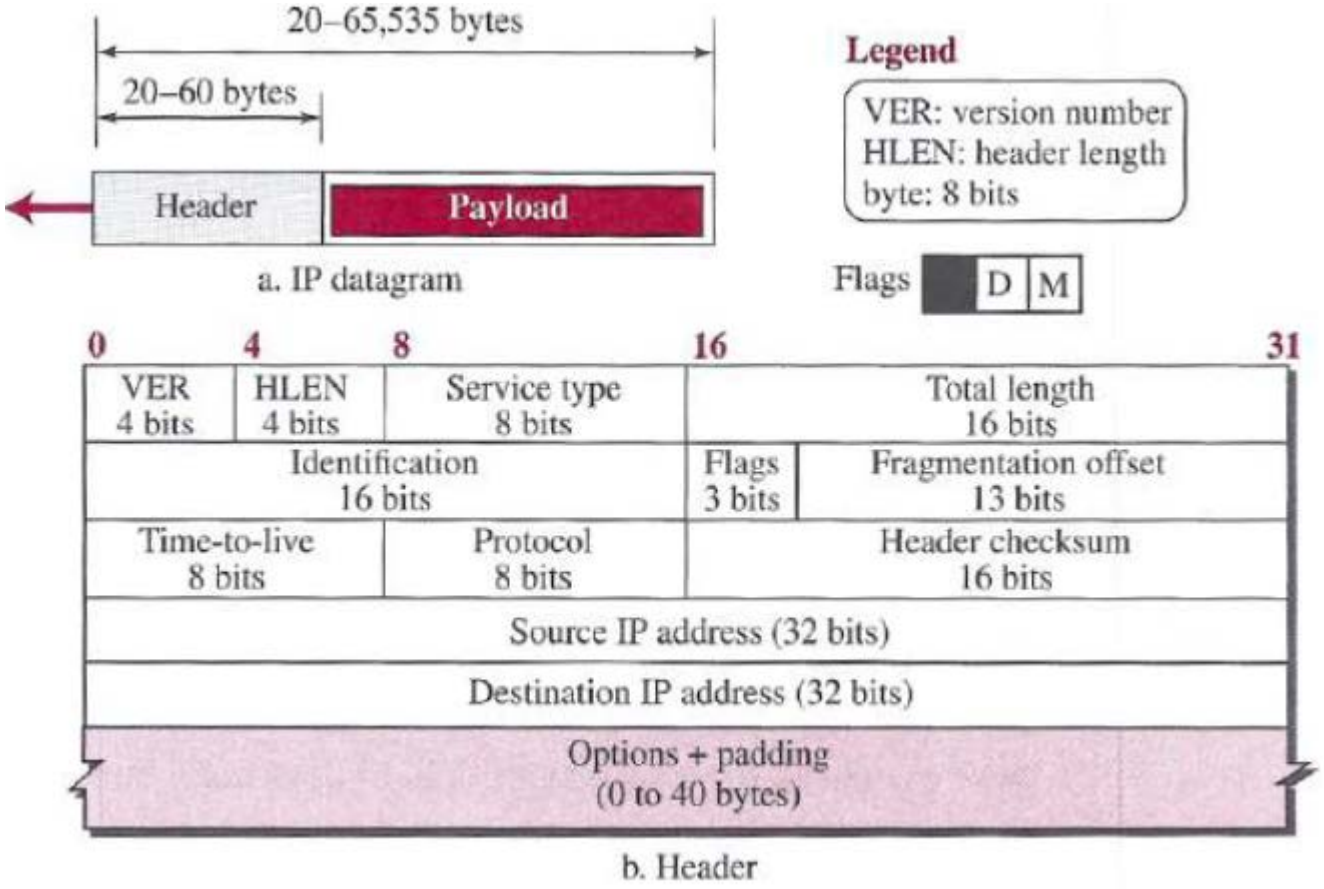
IP Header

- The most widely used protocol for internetworking is the Internet Protocol (IP).

