

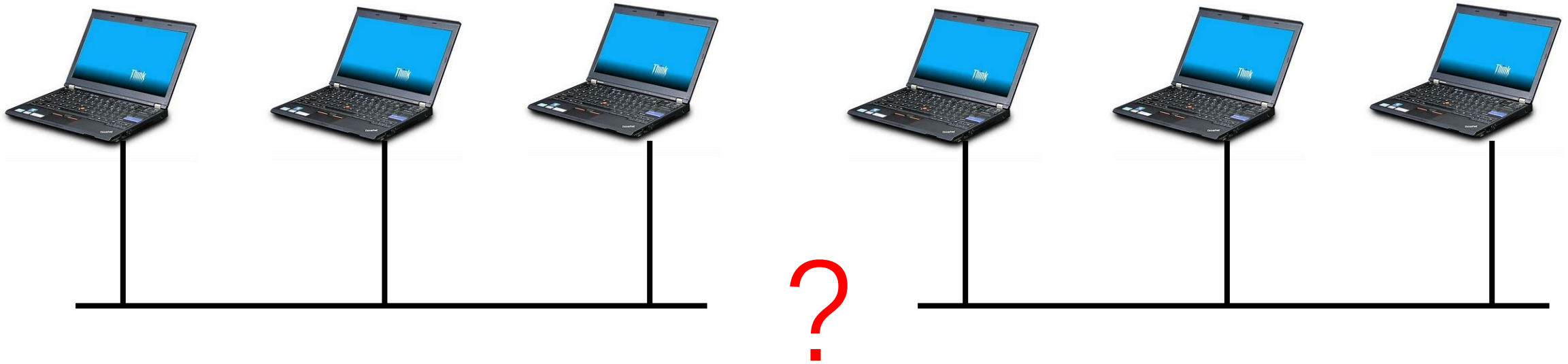


CS120: Computer Networks

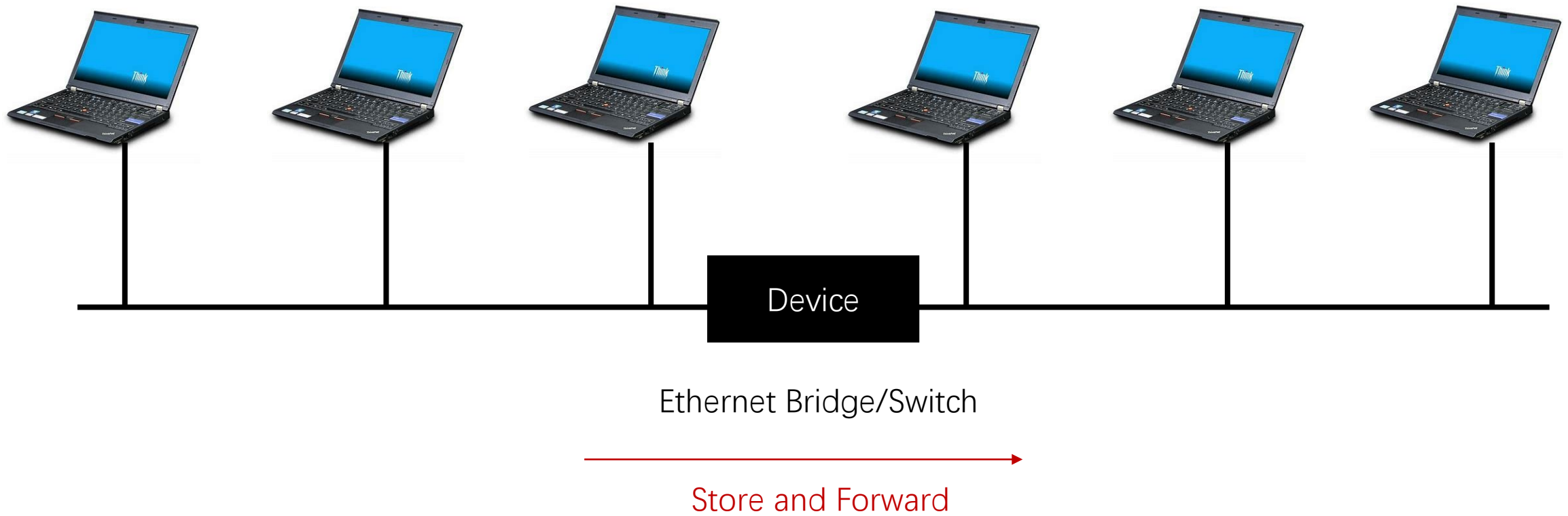
Lecture 8. Switching

Zhice Yang

How to Extend the Ethernet ?

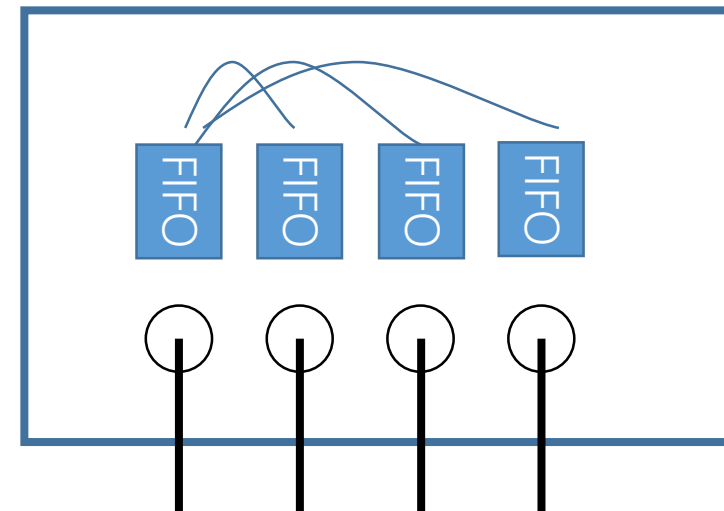
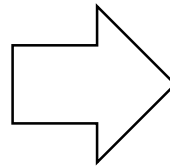


How to Extend the Ethernet ?



Switch

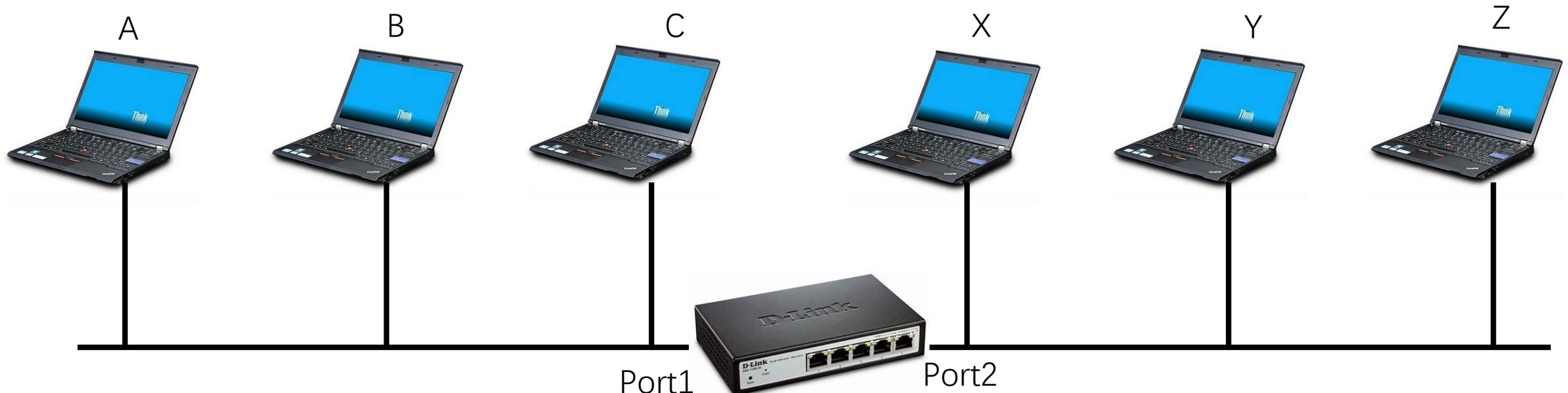
- A multi-input, multi-output device
 - Function: transfer packets from an input to one or more outputs
 - Ports can be connected to hosts
 - Ports can be connected to other switches
 - Performance: more ports in use => higher network throughput
- A device to form Ethernet to a large network



How to Extend the Ethernet ?

- Simplest Strategy
 - Accept LAN frames on inputs and forward them out to **all** other outputs
- Better Strategy: learning Bridge
 - Observation: No need to forward frames to all outputs
 - Forwarding Table

How to Extend the Ethernet ?



