Evading IDS, Firewalls, and Honeypots

Module 16

Unmask the Invisible Hacker.

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Survey: The State of Network Security 2014

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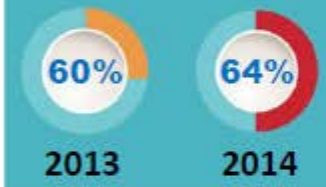
57% of organizations either struggle to identify vulnerabilities or understand IT risk in business content

97% of organizations agree that business stakeholders should be made aware of vulnerabilities in their applications and "own the risk"



of organizations said time-consuming manual processes, lack of visibility into security policies and poor change management were the greatest challenge of managing network security devices

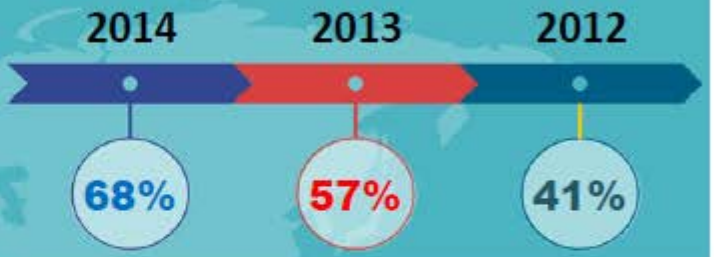
57% of organizations suffered a data center application outage in the last year due to misconfigured security infrastructure

22% of organizations suffered 3 or more data center application outages in the last year

AND

of organizations suffered an application or network outage as a result of an out-of-process security change

Adoption of Next-Generation Firewalls



Who can you trust?

Only **33%** of organizations are confident of their third party provider's capabilities to ensure the highest level of protection

11% of organizations have no confidence in their provider's ability to ensure the highest level of protection

http://blog.algosec.com

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Cybersecurity Market Report

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"Next generation" cybersecurity spending could reach **$15 billion to $20 billion** in the next 3 years

FBR Capital Markets predicts **20% increase** in "next-generation cybersecurity spending" this year (2015), as companies move beyond traditional firewall and endpoint vendors

About **10% of enterprises and government agencies** have upgraded to next-generation security software, such as firewalls that detect and block threats at the application level

High profile data breaches have piqued the demand for **WAF** (web application firewall) systems. The worldwide market is expected to reach **$777.3 million in 2018**

http://cybersecurityventures.com

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Module Objectives

- Understanding IDS, Firewall, and Honeypot Concepts
- IDS, Firewall and Honeypot Solutions
- Understanding different techniques to bypass IDS
- Understanding different techniques to bypass Firewalls

- IDS/Firewall Evading Tools
- Understanding different techniques to detect Honeypots
- IDS/Firewall Evasion Countermeasures
- Overview of IDS and Firewall Penetration Testing



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Module Flow

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01 IDS, Firewall and Honeypot Concepts	02 IDS, Firewall and Honeypot Solutions	03 Evading IDS
04 Evading Firewalls		05 IDS/Firewall Evading Tools
06 Detecting Honeypots	07 IDS/Firewall Evasion Counter-measures	08 Penetration Testing

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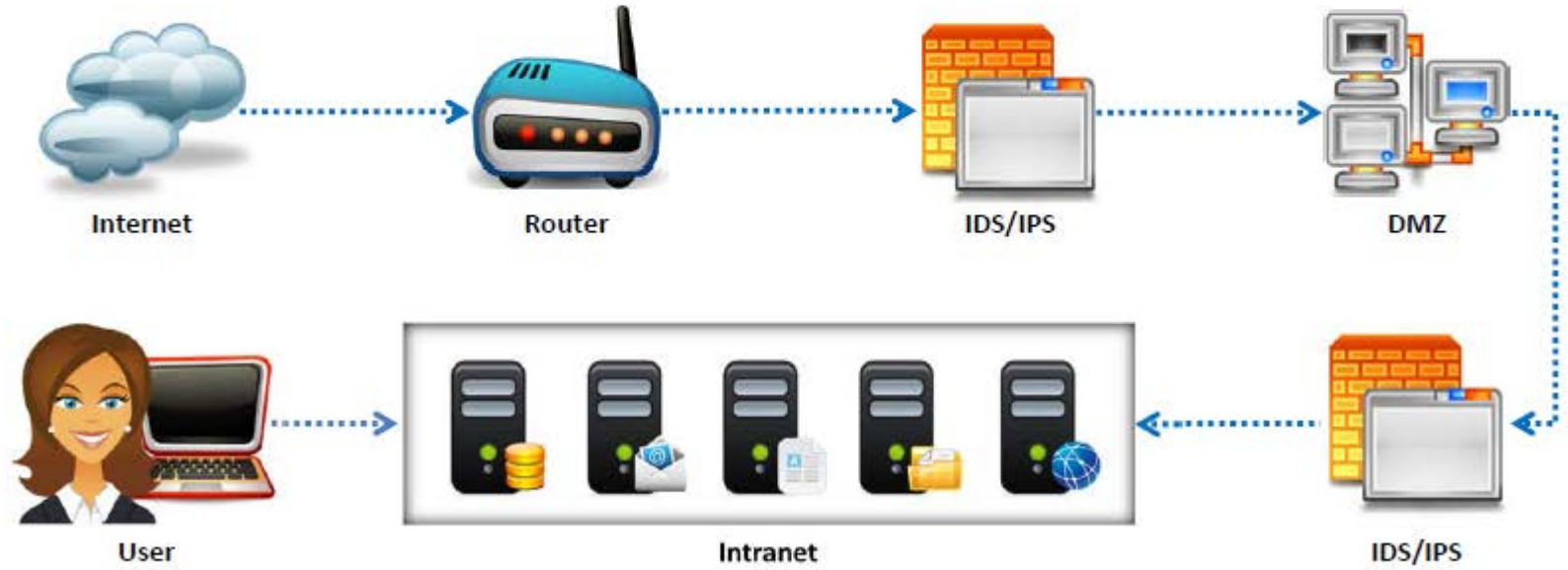
Intrusion Detection Systems (IDS) and their Placement

An intrusion detection system (IDS) **inspects all inbound and outbound network traffic** for suspicious patterns that may indicate a network or system security breach

The IDS **checks traffic** for signatures that match known intrusion patterns, and **signals an alarm** when a match is found



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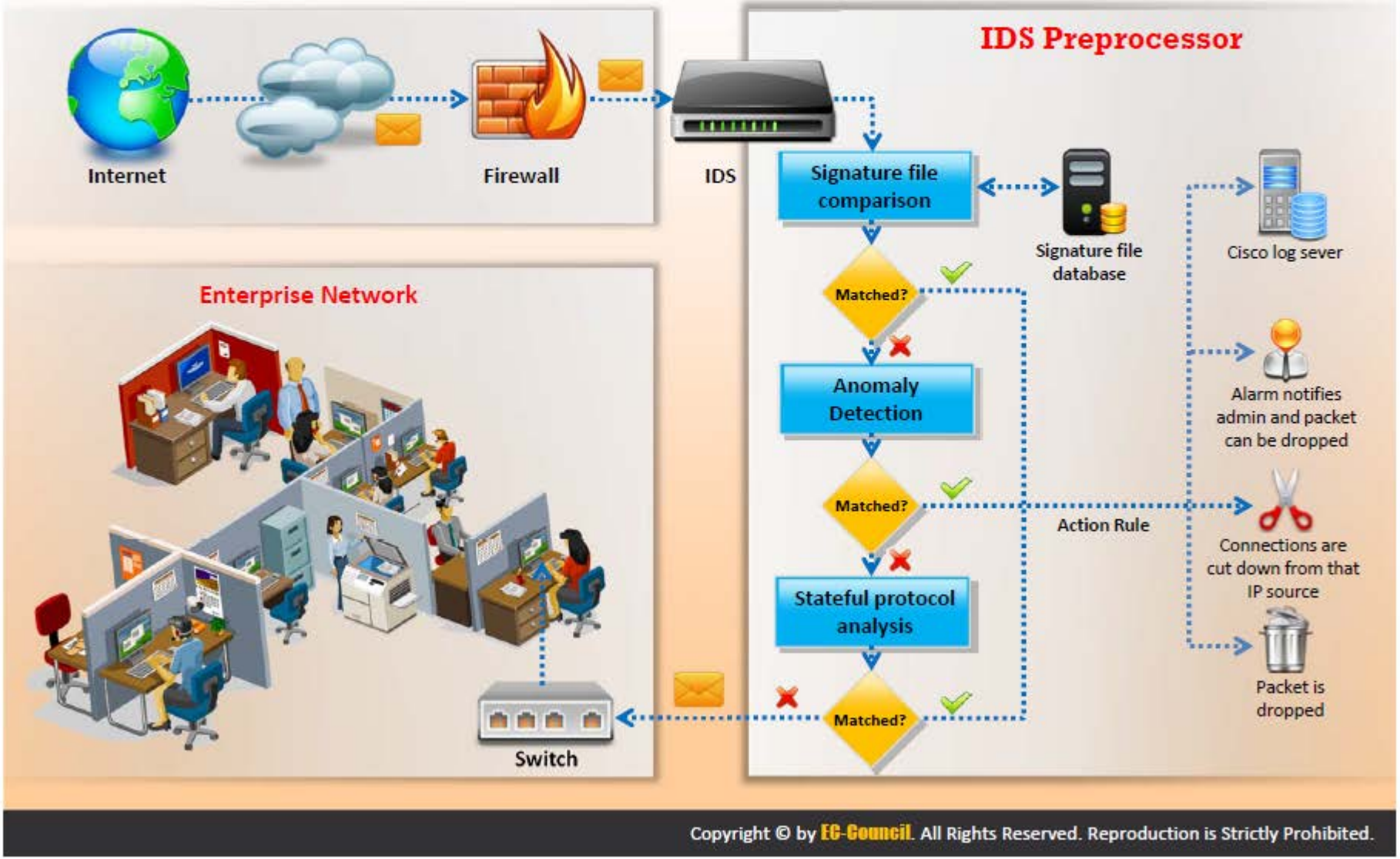
How IDS Works



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Ways to Detect an Intrusion

Signature Recognition

It is also known as misuse detection. Signature recognition tries to identify events that indicate misuse of a system resource

Anomaly Detection

It detects the intrusion based on the fixed behavioral characteristics of the users and components in a computer system

Protocol Anomaly Detection

In this type of detection, models are built to explore anomalies in the way vendors deploy the TCP/IP specification

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General Indications of Intrusions

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System Intrusions

- The presence of new, unfamiliar files, or programs
- Changes in file permissions
- Unexplained changes in a file's size
- Rogue files on the system that do not correspond to your master list of signed files
- Unfamiliar file names in directories
- Missing files

Network Intrusions

- Repeated probes of the available services on your machines
- Connections from unusual locations
- Repeated login attempts from remote hosts
- Arbitrary data in log files, indicating attempts to cause a DoS or to crash a service

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General Indications of System Intrusions

