

A brief introduction to networking and the Internet

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About me

- Software Developer by trade... so a novice to networking and hardware
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What this presentation is about

- Short overview of the history of the Internet and its precursors
- Introduction of key concepts behind how your home network works
- And then what happens after you leave your home network

What I am punting on

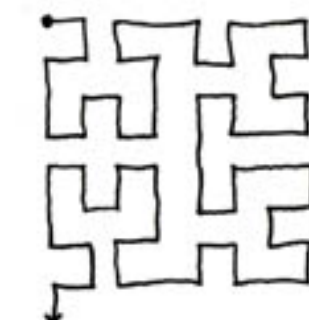
- This won't qualify you earn the CCNA or be an expert in any other way
- I am avoiding most of IPV6... the principles remain the same anyway

A brief history of networking and the internet



THIS CHART SHOWS THE IP ADDRESS SPACE ON A PLANE USING A FRACTAL MAPPING WHICH PRESERVES GROUPING--ANY CONSECUTIVE STRING OF IP_s WILL TRANSLATE TO A SINGLE COMPACT, CONTIGUOUS REGION ON THE MAP. EACH OF THE 256 NUMBERED BLOCKS REPRESENTS ONE /8 SUBNET (CONTAINING ALL IP_s THAT START WITH THAT NUMBER). THE UPPER LEFT SECTION SHOWS THE BLOCKS SOLD DIRECTLY TO CORPORATIONS AND GOVERNMENTS IN THE 1990's BEFORE THE RIRs TOOK OVER ALLOCATION.

0 1 14 15 16 19 →
3 2 13 12 17 18
4 7 8 11
5 6 9 10

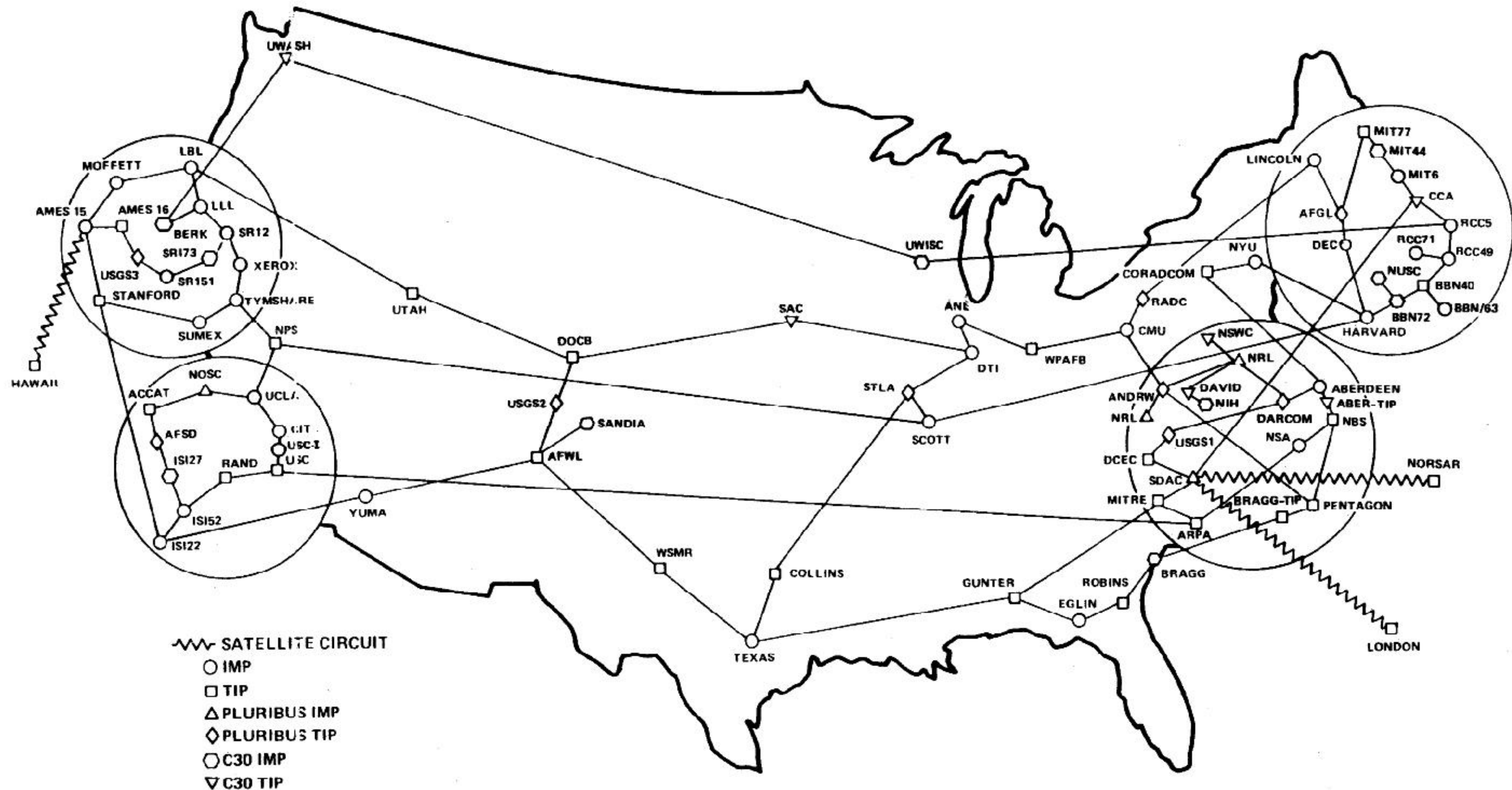


= UNALLOCATED BLOCK

Early networks

- 1950s-Packet Networks Developed
- 1960s-ARPANET
- Late '60s early '70s Switched networks all around