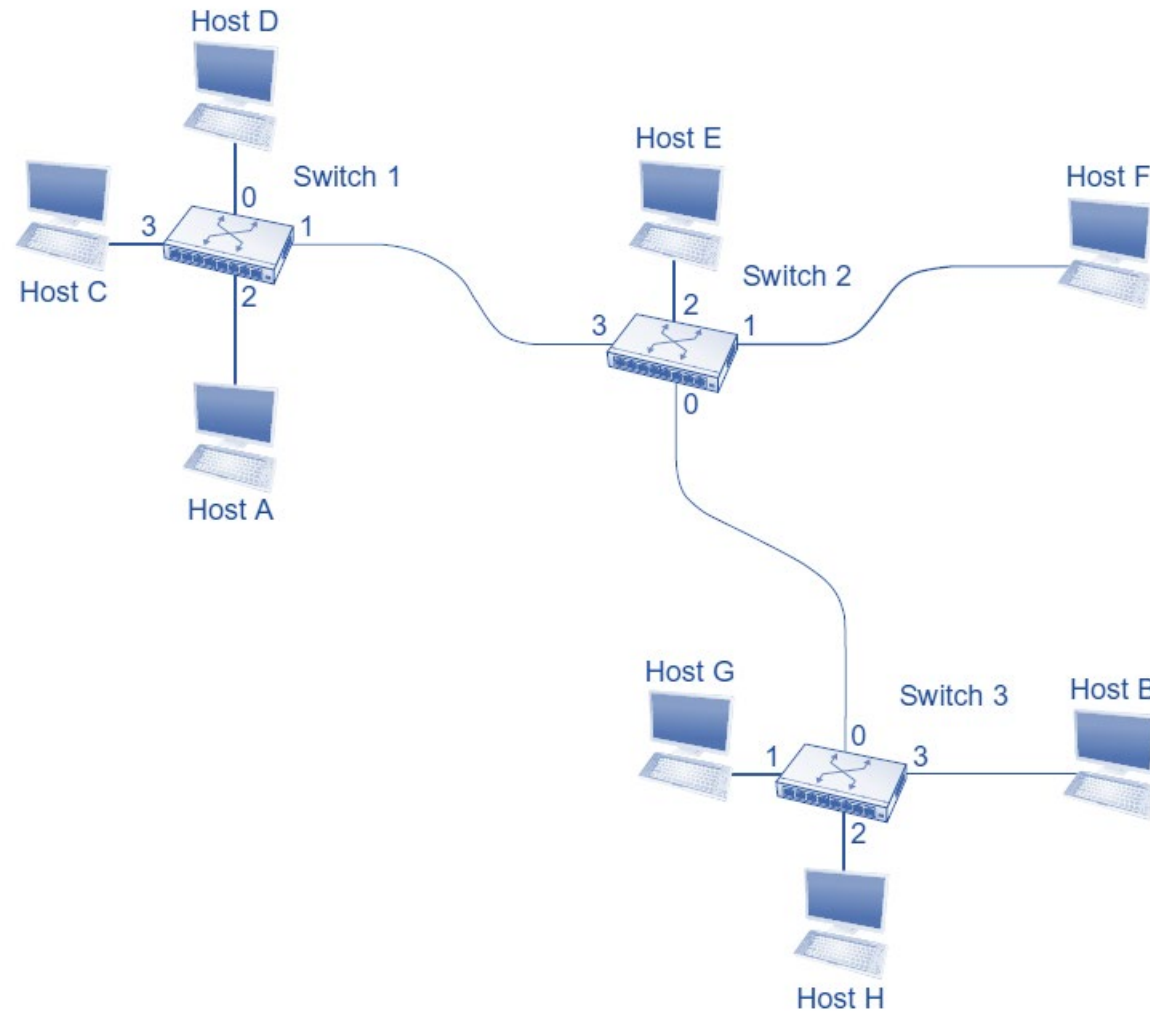
Ethernet Bridge/Switch

Forward

Host	Port

A	1
B	1
C	1
X	2
Y	2
Z	2

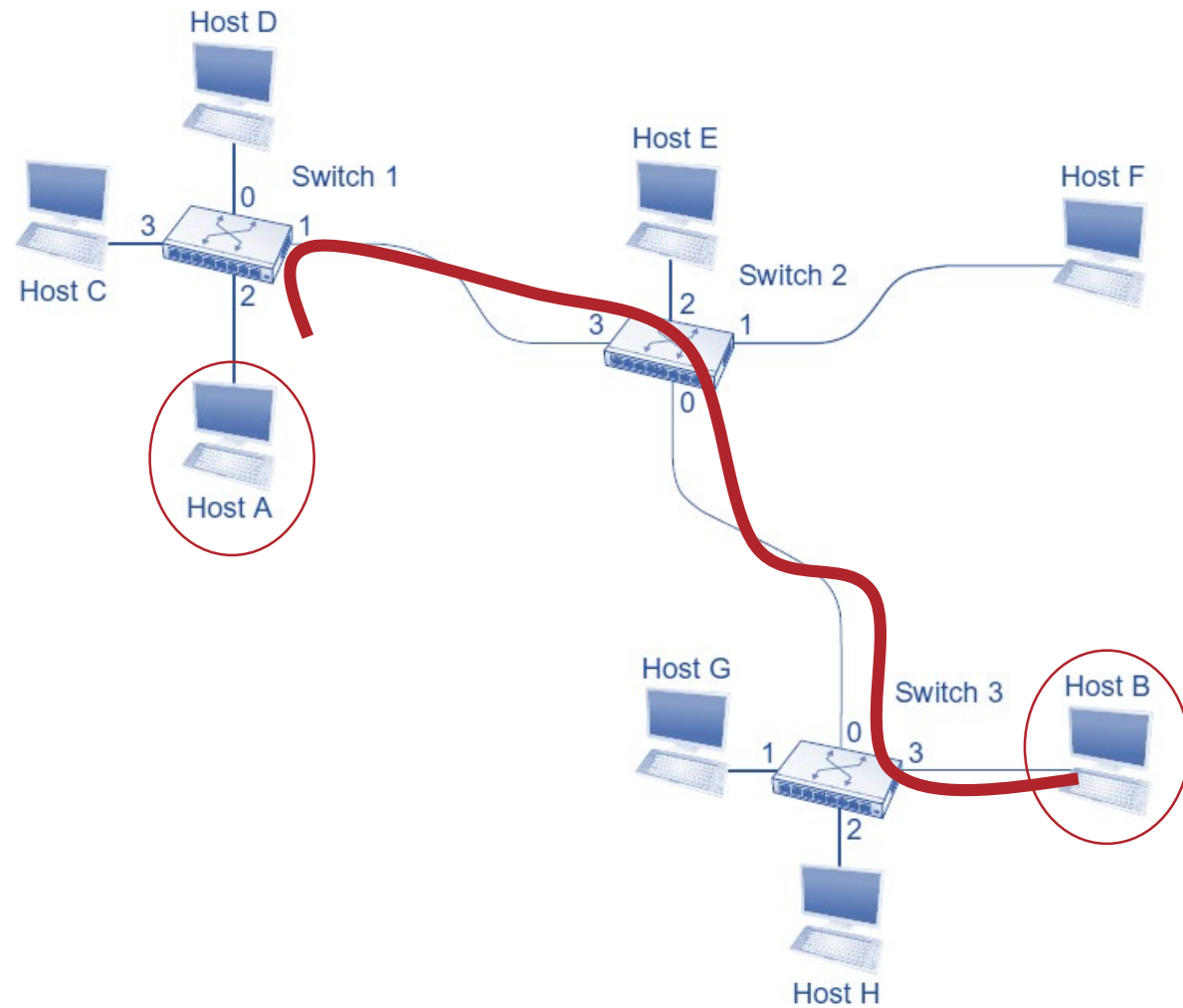
Larger Network with Switches



Switching Methods

- Datagram/Connectionless
 - e.g. Ethernet
- Virtual Circuit(VC)/Connection
 - e.g. X.25, ATM
- Source Routing

Datagram



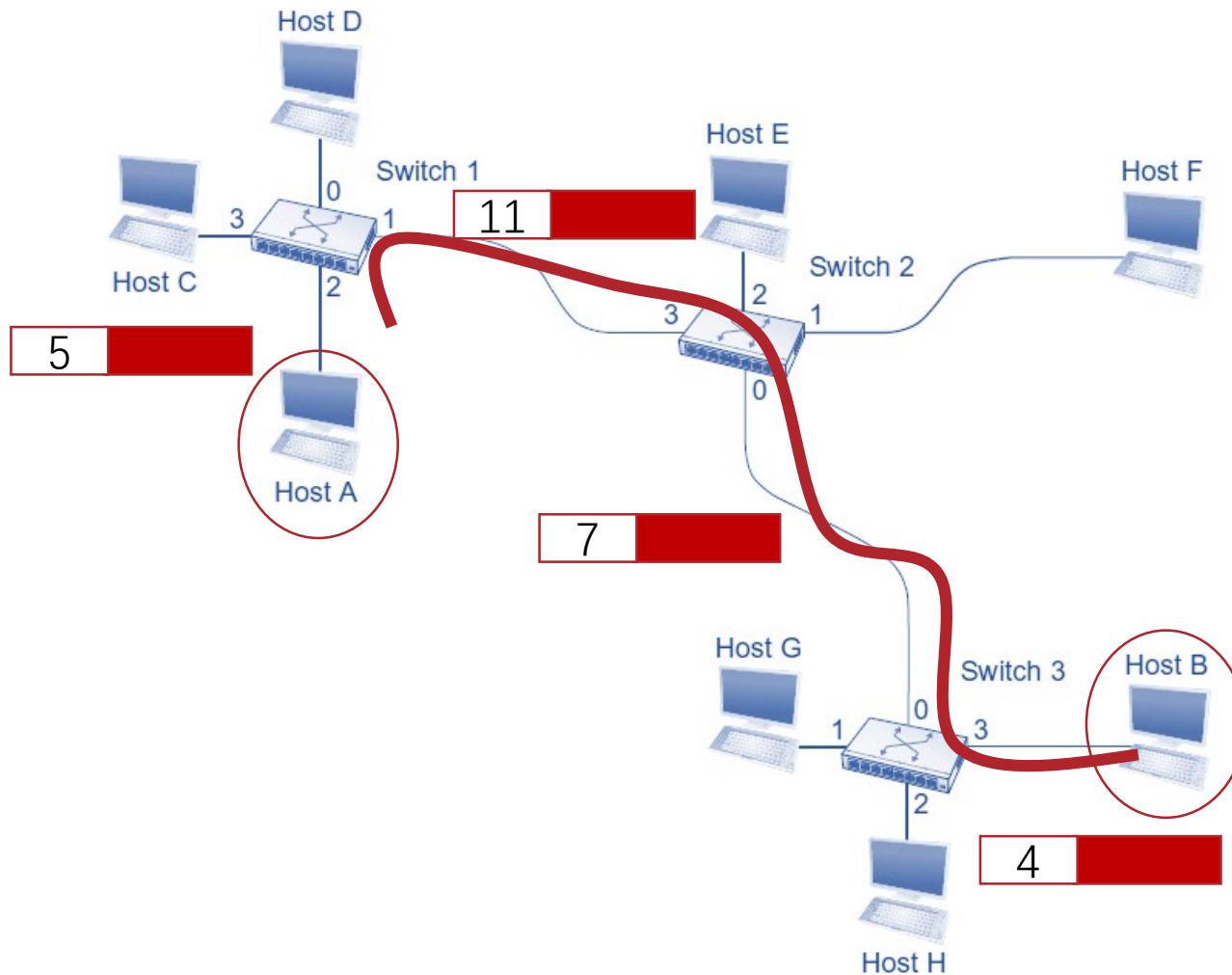
Forwarding Table

Switch1		Switch2		Switch3	
Dest	Port	Dest	Port	Dest	Port
A	2	A	3	A	0
B	1	B	0	B	3
C	3	C	3	C	0
D	0	D	3	D	0
E	1	E	2	E	0
F	1	F	1	F	0
G	1	G	0	G	1
H	1	H	0	H	2

Datagram

- Elastic Service
 - Send at any time
- No Guarantee for
 - Success delivery
 - Performance
 - Delay, Throughput
 - Packet Order

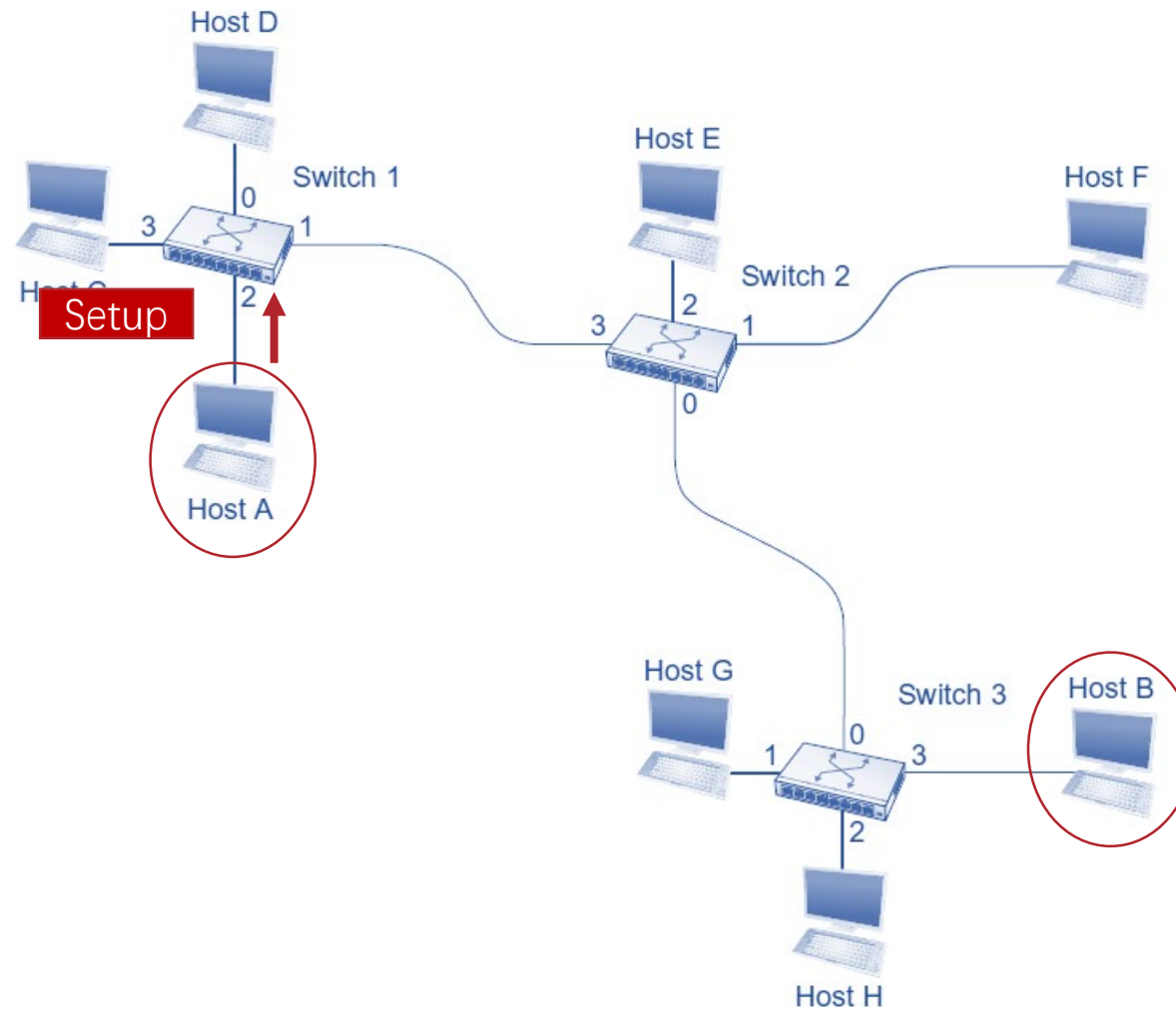
Virtual Circuit



Virtual Circuit Table

Switch1			
Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
2	5	1	11
Switch2			
Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
3	11	0	7
Switch3			
Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
0	7	3	4

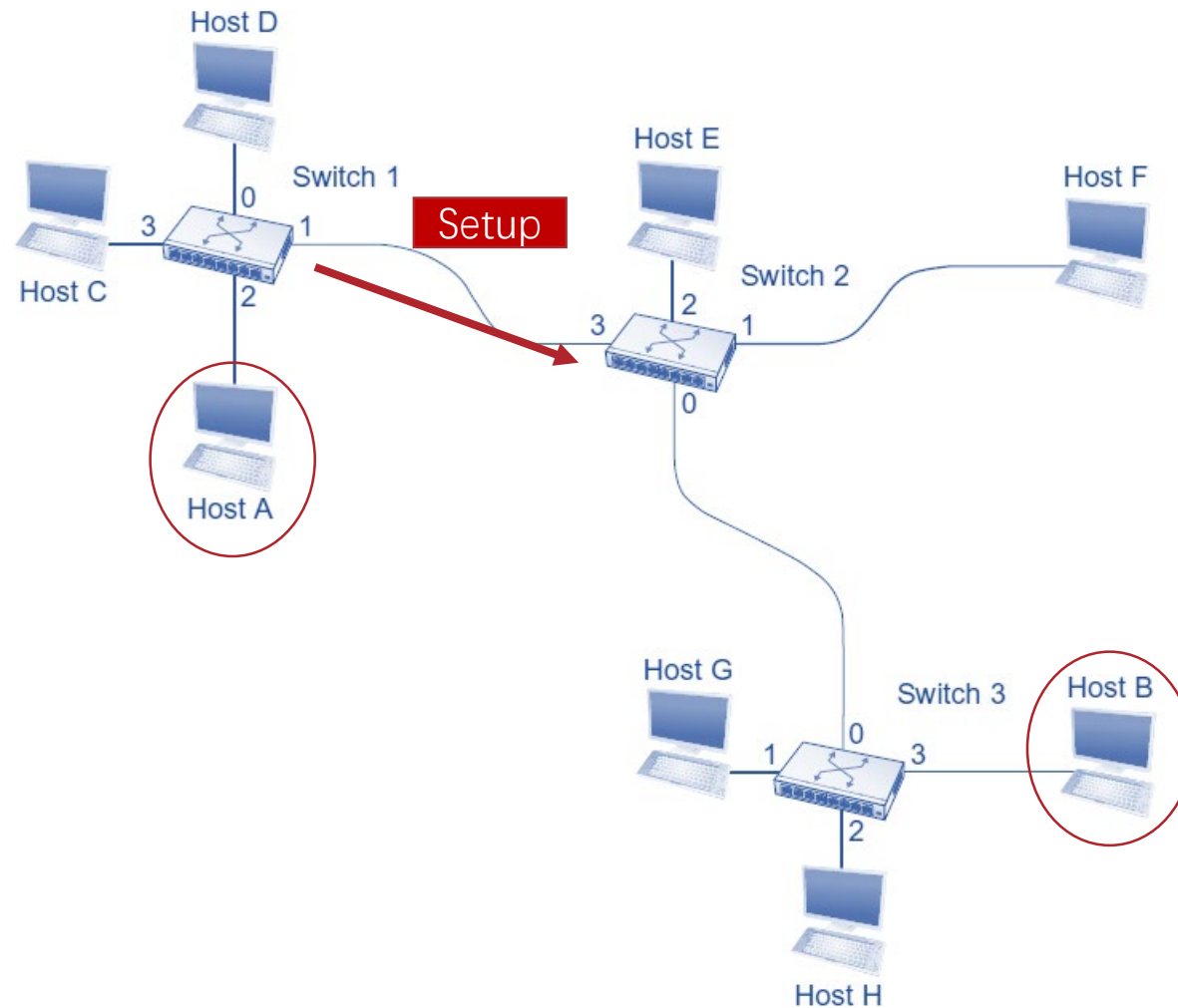
Virtual Circuit



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Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
Host A		Host B	
Destination	Outgoing VCI	Source	Incoming VCI

