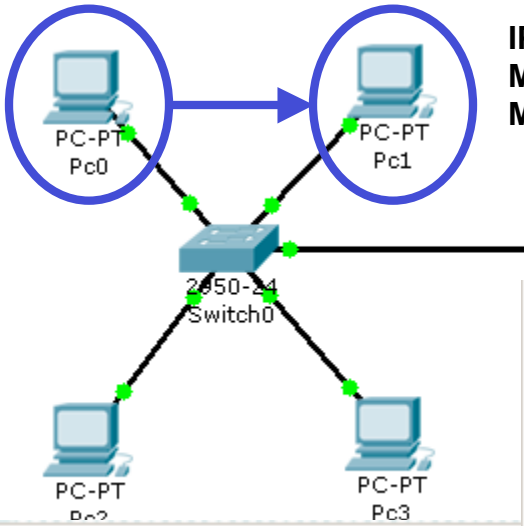
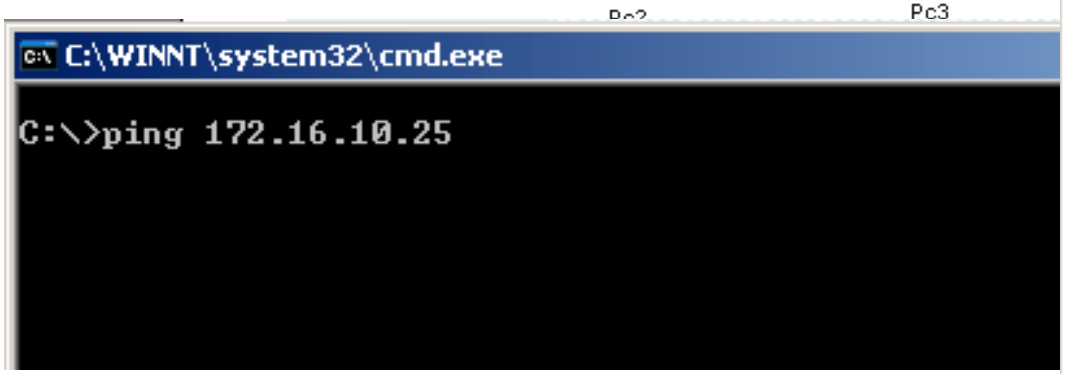
ARP Scenarios

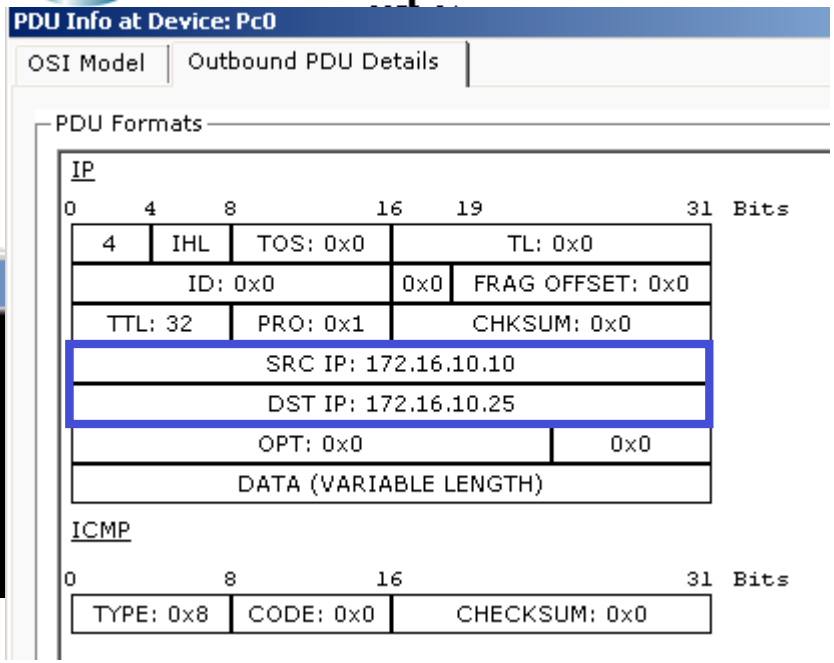
Scenario 1: Sending packets directly to the destination when going inside the network

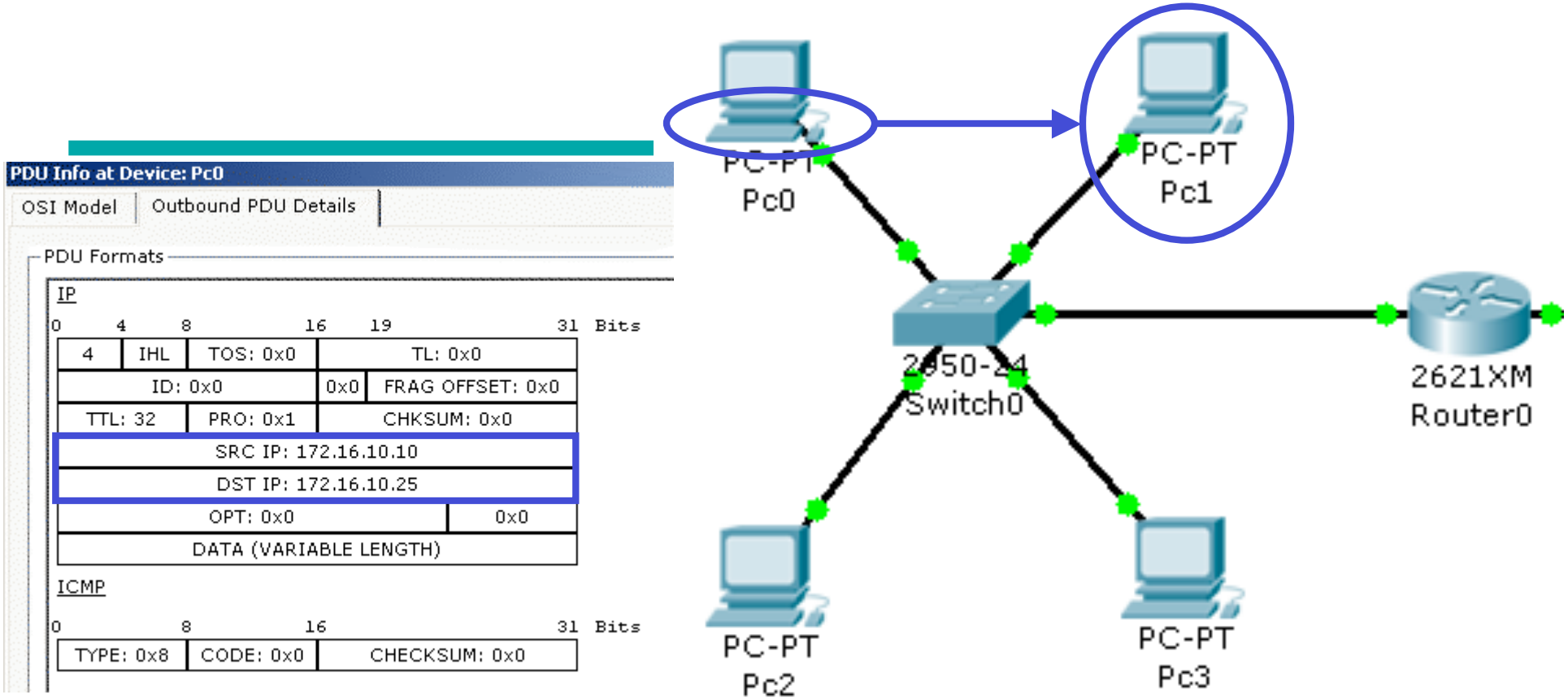
IP: 172.16.10.10
Mask: 255.255.255.0
Def.Gate: 172.16.10.1
MAC: 2790



