

# Internet Protocol

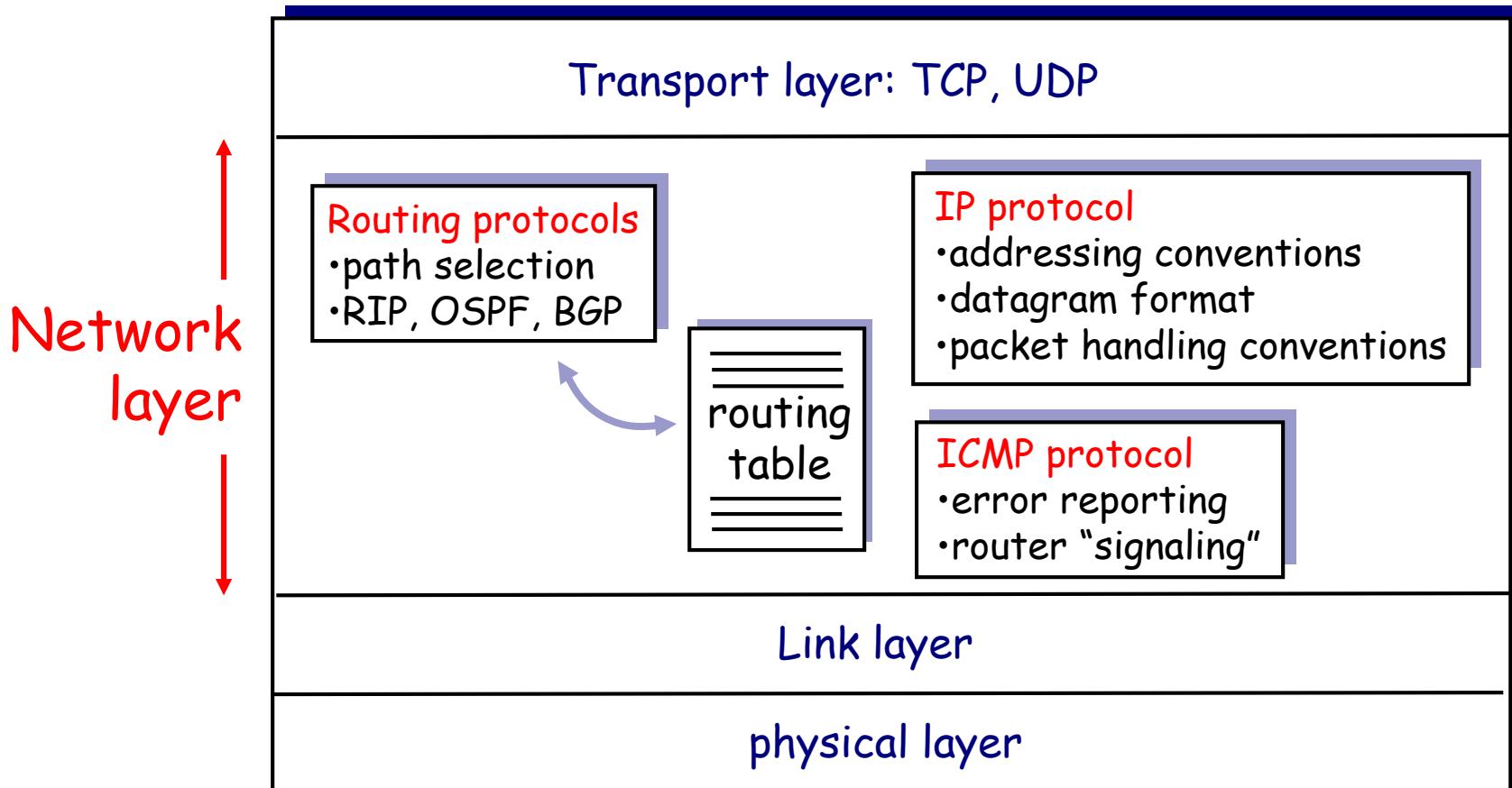
CSC 512 – Networks: Architectures and Protocols

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# The Internet Network layer



# INTERNET PROTOCOL (IP) OVERVIEW

- Basic unit of data transfer in the Internet
- Unreliable, connectionless delivery mechanism
- Packet routing
  - Routing table
- Packet Fragmentation

