



Introduction to Networks & Distributed Computing

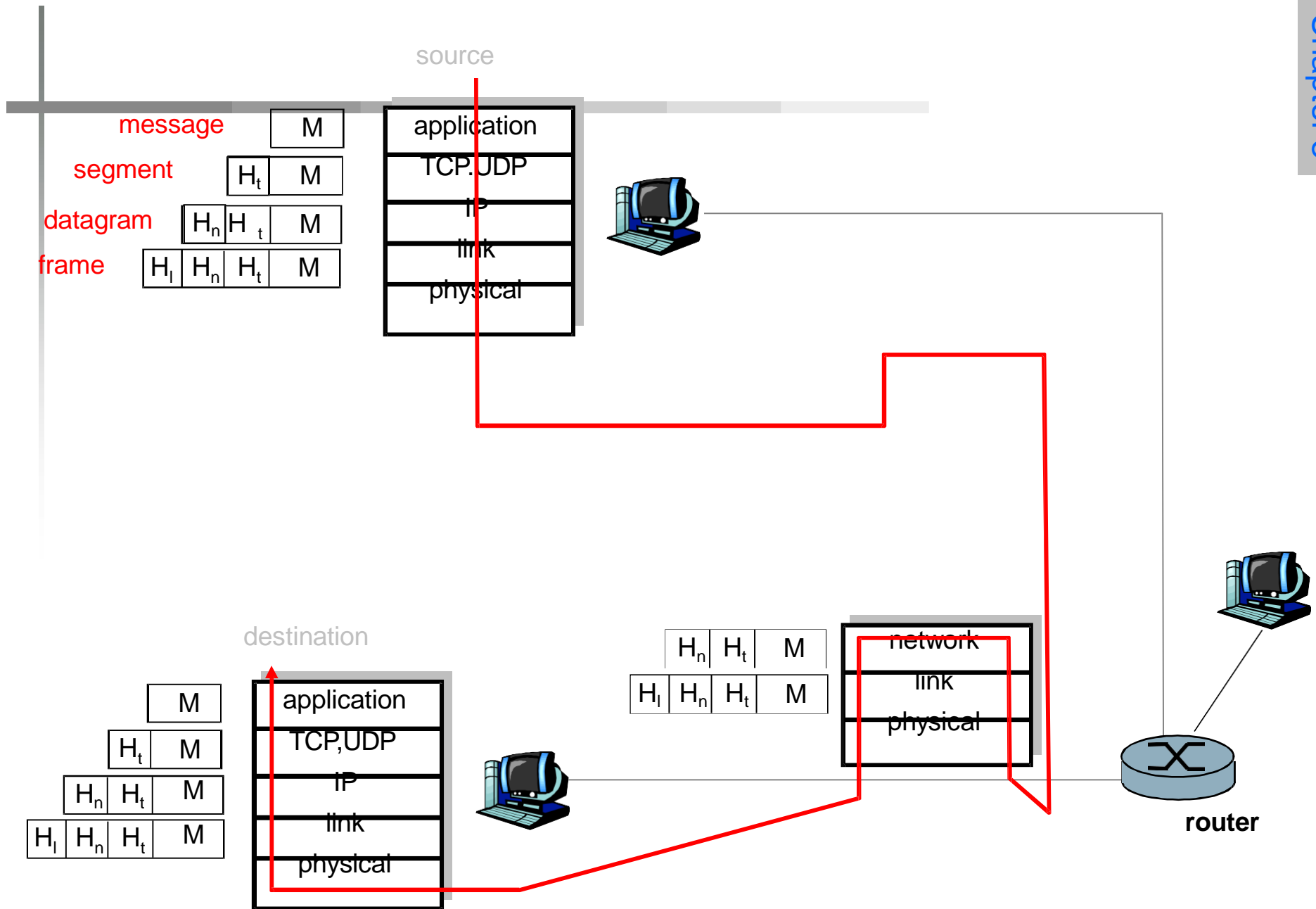
CECS 327

IP Fragmentation

TCP/IP Layers

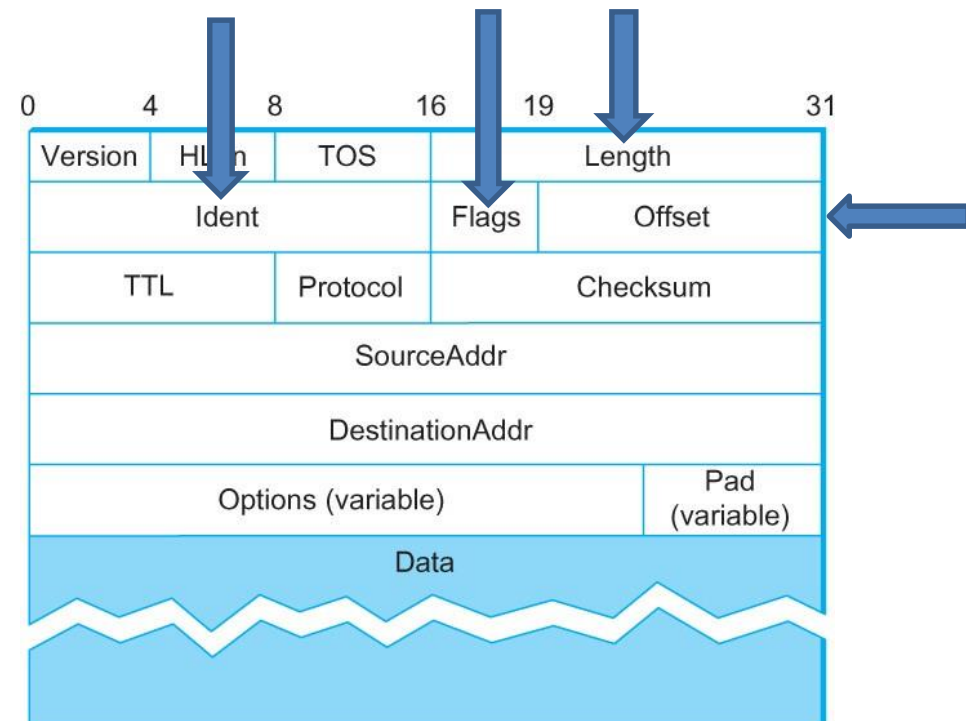
TCP/IP Protocols

Application Layer	HTTP	FTP	Telnet	SMTP	DNS
Transport Layer	TCP			UDP	
Network Layer	IP		ARP	ICMP	IGMP
Network Interface Layer	Ethernet	Token Ring		Other Link-Layer Protocols	
Physical	Bits of data				



IP Packet Format

