

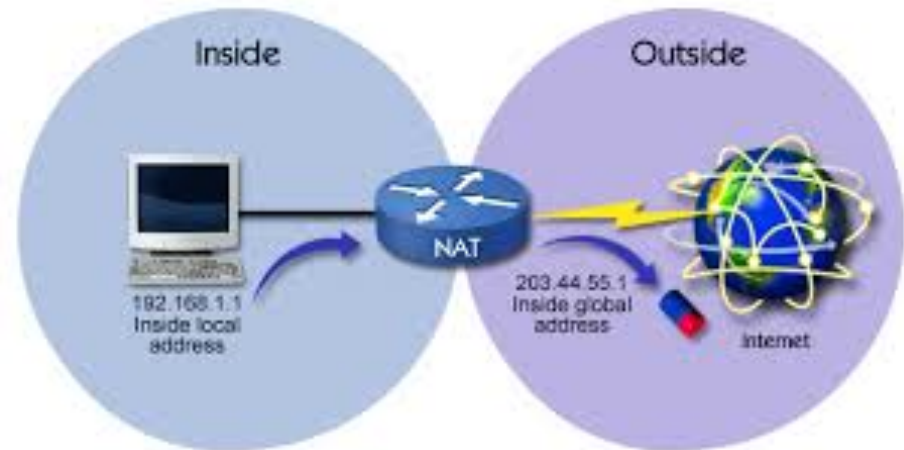
# **COSC 301**

## **Network Management and Security**

### **Lecture 22: Firewalls & NAT**

# Today's Focus

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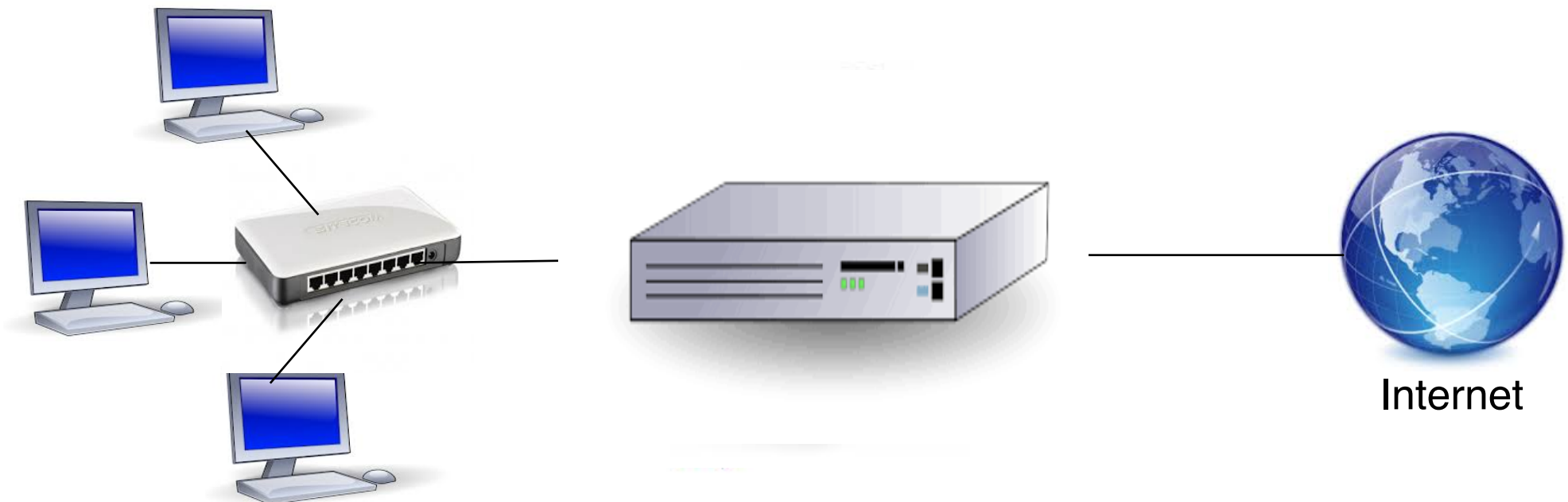


How to protect an intranet?

