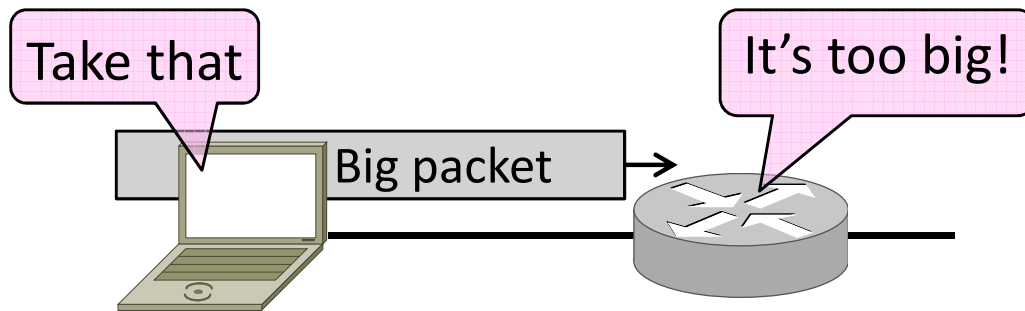# Computer Networks

Packet Fragmentation(§5.5.5)

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Topic

- How do we connect networks with different maximum packet sizes?
  - Need to split up packets, or discover the largest size to use

Packet Size Problem

- Different networks have different maximum packet sizes
  - Or MTU (Maximum Transmission Unit)
  - E.g., Ethernet 1.5K, WiFi 2.3K

- Prefer large packets for efficiency
  - But what size is too large?
  - Difficult because node does not know complete network path

Packet Size Solutions

- Fragmentation (==now==)
  - Split up large packets in the network if they are too big to send
  - Classic method, dated

- Discovery (next)
  - Find the largest packet that fits on the network path and use it
 - IP uses today instead of fragmentation

IPv4 Fragmentation

- Routers fragment packets that are too large to forward
- Receiving host reassembles to reduce load on routers

Fits on first link
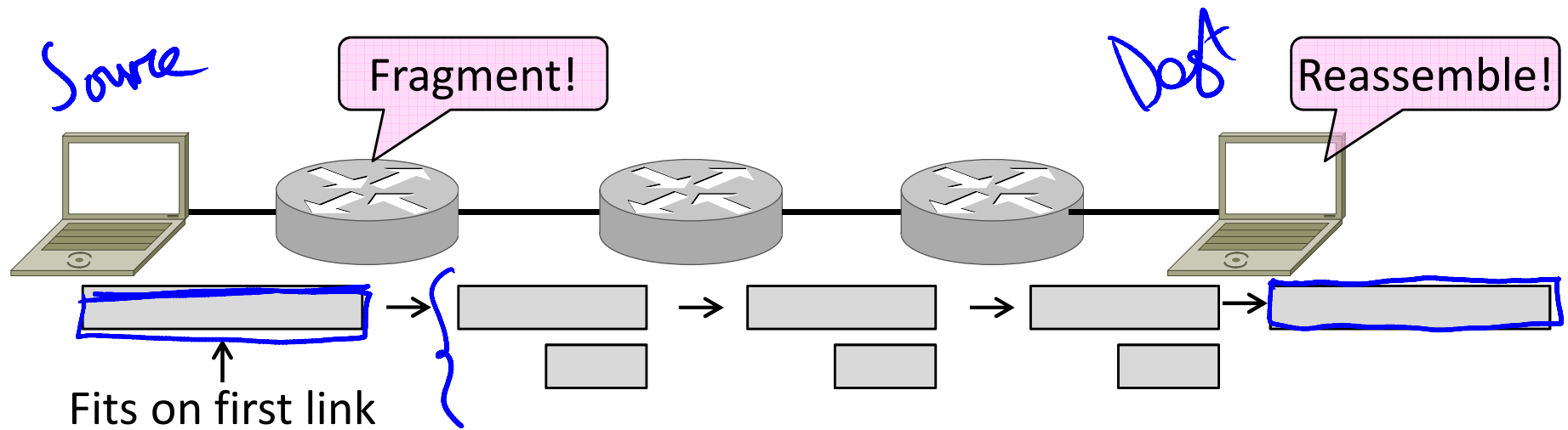
IPv4 Fragmentation Fields

- Header fields used to handle packet size differences
  - Identification, Fragment offset, MF/DF control bits