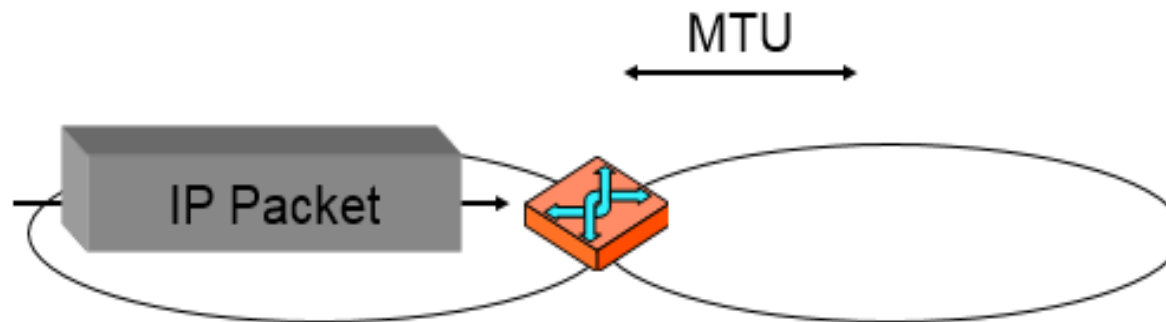
- Version (4): currently 4
- Hlen (4): number of 32-bit words in header
- TOS (8): type of service (not widely used)
- Length (16): number of bytes in this datagram
- Ident (16): used by fragmentation
- Flags/Offset (16): used by fragmentation
- TTL (8): number of hops this datagram has traveled
- Protocol (8): demux key (TCP=6, UDP=17)
- Checksum (16): of the header only
- DestAddr & SrcAddr (32)