ARPANET GEOGRAPHIC MAP, AUGUST 1981



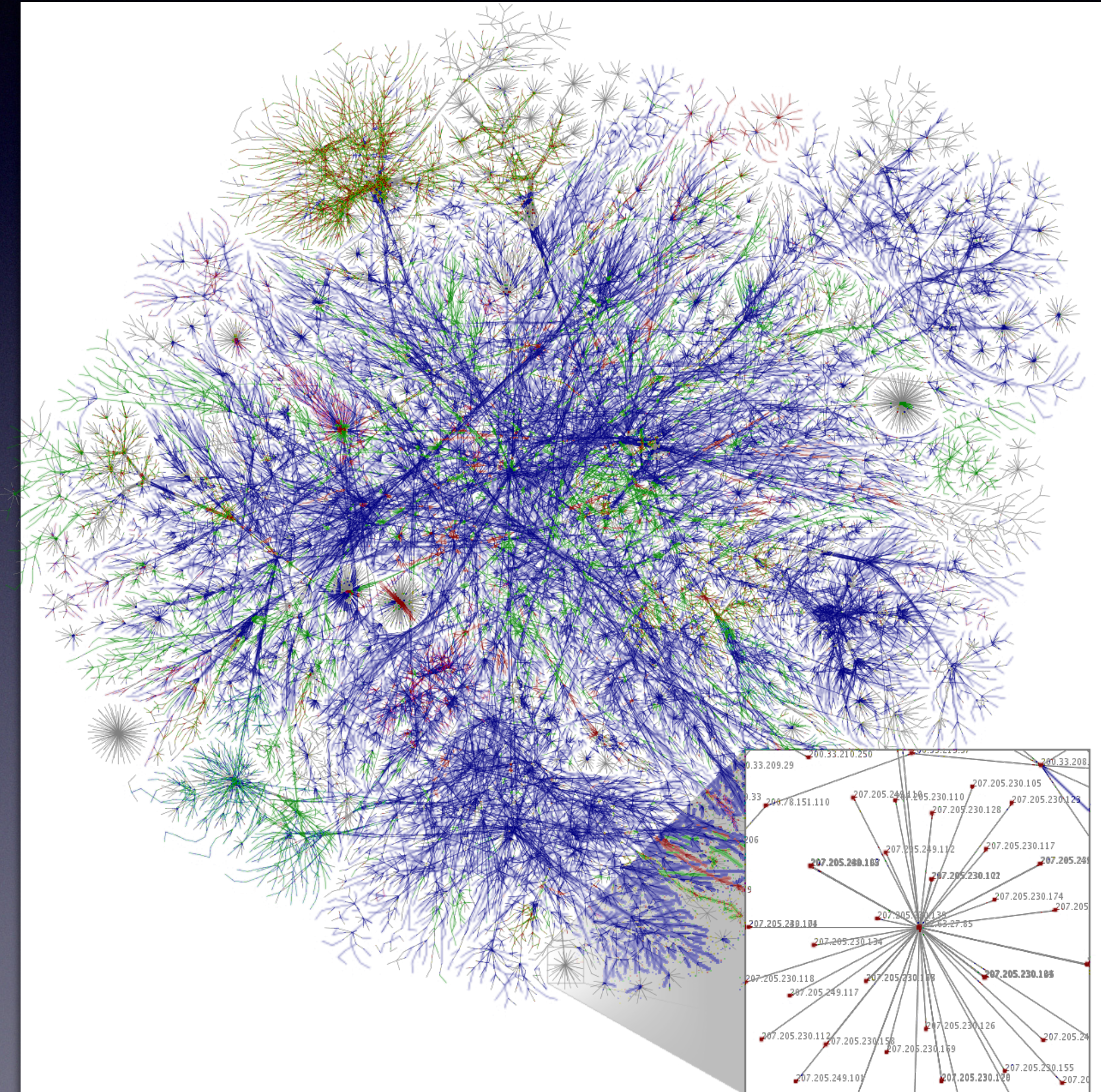
Birth of the Internet

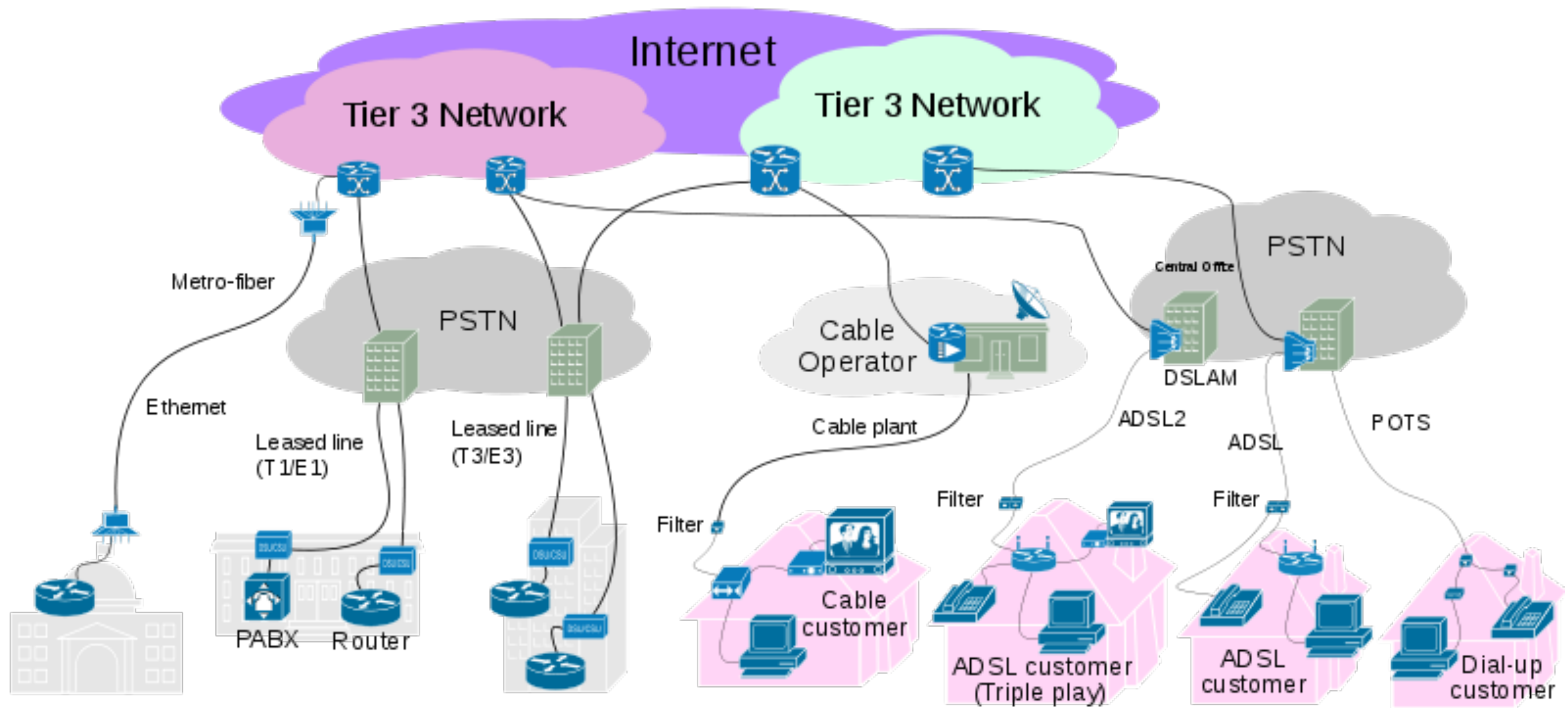
- 1981 ARPANET expanded by NSF to CSNET
- 1982 TCP/IP standard networking protocol on ARPANET
- Early '80s NSF starts supercomputer centers at several universities