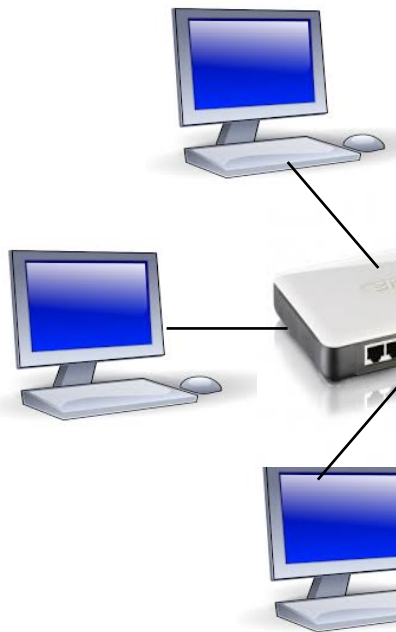
- Firewall
- Network Address Translation(NAT)

# What is Firewall?

- A firewall is a hardened and trusted host that acts as a *check point* between an internal network and the rest of the Internet
  - All affected network traffic is routed through the firewall
  - Is configured with rules that determine which traffic to be passed and which to be blocked



- A firewall *check point* for the Internet
  - All affected
  - Is controlled
  - Passed



acts as a  
the rest of  
firewall  
difficult to be



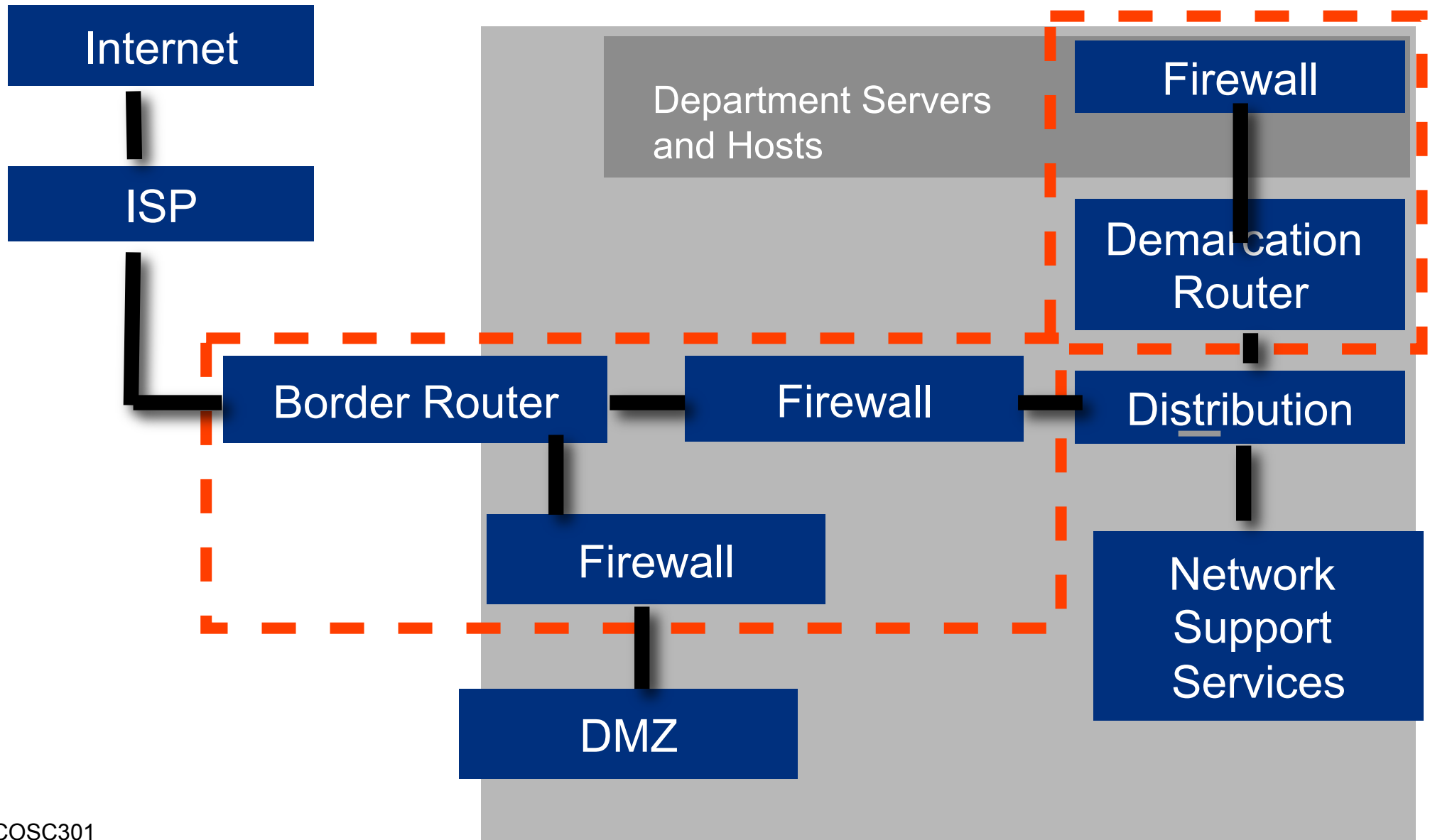
Internet

# Router/Gateway

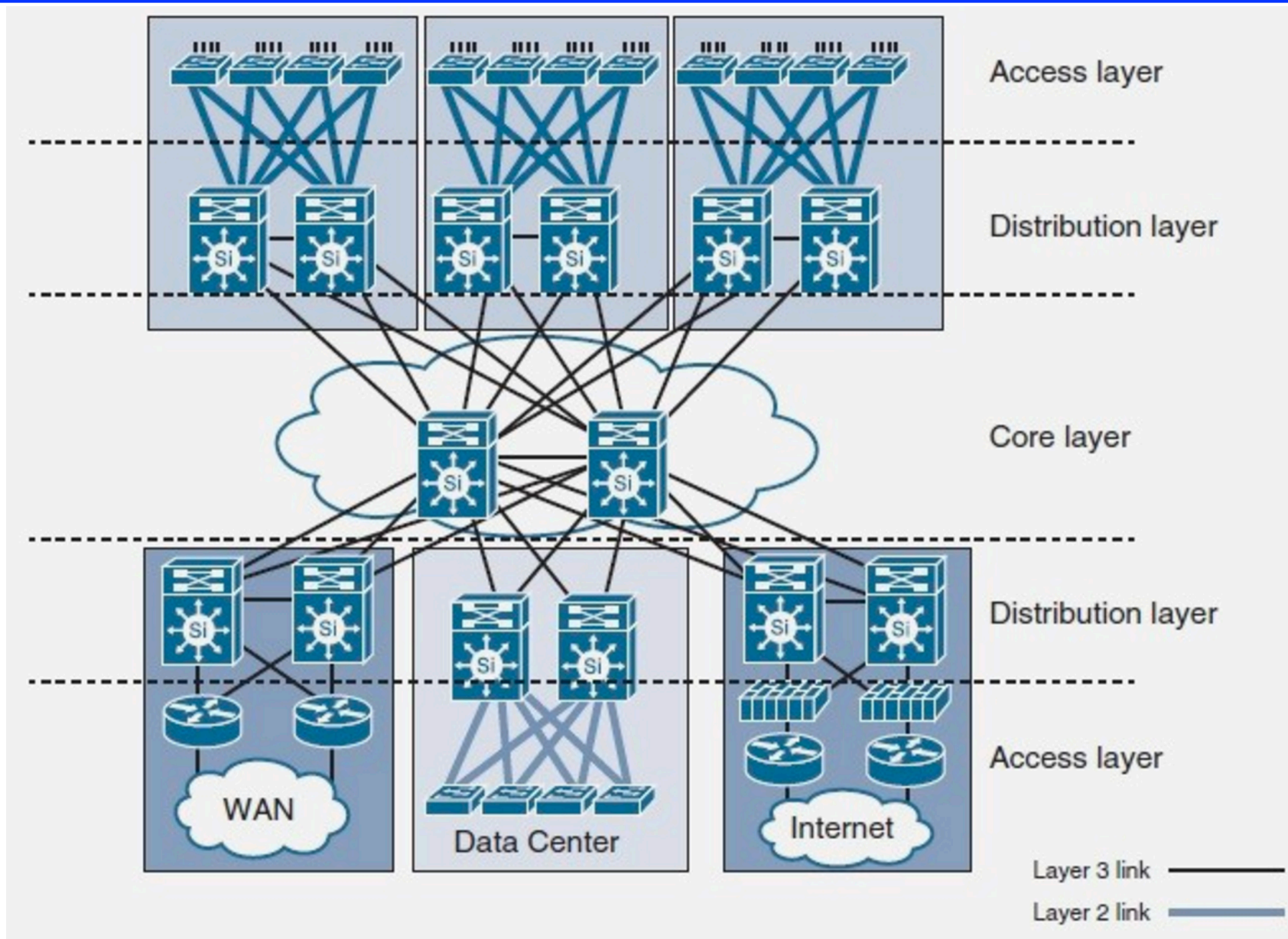
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- Router
  - Primary purpose is to forward packets (Layer 3).
  - Demarcates a broadcast zone (e.g. Ethernet).
  - May demarcate management borders.
  - Used to shield the border of networks.
  - Often some firewall capabilities. (Layer 4)
- Gateway
  - A very broad term.
  - Application Layer Gateway: Email, Web