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01 Short or incomplete logs

02 Unusual graphic displays or text messages

03 Unusually slow system performance

04 Modifications to system software and configuration files

05 Missing logs or logs with incorrect permissions or ownership

06 System crashes or reboots

07 Gaps in the system accounting

08 Unfamiliar processes

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Types of Intrusion Detection Systems

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Network-Based Intrusion Detection Systems — 01

- These mechanisms typically consist of a **black box** that is placed on the network in the promiscuous mode, listening for patterns indicative of an intrusion
- It detects malicious activity such as **Denial-of-Service attacks**, port scans, or even attempts to crack into computers by monitoring network traffic

Host-Based Intrusion Detection Systems — 02

- These mechanisms usually include auditing for events that occur on a **specific host**
- These are not as common, due to the overhead they incur by having to **monitor each system event**

Network-based IDS (NISD)

Host-based IDS (HIDS)

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System Integrity Verifiers (SIV)

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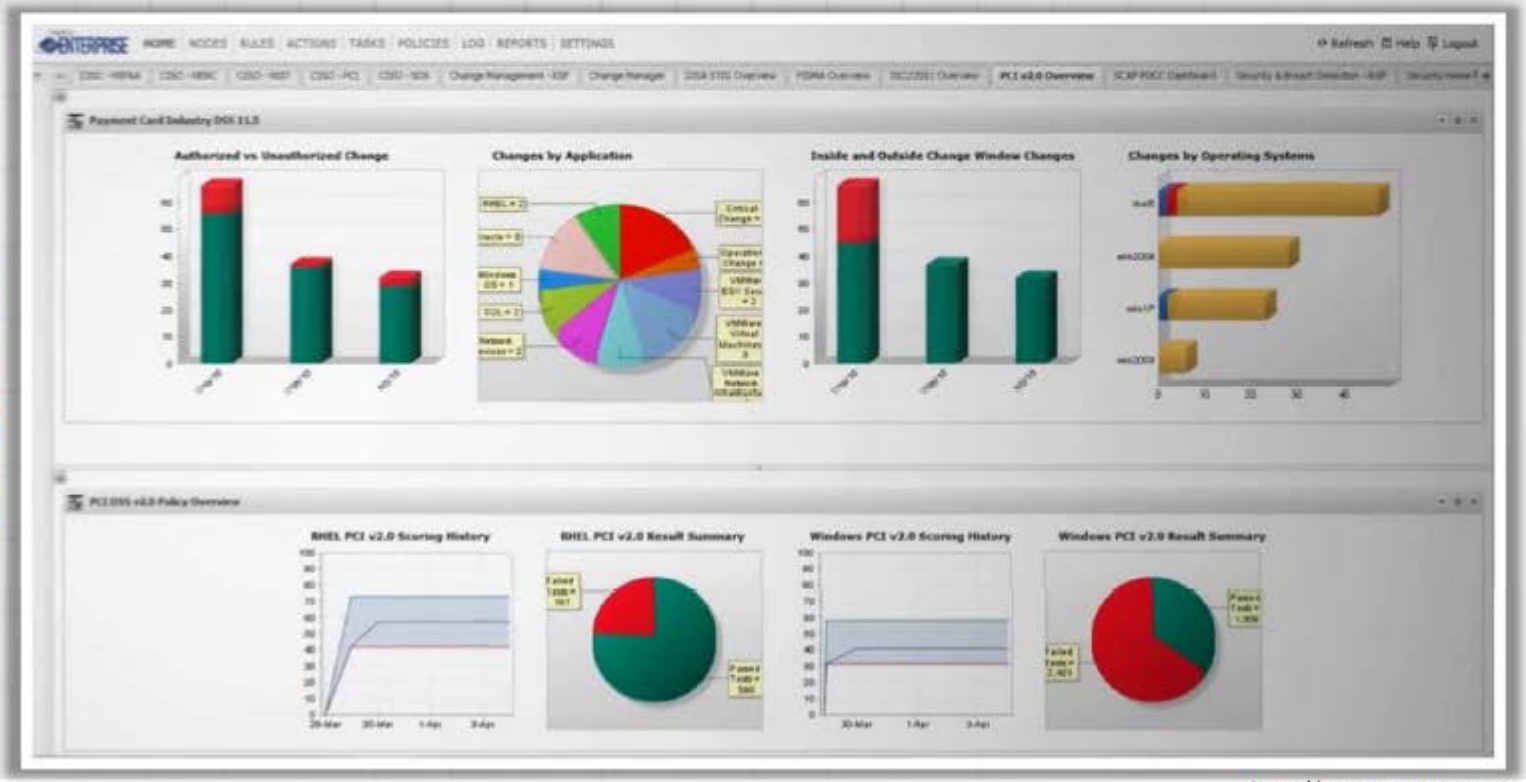
System Integrity Verifiers **detect changes** in critical system components which help in detecting system intrusions

SIVs **compares a snapshot** of the file system with an existing baseline snapshot

Tripwire



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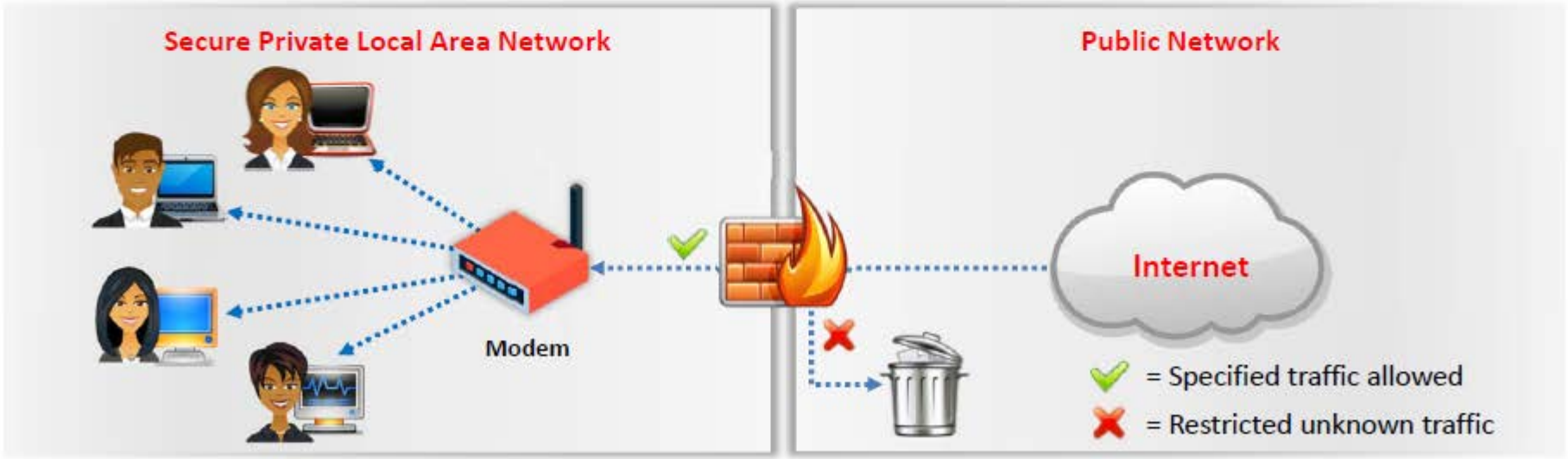
Firewall

Firewalls are hardware and/or software designed to prevent **unauthorized access** to or from a private network

Firewalls **examine all messages entering or leaving the Intranet** and blocks those that do not meet the specified security criteria

They are placed at the junction or **gateway** between the two networks, which is usually a private network and a public network such as the Internet

Firewalls may be concerned with the type of traffic or with the **source** or **destination addresses** and ports



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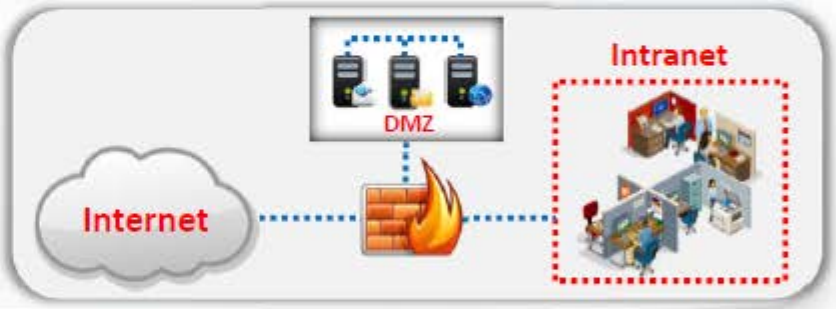
Firewall Architecture

Bastion Host

- Bastion host is a computer system designed and configured to protect **network resources** from attack
- Traffic entering or leaving the network passes through the firewall, it has two interfaces:
  - **public interface** directly connected to the Internet
  - **private interface** connected to the Intranet

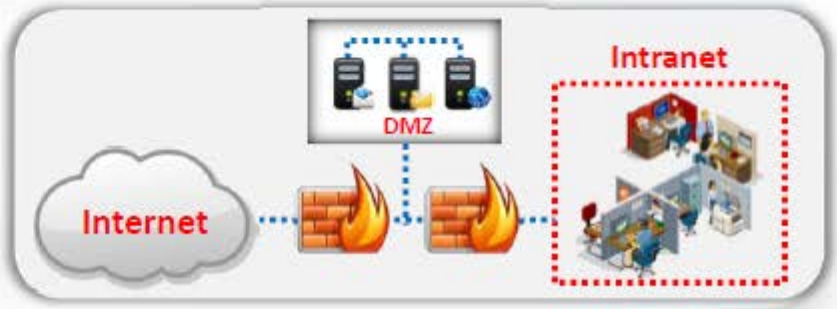
Screened Subnet

- The screened subnet or DMZ (additional zone) contains **hosts** that offer public services
- The DMZ zone **responds to public requests**, and has no hosts accessed by the private network
- Private zone can not be accessed by **Internet users**



Multi-homed Firewall

- In this case, a firewall with two or more interfaces is present that allows further subdivision of the network based on the **specific security objectives** of the organization



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DeMilitarized Zone (DMZ)