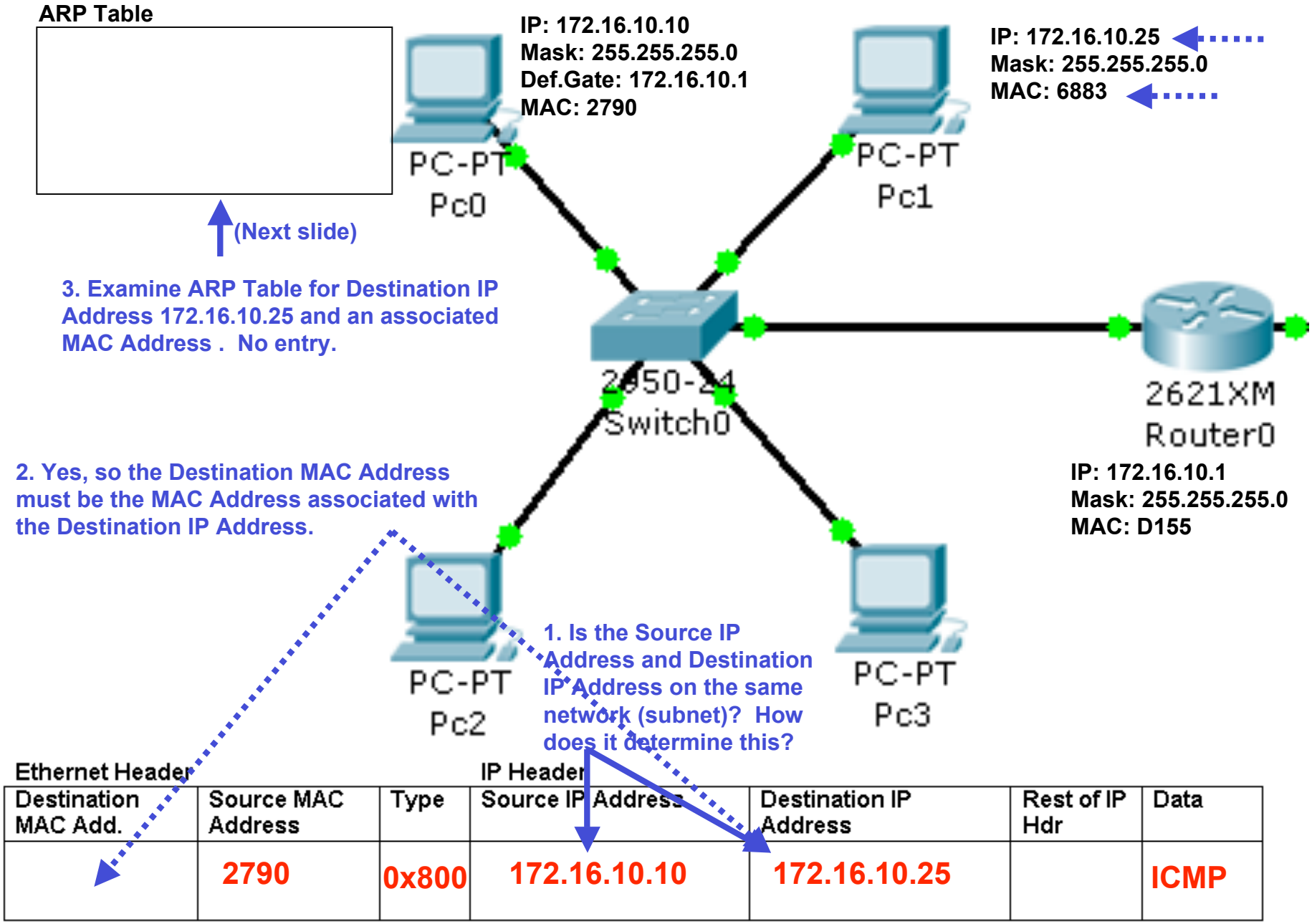
IP: 172.16.10.25
Mask: 255.255.255.0
MAC: 6883





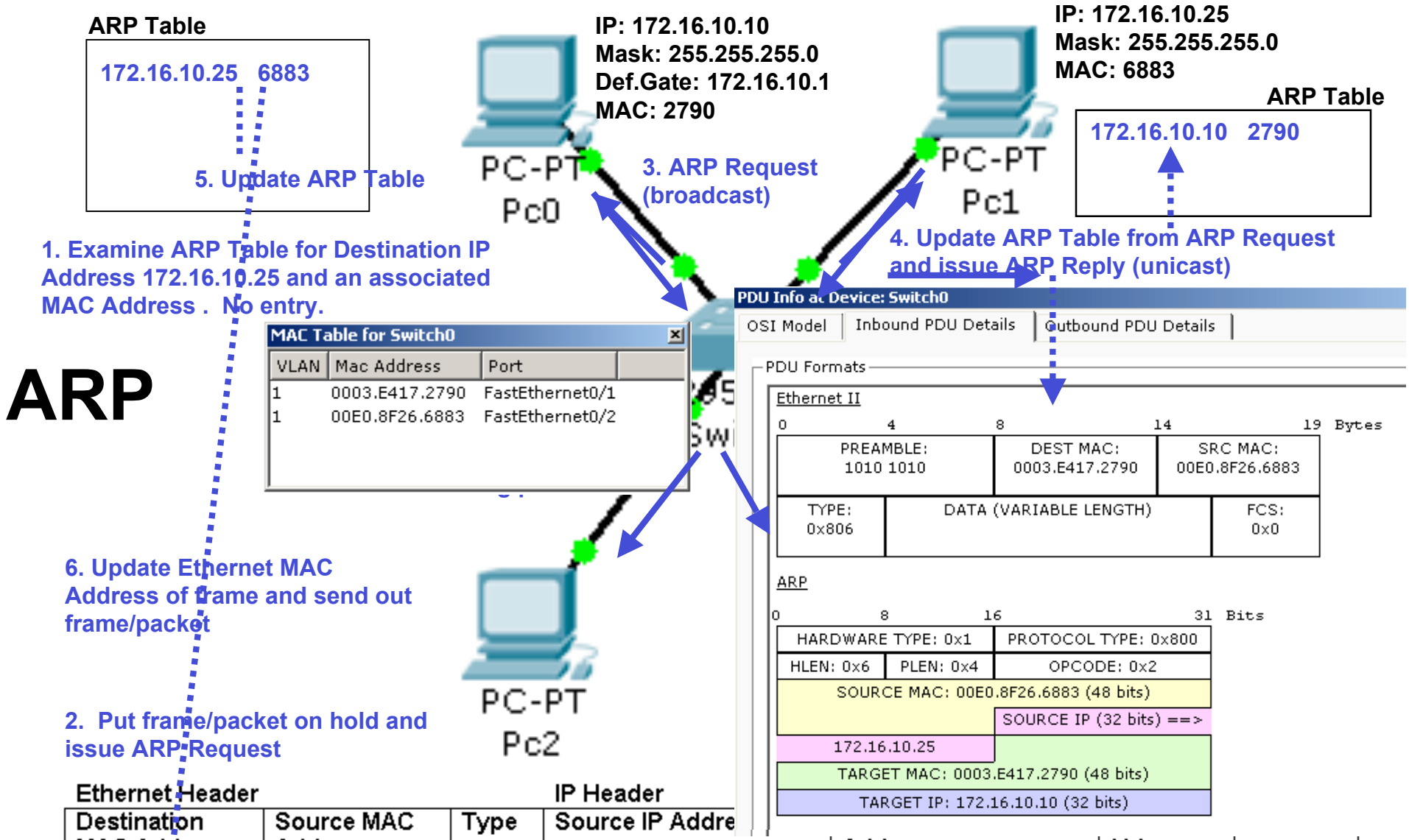


- Does the Pc0 need to issue an ARP Request before sending out this packet?
  - Framing the ARP Request: What is the Destination MAC Address? _____
  - ARP Request: I know _____, but I need to know the _____.
  - ARP Reply: You knew my _____, but here is my _____.
  - What information is added to the ARP Table? _____
- What does Pc0 do with the ARP Request information?



Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
	2790	0x800	172.16.10.10	172.16.10.25		ICMP

ARP



Ethernet Header			IP Header			
Destination MAC Add	Source MAC Address	Type	Source IP Addre	Address	Hdr	
6883	2790	0x800	172.16.10.10	172.16.10.25		ICMP

ICMP Echo Request

ARP Table

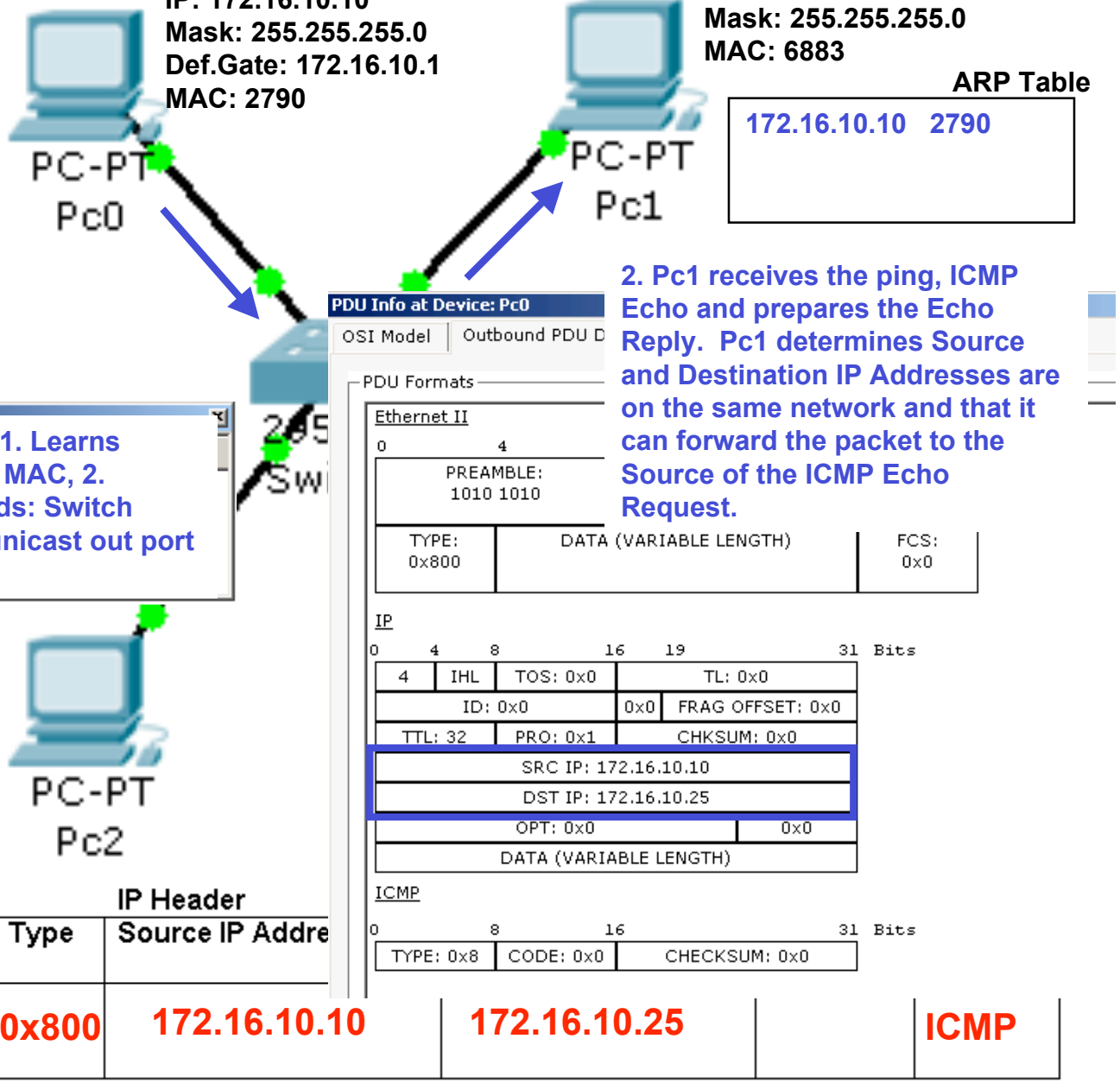
172.16.10.25	6883

IP: 172.16.10.10
Mask: 255.255.255.0
Def.Gate: 172.16.10.1
MAC: 2790

IP: 172.16.10.25
Mask: 255.255.255.0
MAC: 6883

ARP Table

172.16.10.10	2790



2. Pc1 receives the ping, ICMP Echo and prepares the Echo Reply. Pc1 determines Source and Destination IP Addresses are on the same network and that it can forward the packet to the Source of the ICMP Echo Request.