# IPv6 (IP the Next Generation, IPng)

- Larger IP addresses (128 bits)
- Extended address hierarchy
- New address type (anycast)
- Flexible header format
- Improved support for options

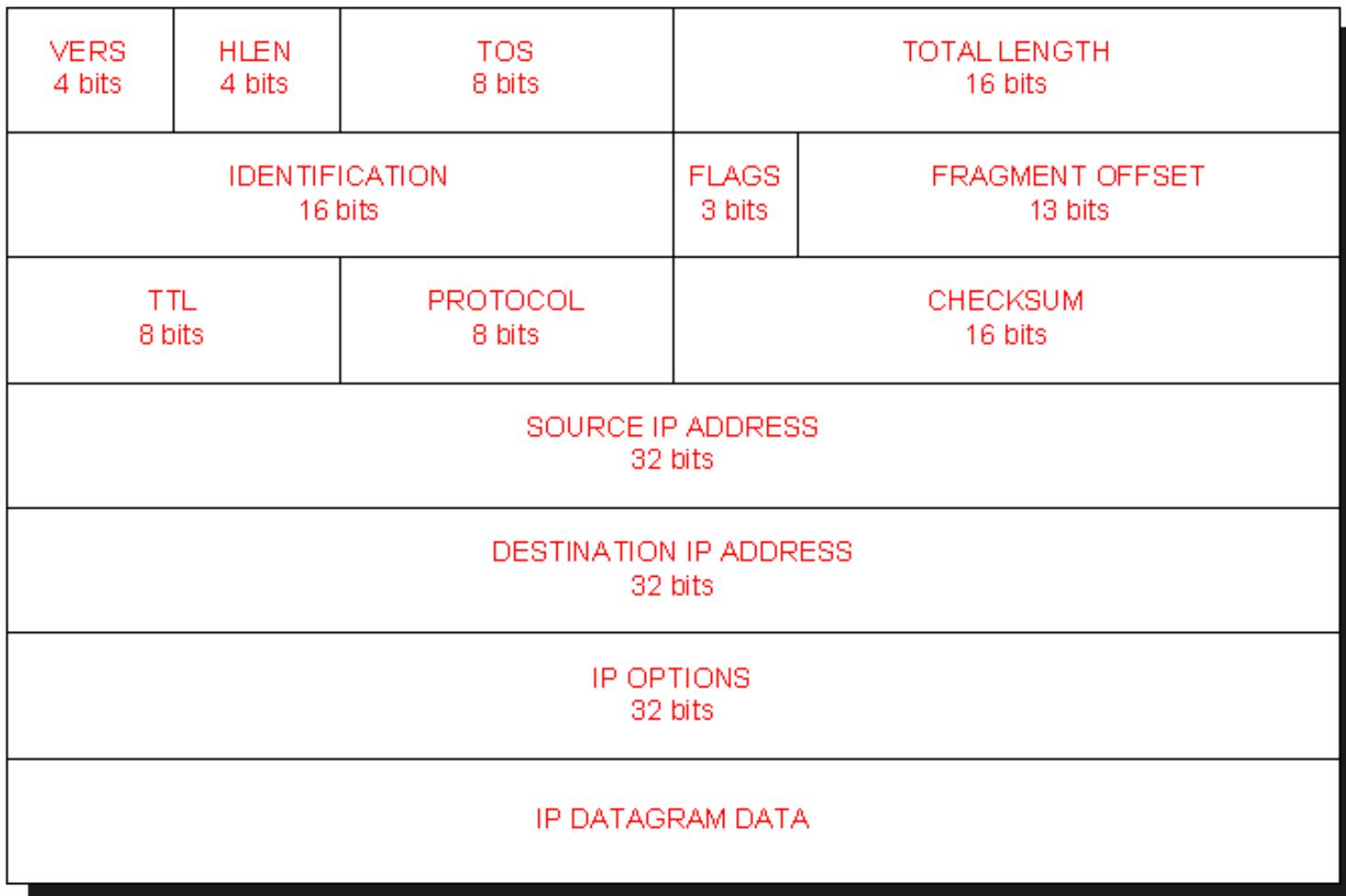
# IPv6

- Support for Autoconfiguration & renumbering
- Support for resource allocation
- Flow labeling and priority
- Extensions for authentication and privacy
- Flow labeling and priority
- New version of ICMP