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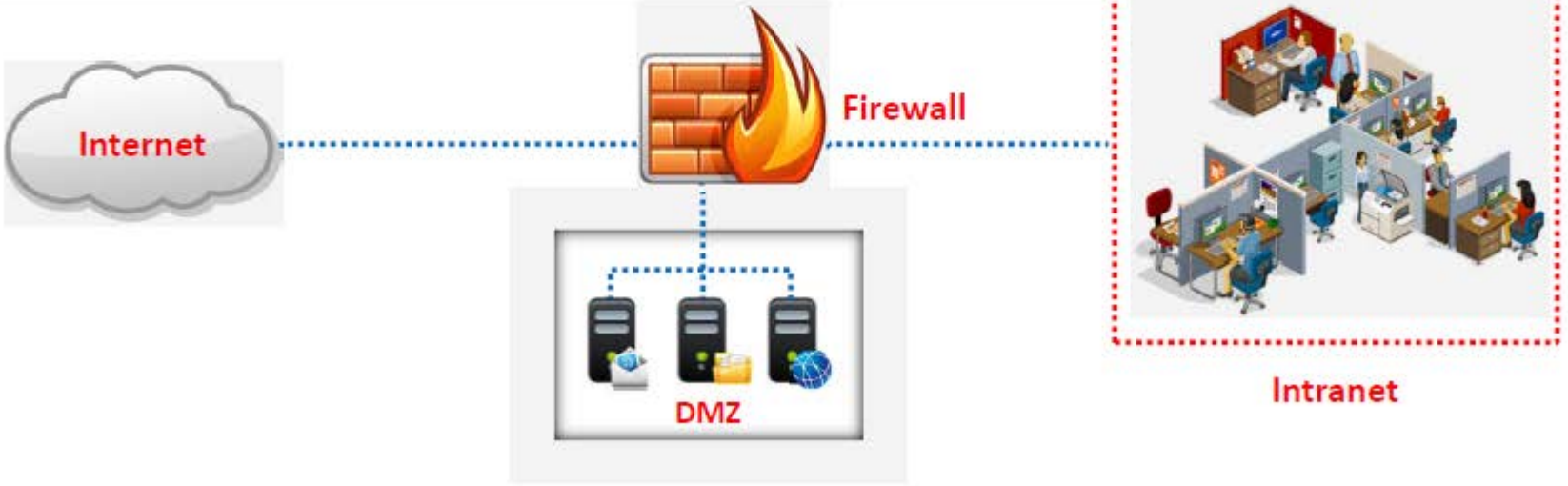
01 DMZ is a network that **serves as a buffer** between the internal secure network and insecure Internet

02 It can be created **using firewall with three or more network interfaces** assigned with specific roles such as Internal trusted network, DMZ network, and external un-trusted network



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Types of Firewall

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01 Packet Filters

02 Circuit Level Gateways

03 Application Level Gateways

04 Stateful Multilayer Inspection Firewalls

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Packet Filtering Firewall

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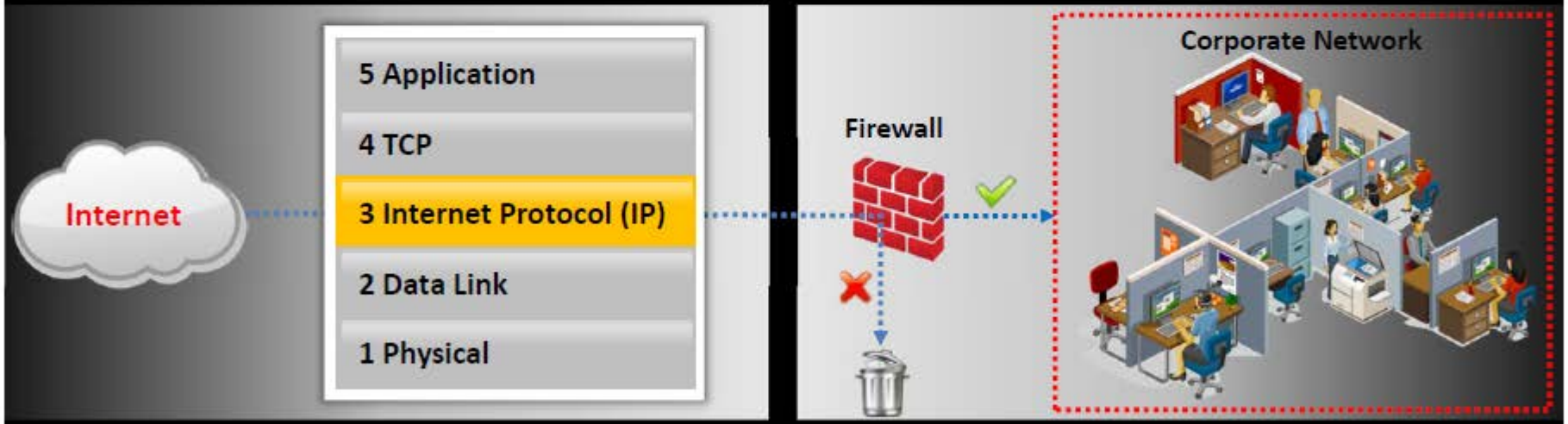
Packet filtering firewalls work at the **network layer of the OSI model** (or the IP layer of TCP/IP), they are usually a part of a router

Depending on the **packet and the criteria**, the firewall can drop the packet and forward it, or send a message to the originator

In a packet filtering firewall, **each packet is compared** to a set of criteria before it is forwarded

Rules can include the source and the destination **IP address**, the source and the destination **port number**, and the **protocol** used



= Traffic allowed based on source and destination **IP address, packet type, and port number**

= Disallowed Traffic

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Circuit-Level Gateway Firewall

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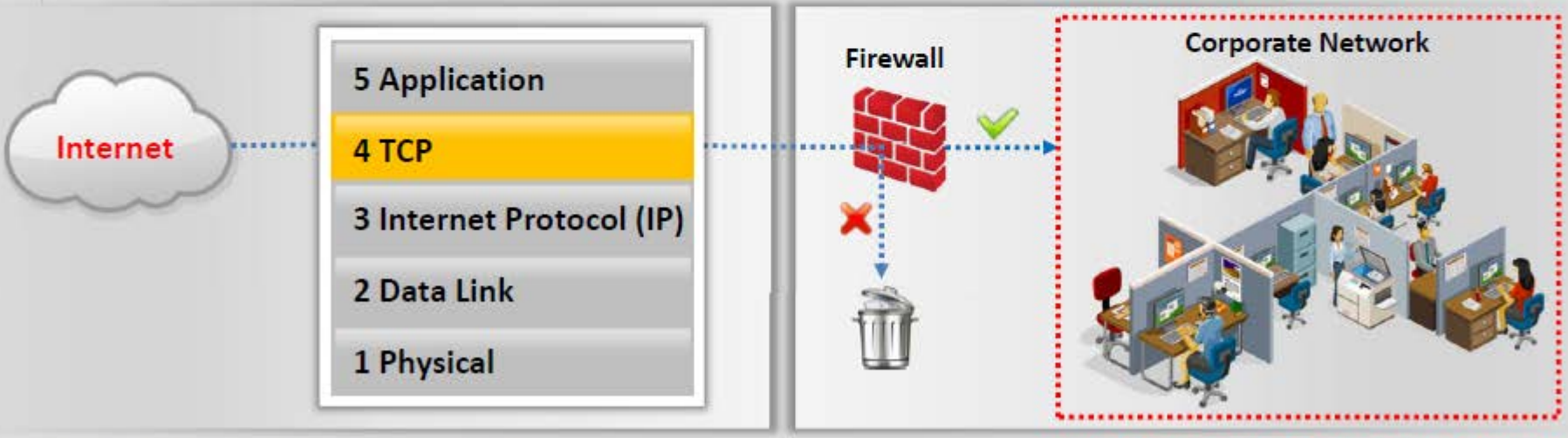
Circuit-level gateways work at the session layer of the OSI model (or the TCP layer of TCP/IP)

Information passed to a remote computer through a circuit-level gateway appears to have originated from the gateway

They monitor requests to create sessions, and determine if those sessions will be allowed

Circuit proxy firewalls allow or prevent data streams, they do not filter individual packets



= Traffic allowed based on session rules, such as when a session is initiated by a recognized computer

= Disallowed Traffic

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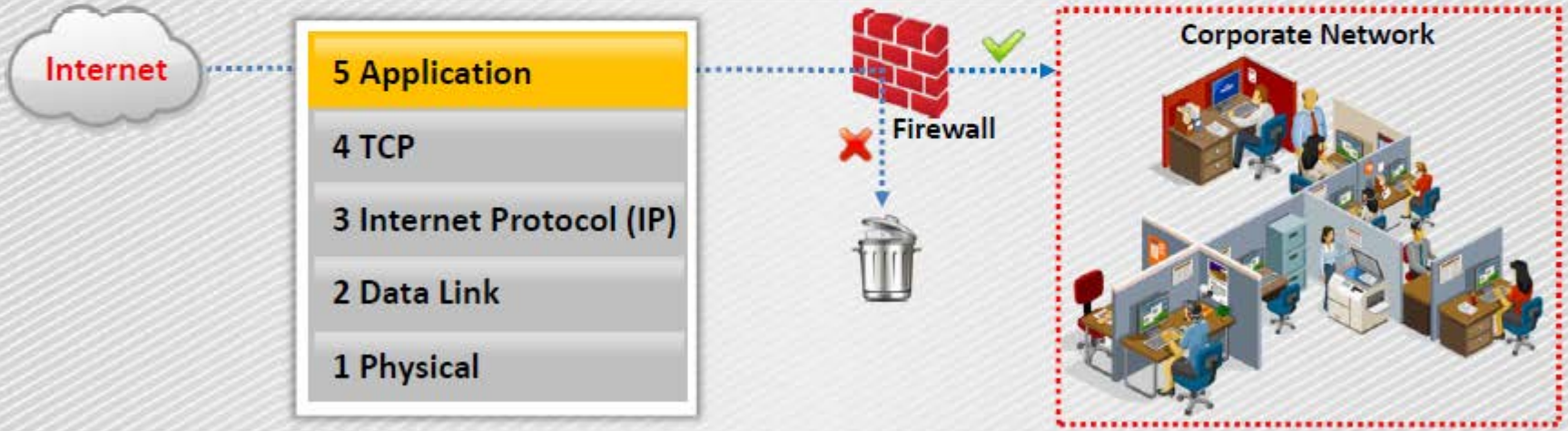
Application-Level Firewall

- Application-level gateways (proxies) can filter packets at the **application layer of the OSI model** (or the application layer of TCP/IP)
- Incoming and outgoing traffic is **restricted to services** supported by proxy; all other service requests are denied

- Application-level gateways configured as a web proxy **prohibit** FTP, gopher, telnet, or other traffic
- Application-level gateways examine traffic and filter on **application-specific commands** such as http:post and get



= Traffic allowed based on **specified applications** (such as a browser) or a **protocol**, such as FTP, or combinations

= Disallowed Traffic

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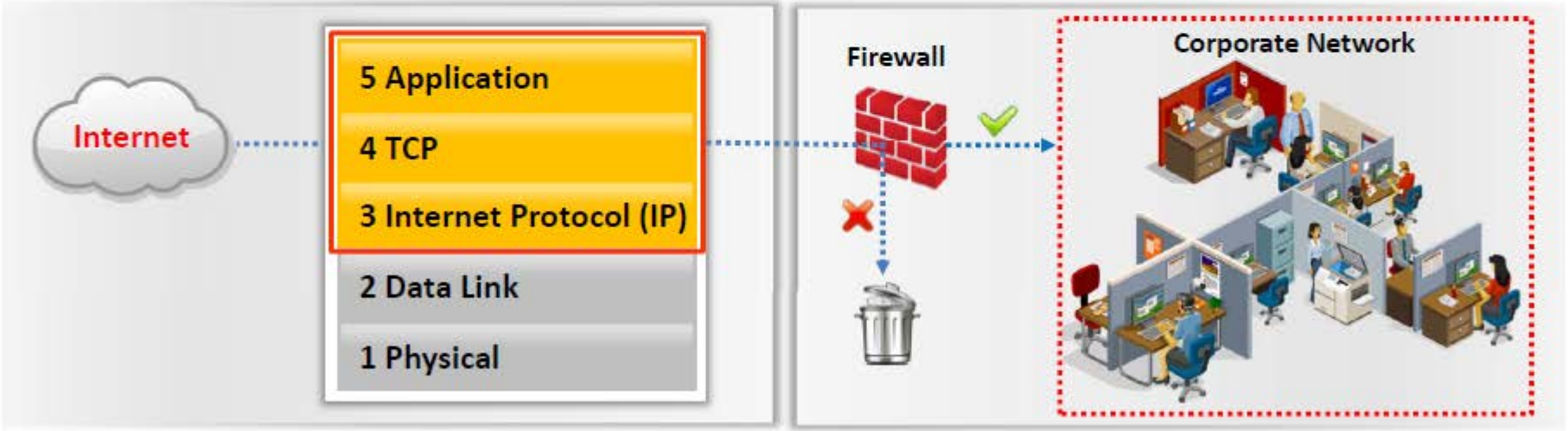
Stateful Multilayer Inspection Firewall

