18CSC302J- Computer Networks

Unit I

Syllabus - Unit I

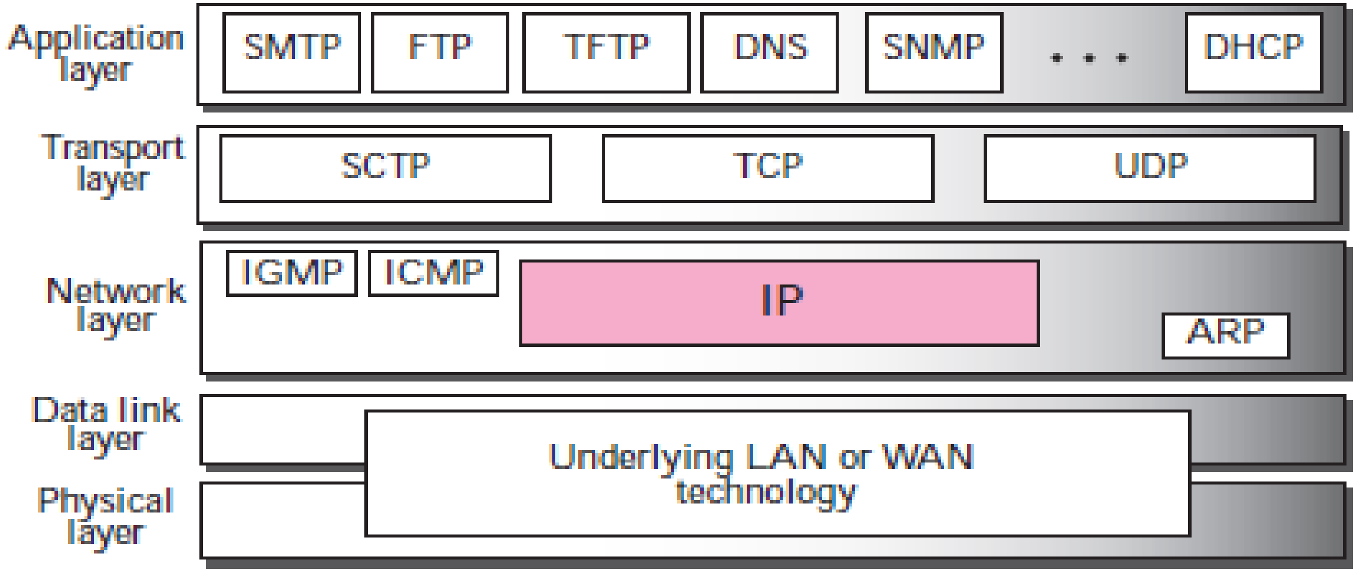
- IP Header
- IP Fragmentation
- ARP
- RARP
- ICMP
  - Introduction
  - Messages
  - Debugging Tools
  - ICMP Package
- UDP Datagram
  - Characteristics
- TCP Header
  - TCP Connection Establishment Process
  - Error Control
  - Congestion Control
  - Flow Control
- Multicasting & Multicast Routing Protocols
- Stream Control Transmission Protocol

IP Header & IP Fragmentation

IP Header & IP Fragmentation

IP– An Introduction

- The **Internet Protocol (IP)** is the transmission mechanism used by the TCP/IP protocols at the network layer Operates at higher level



Position of IP in TCP/IP protocol suite

IP Header & IP Fragmentation

IP– An Introduction

- IP is an unreliable and connectionless datagram protocol—a **best-effort delivery** service.
- The term *best-effort* means that IP packets can be corrupted, lost, arrive out of order, or delayed and may create congestion for the network.
- If reliability is important, IP must be paired with a reliable protocol such as TCP.

IP Header & IP Fragmentation

IP– An Introduction

- ***Example***
  - ✓ The post office does its best to deliver the mail but does not always succeed. If an unregistered letter is lost, it is up to the sender or would-be recipient to discover the loss and rectify the problem.
  - ✓ The post office itself does not keep track of every letter and cannot notify a sender of loss or damage.
- IP is also a connectionless protocol for a packet switching network that uses the datagram approach
- This means that each datagram is handled independently, and each datagram can follow a different route to the destination.