- 1986 NSFNET interconnects and provides access to research and education orbs
- Late 80s Commercial ISPs emerge



Birth of the Internet (cont.)

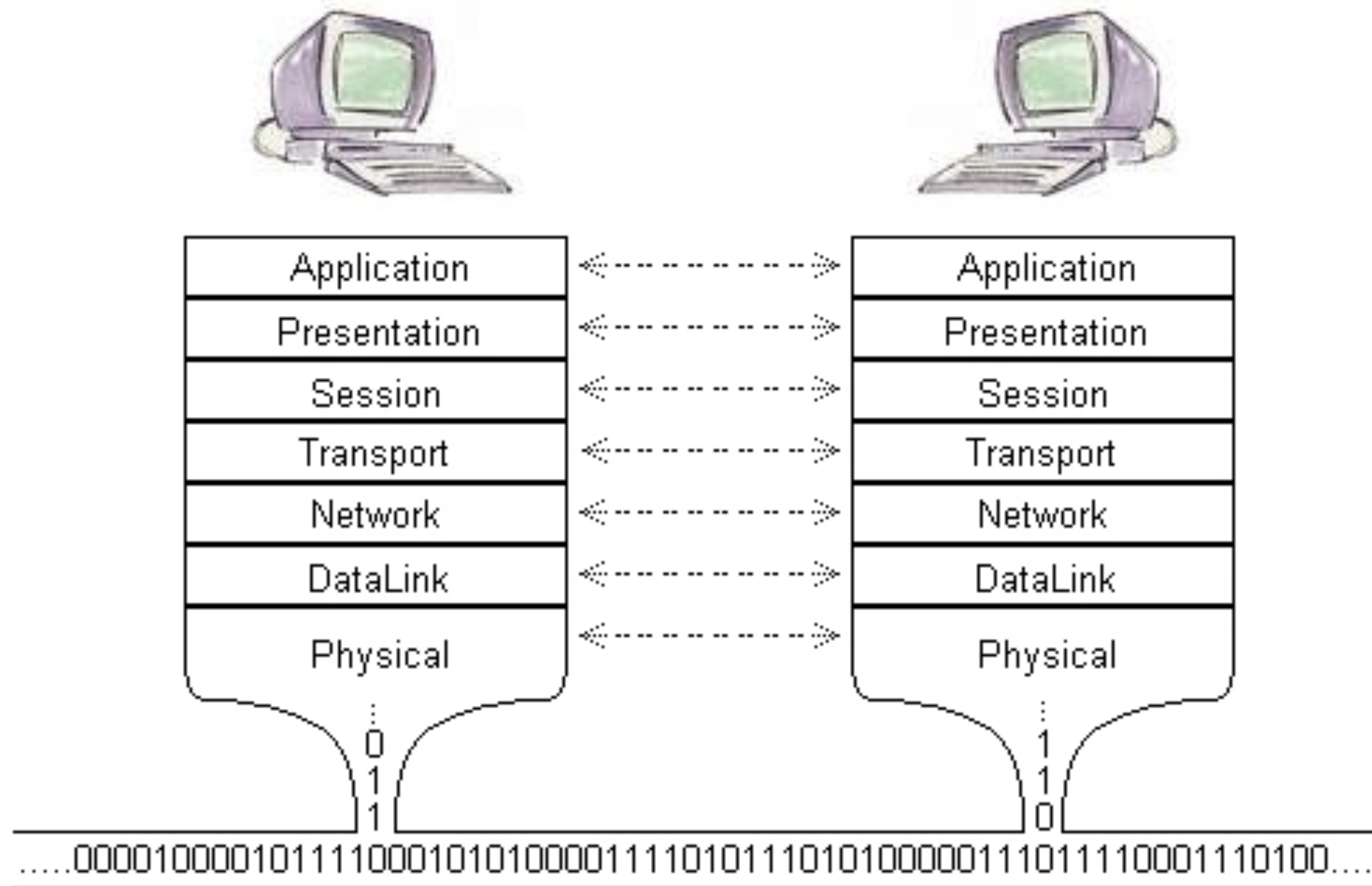
- 1990 ARPANET decommissioned
- 1995 NSFNET decommissioned





