

# Datagram Forwarding and Fragmentation



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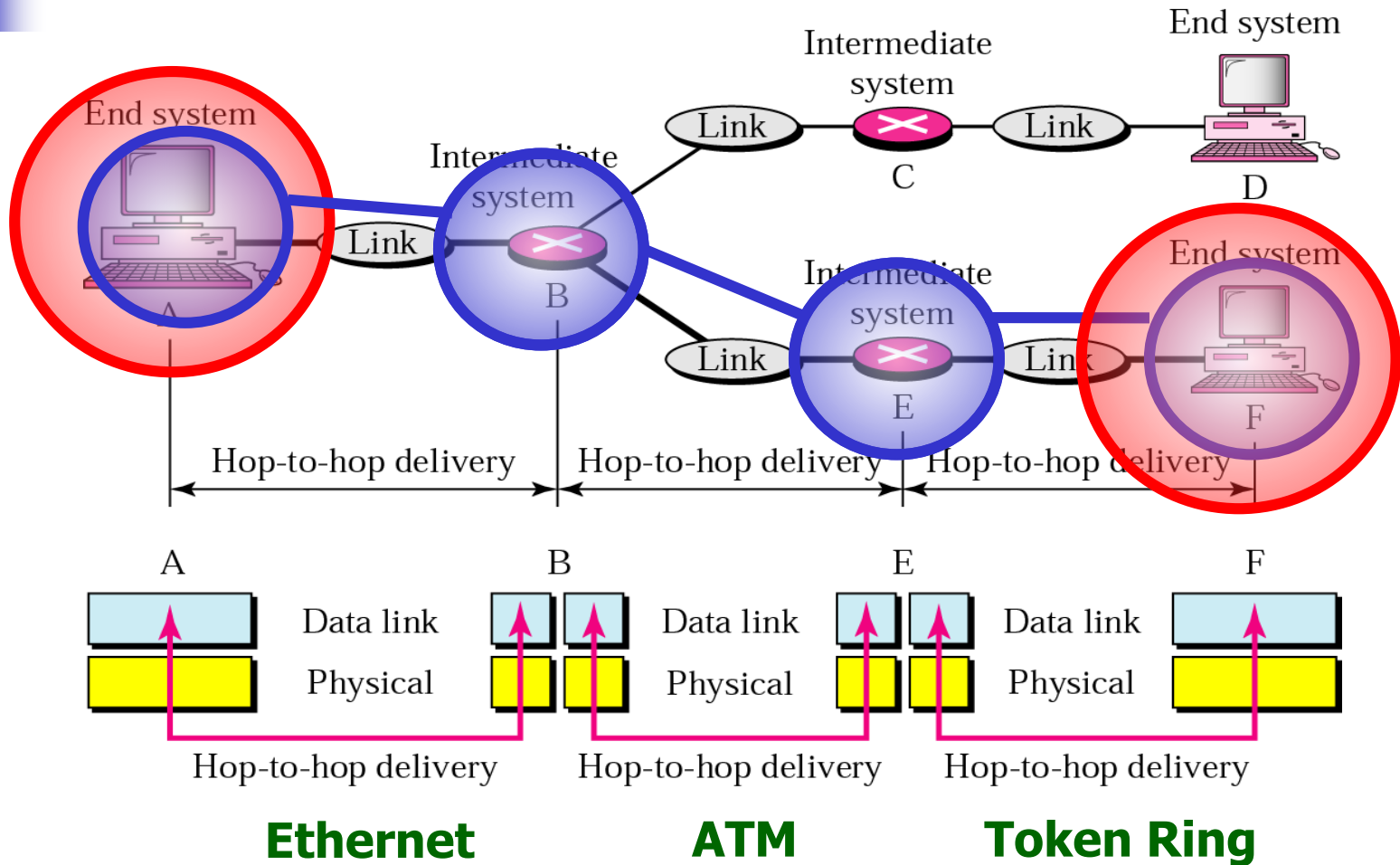


