

CS2105 Introduction to Computer Networks

Lecture 12

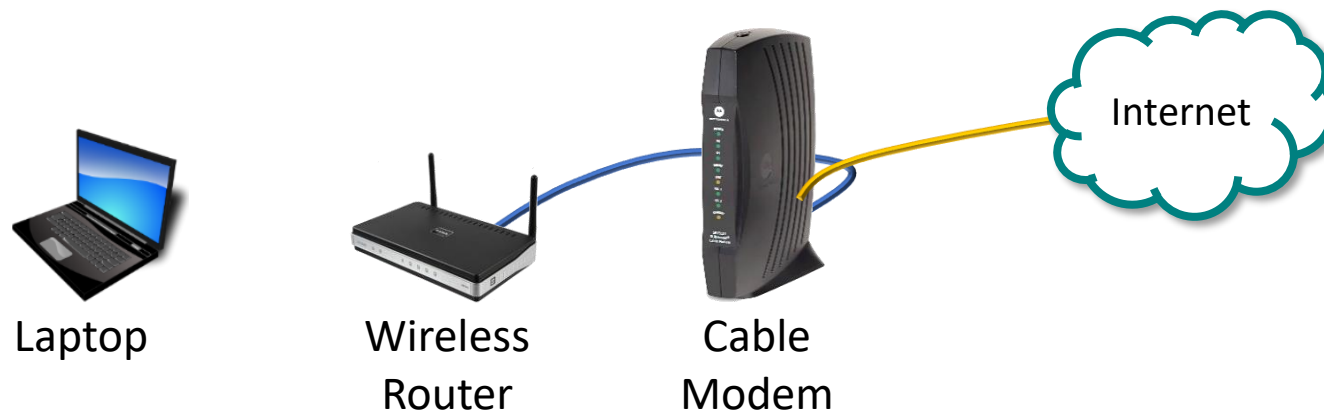
Putting Everything Together

12 November 2018

Scenario

1. Turn on modem
2. Turn on router
3. Turn on laptop
4. Visit facebook

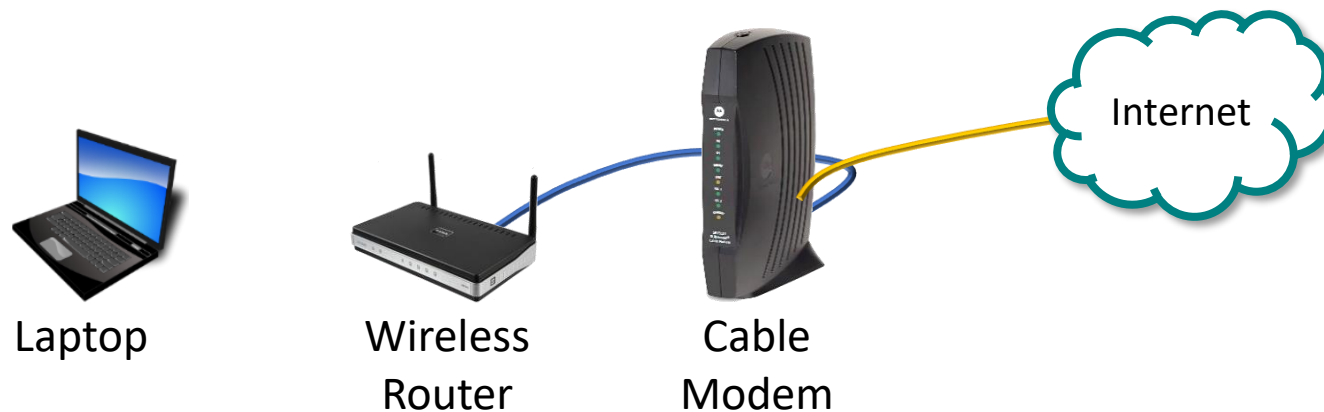
❖ The home network



Scenario

1. Turn on modem
2. Turn on router
3. Turn on laptop
4. Visit facebook

❖ The home network



1. Turn on Modem

- Modem:
M**OD**ulate/D**EM**odulate
between Digital & Analog
 - Example:
Manchester \leftrightarrow QAM/QPSK



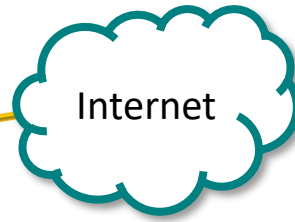
Laptop



Wireless
Router



Cable
Modem

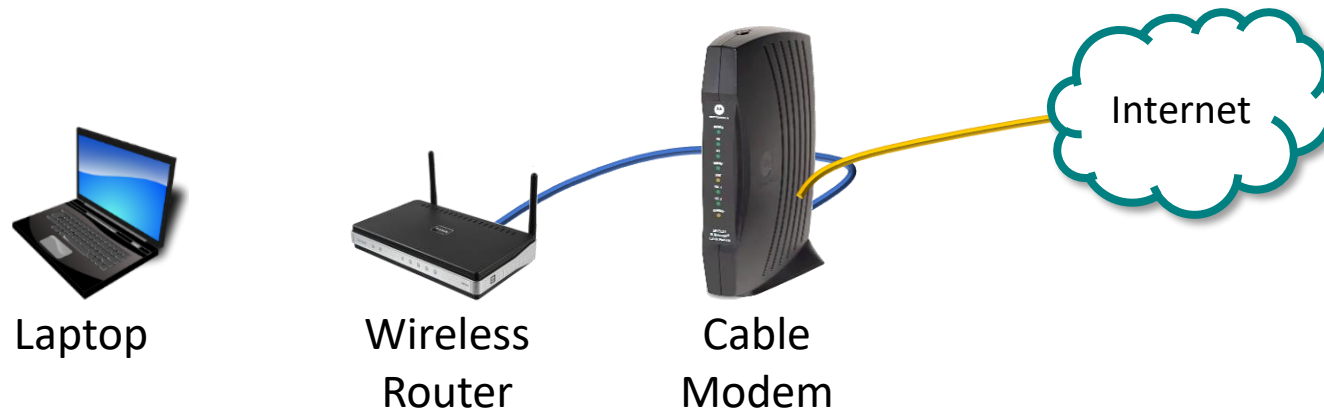


Internet

Scenario

1. Turn on modem
2. Turn on router
3. Turn on laptop
4. Visit facebook

❖ The home network



2. Turn on Router

- Router: Run DHCP

- Steps:

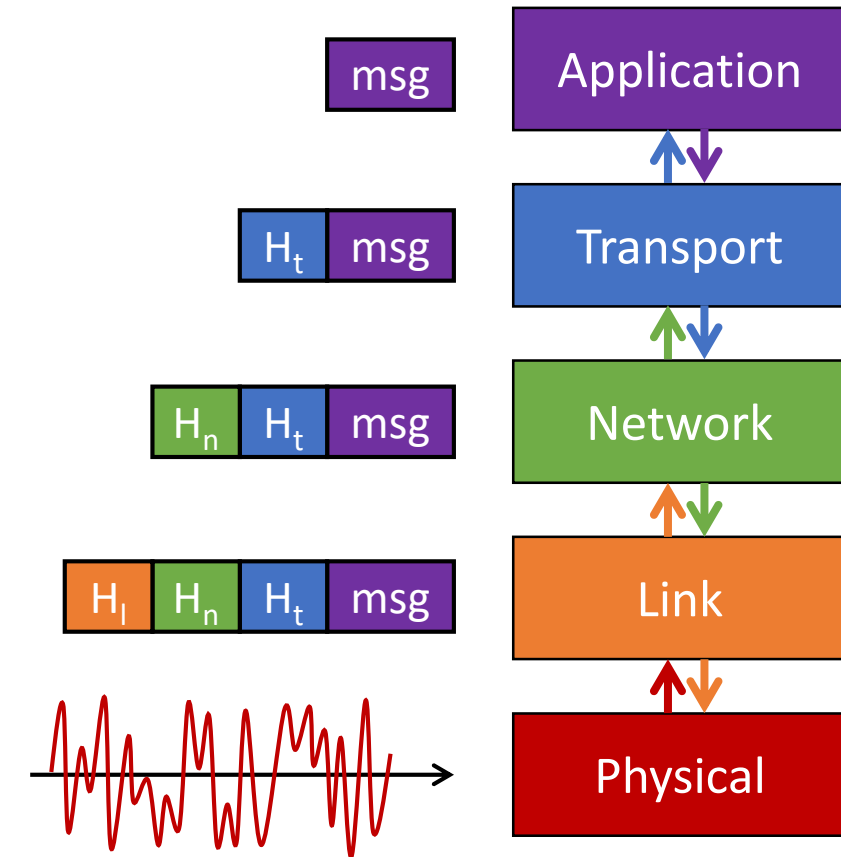
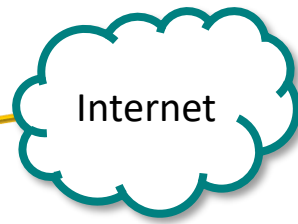
- DHCP Discover

- ← DHCP Offer

- DHCP Request

- ← DHCP ACK

- ❖ Layering



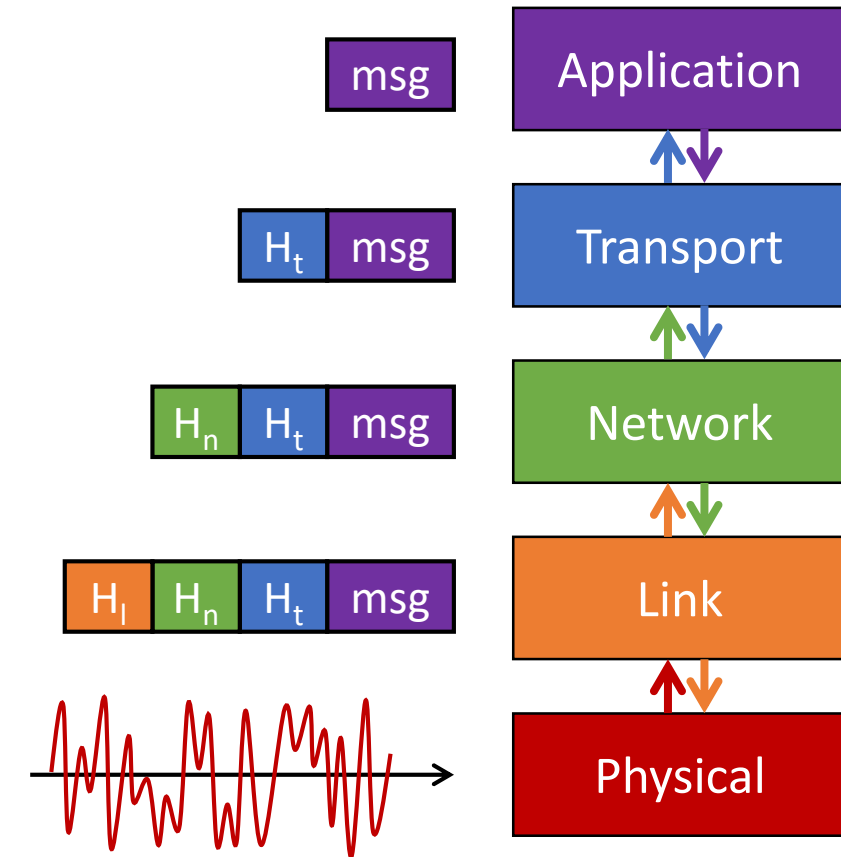
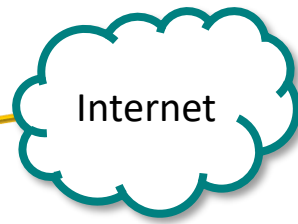
2. Turn on Router

→ DHCP Discover

- Create a DHCP Discover message

```
src: 0.0.0.0:68  
dst: 255.255.255.255:67  
yiaddr: 0.0.0.0  
transaction Id: 654
```

