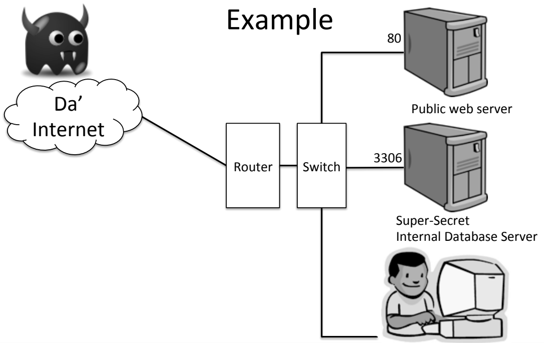
Network Firewalls

Don Porter

Firewalls: An Essential Tool

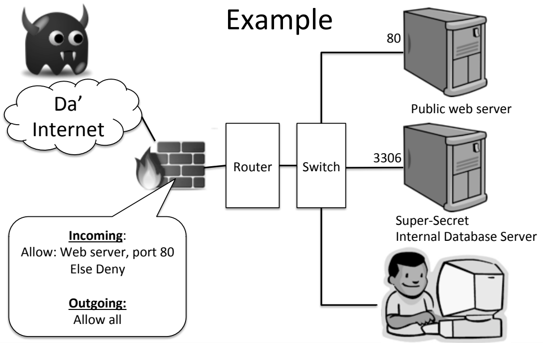
- Previous Lectures: Every service on a system visible to the outside world is a potential attack vector
- Observations:
  - It is really hard to police every single system for insecure software (although you should do this)
  - Some network services are intended only for use inside your network
- Idea: Filter incoming network connections

Example



How to let users access database, but not bad guy?

Example



Direct outside connections to database blocked

Example Recap

- A firewall (aka packet filter) looks at packet headers and filters them based on attributes such as IP address and port number
- Can filter incoming and outgoing traffic
- Can log dodgy packets for further inspection

Types of Firewalls

- Most personal computers include firewall software
  - Linux: iptables
  - Windows: part of Microsoft Security Essentials
- For enterprise deployments, you can buy stand-alone firewall boxes from companies like Cisco
- For smaller deployments, a Linux system can also act as a firewall, using same software
  - In fact, many personal router/firewall/access point boxes run a lightweight Linux build + iptables

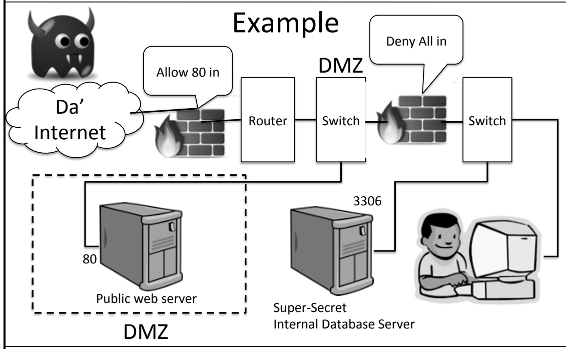
More Layered Security

- Some servers are intended to be publicly accessible (e.g., the web server)
- Others are for internal-use only and contain sensitive information (e.g., the database server)
- What happens if the web server is compromised?
  - Web server is inside the firewall
  - Can access the sensitive database server
  - Attacker can use web server to attack database

Refinement: DMZ

- Idea: Put a second firewall between public and private services
- We call the public part of the network the ***Demilitarized Zone (DMZ)***

Example



DMZ Recap

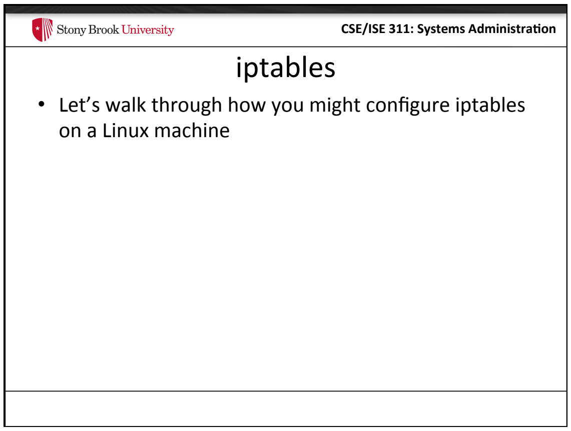
- Best practice: 2 firewalls
  - One between you and internet
  - One between public and private servers
- Limits damage if your web server is compromised