http://en.wikipedia.org/wiki/File:Internet_Connectivity_Access_layer.svg

OSI Model



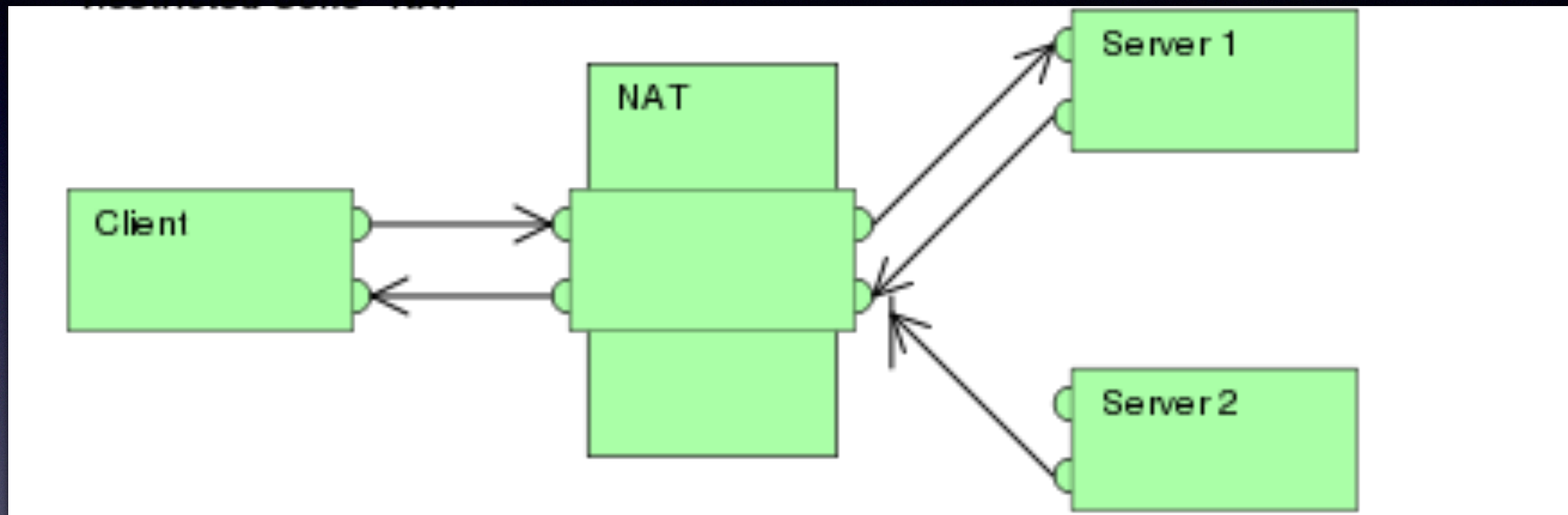
http://en.wikipedia.org/wiki/File:Osi_model_trad.jpg

OSI Model			
	Data unit	Layer	Function
Host layers	Data	7. Application	Network process to application
		6. Presentation	Data representation, encryption and decryption, convert machine dependent data to machine independent data
		5. Session	Interhost communication, managing sessions between applications
	Segments	4. Transport	Reliable delivery of packets between points on a network.
Media layers	Packet/Datagram	3. Network	Addressing, routing and (not necessarily reliable) delivery of datagrams between points on a network.
	Bit/Frame	2. Data link	A reliable direct point-to-point data connection.
	Bit	1. Physical	A (not necessarily reliable) direct point-to-point data connection.