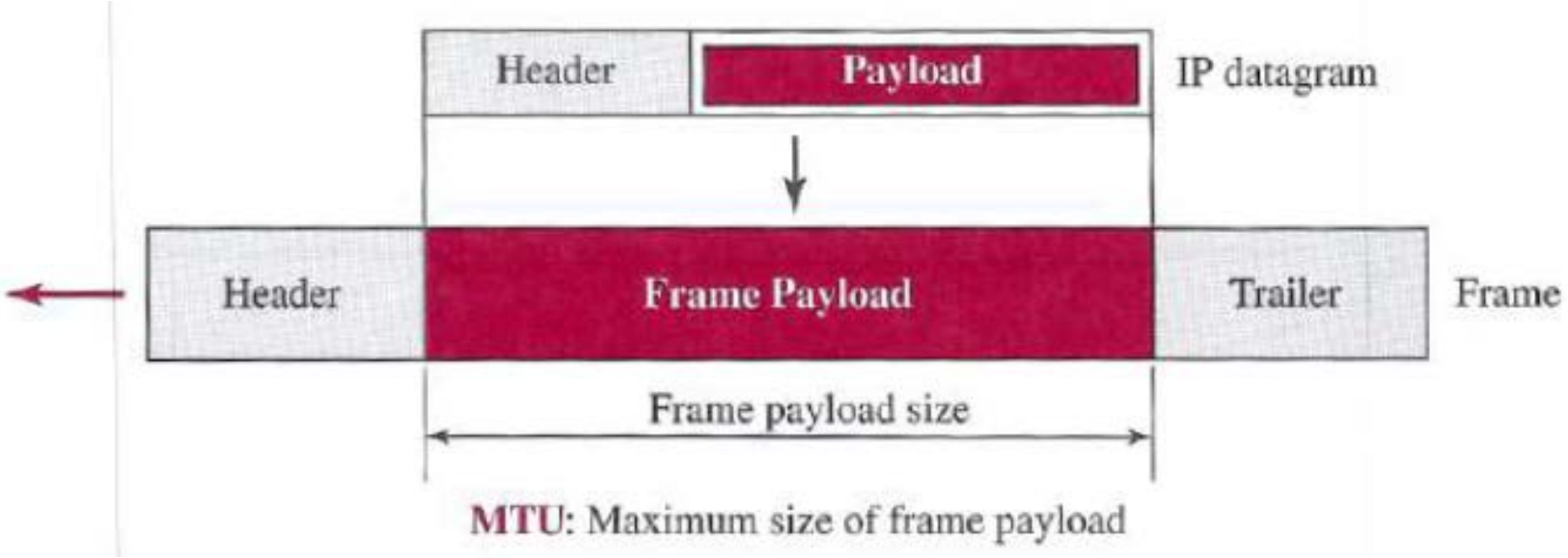


IP Datagram Fields

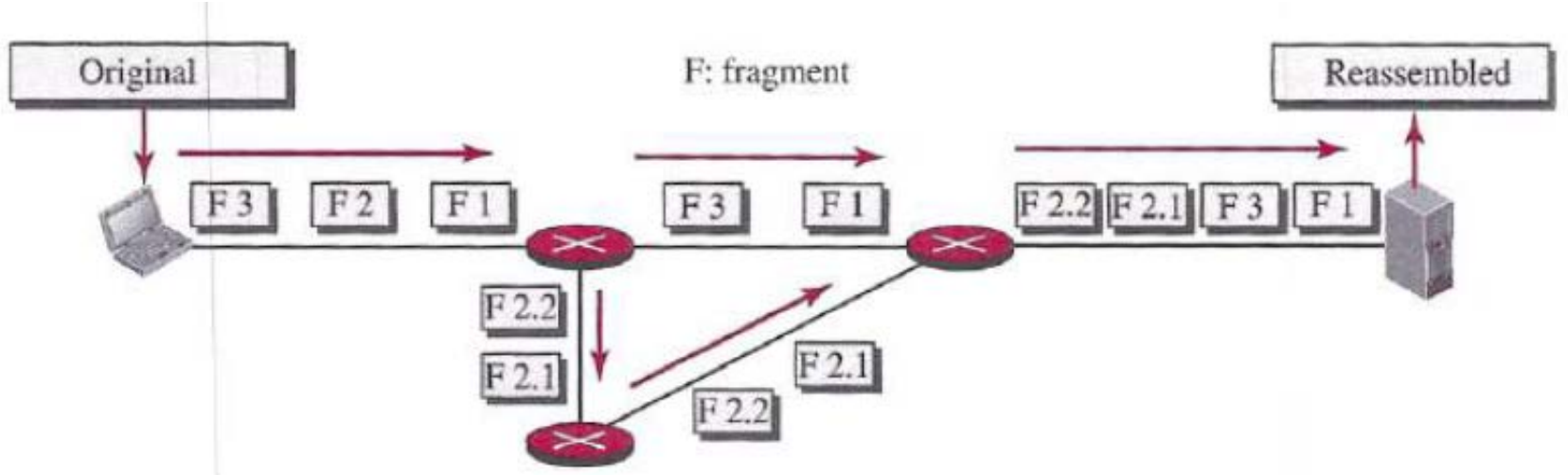
- VER: version of the IPv4 protocol
- HLEN: total length of the datagram header
- ToS: provides *differentiated services* (DiffServ)
- Total length: header plus data in byte
- Identification, Flags, Fragmentation Offset: These three fields are related to the fragmentation of the IP datagram
- TTL: control the maximum number of hops (routers) visited by the datagram
- Protocol: this field helps to define to which protocol the payload should be delivered
- Checksum: helps to check the error in datagram header
- Source & Destination Address: 32 bit IP addresses
- Options & Padding: used for network testing and debugging
- Payload: the packet coming from other protocols that use the service of IP