# Migrating to IPv6

- Dual-stack approach
- Tunneling approach
- IPv4 address encoded into IPv6 address
  - 80 zero bits, 16 bits (0's or 1's), IPv4 add
  - Translation

# IP Datagram



# IPv6 Datagram



# IPv6 Header Format



# Type of Service Field

- 1990's – IETF
- Differentiated Services
  - Codepoint – 6 bits
  - Unused – 2 bits
- Precedence
  - High-priority traffic → 6 or 7
  - Normal traffic
- Codepoint values
  - 64 possible
  - 3 pools

# IP options

- Record route option
- Source route option
  - Strict source routing
  - Loose source routing
- Timestamp option

# IPv6 Extension Headers

- Hop-by-Hop options header
- Routing header
- Fragment header
- Destination options header
- Authentication header
- Encrypted Security Payload header

# Extension Header Order

- IPv6 base header
- Hop-by-Hop Options header
- Destination Options header
- Routing header
- Fragment header
- Authentication header
- Encapsulating Security Payload header
- Destination Options header
- Upper-layer header

# Example IPv6 Datagrams



(a)



(b)



(c)

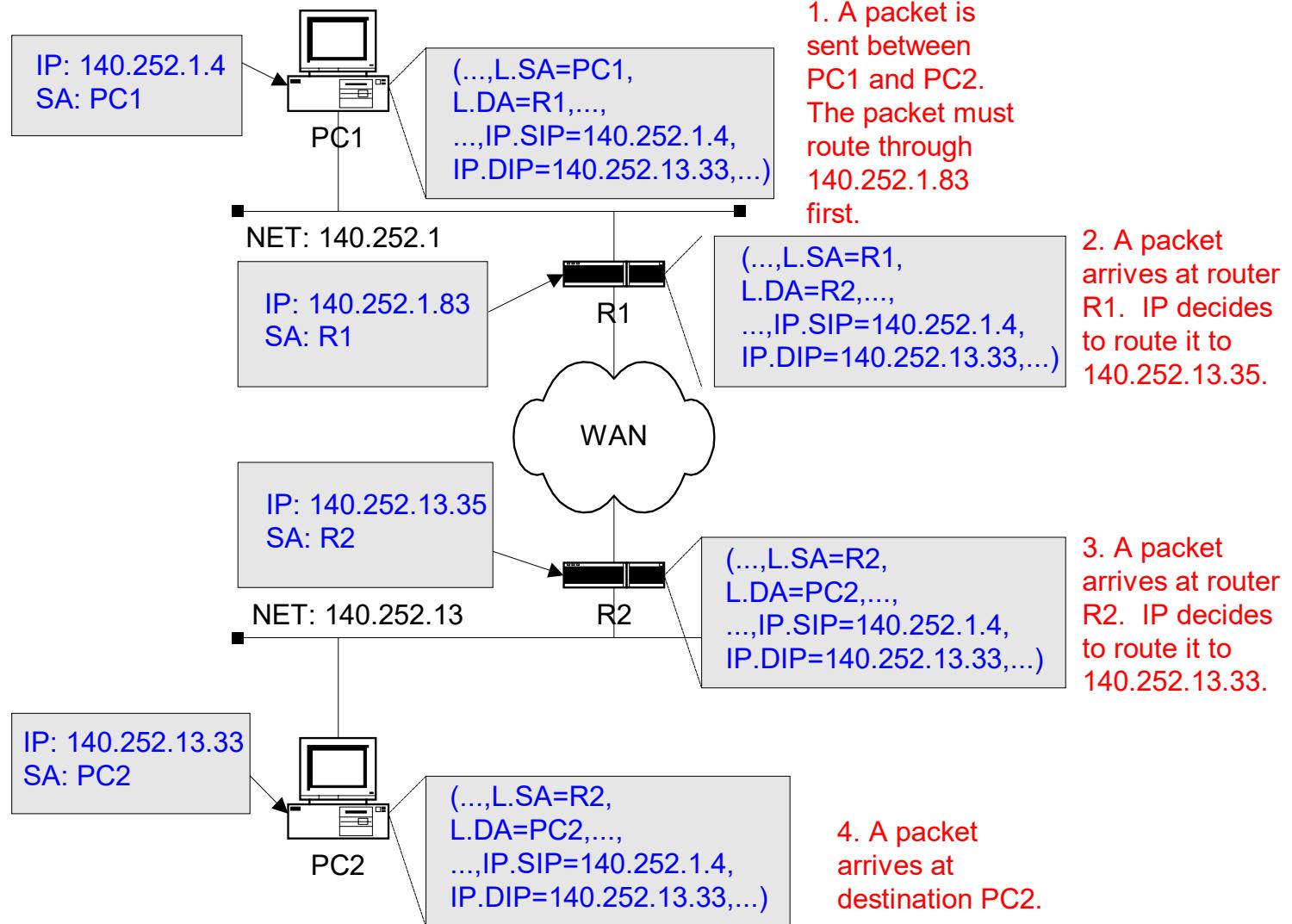
# Routing Header

- Source can specify specific route
- First node to process header -> destination address
- Decrement “segments left”
- Move “next address” field to destination address field
- Forward datagram

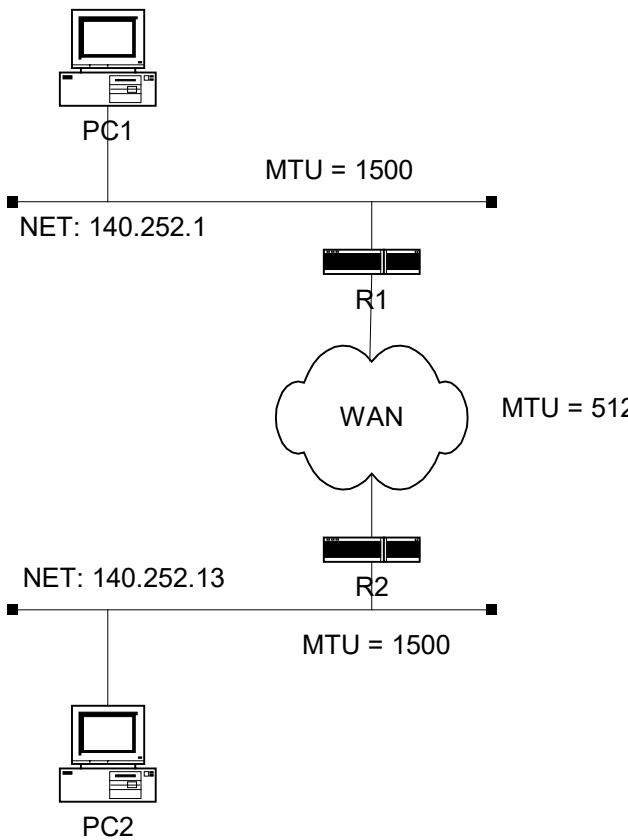
# Other Extension Headers

- Hop-by-Hop Options header
- Destination Options header
- Authentication header
- Encrypted Security Payload header

# IP ROUTING



# IP FRAGMENTATION



- MTU - Maximum Transfer Unit
- Examples