Important concepts

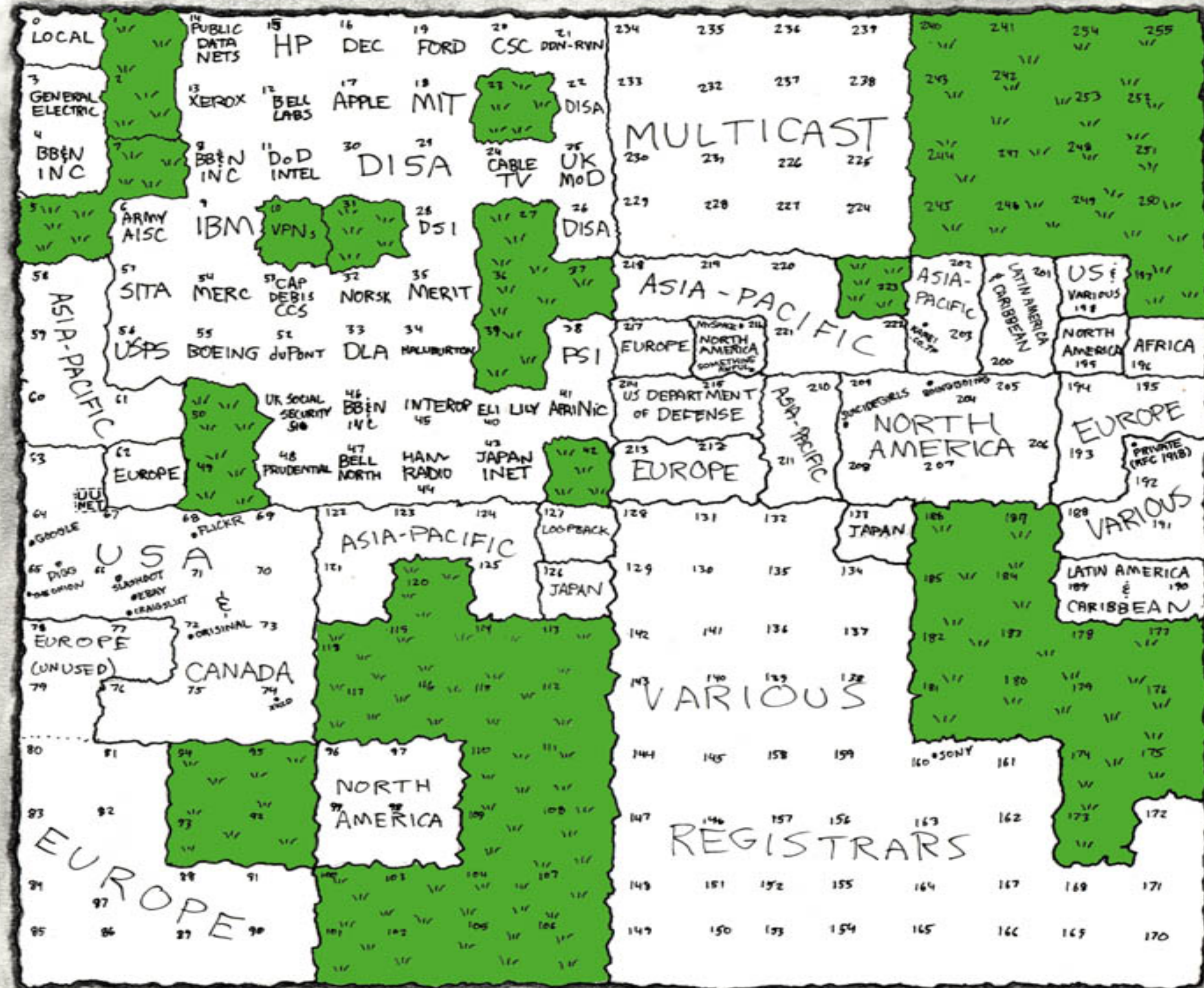
- MAC address
- IP Address
- DNS
- Network hub
Switch
Router
- Firewall
- NAT