Fragmentation & Reassembly

- A datagram can travel through different networks.
- Each router decapsulates the IP datagram from the frame it receives, processes it, and then encapsulates it in another frame.



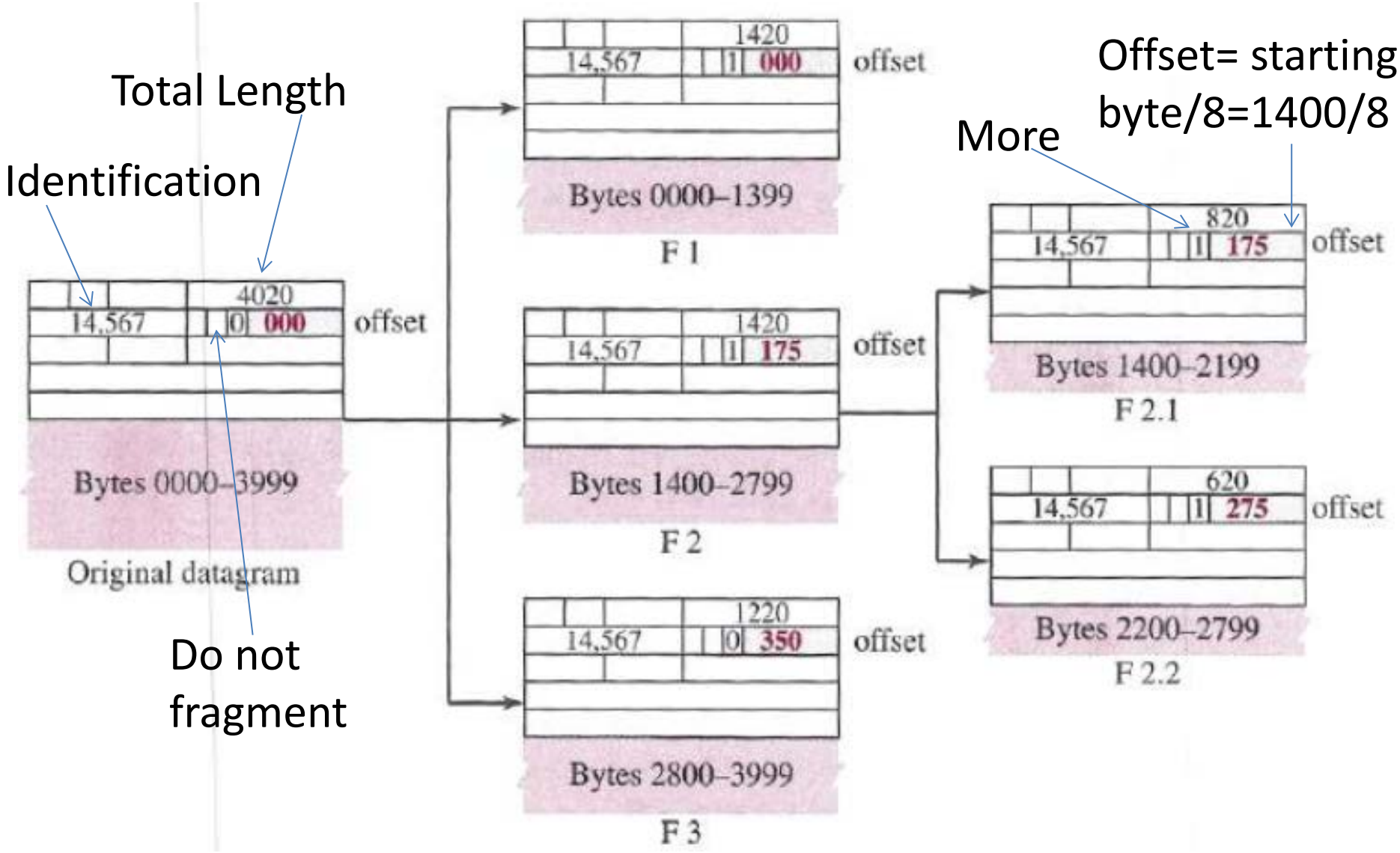
Cont…



- Fragmentation is done by the source host or intermediate router. Reassembly is done by the receiver

- 16-bit *identification field:* identifies a datagram. This is the present value of a counter maintained by sender.
- 3-bit flags *field*: *Not used, D: do not fragment, M: more fragment*
- 13-bit *fragmentation offset field:* shows the relative position of a fragment w.r.t. the whole datagram

