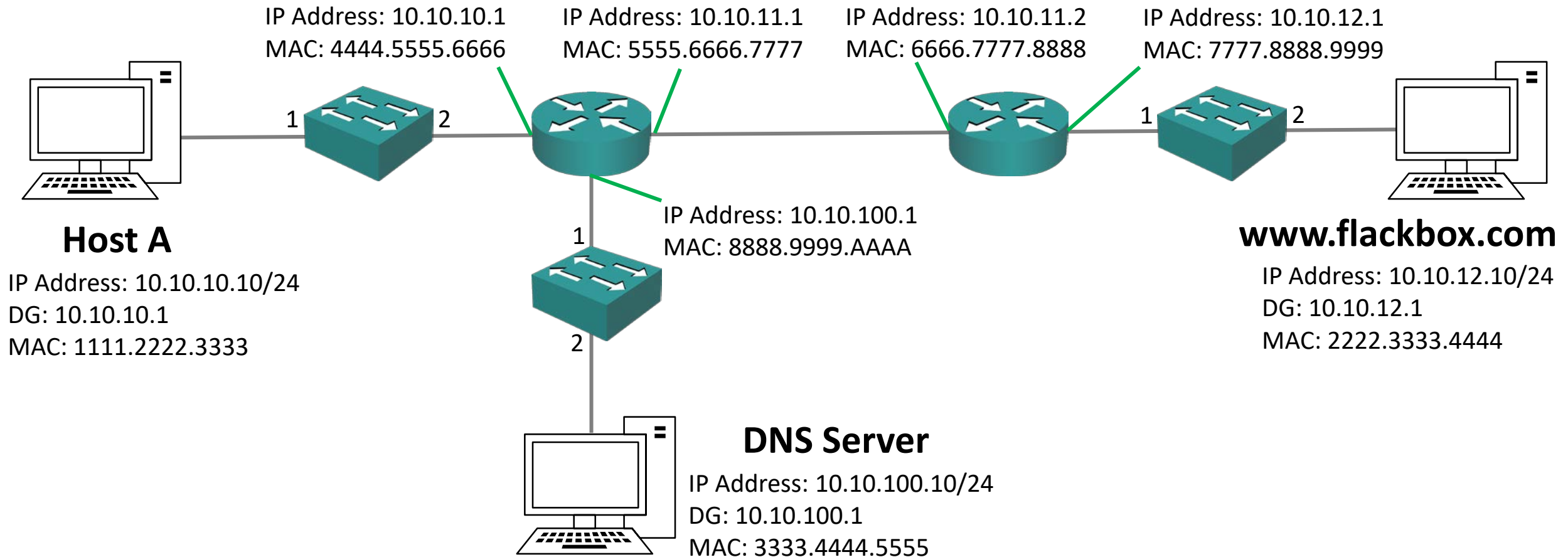
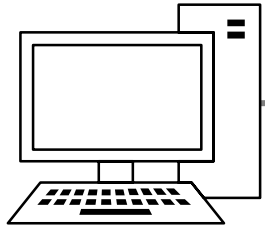


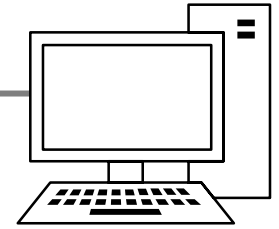
# The Life of a Packet



# OSI Reference Model - Encapsulation



**Sender**



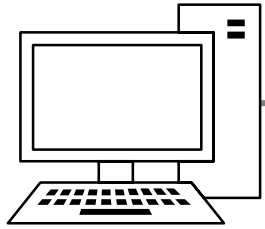
**Receiver**

Layer	Name	Includes
7		
6		
5		
4		
3		
2		
1		

# OSI Reference Model - Encapsulation



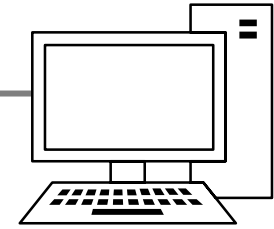
# OSI Reference Model - Encapsulation



**Sender**



Layer	Name	Includes
7	Application	
6	Presentation	
5		
4		
3		
2		
1		



**Receiver**

# OSI Reference Model - Encapsulation



**Sender**



Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4		
3		
2		
1		


**Receiver**

# OSI Reference Model - Encapsulation



**Sender**

**Receiver**




Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP, Dst. Port 80
3		
2		
1		

# OSI Reference Model - Encapsulation



**Sender**

**Receiver**



Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP, Dst. Port 80
3	Network	IP Address?
2		
1		

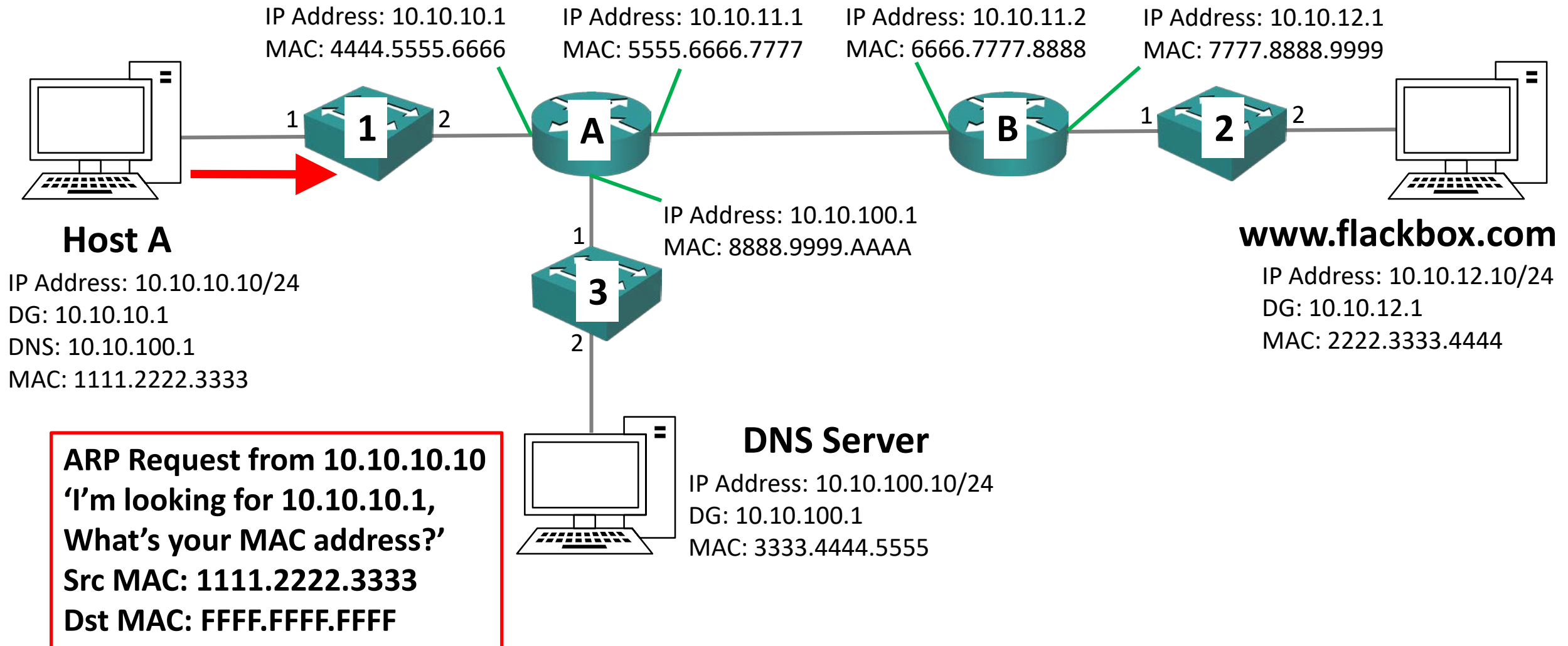
# The Life of a Packet



- Host A (10.10.10.10/24) wants to send a packet to the FQDN `www.flackbox.com`, but it doesn't know the destination IP address
- It will hold the packet and send a DNS request to its DNS server at 10.10.100.10
- Host A compares its IP address and subnet mask to the destination address of the DNS server and sees it is on a different subnet, so the DNS request needs to be sent via its default gateway
- Host A will hold the DNS request and send a broadcast ARP request for its default gateway at 10.10.10.1



# The Life of a Packet

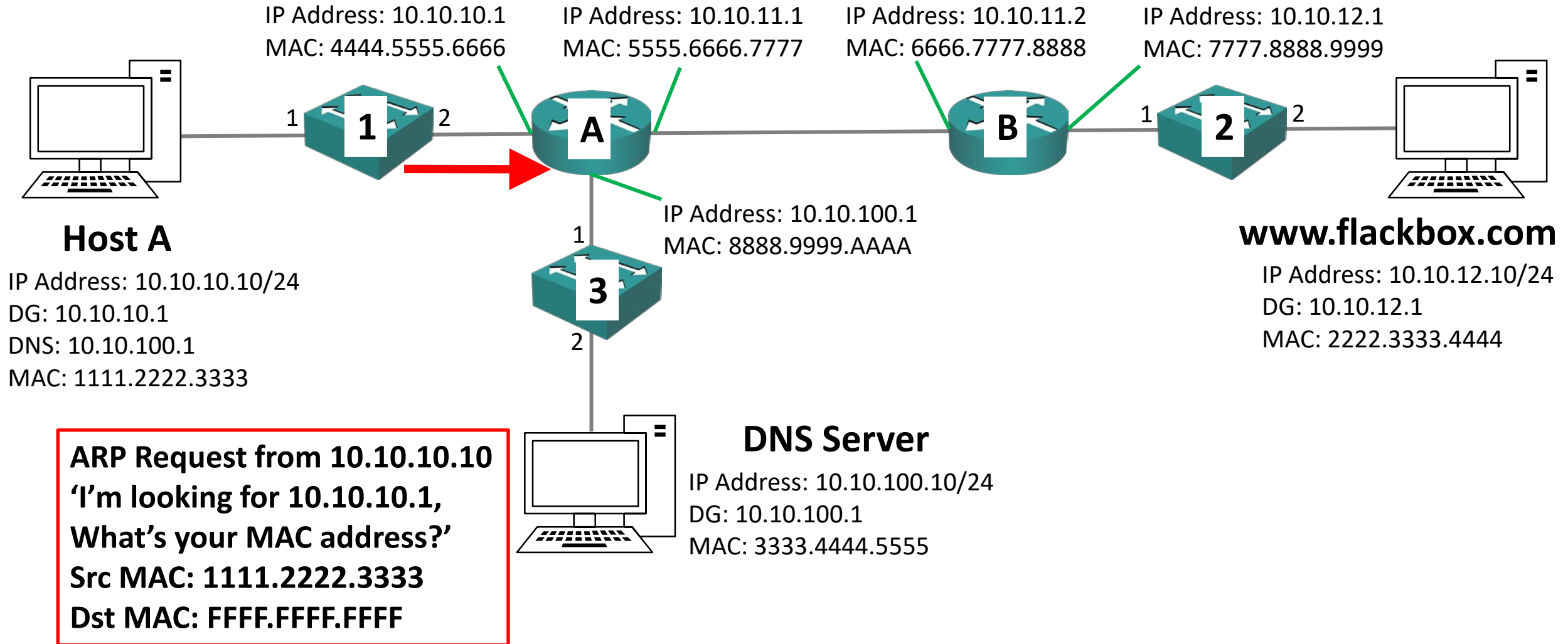


# The Life of a Packet



- The ARP request will be received by Switch 1
- Switch 1 will add an entry in its MAC address table mapping Host A's MAC address 1111.2222.3333 to Port 1
- Switch 1 will flood the broadcast traffic out all ports apart from the one it was received on

# The Life of a Packet

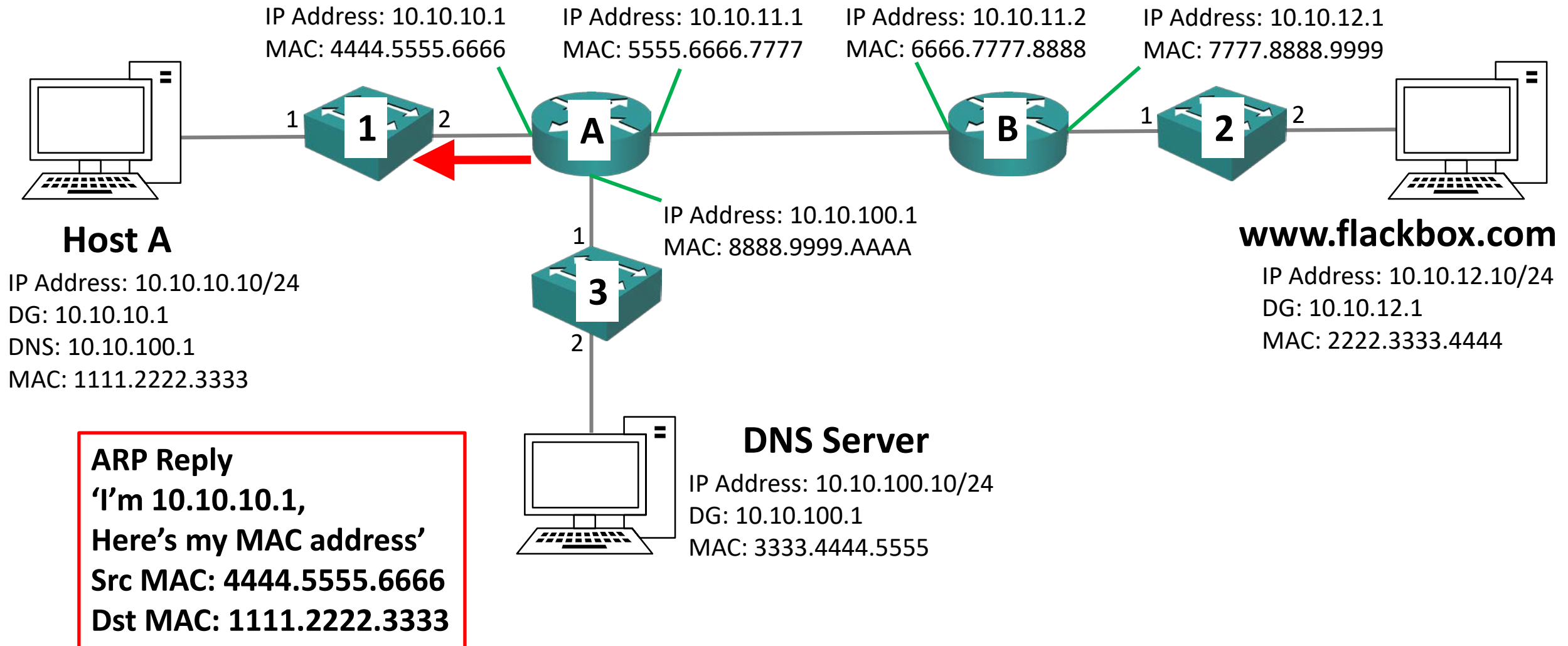


# The Life of a Packet



- The ARP request will hit Router A's interface 10.10.10.1
- Router A will process the ARP request and see it is for itself
- Router A will send a unicast ARP reply to Host A
- Router A will add an entry for Host A mapping IP address 10.10.10.10 to MAC address 1111.2222.3333 to its ARP cache