Stateful multilayer inspection firewalls **combine the aspects of the other three types** of firewalls

They **filter packets** at the network layer of the OSI model (or the IP layer of TCP/IP), to determine whether session packets are legitimate, and they evaluate the contents of packets at the application layer



= Traffic is filtered at three layers based on a wide range of the **specified application, session,** and **packet filtering rules**

= Disallowed Traffic

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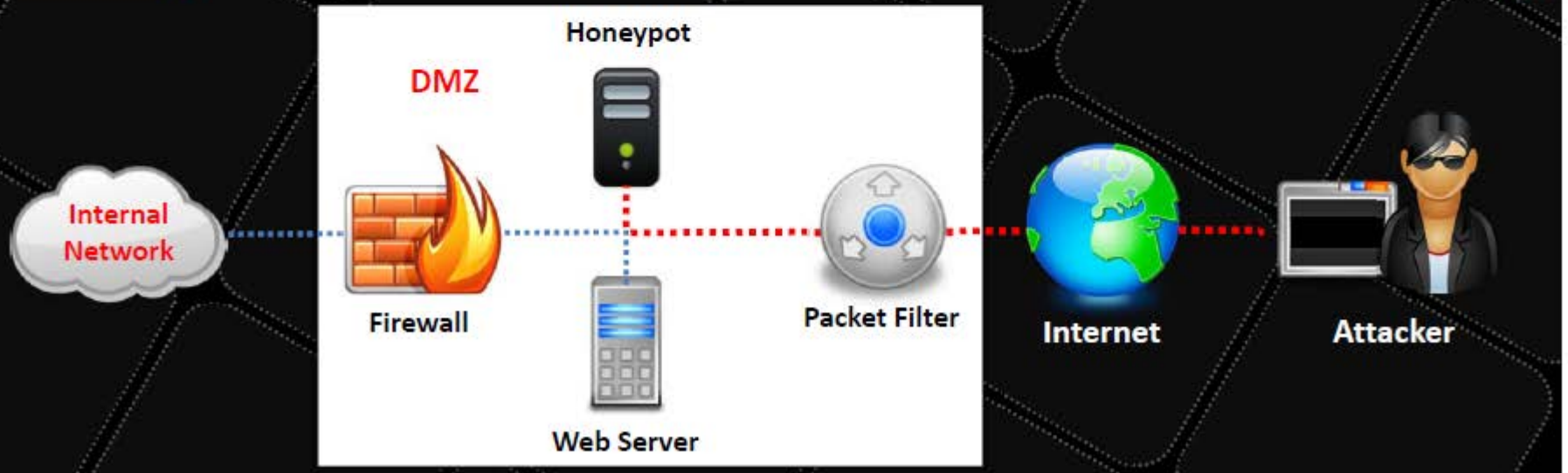
Honeypot

A honeypot is an information system resource that is expressly **set up to attract and trap people** who attempt to penetrate an organization's network

It has no authorized activity, does not have any production value, and any traffic to it is **likely a probe, attack, or compromise**

A honeypot can **log port access attempts, or monitor an attacker's keystrokes. These could be early warnings** of a more concerted attack



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Types of Honeypots

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01

Low-interaction Honeypots

- These honeypots simulate only a **limited number of services** and applications of a target system or network
- Can not be compromised completely
- Generally, set to collect higher level information about attack vectors such as network probes and worm activities
  - Ex: Specter, Honeyd, and KFSensor

02

High-interaction Honeypots

- These honeypots **simulates all services** and applications
- Can be **completely compromised** by attackers to get full access to the system in a controlled area
- Capture **complete information** about an attack vector such attack techniques, tools and intent of the attack
  - Ex: Symantec Decoy Server and Honeynets

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Module Flow

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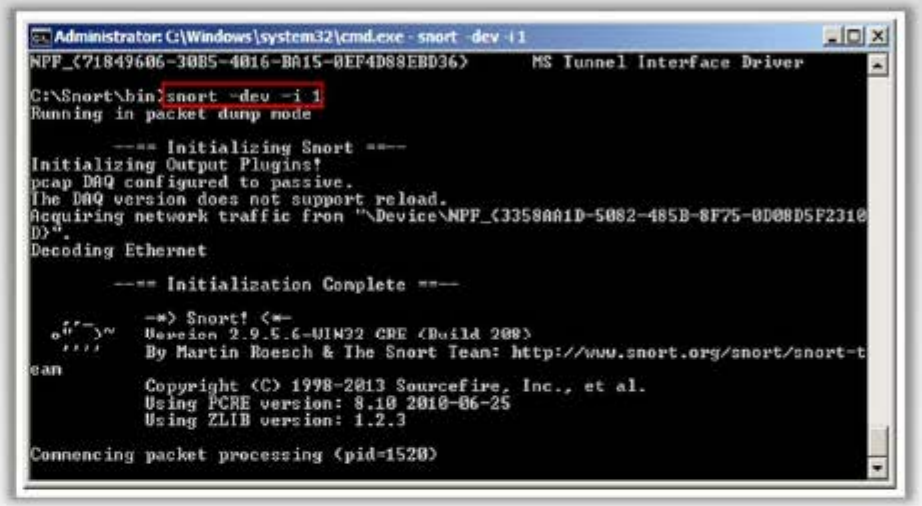
Intrusion Detection Tool: Snort

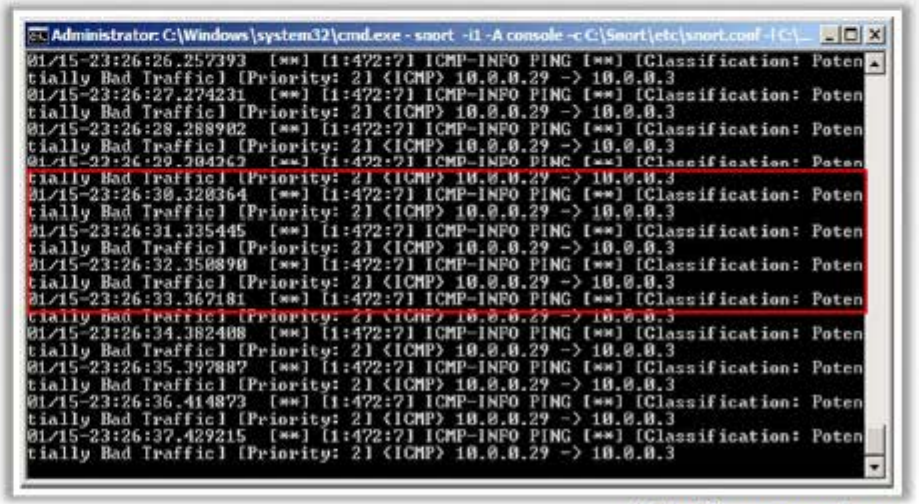
1. Snort is an open source network intrusion detection system, capable of performing real-time **traffic analysis and packet logging on IP networks**

2. It can perform **protocol analysis** and **content searching/matching**, and is used to detect a variety of **attacks and probes**, such as buffer overflows, stealth port scans, CGI attacks, SMB probes, and OS fingerprinting attempts

3. It uses a flexible **rules language** to describe traffic that it should collect or pass, as well as a **detection engine** that utilizes a modular plug-in architecture

4. **Uses of Snort:**
   - Straight packet sniffer like tcpdump
   - Packet logger (useful for network traffic debugging, etc.)
   - Network intrusion prevention system





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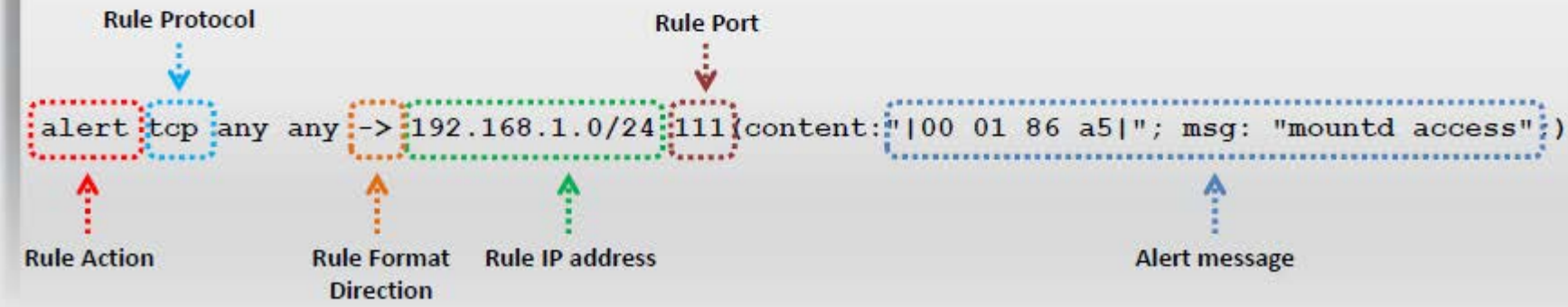
Snort Rules

- Snort's rule engine enables **custom rules** to meet the needs of the network
- Snort rules help in differentiating between **normal Internet activities** and **malicious activities**
- Snort rules must be contained on a **single line**, the Snort rule parser **does not handle rules on multiple lines**
- Snort rules come with two logical parts:
  - **Rule header**: Identifies **rule's actions** such as alerts, log, pass, activate, dynamic, etc.
  - **Rule options**: Identifies rule's **alert messages**

Example:



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Snort Rules: Rule Actions and IP Protocols

Rule Actions

- The rule header stores the complete **set of rules** to identify a packet, and determines the action to be performed or what rule to be applied
- The rule action **alerts Snort** when it finds a packet that matches the rule criteria
- Three available actions in Snort:
  - **Alert** - Generate an alert using the selected alert method, and then log the packet
  - **Log** - Log the packet
  - **Pass** - Drop (ignore) the packet

IP Protocols

Three available IP protocols that Snort supports for suspicious behavior:

I. TCP

II. UDP

III. ICMP

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Y0uR SeCuiTy iS N0t En0Ugh
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Snort Rules: The Direction Operator and IP Addresses

