Network Attacks & Defenses

EECS 388 F17

Administrivia

Web project due

Homework 3 is available at https://eecs388.org

Office Hours: by appt

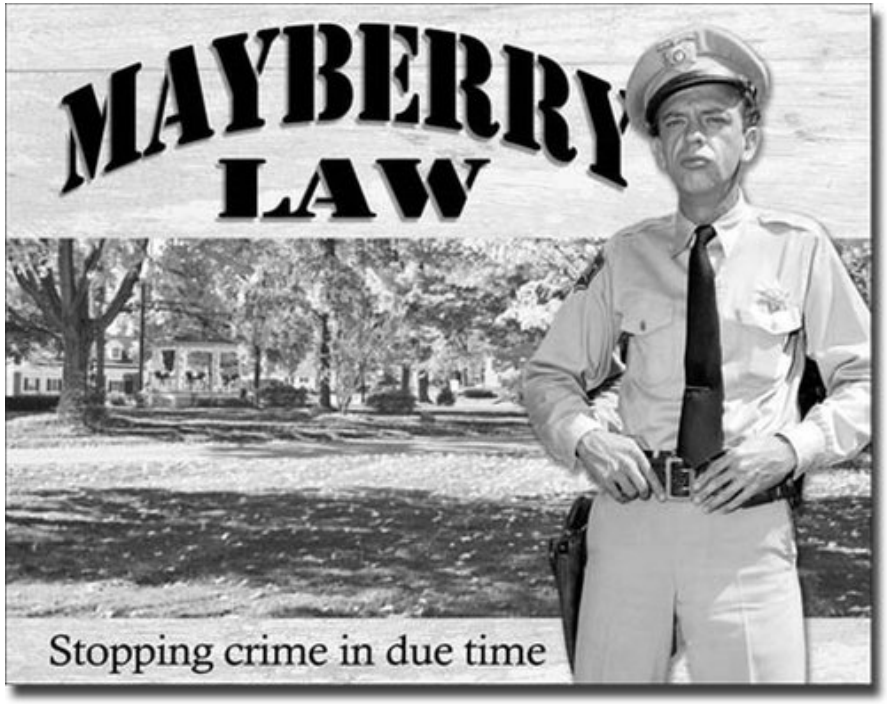
Back In The Day

The Internet was a small town

HTTP

SMTP

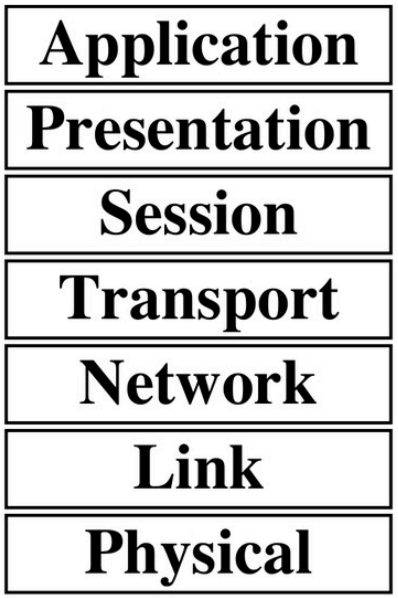
NTP



Well, let's just make secure things!

Layers are great!

Layers are a pain!



Classes of Network Vulnerabilities

- Unencrypted transmission
- No source authentication
- No integrity
- No built-in bandwidth control

Two Types of Attackers

- Eve the Eavesdropper
- Mallory the Man In The Middle

How?

Wireless Networks

Open networks: anyone in range can listen

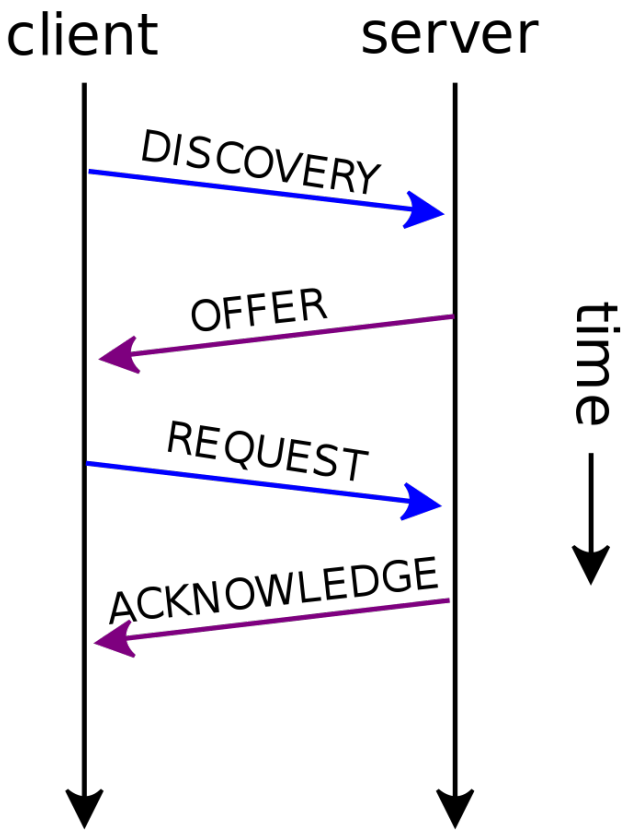
Secure protocols:

- WEP -> lol
- WPA -> WPA2

Wired Networks

Hub vs. switch

Dynamic Host Configuration Protocol



Address Resolution Protocol (ARP)

Internet Protocol (IPv4) over Ethernet ARP packet		
octet offset	**0**	**1**
0	Hardware type (HTYPE)	
2	Protocol type (PTYPE)	
4	Hardware address length (HLEN)	Protocol address length (PLEN)
6	Operation (OPER)	
8	Sender hardware address (SHA) (first 2 bytes)	
10	(next 2 bytes)	
12	(last 2 bytes)	
14	Sender protocol address (SPA) (first 2 bytes)	
16	(last 2 bytes)	
18	Target hardware address (THA) (first 2 bytes)	
20	(next 2 bytes)	
22	(last 2 bytes)	
24	Target protocol address (TPA) (first 2 bytes)	
26	(last 2 bytes)	

Wired Networks

How does a client know its gateway to the Internet?