# The Life of a Packet

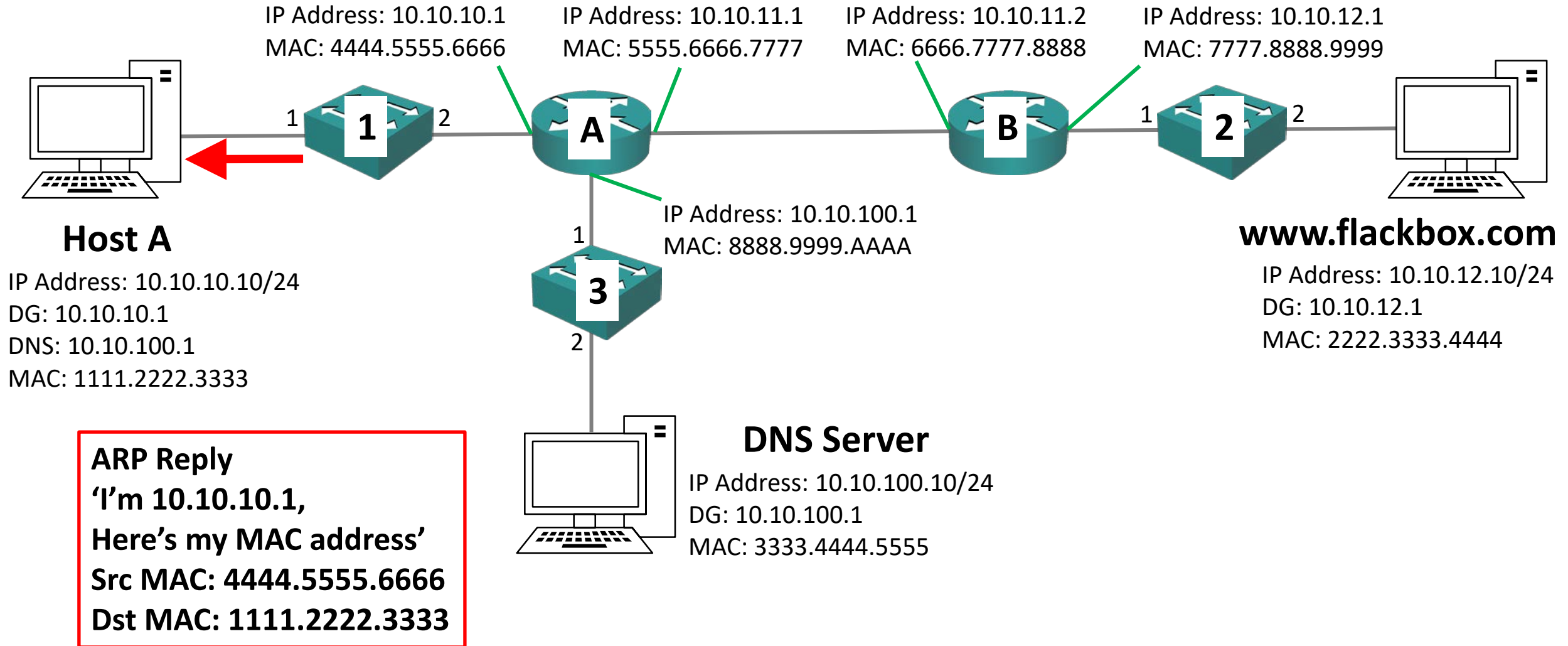


# The Life of a Packet



- Switch 1 will add an entry in its MAC address table mapping Router A's MAC address 4444.5555.6666 to Port 2
- Switch 1 will send the ARP reply out only Port 1 which Host A is plugged into (which it already has in its MAC address table)

# The Life of a Packet



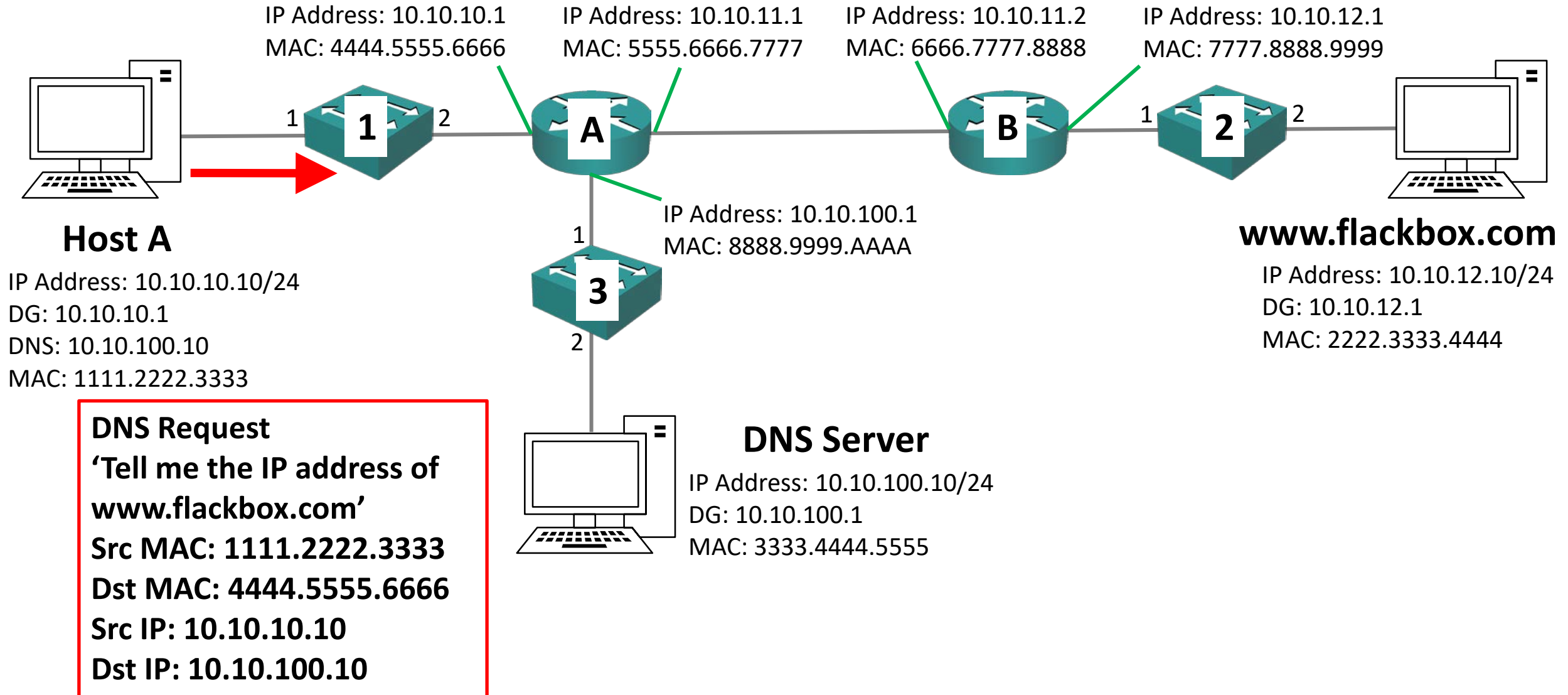
# The Life of a Packet



- Host A will add an entry for Router A mapping IP address 10.10.10.1 to MAC address 4444.5555.6666 to its ARP cache
- It will use this whenever it needs to send traffic to another IP subnet
- Host A will send the DNS request for [www.flackbox.com](http://www.flackbox.com)



# The Life of a Packet

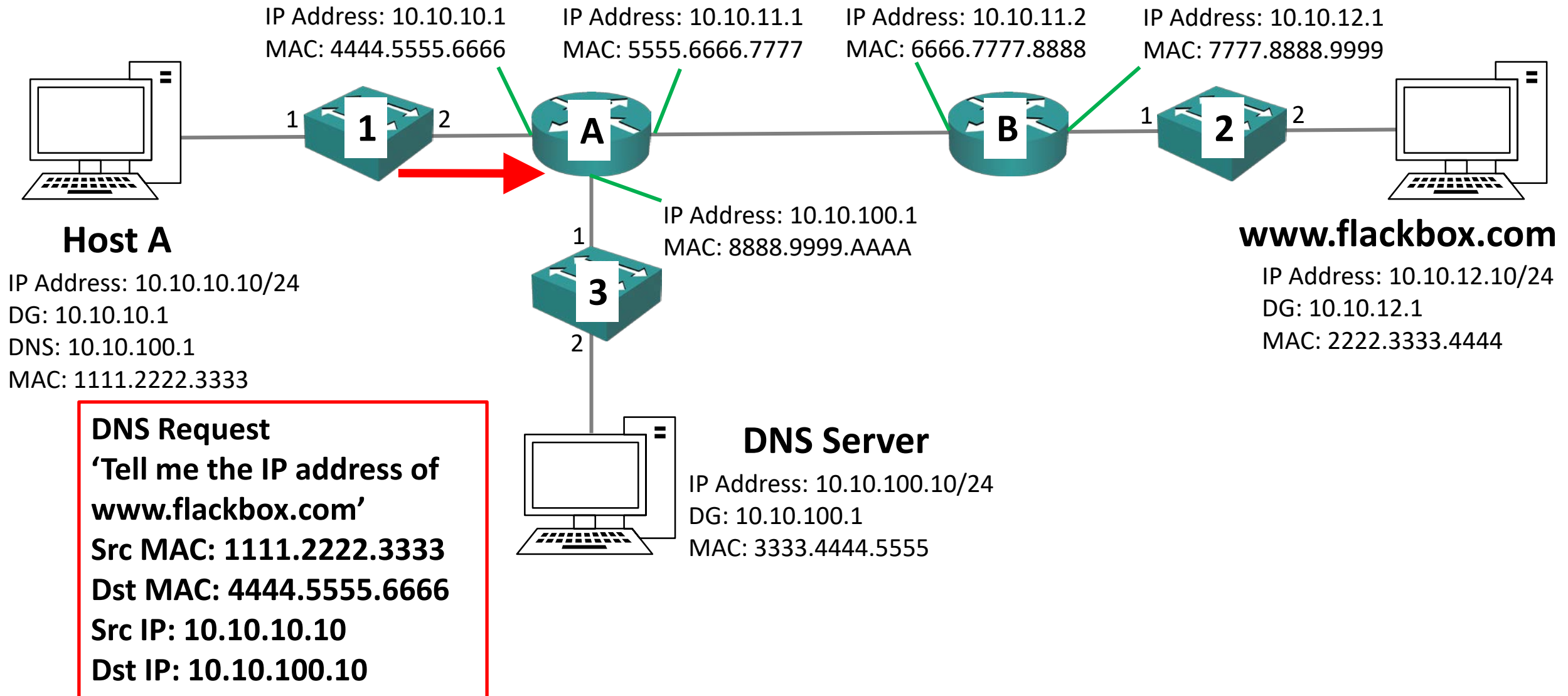


# The Life of a Packet



- Switch 1 will send the DNS request out only Port 2 which Router A is plugged into (which it already has in its MAC address table)

# The Life of a Packet

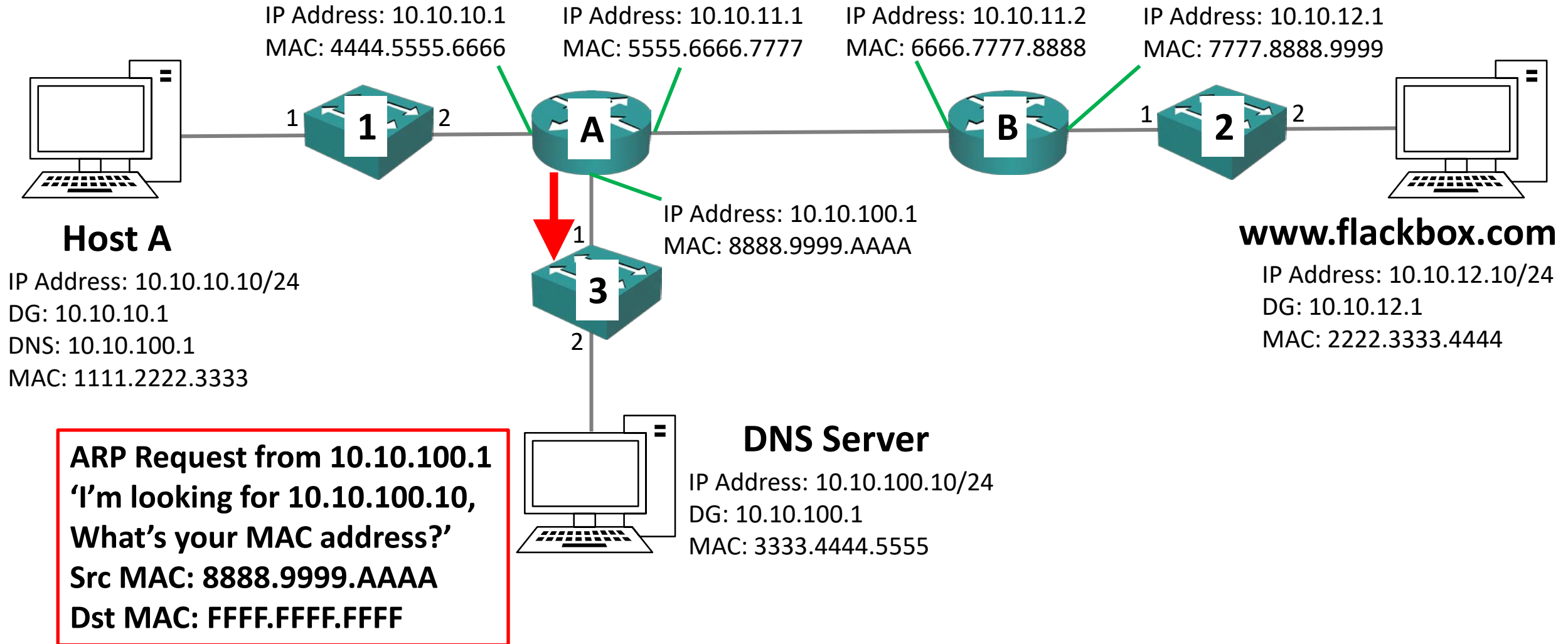


# The Life of a Packet



- Router A will receive the DNS request packet and see that the destination IP address is 10.10.100.10
- Router A has an interface in the subnet 10.10.100.0/24, so it knows the destination should be available out that port
- It doesn't know the MAC address of 10.10.100.10 so it will hold the DNS request packet and send an ARP request out of the 10.10.100.1 interface