DHCP Discover



2. Turn on Router

→ DHCP Discover

- UDP Datagram



Laptop



Wireless
Router

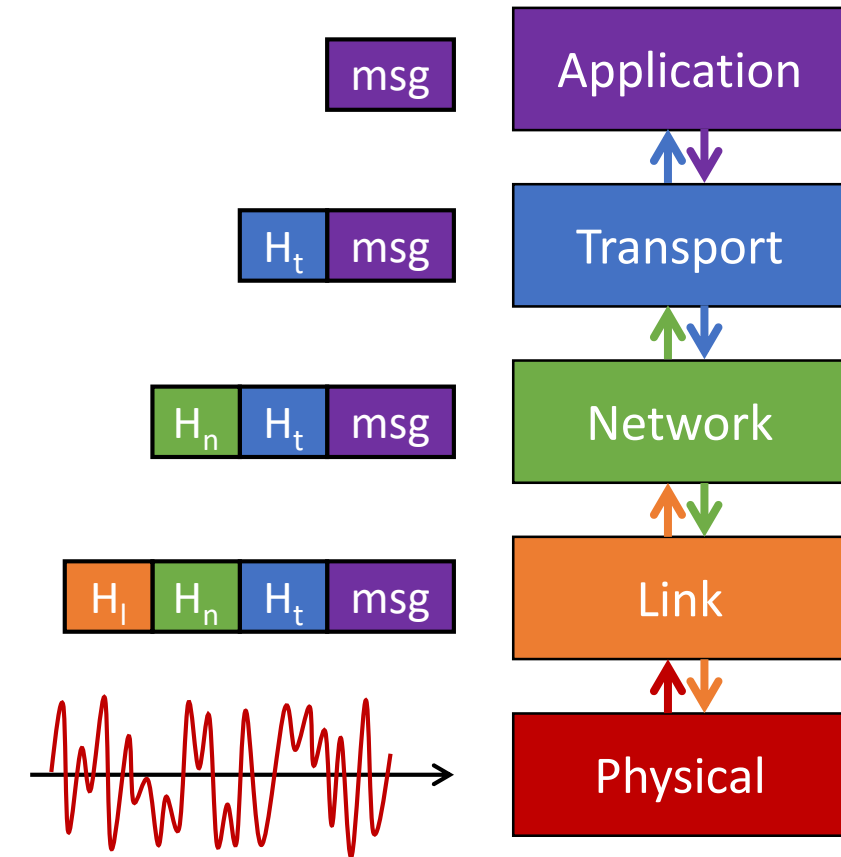


Cable
Modem



Internet

68	67
length	checksum
DHCP Discover	



2. Turn on Router

→ DHCP Discover

- IP Segment



Laptop



Wireless Router

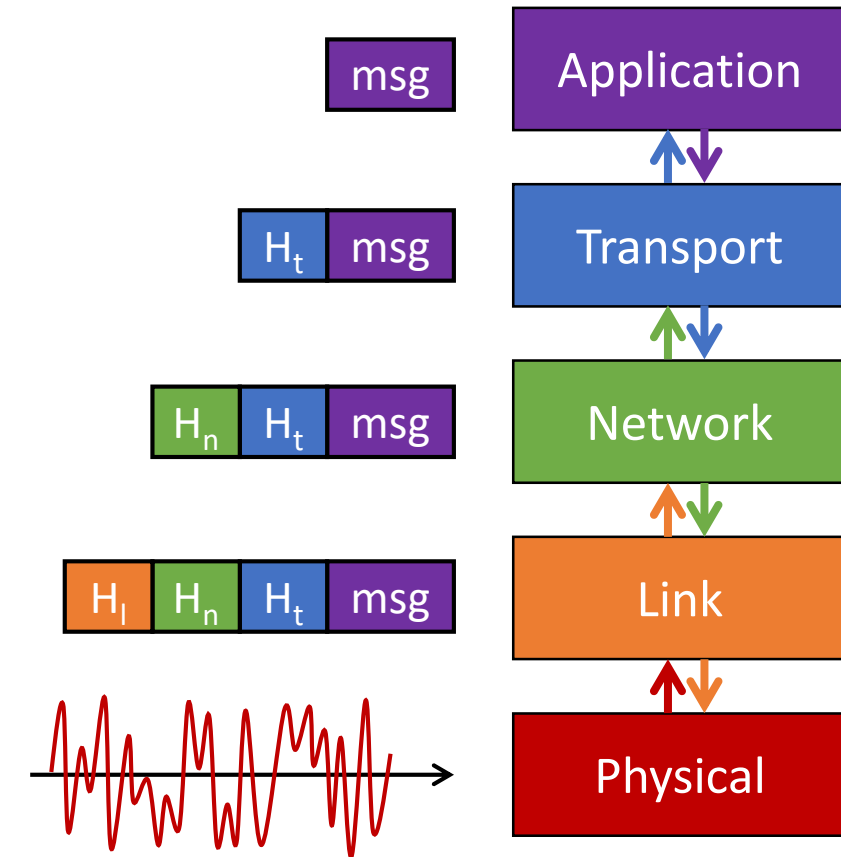


Cable Modem



Internet

ver	IHL	TOS	total length	
identification			flags	offset
TTL		UDP	header checksum	
0.0.0.0				
255.255.255.255				
68			67	
length			checksum	
DHCP Discover				



2. Turn on Router

→ DHCP Discover

- Ethernet Frame



Laptop



Wireless Router



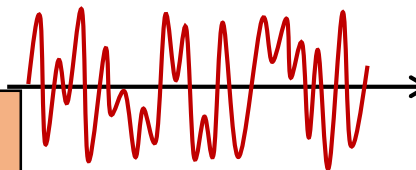
Cable Modem



Internet

ver	IHL	TOS	total length	
identification			flags	offset
TTL		UDP	header checksum	
0.0.0.0				
255.255.255.255				
68			67	
length			checksum	
DHCP Discover				