Handwritten annotations: MF = More fragments, DF = Don't fragment
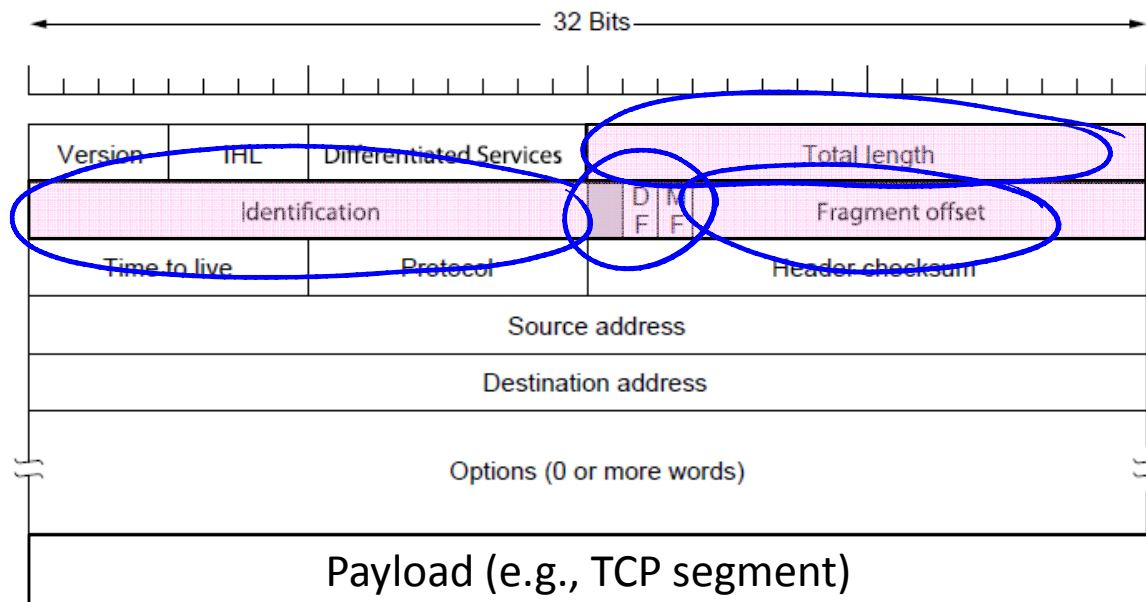
IPv4 Fragmentation Procedure

- Routers split a packet that is too large:
  - Typically break into large pieces
  - Copy IP header to pieces
  - Adjust length on pieces
  - Set offset to indicate position
  - Set MF (More Fragments) on all pieces except last

- Receiving hosts reassembles the pieces:
  - Identification field links pieces together, MF tells receiver when it has all pieces
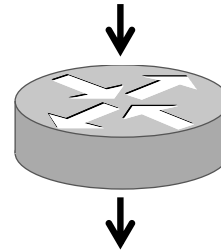
IPv4 Fragmentation (2)

Before
MTU = 2300

ID = 0x12ef
Data Len = 2300
Offset = 0
MF = 0

(Ignore length of headers)

After
MTU = 1500

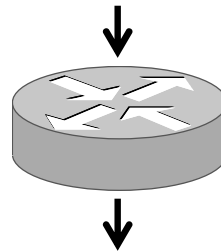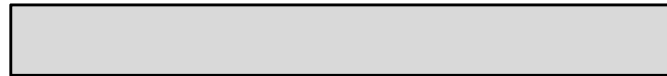ID = 0x12ef
Data Len = 1580
Offset = 0
MF = 1

1st

ID = 0x12ef
Data Len = 880
Offset = 1580
MF = 0

2nd

IPv4 Fragmentation (3)

Before
MTU = 2300

ID = 0x12ef
Data Len = 2300
Offset = 0
MF = 0

After
MTU = 1500

ID = 0x12ef
Data Len = 1500
Offset = 0
MF = 1

ID = 0x12ef
Data Len = 800
Offset = 1500
MF = 0

IPv4 Fragmentation (4)