Restricted Cone NAT



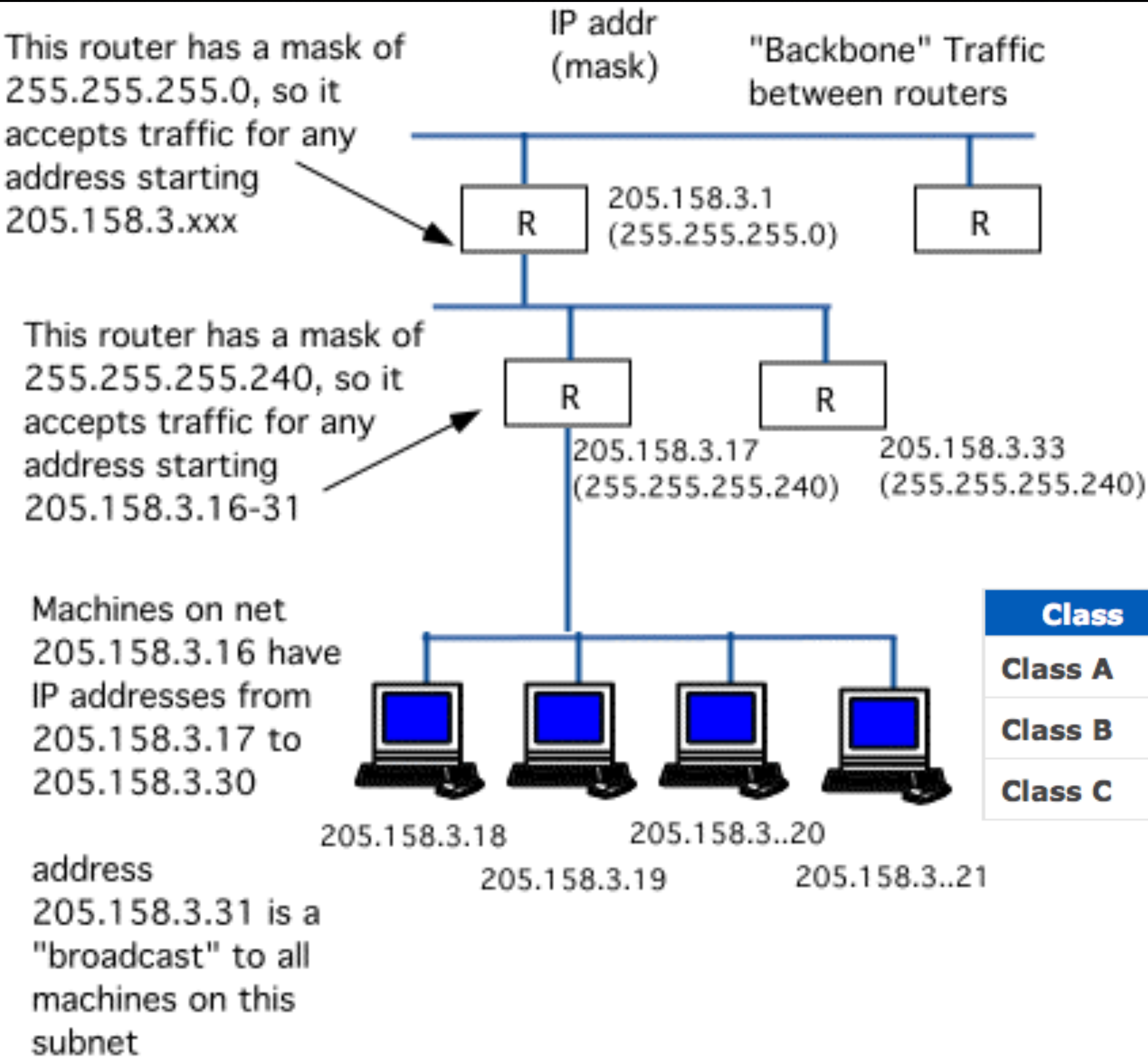
MAP OF THE INTERNET

THE IPv4 SPACE, 2006



Private IP addresses

RFC1918 name	IP address range	number of addresses	largest CIDR block (subnet mask)	host id size	mask bits	<i>classful</i> description ^[Note 1]
24-bit block	10.0.0.0 - 10.255.255.255	16,777,216	10.0.0.0/8 (255.0.0.0)	24 bits	8 bits	single class A network
20-bit block	172.16.0.0 - 172.31.255.255	1,048,576	172.16.0.0/12 (255.240.0.0)	20 bits	12 bits	16 contiguous class B networks
16-bit block	192.168.0.0 - 192.168.255.255	65,536	192.168.0.0/16 (255.255.0.0)	16 bits	16 bits	256 contiguous class C networks



Class	Netmask length	# of networks	# of hosts	Netmask
Class A	8	126	16,777,214	255.0.0.0
Class B	16	16,382	65,534	255.255.0.0
Class C	24	2,097,150	254	255.255.255.0

