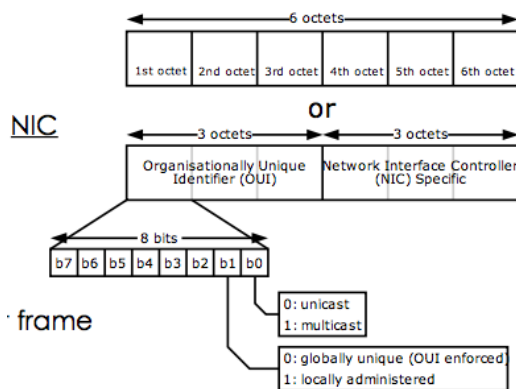


LAN = Local Area Network

Preamble	Start of Frame	MAC dest	MAC src	802.1Q tag [opt]	Type / Length	Payload	Checksum
7 byte	1 byte	6 byte	6 byte	4 byte	2 byte	42-1500 byte	4 byte

Ethernet Frame:

Address: ff:ff:ff:ff:ff:ff = broadcast frame



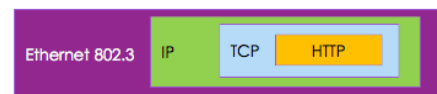
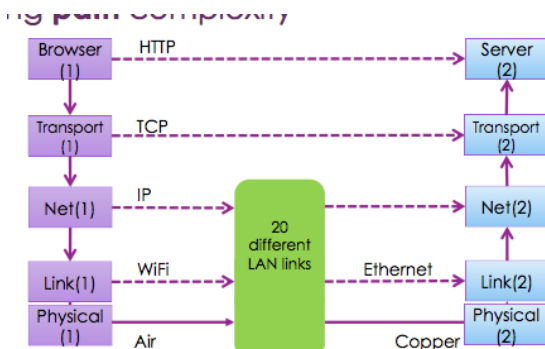
images

802.11 Frames

X Mb/s			Y Mb/s			
Preamble	Start Frame	PLCP	Header	Payload		Checksum
7/16 byte	1 byte	6 byte	30 byte	0-2312 byte		4 byte

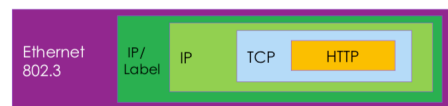
Frame Control	Duration/Connection	Addr 1	Addr 2	Addr 3	Seq Ctrl	Addr 4
2 byte	2 byte	6 byte	6 byte	6 byte	2 byte	6 byte

PLCP = Physical Link Convergence Protocol – (rate, checksum, length)



Preamble	Start of Frame	MAC dest	MAC src	802.1Q tag [opt]	Type / Length	Payload	Checksum
7 byte	1 byte	6 byte	6 byte	4 byte	2 byte	42-1500 byte	4 byte

Layer	Name	Function
10	Money	Actually decides what happens
9	Religion	Arguing for the sake of it
8	Politics	Stomps on what you'd like to do
7	Application	Deliver functionality
6	Presentation	Convert information for application needs
5	Session	Combine diverse communications, maintain state
4	Transport	Ensure end-to-end performance
3	Network	Send packets over multiple links
2	Link	Transmit Frames
1	Physical	Modulation and encoding of bits



7 notstat n

What's happening on my machine?

[illegible][illegible]

ARP cache

- Dynamic
 - Learned
- Static
 - Configured
- 2 interfaces
 - WiFi, Ethernet
- 192.168.178/24 subnet
- Some special addresses

```

C:\Users\User>arp -a

Interface: 192.168.178.47 --- 0x7
Internet Address      Physical Address      Type
192.168.178.1         38-10-d5-bc-be-99    dynamic
192.168.178.32        e8-5b-5b-64-13-62    dynamic
192.168.178.35        1c-1b-bd-72-01-52    dynamic
192.168.178.38        b8-ca-3a-e2-5b-6f    dynamic
192.168.178.39        f0-bf-97-9c-84-7e    dynamic
192.168.178.44        00-13-32-64-08-d9    dynamic
192.168.178.50        00-19-1e-b8-02-87    dynamic
192.168.178.63        3c-bd-d8-26-f7-ac    dynamic
192.168.178.255       ff-ff-ff-ff-ff-ff    static
224.0.0.22            01-00-5e-00-00-16    static
224.0.0.251           01-00-5e-00-00-fb    static
224.0.0.252           01-00-5e-00-00-fc    static
224.0.0.1             01-00-5e-00-00-01    static
239.255.255.250       01-00-5e-7f-ff-fa    static
255.255.255.255       ff-ff-ff-ff-ff-ff    static

Interface: 169.254.164.48 --- 0x0
Internet Address      Physical Address      Type
169.254.255.255       ff-ff-ff-ff-ff-ff    static
224.0.0.22            01-00-5e-00-00-16    static
224.0.0.251           01-00-5e-00-00-fb    static
224.0.0.252           01-00-5e-00-00-fc    static
224.0.0.1             01-00-5e-00-00-01    static
239.255.255.250       01-00-5e-7f-ff-fa    static
255.255.255.255       ff-ff-ff-ff-ff-ff    static
    
```