The Direction Operator

- This operator indicates the direction of interest for the traffic; traffic can flow in either single direction or bi-directionally
- Example of a Snort rule using the Bidirectional Operator:

```
log !192.168.1.0/24 any <> 192.168.1.0/24 23
```

IP Addresses

- Identifies IP address and port that the rule applies to
- Use keyword "**any**" to define any IP address
- Use numeric IP addresses qualified with a CIDR netmask
- Example IP Address Negation Rule:

```
alert tcp !192.168.1.0/24 any -> 192.168.1.0/24 111 (content:
"|00 01 86 a5|"; msg: "external mountd access";)
```

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Snort Rules: Port Numbers

Port numbers can be listed in different ways, including "any" ports, static port definitions, port ranges, and by negation

Port ranges are indicated with the range operator ":"

Example of a Port Negation

```
log tcp any any -> 192.168.1.0/24 !6000:6010
```

Protocols	IP address	Action
Log UDP any any ->	92.168.1.0/24 1:1024	Log UDP traffic coming from any port and destination ports ranging from 1 to 1024
Log TCP any any ->	192.168.1.0/24 :5000	Log TCP traffic from any port going to ports less than or equal to 5000
Log TCP any :1024 ->	192.168.1.0/24 400:	Log TCP traffic from the well known ports and going to ports greater than or equal to 400

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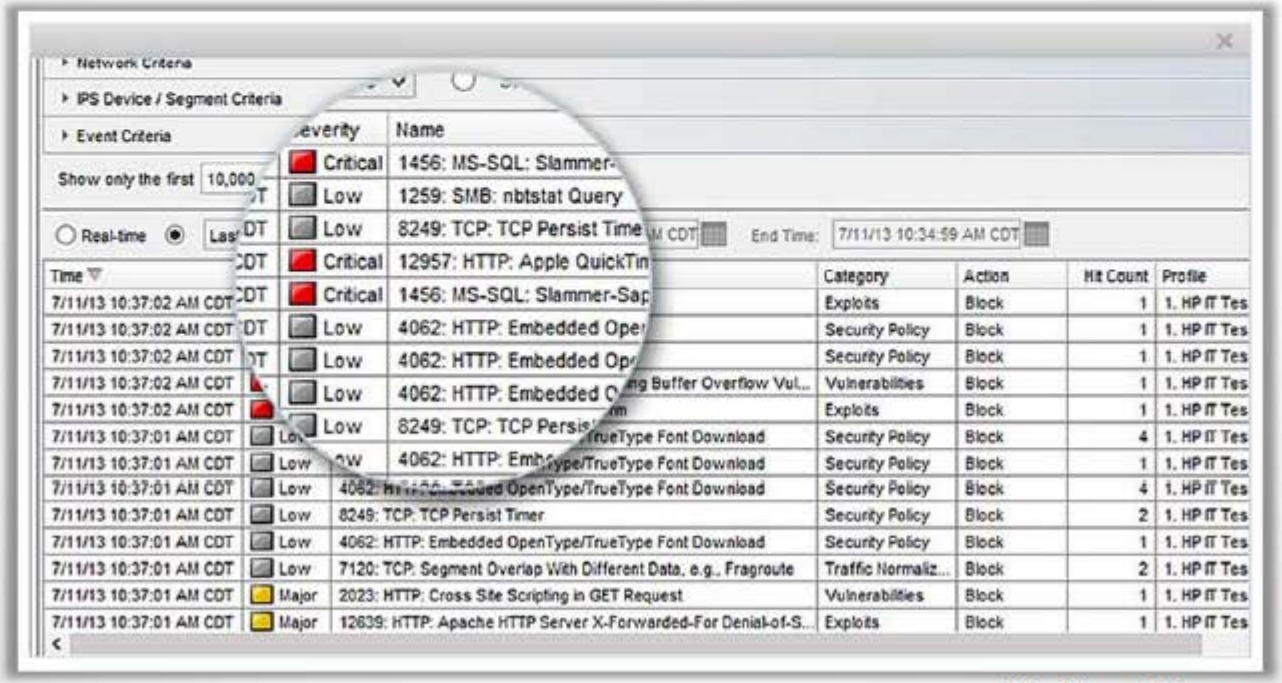
Intrusion Detection System: TippingPoint

- TippingPoint IPS is **in-line threat protection** that defends critical data and applications without affecting performance and productivity
- It contains over **8,700 security filters** written to address zero-day and known vulnerabilities



http://www8.hp.com

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wE FrEE t0 FIY
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Intrusion Detection Tools

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IBM Security Network Intrusion Prevention System
http://www-03.ibm.com

OSSEC
http://www.ossec.net

Peek & Spy
http://networkingdynamics.com

Cisco Intrusion Prevention Systems
http://www.cisco.com

INTOUCH INSA-Network Security Agent
http://www.ttinet.com

AIDE (Advanced Intrusion Detection Environment)
http://aide.sourceforge.net

SilverSky
https://www.silversky.com

SNARE (System iNtrusion Analysis & Reporting Environment)
http://www.intersectalliance.com

IDP8200 Intrusion Detection and Prevention Appliances
https://www.juniper.net

Vanguard Enforcer
http://www.go2vanguard.com

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Intrusion Detection Tools (Cont'd)

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Check Point Threat Prevention Appliance
http://www.checkpoint.com

fragroute
http://www.monkey.org

Next-Generation Intrusion Prevention System (NGIPS)
http://www.sourcefire.com

Outpost Network Security
http://www.agnitum.com

Check Point IPS Software Blade
http://www.checkpoint.com

FortiGate
http://www.fortinet.com

Enterasys® Intrusion Prevention System
http://www.extremenetworks.com

AlienVault Unified Security Management
http://www.alienvault.com

Cyberoam Intrusion Prevention System
http://www.cyberoam.com

McAfee Host Intrusion Prevention for Desktops
http://www.mcafee.com

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Intrusion Detection Tools for Mobile

WiFi Intrusion Detection

https://play.google.com

Wifi Intruder Detector Pro

https://play.google.com

Wifi Inspector

https://play.google.com

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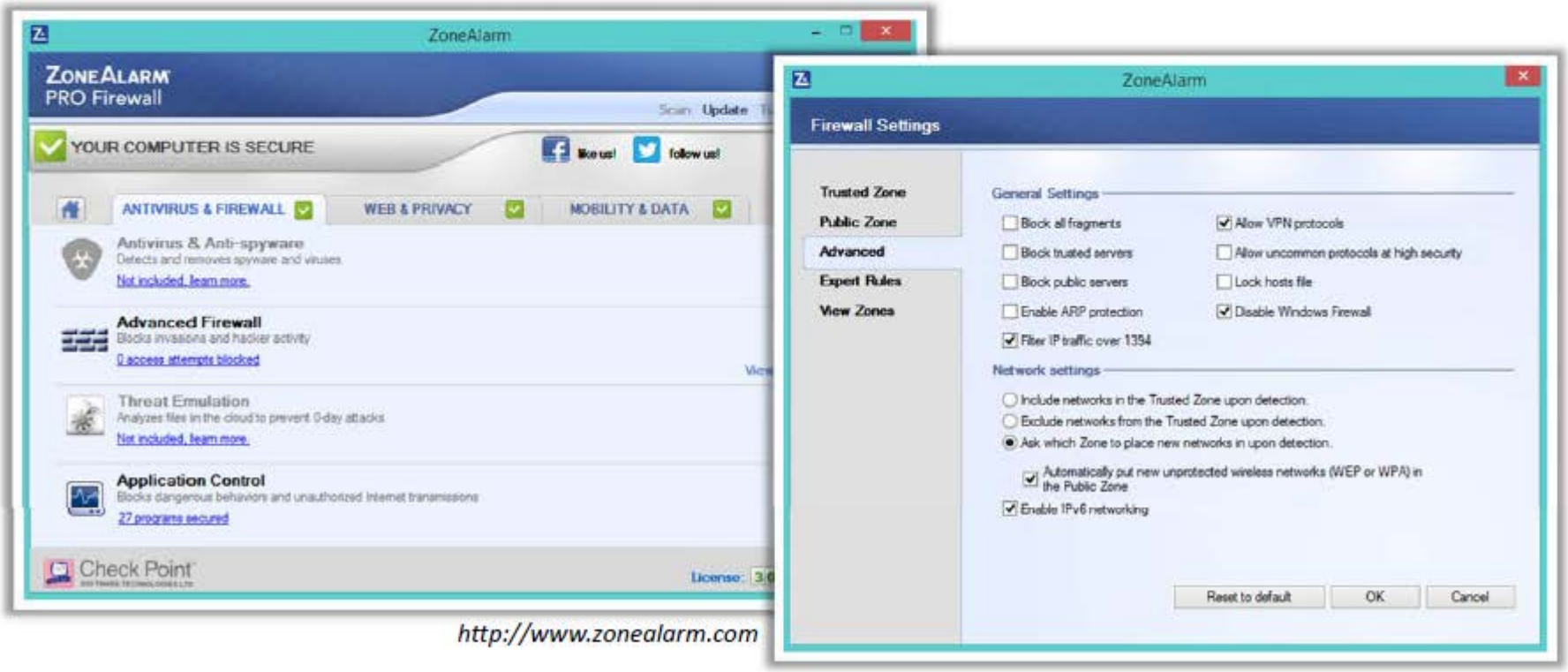
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Firewall: ZoneAlarm PRO Firewall 2015

- ZoneAlarm PRO Firewall 2015 **monitors programs for suspicious behavior** spotting and stopping new attacks that bypass traditional anti-virus protection
- It makes your **PC invisible to hackers** and stops spyware from sending your data out to the Internet



http://www.zonealarm.com

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Firewall: Comodo Firewall

- Keeps you updated on all **suspicious files**
- Prevention-based technology **stops viruses**
- Automatic updates for the most **current protection**

http://personalfirewall.comodo.com

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Firewalls

Cisco ASA 1000V Cloud Firewall
http://www.cisco.com

Novell BorderManager
http://www.novell.com

Check Point Firewall Software Blade
http://www.checkpoint.com

Untangle NG Firewall
https://www.untangle.com

eScan Enterprise Edition
http://www.escanav.com

Sonicwall
http://www.sonicwall.com

Jetico Personal Firewall
http://www.jetico.com

Online Armor
http://www.online-armor.com

Outpost Security Suite
http://free.agnitum.com

FortiGate-5101C
http://www.fortinet.com

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Firewalls for Mobile: Android Firewall and Firewall iP