# Outline

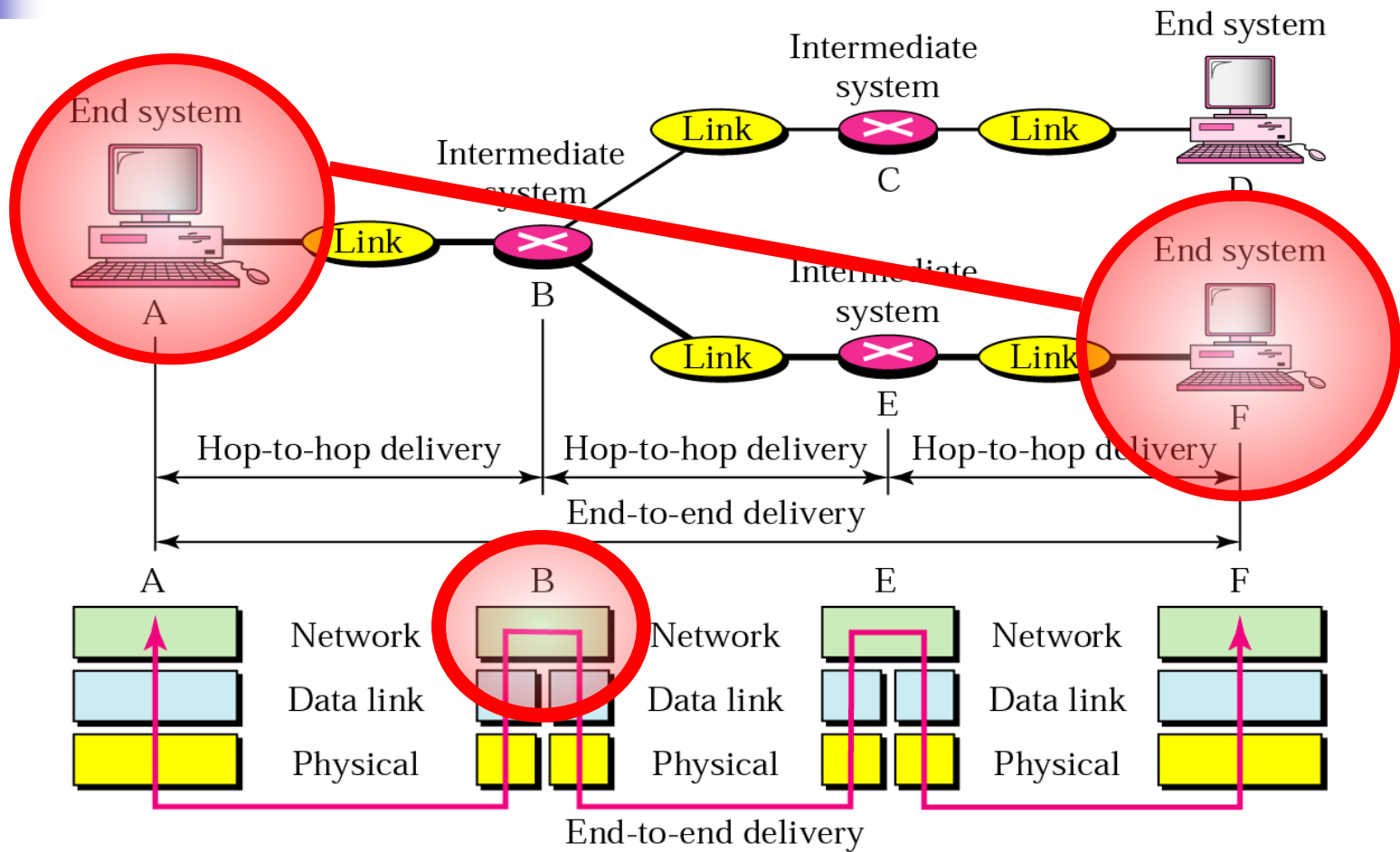
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- Datagram forwarding
- IP Datagram
  - Fragmentation