IP Header & IP Fragmentation

IP Datagram

<table>
<tr><td></td><td>Bit 0</td><td></td><td></td><td></td><td>Bit 31</td></tr>
<tr><td rowspan="6">Header</td><td>Version (4)</td><td>Hdr Len (4)</td><td>TOS (8)</td><td colspan="2">Total Length in bytes (16)</td></tr>
<tr><td colspan="3">Identification (16 bits)</td><td>Flags (3)</td><td>Fragment Offset (13)</td></tr>
<tr><td colspan="2">Time to Live (8)</td><td>Protocol (8)</td><td colspan="2">Header Checksum (16)</td></tr>
<tr><td colspan="5">Source IP Address</td></tr>
<tr><td colspan="5">Destination IP Address</td></tr>
<tr><td colspan="5">Options (if any)</td></tr>
<tr><td>Data</td><td colspan="5">Data (variable length)</td></tr>
</table>

IP Header & IP Fragmentation

- Version
  - Version number of IP protocol
  - Current version is Version 4
  - Version 6 has different header format

IP Packet Header

Bit 0 … Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
Options (if any)				

IP Header & IP Fragmentation

- Header Length (in 32 bit words)
  - Indicates end of header and beginning of payload
  - If no options, Header length = 5

- Bit 0 Bit 31

<table>
<tr><td>Version (4)</td><td>Hdr Len (4)</td><td colspan="2">TOS (8)</td><td colspan="4">Total Length in bytes (16)</td></tr>
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IP Header & IP Fragmentation

- Type of Service (TOS)
  - Allows different types of service to be requested
  - Initially, meaning was not well defined
  - Currently being defined (diffserv)

Bit 0 — Bit 31

<table>
<tr><td colspan="4">Version (4)</td><td colspan="4">Hdr Len (4)</td><td colspan="8">TOS (8)</td><td colspan="16">Total Length in bytes (16)</td></tr>
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<tr><td colspan="8">Time to Live (8)</td><td colspan="8">Protocol (8)</td><td colspan="16">Header Checksum (16)</td></tr>
<tr><td colspan="32">Source IP Address</td></tr>
<tr><td colspan="32">Destination IP Address</td></tr>
<tr><td colspan="32">Options (if any)</td></tr>
</table>

IP Header & IP Fragmentation

- Packet Length (in Bytes)
  - Unambiguously specify end of packet
  - Max packet size = 2^{16} = 65,535 Bytes

Bit 0 ... Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
Options (if any)				

IP Header & IP Fragmentation

- These three fields for Fragmentation Control

Bit 0 Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
Options (if any)				

IP Header & IP Fragmentation

- Time to Live
  - Initially set by sender (up to 255)
  - Decremented by each router
  - Discard when TTL = 0 to avoid infinite routing loops

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IP Header & IP Fragmentation

- Protocol
  - Value indicates what is in the data field
  - Example: TCP or UDP

Bit 0 … Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
Options (if any)				

IP Header & IP Fragmentation

- Header Checksum
  - Checks for error in the header only
  - Bad headers can harm the network
  - If error found, packet is simply discarded

- Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
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IP Header & IP Fragmentation

- Source and Destination IP Addresses
  - Strings of 32 ones and zeros

Bit 0 — Bit 31

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IP Header & IP Fragmentation

- Options
  - Example: timestamp, record route, source route

Bit 0 … Bit 31

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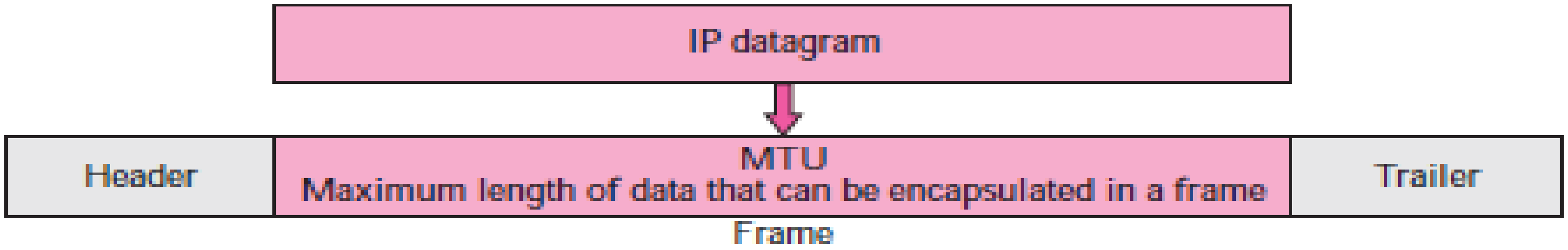
IP Header & IP Fragmentation