Dynamic Host Configuration Protocol

How does a switch know where to send traffic?

Address Resolution Protocol

ARP Spoofing

ARP isn't authenticated

Shout loud enough and you get the traffic

QED

How could we authenticate ARP?

How could we otherwise defend against ARP spoofing?

Tools?

tcpdump

Wireshark

dSniff

Okay, so what can we do?

Capture

Sensitive data

Session data

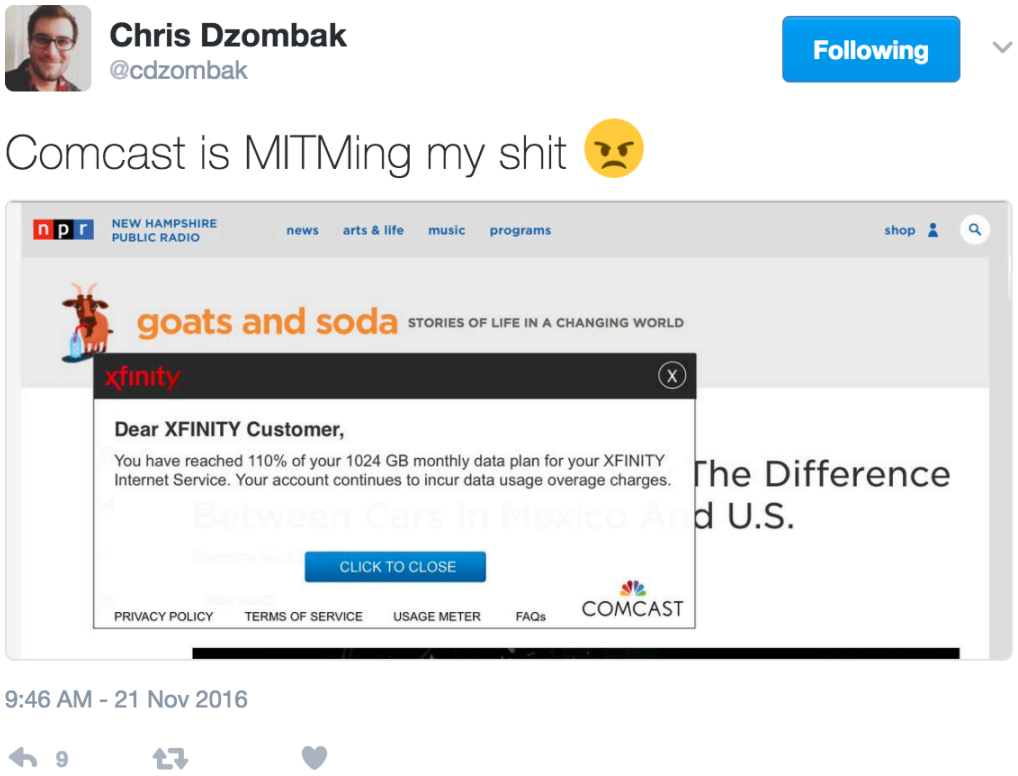
Modify

Infect executables

Inject content

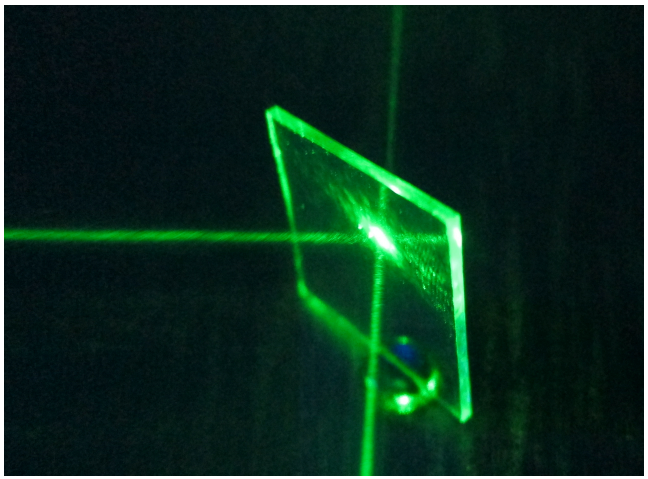
What kind of content would be interesting to inject?