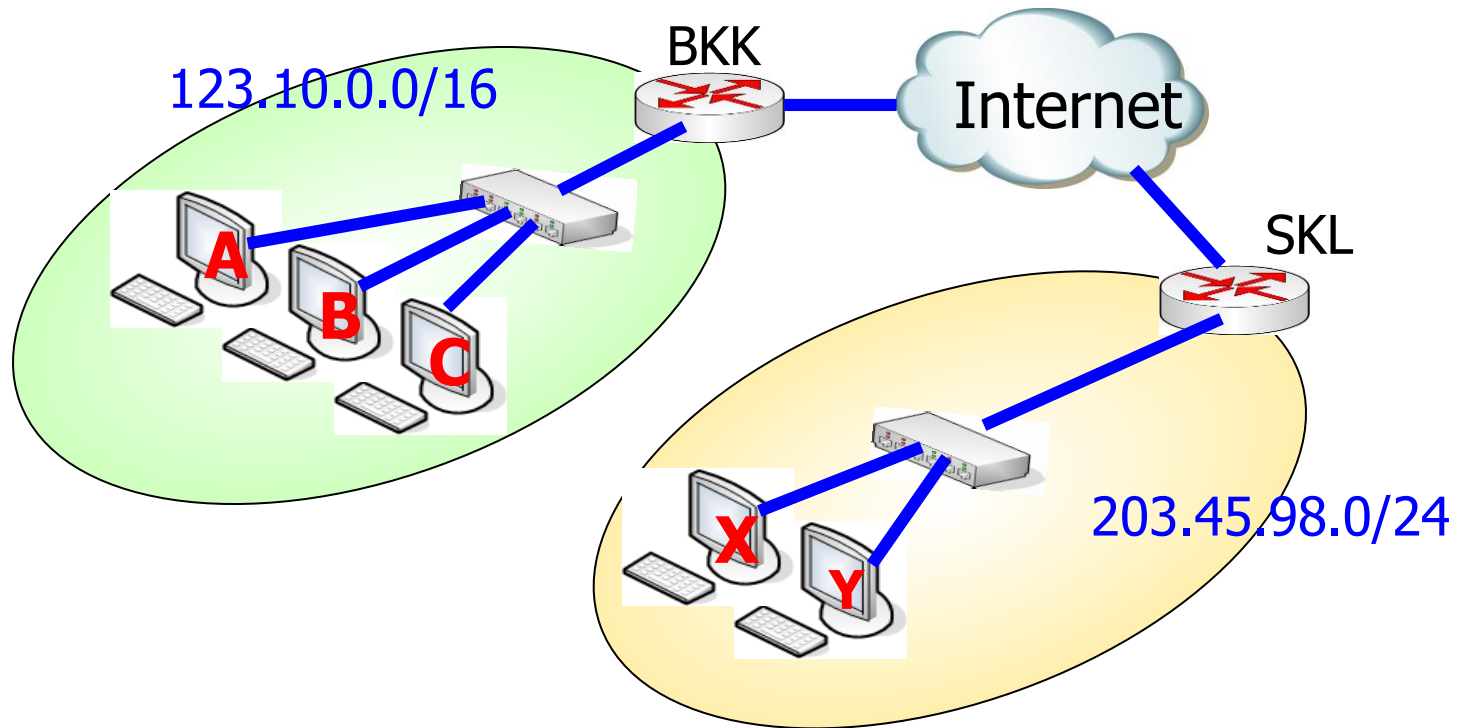
# Node-to-node delivery



# Source-to-destination delivery

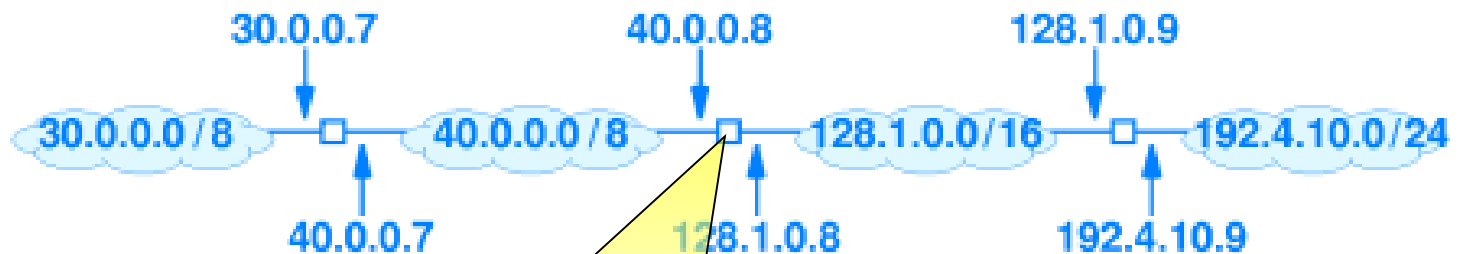


# Forwarding IP Datagram



Each router maintains **routing table**  
It's **best effort** !

# Routing Table Entries



Destination	Mask	Next Hop
30.0.0.0	255.0.0.0	40.0.0.7
40.0.0.0	255.0.0.0	deliver direct
128.1.0.0	255.255.0.0	deliver direct
192.4.10.0	255.255.255.0	128.1.0.9

# Packet forwarding (Routing)

- Router reads **destination IP add**
- Router finds out the **network address**
  - destination IP & Mask → network address
  - 192.4.10.15 & 255.255.255.0 → 192.4.10.0