My Forwarding table

- Lots of interfaces
- Default route
 - My router
- LAN route
 - 192.168.178/24
 - My subnet
 - All "On-link"
- All learned routes
 - No static or "persistent" routes

```

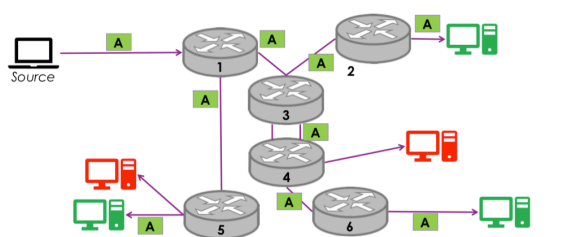
C:\Users\User>netstat -r

=====
Interface List
24...00 50 b6 67 be bf .....USB Giga Ethernet
22...00 ff db e1 48 f8 .....Speedify Virtual Adapter
15...02 00 4c 4f 4f 50 .....Hicap Loopback Adapter
9...7c 7a 91 75 36 46 .....Microsoft Wi-Fi Direct Virtual Adapter #5
19...7e 7a 91 75 36 45 .....Microsoft Wi-Fi Direct Virtual Adapter #6
6...7c 7a 91 75 36 49 .....Bluetooth Device (Personal Area Network) #2
7...7c 7a 91 75 36 45 .....Intel(R) Wireless-N 7260
1.....Software Loopback Interface 1

=====
IPv4 Route Table

=====
Active Routes:
Network Destination        Netmask          Gateway          Interface        Metric
0.0.0.0                    0.0.0.0          192.168.178.1    192.168.178.34    25
127.0.0.1                  255.255.255.255  On-link         127.0.0.1         331
169.254.0.0                255.255.0.0     On-link         169.254.164.48    281
192.168.178.0              255.255.255.0   On-link         192.168.178.34    281
192.168.178.255            255.255.255.255 On-link         192.168.178.34    281
224.0.0.0                  240.0.0.0       On-link         127.0.0.1         331
[...]
```

IP Multicast



Packets sent to **all green** subscribers (224/8)
- sender sends once

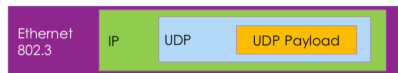
Internet Group Membership Protocol (IGMP)

IP Fragmentation

0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
Version		IHL		Diff. Serv.				ECN		Total Length																					
Identification														D F		M F		Fragment Offset													
Time to Live				Protocol				Header Checksum																							
Source Address																															
Destination Address																															
Options (0 or more words)																															
Payload (...)																															

- Identification = key to identify a packet uniquely
- MF = More Fragments (flag)
- DF = Don't Fragment (flag)
- Total Length = of **this** packet
- Fragment Offset = position within original

UDP



Source Port	Destination Port
Length	Checksum
Payload (...)	

- UDP adds to IP: Ports, payload length and a Checksum
- And nothing else...

TCP segment format

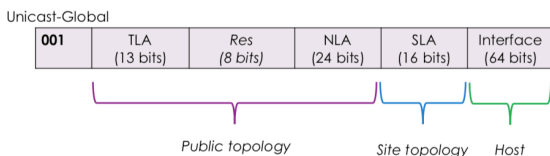
Source port	Destination Port
Sequence Number	
Acknowledgement Number	
Window Size	
Checksum	
Urgent Pointer	
Options (0 or more)	
Payload (optional...)	

Performance Acknowledgement Start&Stop

IPv6 packets

Version	Traffic class	Flow label
Payload length		Next Header
Source Address		Hop Limit
(128-bit)		
Destination Address		
(128-bit)		
Payload (...)		