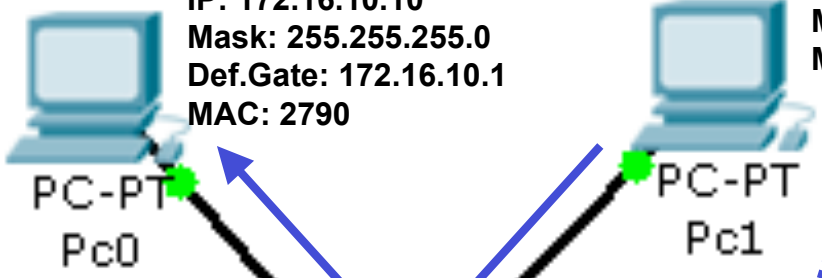
1. Update Ethernet MAC Address of frame and send out frame/packet

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Addre			
6883	2790	0x800	172.16.10.10	172.16.10.25		ICMP

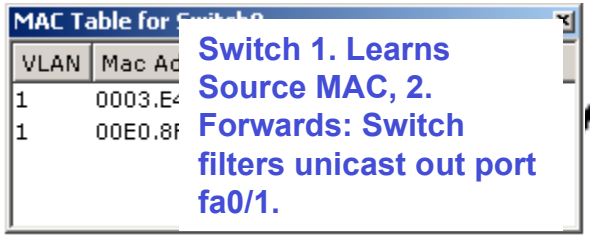
ICMP Echo Reply

ARP Table

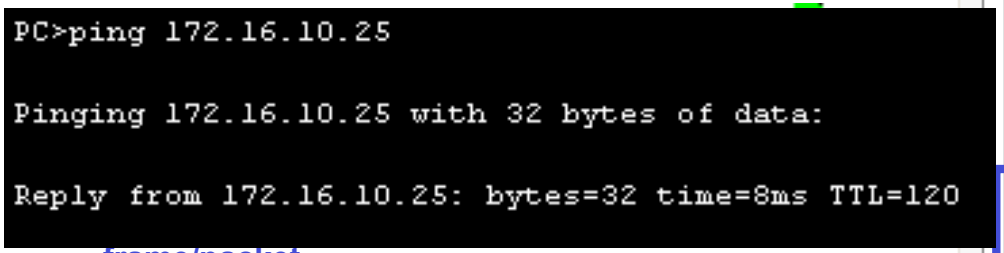
172.16.10.25	6883



1. Pc1 creates IP Packet with ICMP Echo Reply.
2. Pc1 examines the Destination IP Address and notices it is on same network as its Source IP Address, and looks for Dest.IP in its ARP Table.
3. The information is in the ARP Table so Pc1 encapsulates the IP packet into an Ethernet frame with the MAC address of 172.16.10.10.



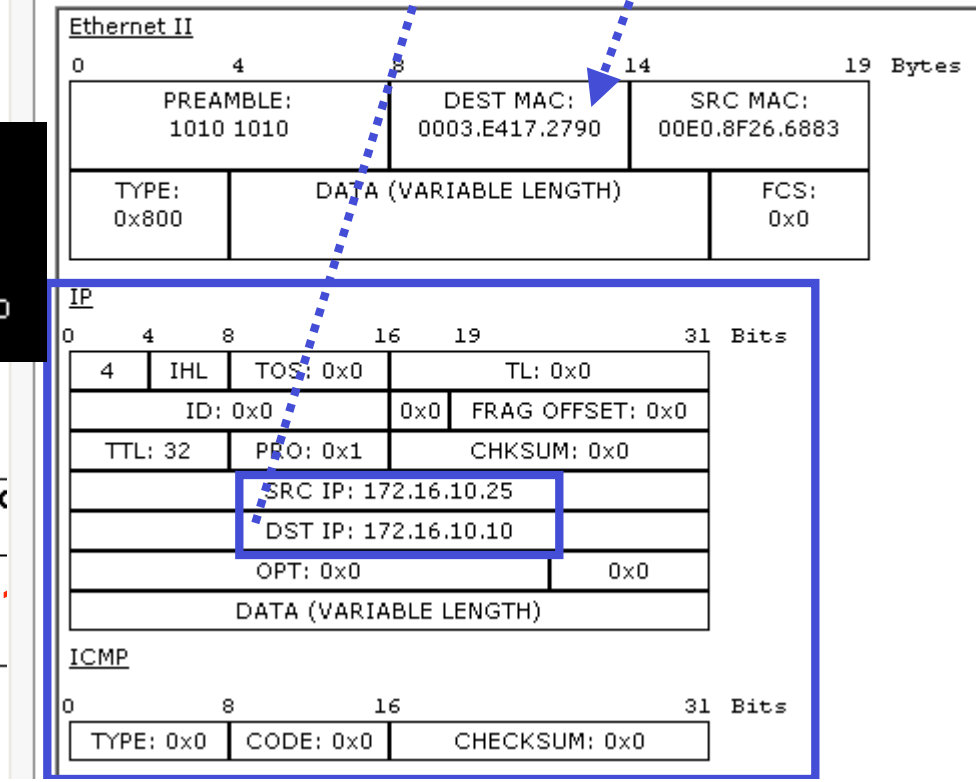
Switch 1. Learns Source MAC, 2. Forwards: Switch filters unicast out port fa0/1.



frame/packet

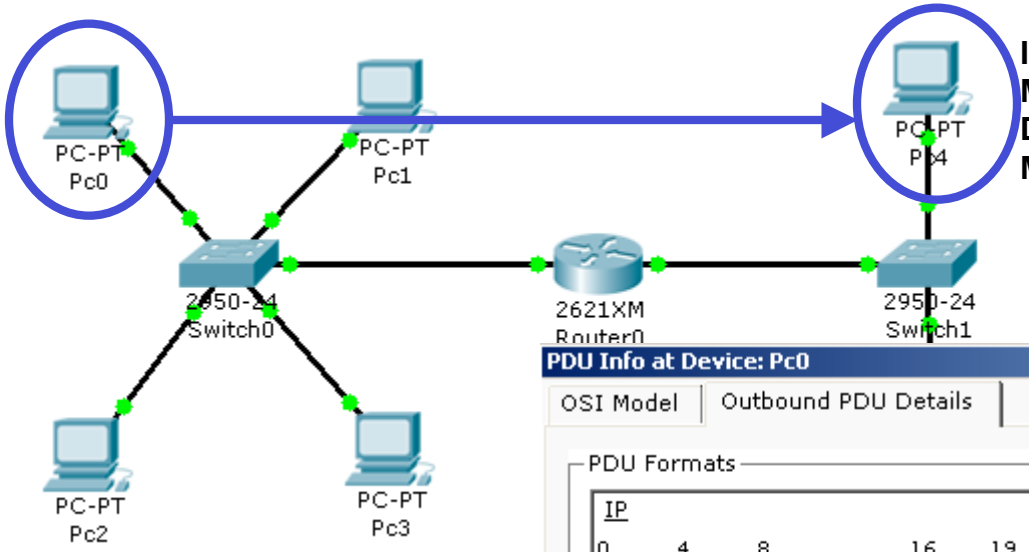
Pc2

Ethernet Header			IP Header
Destination MAC Add.	Source MAC Address	Type	Source IP Ac
6883	2790	0x800	172.16.1