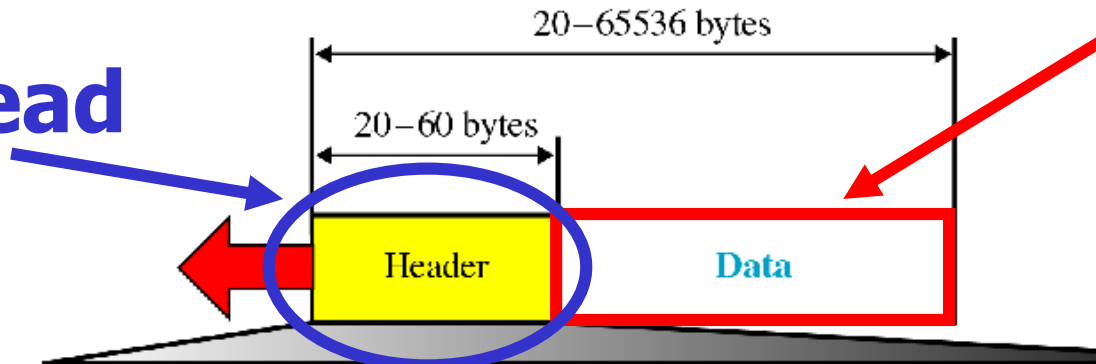
	192		4		10		15		
	1100	0000	0000	0100	0000	1010	0000	1111	&
255	1111	1111	1111	1111	1111	1111	0000	0000	
	1100	0000	0000	0100	0000	1010	0000	0000	

- Use network add to look for **next hop** in routing table

# IP Datagram (IPv4)

**Overhead**

**Payload**



<b>VER</b> 4 bits	<b>HLEN</b> 4 bits	<b>Service type</b> 8 bits	<b>Total length</b> 16 bits	
<b>Identification</b> 16 bits			<b>Flags</b> 3 bits	<b>Fragmentation offset</b> 13 bits
<b>Time to live</b> 8 bits		<b>Protocol</b> 8 bits	<b>Header checksum</b> 16 bits	
<b>Source IP address</b>				
<b>Destination IP address</b>				
<b>Option</b>				



