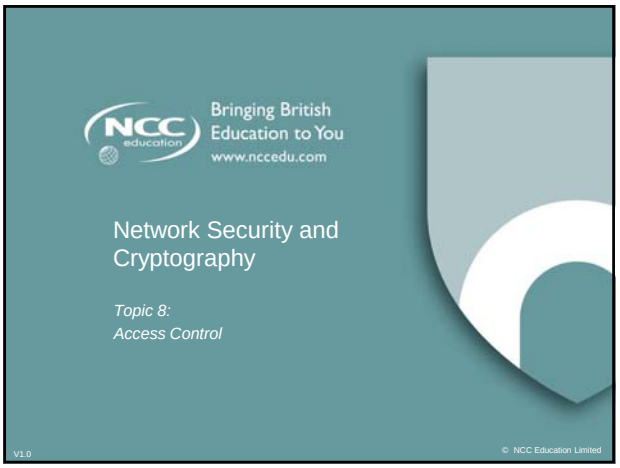
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Topic 8 – Lecture 1:
Packet Filters & Access Control Lists
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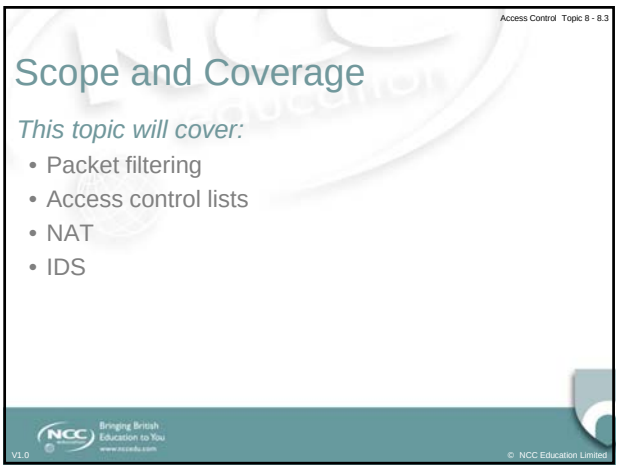
Access Control Topic 8 - 8.3
Scope and Coverage
This topic will cover:
• Packet filtering
• Access control lists
• NAT
• IDS
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Access Control Topic 8 - 8.4

Learning Outcomes

By the end of this topic students will be able to:

- Configure access control mechanisms
- Apply and manage port forwarding rules

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Access Control Topic 8 - 8.5

Access Control

- Network traffic is in the form of IP/TCP/UDP packets
- The headers of these packets contain information as to source and destination of the packets
- Routing devices uses the source and destination addresses to route traffic through the network
- These addresses can be used to create access control rules
- We will examine methods for determining if traffic is allowed on a network or section of a network

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Packet Filtering

- Routing devices examine a packet's destination address and decide where to send it
- Packet filtering adds an extra layer to this process
- First the destination address is examined
- If the router determines that it should process the packet it then applies a set of rules to determine what happens to it
- Can apply these rules to both incoming and outgoing packets

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Filtering Rules

- Implement security policies as services that are allowed or disallowed
- Examples:
  - Packets for particular machines can be blocked
  - Specific types of packets can be blocked
  - Packets going out of your network can be blocked
- Packet filtering rules can be very general or can be applied to specific machines or ports

Use of Packet Filtering

- Commonly used to protect a network from attack from machines outside of the network
- Most routing devices have packet filtering capabilities
- An inexpensive option as no extra equipment required
- Very powerful tool
- Does not provide full protection

Packet Filtering Possibilities

- Can be applied to:
  a. Machines
  b. Ports
  c. Combinations of machines and ports
- Examples:
  a. Block all traffic to machine A
  b. Block all traffic to port 80 (http)
  c. Block all traffic to port 80 except on machine A

Stateless Filtering - 1

- Simple rules
- Easy to implement
- Not flexible
- For example:
  - If all traffic to port 80 is blocked a static filter will block all http traffic
  - It cannot be set to block all traffic to port 80 except that from http://campus.nccedu.com in a single rule