- It works!
  - Allows repeated fragmentation

- But <mark>fragmentation is undesirable</mark>
  - More work for routers, hosts
  - Tends to magnify loss rate
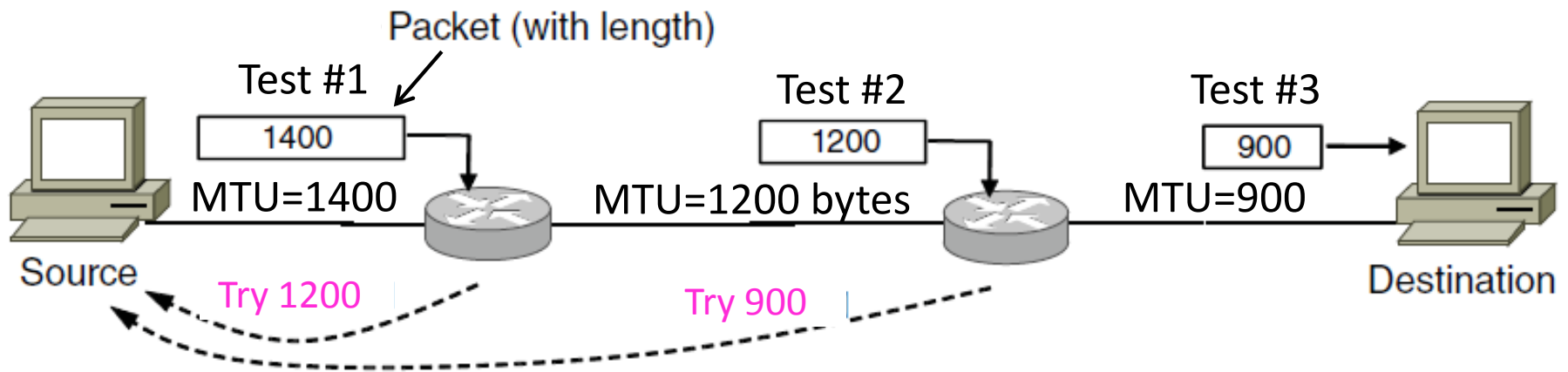 - Security vulnerabilities too

Path MTU Discovery

- Discover the MTU that will fit
  - So we can avoid fragmentation
  - The method in use today

- Host tests path with large packet
  - Routers provide feedback if too large; they tell host what size would have fit

Path MTU Discovery (2)
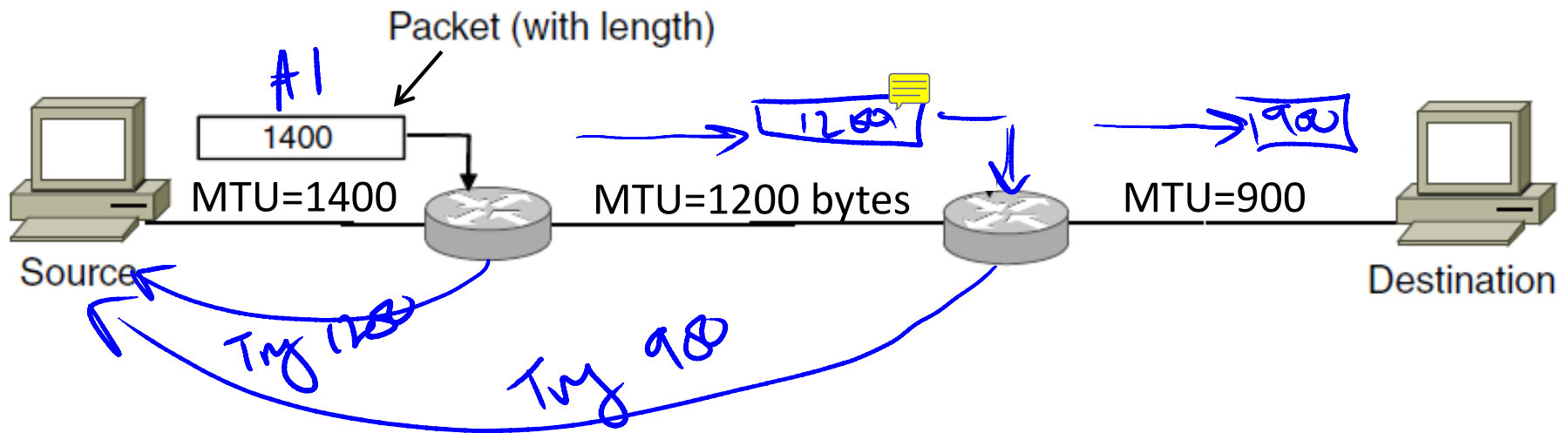
Path MTU Discovery (3)

Path MTU Discovery (4)

- Process may seem involved
  - But usually quick to find right size

- Path MTU depends on the path and so can change over time
  - Search is ongoing

- Implemented with ICMP (next)
  - Set DF (Don't Fragment) bit in IP header to get feedback messages

END

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