IP Fragmentation & Reassembly

- Maximum Transmission Unit (MTU)
  - Largest IP packet a network will accept
  - Arriving IP packet may be larger (max IP packet size = 65,535 bytes)
- Sender or router will split the packet into multiple fragments
- Destination will reassemble the packet
- IP header fields used to identify and order related fragments



IP Header & IP Fragmentation

IP Fragmentation & Reassembly

- Divide the datagram to make it possible to pass through these networks called **fragmentation.**
- A fragmented datagram may itself be fragmented if it encounters a network with an even smaller MTU.
- A datagram can be fragmented by the source host or any router in the path
- the reassembly of the datagram, however, is done only by the destination host

IP Header & IP Fragmentation

- Identification
  - – All fragments of a single datagram have the same identification number

- Bit 0 Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
Source IP Address				
Destination IP Address				
Options (if any)				

IP Header & IP Fragmentation

- Flags:
  - 1st bit: reserved, must be zero
  - 2nd bit: DF -- Do Not Fragment
  - 3rd bit: MF -- More Fragments

Bit 0 … Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
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Options (if any)				

IP Header & IP Fragmentation

- Fragment Offset (in units of 8 bytes)
  - Used for reassembly of packet
  - 1^{st} fragment has offset = 0

Bit 0 Bit 31

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Identification (16 bits)			Flags (3)	Fragment Offset (13)
Time to Live (8)		Protocol (8)	Header Checksum (16)	
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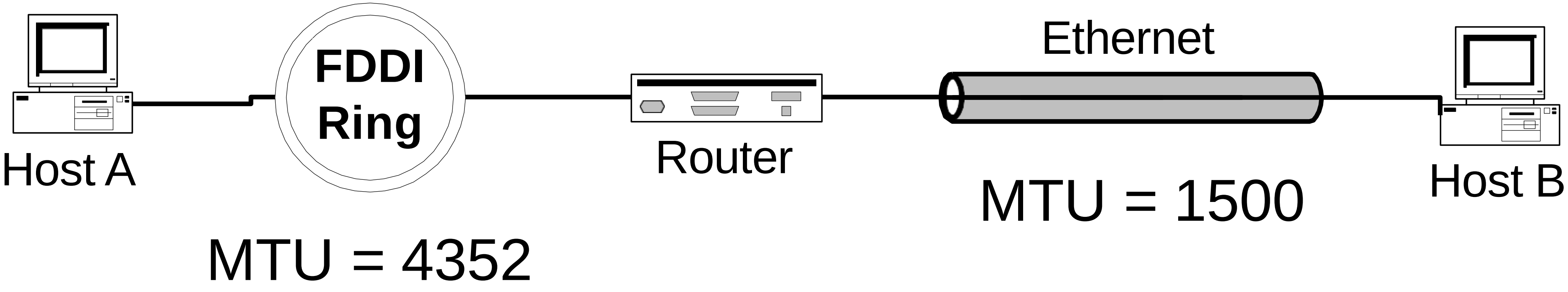
IP Header & IP Fragmentation