Stateless Filtering - 2

- Filtering process is “dumb”
  - Applies a set of static rules to every packet
  - Does not store any results from previous packets
  - No intelligence or learning built into the filtering system
- The set of rules is an ***Access Control List*** (ACL)
  - Rules are checked in a specific order
  - The first matching rule found is applied to the packet
  - If there are no rules matching the packet is blocked

Stateful Filtering

- Also known as Dynamic Packet Filtering
- Uses a state table that stores detail of legitimate traffic requests:
  - IP addresses
  - Ports
  - Handshake status
  - Route/Time
- Compare packets with previous valid traffic
- Allows traffic based upon connections

Configuring Static Packet Filters

- There are three main steps to correctly configuring static packet filters

1. Decide what traffic to permit and what traffic to block
   - Determined by nature of business and assessment of security risks
2. Define this as a set of rules that includes IP addresses and port numbers
3. Translate these rules into a language that the router or other device understands
   - May be vendor specific so we do not cover this

What is Permitted?

- This is done at a conceptual level
  - Is internet access allowed
  - Can individual machines accept email from the Internet or will it all come through a central mail server
  - Are all messages from a specific location blocked
- A good general rule is to block all packets except those that have been specifically allowed
  - Default is to block all packets not processed by the rule list

Access Control Lists - 1

- A simple tabular template should be used that has one rule for each line of the table
- The following columns should be included:
  - Source IP address
  - Source port
  - Destination IP address
  - Destination port
  - Action (block/allow)
  - Comments (allow a brief text explanation)
- Protocol can be included in this

Access Control Lists - 2

- The order of the rules is important
- The first rule that matches with the packet being inspected will be implemented
- All remaining rules will be ignored

Source IP	Source port	Destination IP	Destination port	Action	Comment
81.109.47.141	*			Block	Block all traffic from this
		192.37.22.01	110	Allow	Open internal POP3 port

Access Control Lists - 3

- What happens when 81.109.47.141 sends an email message to 192.37.22.01?
- What happens if 81.109.47.142 sends an email message to 192.37.22.01?
- What happens if 81.109.47.142 sends a telnet message to 192.37.22.01?
- What if the rule order is swapped?

Source IP	Source port	Destination IP	Destination port	Action	Comment
81.109.47.141	*			Block	Block all traffic from this
		192.37.22.01	110	Allow	Open internal POP3 port

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Network Security and Cryptography

Topic 8 – Lecture 2:
NAT and IDS

Network Address Translation

- NAT provides a means to connect multiple computers to an IP network using only one IP address
- Three reasons this is useful:
  - Shortage of IP addresses (under IPv4)
  - Security
  - Flexible network administration

The Number of IP Addresses

- A typical IP address is written as dotted quad
  - E.g. 81.109.47.141
- In IPv4 there was theoretical limit on the number of available IP addresses
  - 4 bytes = 2^{32} = 4,294,967,296 possible addresses
- Method was required to create “extra” IP addresses or the Internet would reach capacity
- The main reason for the use of NAT originally was to create “extra” IP addresses

The IP Address

- An IP address has two parts:
  - a network number
  - a host number
- Computers on one physical network have the same network number
  - Think street name in a postal address
- The rest of the IP address defines an individual computer
  - Think house number in a postal address

Access Control Topic 8 - 8.22

IP Address Classes - 1

- The network size determines the class of IP address
- There is a network and host part in each IP address
- IP addresses come in 4 classes (A, B, C and D)
- Each class suits a different network size

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IP Address Classes - 2

- Network addresses with first byte between 1 and 126 are class A with approx.17 million hosts each
- Network addresses with first byte between 128 and 191 are class B with approx. 65000 hosts each
- Network addresses with first byte between 192 and 223 are class C with 256 hosts
- All other networks are class D, used for special functions, or class E which is reserved

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Dynamically Assigning Addresses

- Internet Service Providers (ISPs) usually allocate a single address to a single customer
- This is assigned dynamically
  - every time a client connects to the ISP a different address is provided
- Large companies can buy several addresses
- It is more economic for small businesses to use a single address