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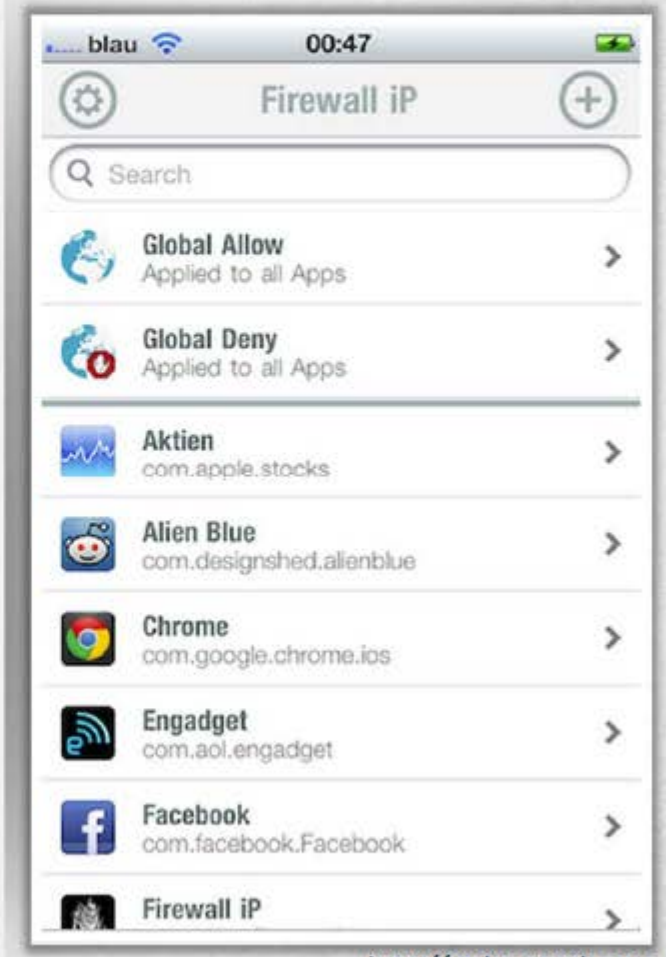
Android Firewall

https://play.google.com

Firewall iP



http://cydia.saurik.com

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Firewalls for Mobile

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Mobiwol: NoRoot Firewall
http://www.mobiwol.com

DroidWall
https://code.google.com

AFWall+
https://github.com

Firewall Plus
http://squariolabs.com

Root Firewall
http://www.rootuninstaller.com

Android Firewall Gold
https://play.google.com

Droid Firewall
https://play.google.com

Privacy Shield
http://www.snoopwall.com

aFirewall
http://afirewall.wordpress.com

NoRoot Firewall
https://play.google.com

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Honeypot Tools: KFSensor and SPECTER

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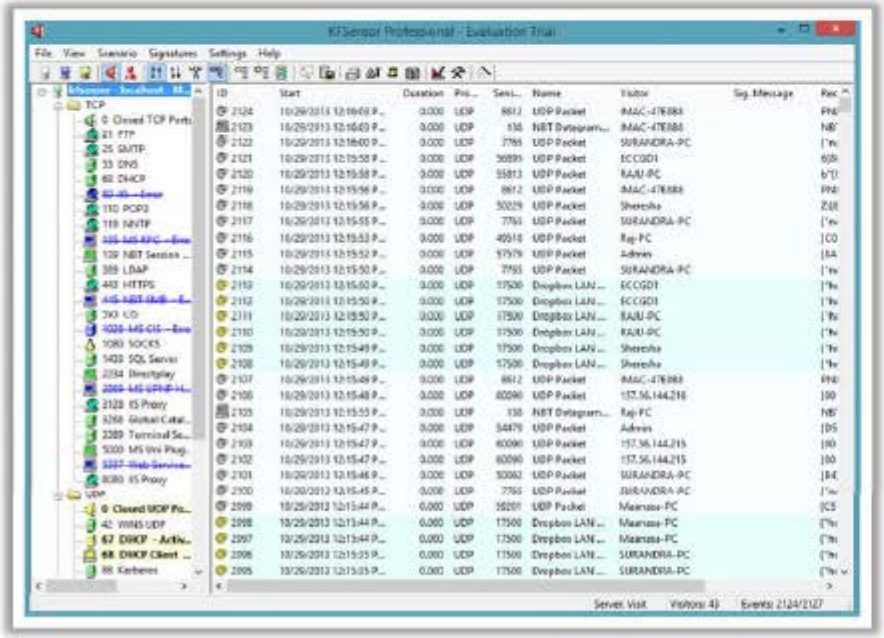
KFSensor

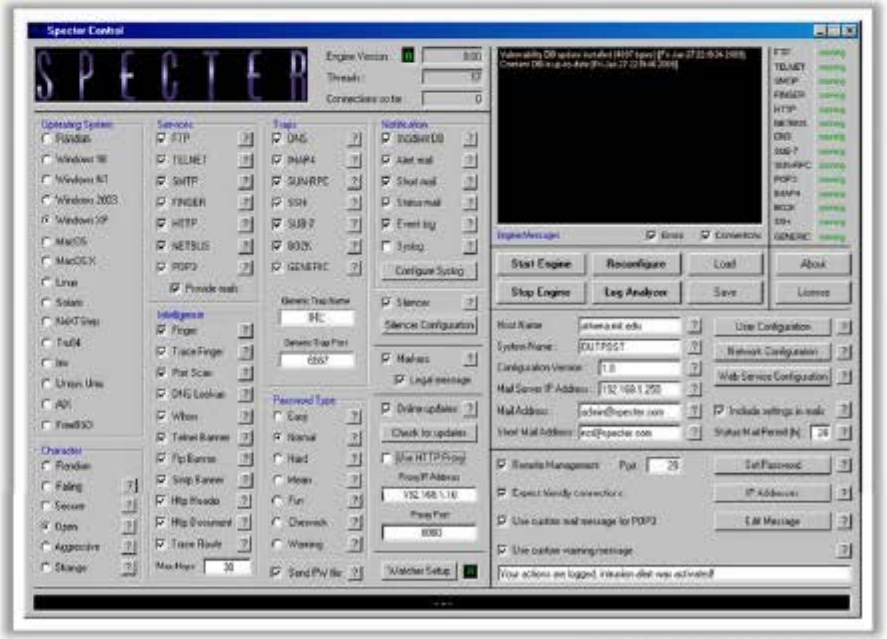
KFSensor is a **host-based** Intrusion Detection System (IDS) that acts as a honeypot to attract and detect hackers and worms by **simulating vulnerable system services** and **Trojans**



http://www.keyfocus.net

SPECTER

SPECTER is a smart **honeypot-based** intrusion detection system that offers common **Internet services** such as SMTP, FTP, POP3, HTTP, and TELNET which appear perfectly normal to the attackers but in fact are traps



http://www.specter.com

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Honeypot Tools

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LaBrea Tarpit
http://labrea.sourceforge.net

WinHoneyd
http://www2.netvigilance.com

PatriotBox
http://www.alkasis.com

HIHAT
http://hihat.sourceforge.net

Kojoney
http://kojoney.sourceforge.net

Argos
http://www.few.vu.nl

HoneyBOT
http://www.atomicsoftwaresolutions.com

Glastopf
http://glastopf.org

Google Hack Honeypot
http://ghh.sourceforge.net

Send-Safe Honeypot Hunter
http://www.send-safe.com

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Honeypot Tool for Mobile: HosTaGe

- HosTaGe is generic honeypot for mobile devices that aim on the **detection of malicious, wireless network environments**
- As most malware propagate over the network via specific protocols, a low-interaction honeypot located at a mobile device can **check wireless networks for actively propagating malware**

http://www.tk.informatik.tu-darmstadt.de

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Module Flow

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01 IDS, Firewall and Honeypot Concepts	02 IDS, Firewall and Honeypot Solutions	03 Evading IDS
04 Evading Firewalls		05 IDS/Firewall Evading Tools
06 Detecting Honeypots	07 IDS/Firewall Evasion Counter-measures	08 Penetration Testing

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Insertion Attack

An IDS blindly believes and accepts a packet that an end system rejects

This attack occurs when NIDS is less strict in processing packets

Hence, the IDS gets more packets than the destination

1 2 3 4 5

An attacker exploits this condition and inserts data into the IDS

Attacker obscures extra traffic and IDS concludes traffic is harmless

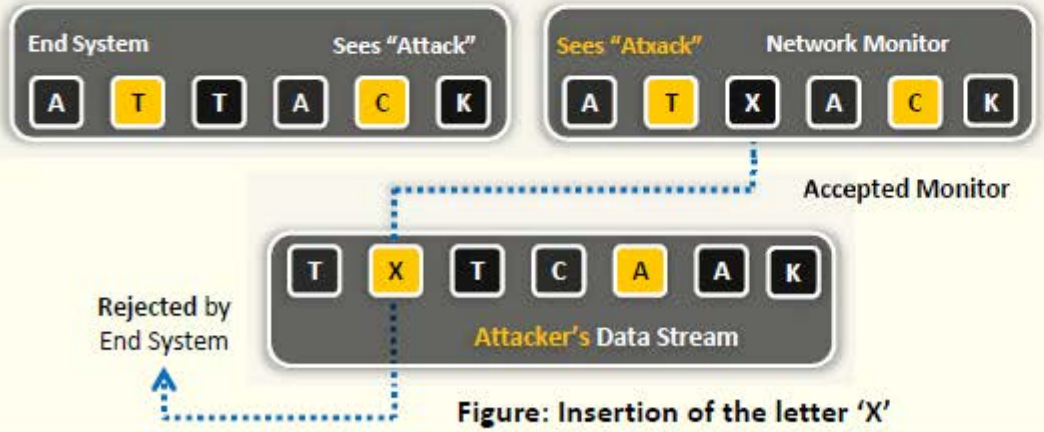

Figure: Insertion of the letter 'X'

- An attacker sends one-character packets to the target system via the IDS with **varying TTL** such that some packets reach to the IDS but not the target system
- This will result in the IDS and the target system having **two different character strings**

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Evasion

1. In this evasion technique, an end system **accepts a packet** that an IDS rejects
2. Using this technique, an attacker **exploits** the host computer
3. Attacker sends **portions of the request** in packets that the IDS mistakenly rejects, allowing the removal of parts of the stream from the IDS
4. For example, if the malicious sequence is sent **byte-by-byte**, and one byte is rejected by the IDS, the IDS cannot detect the attack
5. Here, the IDS gets fewer packets than the destination

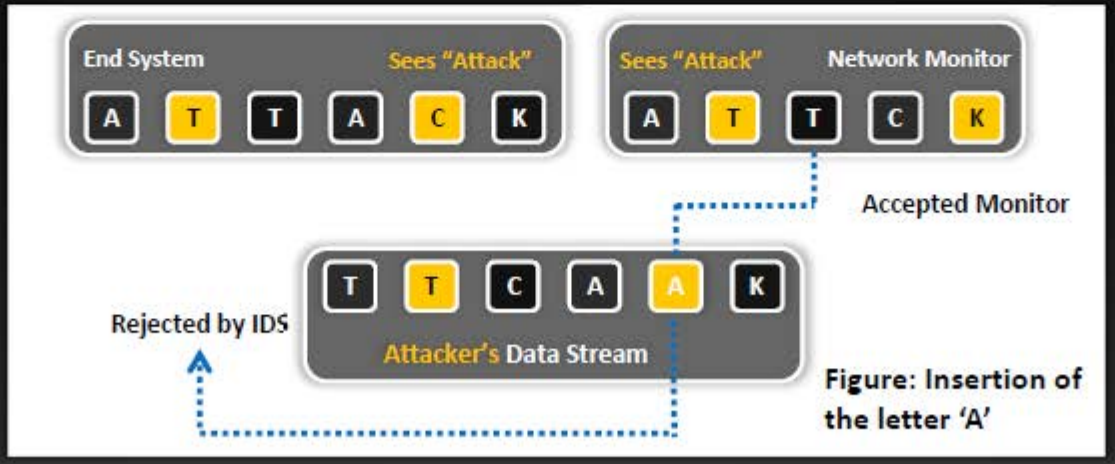

Figure: Insertion of the letter 'A'