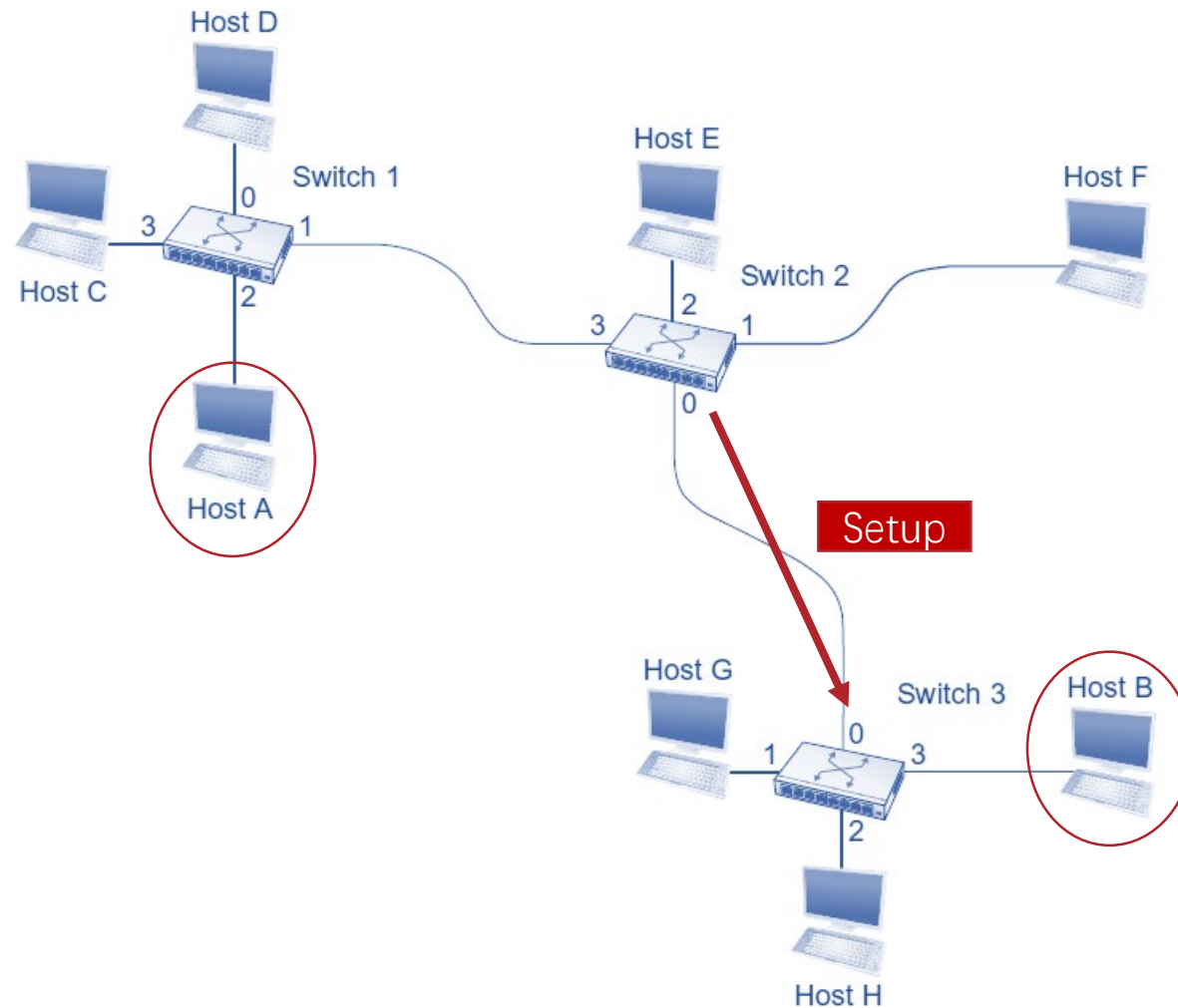
Virtual Circuit



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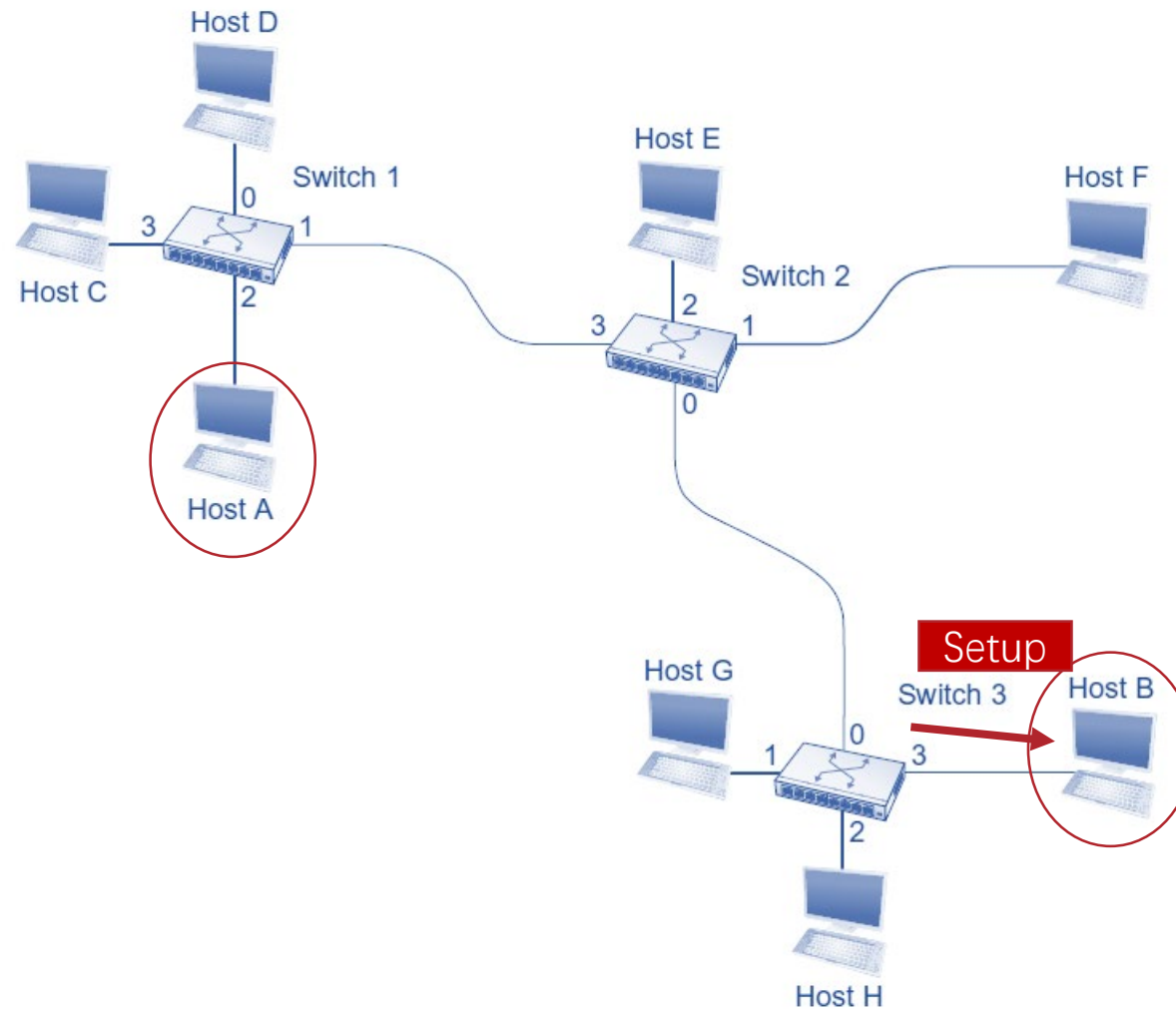
Virtual Circuit



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Host A		Host B	
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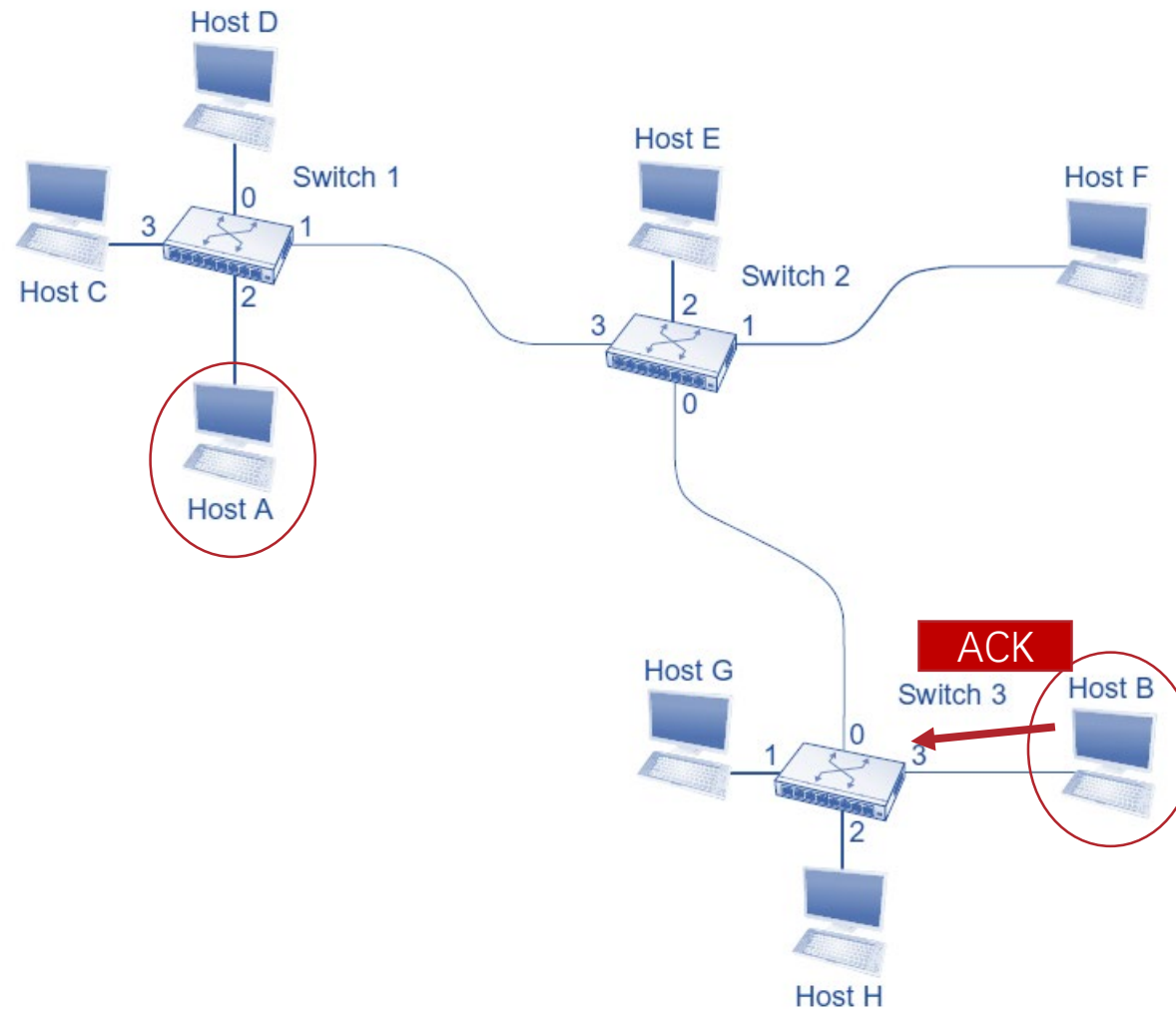
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Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
0	7		
Host A		Host B	
Destination	Outgoing VCI	Source	Incoming VCI
		From A	4