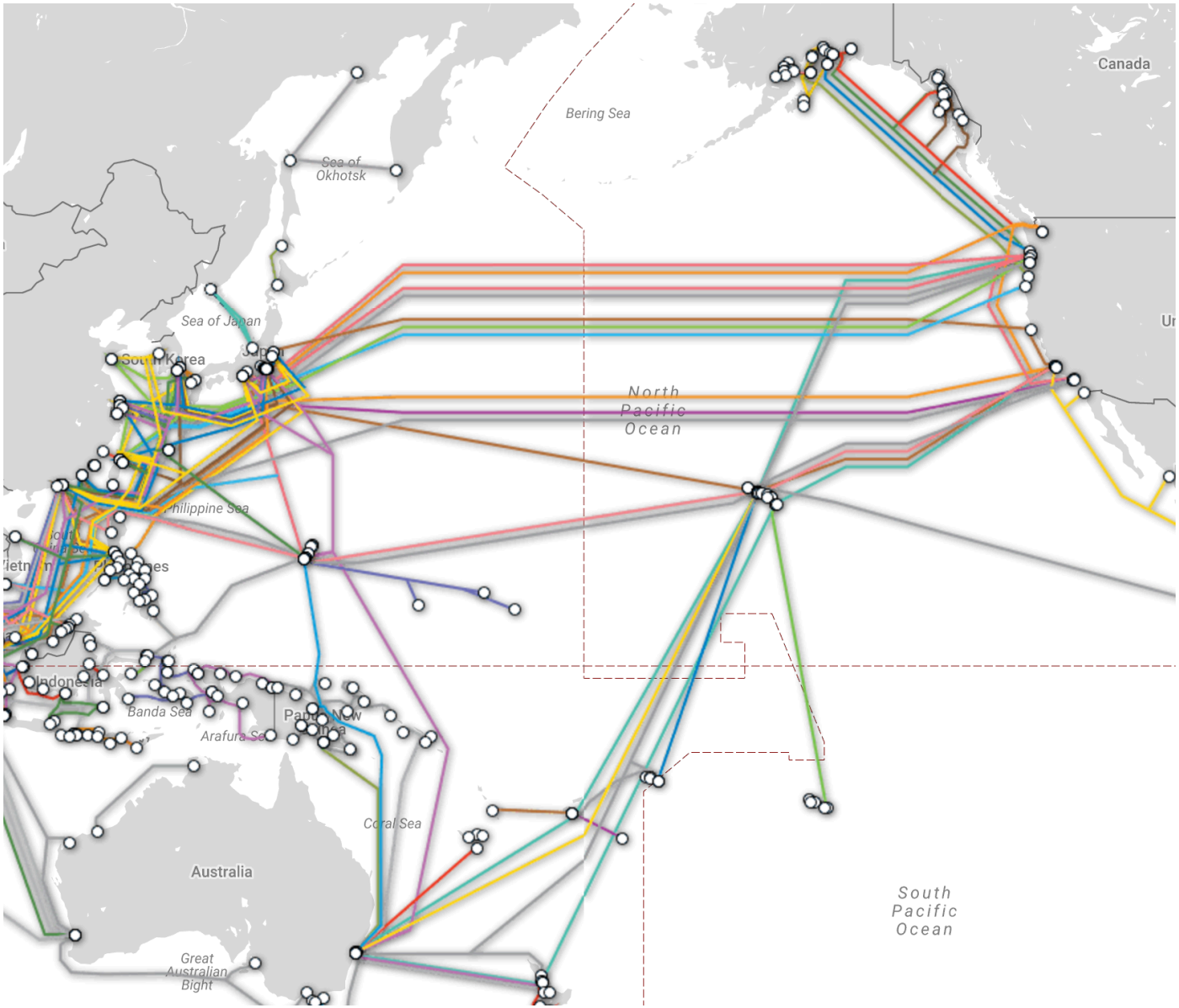
F’ing Comcast



Large-Scale Attacks?

What can you learn if you passively read all data that goes through an ISP?




Canada
Bering Sea
Sea of Okhotsk
Sea of Japan
South Korea
North Pacific Ocean
Philippine Sea
Indonesia
Banda Sea
Arafura Sea
Coral Sea
Australia
Great Australian Bight
South Pacific Ocean

Okay, so what can we do?

Solutions?

Secure protocols (TLS, SSH, etc.)

VPN

Wireless: WPA2

IP: No Source Authentication

Can’t Trust Source IP

IP Raw Sockets

You pick the Layer 4 protocol (or do it yourself)

Why is IP spoofing less effective for TCP than UDP?