Incoming Traffic Caveats

- As presented, the rules are pretty simple:
  - E.g., block everything except traffic to web server
- But what about responses to external traffic?
  - E.g., http GET of www.google.com?
- Firewalls generally track some connection-level state, allow incoming responses to requests from inside the firewall
  - Sometimes called stateful inspection
  - States of note: Established and Related

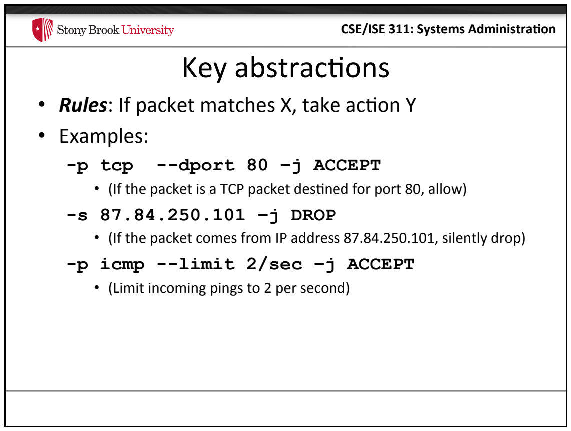
Firewall Overview Summary

- Placing packet filters near your router can protect your network
  - Block access to private systems
  - Mitigate risk of user running a vulnerable service without your knowledge
- Multiple firewalls can be useful
  - DMZ
  - Host-level firewall
- Only one piece of the puzzle!
  - Disabling vulnerable services, security patches, etc., still matter



iptables

- Let's walk through how you might configure iptables on a Linux machine



Key abstractions

- ***Rules***: If packet matches X, take action Y
- Examples:

```
-p tcp  --dport 80 -j ACCEPT
```

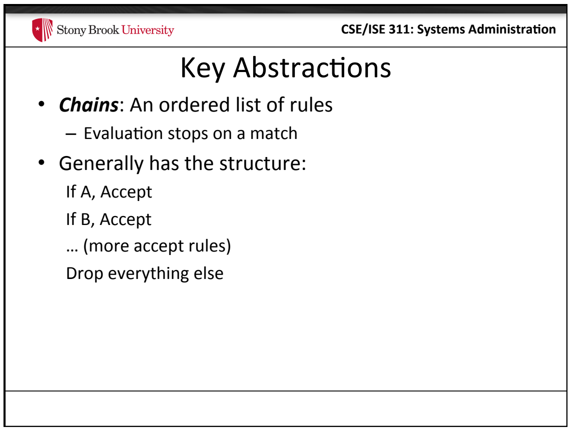
  - (If the packet is a TCP packet destined for port 80, allow)

```
-s 87.84.250.101 -j DROP
```

  - (If the packet comes from IP address 87.84.250.101, silently drop)

```
-p icmp --limit 2/sec -j ACCEPT
```

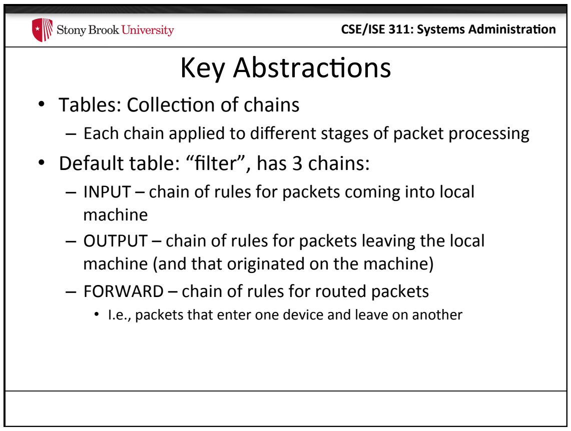
  - (Limit incoming pings to 2 per second)



Key Abstractions

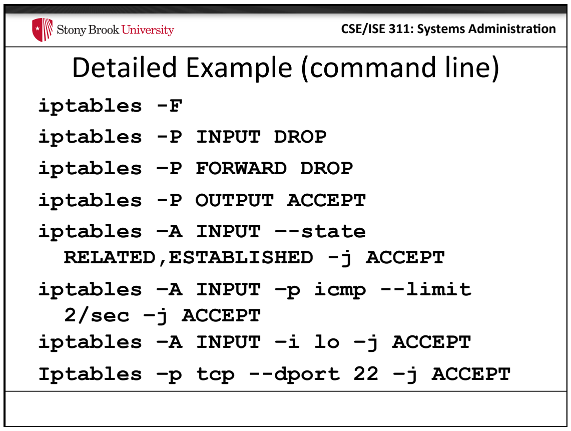
- ***Chains***: An ordered list of rules
  - Evaluation stops on a match
- Generally has the structure:

  If A, Accept
  If B, Accept
  … (more accept rules)
  Drop everything else



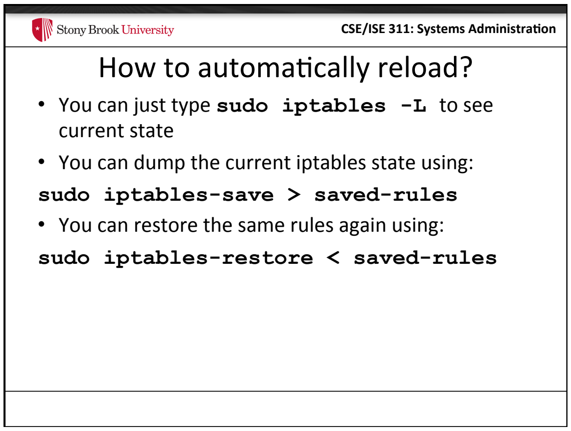
Key Abstractions

- Tables: Collection of chains
  - Each chain applied to different stages of packet processing
- Default table: "filter", has 3 chains:
  - INPUT – chain of rules for packets coming into local machine
  - OUTPUT – chain of rules for packets leaving the local machine (and that originated on the machine)
  - FORWARD – chain of rules for routed packets
    - I.e., packets that enter one device and leave on another



Detailed Example (command line)

```
iptables -F
iptables -P INPUT DROP
iptables -P FORWARD DROP
iptables -P OUTPUT ACCEPT
iptables -A INPUT --state
  RELATED,ESTABLISHED -j ACCEPT
iptables -A INPUT -p icmp --limit
  2/sec -j ACCEPT
iptables -A INPUT -i lo -j ACCEPT
Iptables -p tcp --dport 22 -j ACCEPT
```



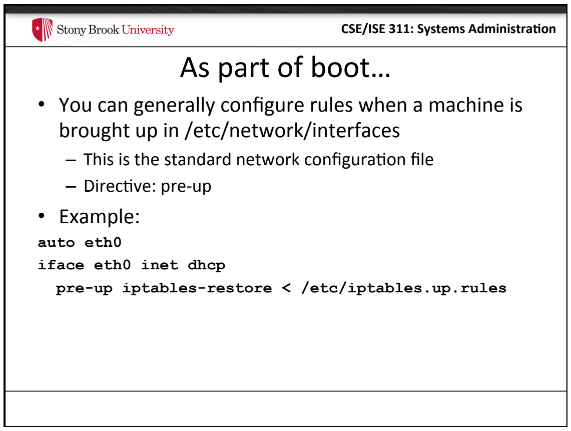
How to automatically reload?

- You can just type **`sudo iptables -L`** to see current state
- You can dump the current iptables state using:

```
sudo iptables-save > saved-rules
```

- You can restore the same rules again using:

```
sudo iptables-restore < saved-rules
```



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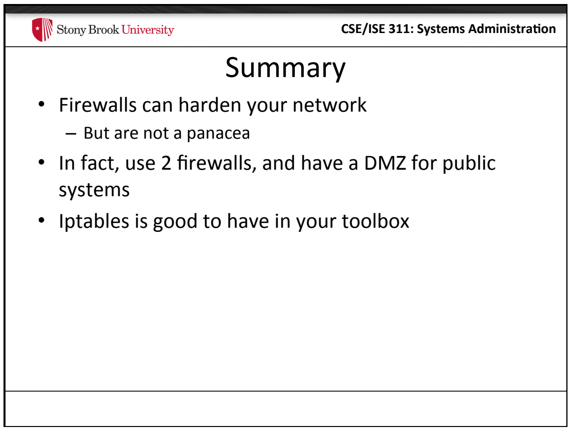
As part of boot…

- You can generally configure rules when a machine is brought up in /etc/network/interfaces
  - This is the standard network configuration file
  - Directive: pre-up
- Example:

```
auto eth0
iface eth0 inet dhcp
  pre-up iptables-restore < /etc/iptables.up.rules
```



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Summary

- Firewalls can harden your network
  - But are not a panacea
- In fact, use 2 firewalls, and have a DMZ for public systems
- Iptables is good to have in your toolbox