1010... ...1011	ff:ff:ff:ff:ff:ff	aa:bb:cc:dd:ee:ff	IP		CRC
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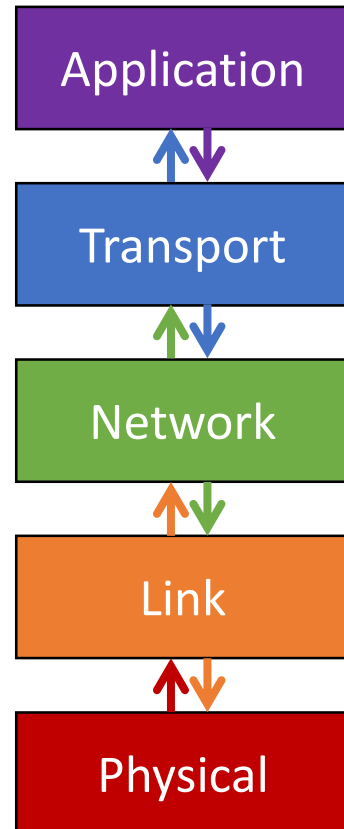


msg

H_t msg

H_n H_t msg

H_l H_n H_t msg



2. Turn on Router

→ DHCP Discover

- Physical Signal



Laptop



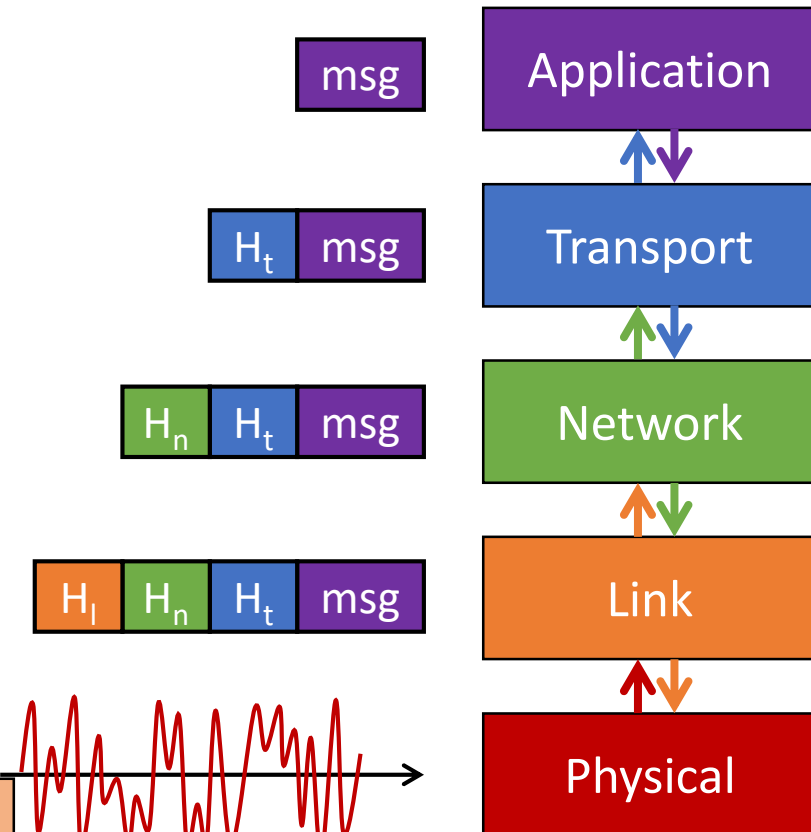
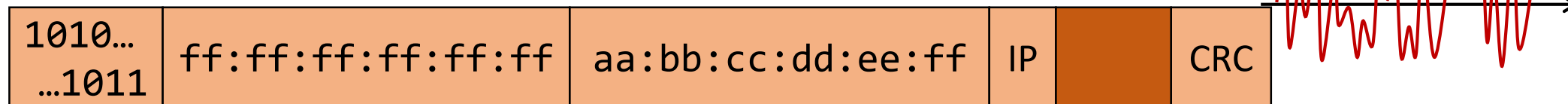
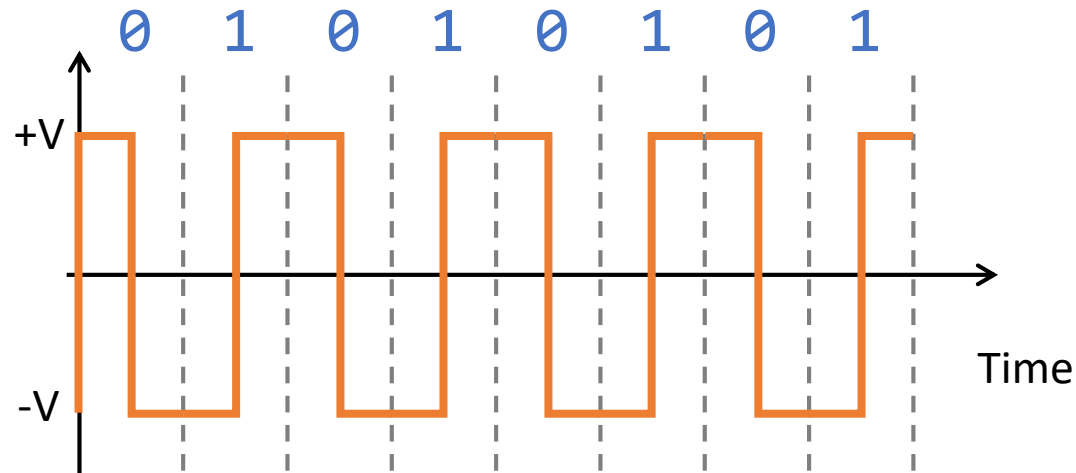
Wireless Router



Cable Modem



Internet



2. Turn on Router

← DHCP Offer

- DHCP Server responds with DHCP offer

src: 223.1.2.5:67
dst: 255.255.255.255:68
yiaddr: 223.1.2.4
transaction Id: 654
DHCP server: 223.1.2.5
Lifetime: 3600 secs



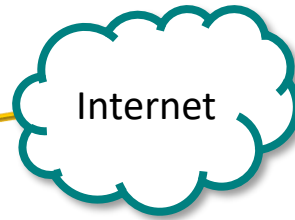
Laptop



Wireless
Router



Cable
Modem



Internet

1010... ...1011	ff:ff:ff:ff:ff:ff	ab:ab:ab:ab:ab:ab	IP		CRC
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2. Turn on Router