  - Token Ring (16 Mb/s)  
MTU is 17914 bytes
  - **Ethernet MTU is 1500 bytes**
  - FDDI MTU is 4352 bytes

# IP Fragmentation & Reassembly

	length =3980	ID =71	fragflag =0	offset =0	
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One large datagram becomes several smaller datagrams

	length =1500	ID =71	fragflag =1	offset =0	
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	length =1500	ID =71	fragflag =1	offset =185	
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	length =1040	ID =71	fragflag =0	offset =370	
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# Fragment Header

- Only done at source computer
- Use:
  - Guaranteed minimum MTU (1280 bytes)
  - Path MTU Discovery
- Increases router performance
- Problems if router changes route

# IP Option Octet



Option Class	Meaning
0	Datagram or network control
1	Reserved for future use
2	Debugging and measurement
3	Reserved for future use

# ICMP

- Internet Control Message Protocol
- Error reporting
  - Reported back to source – why?
- Ping
  - Echo Request and Echo Reply messages
- Traceroute

# ICMP Message Format

- TYPE field – 8 bits
- CODE field – 8 bits
- CHECKSUM field – 16 bits
- If reporting errors:
  - Header of datagram causing error
  - First 64 data bits of datagram causing error

# ICMP Type Field – common ones

<u>Type field</u>	<u>ICMP Message Type</u>
0	Echo reply (ping response)
3	Destination unreachable
4	Source quench
8	Echo request (ping)
9	Router advertisement
10	Router solicitation
11	TTL = 0

# Common error messages

- Destination unreachable (fig in text)
- Source quench messages