# The Life of a Packet

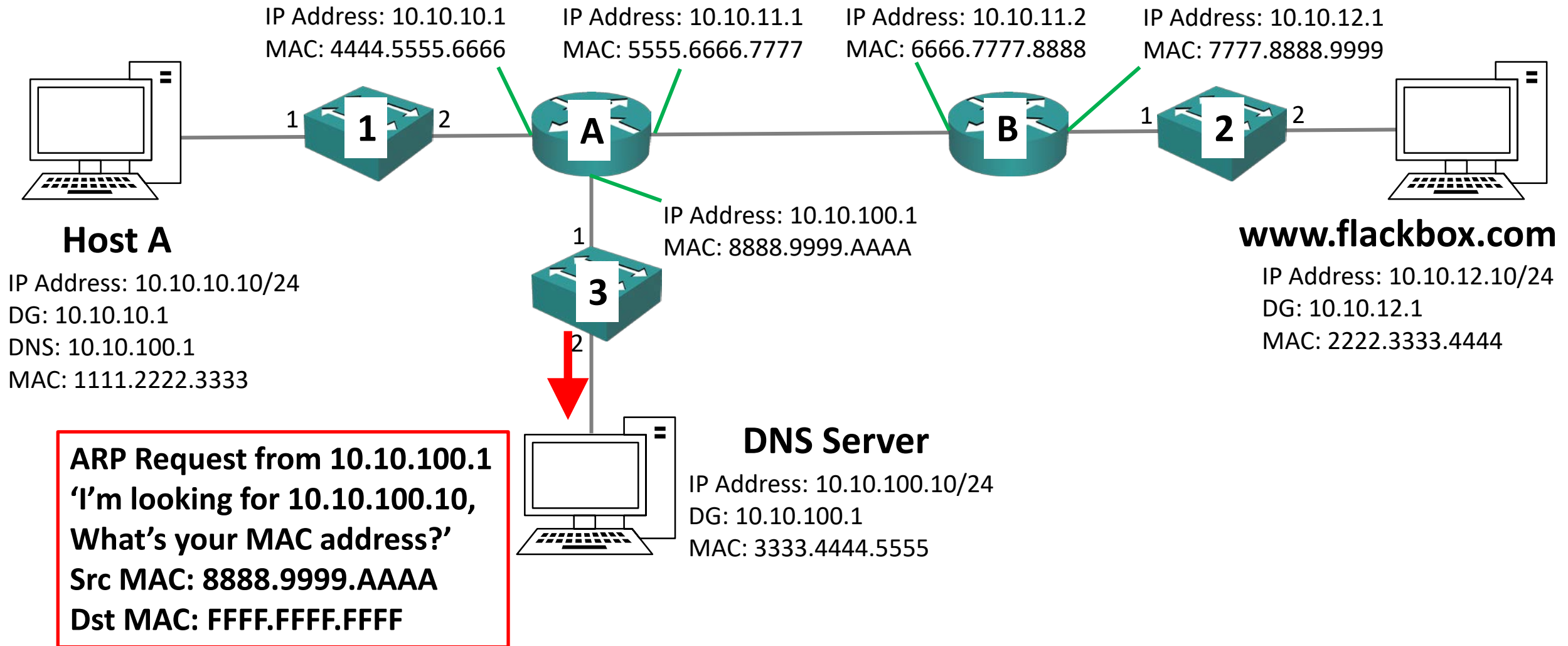


# The Life of a Packet



- The ARP request will be received by Switch 3
- Switch 3 will add an entry in its MAC address table mapping Router A's MAC address 8888.9999.AAAA to Port 1
- Switch 3 will flood the broadcast traffic out all ports apart from the one it was received on

# The Life of a Packet



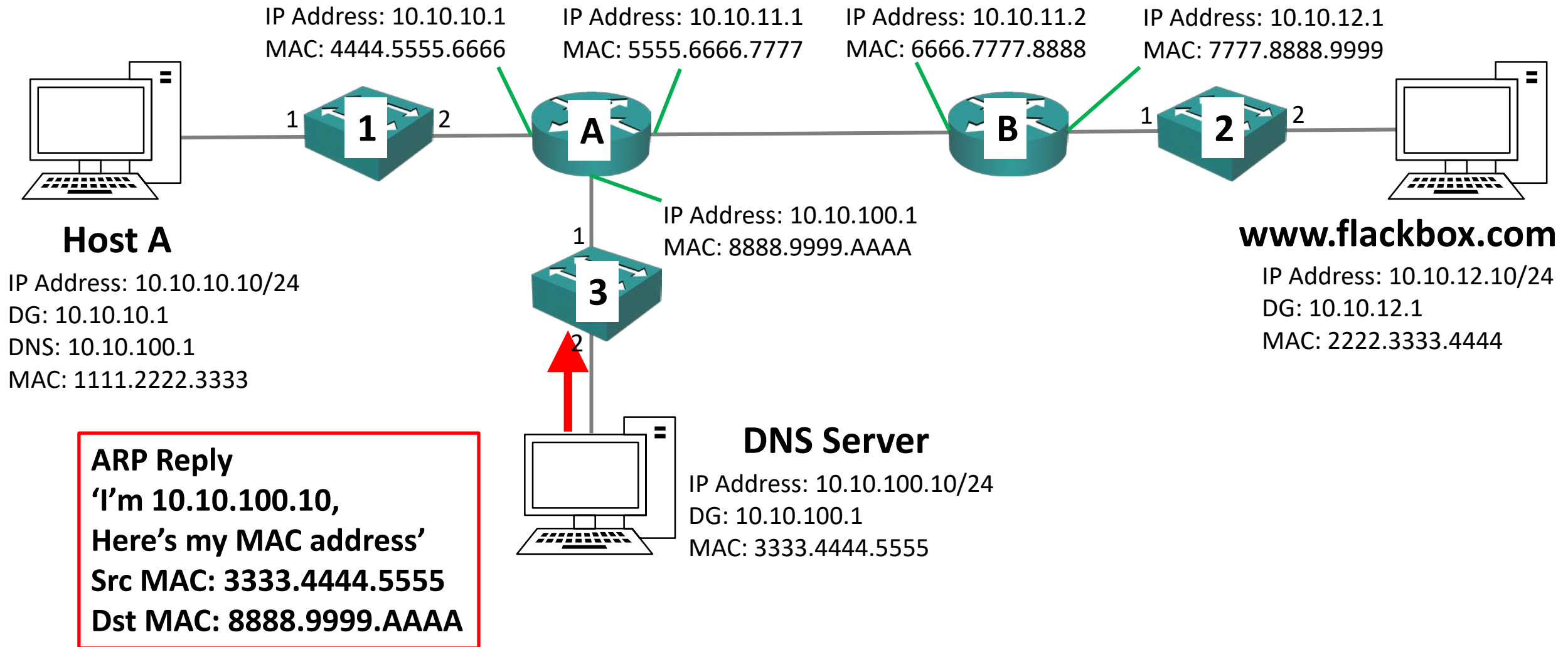
# The Life of a Packet



- The ARP request will hit the DNS Server's interface 10.10.100.10
- The DNS Server will process the ARP request and see it is for itself
- The DNS Server will send a unicast ARP reply to Router A
- The DNS Server will add an entry for Router A mapping IP address 10.10.100.1 to MAC address 8888.9999.AAAA to its ARP cache
- It will use this whenever it needs to send traffic to another IP subnet



# The Life of a Packet

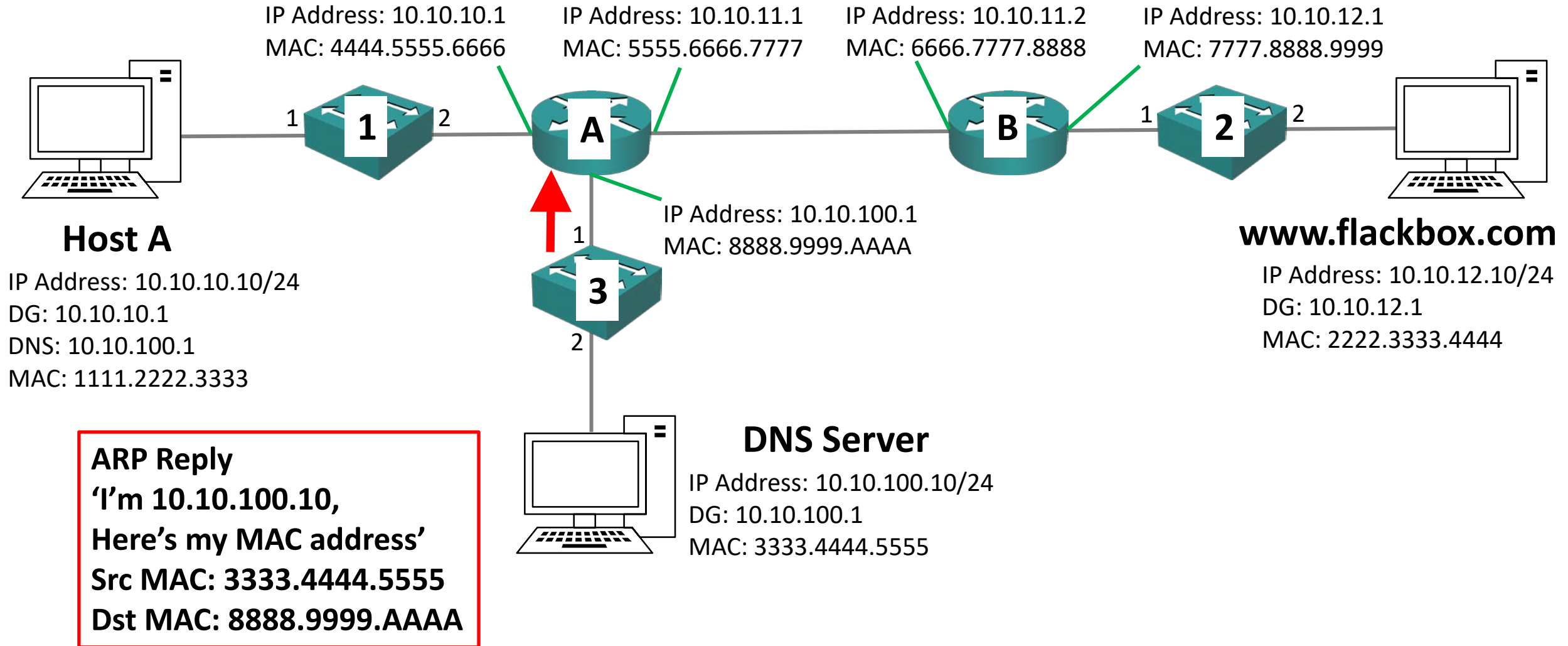


# The Life of a Packet



- Switch 3 will add an entry in its MAC address table mapping the DNS Server's MAC address 3333.4444.5555 to Port 2
- Switch 3 will send the ARP reply out only Port 1 which Router A is plugged into (which it already has in its MAC address table)

# The Life of a Packet



# The Life of a Packet



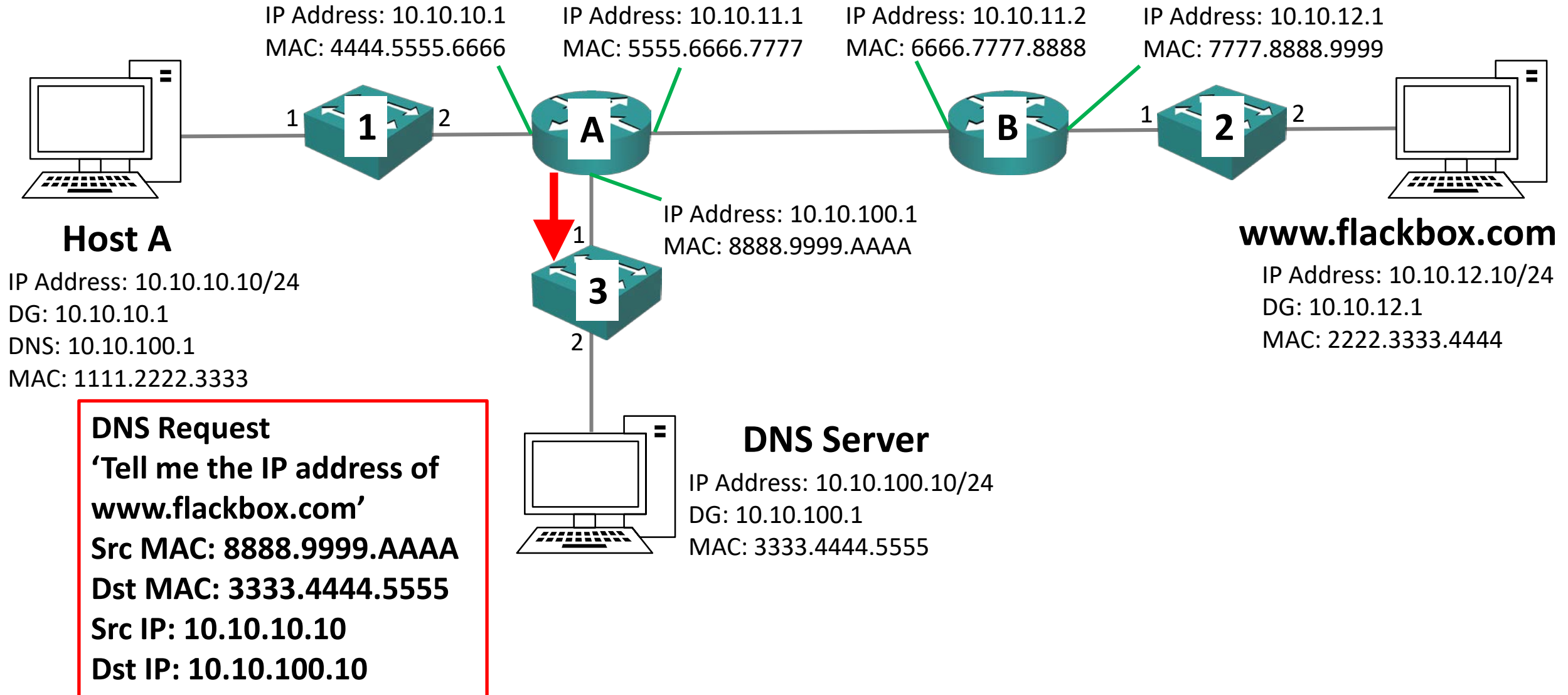
- Router A will add an entry for the DNS Server mapping IP address 10.10.100.10 to MAC address 3333.4444.5555 to its ARP cache
- Router A will send the DNS request it was holding to the DNS Server

# The Life of a Packet



- **The source and destination MAC addresses of a packet are updated hop by hop, the source and destination IP addresses always remain unchanged end to end**
- The source and destination MAC addresses will be updated to come from Router A and go to the DNS Server
- The source and destination IP addresses are still Host A 10.10.10.10 and the DNS Server 10.10.100.10