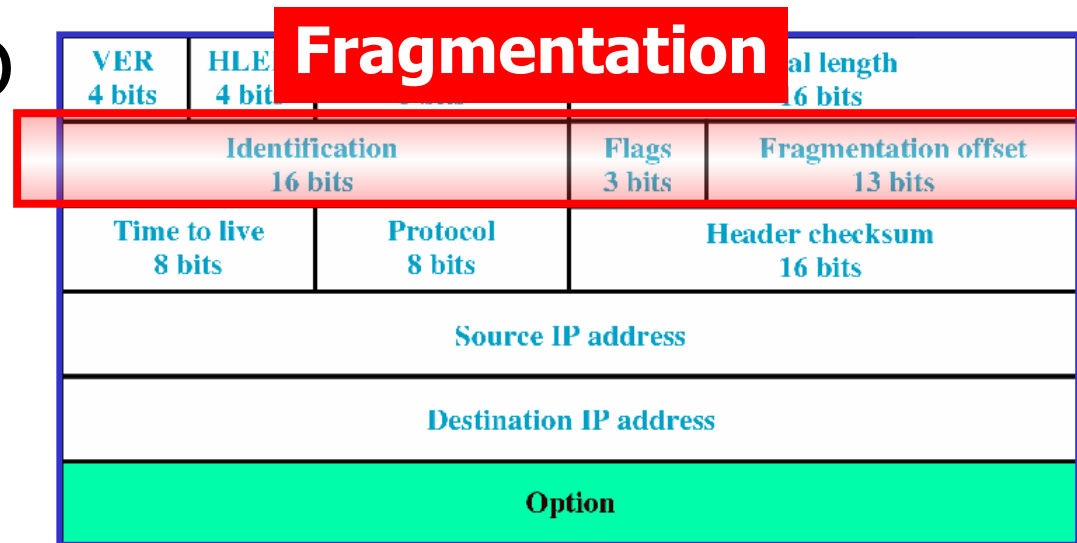
# IP Datagram

- Version
- Header Length
  - unit: 4-byte word
  - Normally: 5
- Type of Services
  - prioritize, routing
- Datagram Length (data + header)
  - Size limitation

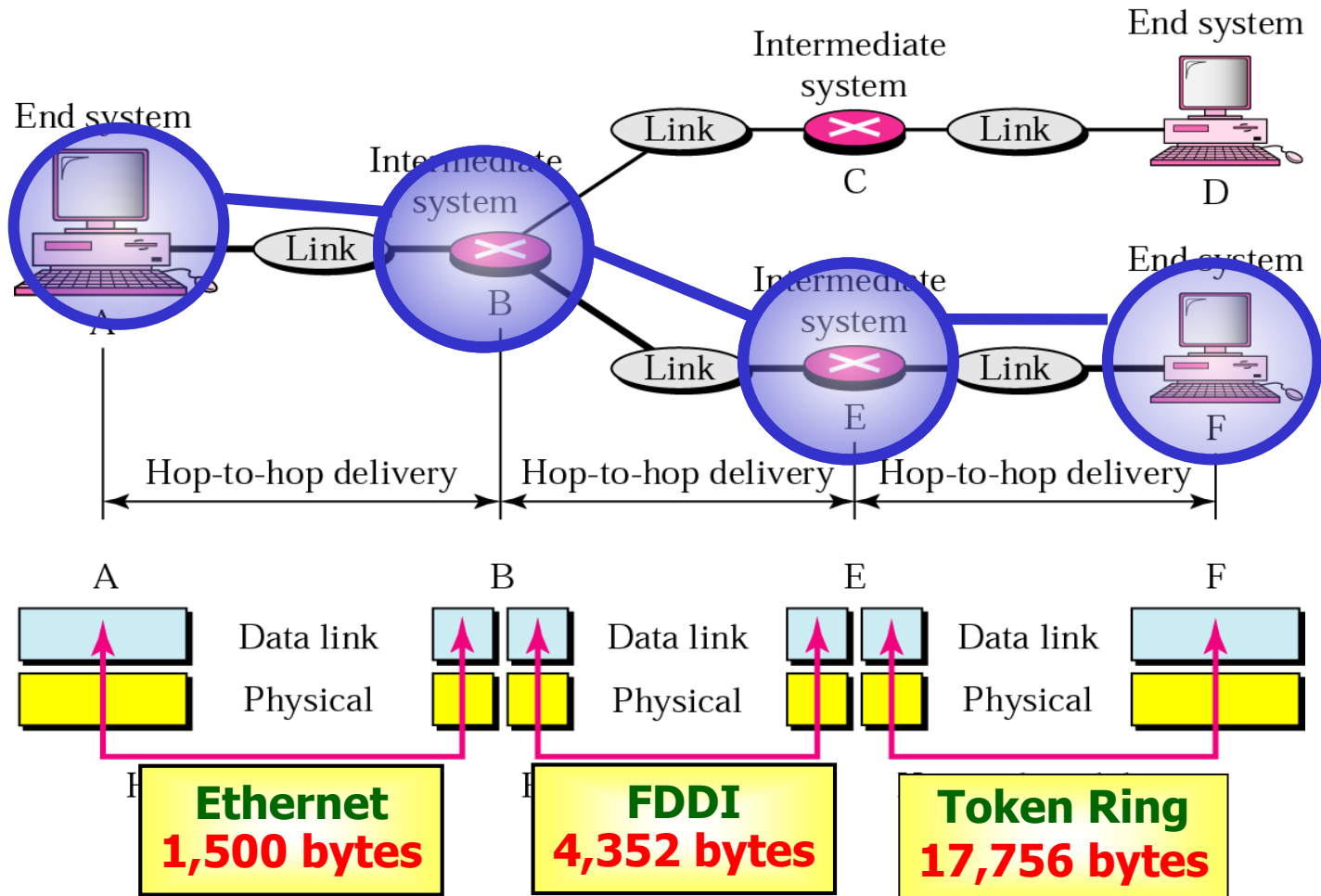
VER 4 bits	HLEN 4 bits	Service type 8 bits	Total length 16 bits	
Identification 16 bits			Flags 3 bits	Fragmentation offset 13 bits
Time to live 8 bits		Protocol 8 bits	Header checksum 16 bits	
Source IP address				
Destination IP address				
Option				