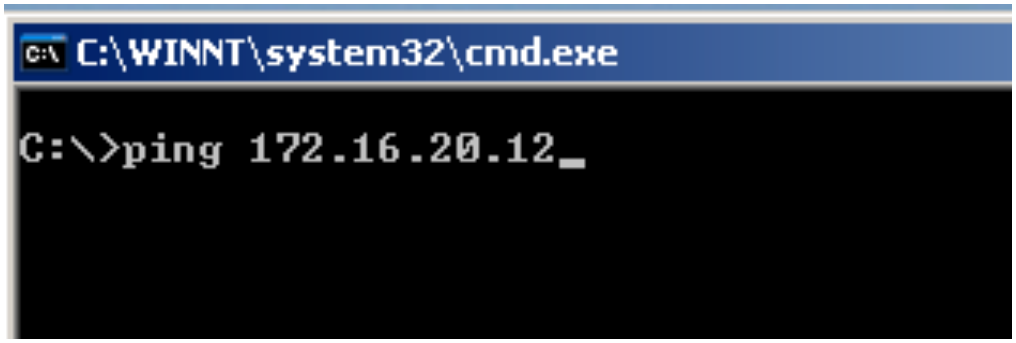


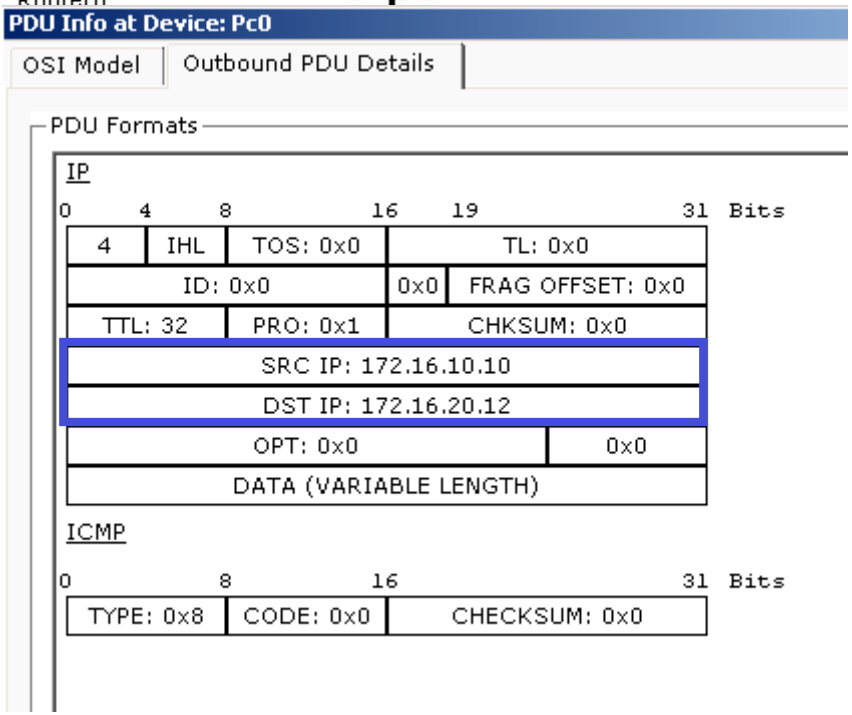
Scenario 2: Sending packets to the default gateway when going outside the network

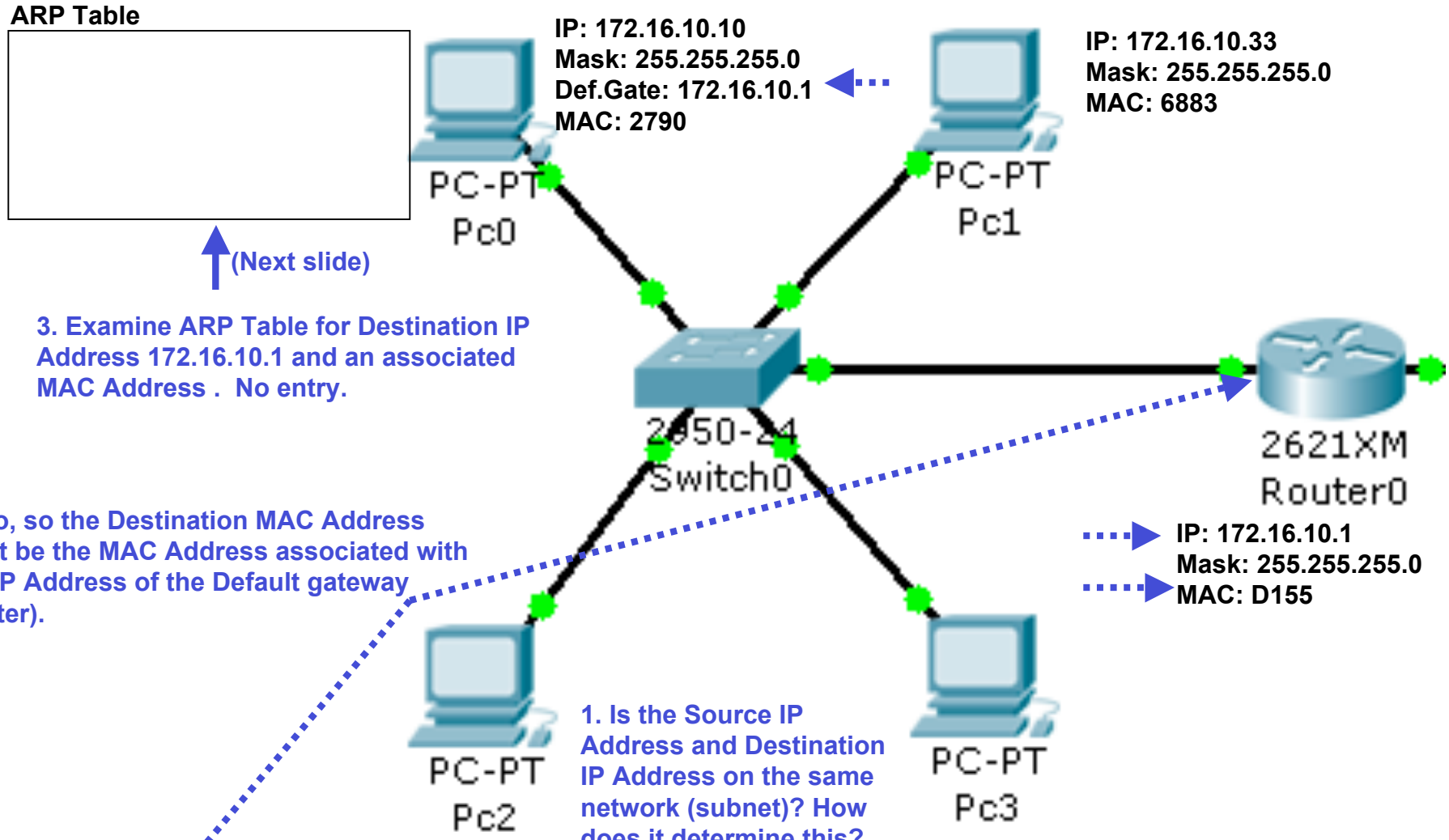
IP: 172.16.10.10
Mask: 255.255.255.0
Def.Gate: 172.30.10.1
MAC: 2790



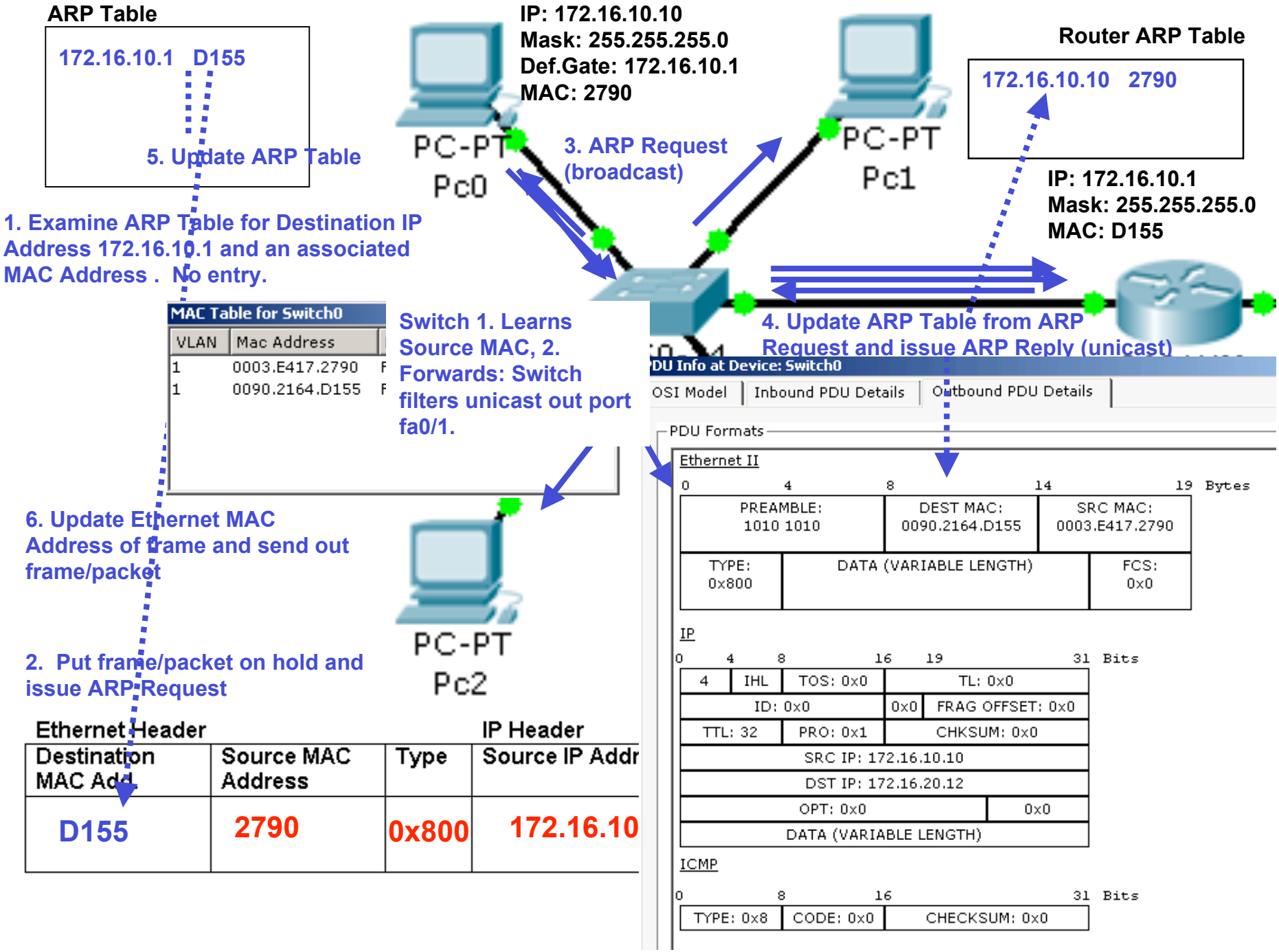
IP: 172.16.20.12
Mask: 255.255.255.0
Def.Gate: 172.30.20.1
MAC: 6883