# Sample Large Networks



# Interior Network Topology



# Border Router

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- Coarse-grained inspection.
- Block offensive networks from getting inside your network.
  - Route to null(0) or drop at firewall.
- Hide parts of interior network from outside.
- Stop interior hosts from accessing internet directly.
  - Force use of web proxy or e-mail gateway.



# Firewall

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- Commonly done on the router.
- Used to implement a finer-grained access policy.
- Protects against illegitimate packets.
- Position
  - **Inside of router:** Routers are faster, better equipped for simple dropping
  - **In front of infrastructure:** Firewalls incur some delay, but it is usually negligible when compared with the Internet.
- Individual hosts commonly have firewalls.
  - Fast becoming the out-of-box configuration.

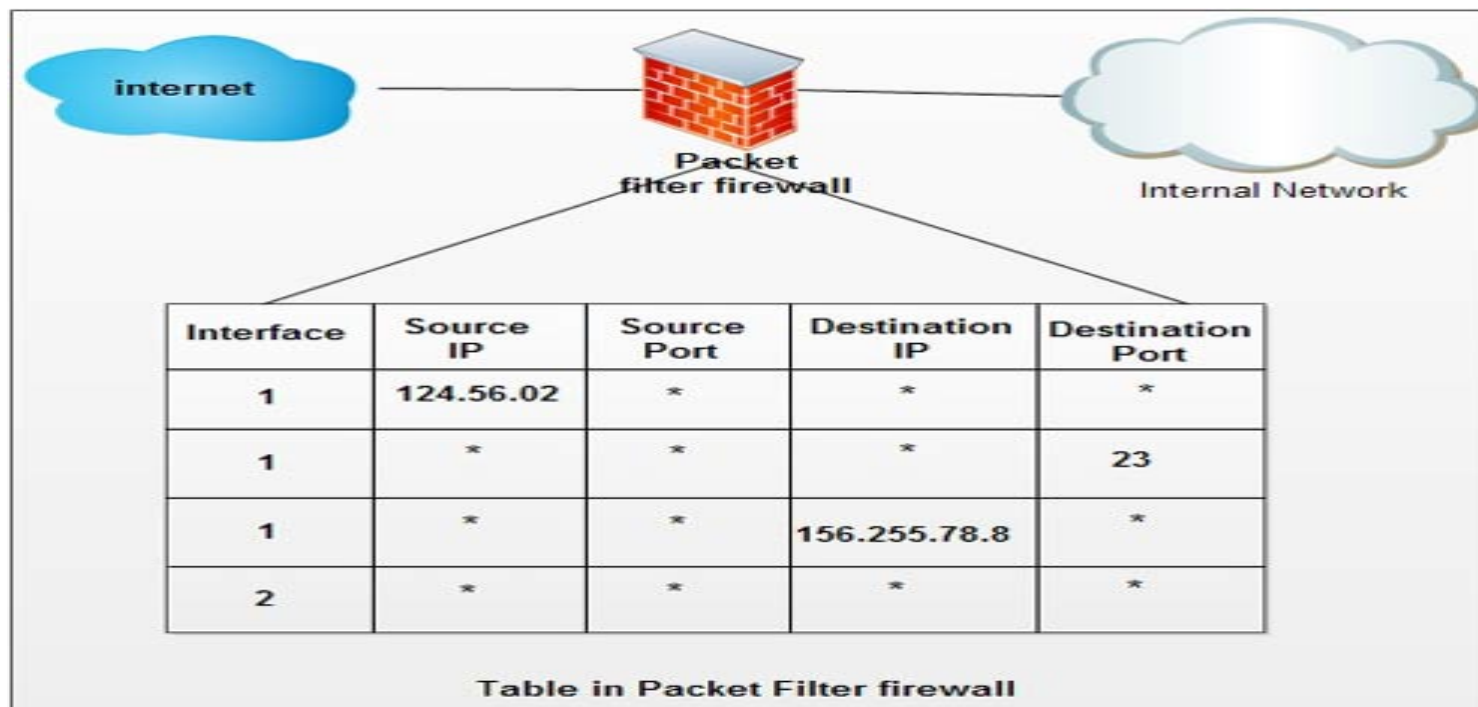
# Gateway

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- Can be used to implement a Web Proxy.
  - Use can be enforced by router / firewall.
- Can be used as e-mail filtering solution.
  - e.g. all outgoing and incoming mail must go through a mailhub—only authorised hosts can be e-mail servers.
  - All e-mail is scanned for viruses and SPAM.

# 1<sup>st</sup> : Packet-Filter Firewall

- Forward or block packets based on the information in network-layer and transport-layer headers
  - Source and destination addresses
  - Source and destination port addresses
  - Type of protocol (TCP or UDP)