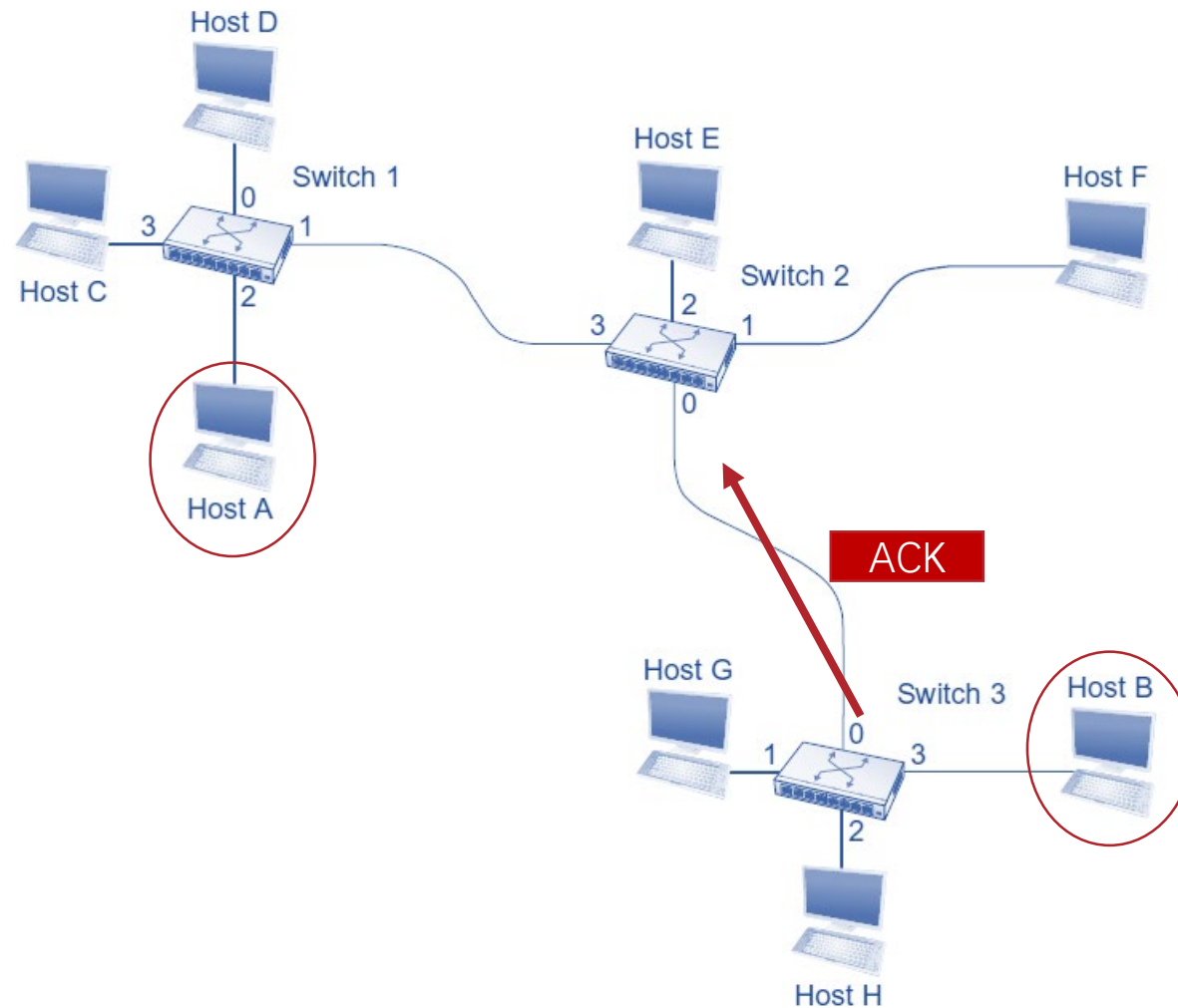
Virtual Circuit



Virtual Circuit Table

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Host A		Host B	
Destinati on	Outgoing VCI	Source	Incoming VCI
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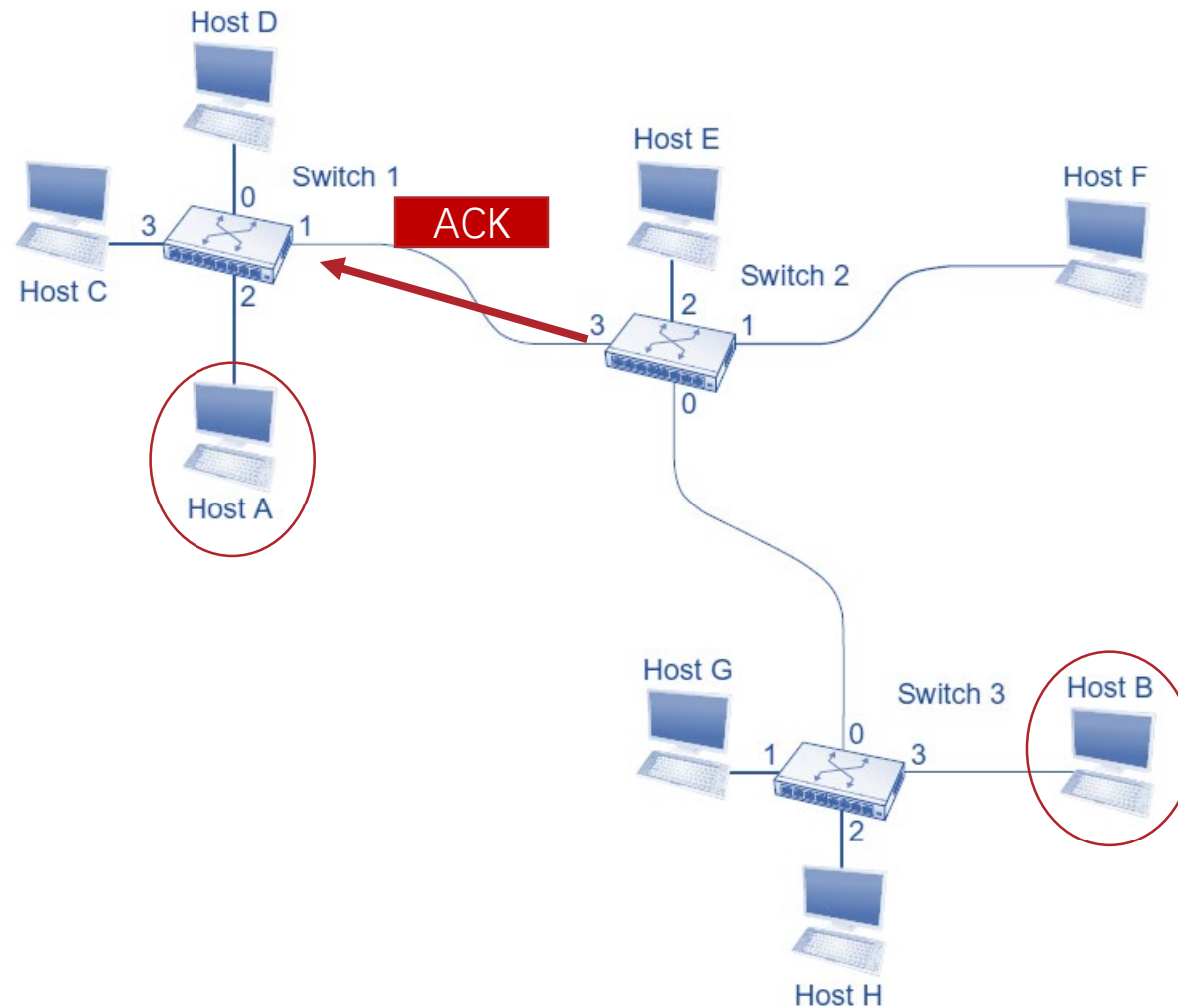
Virtual Circuit



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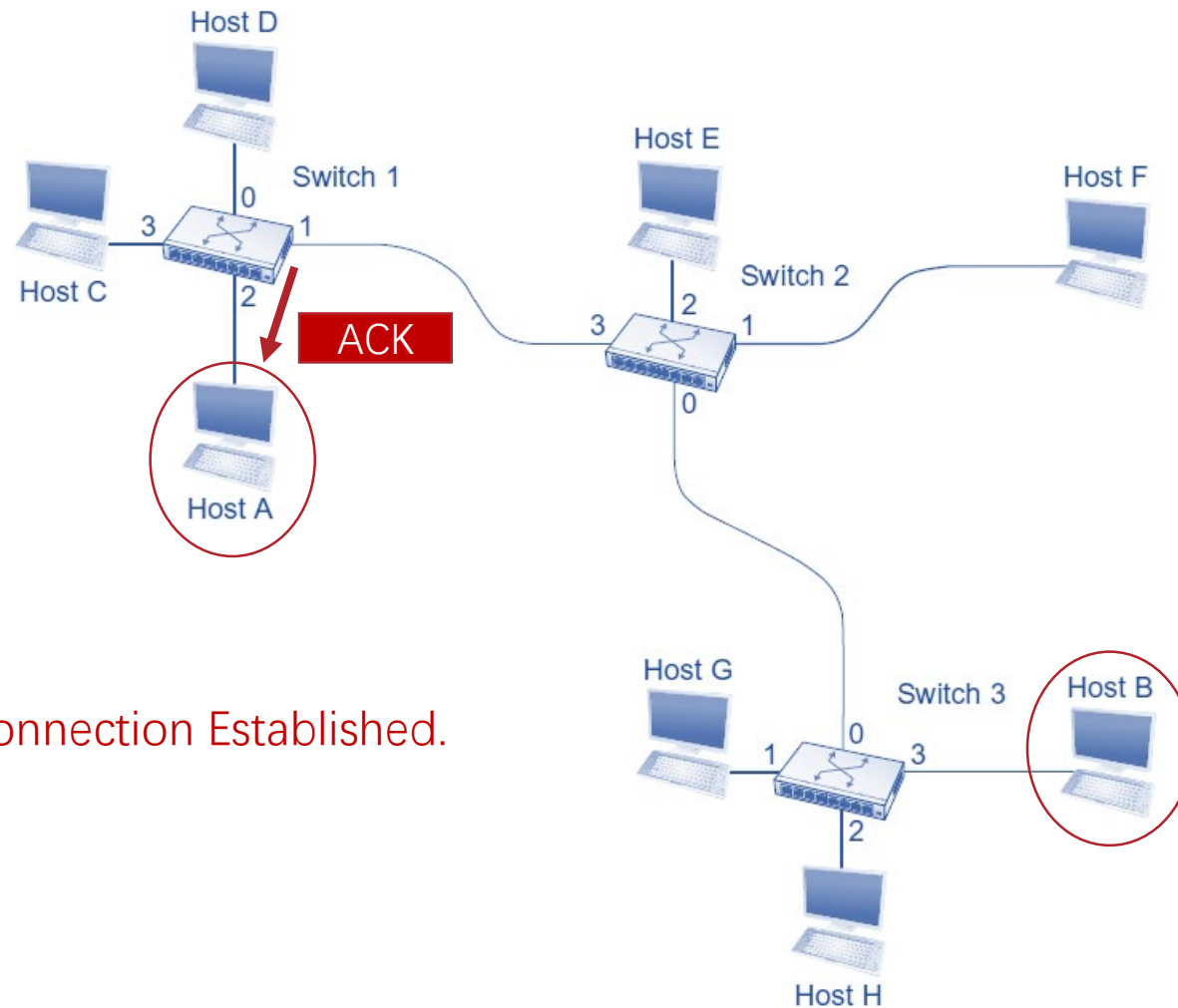
Virtual Circuit



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Host A		Host B	
Destination	Outgoing VCI	Source	Incoming VCI
		From A	4

Virtual Circuit



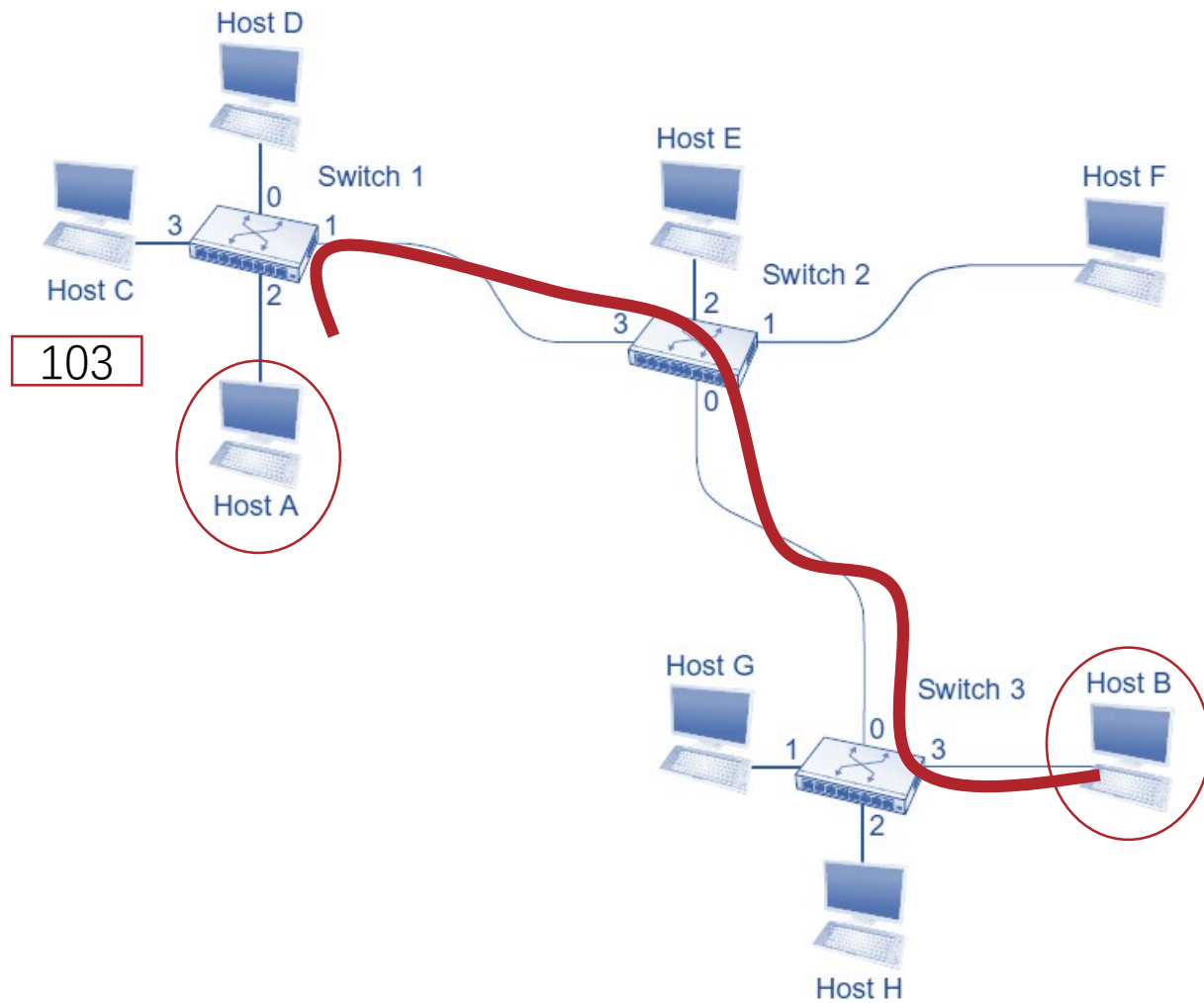
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Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
3	11	0	7
Switch3			
Incoming Interface	Incoming VCI	Outgoing Interface	Outgoing VCI
0	7	3	4
Host A		Host B	
Destinati on	Outgoing VCI	Source	Incoming VCI
To B	5	From A	4