Troubleshooting Tools


```
adenner@localhost:~$ ping -c 5 cialug.org
PING cialug.org (67.224.64.36) 56(84) bytes of data.
64 bytes from mail.cialug.org (67.224.64.36): icmp_seq=1 ttl=51 time=29.5 ms
64 bytes from mail.cialug.org (67.224.64.36): icmp_seq=2 ttl=51 time=29.2 ms
64 bytes from mail.cialug.org (67.224.64.36): icmp_seq=3 ttl=51 time=30.0 ms
64 bytes from mail.cialug.org (67.224.64.36): icmp_seq=4 ttl=51 time=29.2 ms
64 bytes from mail.cialug.org (67.224.64.36): icmp_seq=5 ttl=51 time=29.4 ms

--- cialug.org ping statistics ---
5 packets transmitted, 5 received, 0% packet loss, time 4004ms
rtt min/avg/max/mdev = 29.239/29.519/30.043/0.344 ms
adenner@localhost:~$
```



```
adenner@localhost:~$ traceroute cialug.org
traceroute to cialug.org (67.224.64.36), 30 hops max, 60 byte packets
 1  router2-dal.linode.com (67.18.7.162)  0.574 ms  0.614 ms  0.763 ms
 2  xe-2-0-0.car04.dl1stx2.networklayer.com (67.18.7.93)  0.416 ms  0.388 ms  0.352 ms
 3  po102.dsr01.dl1stx2.networklayer.com (70.87.254.81)  1.013 ms  1.080 ms  1.153 ms
 4  po21.dsr01.dl1stx3.networklayer.com (70.87.255.65)  0.874 ms  0.970 ms  1.124 ms
 5  ae16.bbr02.eq01.dal03.networklayer.com (173.192.18.228)  0.511 ms  0.497 ms  0.503 ms
 6  ae55.edge5.Dallas3.Level3.net (4.59.36.93)  0.468 ms  0.502 ms  0.475 ms
 7  ae-2-70.edge2.Dallas1.Level3.net (4.69.145.75)  0.572 ms ae-4-90.edge2.Dallas1.Level3.net (4.69.145.203)  0.667 ms  0.897 ms
 8  4.68.111.102 (4.68.111.102)  1.280 ms  1.170 ms  2.731 ms
 9  be2032.ccr22.dfw01.atlas.cogentco.com (154.54.6.53)  1.622 ms be2031.ccr21.dfw01.atlas.cogentco.com (154.54.7.45)  1.528 ms  1.382 ms
10  be2141.mpd22.mci01.atlas.cogentco.com (154.54.5.157)  11.522 ms be2012.ccr21.mci01.atlas.cogentco.com (154.54.2.113)  11.960 ms  11.905 ms
11  be2156.ccr21.ord01.atlas.cogentco.com (154.54.6.86)  22.276 ms  22.125 ms  22.353 ms
12  te3-8.ccr01.dsm01.atlas.cogentco.com (154.54.0.78)  30.219 ms te4-1.ccr01.dsm01.atlas.cogentco.com (154.54.25.193)  31.999 ms te3-8.ccr01.dsm01.atlas.cogentco.com (154.54.0.78)  30.311 ms
13  38.108.132.122 (38.108.132.122)  33.171 ms  33.037 ms  33.252 ms
14  mail.cialug.org (67.224.64.36)  29.380 ms  29.193 ms  29.291 ms
adenner@localhost:~$ traceroute www.iastate.edu
traceroute to www.iastate.edu (129.186.23.166), 30 hops max, 60 byte packets
 1  router1-dal.linode.com (67.18.7.161)  0.701 ms  0.654 ms  0.859 ms
 2  xe-2-0-0.car03.dl1stx2.networklayer.com (67.18.7.89)  0.523 ms  0.507 ms  0.481 ms
 3  po101.dsr02.dl1stx2.networklayer.com (70.87.254.77)  0.675 ms  0.663 ms  0.743 ms
 4  po22.dsr02.dl1stx3.networklayer.com (70.87.255.69)  1.138 ms  1.107 ms  1.067 ms
 5  ae17.bbr02.eq01.dal03.networklayer.com (173.192.18.230)  0.450 ms ae17.bbr01.eq01.dal03.networklayer.com (173.192.18.226)  0.529 ms  0.505 ms
 6  ae0.bbr01.eq01.chi01.networklayer.com (173.192.18.137)  23.744 ms ae7.bbr01.eq01.dal03.networklayer.com (173.192.18.208)  0.632 ms  0.637 ms
 7  ae0.bbr01.eq01.chi01.networklayer.com (173.192.18.137)  21.933 ms equinix-exchange.chi.wiscnet.NET (206.223.119.7)  21.676 ms ae0.bbr01.eq01.chi01.networklayer.com (173.192.18.137)  20.434 ms
 8  equinix-exchange.chi.wiscnet.NET (206.223.119.7)  23.517 ms  19.755 ms 216.56.50.42 (216.56.50.42)  37.456 ms
 9  216.56.50.42 (216.56.50.42)  39.644 ms b31dmz1-438.tele.iastate.edu (192.245.179.49)  37.645 ms  36.120 ms
10  b06sr1-vlan254.tele.iastate.edu (129.186.254.139)  39.094 ms  35.653 ms b31dmz1-438.tele.iastate.edu (192.245.179.49)  37.592 ms
11  * * b06sr1-vlan254.tele.iastate.edu (129.186.254.139)  39.352 ms
12  * * *
13  * * *
14  * * *
15  * * *
16  * * *
17  * * *
18  * * *
19  * * *
20  * * *
21  * * *
22  * * *
23  * * *
24  * * *
25  * * *
26  * * *
27  * * *
28  * * *
29  * * *
30  * * *
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11 be2156.ccr21.ord01.atlas.cogentco.com (154.54.6.86)  22.276 ms  22.125 ms  22.353 ms
12 te3-8.ccr01.dsm01.atlas.cogentco.com (154.54.0.78)  30.219 ms  te4-1.ccr01.dsm01.atlas.cogentco.com (154.54.25.193)  31.999 ms  31.999 ms
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6  ae0.bbr01.eq01.chi01.networklayer.com (173.192.18.137)  23.744 ms  ae7.bbr01.eq01.dal03.networklayer.com (173.192.18.208)  0.633 ms  0.633 ms
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8  equinix-exchange.chi.wisnet.NET (206.223.119.7)  23.517 ms  19.755 ms  216.56.50.42 (216.56.50.42)  37.456 ms  37.456 ms
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11 * * b06sr1-vlan254.tele.iastate.edu (129.186.254.139)  39.352 ms
12 * * *
13 * * *
14 * * *
```



```
adenner@localhost:~$ dig cialug.org
```

```
; <> DiG 9.9.3-rpz2+rl.13214.22-P2-Ubuntu-1:9.9.3.dfsg.P2-4ubuntu1.1 <> cialug.org
```

```
;; global options: +cmd
```

```
;; Got answer:
```

```
;; ->>HEADER<<- opcode: QUERY, status: NOERROR, id: 31705
```

```
;; flags: qr rd ra; QUERY: 1, ANSWER: 1, AUTHORITY: 3, ADDITIONAL: 1
```

```
;; OPT PSEUDOSECTION:
```

```
; EDNS: version: 0, flags:; udp: 4096
```

```
;; QUESTION SECTION:
```

```
;cialug.org.                IN      A
```

```
;; ANSWER SECTION:
```

```
cialug.org.                14400   IN      A      67.224.64.36
```

```
;; AUTHORITY SECTION:
```

```
cialug.org.                14400   IN      NS      ns2.infoplex.com.
```

```
cialug.org.                14400   IN      NS      ns3.infoplex.com.
```

```
cialug.org.                14400   IN      NS      ns1.infoplex.com.
```

```
;; Query time: 73 msec
```

```
;; SERVER: 72.14.188.5#53(72.14.188.5)
```

```
;; WHEN: Wed Apr 16 06:22:20 UTC 2014
```

```
;; MSG SIZE  rcvd: 121
```

```
adenner@localhost:~$
```



```
adenner@localhost:~$ ifconfig eth0
eth0      Link encap:Ethernet  HWaddr f2:3c:91:96:23:c9
          inet addr:69.164.203.82  Bcast:69.164.203.255  Mask:255.255.255.0
          inet6 addr: 2600:3c00::f03c:91ff:fe96:23c9/64 Scope:Global
          inet6 addr: fe80::f03c:91ff:fe96:23c9/64 Scope:Link
          UP BROADCAST RUNNING MULTICAST  MTU:1500  Metric:1
          RX packets:9880405 errors:0 dropped:0 overruns:0 frame:0
          TX packets:9324224 errors:0 dropped:0 overruns:0 carrier:0
          collisions:0 txqueuelen:1000
          RX bytes:1358629505 (1.3 GB)  TX bytes:3119485980 (3.1 GB)
          Interrupt:68

adenner@localhost:~$ █
```