DNS: Kaminsky Attack

DNS Transaction IDs

16 bit field -> only 2^{16} possible transaction IDs

Dan Kaminsky: just shout loud enough and wait

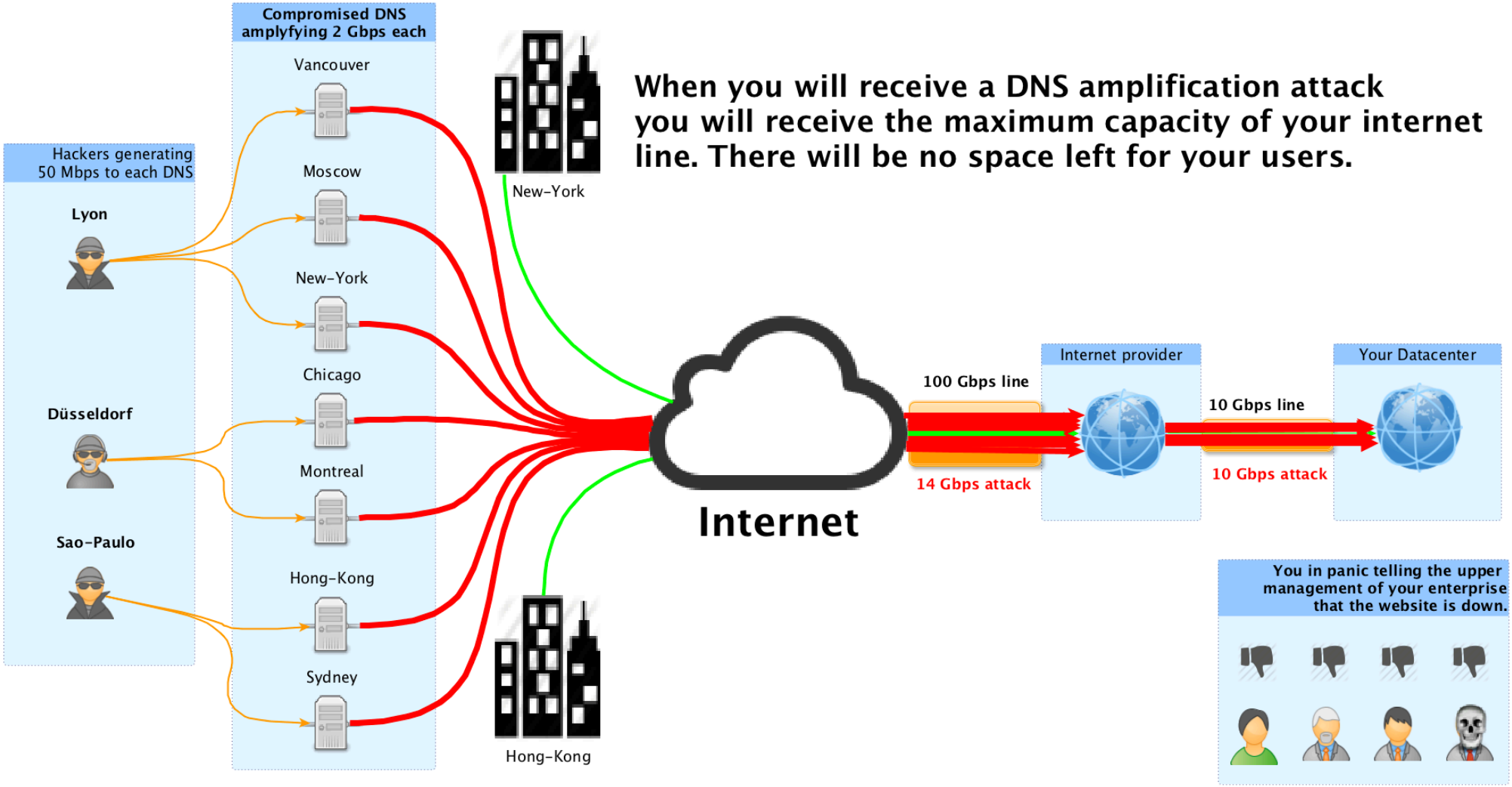
Fix: randomization of source port

How many possibilities now?

Reflection

UDP: to, from, data

UDP protocols that provide services: NTP, DNS


When you will receive a DNS amplification attack you will receive the maximum capacity of your internet line. There will be no space left for your users.
Hackers generating 50 Mbps to each DNS
Lyon
Düsseldorf
Sao-Paulo
Compromised DNS amplyfying 2 Gbps each
Vancouver
Moscow
New-York
Chicago
Montreal
Hong-Kong
Sydney
New-York
Hong-Kong
Internet
100 Gbps line
14 Gbps attack
Internet provider
10 Gbps line
10 Gbps attack
Your Datacenter
You in panic telling the upper management of your enterprise that the website is down.