# The Life of a Packet

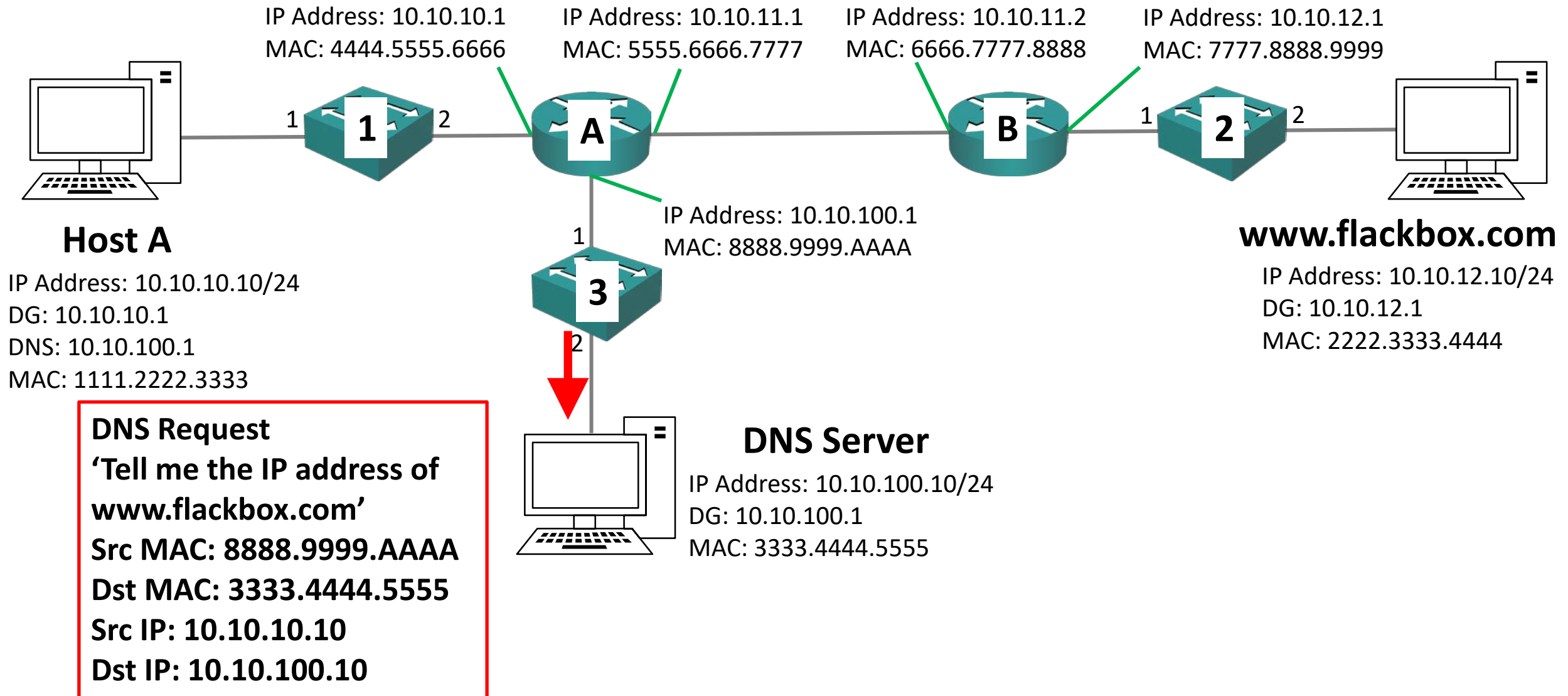


# The Life of a Packet



- Switch 3 will send the DNS request out only Port 2 which the DNS Server is plugged into (which it already has in its MAC address table)

# The Life of a Packet



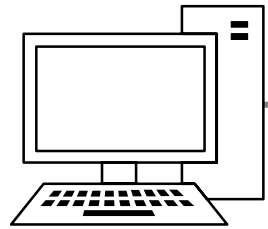


# The Life of a Packet

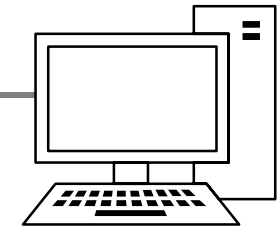


- The DNS Server will receive the DNS request packet and see that the destination is itself

# OSI Reference Model – De-encapsulation



**Sender**

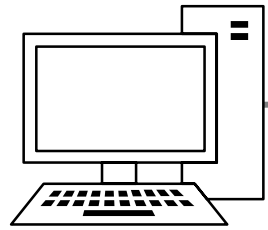


**Receiver**

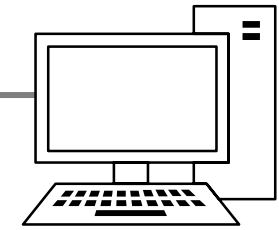
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	
2	Data-Link	
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

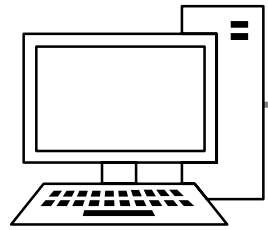


**Receiver**

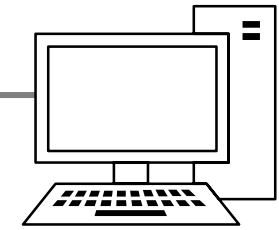
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

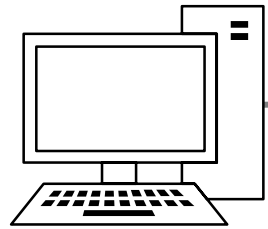


**Receiver**

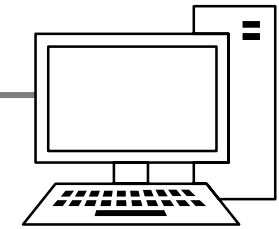
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	Dst: 10.10.100.10
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

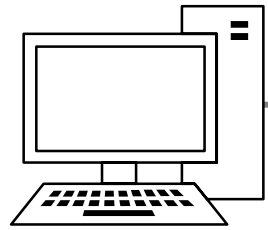


**Receiver**

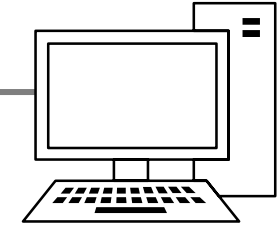
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	UDP Port 53
3	Network	Dst: 10.10.100.10
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

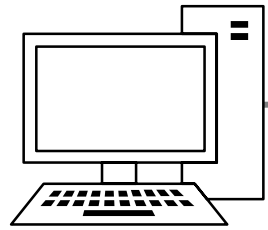


**Receiver**

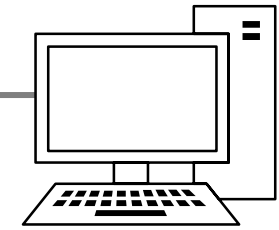
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	UDP Port 53
3	Network	Dst: 10.10.100.10
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**



**Receiver**

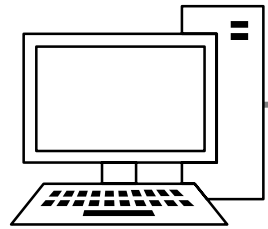
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	UDP Port 53
3	Network	Dst: 10.10.100.10
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



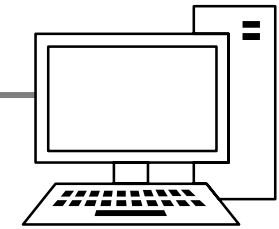
L6

L7

# OSI Reference Model – De-encapsulation



**Sender**



**Receiver**

Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	UDP Port 53
3	Network	Dst: 10.10.100.10
2	Data-Link	Dst: 3333.4444.5555
1	Physical	



**L7**

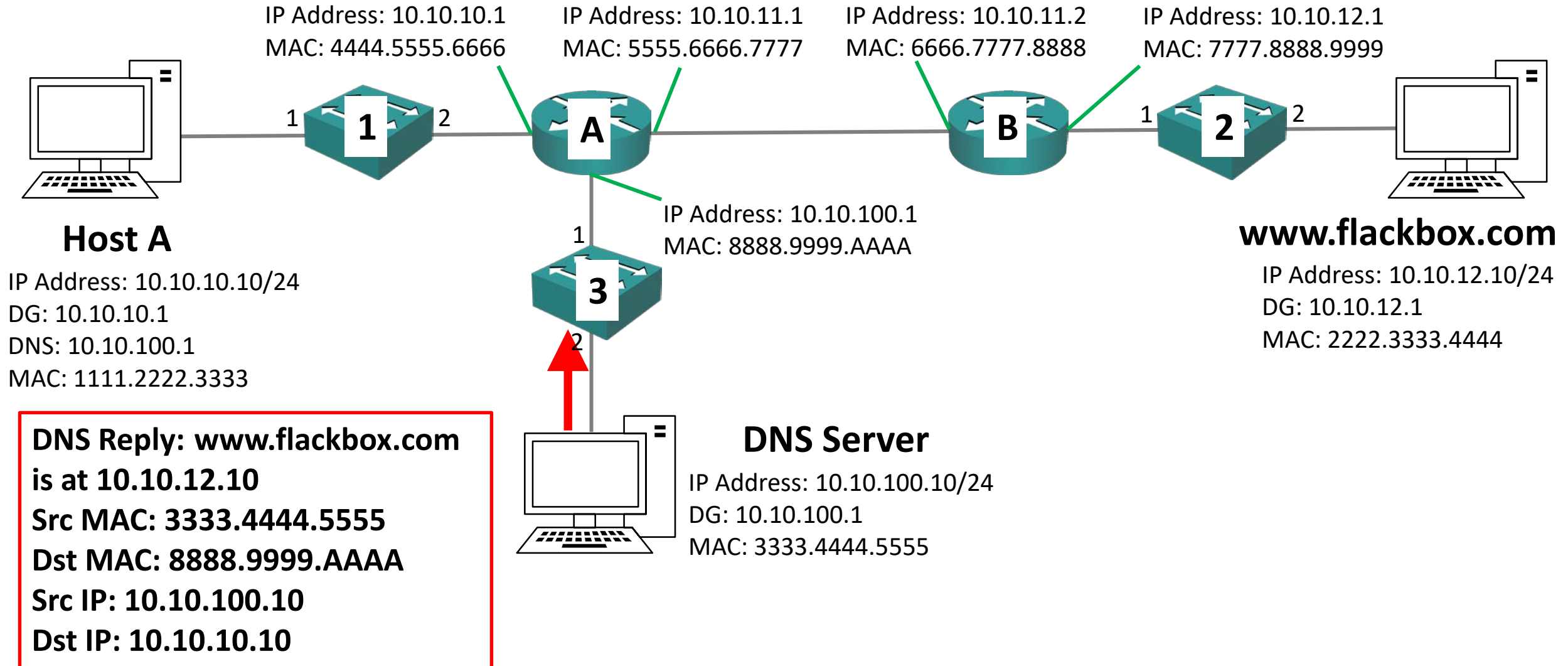


# The Life of a Packet



- The DNS Server will look in its DNS database and see an Address record for `www.flackbox.com` at `10.10.12.10`
- It will send this information to Host A in a DNS response
- It knows to send the response to `10.10.10.10` from the source IP address in the DNS request
- It knows to send it via Router A because the destination is in another subnet
- It already has Router A's MAC address in its ARP cache

# The Life of a Packet

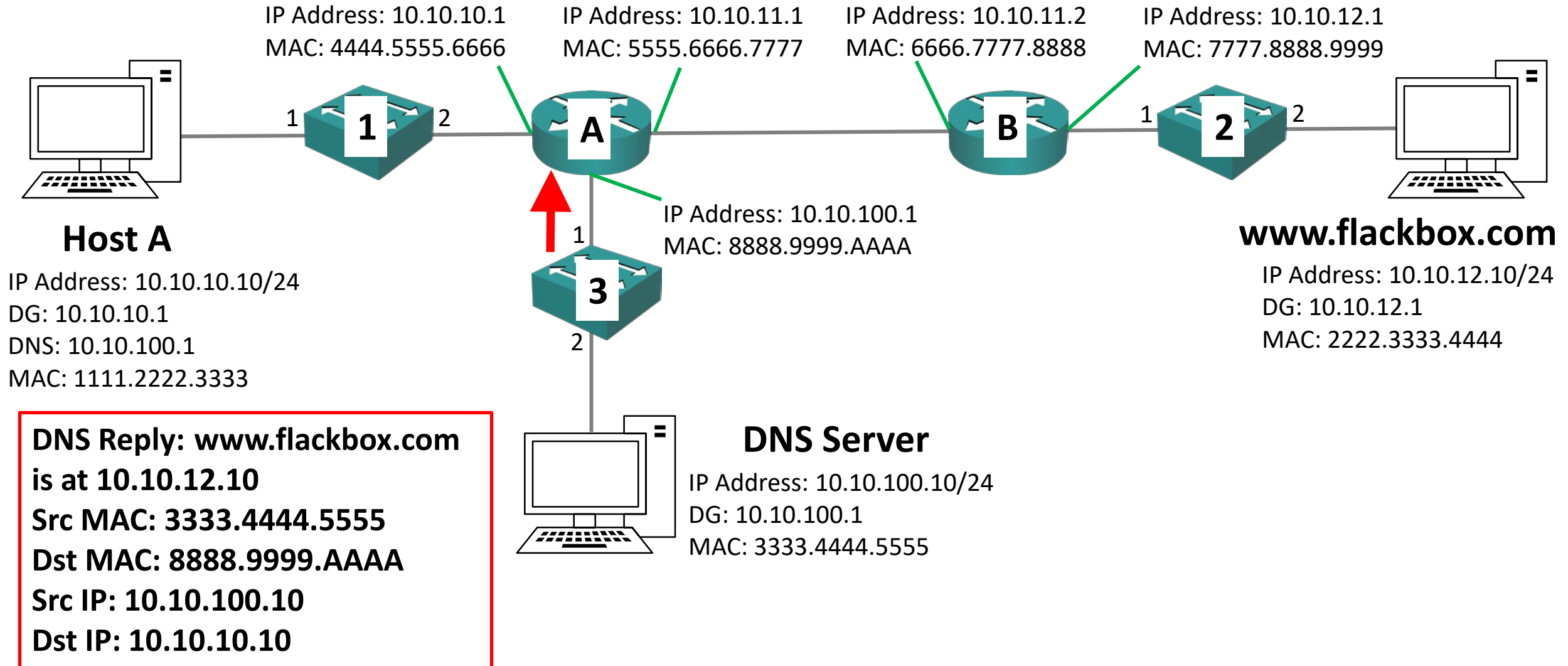


# The Life of a Packet



- Switch 3 will receive the DNS response and send it out only Port 1 which Router A is plugged into (which it already has in its MAC address table)