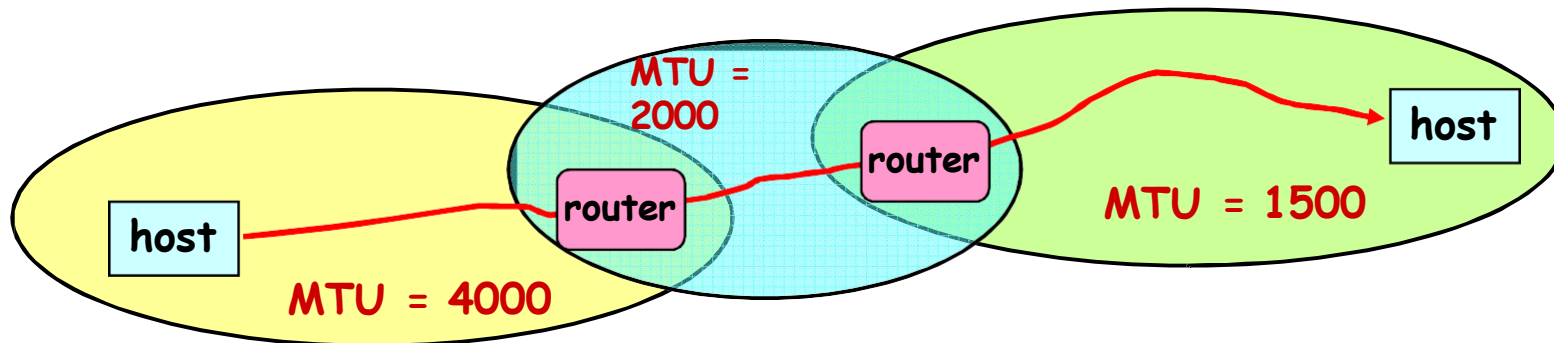
MTU

Maximum Transmission Unit (MTU)

Largest IP packet a *network* will accept
Arriving IP packet may be larger



IP Fragmentation



- Every Network has Own Maximum Transmission Unit (MTU)
 - Largest IP datagram it can carry within its own packet frame
 - Ethernet (1500 bytes), FDDI (4500 bytes)
 - Don't know MTUs of all intermediate networks in advance
- IP Solution
 - When hit network with small MTU, fragment packets
 - Might get further fragmentation as proceed farther

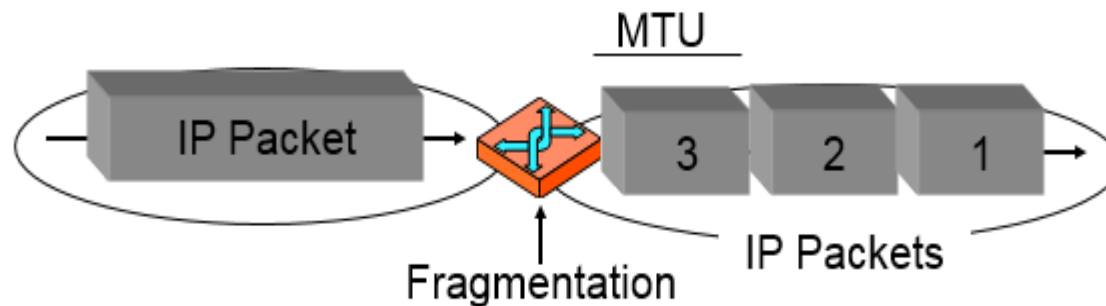
IP Fragmentation

If IP packet is longer than the MTU, the router breaks packet into smaller packets