BGP:
Border Gateway Protocol

BGP:
Border Gullible Protocol

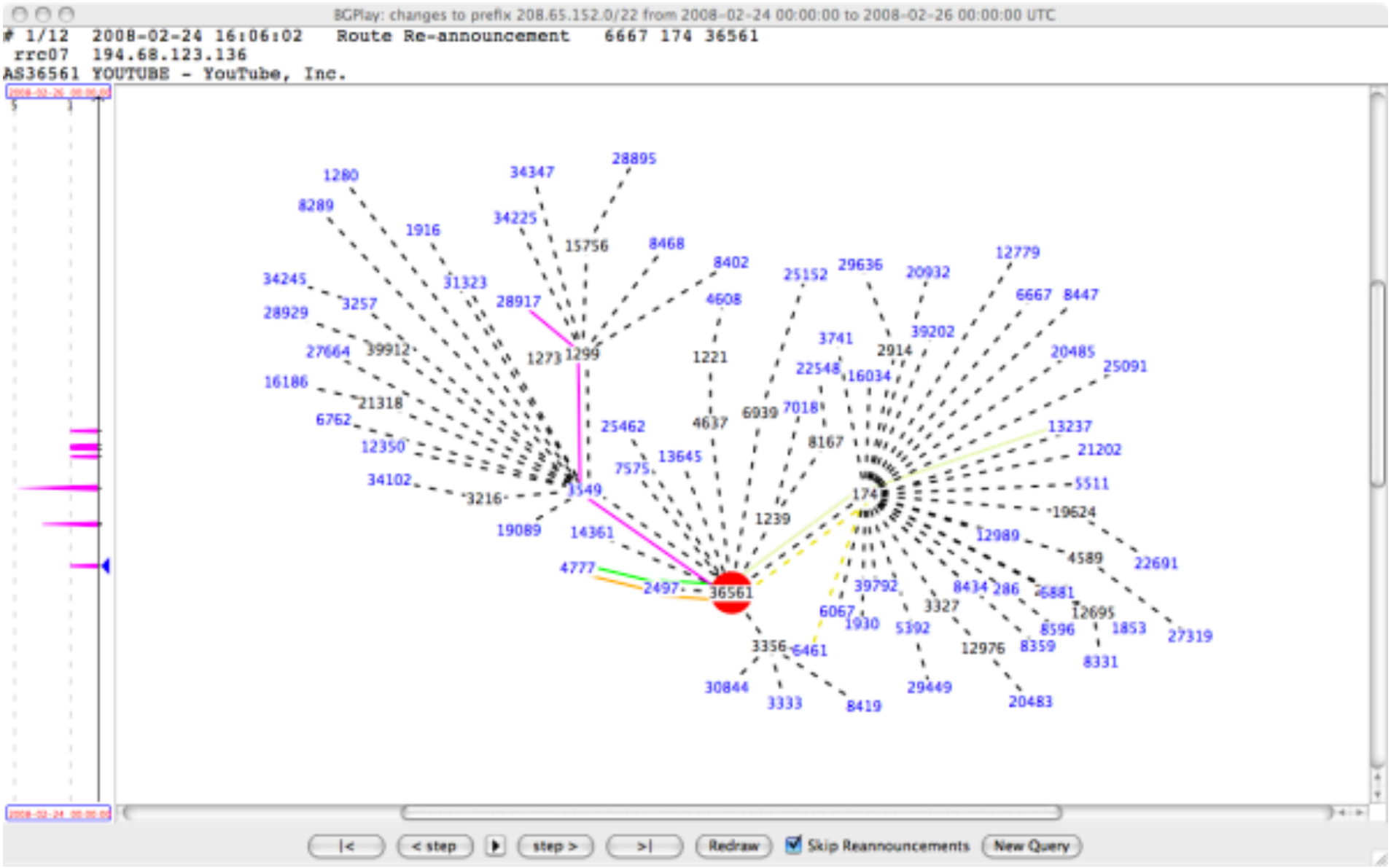
Routing

BGP

ASes advertise their connectivity to blocks of IP addresses

BGP uses route advertisements to form forwarding tables, loads them into edge routers

May be multiple routes to some AS. Q: How decide which route to use? A: Heuristics like “more specific address block”