# The Life of a Packet

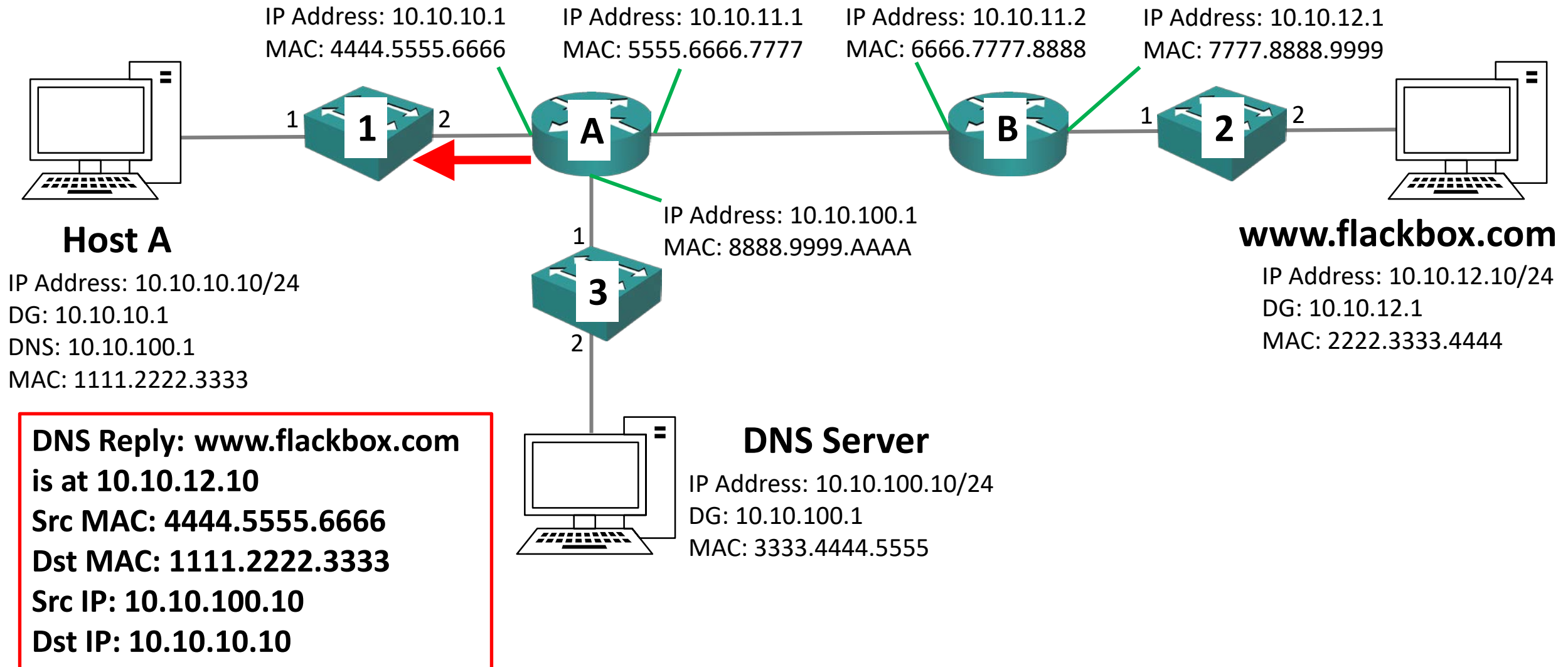


# The Life of a Packet



- Router A will receive the DNS response packet and see that the destination IP address is 10.10.10.10
- Router A has an interface in the subnet 10.10.10.0/24, so it knows the destination is available out that port
- Router A already has the MAC address for 10.10.10.10 in its ARP cache

# The Life of a Packet

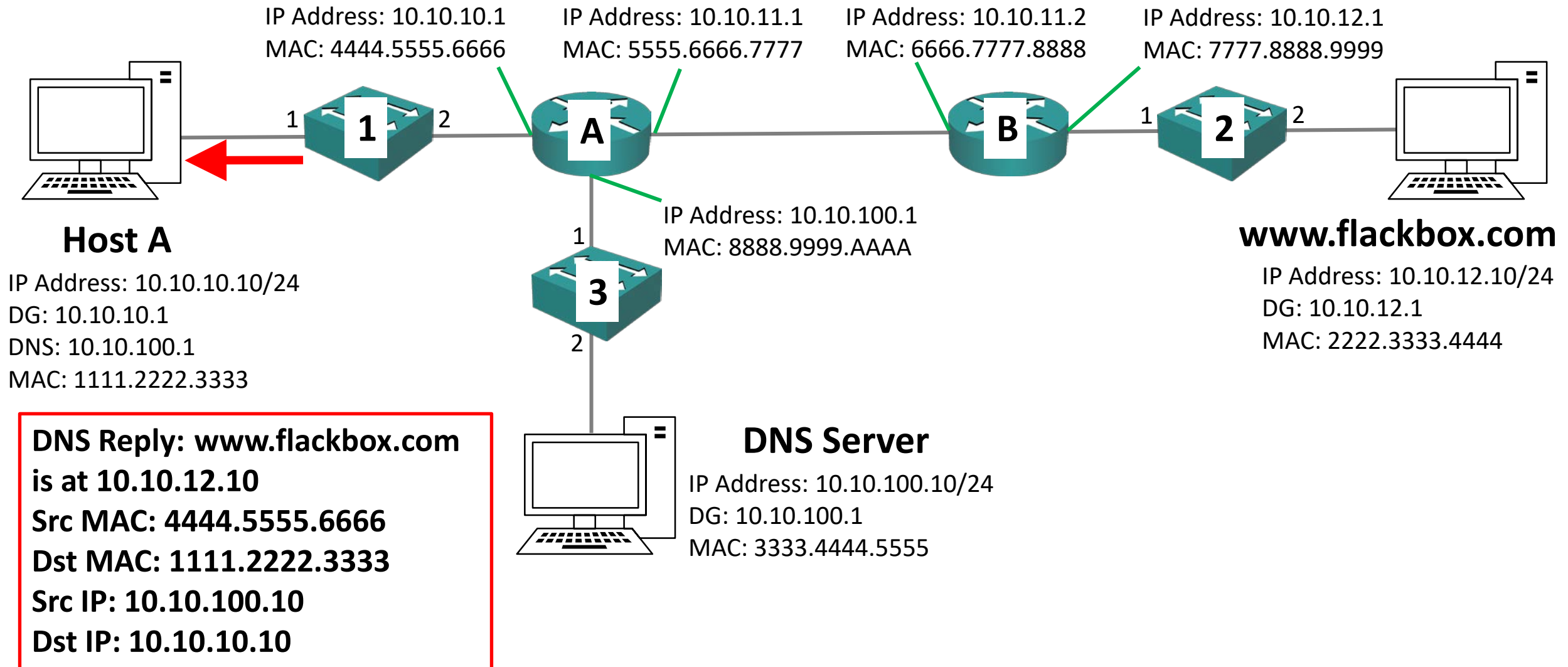


# The Life of a Packet



- Switch 1 will receive the DNS response and send it out only Port 1 which Host A is plugged into (which it already has in its MAC address table)

# The Life of a Packet





# The Life of a Packet




- Host A learns that `www.flackbox.com` is available at `10.10.12.10`
- It can now update the packet it was waiting to send to `www.flackbox.com` with that destination IP address
- Host A sees that `www.flackbox.com` is not on its own subnet so it knows any packets it sends there must go via its default gateway

# OSI Reference Model - Encapsulation



**Sender**

**Receiver**



Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP, Dst. Port 80
3	Network	IP Address?
2		
1		

# OSI Reference Model - Encapsulation



**Sender**

**Receiver**

Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP, Dst. Port 80
3	Network	Dst: 10.10.12.10
2		
1		

# OSI Reference Model - Encapsulation

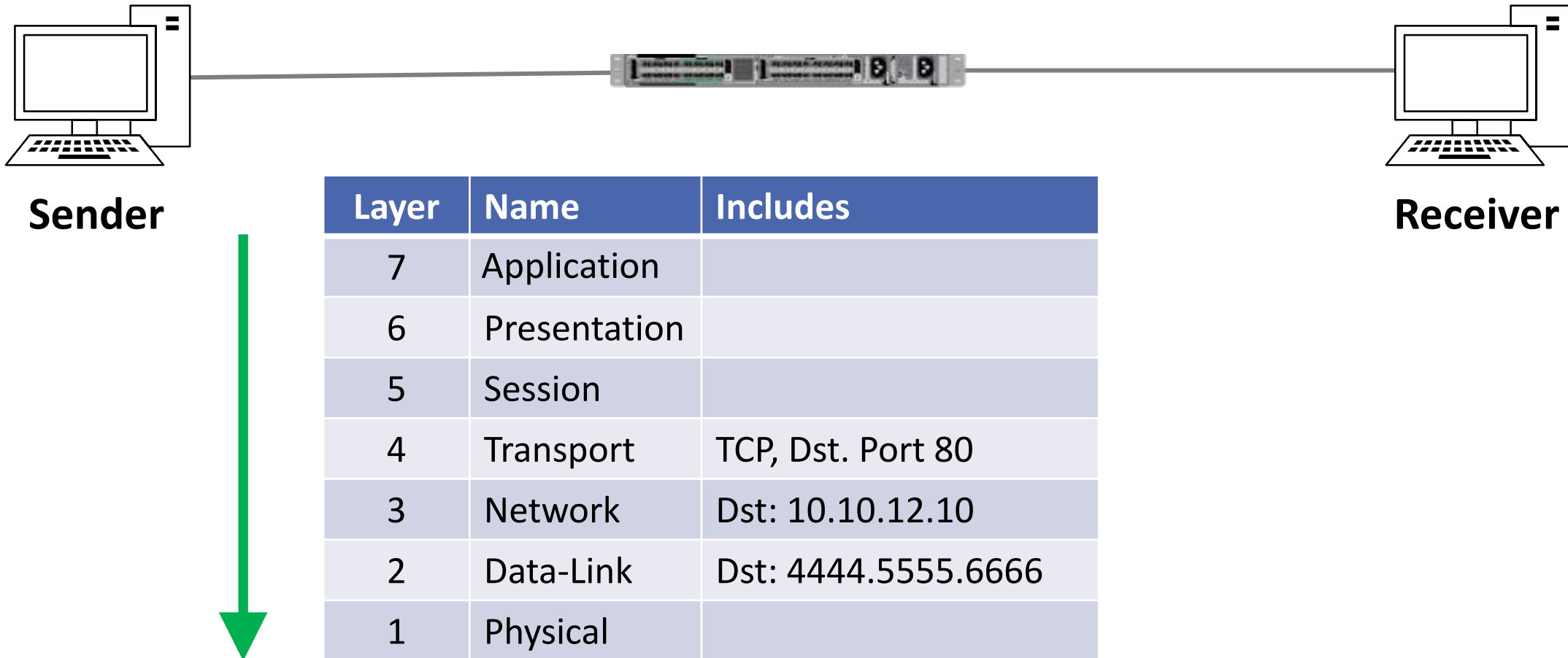


**Sender**

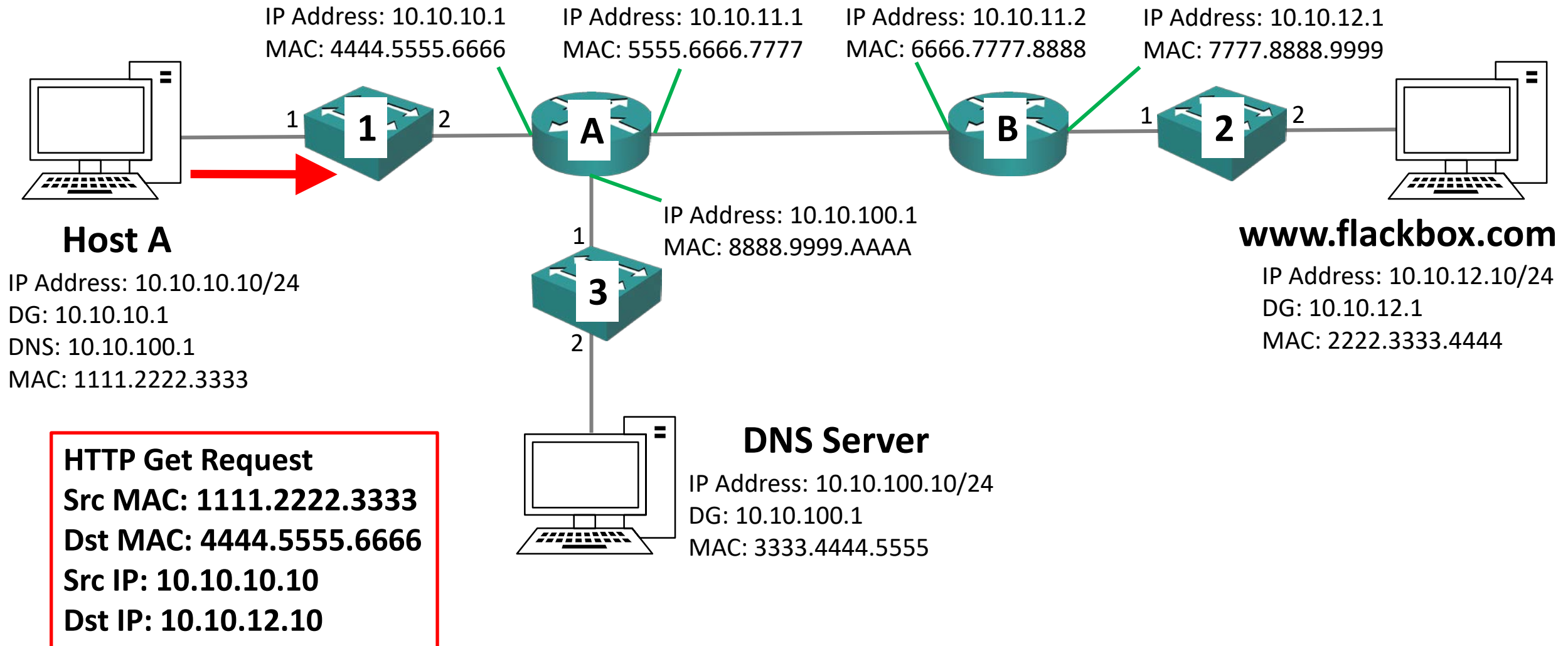
**Receiver**

Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP, Dst. Port 80
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 4444.5555.6666
1		