test.cap

File Edit View Go Capture Analyze Statistics Telephony Tools Internals Help

Filter: Expression... Clear Apply

No.	Time	Source	Destination	Protocol	Length	Info
1	0.000000	192.168.0.2	Broadcast	ARP	42	Gratuitous ARP for 192.168.0.2 (F
2	0.299139	192.168.0.1	192.168.0.2	NBNS	92	Name query NBSTAT *<00><00><00><0
3	0.299214	192.168.0.2	192.168.0.1	ICMP	70	Destination unreachable (Port unreach
4	1.025659	192.168.0.2	224.0.0.22	IGMP	54	v3 Membership Report / Join group
5	1.044366	192.168.0.2	192.168.0.1	DNS	110	standard query SRV _ldap._tcp.nbg
6	1.048652	192.168.0.2	239.255.255.250	SSDP	175	M-SEARCH * HTTP/1.1
7	1.050784	192.168.0.2	192.168.0.1	DNS	86	standard query SOA nb10061d.ww004
8	1.055053	192.168.0.1	192.168.0.2	SSDP	337	HTTP/1.1 200 OK
9	1.082038	192.168.0.2	192.168.0.255	NBNS	110	Registration NB NB10061D<00>
10	1.111945	192.168.0.2	192.168.0.1	DNS	87	standard query A proxyconf.ww004.
11	1.226156	192.168.0.2	192.168.0.1	TCP	62	ncu-2 > http [SYN] Seq=0 win=6424
12	1.227282	192.168.0.1	192.168.0.2	TCP	60	http > ncu-2 [SYN, ACK] Seq=0 Ack

Frame 11: 62 bytes on wire (496 bits), 62 bytes captured (496 bits)

Ethernet II, Src: 192.168.0.2 (00:0b:5d:20:cd:02), Dst: Netgear_2d:75:9a (00:09:5b:2d:75:9a)

Internet Protocol, Src: 192.168.0.2 (192.168.0.2), Dst: 192.168.0.1 (192.168.0.1)

Transmission Control Protocol, Src Port: ncu-2 (3196), Dst Port: http (80), Seq: 0, Len: 0

Source port: ncu-2 (3196)

Destination port: http (80)

[Stream index: 5]

Sequence number: 0 (relative sequence number)

Header length: 28 bytes

Flags: 0x02 (SYN)

window size value: 64240

```

0000  00 09 5b 2d 75 9a 00 0b 5d 20 cd 02 08 00 45 00  ..[-u... ] ....E.
0010  00 30 18 48 40 00 80 06 61 2c c0 a8 00 02 c0 a8  .0.H@... a,.....
0020  00 01 0c 7c 00 50 3c 36 95 f8 00 00 00 00 70 02  ...|.P<6 .....p.
0030  fa f0 27 e0 00 00 02 04 05 b4 01 01 04 02      ...:.....

```

File: "C:/test.cap" 14 KB 00:00:02 Packets: 120 Displayed: 120 Marked: 0 Load time: 0:00.000 Profile: Default

<http://wireshark.org>