IPv6 address semantics – 1 example



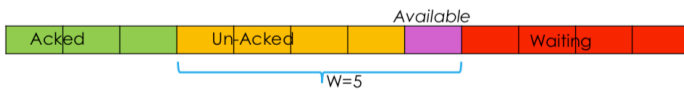
TLA: Top level aggregator – IANA-> global ISP
NLA: Next level aggregator – global ISP->site
SLA: Site level aggregator – site->subnets

Res: reserved

Sliding Window approach

Sender buffers up W segments until they are ACKed

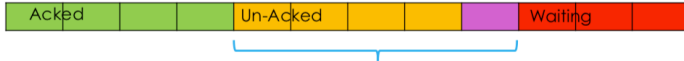
→ Seq#



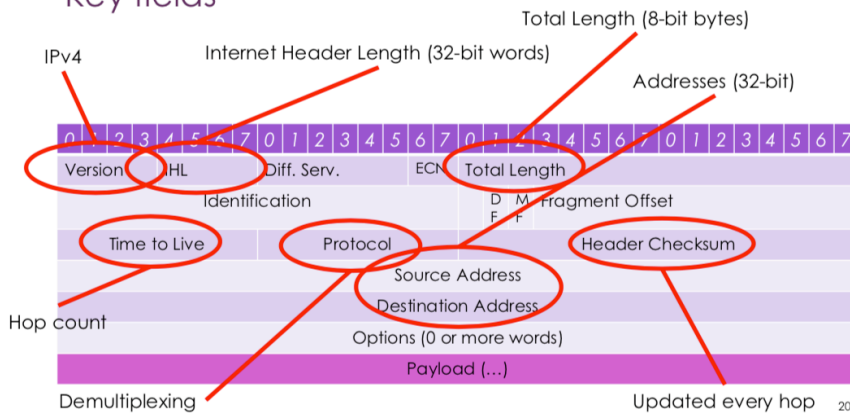
Window not full, so send a packet



Packet ACKed, so Window not full

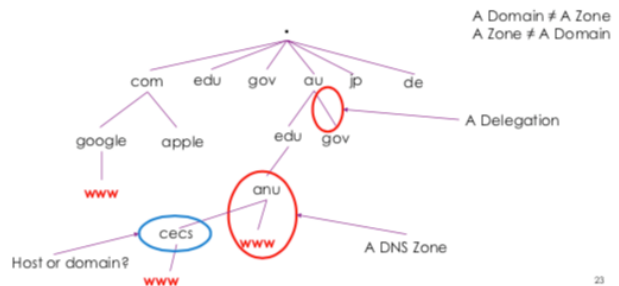
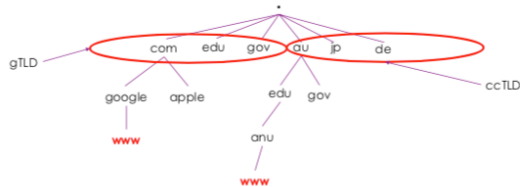


Key fields



Back to tech!

Typical DNS hierarchy view



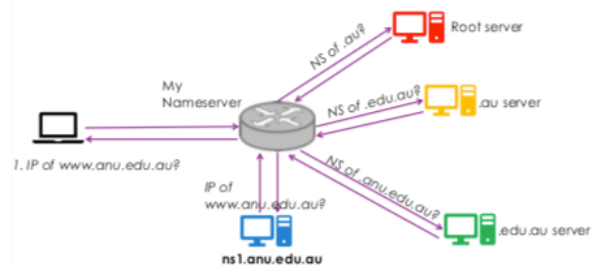
23

Zone example

• ANU examples:

1. `anu.edu.au.` 35619 IN SOA `ns1.anu.edu.au. hostmaster.anu.edu.au. 2019032016 3600 1800 1800000 36000`
2. `anu.edu.au.` 150 IN MX 10 `mail.anu.edu.au.`
3. `www.anu.edu.au.` 130 IN CNAME `gaia-proxy.anu.edu.au.`
4. `gaia-proxy.anu.edu.au.` 132 IN A 130.56.66.152

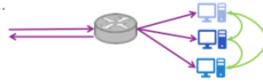
Resolving down the tree



24

Nameserver replication

- When one authoritative nameserver isn't enough...



- Register multiple nameservers
 - Spread the load, and the risk

- Client picks one

```
- anu.edu.au.      29112  IN    NS    ns1.anu.edu.au.
- anu.edu.au.      29112  IN    NS    ns.adelaide.edu.au.
- anu.edu.au.      29112  IN    NS    una.anu.edu.au.
```

- **Zone transfers** – master/slave replication
 - Another type of DNS query/response

ANU returns the favour...?

```
* adelaide.edu.au.      85674  IN    NS    ns2.adelaide.edu.au.
* adelaide.edu.au.      85674  IN    NS    authdns2.netcom.duke.edu.
* adelaide.edu.au.      85674  IN    NS    authdns1.netcom.duke.edu.
* adelaide.edu.au.      85674  IN    NS    authdns3.netcom.duke.edu.
* adelaide.edu.au.      85674  IN    NS    ns1.adelaide.edu.au.
* adelaide.edu.au.      85674  IN    NS    authdns4.netcom.duke.edu.
* adelaide.edu.au.      85674  IN    NS    ns.adelaide.edu.au.
* adelaide.edu.au.      85674  IN    NS    ns1.anu.edu.au.
```