→ DHCP Request

- Broadcast selection from offers & send request

```
src: 0.0.0.0:68  
dst: 255.255.255.255:67  
yiaddr: 223.1.2.4  
transaction Id: 655  
DCHP server: 223.1.2.5  
Lifetime: 3600 secs
```



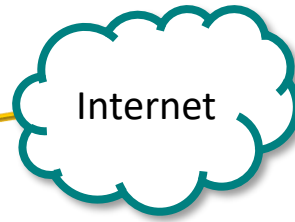
Laptop



Wireless
Router



Cable
Modem



Internet

1010... ...1011	ff:ff:ff:ff:ff:ff	aa:bb:cc:dd:ee:ff	IP		CRC
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2. Turn on Router

← DHCP ACK

- DHCP server confirms requested parameters

src: 223.1.2.5:67
dst: 255.255.255.255:68
yiaddr: 223.1.2.4
transaction Id: 655
DHCP server: 223.1.2.5
Lifetime: 3600 secs



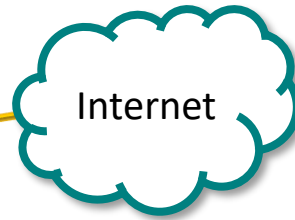
Laptop



Wireless
Router



Cable
Modem



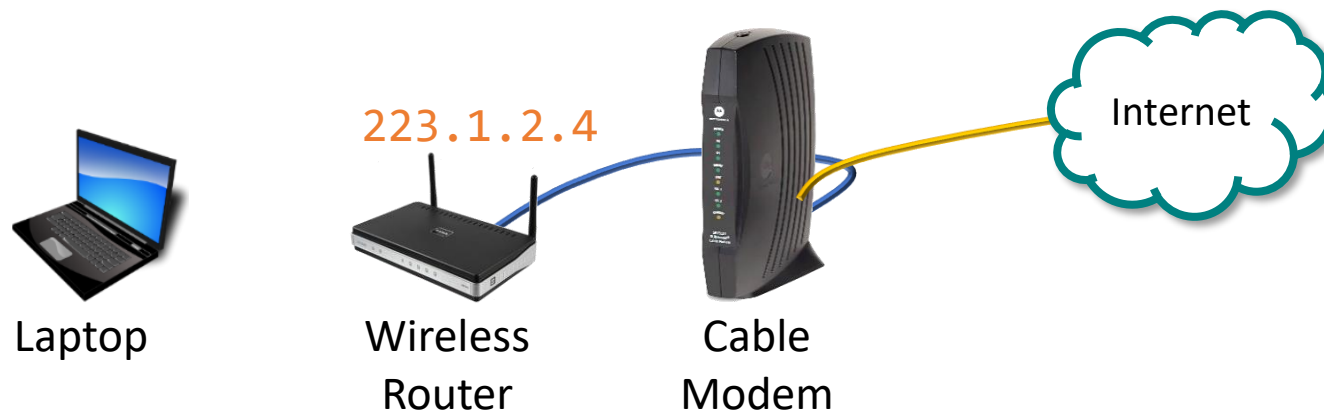
Internet

1010... ...1011	ff:ff:ff:ff:ff:ff	ab:ab:ab:ab:ab:ab	IP		CRC
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Scenario

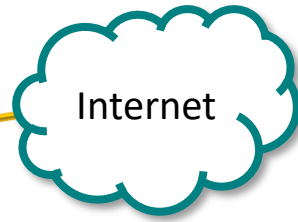
1. Turn on modem
2. Turn on router
3. Turn on laptop
4. Visit facebook

❖ The home network



3. Turn on Router

- Connect to Wi-Fi
 - Laptop runs DHCP client
 - Router runs DHCP server
 - Laptop obtains network configuration