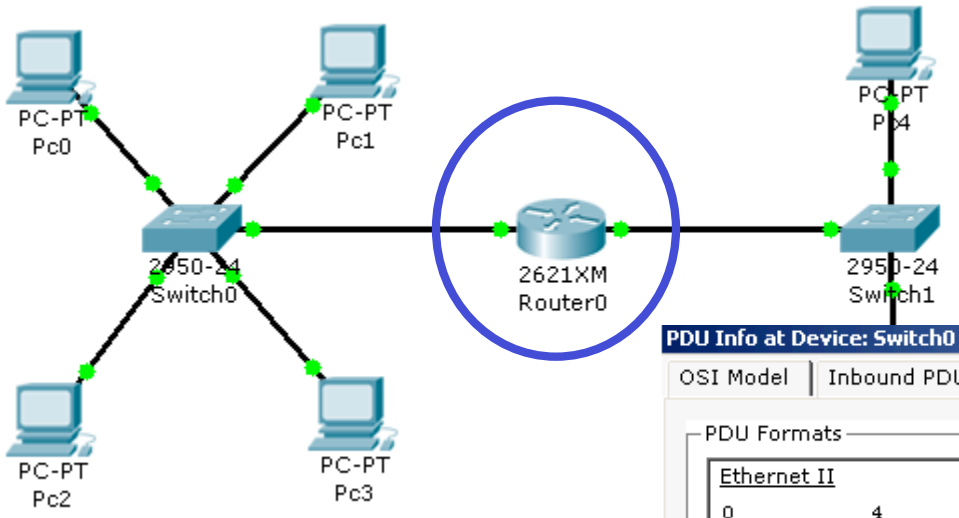


Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
	2790	0x800	172.16.10.10	172.16.20.12		ICMP



Ethernet Header			IP Header
Destination MAC Add	Source MAC Address	Type	Source IP Addr
D155	2790	0x800	172.16.10

Now, what does the router do with it?



- This is just a preview!
- Let's see if we can figure it out!

PDU Info at Device: Switch0

OSI Model | Inbound PDU Details | Outbound PDU Details

PDU Formats

Ethernet II

0	4	8	14	19 Bytes
PREAMBLE: 1010 1010		DEST MAC: 0090.2164.D155	SRC MAC: 0003.E417.2790	
TYPE: 0x800	DATA (VARIABLE LENGTH)			FCS: 0x0

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0			0x0	FRAG OFFSET: 0x0	
TTL: 32		PRO: 0x1	CHKSUM: 0x0		
SRC IP: 172.16.10.10					
DST IP: 172.16.20.12					
OPT: 0x0				0x0	
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x8	CODE: 0x0	CHECKSUM: 0x0	

PDU Info at Device: Switch0

OSI Model | Inbound PDU Details | Outbound PDU Details

PDU Formats

Ethernet II

0	4	8	14	19 Bytes
PREAMBLE: 1010 1010		DEST MAC: 0090.2184.D155		SRC MAC: 0003.E417.2790
TYPE: 0x800	DATA (VARIABLE LENGTH)			FCS: 0x0

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0		0x0	FRAG OFFSET: 0x0		
TTL: 32	PRO: 0x1	CHKSUM: 0x0			
SRC IP: 172.16.10.10					
DST IP: 172.16.20.12					
OPT: 0x0			0x0		
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x8	CODE: 0x0	CHECKSUM: 0x0	

PDU Info at Device: Router0

OSI Model | Inbound PDU Details | Outbound PDU Details

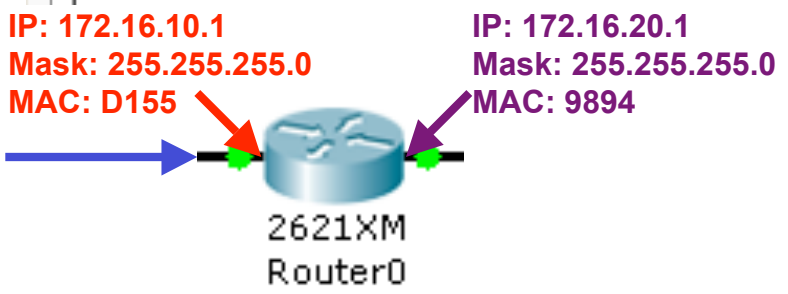
PDU Formats

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0		0x0	FRAG OFFSET: 0x0		
TTL: 31	PRO: 0x1	CHKSUM: 0x0			
SRC IP: 172.16.10.10					
DST IP: 172.16.20.12					
OPT: 0x0			0x0		
DATA (VARIABLE LENGTH)					

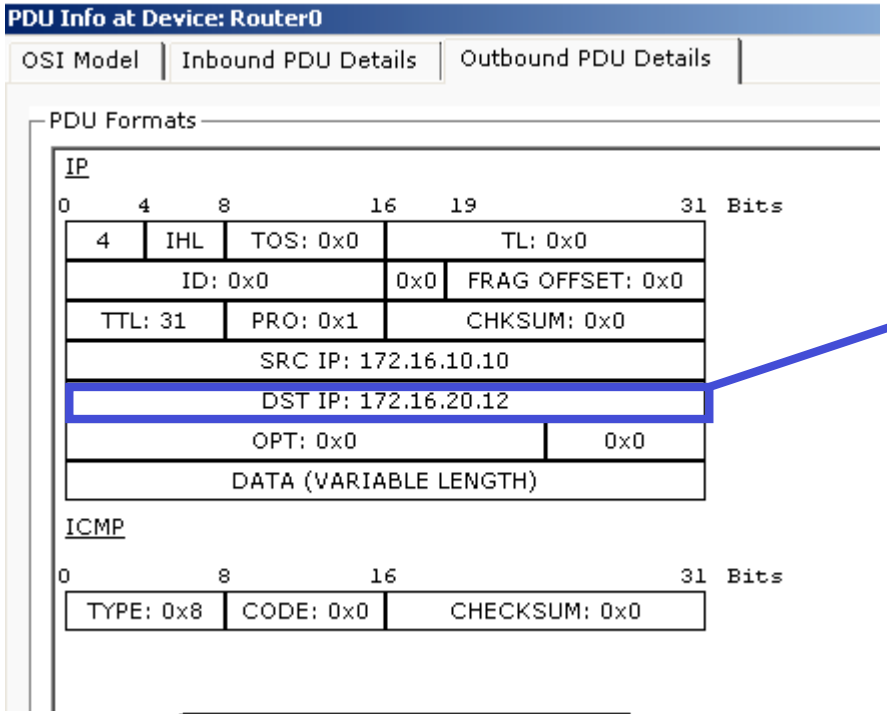
ICMP

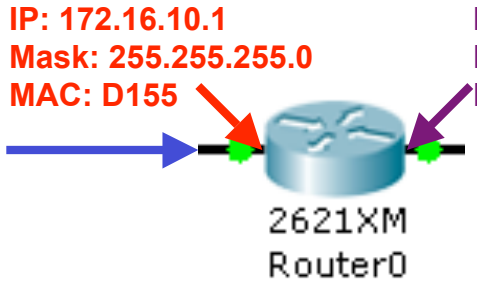
0	8	16	31 Bits
TYPE: 0x8	CODE: 0x0	CHECKSUM: 0x0	

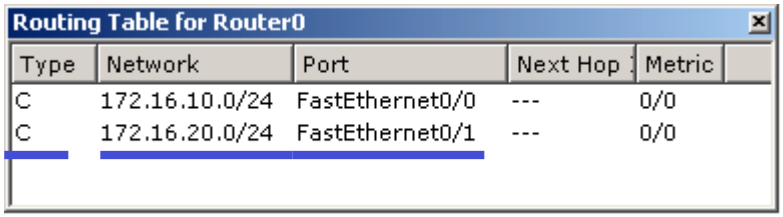


- Router copies in Ethernet frame, because the Destination MAC Address matches its Ethernet interface MAC Address.
- The router strips off the Ethernet header and examines the Layer 3 IP packet.

1. The router looks for the Destination IP Address in the routing table.

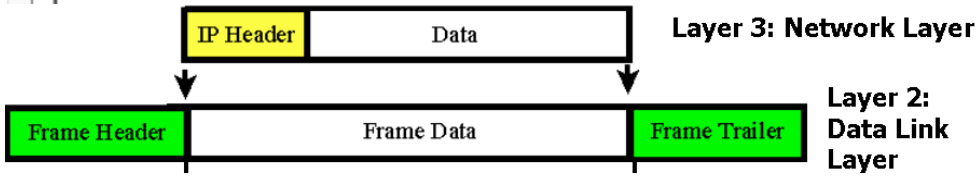




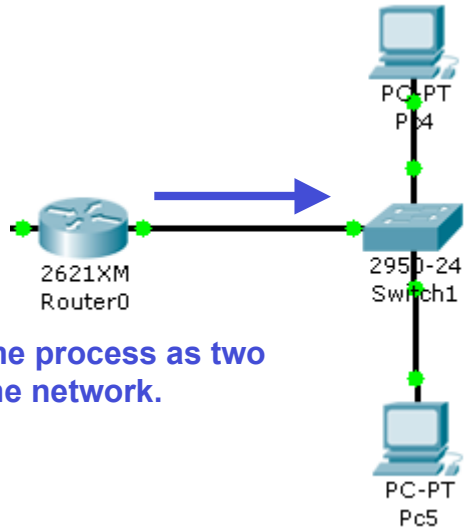


2. The Destination IP Address of the packet belongs to the 172.16.20.0/24 network in its routing table.

3. The port or exit interface is FastEternet0/1. This is an Ethernet interface, which means the router must encapsulate this IP packet into an Ethernet frame.