BGPlay: changes to prefix 208.65.152.0/22 from 2008-02-24 00:00:00 to 2008-02-26 00:00:00 UTC
1/12 2008-02-24 16:06:02 Route Re-announcement 6667 174 36561
rrc07 194.68.123.136
AS36561 YOUTUBE - YouTube, Inc.
1280
8289
1916
34347
28895
34225
15756
8468
8402
34245
3257
31323
28917
4608
25152
29636
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12779
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39912
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16186
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< step
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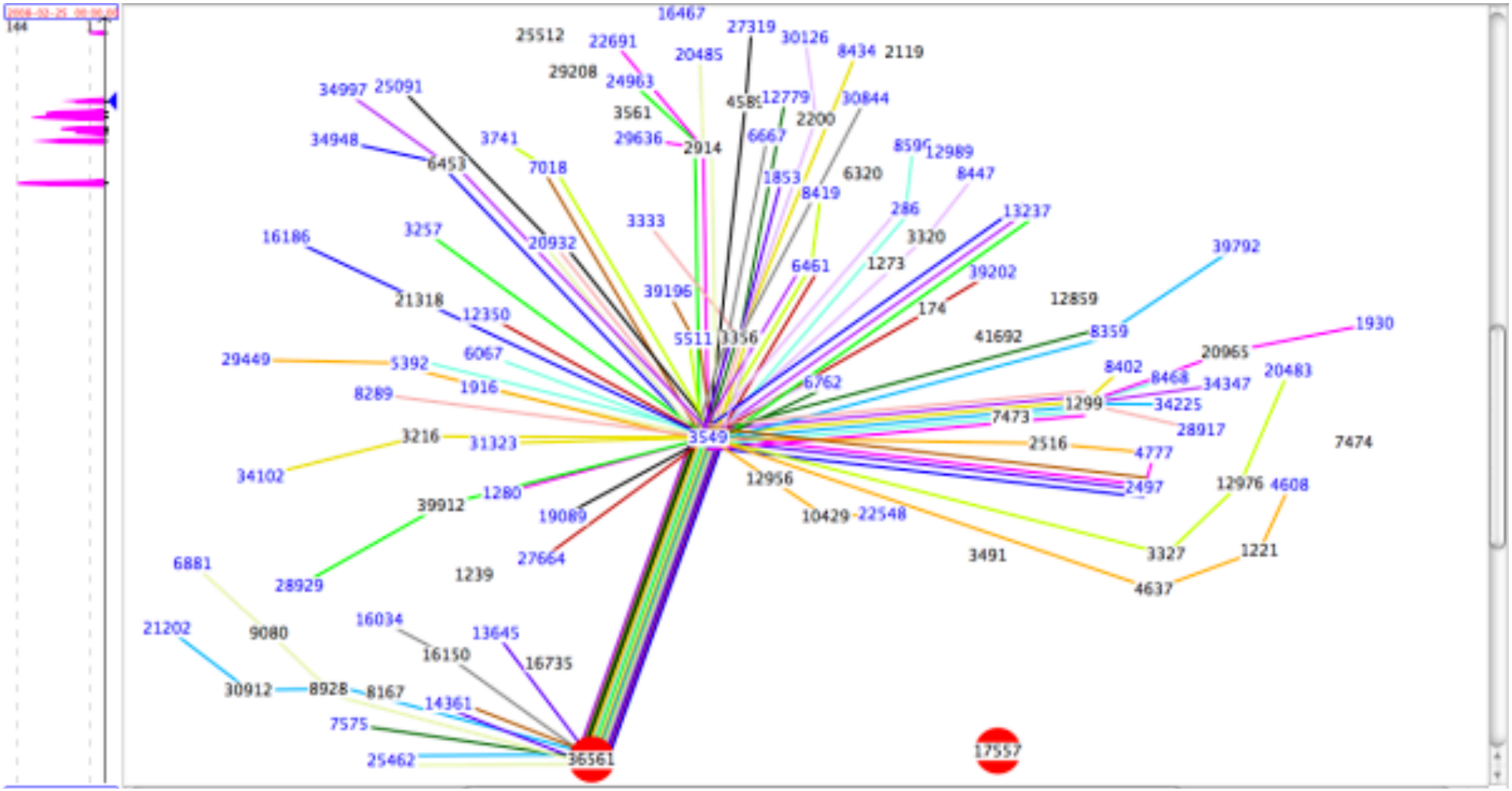
Redraw
Skip Reannouncements
New Query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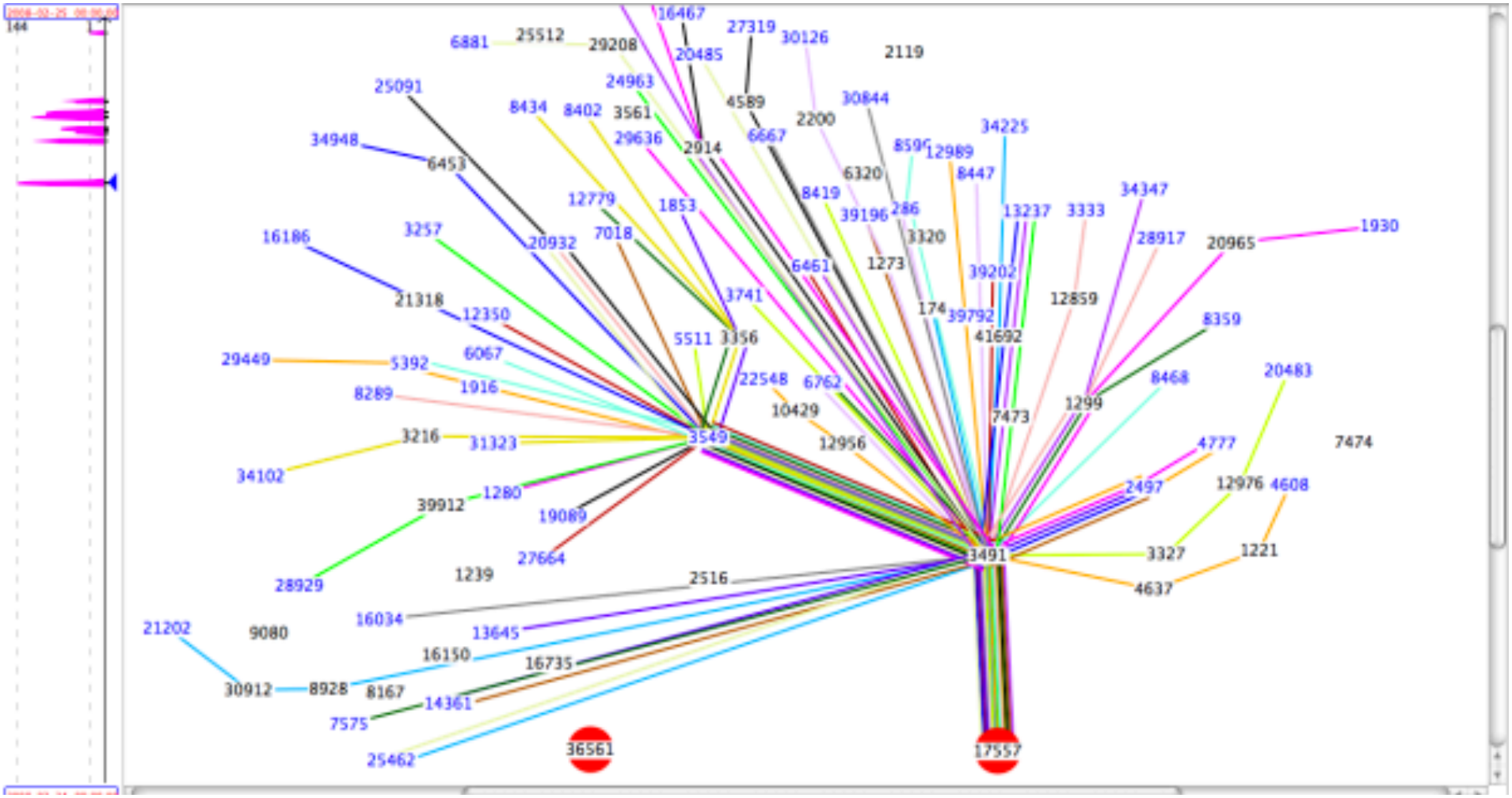
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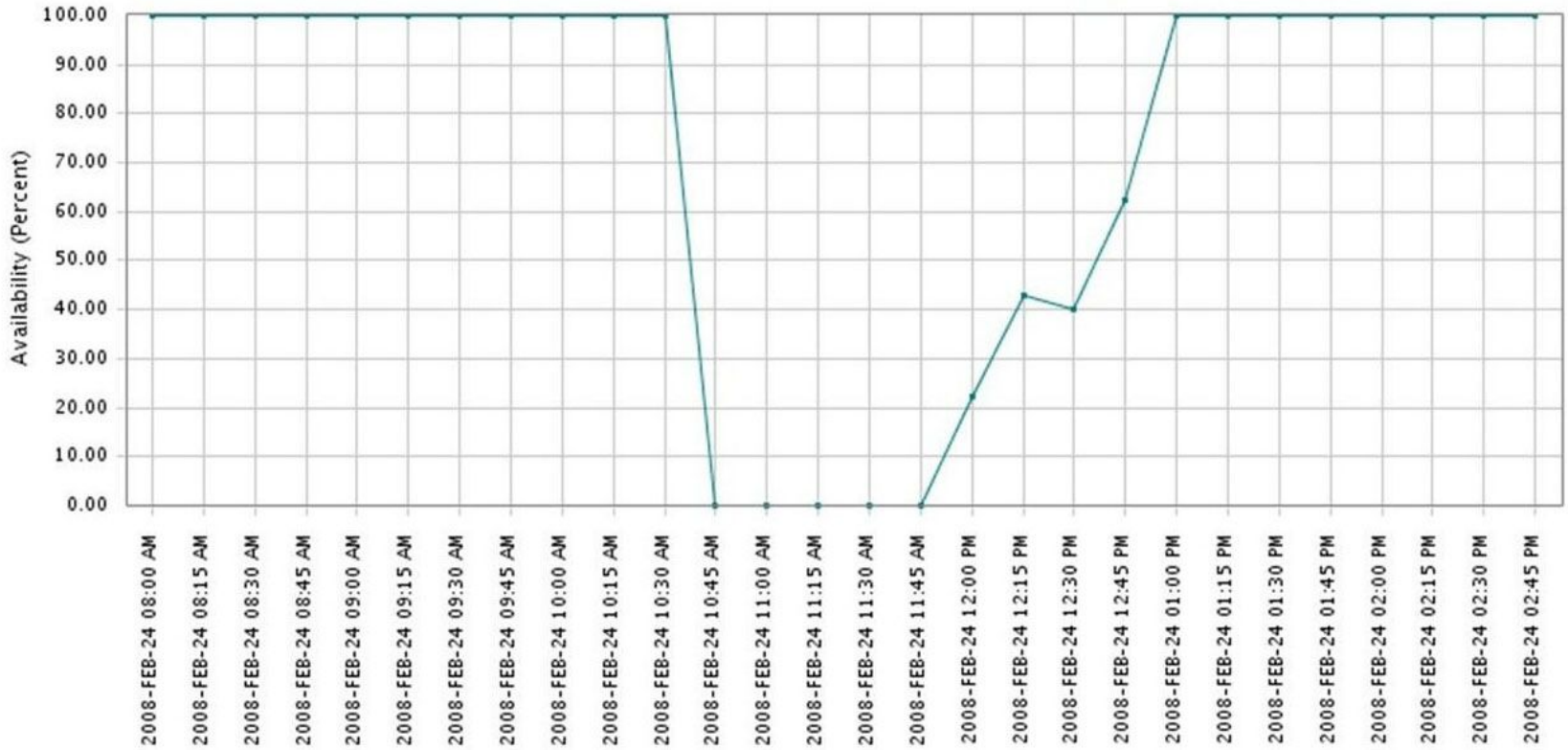
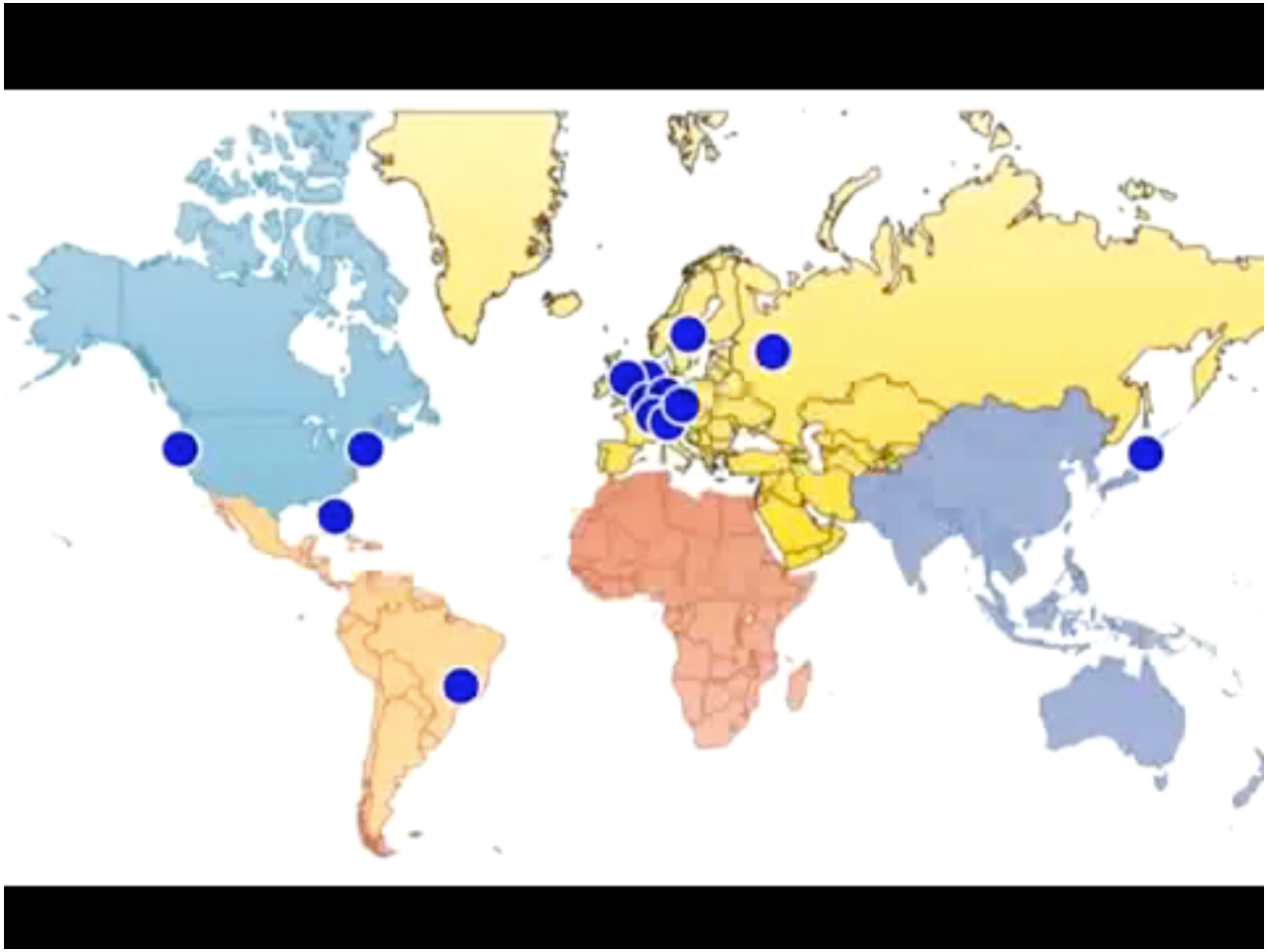
Two minutes later …