Called IP fragments

Fragments are still IP packets

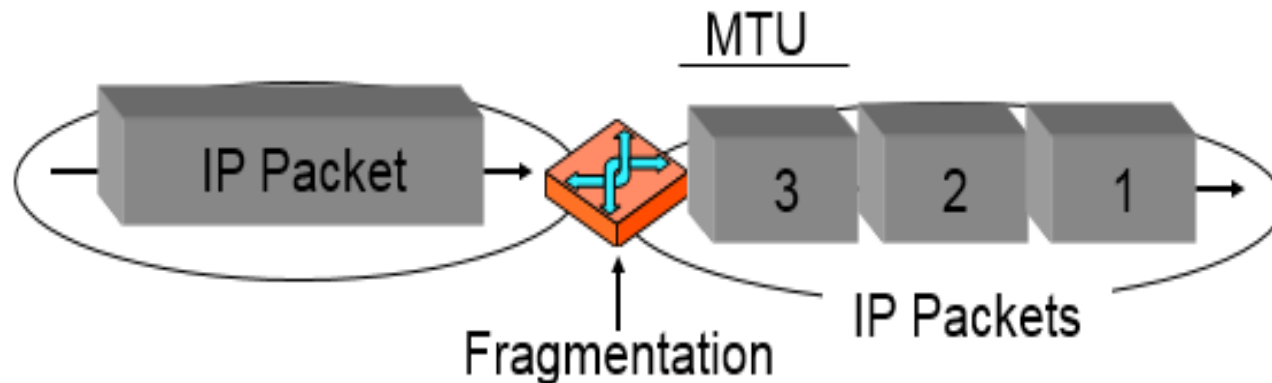
Earlier in Mod A, fragmentation in TCP



IP Fragmentation

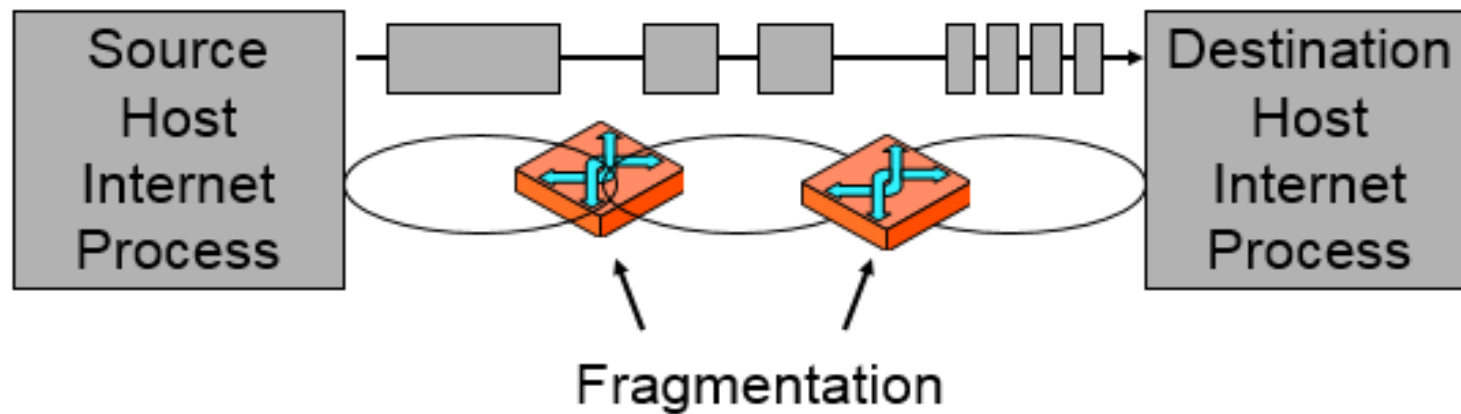
What is Fragmented?