4. Because this network is “C” directly connected, this means that the device with this Destination IP address is on the same network as the exit interface Fa0/1 and is somewhere on this network.



5. This is the same process as two hosts on the same network.

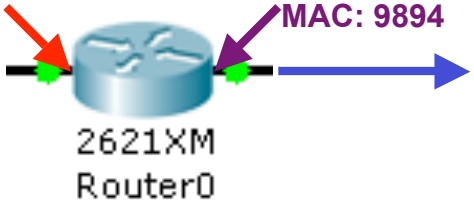
1. The IP Packet needs to be encapsulated in an Ethernet Frame.

Routing Table for Router0

Type	Network	Port	Next Hop	Metric
C	172.16.10.0/24	FastEthernet0/0	---	0/0
C	172.16.20.0/24	FastEthernet0/1	---	0/0

IP: 172.16.10.1
Mask: 255.255.255.0
MAC: D155

IP: 172.16.20.1
Mask: 255.255.255.0
MAC: 9894



2. Remember, the router's exit interface's IP Address is on the same network as the Destination IP Address of the IP packet. This is just like two hosts on the same network!

ARP Table for Router0

IP Address	Hardware Address	Interface
172.16.10.1	0090.2164.D155	FastEthernet0/0
172.16.10.10	0003.E417.2790	FastEthernet0/0
172.16.20.1	00E0.B038.9894	FastEthernet0/1

3. Examine ARP Table for Destination IP Address 172.16.20.12 and an associated MAC Address . No entry. (Next Slide)

PDU Info at Device: Router0

OSI Model | Inbound PDU Details | Outbound PDU Details

PDU Formats

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0		0x0	FRAG OFFSET: 0x0		
TTL: 31	PRO: 0x1	CHKSUM: 0x0			
SRC IP: 172.16.10.10					
DST IP: 172.16.20.12					
OPT: 0x0			0x0		
DATA (VARIABLE LENGTH)					

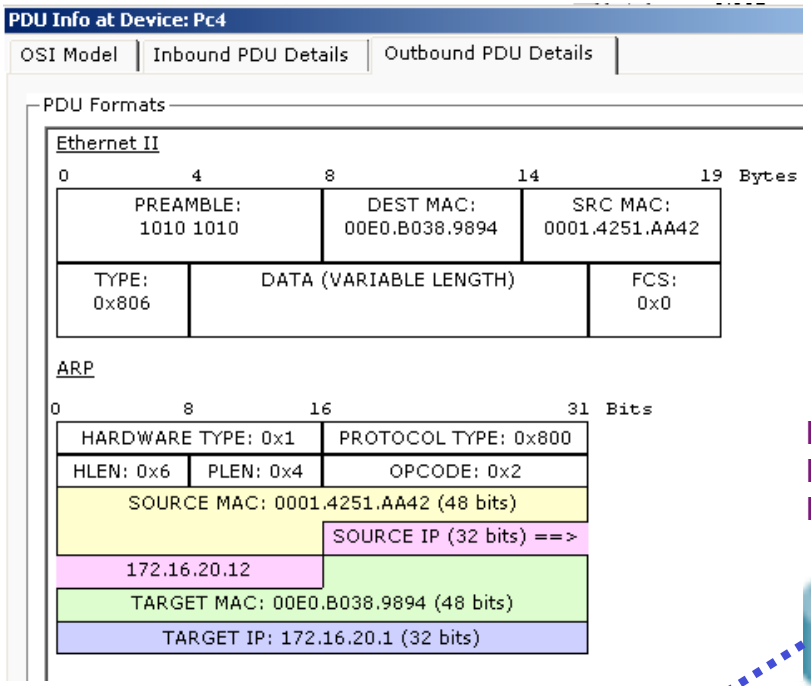
ICMP

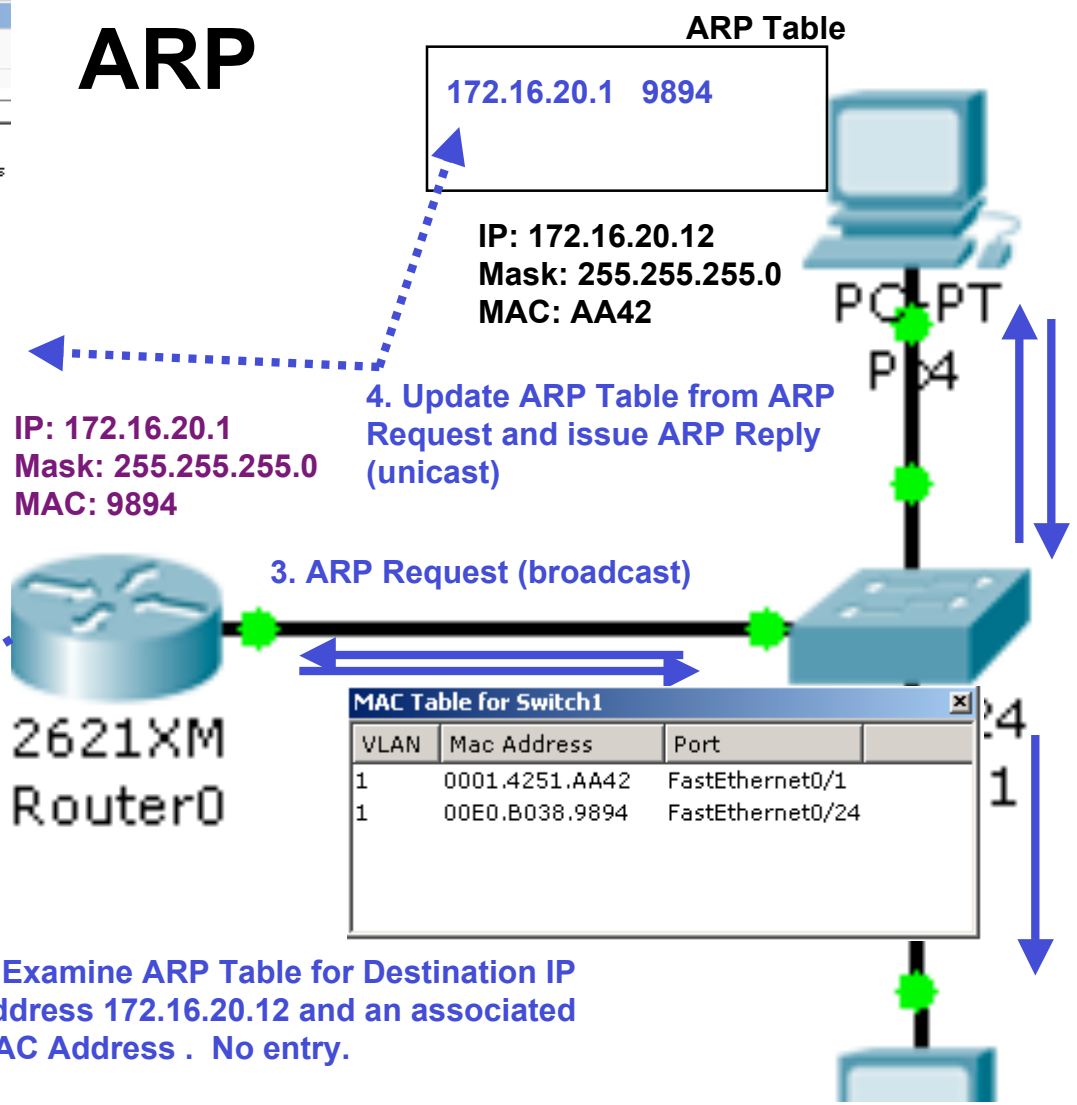
0	8	16	31 Bits
TYPE: 0x8	CODE: 0x0	CHECKSUM: 0x0	

3. The Destination MAC Address must be the MAC Address associated with the Destination IP Address.

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
	9894	0x800	172.16.10.10	172.16.20.12		ICMP

ARP





ARP Table for Router0

IP Address	Hardware Address	Interface
172.16.10.1	0090.2164.D155	FastEthernet0/0
172.16.10.10	0003.E417.2790	FastEthernet0/0
172.16.20.1	00E0.B038.9894	FastEthernet0/1
172.16.20.12	0001.4251.AA42	FastEthernet0/1

2. Put frame/packet on hold and issue ARP Request

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
AA42	9894	0x800	172.16.10.10	172.16.20.12		ICMP

Packet Forwarding

4. The ICMP Echo Reply is encapsulated in an Ethernet frame with the MAC Address found in the ARP Table. The frame is sent to the switch.

Ethernet II

0	4	8	14	19 Bytes
PREAMBLE: 1010 1010		DEST MAC: 00E0.B038.9894	SRC MAC: 0001.4251.AA42	
TYPE: 0x800	DATA (VARIABLE LENGTH)			FCS: 0x0

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0		0x0	FRAG OFFSET: 0x0		
TTL: 32	PRO: 0x1	CHKSUM: 0x0			
SRC IP: 172.16.20.12					
DST IP: 172.16.10.10					
OPT: 0x0			0x0		
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x0	CODE: 0x0	CHECKSUM: 0x0	

ARP Table for Router0

IP Address	Hardware Address	Interface
172.16.10.1	0090.2164.D155	FastEthernet0/0
172.16.10.10	0003.E417.2790	FastEthernet0/0
172.16.20.1	00E0.B038.9894	FastEthernet0/1
172.16.20.12	0001.4251.AA42	FastEthernet0/1

3. Pc4 examines its ARP table and finds the MAC Address for the Default Gateway.

ARP Table

172.16.20.1	9894

IP: 172.16.20.12
Mask: 255.255.255.0
MAC: AA42

PC-PT Pc4

2. Pc4 receives the ping, ICMP Echo and prepares the Echo Reply. Pc4 determines Source and Destination IP Addresses are on different networks and that it needs to forward the packet to the Default Gateway (router).