# IP Datagram

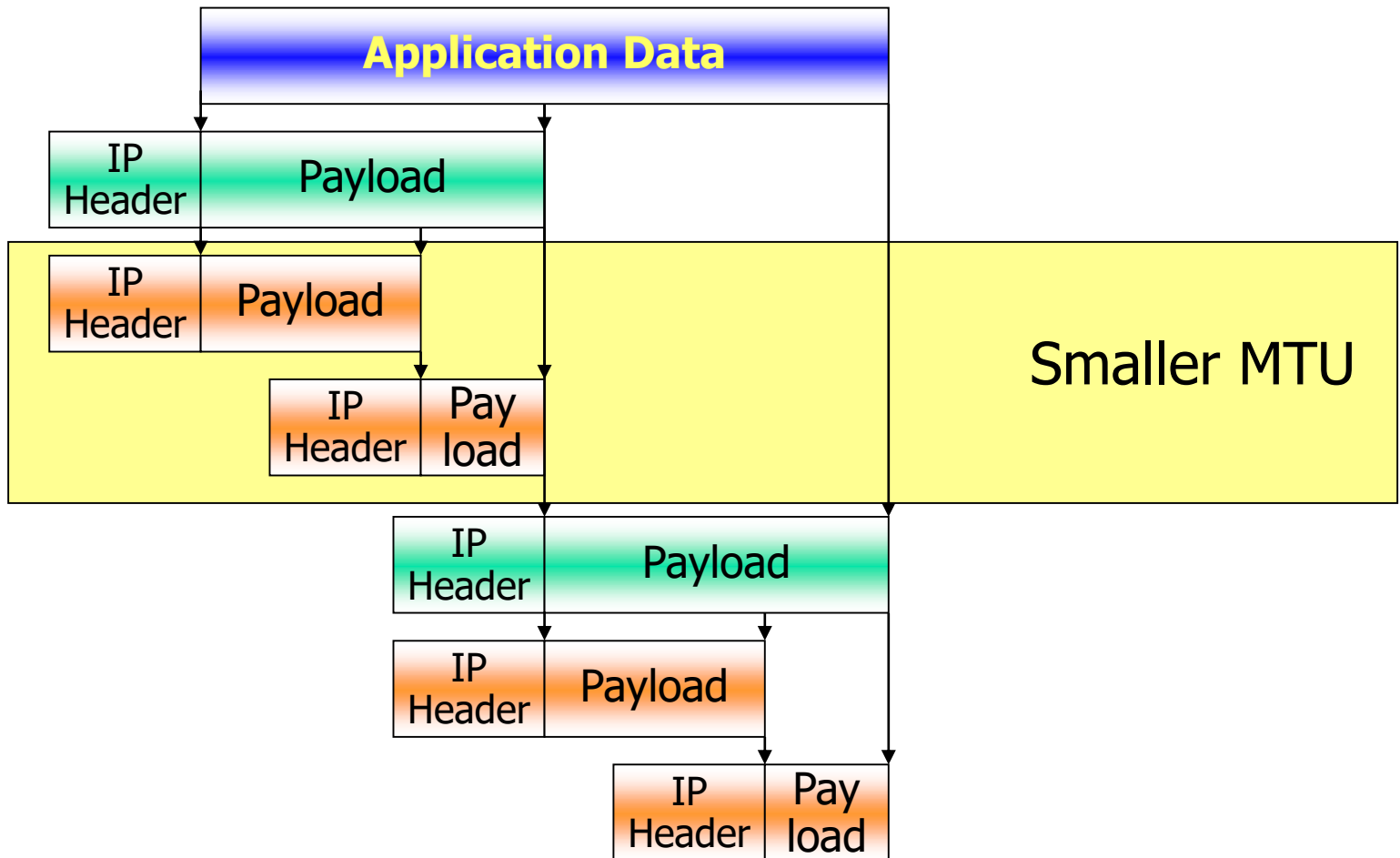
- Fragmentation ID
  - Break/Group
- Flag and Offset
  - Control
- MTU
  - Maximum Transmission Unit