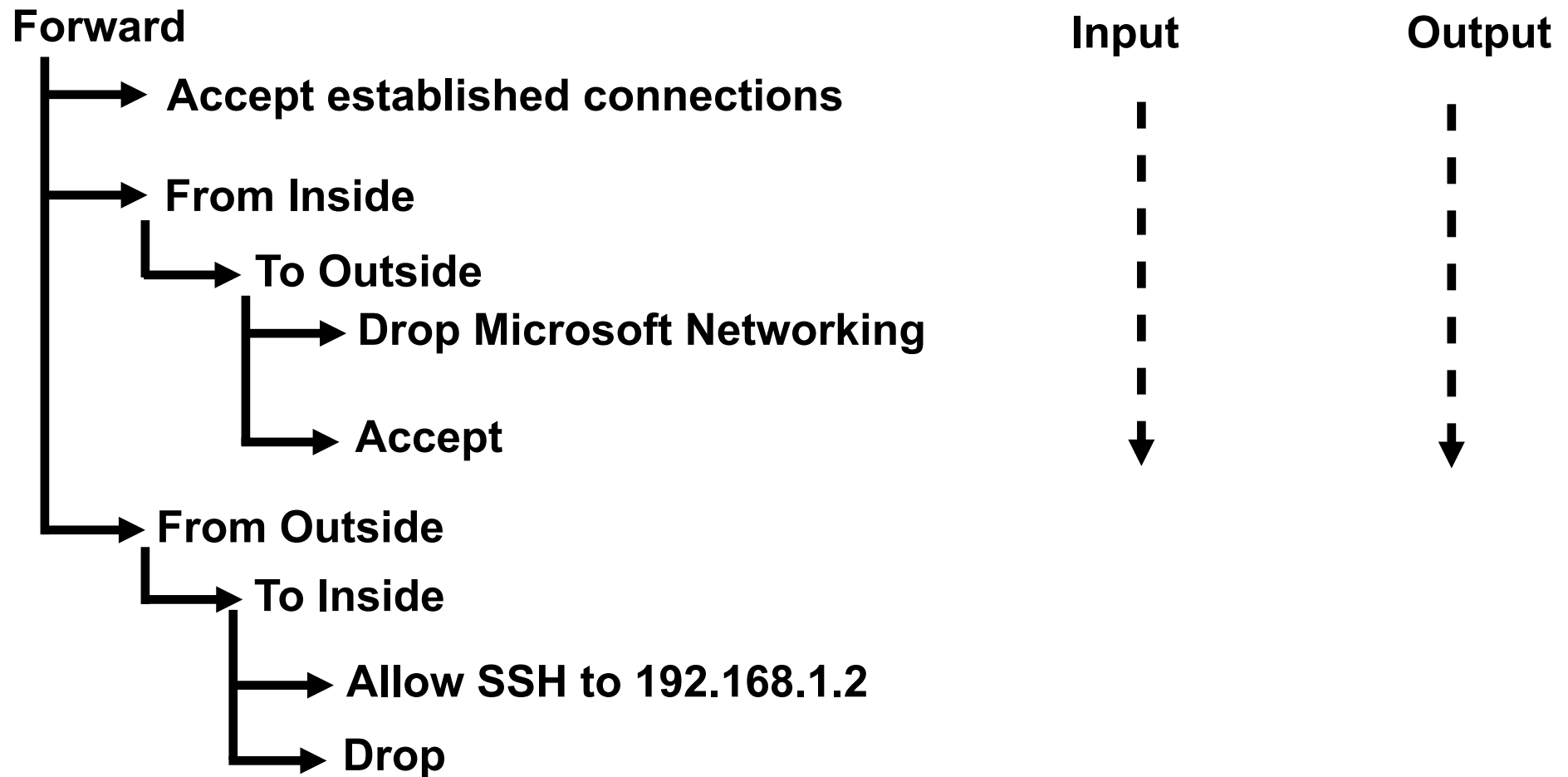


# Packet Filter Process

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- Think of a firewall as a set of inverted trees.
  - Input, Output and Forward
  - Create a chain for each combination of {in,out}
  - Each packet starts at the top of its respective tree.
- Packet is inspected one test at a time
  - Accept or drop (processing stops)
  - Jump into another rule-set (continue processing)
  - Return from a rule-set (or fall-off a rule-set)
  - Falling off the tree's rule-set invokes the default policy for that tree.

# Tree of Chains



If a rule in the firewall exists to block telnet access, it will block the TCP protocol for port number 23

# IP rules

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- To allow all incoming SSH
  - iptables –A INPUT –p tcp –dport 22 –m conntrack –ctstate NEW,ESTABLISHED –j ACCEPT
  - iptables –A OUTPUT –p tcp –sport 22 –m conntrack –ctstate ESTABLISHED –j ACCEPT
- To allow all outgoing SSH
  - iptables –A OUTPUT –p tcp –dport 22 –m conntrack –ctstate NEW,ESTABLISHED –j ACCEPT
  - iptables –A INPUT –p tcp –sport 22 –m conntrack –ctstate ESTABLISHED –j ACCEPT