IP: 172.16.20.1
Mask: 255.255.255.0
MAC: 9894

2621XM Router0

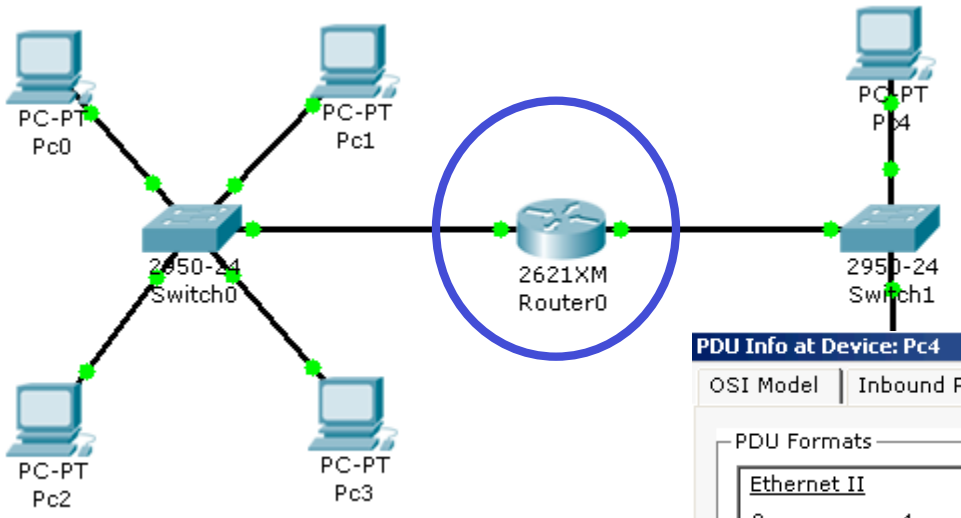
MAC Table for Switch1

VLAN	Mac Address	Port
1	0001.4251.AA42	FastEthernet0/1
1	00E0.B038.9894	FastEthernet0/24

1. Now that the IP packet has been encapsulated into an Ethernet frame, the frame can be forwarded on to the switch.

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
AA42	9894	0x800	172.16.10.10	172.16.20.12		ICMP

Now, what does the router do with it?



Reminder:

- This is just a preview!
- Let's see if we can figure it out!

PDU Info at Device: Pc4

OSI Model | Inbound PDU Details | Outbound PDU Details

PDU Formats

Ethernet II

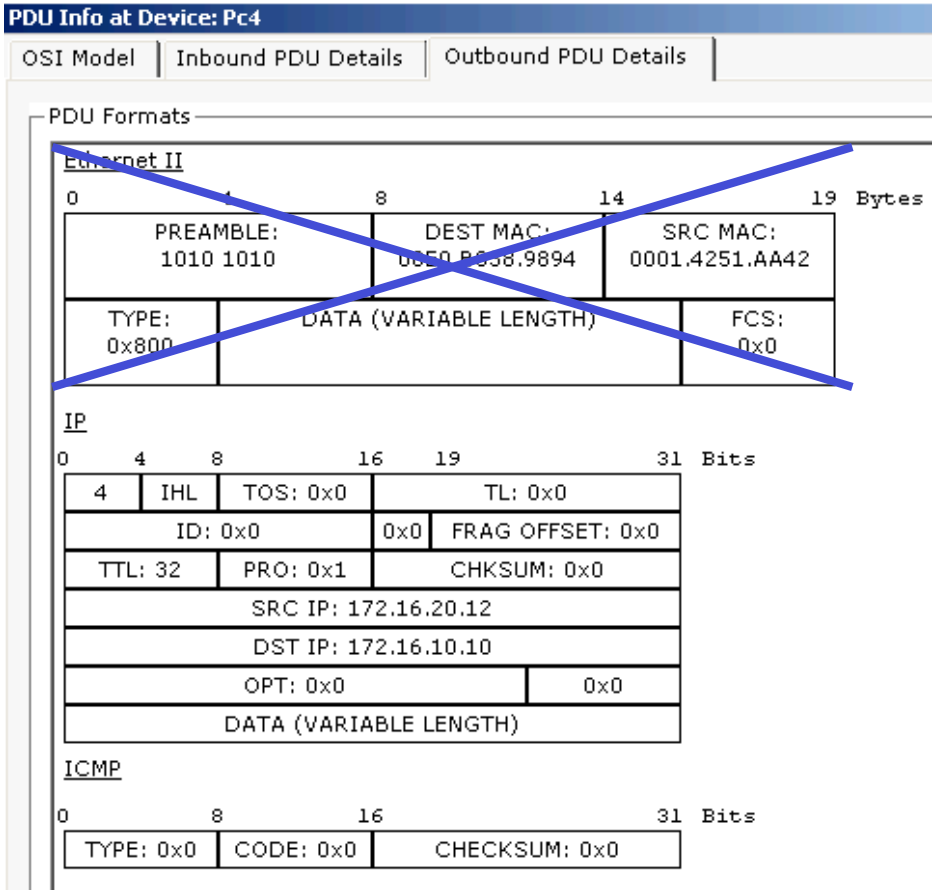
0	4	8	14	19 Bytes
PREAMBLE: 1010 1010		DEST MAC: 00E0.B038.9894	SRC MAC: 0001.4251.AA42	
TYPE: 0x800	DATA (VARIABLE LENGTH)			FCS: 0x0

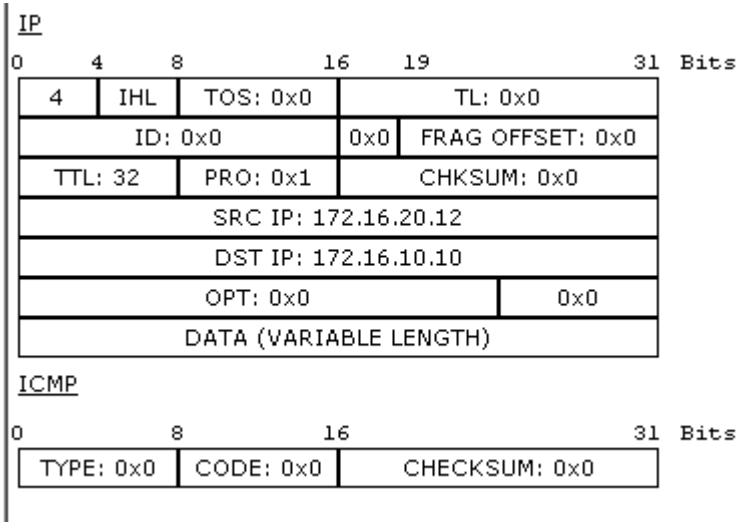
IP

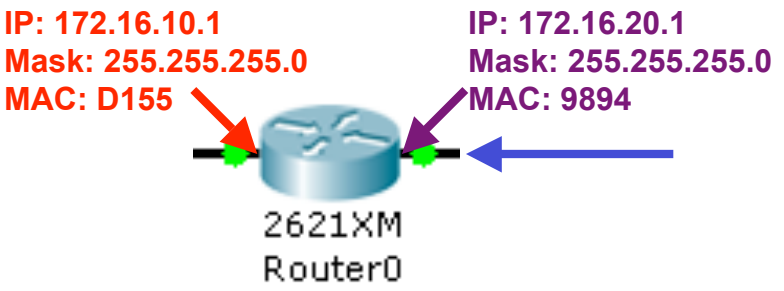
0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0			0x0	FRAG OFFSET: 0x0	
TTL: 32		PRO: 0x1	CHKSUM: 0x0		
SRC IP: 172.16.20.12					
DST IP: 172.16.10.10					
OPT: 0x0				0x0	
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x0	CODE: 0x0	CHECKSUM: 0x0	

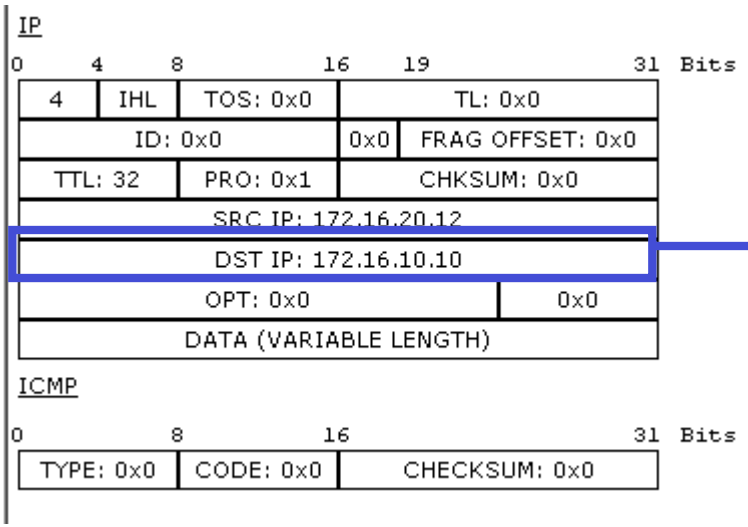


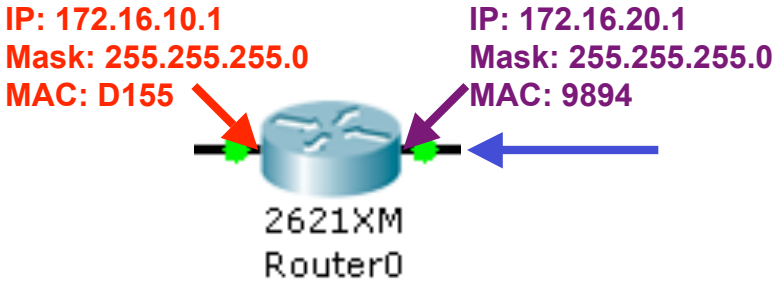


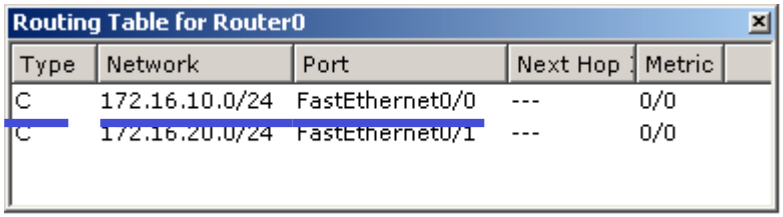


- Router copies in Ethernet frame, because the Destination MAC Address matches its Ethernet interface MAC Address.
- The router strips off the Ethernet header and examines the Layer 3 IP packet.