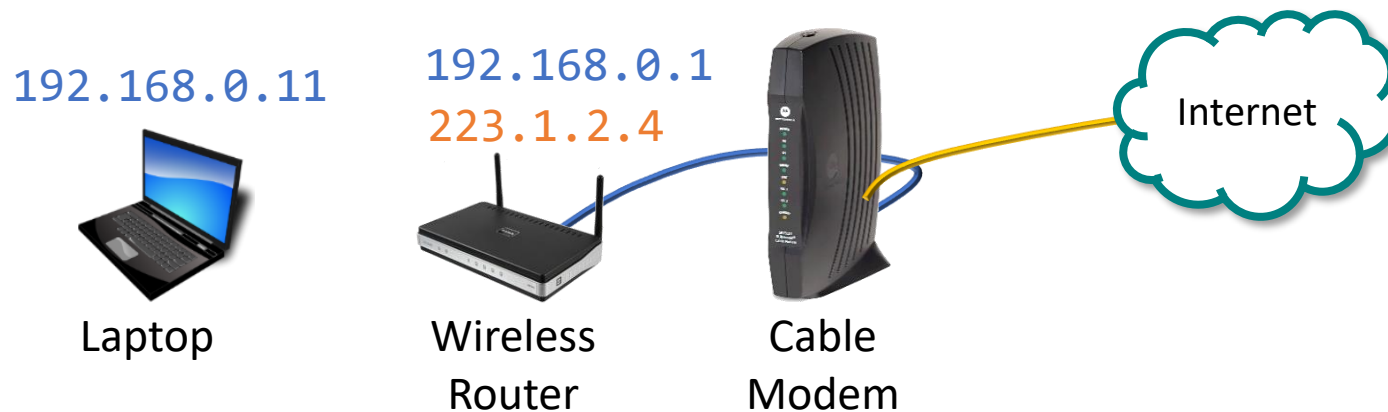


❖ Authentication and association with AP is not discussed here

Scenario

1. Turn on modem
2. Turn on router
3. Turn on laptop
4. Visit facebook

❖ The home network



4. Visit Facebook

- Type facebook address on web browser

192.168.0.11



Laptop

192.168.0.1
223.1.2.4

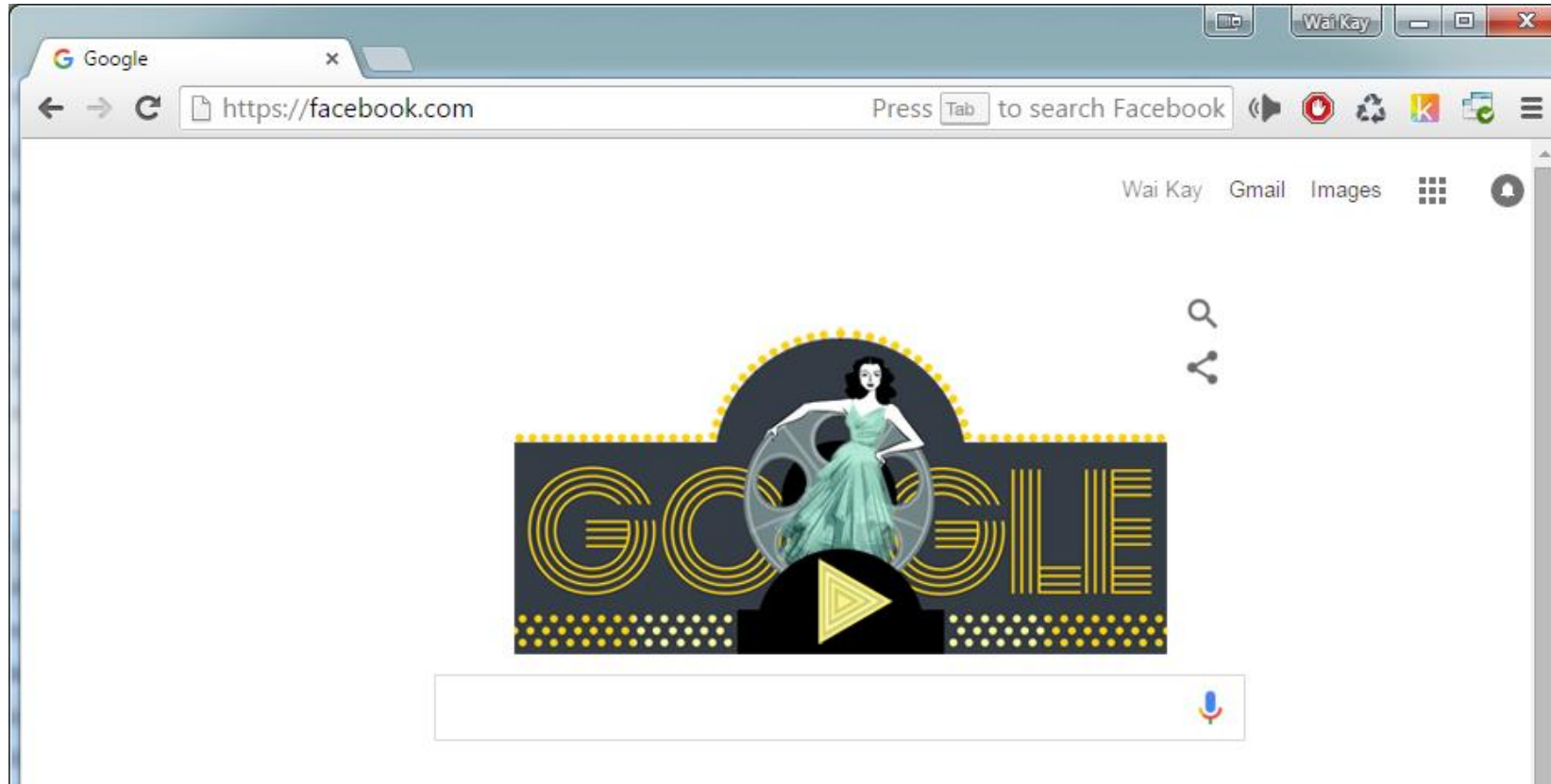


Wireless Router



Cable Modem

Internet



4. Visit Facebook

- Find the IP address
 - DNS Lookup

ver	IHL	TOS	total length	
identification			flags	offset
TTL		UDP	header checksum	
192.168.0.11				
202.156.1.16				
33705			53	
length			checksum	
DNS Query				

192.168.0.11



Laptop

192.168.0.1
223.1.2.4



Wireless Router



Cable Modem

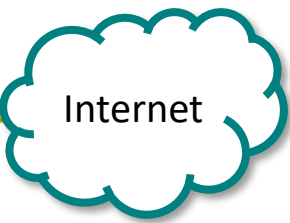
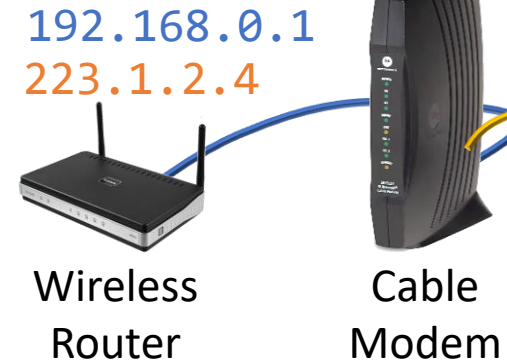