# OSI Reference Model - Encapsulation



# The Life of a Packet

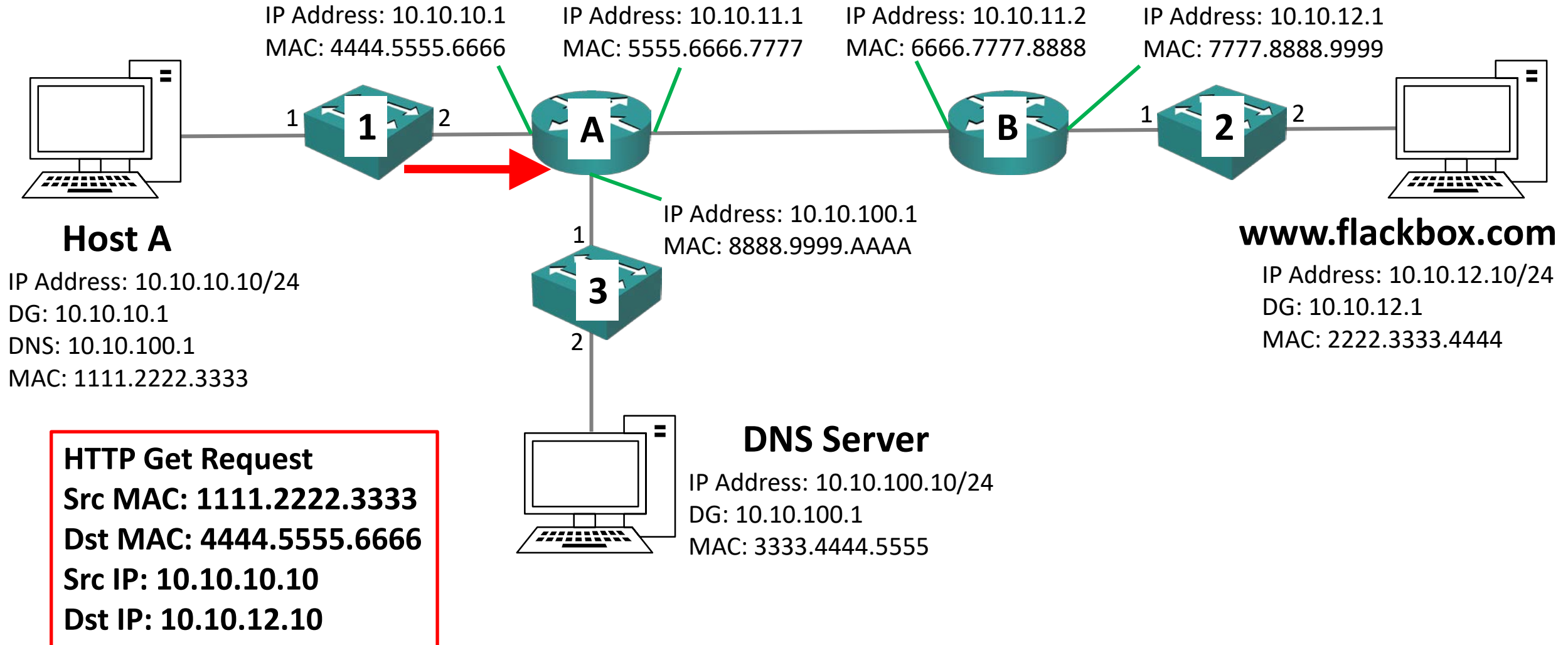


# The Life of a Packet



- Switch 1 will send the packet to Router A which it already has in its MAC address table

# The Life of a Packet





# The Life of a Packet



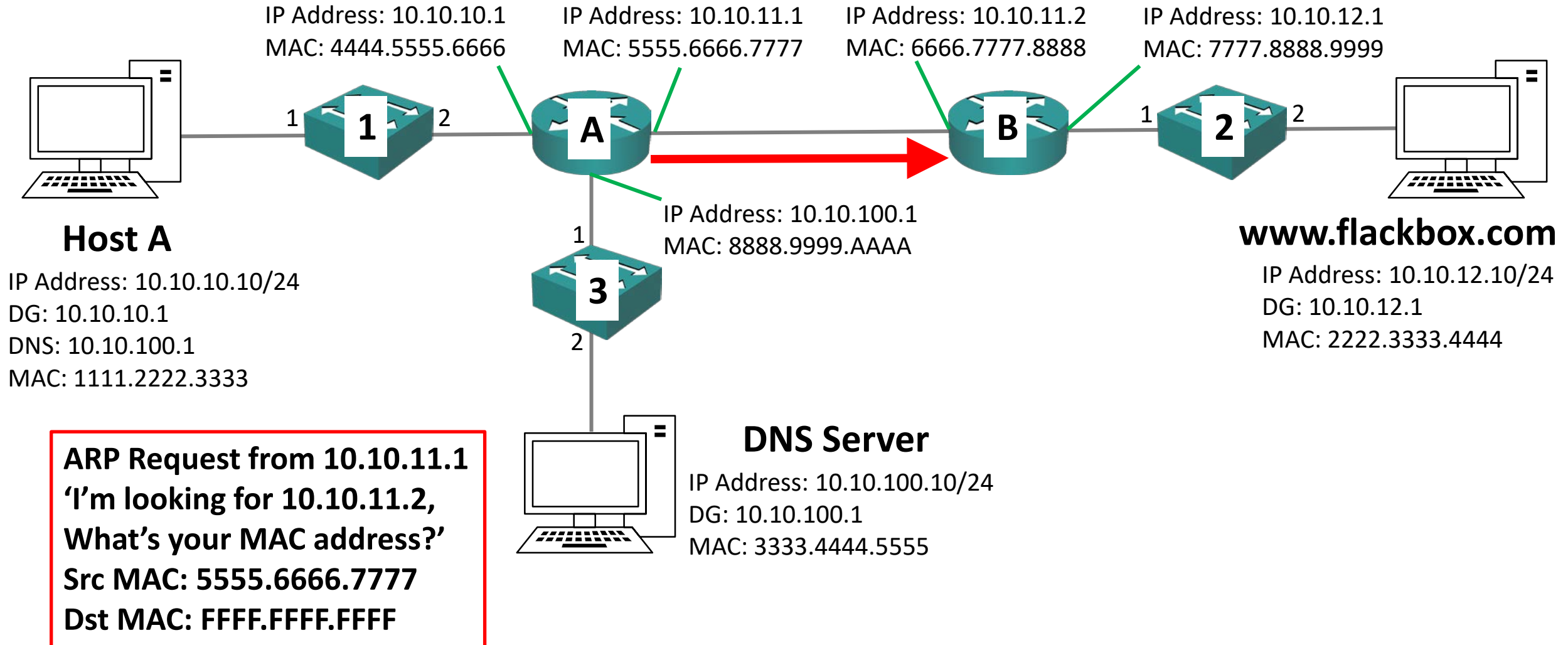
- Router A will receive the packet with destination IP address 10.10.12.10
- Router A does not have any interfaces in the 10.10.12.0/24 subnet
- In this case it will need a route to get there
- The route can be either statically configured by an administrator or learned dynamically through a routing protocol

# The Life of a Packet



- In this example the administrator has configured a static route for 10.10.12.0/24 with the next hop address 10.10.11.2
- Router A has an Ethernet interface in the 10.10.11.0 subnet
- It doesn't know the MAC address for the next hop address 10.10.11.2 yet
- It will hold the HTTP packet and send an ARP request for 10.10.11.2

# The Life of a Packet

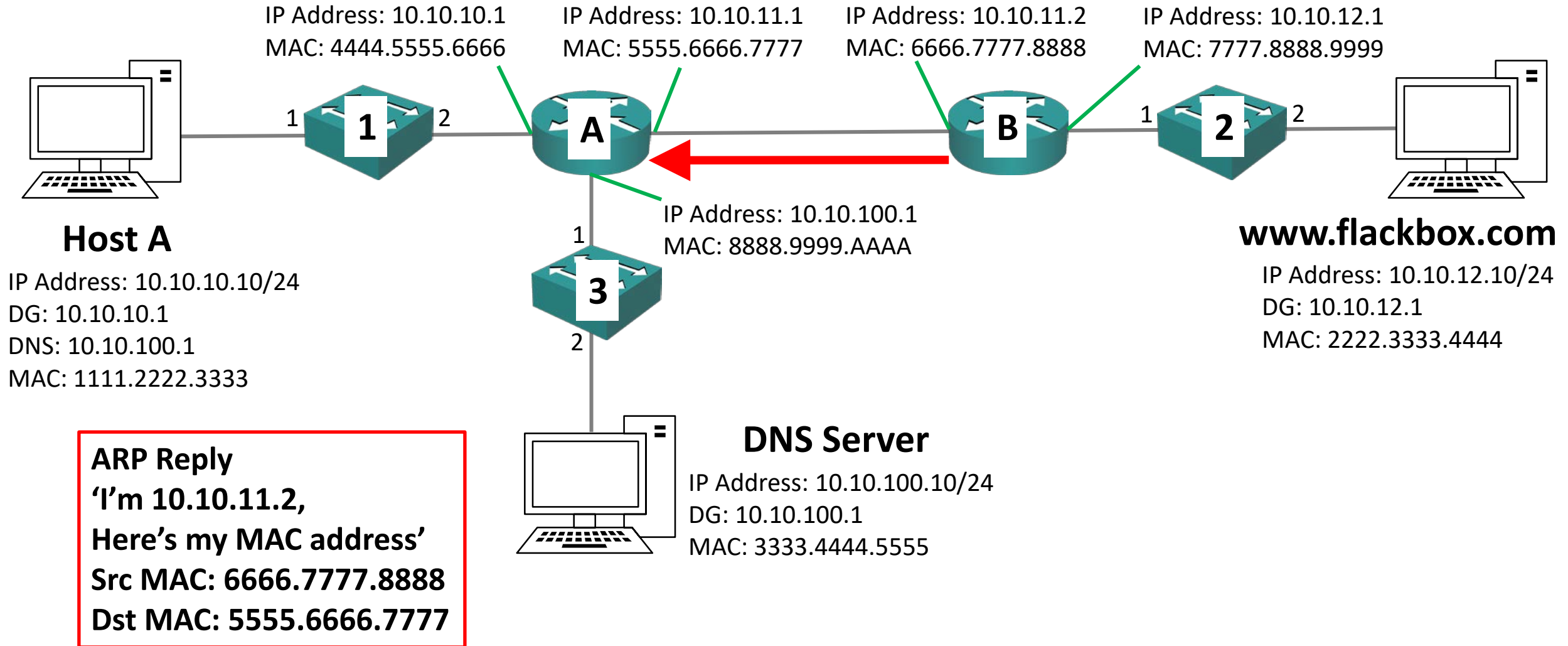


# The Life of a Packet



- The ARP request will hit Router B's interface 10.10.11.2
- Router B will process the ARP request and see it is for itself
- Router B will send a unicast ARP reply to Router A
- Router B will add an entry for Router A mapping IP address 10.10.11.1 to MAC address 5555.6666.7777 to its ARP cache

# The Life of a Packet

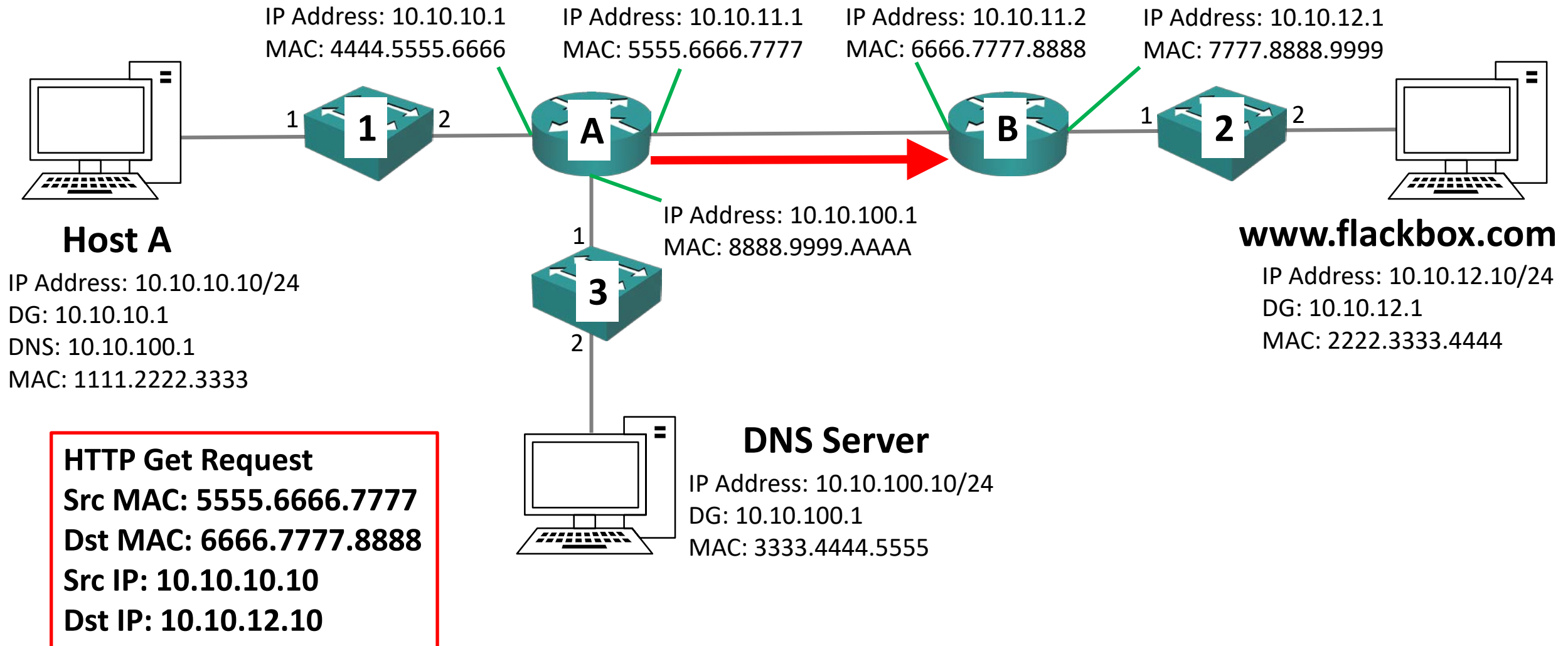


# The Life of a Packet



- Router A will forward the HTTP packet it was holding to Router B

# The Life of a Packet



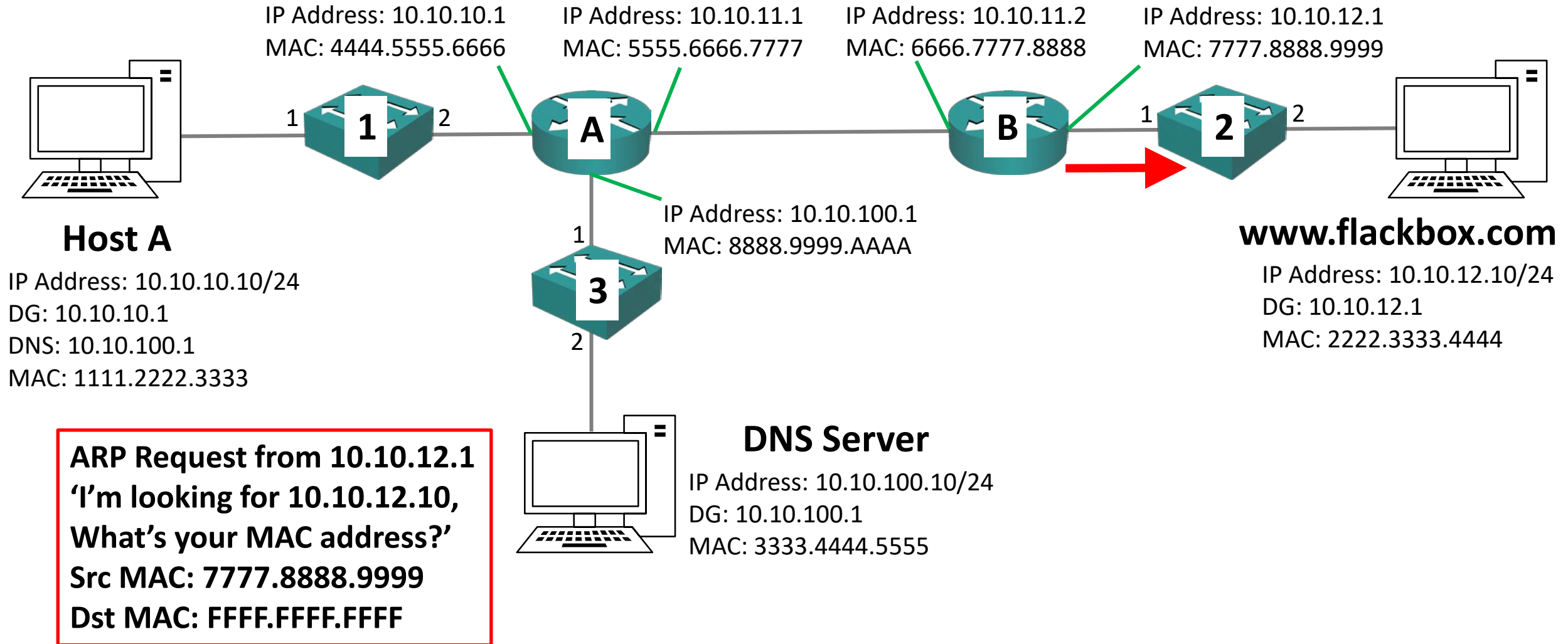
# The Life of a Packet



- Router B will receive the HTTP packet and see that the destination IP address is 10.10.12.10
- Router B has an interface in the subnet 10.10.12.0/24, so it knows the destination should be available out that port
- It doesn't know the MAC address of 10.10.12.10 so it will hold the HTTP packet and send an ARP request out of the 10.10.12.1 interface