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Denial-of-Service Attack (DoS)

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01

Many IDSs use a **centralized server for logging** alerts

02

If attackers know the **IP address of the centralized server** they can perform **DoS** or other hacks to slow down or crash the server

03

As a result, attackers **intrusion attempts will not be logged**

Using this evasion technique, an attacker:

1. Causes the device to lock up
2. Causes personnel to be unable to investigate all the alarms
3. Causes more alarms than can be handled by management systems (such as databases, etc.)
4. Fills up disk space causing attacks to not be logged
5. Consumes the device's processing power and allows attacks to sneak by

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Obfuscating

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1. An IDS can be evaded by obfuscating or encoding the attack payload in a way that the target computer understands but the IDS will not
2. Attackers can encode attack patterns in unicode to bypass IDS filters, but be understood by an IIS web server
3. Polymorphic code is another means to circumvent signature-based IDSs by creating unique attack patterns, so that the attack does not have a single detectable signature
4. Attackers manipulate the path referenced in the signature to fool the HIDS
5. Attacks on encrypted protocols such as HTTPS are obfuscated if the attack is encrypted

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False Positive Generation

Attackers with the knowledge of the target IDS, craft malicious packets just to generate alerts

These packets are sent to the IDS to generate a large number of false positive alerts

Attackers then use these false positive alerts to hide real attack traffic

Attackers can bypass IDS unnoticed as it is difficult to differentiate the attack traffic from the large volume of false positives

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Session Splicing

1. A technique used to bypass IDS where an attacker **splits the attack traffic** in to many packets such that no single packet triggers the IDS
2. It is effective against IDSs **that do not reconstruct** packets before checking them against intrusion signatures
3. If attackers are aware of **delay in packet reassembly** at the IDS, they can add delays between packet transmissions to bypass the reassembly
4. Many IDSs **stops reassembly** if they do not receive packets within a certain time
5. IDS will stop working if the target host keeps session active for a time longer than the **IDS reassembly time**
6. Any attack attempt after a successful splicing attack will **not be logged** by the IDS

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Unicode Evasion Technique

1. Unicode is a character coding system to support the worldwide interchange, processing, and display of the written texts
2. For example, / → %u2215, e → %u00e9 (UTF-16) and © → %c2%a9, ≠ → %e2%89%a0 (UTF-8)
3. Attackers can convert attack strings to Unicode characters to avoid pattern and signature matching at the IDS
4. Attackers can encode URLs in HTTP requests using Unicode characters to bypass HTTP-based attack detection at the IDS

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Fragmentation Attack

Fragmentation can be used as an attack vector when **fragmentation timeouts** vary between IDS and host

If fragment reassembly timeout is **10 seconds** at the IDS and **20 seconds** at the target system, attackers will send the second fragment after **15 seconds** of sending the first fragment

In this scenario, the IDS will **drop the fragment** as the second fragment is received after its reassembly time but the target system will reassemble the fragments

Attackers will keep sending the fragments with **15 second delays** until all the attack payload is reassembled at the target system

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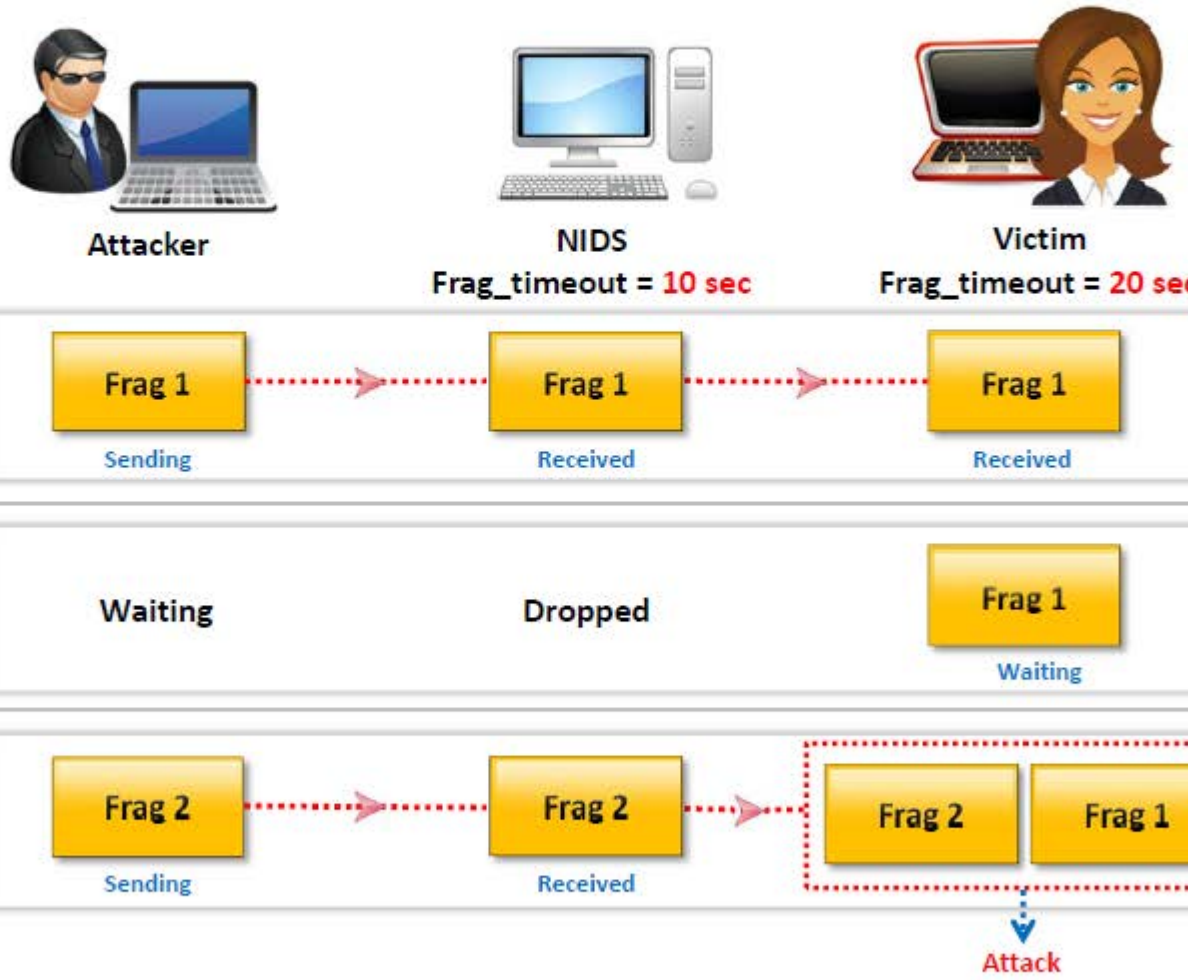
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Fragmentation Attack (Cont'd)



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Fragmentation Attack (Cont'd)

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A similar fragmentation attack works when the IDS timeout exceeds the victim's

1. Victim and IDS receive **frag 2 and 4** out of 4 fragments, both carry a false payload
2. Victim drops these two fragments after **30 sec**, and does not send ICMP since frag 1 never received
3. Victim and IDS receive **frag 1 and 3** out of 4 fragments
4. IDS reassembles 4 received fragments, but computed net **checksum** is invalid, so packet is dropped
5. Victim and IDS receive real **frag 2** and **4** out of 4 fragments
6. Victim reassembles 4 received fragments and is **attacked**; IDS times out frag 2 and 4 and drops

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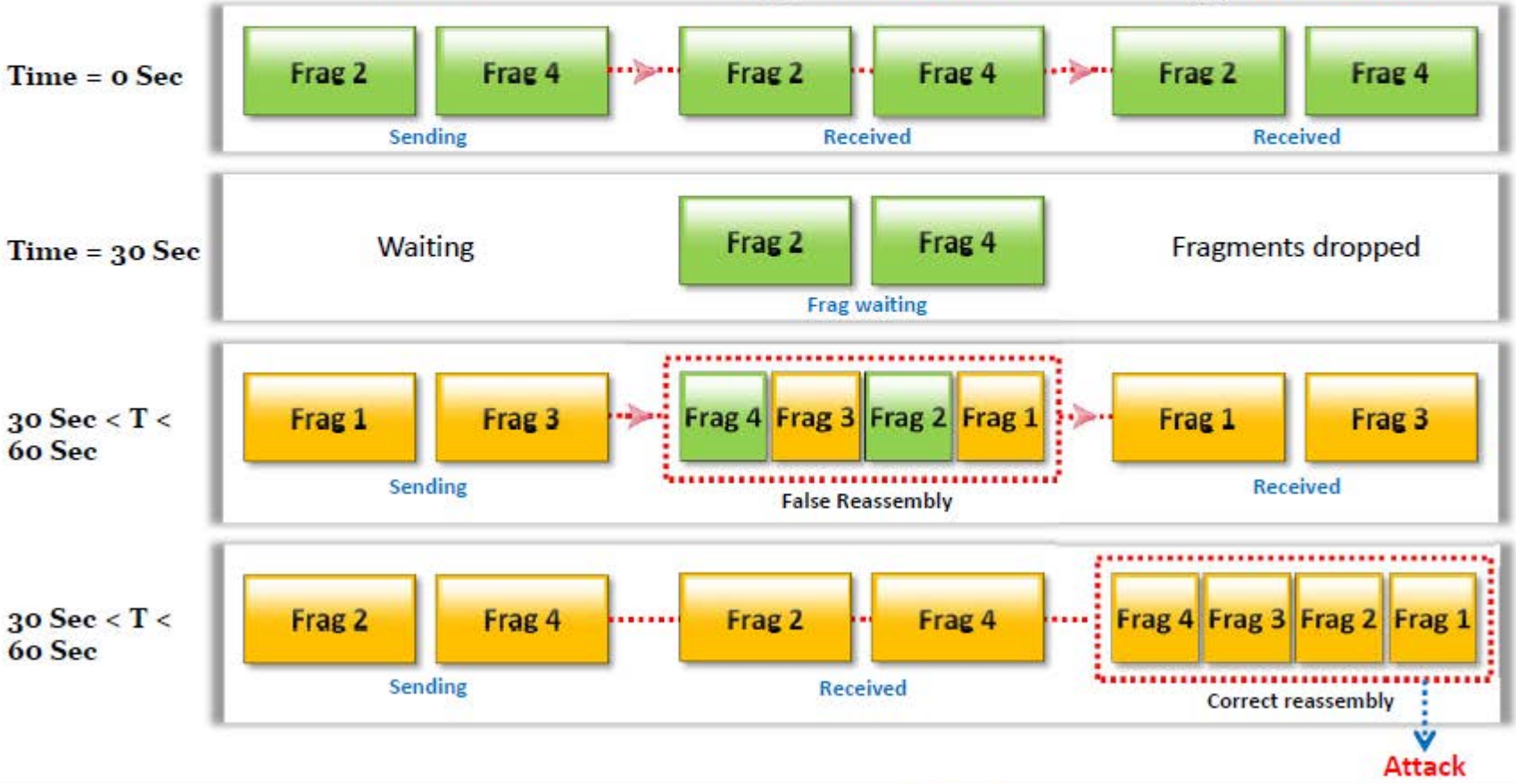
Fragmentation Attack (Cont'd)