DNS Request



4. Visit Facebook

- Find the IP address
 - NAT

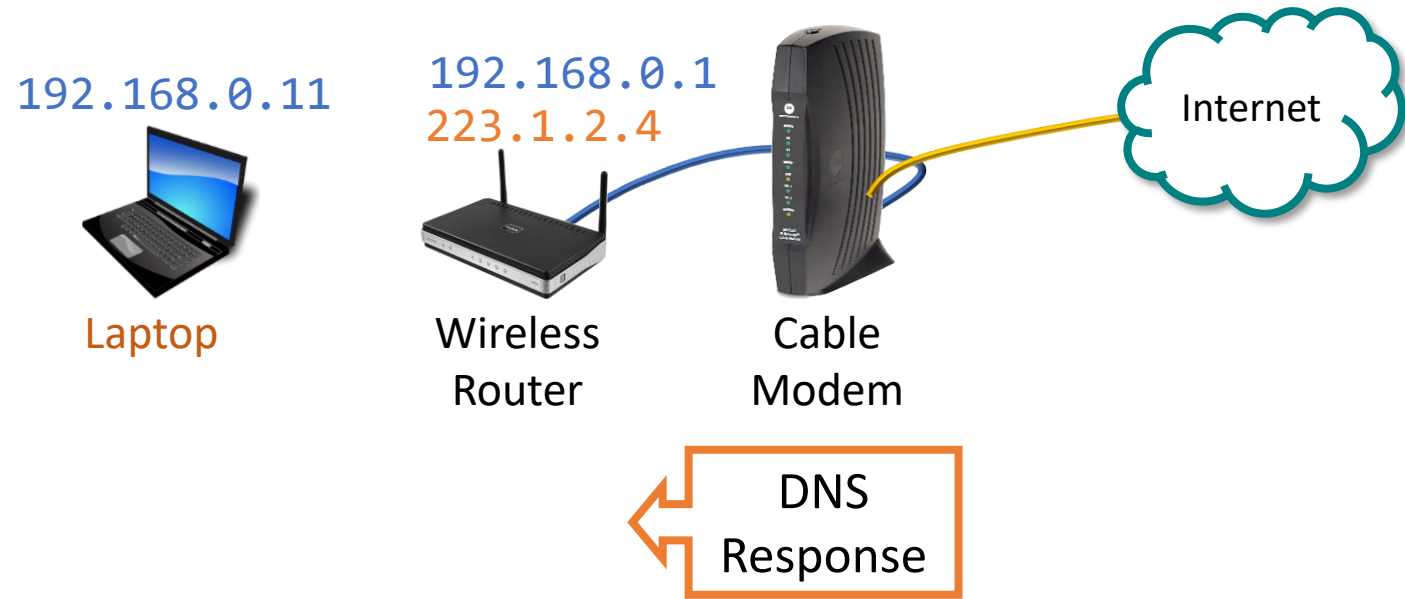


ver	IHL	TOS	total length	
identification			flags	offset
TTL		UDP	header checksum	
223.1.2.4				
202.156.1.16				
33705			53	
length			checksum	
DNS Query				



4. Visit Facebook

- Find the IP address
 - DNS Response



;; QUESTION SECTION:

;facebook.com. IN A

;; ANSWER SECTION:

facebook.com. 300 IN A 69.171.230.5

;; AUTHORITY SECTION:

facebook.com. 123208 IN NS a.ns.facebook.com.

facebook.com. 123208 IN NS b.ns.facebook.com.

4. Visit Facebook

- Initiates TCP Connection
 - HTTPS to port 443

ver	IHL	TOS	total length				
identification			flags		offset		
TTL		TCP	header checksum				
192.168.0.11							
69.171.230.5							
57312				443			
sequence number							
acknowledgement number							
offset						SYN	
checksum							