# The Life of a Packet

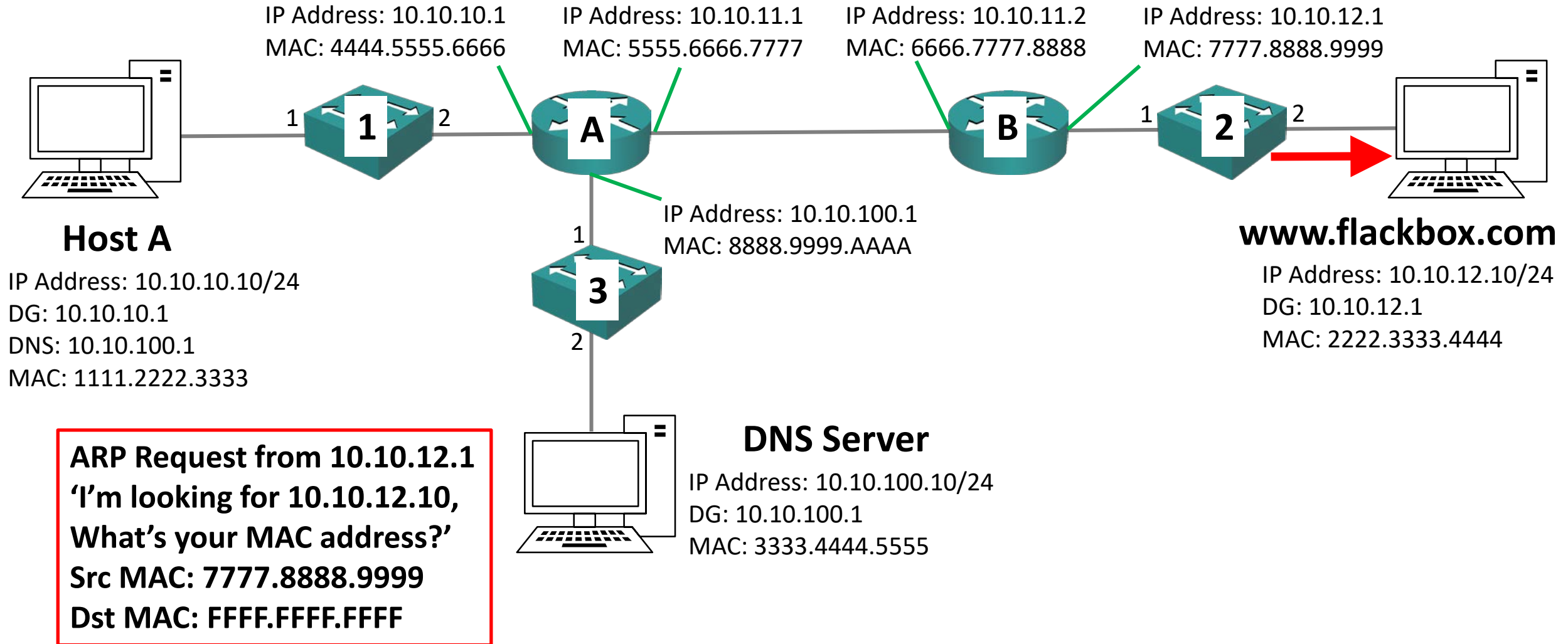


# The Life of a Packet



- The ARP request will be received by Switch 2
- Switch 2 will add an entry in its MAC address table mapping Router B's MAC address 7777.8888.9999 to Port 1
- Switch 2 will flood the broadcast traffic out all ports apart from the one it was received on

# The Life of a Packet

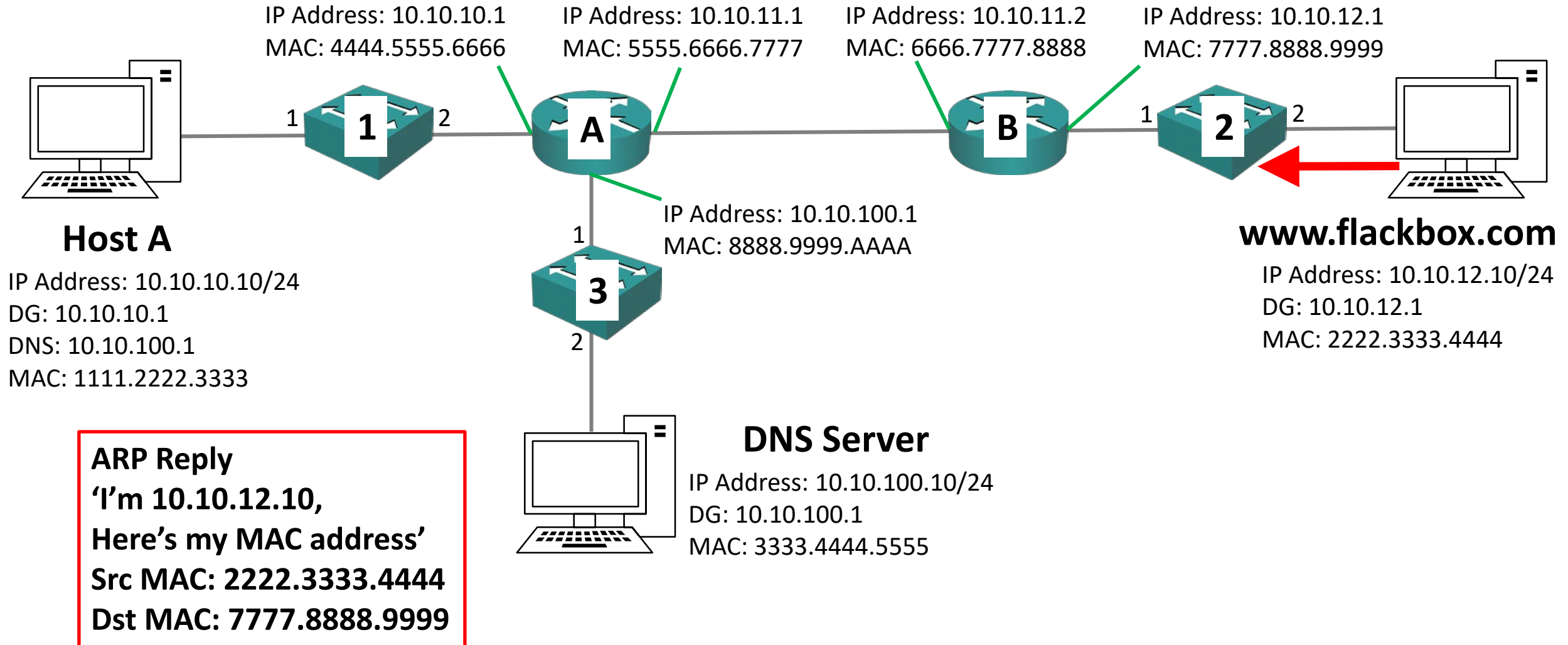


# The Life of a Packet



- The ARP request will hit the Web Server's interface 10.10.12.10
- The Web Server will process the ARP request and see it is for itself
- The Web Server will send a unicast ARP reply to Router B
- The Web Server will add an entry for Router B mapping IP address 10.10.12.1 to MAC address 7777.8888.9999 to its ARP cache
- It will use this whenever it needs to send traffic to another IP subnet

# The Life of a Packet

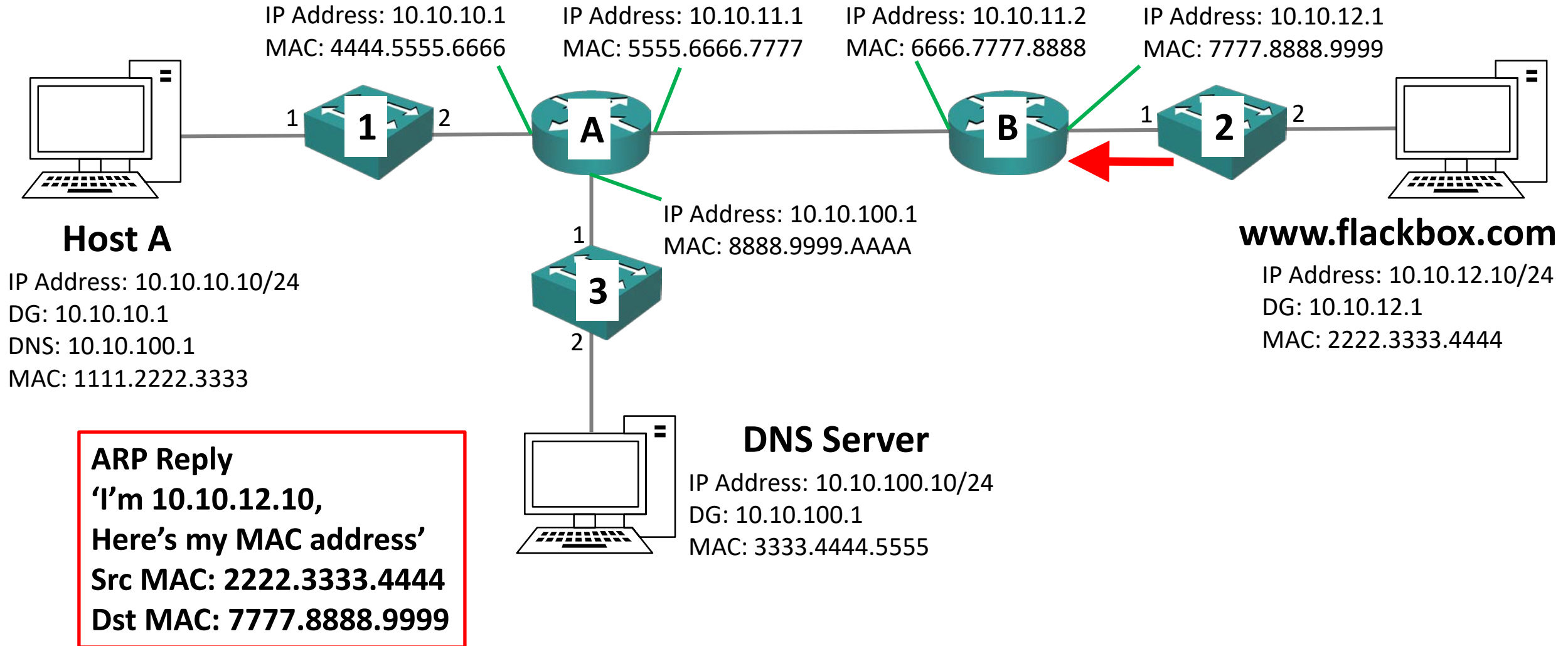


# The Life of a Packet



- Switch 2 will add an entry in its MAC address table mapping the Web Server's MAC address 2222.3333.4444 to Port 2
- Switch 2 will send the ARP reply out only Port 1 which Router B is plugged into (which it already has in its MAC address table)

# The Life of a Packet



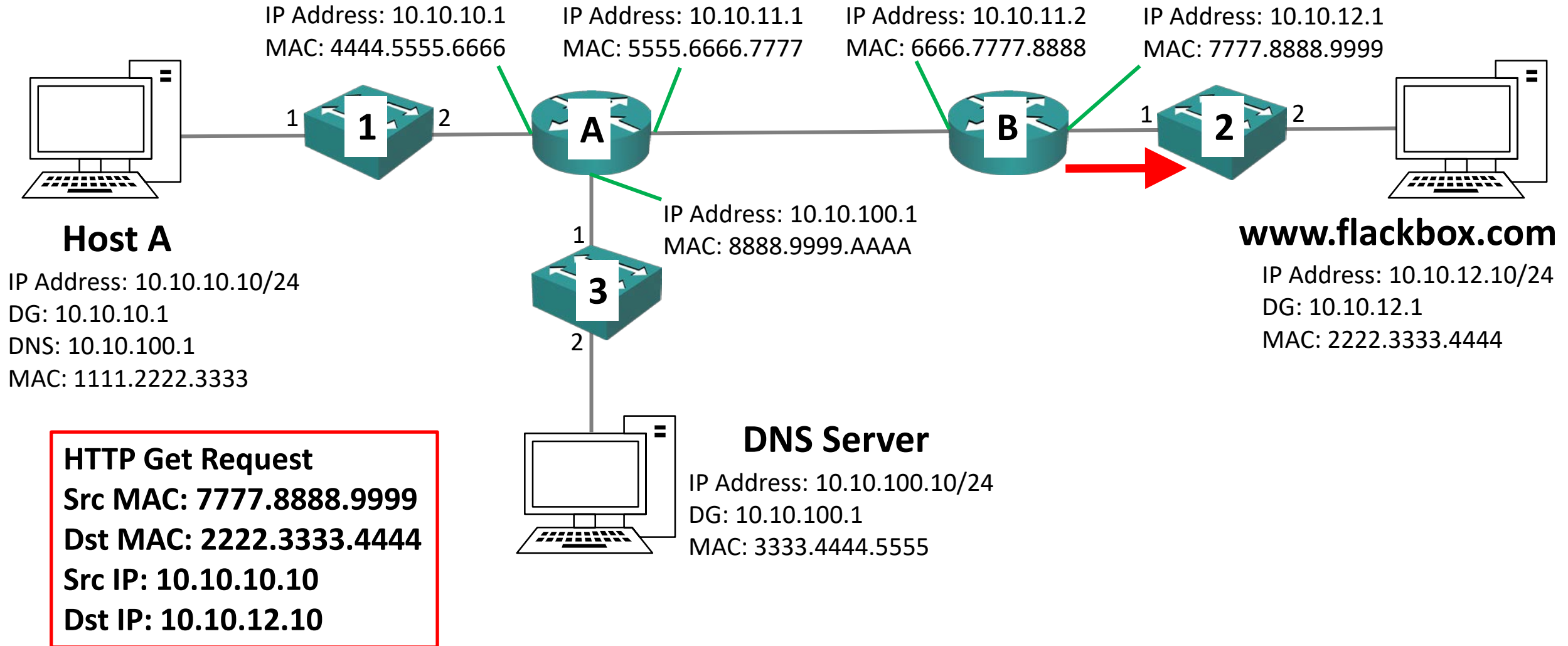
# The Life of a Packet



- Router B will add an entry for the Web Server mapping IP address 10.10.12.10 to MAC address 2222.3333.4444 to its ARP cache
- Router B will send the HTTP request it was holding to the Web Server