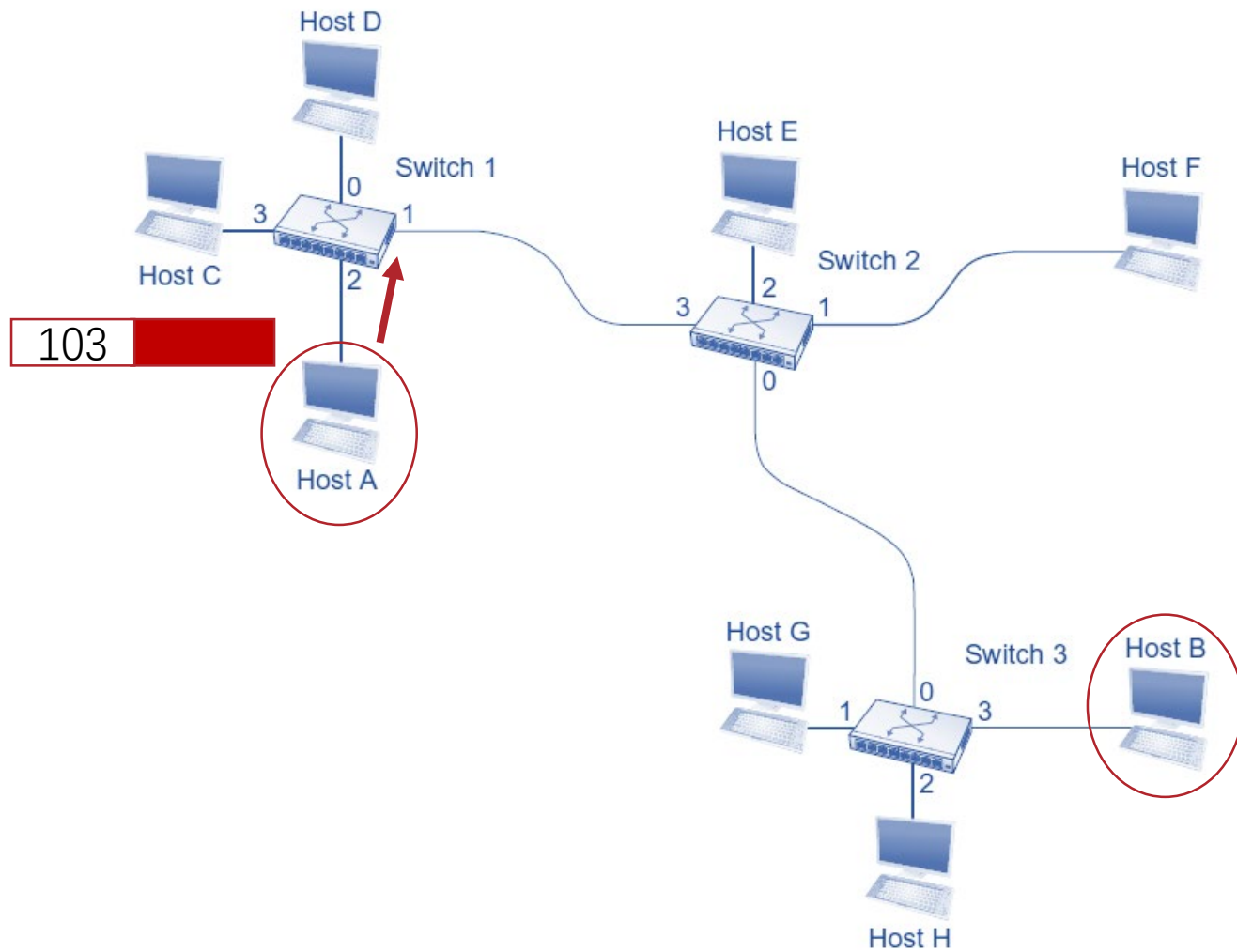
Virtual Circuit

- Reservation Service
 - Reserve Before Sending
- Guaranteed Service
 - Bitrate, Delay, etc.
 - Performance
 - Through reserving buffer, connection bandwidth, etc.