192.168.0.11



Laptop

192.168.0.1
223.1.2.4



Wireless
Router



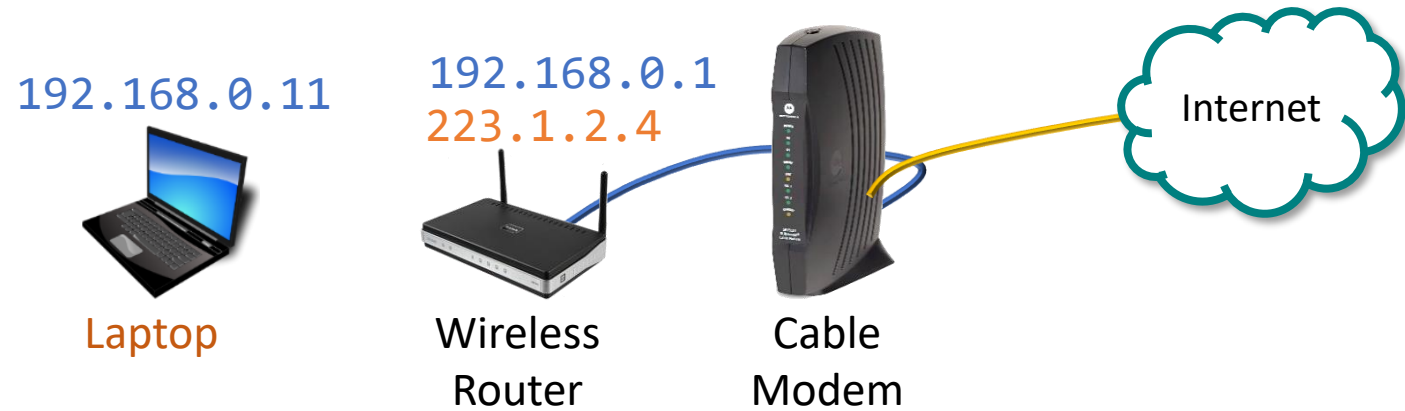
Cable
Modem



Internet

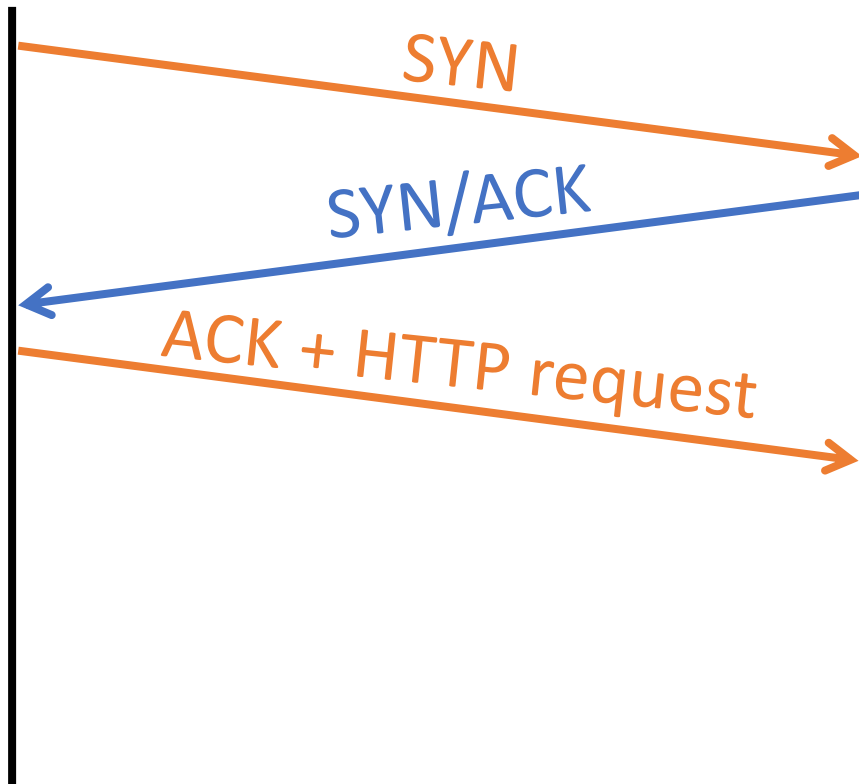
4. Visit Facebook

- Initiates TCP Connection
 - TCP 3-way Handshake



laptop

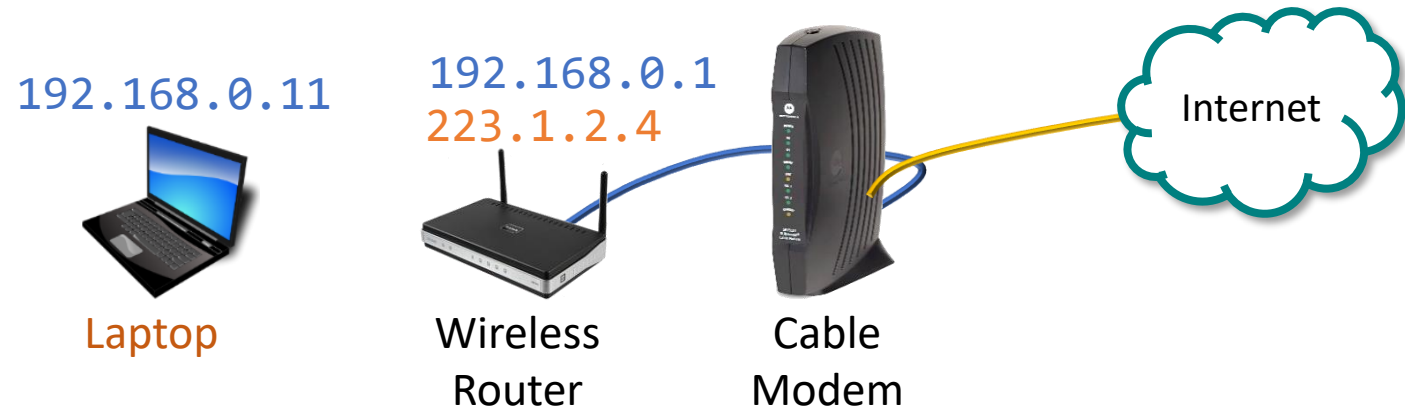
facebook



```
GET / HTTP/1.1
Host: facebook.com
User-Agent: Mozilla/5.0
Keep-Alive: 300
Connection: keep-alive
Cookie: __utma=145952555.278120873
```

4. Visit Facebook

- HTTP Response



HTTP/1.1 301 Moved Permanently

Location: https://www.facebook.com/?_rdr

Strict-Transport-Security: max-age=15552000; preload

X-FB-Stats-Contexts: www

X-FB-Stats-Contexts: V3

Vary: Accept-Encoding

Content-Type: text/html

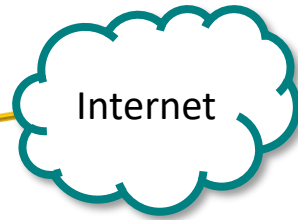
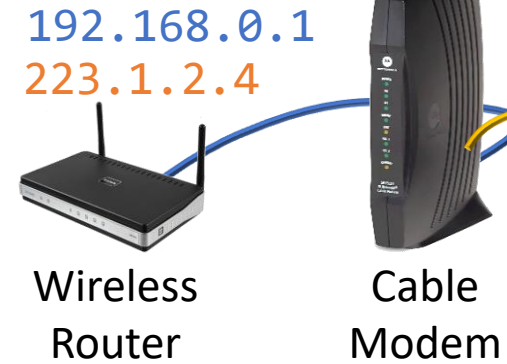
Date: Sun, 08 Nov 2015 16:00:02 GMT

Connection: keep-alive

Content-Length: 0

4. Visit Facebook

- New HTTP Request



```
* About to connect() to www.facebook.com port 443 (#0)
* Trying 31.13.79.220... connected
* successfully set certificate verify locations:
*   CAfile: none
*   Cpath: /etc/ssl/certs
* SSLv3, TLS handshake, Client hello (1):
* SSLv3, TLS handshake, Server hello (2):
* SSLv3, TLS handshake, CERT (11):
* SSLv3, TLS handshake, Server key exchange (12):
* SSLv3, TLS handshake, Server finished (14):
* SSLv3, TLS handshake, Client key exchange (16):
* SSLv3, TLS change cipher, Client hello (1):
* SSLv3, TLS handshake, Finished (20):
* SSLv3, TLS change cipher, Client hello (1):
* SSLv3, TLS handshake, Finished (20):
* SSL connection using ECDHE-ECDSA-AES128-SHA
* Server certificate:
*   subject: C=US; ST=CA; L=Menlo Park; O=Facebook, Inc.; CN=*.facebook.com
*   start date: 2014-08-28 00:00:00 GMT
*   expire date: 2015-12-31 12:00:00 GMT
*   subjectAltName: www.facebook.com matched
*   issuer: C=US; O=DigiCert Inc; OU=www.digicert.com; CN=DigiCert High Assurance CA-3
*   SSL certificate verify ok.
GET / HTTP/1.1
User-Agent: Mozilla/5.0 (Windows NT 6.1; WOW64) AppleWebKit/537.36 (KHTML, like Gecko) Chrome/46.0.2490.80
Safari/537.36
Host: www.facebook.com
```