# Fragmentation



# Fragmentation



# IP Datagram

## ■ TTL

- avoid **looping**
- hop count (not time count)
- TCP (60)

VER 4 bits	HLEN 4 bits	Service type 8 bits	Total length 16 bits	
Identification 16 bits			Flags 3 bits	Fragmentation offset 13 bits
Time to live 8 bits		Protocol 8 bits	Header checksum 16 bits	
Source IP address				
Destination IP address				
Option				

# IP Datagram

VER 4 bits	HLEN 4 bits	Service type 8 bits	Total length 16 bits	
Identification 16 bits		Flags 3 bits	Fragmentation offset 13 bits	
Time to live 8 bits	Protocol 8 bits		Header checksum 16 bits	
Source IP address				
Destination IP address				
Option				

- Protocol
  - identify the protocol in payload

Protocol No.	Protocol Name	RFC
1	ICMP	792
2	IGMP	1112
4	IP encapsulated	2003
6	TCP	793
17	UDP	768
89	OSPF	2328

# IP Datagram

VER 4 bits	HLEN 4 bits	Service type 8 bits	Total length 16 bits	
Identification 16 bits			Flags 2 bits	Fragmentation offset 12 bits
Time to live 8 bits	Protocol 8 bits	Header checksum 16 bits		
Source IP address				
Destination IP address				
Option				

- Header Checksum
  - for header only → fast speed
  - How about Data ???
  - regular checksum detection is not really accurate
    - 1-byte data with 1-byte checksum
    - add/subtract
  - IP uses 1's compliment checksum
    - Overflow!

# IP Address

<b>VER</b> 4 bits	<b>HLEN</b> 4 bits	<b>Service type</b> 8 bits	<b>Total length</b> 16 bits	
<b>Identification</b> 16 bits			<b>Flags</b> 3 bits	<b>Fragmentation offset</b> 13 bits
<b>Time to live</b> 8 bits		<b>Protocol</b> 8 bits	<b>Header checksum</b> 16 bits	
<b>Source IP address</b>			<b>32 bits</b>	
<b>Destination IP address</b>			<b>32 bits</b>	
<b>Option</b>				