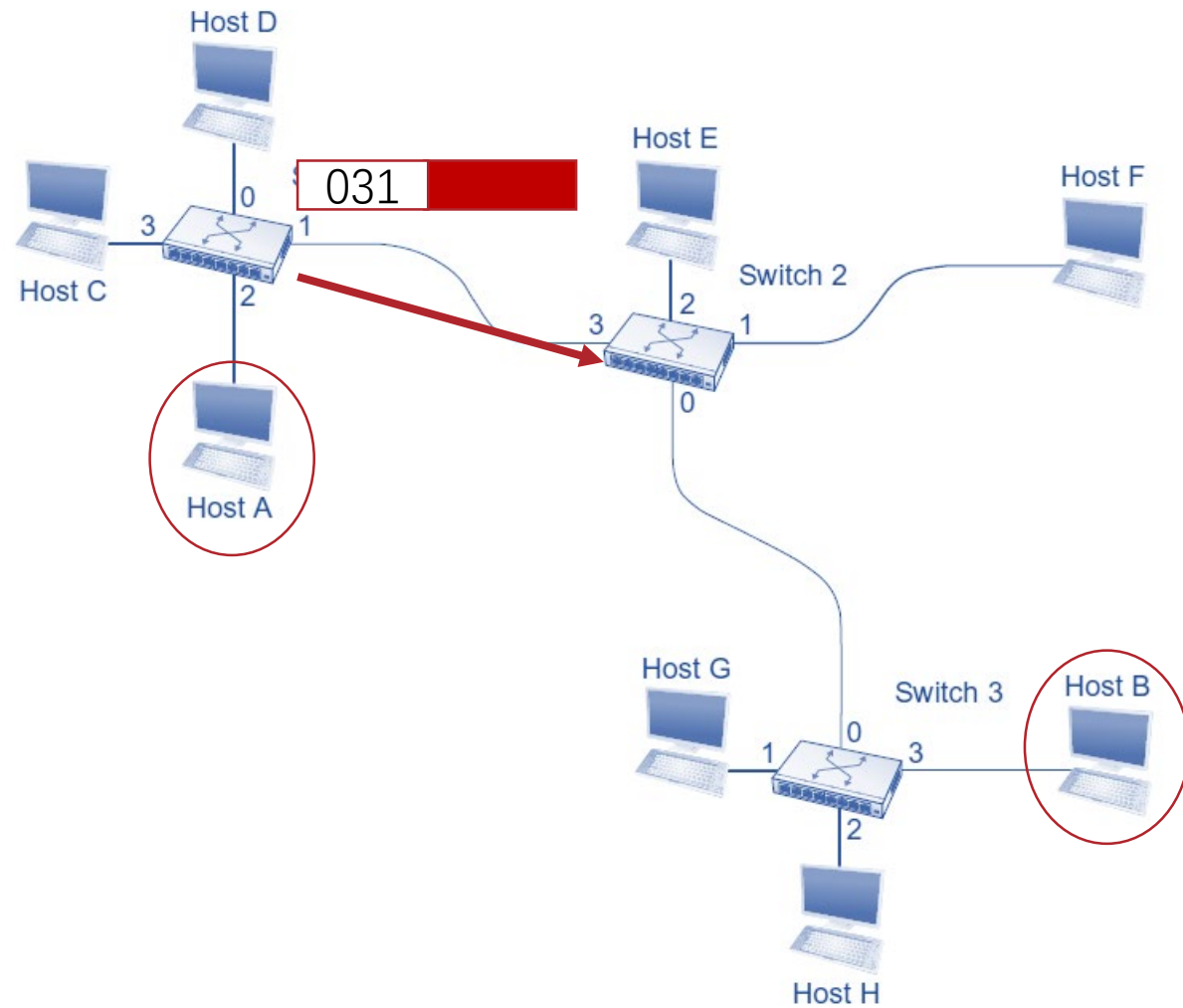
Source Routing



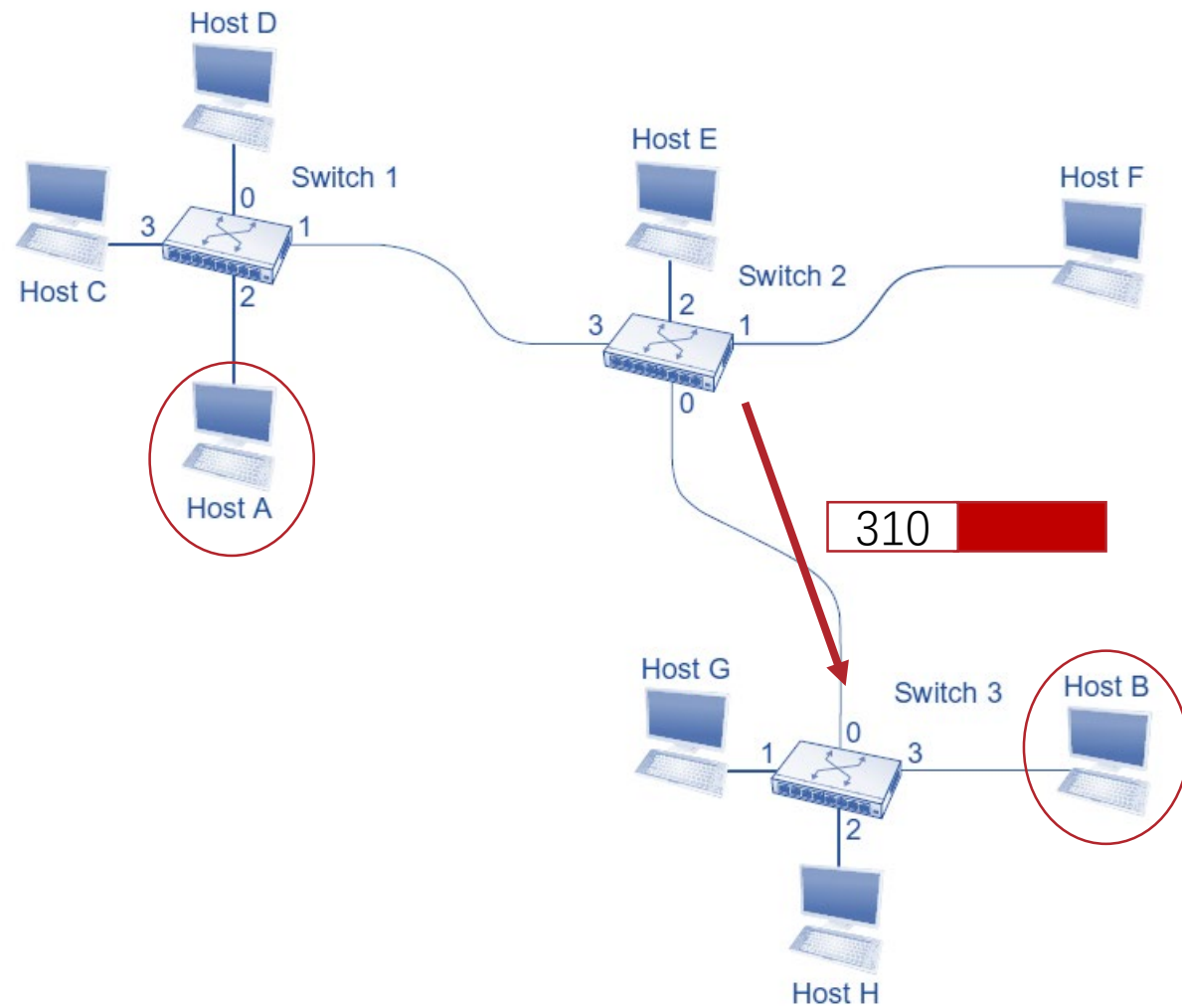
Source Routing



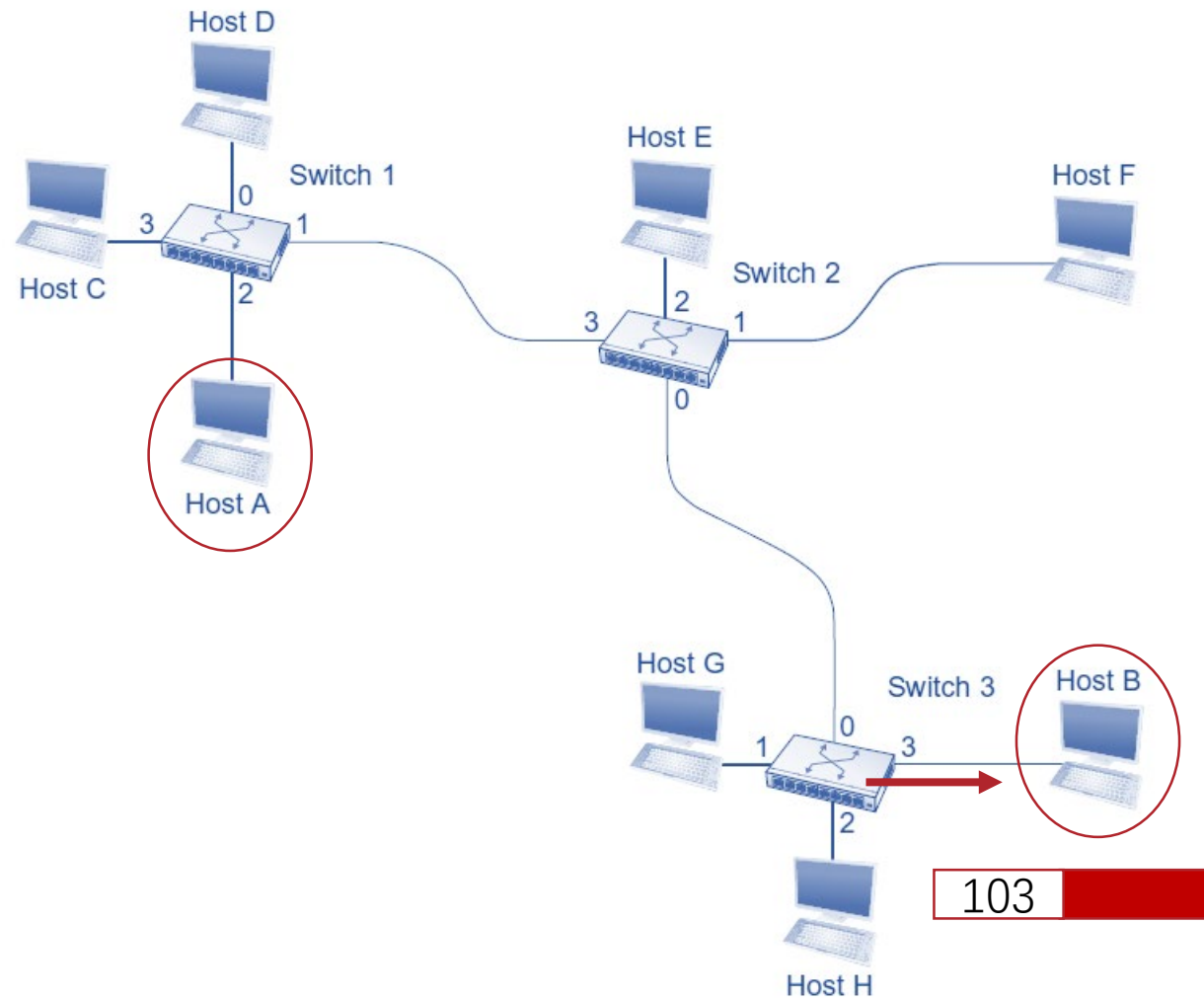
Source Routing



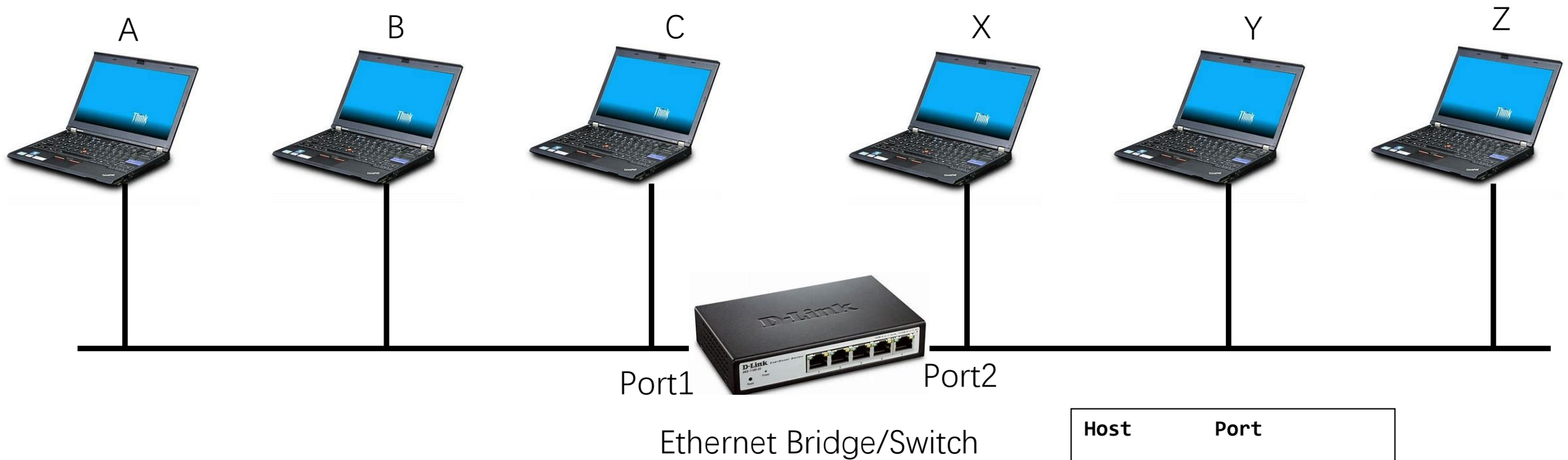
Source Routing



Source Routing



How to Extend the Ethernet ?