# The Life of a Packet

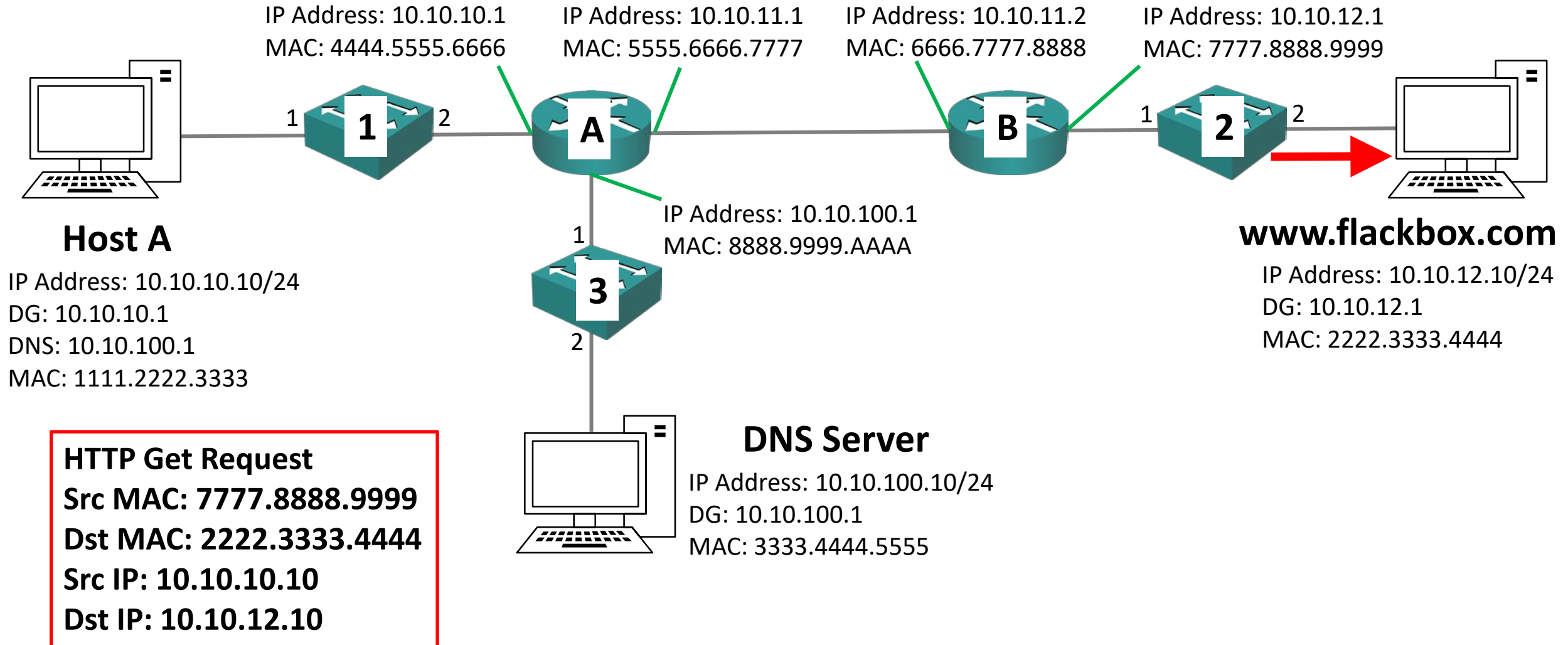


# The Life of a Packet

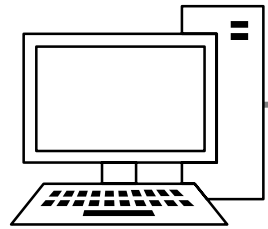


- Switch 2 will send the HTTP request out only Port 2 which the Web Server is plugged into (which it already has in its MAC address table)

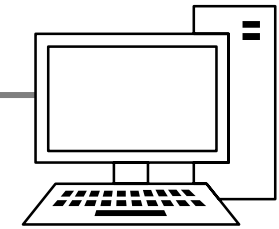
# The Life of a Packet



# OSI Reference Model – De-encapsulation



**Sender**

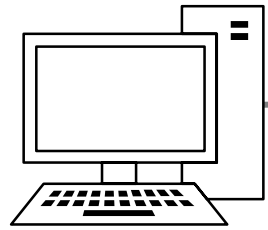


**Receiver**

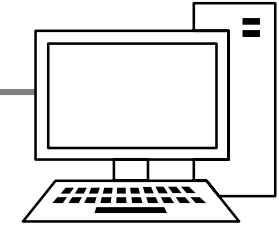
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	
2	Data-Link	
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

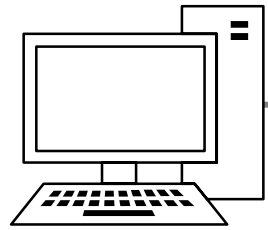


**Receiver**

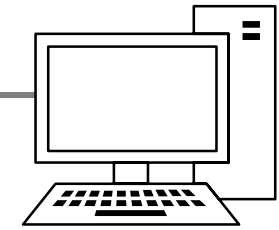
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	
2	Data-Link	Dst: 2222.3333.4444
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

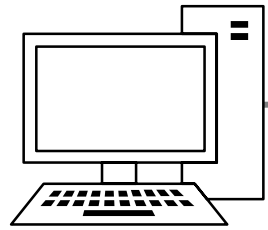


**Receiver**

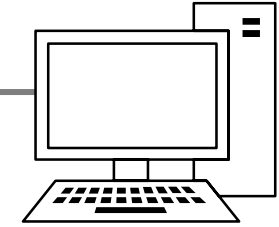
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 2222.3333.4444
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**

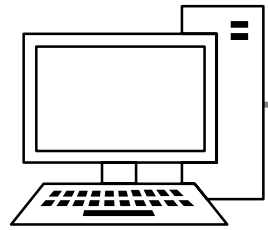


**Receiver**

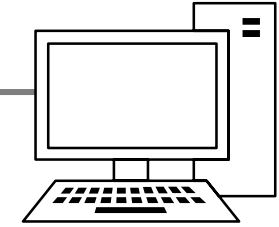
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP Port 80
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 2222.3333.4444
1	Physical	



# OSI Reference Model – De-encapsulation



**Sender**



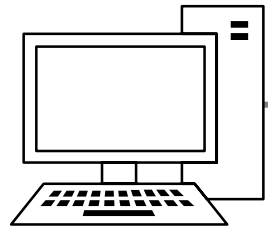
**Receiver**

Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP Port 80
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 2222.3333.4444
1	Physical	

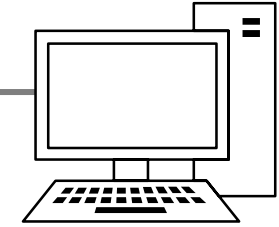




# OSI Reference Model – De-encapsulation



**Sender**



**Receiver**

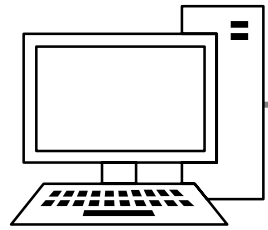
Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP Port 80
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 2222.3333.4444
1	Physical	



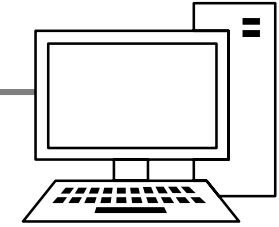
L6

L7

# OSI Reference Model – De-encapsulation



**Sender**



**Receiver**

Layer	Name	Includes
7	Application	
6	Presentation	
5	Session	
4	Transport	TCP Port 80
3	Network	Dst: 10.10.12.10
2	Data-Link	Dst: 2222.3333.4444
1	Physical	



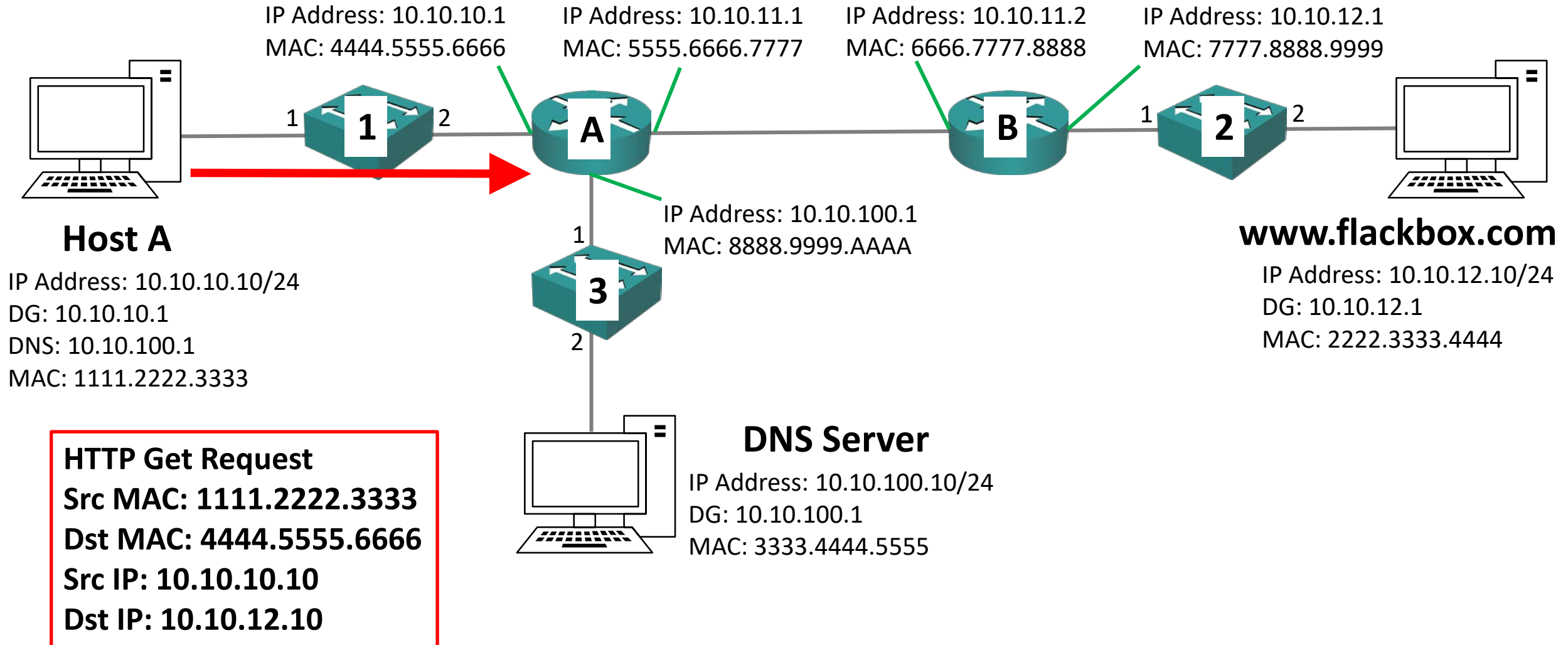
**L7**

# The Life of a Packet

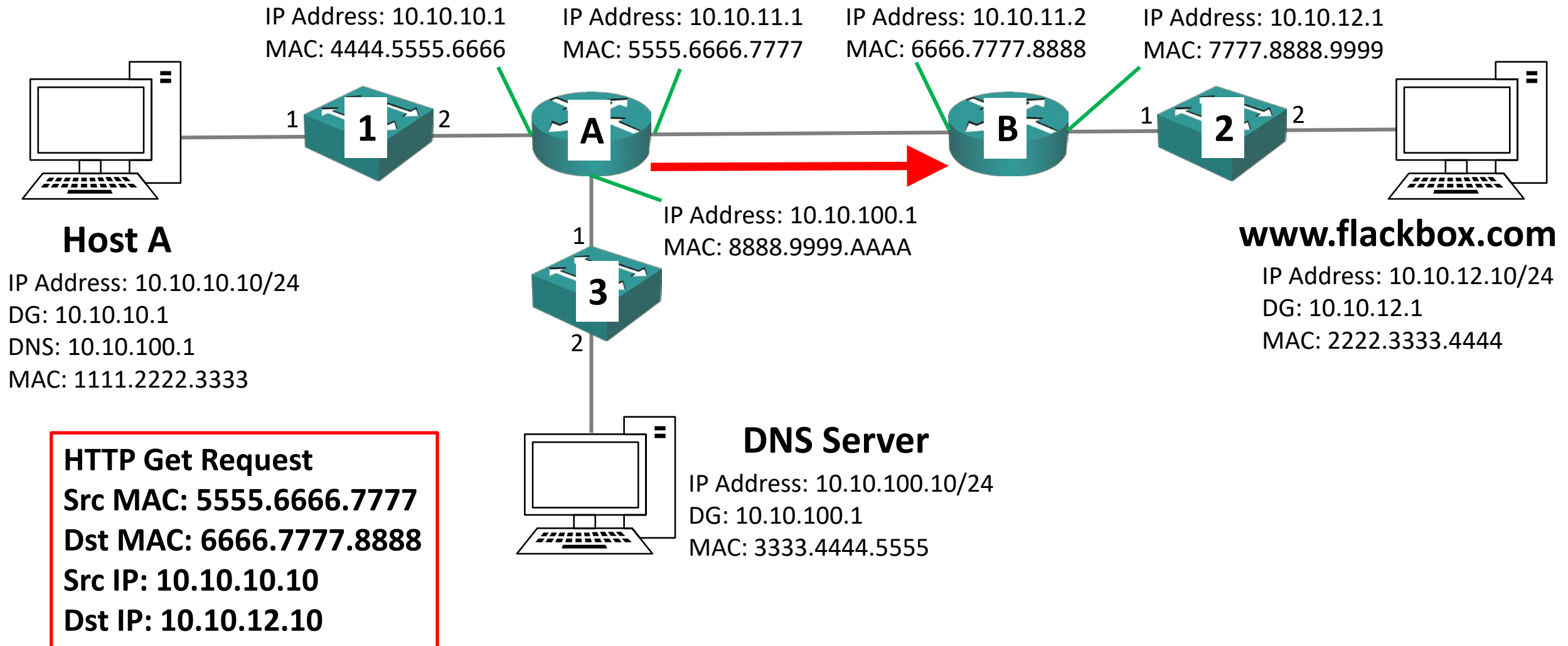


- The ARP and MAC addresses tables are already built so subsequent packets in either direction will flow without any need for ARP requests or switch flooding

# The Life of a Packet



# The Life of a Packet



# The Life of a Packet