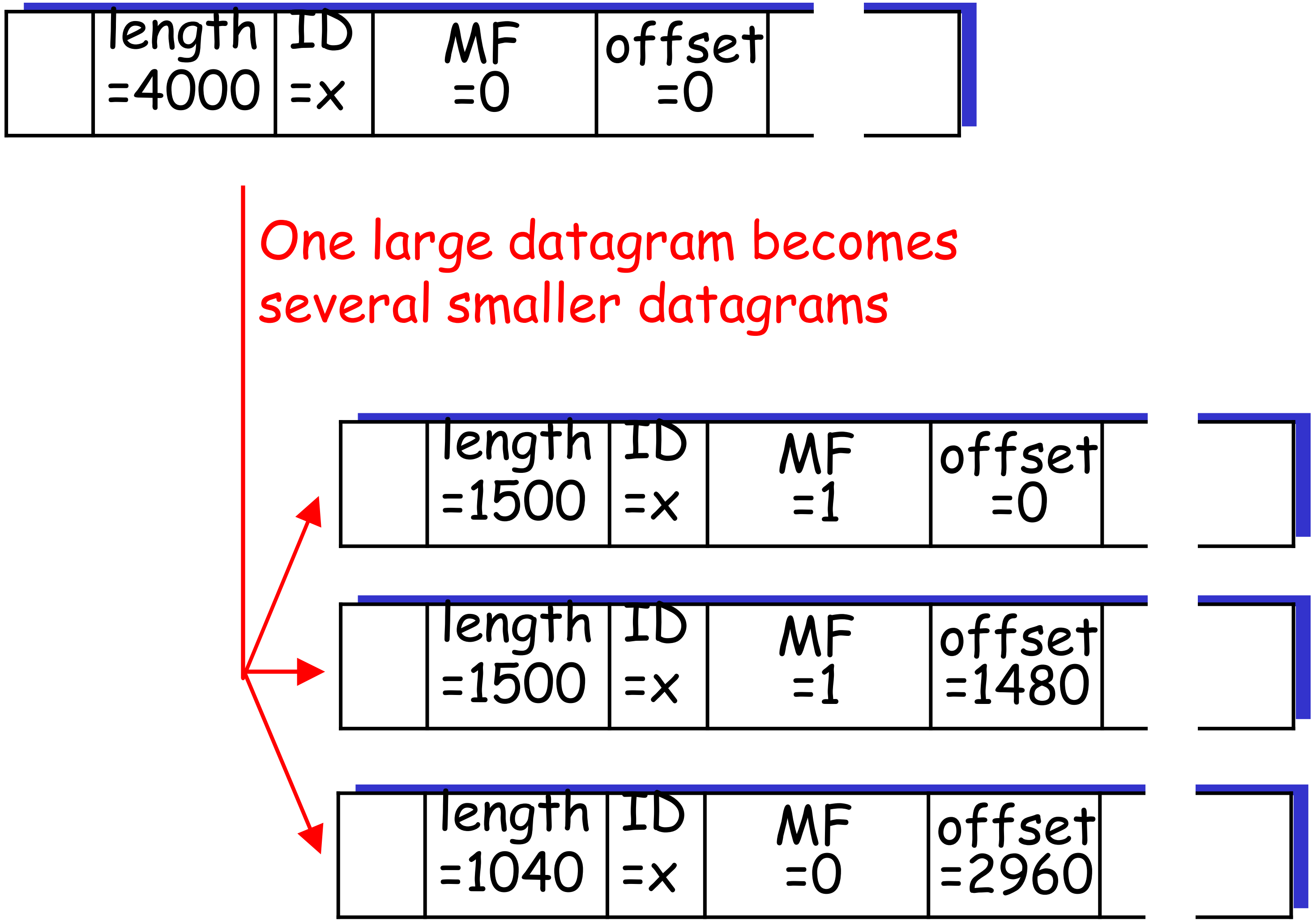
IP Fragmentation Example

- Host A wants to send to Host B an IP datagram of size = 4000 Bytes



IP Header & IP Fragmentation

IP Fragmentation Example



IP Header & IP Fragmentation

Multiple Fragmenting Points

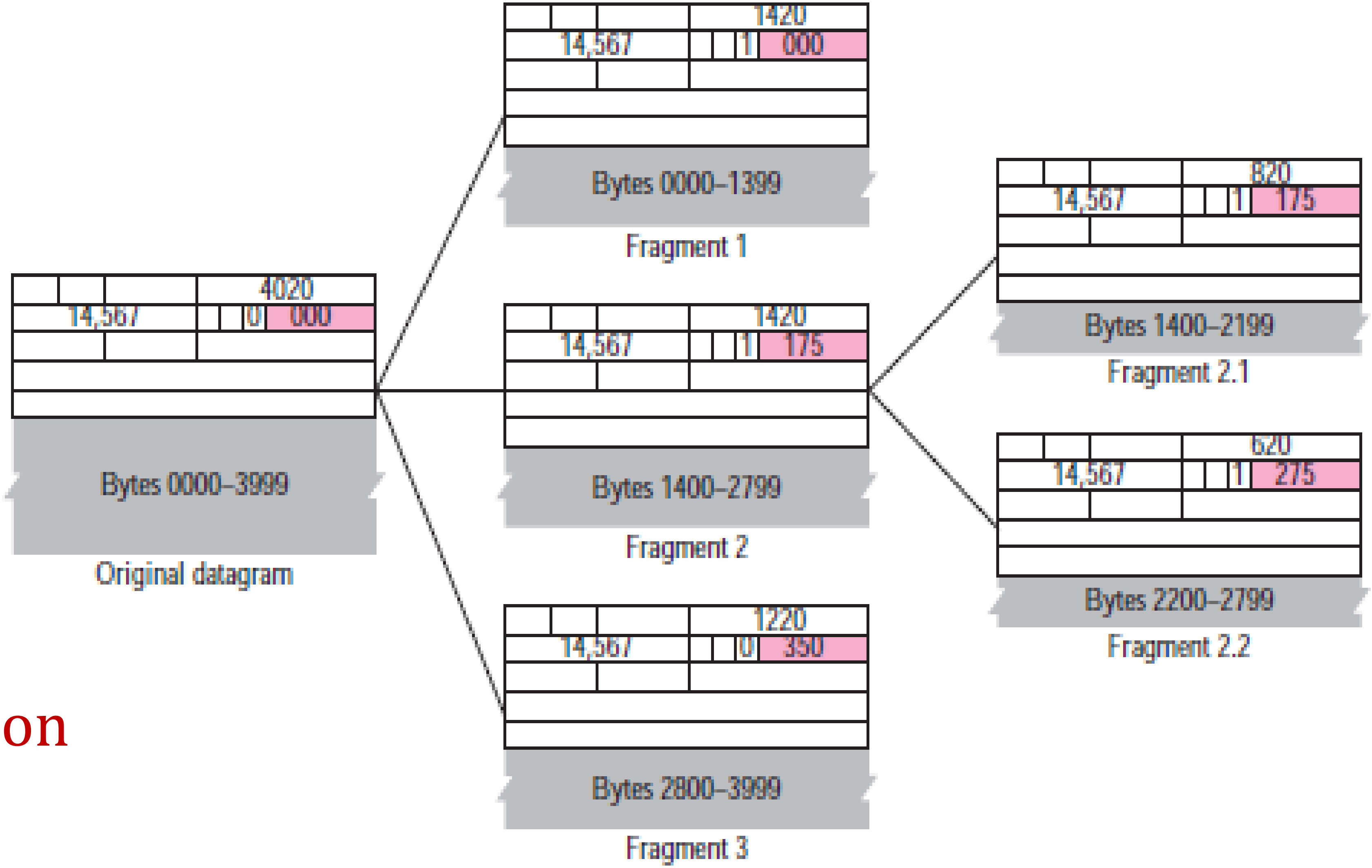
Let MTUs along internet path be

- 1500
- 1500
- 1000
- 1500
- 576
- 1500

Result: fragmentation can occur twice

IP Header & IP Fragmentation

Multiple Fragmenting Points



Detailed fragmentation example

IP Header & IP Fragmentation

- The figure shows what happens if a fragment itself is fragmented.

  In this case the value of the offset field is always relative to the original datagram.

  a. The first fragment has an offset field value of zero.

  b. Divide the length of the first fragment by 8. The second fragment has an offset value equal to that result.

  c. Divide the total length of the first and second fragment by 8. The third fragment has an offset value equal to that result.

  d. Continue the process. The last fragment has a *more* bit value of 0.