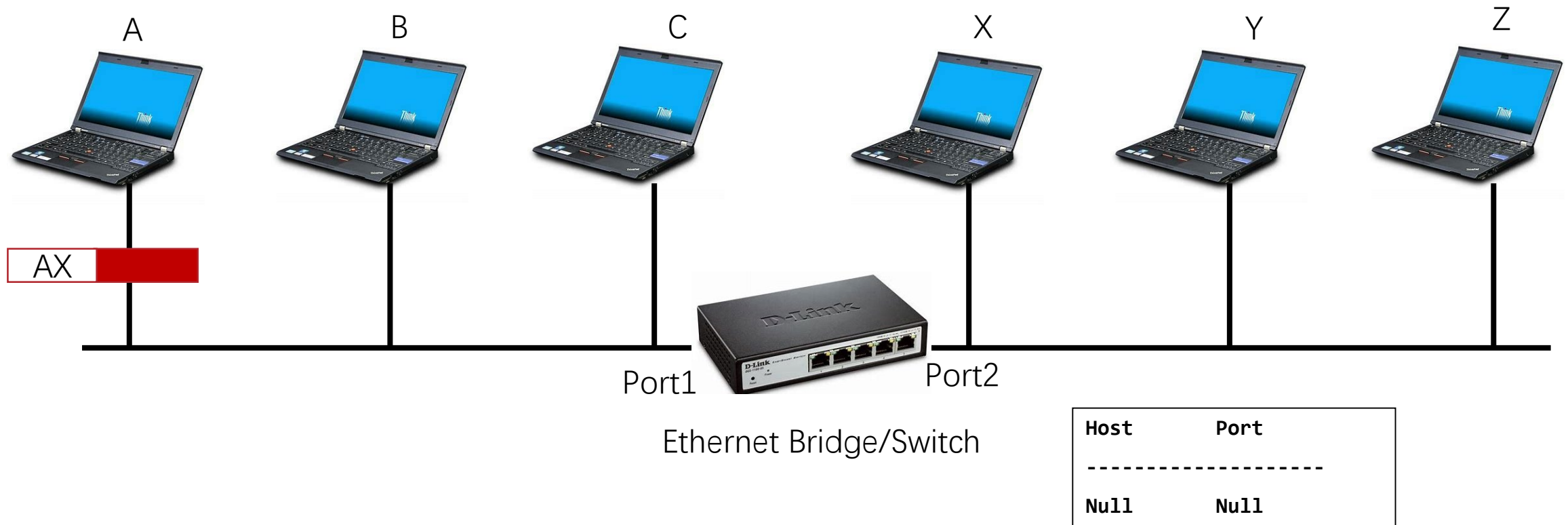


How to Obtain the Forwarding Table

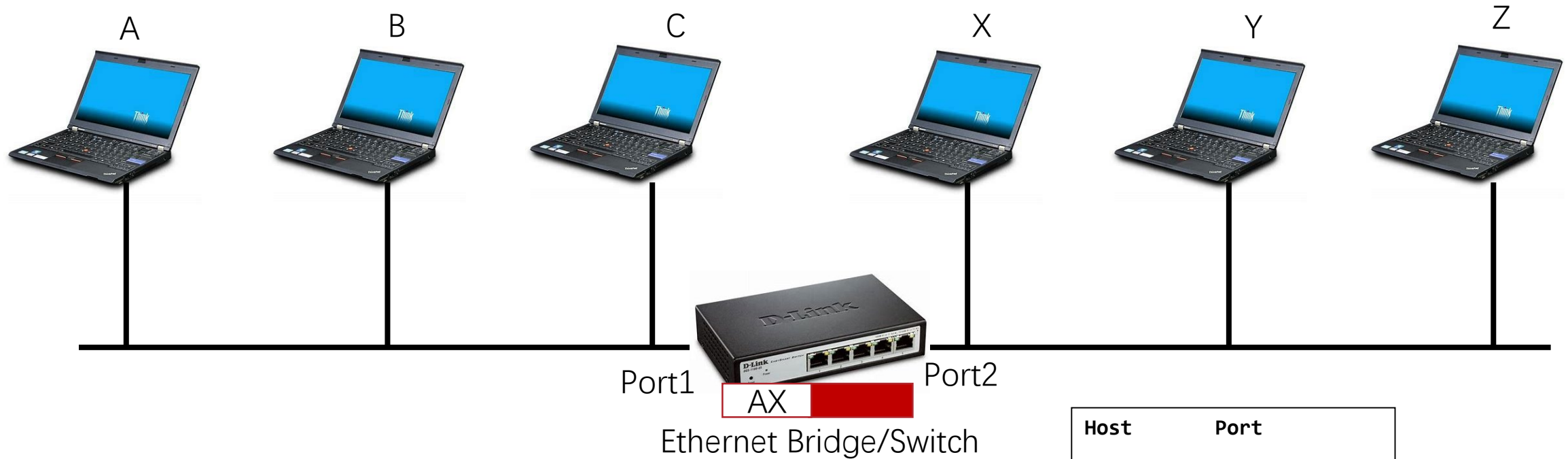
Host	Port

X	1
Y	2
Z	2

Learning Switch



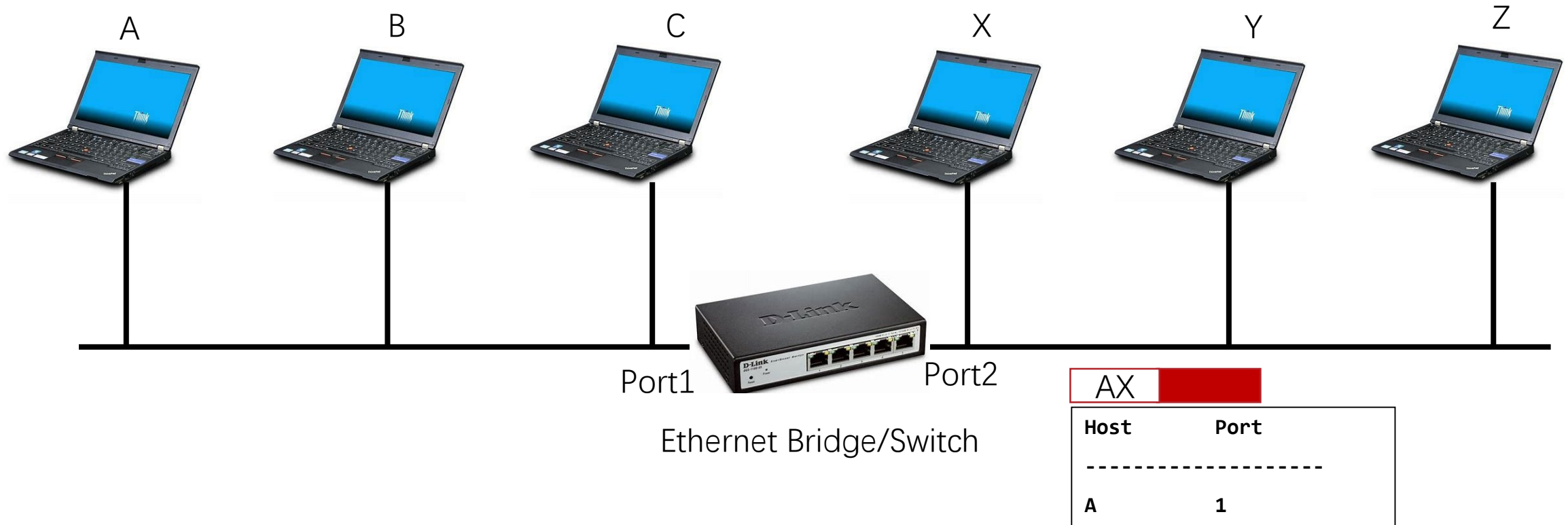
Learning Switch



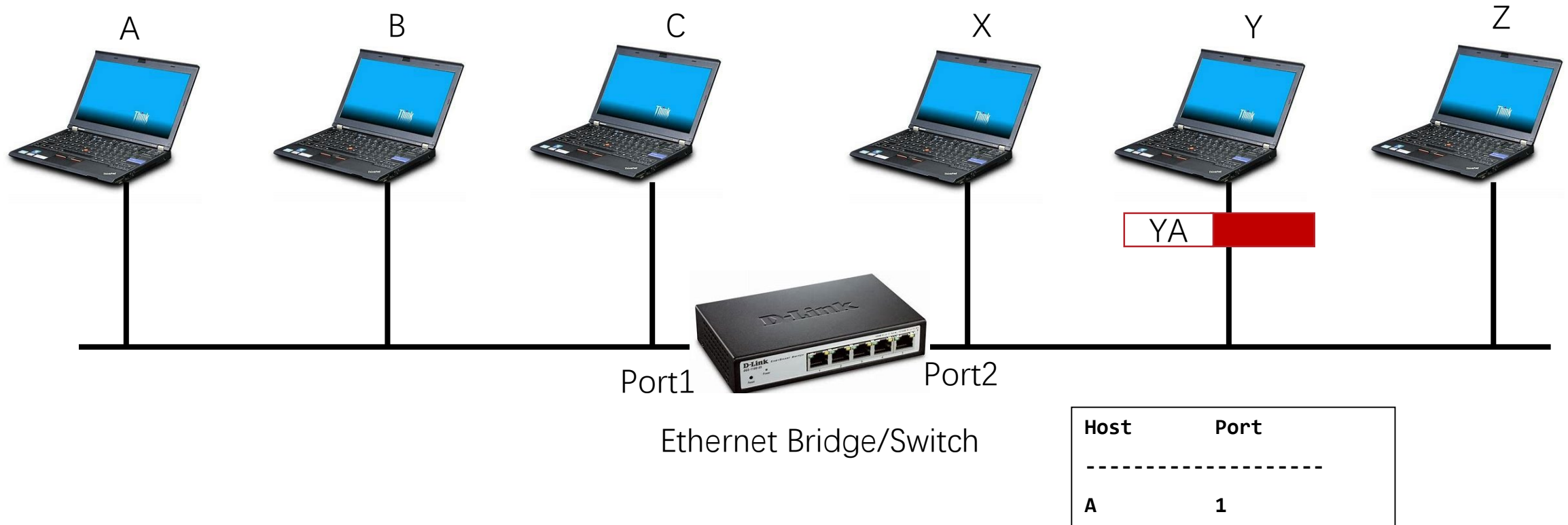
Host	Port

A	1

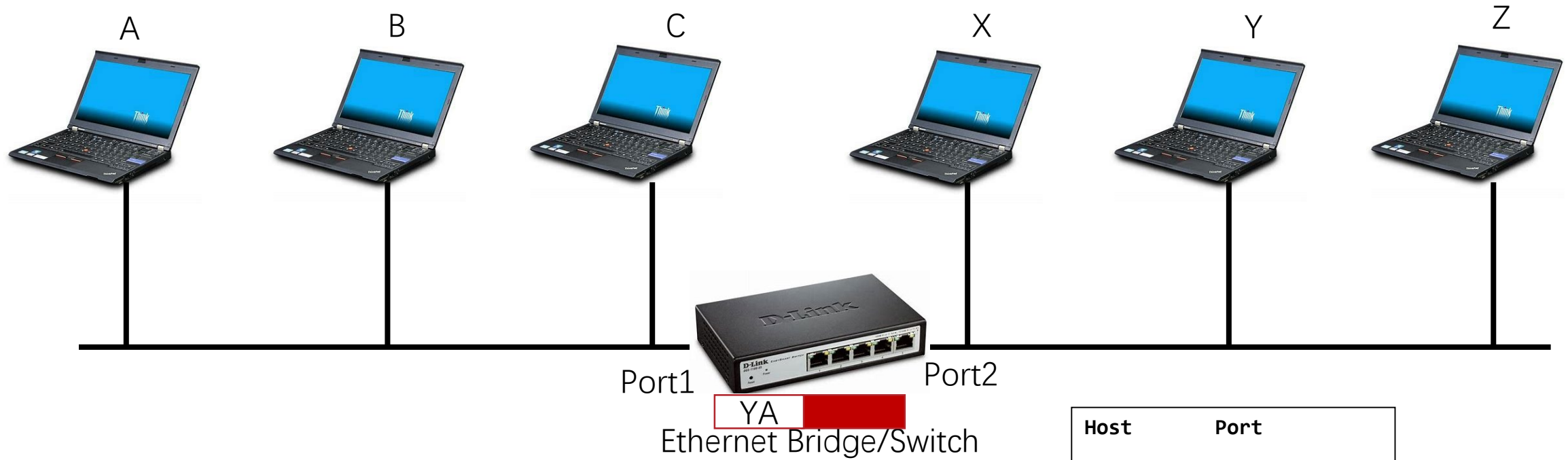
Learning Switch



Learning Switch



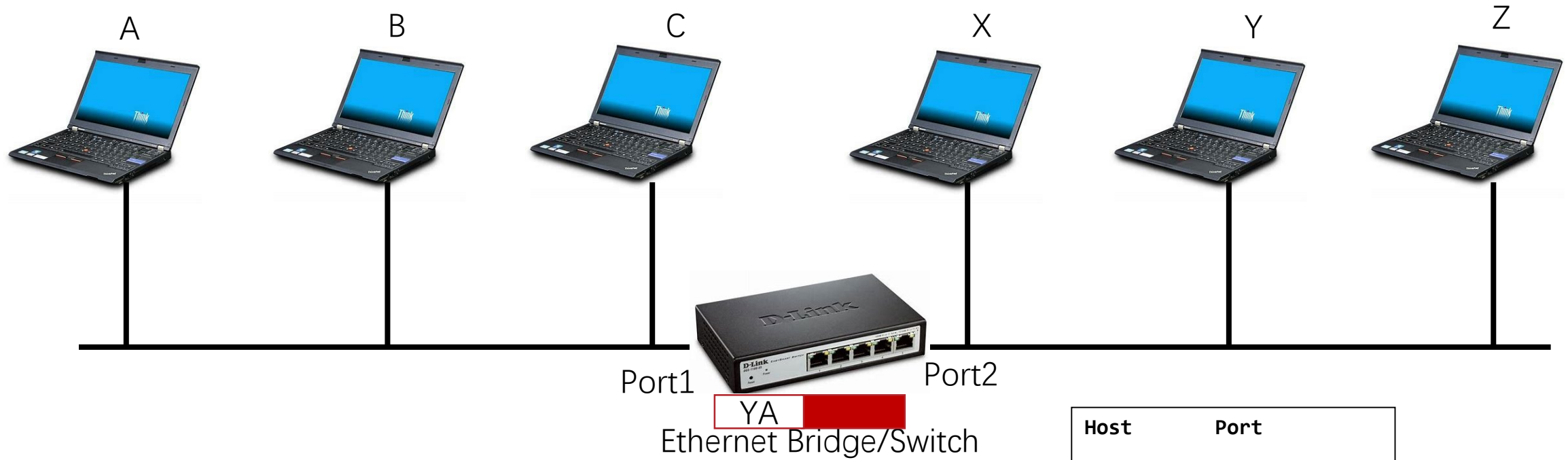
Learning Switch



Host	Port

A	1
Y	2

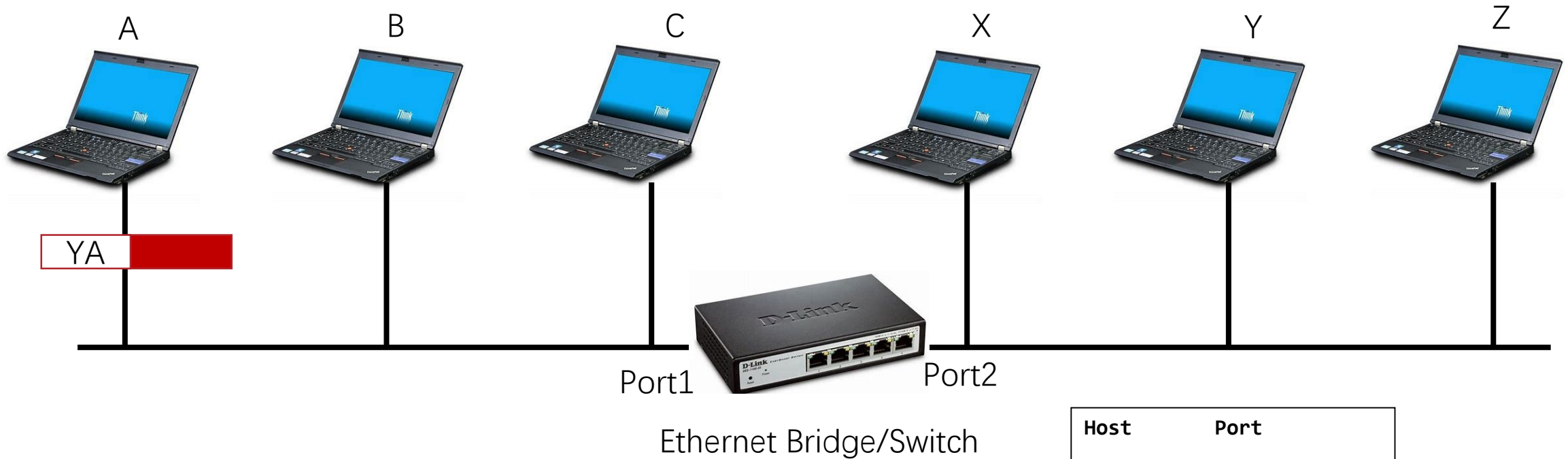
Learning Switch



Host	Port

A	1
Y	2

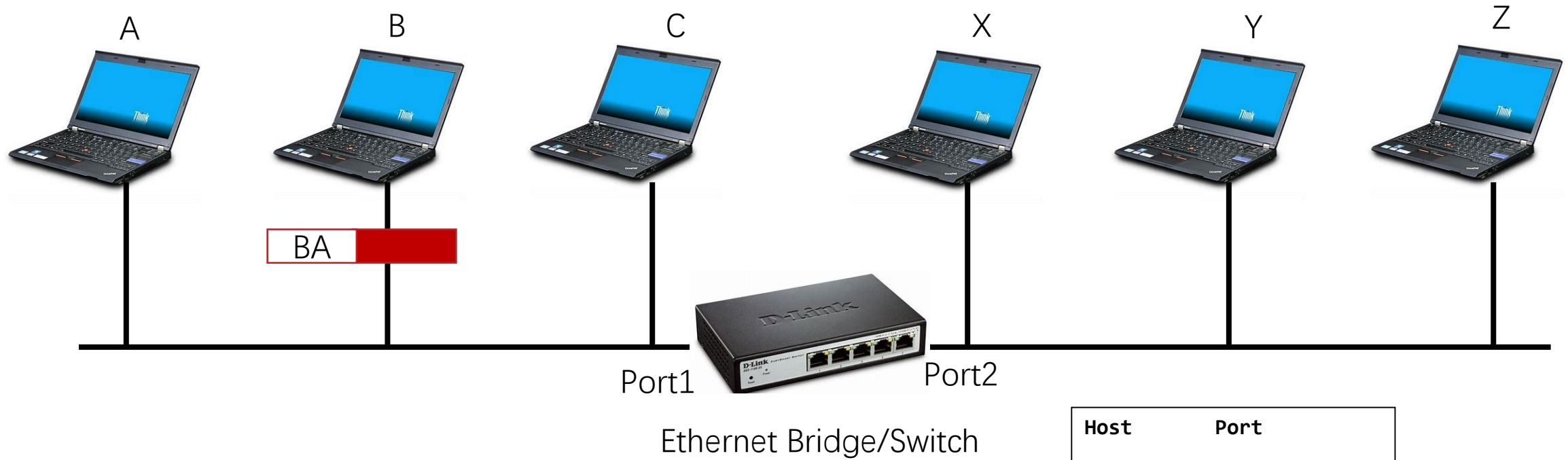
Learning Switch



Host	Port

A	1
Y	2

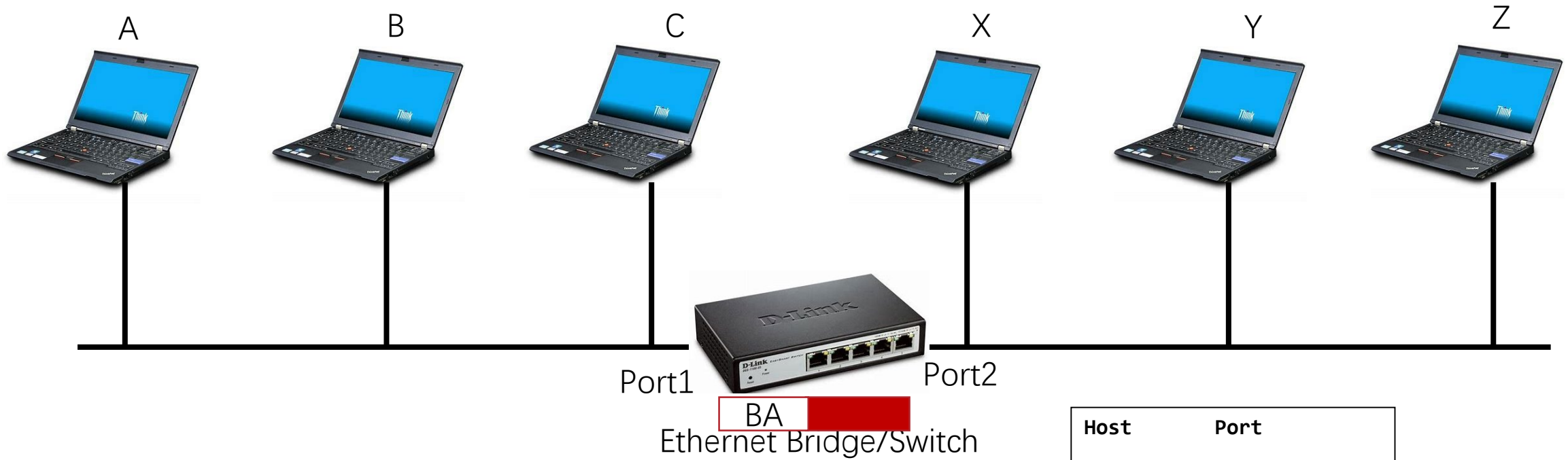
Learning Switch



Host	Port

A	1
Y	2

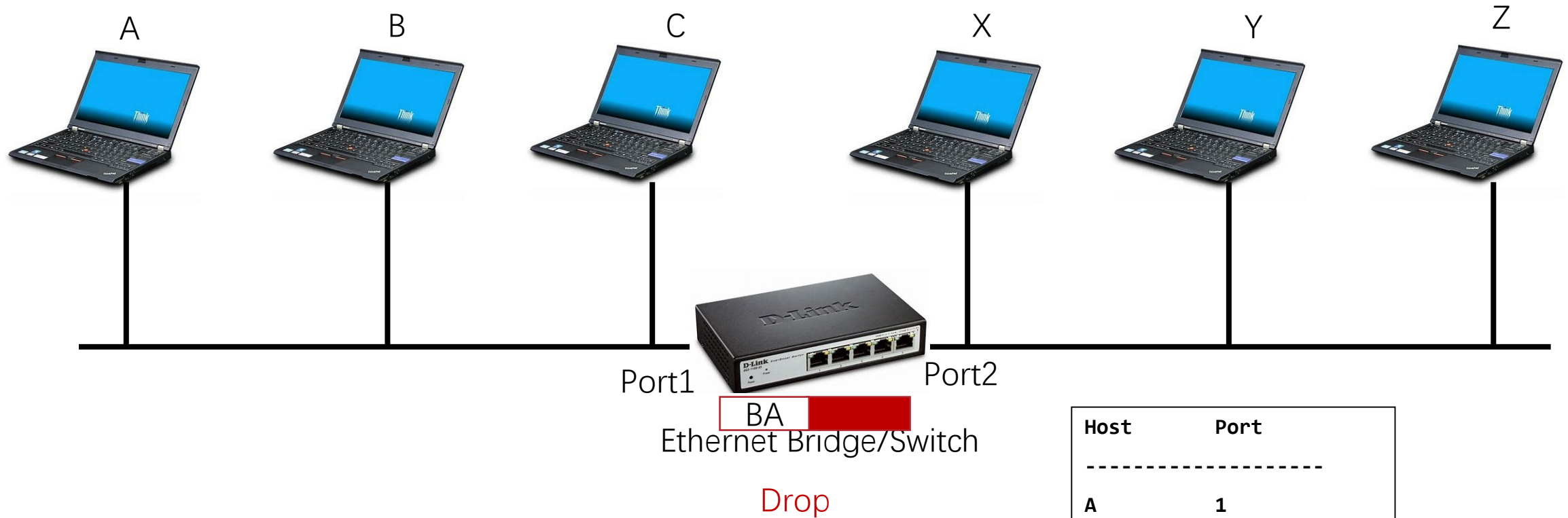
Learning Switch



Host	Port

A	1
Y	2
B	1

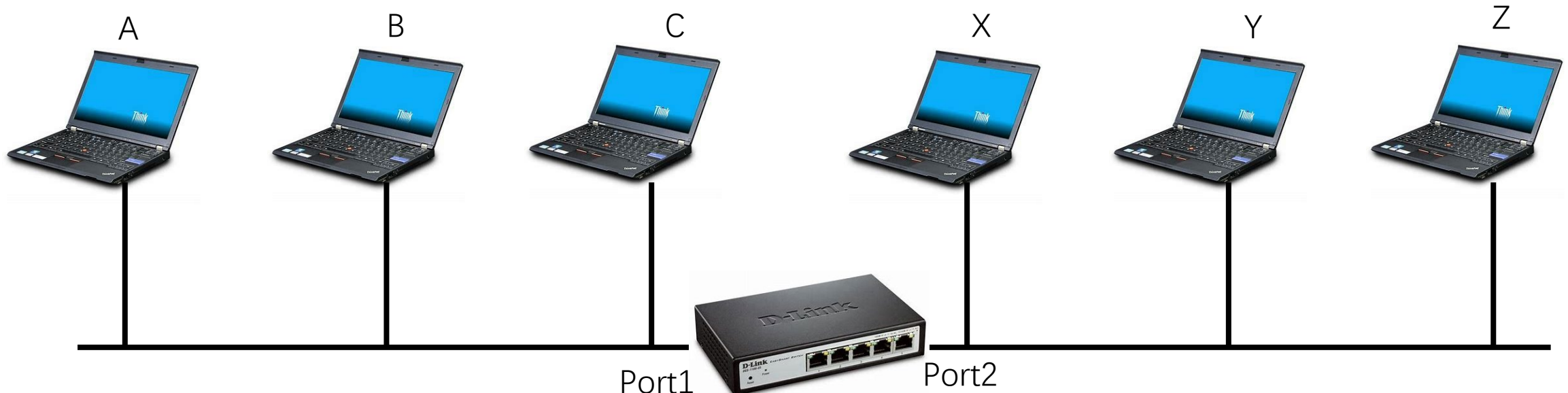
Learning Switch



Host	Port

A	1
Y	2
B	1

How to Extend the Ethernet ?



Port1

Port2

Ethernet Bridge/Switch

Forward

Host	Port

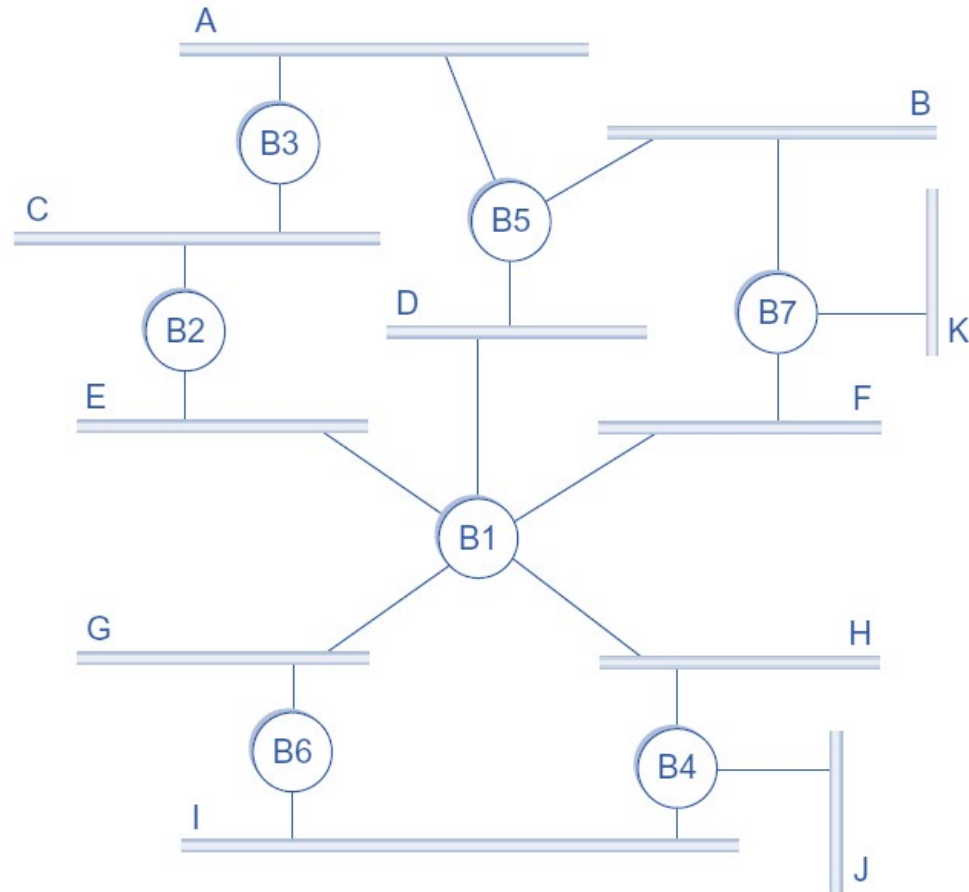
A	1
B	1
C	1
X	2
Y	2
Z	2

Ethernet Switch

- When packet is received at switch
 - Record incoming port, source address
 - Index forwarding table using destination address
 - if destination exists