Only the original data field
New headers are created



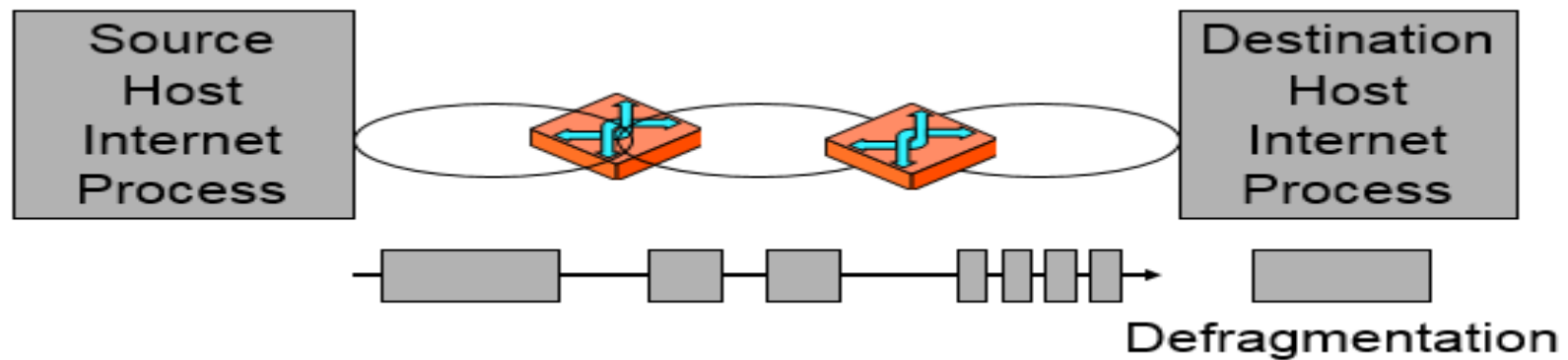
Multiple Fragmentations

Original packet may be fragmented multiple times along its route



Defragmentation

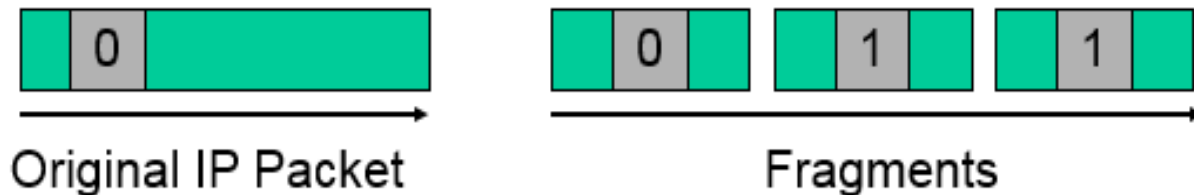
- “Internet layer” process on destination host defragments, restoring the original packet
- IP Defragmentation only occurs once



Fragmentation and IP Fields

More Fragments field (1 bit) / (**Flag**)

- If router fragments, sets **More Fragments** (**Flag**) field in last fragment to 0
- In all other fragments, sets to 1
- 1 if more fragments
- 0 if not



Identification Field

IP packet has a 16-bit *Identification* field

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Indication (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)				PAD
Data Field				

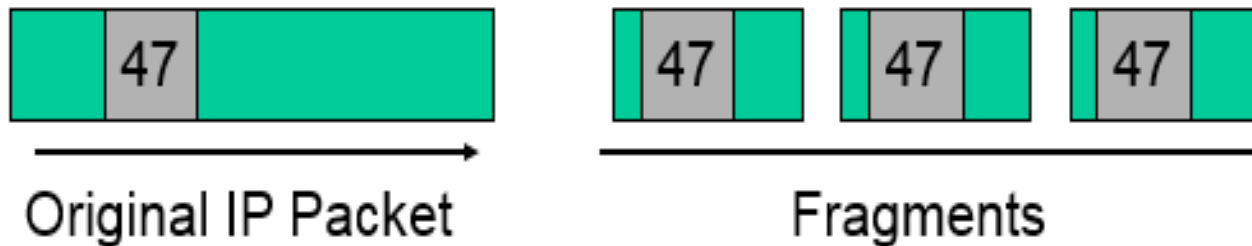
Identification Field

- IP packet has a 16-bit *Identification* field
 - Source host internet process places a “random number” in the Identification field
 - The “random number” is different for each IP packet

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

Identification Field

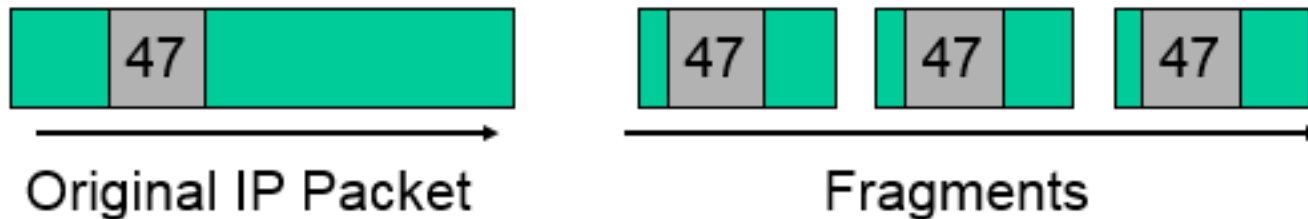
- IP packet has a 16-bit Identification field
 - If router fragments, places the original Identification field value in the Identification field of each fragment