Cont…


Total Length
Identification
Do not fragment
4020
14,567
0 000
offset
Bytes 0000–3999
Original datagram
1420
14,567
1 000
offset
Bytes 0000–1399
F 1
1420
14,567
1 175
offset
Bytes 1400–2799
F 2
1220
14,567
0 350
offset
Bytes 2800–3999
F 3
Offset= starting byte/8=1400/8
More
820
14,567
1 175
offset
Bytes 1400–2199
F 2.1
620
14,567
1 275
offset
Bytes 2200–2799
F 2.2

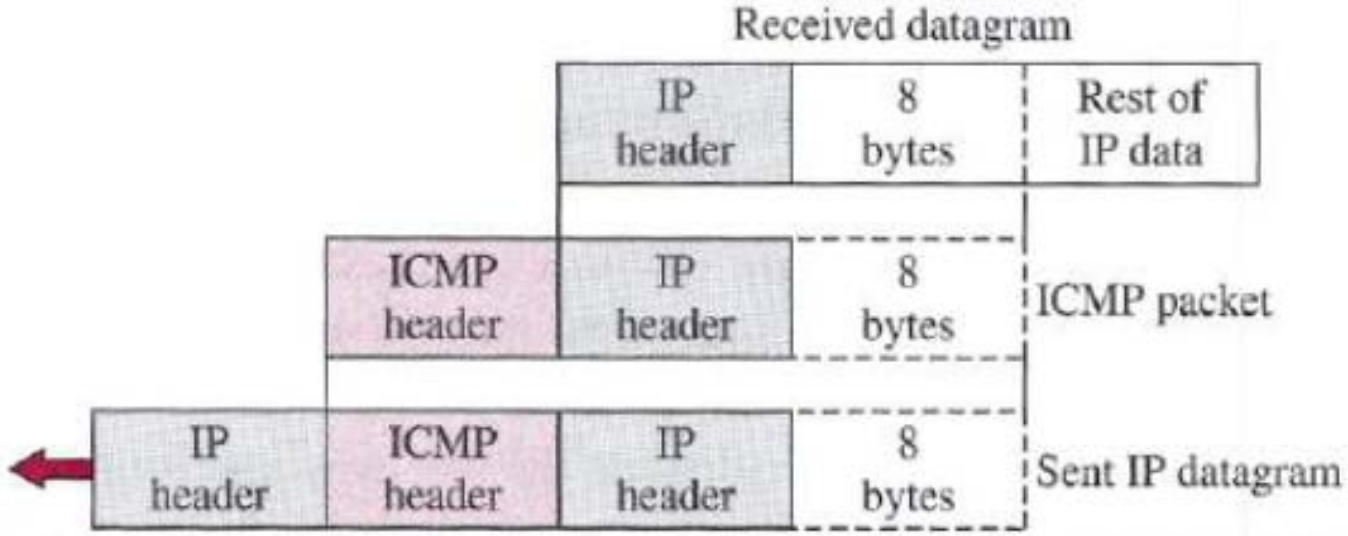
ICMP

- ICMP: Internet Control Message Protocol

- What happens
  - if something goes wrong?
  - if router discards a datagram?
  - if TTL finishes?
  - if fragmentation is not permitted?
- Need a mechanism for network management