RIPE NCC video



Sign All the Things!

Nothing stops this type of hijacking

DNSSEC: signing DNS records

Exploits

sick h4x

Virus: exploit that attaches onto another file or program

Worm: self-propagating exploit

Trojan: exploit disguised as something of interest

Worms

How do worms propagate?

- Scanning for vulnerable hosts
- Sending to everyone in email/chat contacts

Worms

What do worms do?

- Blackmail/ransomware
- Exfiltrate data
- Corrupt files
- Bot

Botnet

Permanently compromised systems with communications

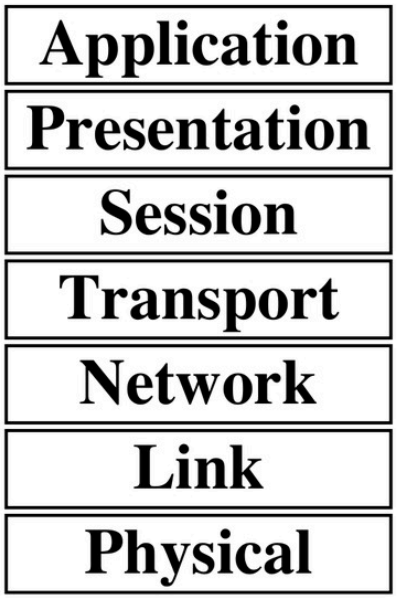
Spam, DDoS, bitcoin mining, etc.

Summary:
Attacking Each Layer

Layer 2 (Link) — Ethernet

ARP Spoofing

Only works on local network



Layer 3 (Network) — IP

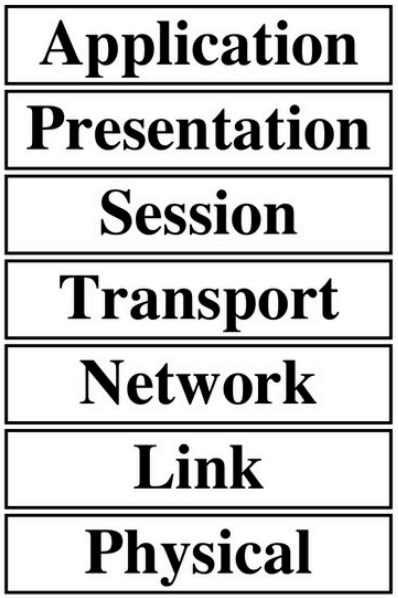
IP Spoofing

Can/should be filtered at the edge

- Ingress filtering: don't forward packets from outside that have inside source address
- Egress filtering: don't forward packets packets from inside that have outside source address.

BGP route hijacking

DNS spoofing



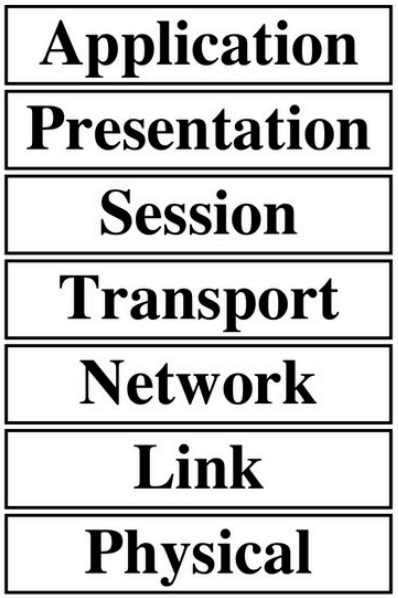
Layer 4 (Transport) — TCP

TCP injection: guess sequence numbers, use IP spoofing

E.g., DoS: TCP RST

Edge filtering

Why don't we do more edge filtering?

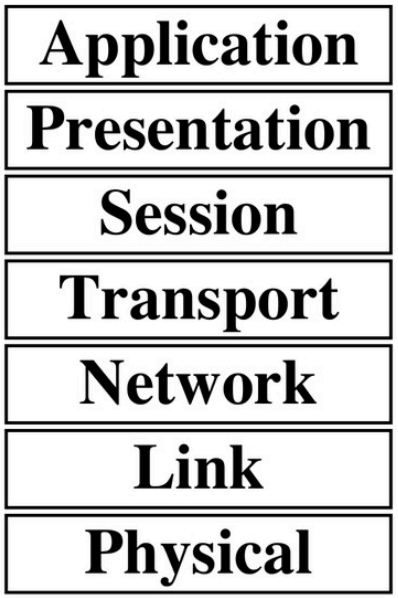


Layer 4 (Transport) — UDP

UDP Amplification

DNS, NTP

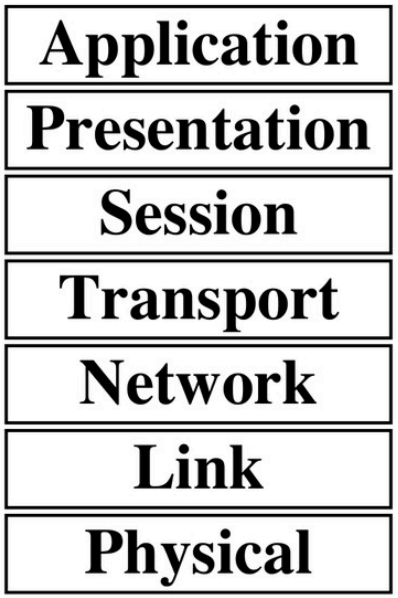
Don’t need a response!



Layer 7 (Application)

DNS maps names to IPs

BGP maps routers to IPs



Getting Security

We can build security on top of untrusted layers!

Next Week…

Authenticating users