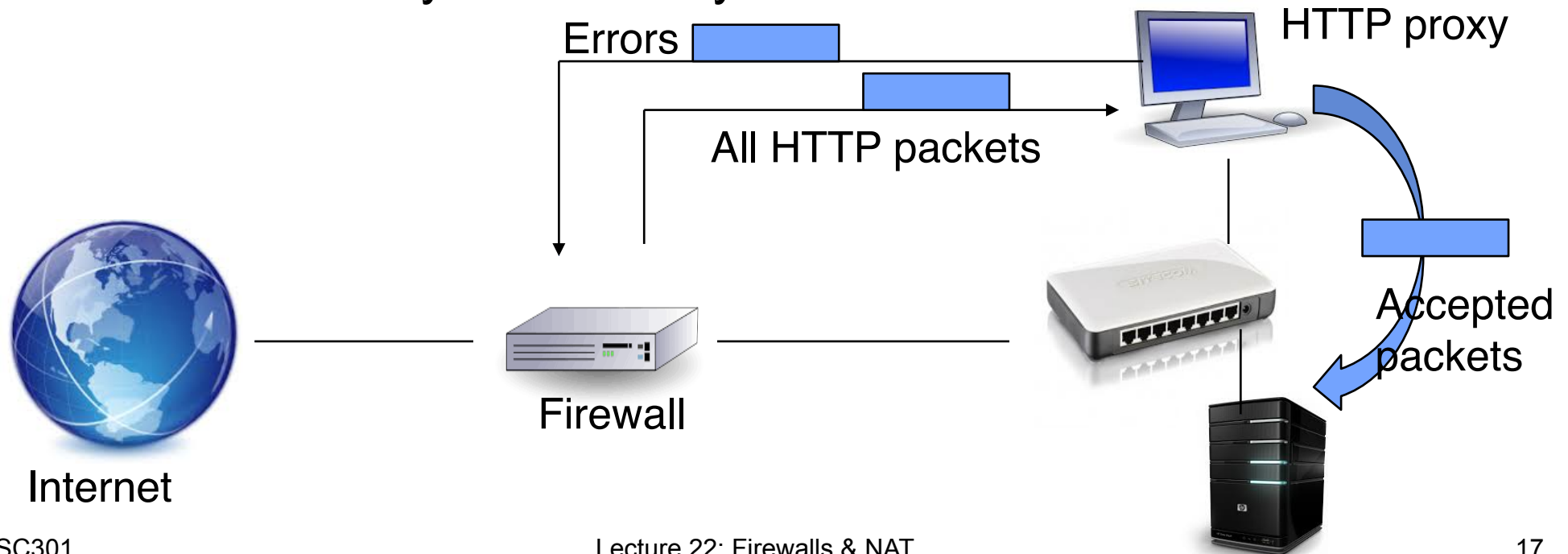
## 2<sup>nd</sup>: Stateful Firewall

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- Performs the work of the packet-filter firewall but operates up to layer 4 (transport layer)
- Stateful packet inspection
  - Keep track of the state of network connections
    - SYN, SYN-ACK, ACK, ESTABLISHED, sequence number, port, IP, ...
  - Determines whether a packet is the start of a new connection, a part of an existing connection, or not part of any connection using the maintained states.
  - UDP is connectionless, so tracking is a little less precise, but still good enough, so long as the source port is random.
  - CPU intensive checking is performed at the time of setup of the connection. They may not be suitable for border routers on larger networks

# 3<sup>rd</sup>: Proxy Firewall

- Filter message based on the information available in the message itself (application layer)
  - Sometimes called application gateway
  - To detect if an unwanted protocol is attempting to bypass the firewall on an allowed port, or detect if a protocol is being abused in any harmful way



# Firewall can Guard Against

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- Near-local spoofing
  - where packets come in on the wrong interface.
- Ping-floods against internal hosts
  - though the firewall still gets flooded.
- Syn-Ack attacks
  - Limit TCP half-open connections to say 20/min.
- Fragment attacks
  - stateful firewalls.

# Firewall isn't a Panacea

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- Spoofing internet hosts
  - solved using tools such as SSL
- Flooding your internet connection
  - requires upstream co-operation. No protocol support for this, e.g. DoS and DDoS
- Detecting network anomalies
  - requires checking of logs, Intrusion Detection Systems
- Poor policy will quickly degrade security.