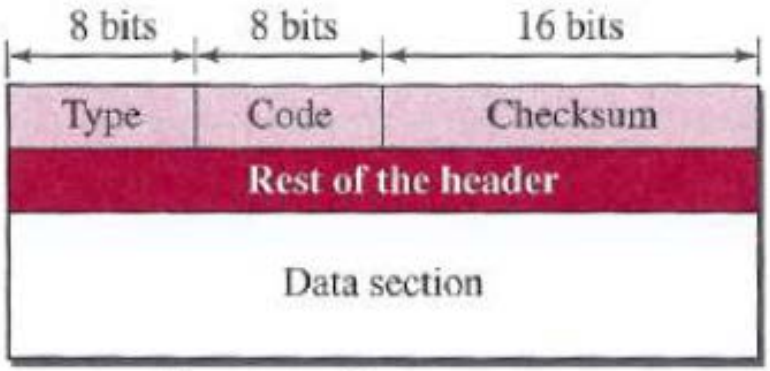
ICMP

- Its messages are not passed directly to the data-link layer as would be expected. Instead, the messages are first encapsulated inside IP datagrams before going to the lower layer.

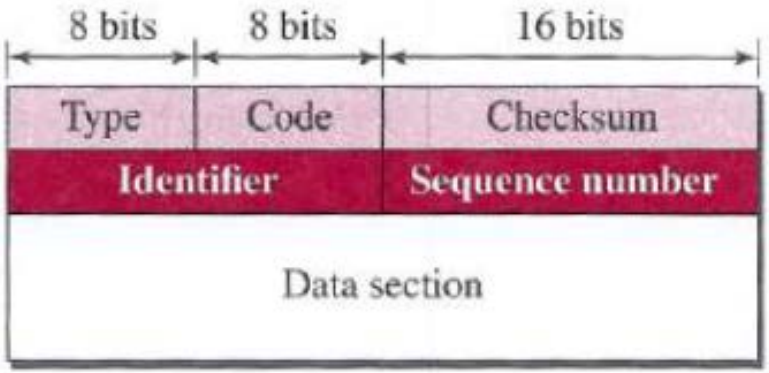


ICMP Messages

- ICMP Message size: 8-byte header and a variable-size data section



Error-reporting messages



Query messages

Type and code values

Error-reporting messages

03: Destination unreachable (codes 0 to 15)
04: Source quench (only code 0)
05: Redirection (codes 0 to 3)
11: Time exceeded (codes 0 and 1)
12: Parameter problem (codes 0 and 1)

Query messages

08 and 00: Echo request and reply (only code 0)
13 and 14: Timestamp request and reply (only code 0)

Error Reporting Messages

- Only error reporting; no error correction
- Messages are sent to original sources of the datagrams
- No error message for:
  - datagram carrying an ICMP error message
  - a fragmented datagram that is not the first fragment
  - a datagram having a multicast address
  - a datagram having a special address such as 127.0.0.0 or 0.0.0.0

Debugging Tools

- ***Ping:*** to find if a host is alive and responding
  - The source host sends ICMP echo-request messages;
  - the destination, if alive, responds with ICMP echo-reply messages.
  - It can calculate the round-trip time

```
$ ping auniversity.edu
PING auniversity.edu (152.181.8.3)  56 (84) bytes of data.
64 bytes from auniversity.edu (152.181.8.3): icmp_seq=0  ttl=62  time=1.91 ms
64 bytes from auniversity.edu (152.181.8.3): icmp_seq=1  ttl=62  time=2.04 ms
64 bytes from auniversity.edu (152.181.8.3): icmp_seq=2  ttl=62  time=1.90 ms
```