 - if destination on port from which packet arrived
 - drop
 - else
 - forward packet on port indicated by entry
 - else
 - forward on all ports except the arriving port

Network with Switches

- A network of Ethernet

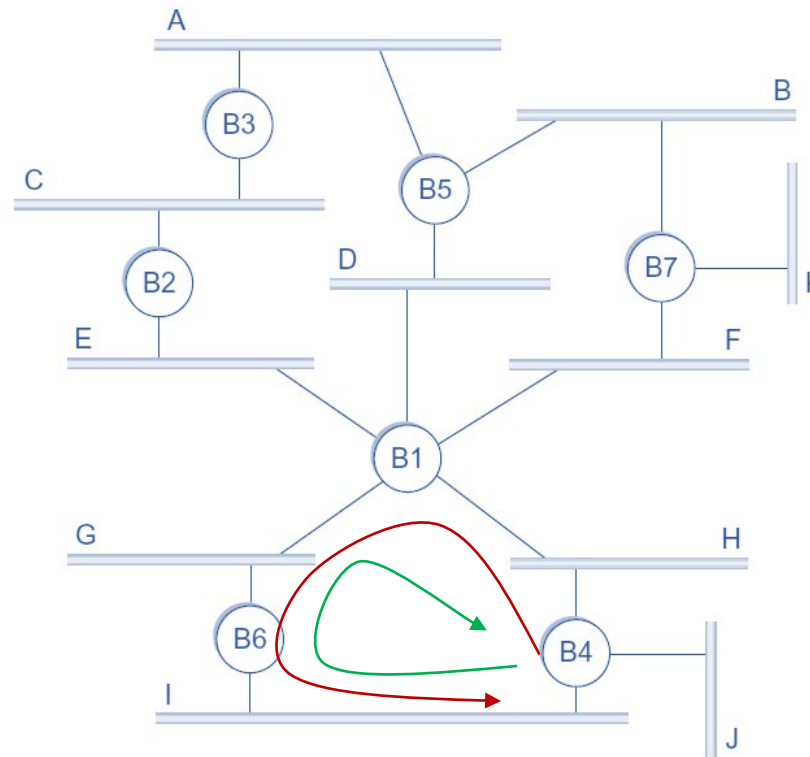


Cycles in Ethernet

- Possible Reasons
 - On purpose: introduce redundancy
 - Cycles in network enable recovery from single link failure
 - Not on purpose: wrong network management
 - Network manager dose not have the entire view of the network
- Problem
 - Broadcast storm

Broadcast Storm

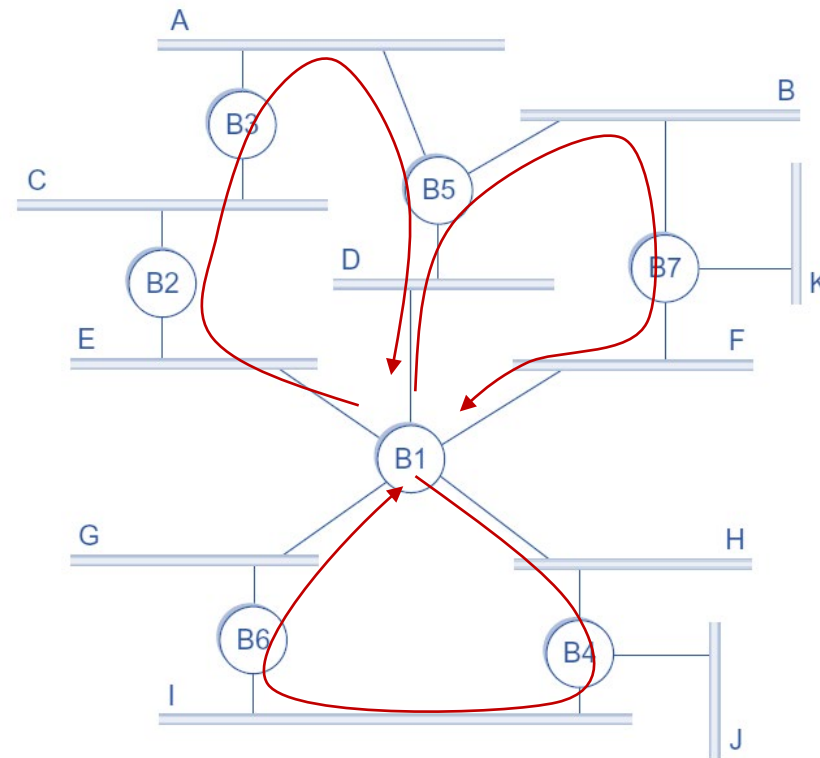
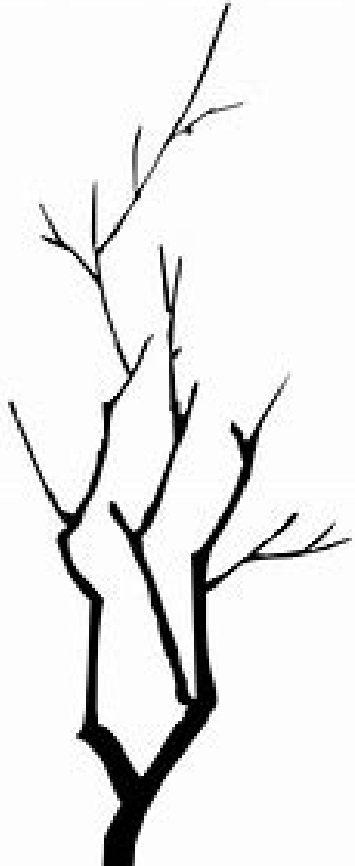
- Network J sends a packet to Network A, but B1, B4, B6 has no entry about Network A



Handling Cycles

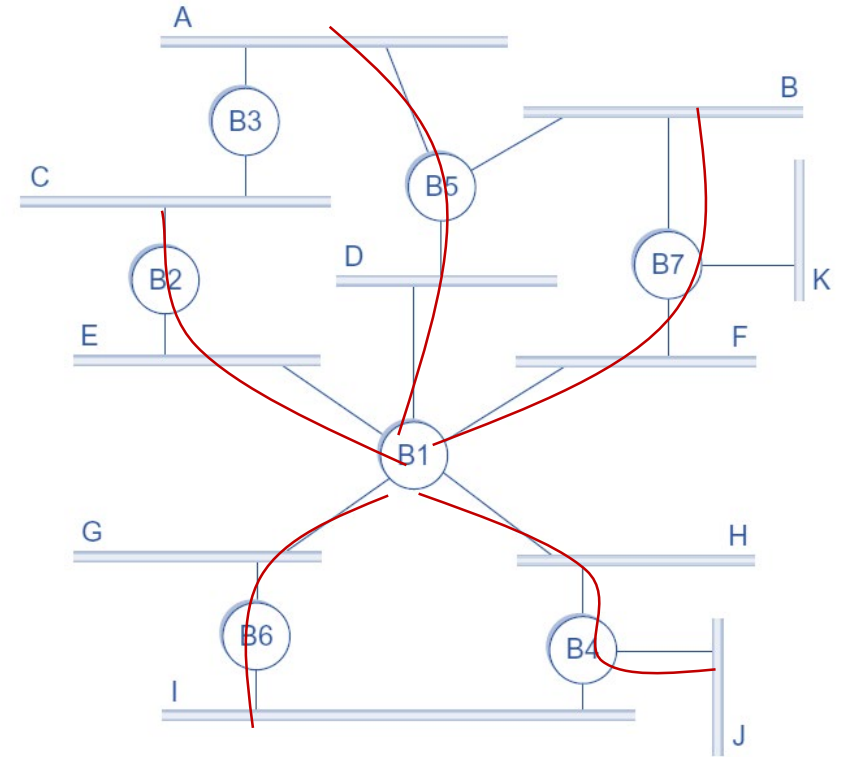
- Break the Cycles

Tree has no cycles



Distributed Spanning Tree Algorithm

- Each switch is a vertex
- Each connected port of a switch is an edge
- Goal: A spanning tree is a sub-graph of this graph that covers all the vertices but contains no cycles
 - Each switch decides the ports over which it is and is not willing to forward frames



Reference

- Textbook 3.1