Identification Field

Purpose

- i. Allows receiving host's “**internet layer**” process know what fragments belong to each original packet
- ii. Works even if an IP packet is fragmented several times



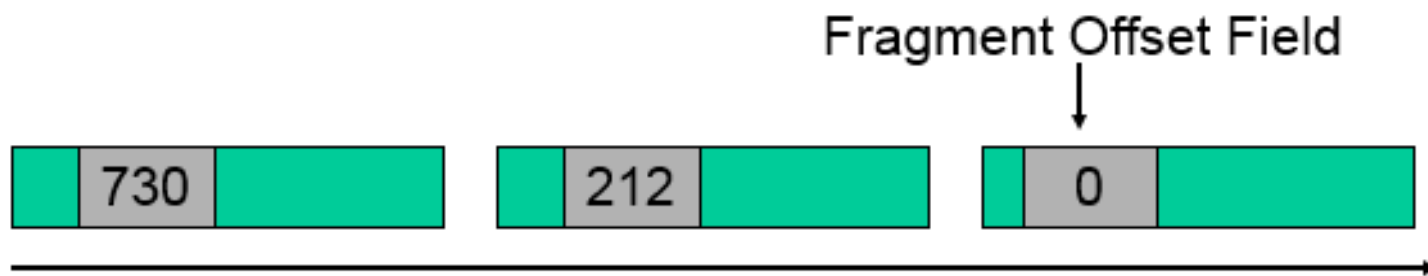
Fragment Offset Field

- Fragment offset field (13 bits) is used to reorder fragments with the same Identification field
- Contains the data field's starting point (in octets) from the start of the data field in the original IP packet

Version (4)	Hdr Len (4)	TOS (8)	Total Length in bytes (16)	
Indication (16 bits)			Flags (3)	Fragment Offset (13)

Fragment Offset Field

- Receiving host's “**internet layer**” process assembles fragments in order of increasing fragment offset field value
- This works even if fragments arrive out of order!
- Works even if fragmentation occurs multiple times



Length

Indicate the Length of IP fragment

Fragmentation: Recap

IP Fragmentation

- Data field of a large IP packet is fragmented
- The fragments are sent into a series of smaller IP packets fitting a network's MTU
- Fragmentation is *done by routers*
- Fragmentation may be done multiple times along the route

Defragmentation: Recap

IP Defragmentation

Defragmentation (reassembly) is *done once*, by destination host's internet layer process

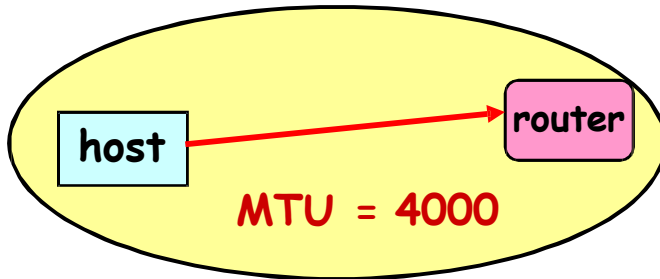
Defragmentation: Recap

- All IP packets resulting from the fragmentation of the same original IP packet have the same Identification field value
- Destination host internet process orders all IP packets from the same original on the basis of their Fragment Offset field values
- More Fragments (**flag**) field tells whether there are no more fragments coming

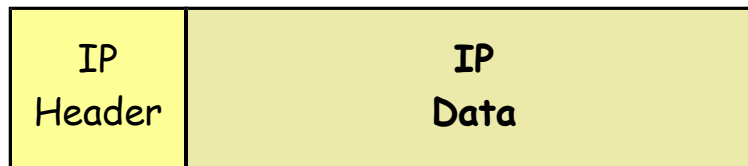
Fragmentation Related Fields

- Length
 - Length of IP fragment
- Identification
 - To match up with other fragments
- Fragment offset
 - Where this fragment lies in entire IP datagram
- Flags
 - “More fragments” flag
 - “Don’t fragment” flag

IP Fragmentation Example #1



Length = 3980, Flag=0



20 bytes for the header

IP Fragmentation Example #2