Connecting Multiple Computers

- In theory one IP address means only one computer can connect to the Internet
- By using a NAT gateway running on a single computer, multiple local computers can connect using the single IP address
- To the Internet this appears as a single computer
- End-to-end connections are not created and this can prevent some protocols from working

Dynamic NAT

- A small number of public IP addresses are dynamically assigned to a large number of private IP addresses
- Port Address Translation (PAT) is a variant of NAT:
  - Allows one or more private networks to share a single public IP address
  - Commonly used in small businesses
  - Remaps both source and destination addresses and source and destination ports of packets

NAT and Security

- NAT only allows connections that come from inside the network
- Internal servers can allow connections from outside via inbound mapping
  - Specific ports are mapped to specific internal addresses
  - Makes services such as FTP or the Internet available but in a highly controlled way
- NATs use their own protocol stack not that of the host machine
  - Protects against some attacks

NAT and Network Administration

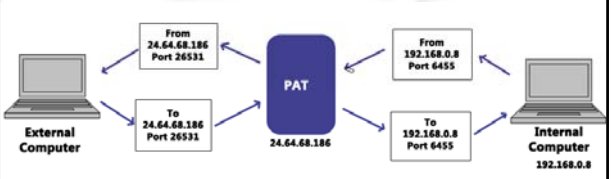
- Can aid network administration in several ways:
  - May contain a dynamic host configuration protocol (DHCP) server
  - Provide methods for restricting Internet access
  - Have traffic logging capabilities
  - Can divide a network into sub-networks

NAT Operation

- Changes the source address on every outgoing packet to the single public address
- Renumbers source ports to be unique
  - Used to keep track of each client connection
- Has a port mapping table to record ports for each client computer
  - Relates real local IP address and source port to translated port number, destination address and port
  - Allows the process to be reversed for incoming packets so they are routed to the correct client

PAT Operation

- An example of how IP and port are changed



Intrusion Detection Systems (IDS)

- Monitors network traffic for suspicious activity
- Alerts the network administrator if suspicious activity discovered
- May also respond to suspicious traffic by:
  - blocking the user from accessing the network
  - blocking the IP address from accessing the network
- Different types that use different methods to detect suspicious activity

IDS Types

- Network based intrusion detection systems (NIDS)
- Host based intrusion detection systems (HIDS)
- IDS that look for signatures of known threats
- IDS that compare traffic patterns against a network baseline and look for anomalies in the patterns

NIDS

- Positioned in strategic locations in the network
- Monitor all traffic to and from network devices
- In a perfect world all traffic would be monitored
- This would create a bottleneck in the network with a huge processing overhead
  - It would deteriorate network speed

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HIDS

- Operate on individual hosts or network devices
- Monitors all inbound and outbound packets but only to and from the device it operates on
- If suspicious activity is detected it usually alerts the user and/or network administrator of that activity

Access Control Topic 8 - 8.35

Signature-based IDS

- Monitors packets on the network
- Compare packets against a stored database of known malicious threats
  - Similar to the operation of antivirus software
- When a new threat appears there is a period of time before this is added to the database
- Any new threat is undetected until such time as the database is updated to include this threat
  - Similar to the operation of antivirus software

Access Control Topic 8 - 8.36

Anomaly-based IDS

- Monitors network traffic
- Compare network traffic with a baseline
- Baseline is “normal” traffic for that network:
  - Bandwidth
  - Protocols
  - Ports
  - Devices
- User and/or network administrator is alerted if there is a significant change from the baseline

IDS Overview

- Ideal for monitoring and protecting a network
- Can be prone to false alarms
- Must be correctly set up to recognize what is normal traffic on the network
- Network administrators and users must:
  - Understand the alerts
  - Know the most effective course of action upon receiving an alert

References

- Scambrey, J., McClure, S. and Kurtz, J. (2001). *Hacking Exposed: Network Security Secrets & Solutions*. 2nd Edition. McGraw Hill.

Topic 8 – Access Control

Any Questions?