1. The router looks for the Destination IP Address in the routing table.

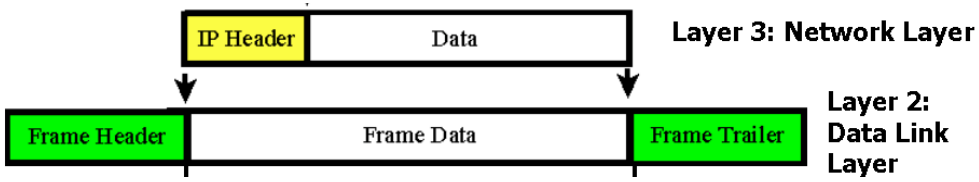






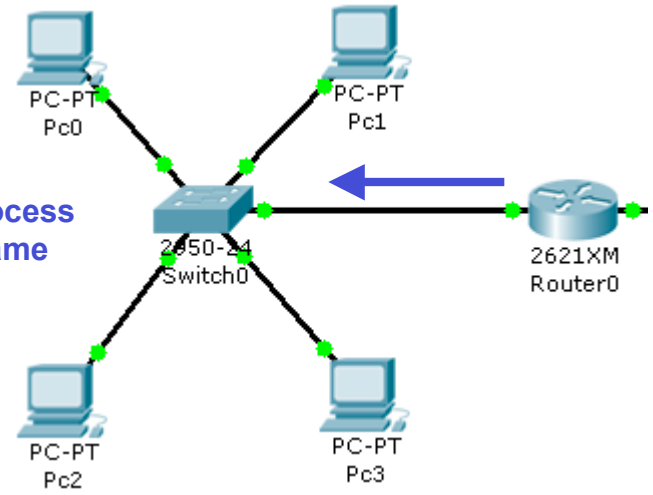
2. The Destination IP Address of the packet belongs to the 172.16.10.0/24 network in its routing table.

3. The port or exit interface is FastEternet0/0. This is an Ethernet interface, which means the router must encapsulate this IP packet into an Ethernet frame.



4. Because this network is “C” directly connected, this means that the device with this Destination IP address is on the same network as the exit interface Fa0/0 and is somewhere on this network.

5. This is the same process as two hosts on the same network.



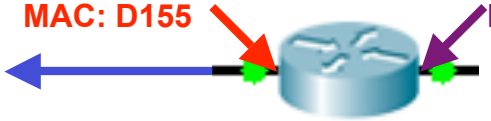
1. The IP Packet needs to be encapsulated in an Ethernet Frame.

Routing Table for Router0

Type	Network	Port	Next Hop	Metric
C	172.16.10.0/24	FastEthernet0/0	---	0/0
C	172.16.20.0/24	FastEthernet0/1	---	0/0

IP: 172.16.10.1
Mask: 255.255.255.0
MAC: D155

IP: 172.16.20.1
Mask: 255.255.255.0
MAC: 9894



2621XM
Router0

2. Remember, the router's exit interface's IP Address is on the same network as the Destination IP Address of the IP packet. This is just like two hosts on the same network!

ARP Table for Router0

IP Address	Hardware Address	Interface
172.16.10.1	0090.2164.D155	FastEthernet0/0
172.16.10.10	0003.E417.2790	FastEthernet0/0
[illegible]	[illegible]	[illegible]
172.16.20.12	0001.4251.AA42	FastEthernet0/1

3. Examine ARP Table for Destination IP Address 172.16.10.10 and an associated MAC Address . Found it! (Next Slide)

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0			0x0	FRAG OFFSET: 0x0	
TTL: 32		PRO: 0x1	CHKSUM: 0x0		
SRC IP: 172.16.20.12					
DST IP: 172.16.10.10					
OPT: 0x0				0x0	
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x0	CODE: 0x0	CHECKSUM: 0x0	

3. The Destination MAC Address must be the MAC Address associated with the Destination IP Address.

Ethernet Header			IP Header			
Destination MAC Add.	Source MAC Address	Type	Source IP Address	Destination IP Address	Rest of IP Hdr	Data
2790	D155	0x800	172.16.20.12	172.16.10.10		ICMP

Packet Forwarding

PDU Info at Device: Router0

OSI Model | Inbound PDU Details | Outbound PDU Details

PDU Formats

Ethernet II

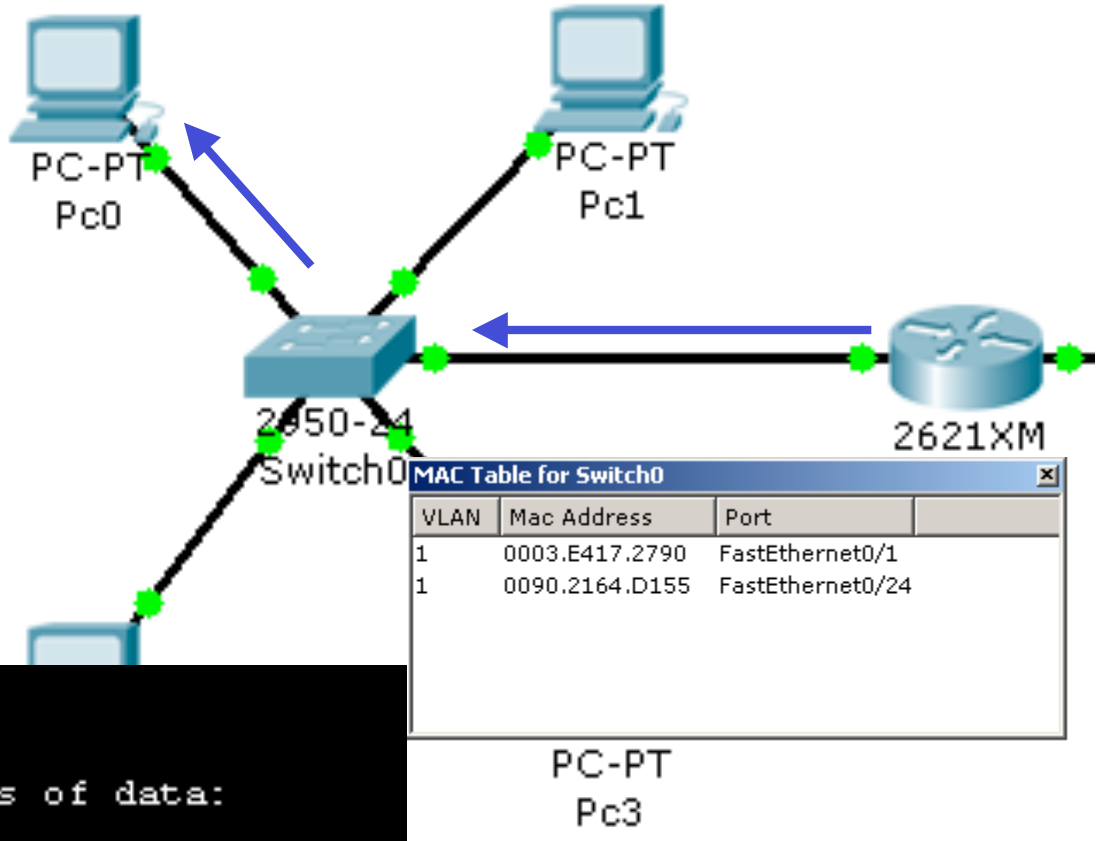
0	4	8	14	19 Bytes
PREAMBLE: 1010 1010		DEST MAC: 0003.E417.2790	SRC MAC: 0090.2164.D155	
TYPE: 0x800	DATA (VARIABLE LENGTH)			FCS: 0x0

IP

0	4	8	16	19	31 Bits
4	IHL	TOS: 0x0	TL: 0x0		
ID: 0x0		0x0	FRAG OFFSET: 0x0		
TTL: 31	PRO: 0x1	CHKSUM: 0x0			
SRC IP: 172.16.20.12					
DST IP: 172.16.10.10					
OPT: 0x0				0x0	
DATA (VARIABLE LENGTH)					

ICMP

0	8	16	31 Bits
TYPE: 0x0	CODE: 0x0	CHECKSUM: 0x0	



MAC Table for Switch0

VLAN	Mac Address	Port
1	0003.E417.2790	FastEthernet0/1
1	0090.2164.D155	FastEthernet0/24

1. Now that the IP packet has been encapsulated into an Ethernet frame, the frame can be forwarded on to the switch.

```
PC>ping 172.16.20.12

Pinging 172.16.20.12 with 32 bytes of data:

Reply from 172.16.20.12: bytes=32 time=8ms TTL=120
```

2. Pc0 receives ICMP Echo Reply and displays the information on the screen.