# Private Network and NAT

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- *Private IP* network is an IP network that is not directly connected to the Internet
- IP addresses in a private network can be assigned arbitrarily.
  - Not registered and not guaranteed to be globally unique
- NAT is a way to conserve IP addresses
  - hide a number of hosts behind a single IP address - A short term solution to IP address depletion
  - Uses private addresses:
    - 10.0.0.0-10.255.255.255,
    - 172.16.0.0-172.32.255.255 or
    - 192.168.0.0-192.168.255.255

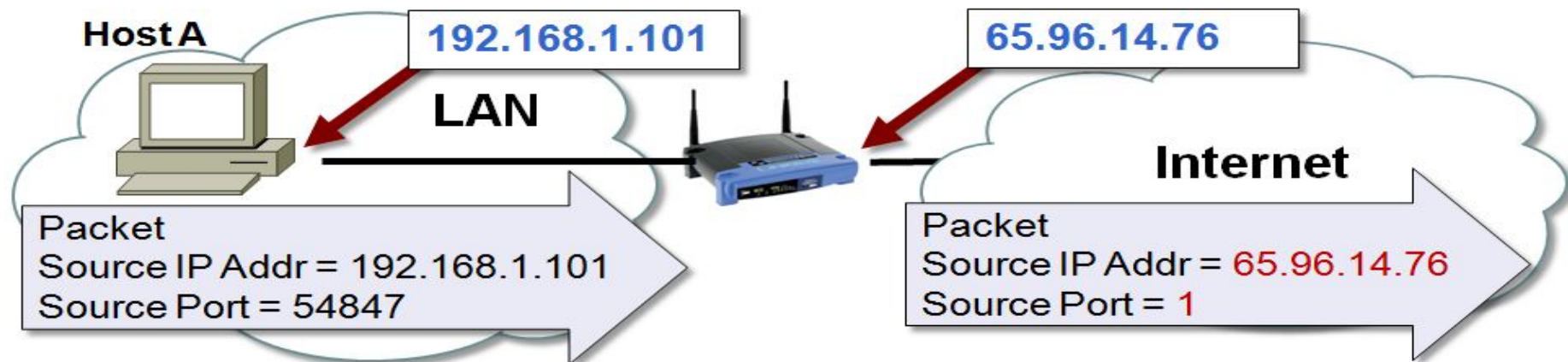
# SNAT and DNAT

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- Source NAT (SNAT)
  - the destination IP address is maintained and the source IP address is changed.
  - allows a host on the “inside” of the NAT to initiate a connection to a host on the “outside” of the NAT.
- Destination NAT (DNAT)
  - the destination address is changed and the source IP address is maintained.
  - allows a host on the “outside” to connect to a host on the “inside”.
- Port Address Translation (PAT)
  - NAT overloading
  - uses one IP address for all clients to multiple ports

# NAT Table

- The NAT table is the heart of the whole NAT operation, which takes place within the router (or any NAT-enabled device) as packets arrive and leave its interfaces.



NAT Translation Table				
	Local IP Address	Source Port #	Internet IP Address	Source Port #
process X, Host A →	192.168.1.101	54,847	= 65.96.14.76	1
Host B →	192.168.1.103	24,123	= 65.96.14.76	2
process Y, Host A →	192.168.1.101	42,156	= 65.96.14.76	3
Host C →	192.168.1.102	33,543	= 65.96.14.76	4

# NAT Concerns

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- Performance
  - Modifying the IP header by changing the IP address requires that NAT boxes recalculate the IP header checksum
  - Modifying port number requires that NAT boxes recalculate TCP checksum
- End-to-end connectivity
  - NAT destroys universal end-to-end reachability of hosts on the Internet.
  - A host in the public Internet often cannot initiate communication to a host in a private network.
  - The problem is worse, when two hosts that are in a private network need to communicate with each other.
    - Port forwarding
    - TCP hole punching




# Summary

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- What is firewall? How does it work?
- Security issues related to firewall
- What is NAT? How does it work?

# References

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-  RFC 2647  
Benchmarking Terminology for Firewall Performance
-  <http://www.netfilter.org/> (iptables)
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