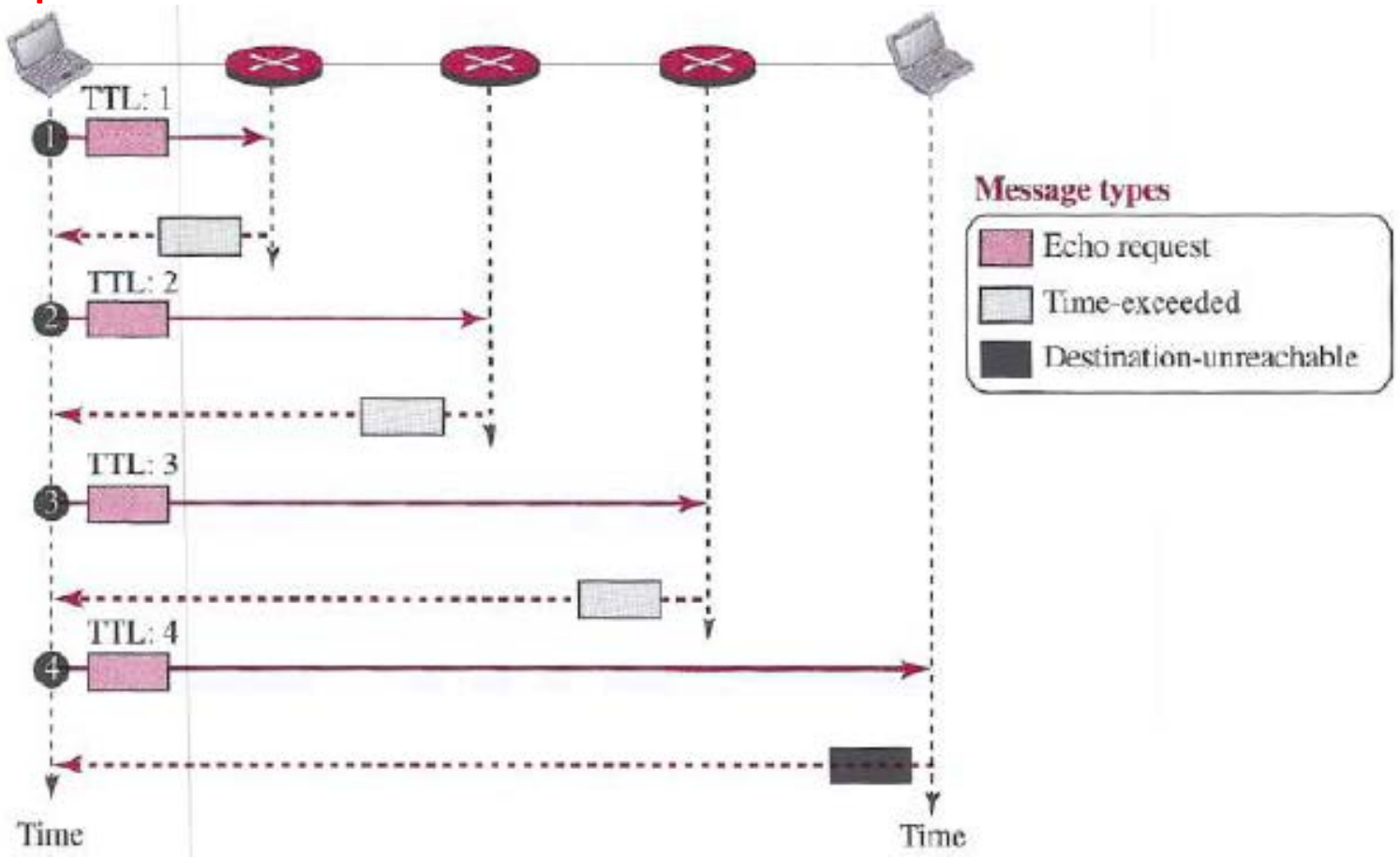
Cont…

- The *traceroute* program in UNIX or *tracert* in Windows can be used to trace the path of a packet from a source to the destination.
  - It can find the IP addresses of all the routers that are visited along the path
  - It gets help from ICMP error reporting messages

```
$ traceroute printers.com
traceroute to printers.com (13.1.69.93), 30 hops max, 38-byte packets
1 route.front.edu      (153.18.31.254)   0.622 ms   0.891 ms   0.875 ms
2 ceneric.net          (137.164.32.140)  3.069 ms   2.875 ms   2.930 ms
3 satire.net           (132.16.132.20)   3.071 ms   2.876 ms   2.929 ms
4 alpha.printers.com   (13.1.69.93)      5.922 ms   5.048 ms   4.922 ms
```

Cont…

- The *traceroute* application program is encapsulated in a UDP user datagram, but *traceroute* intentionally uses a port number that is not available at the destination.



Thanks!