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Overlapping Fragments

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An IDS evasion technique is to **craft a series of packets** with TCP sequence numbers configured to overlap

For example, the first packet will include **80 bytes** of payload, but the second packet's sequence number will be **76 bytes** after the start of the first packet

When the target computer **reassembles the TCP stream**, it must decide how to handle the four overlapping bytes

Some OS will take the **original fragments with a given offset** (e.g., Windows W2K/XP/2003) and some operating systems will take the subsequent fragments with a given offset (e.g., Cisco IOS)


Attacker


Windows XP


Cisco IOS

Attacker	Windows XP	Cisco IOS
Frag 3, Frag 2, Frag 1	Frag 3, Frag 2, Frag 1	Frag 3, Frag 2, Frag 1
Sending	Received	Received
Frag 4, Frag 3, Frag 2	Frag 4, Frag 3, Frag 2, Frag 1	Frag 4, Frag 3, Frag 2, Frag 1
Sending	Reassembled	Reassembled

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Time-To-Live Attacks

- These attacks require the attacker to have a **prior knowledge of the topology** of the victim's network
- This information can be obtained using tools such as **traceroute** which gives information on the **number of routers between the attacker and the victim**

Attacker breaks malicious traffic into 3 fragments (1)

Attacker sends frag 1 with high TTL, false frag 2 with low TTL (2)

IDS receives both fragments, victim receives first fragment only (3)

Attacker sends frag 3 with high TTL (4)

IDS reassembles 3 fragments into meaningless packet and drops (5)

Victim receives real frag 2, and suffers attack, while no log entry created (6)

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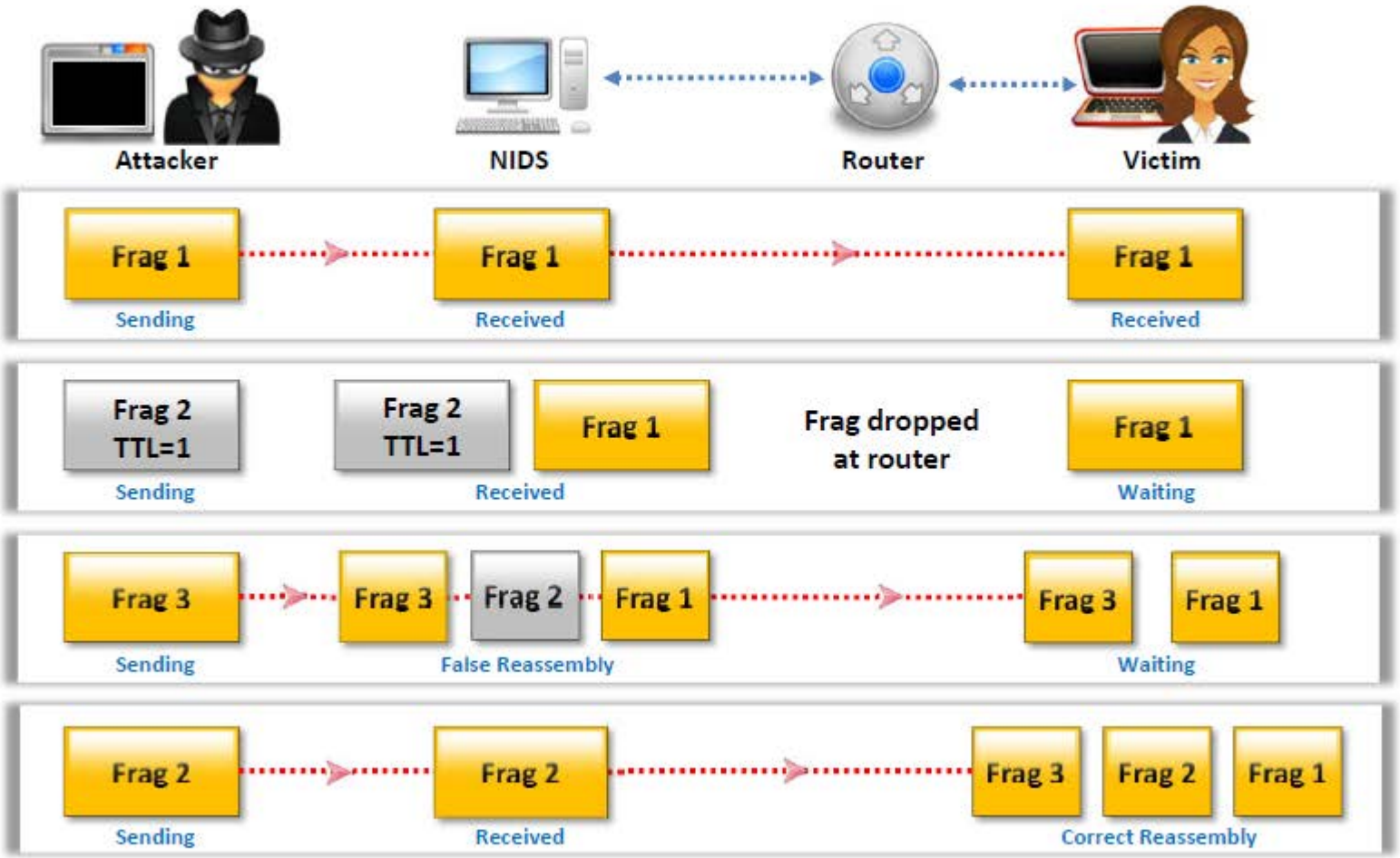
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Time-To-Live Attacks (Cont'd)



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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Invalid RST Packets

01 TCP uses 16-bit checksum field for error-checking of the header and data

02 Reset (RST) flag in a TCP header is used to close a TCP connection

03 In invalid reset attack, attackers send RST packet to the IDS with an invalid checksum

04 IDS stop processing the packet thinking that the TCP communication session has ended but the target system will receive the packet

05 The target system checks the RST packet's checksum and drops it

06 The attack enables attackers to communicate with the target system while the IDS thinks that the communication has ended

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Urgency Flag

01 Urgent (URG) flag in the TCP header is used to mark the data that require **urgent processing** at the receiving end

02 If the URG flag it set, the TCP protocol sets the Urgent Pointer field to a **16-bit offset value** that points to the last byte of urgent data in the segment

03 Many IDSs do **not consider the urgent pointer** and process all the packets in the traffic whereas the target system process only the urgent data

04 This results in the IDS and the target systems having **different set of packets**, which can be exploited by attackers to pass the attack traffic

Urgency flag attack example

```
"1 Byte data, next to Urgent data, will
be lost, when Urgent data and normal
data are combined."
Packet 1: ABC
Packet 2: DEF Urgency Pointer: 3
Packet 3: GHI
End result: ABCDEFHI
```

- This example illustrates how the urgency flag works in conjunction with the urgency pointer
- According to the RFC 1122, the urgency pointer causes one byte of data next to the urgent data to be lost when urgent data is combined with normal data

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Polymorphic Shellcode

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01 Most IDSs contain **signatures** for commonly used strings within shellcode

02 This is easily bypassed by using **encoded shellcode** containing a stub that decodes the shellcode that follows

03 This means that shellcode can be completely different **each time it is sent**

04 Polymorphic shellcode allows attackers to **hide their shellcode** by encrypting it in a simplistic form

05 It is difficult for IDSs to identify this data as **shellcode**

06 This method also hides the **commonly used strings** within shellcode, making shellcode signatures useless

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ASCII Shellcode

ASCII shellcode includes characters which are present only in **ASCII standard**

Attackers can use ASCII shellcode to bypass the IDS signature as the **pattern matching** does not work effectively with the ASCII values

Scope of ASCII shellcode is **limited** as all assembly instructions cannot be converted to ASCII values directly

This limitation can be overcome by using other **sets of instructions** for converting to ASCII values properly

The following is an ASCII shellcode example:

```
char shellcode[] =
"LLLLYhb0pLX5b0pLHSSPPWQPPaPWSUTBRDJfh5t
DS"
"RajYX0Dka0TkafhN9fYf1Lkb0TkdjfY0Lkf0Tkg
fh"
"6rfYf1Lki0tkkh95h8Y1LkmjpY0Lkq0tkrh2wnu
X1"
"Dks0tkwjfX0Dkx0tkx0tkyCjnY0LkzC0TkzCCjt
X0"
"DkzC0tkzCj3X0Dkz0TkzC0tkzChjG3IY1LkzCCC
C0"
"tkzChpfcMX1DkzCCCC0tkzCh4pCnY1Lkz1TkzCC
CC"
"fhJGfXf1Dkzf1tkzCCjHX0DkzCCCCjvY0LkzCCC
jd"
"X0DkzC0TkzCjWX0Dkz0TkzCjdX0DkzCjXY0Lkz0
tk"
"zMdgvvn9F1r8F55h8pG9wnuvjrNfrVx2LGkG3ID
pf"
"cM2KgmnJGgbinYshdvD9d";
```

When executed, the shellcode above executes a `"/bin/sh"` shell. `'bin'` and `'sh'` are contained in the last few bytes of the shellcode.

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Application-Layer Attacks

Applications accessing media files (audio, video and images) **compress** them to smaller size for maximizing data transfer rate

IDS cannot verify the **signature of compressed file** format

This enables an attacker to **exploit the vulnerabilities** in compressed data

IDS can recognize particular conditions favorable for attack but other alternative forms of attack are also possible, for example, various integer values can be used to **exploit integer overflow vulnerabilities**

This makes the detection of attack traffic **extremely difficult** at the IDS

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Desynchronization – Pre-Connection SYN

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01 If a SYN packet is received **after the TCP control block is opened**, the IDS resets the appropriate sequence number to match that of the newly received SYN packet

02 Attackers send **fake SYN packets** with a completely invalid sequence number to desynchronize the IDS

03 This **stops IDS** from monitoring all, legitimate and attack, traffic

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Desynchronization – Post-Connection SYN

1. For this technique, attempt to **desynchronize the IDS** from the actual sequence numbers that the kernel is honoring
2. Send a **post connection SYN packet** in the data stream, which will have **divergent sequence** numbers, but otherwise meet all of the necessary criteria to be accepted by the target host
3. However, the target host will ignore this **SYN packet**, as it references an already established connection
4. The intent of this attack is to get the IDS to **resynchronize** its notion of the sequence numbers to the new SYN packet
5. It will then ignore any data that is a **legitimate part of the original stream**, because it will be awaiting a different sequence number
6. Once succeeded in resynchronizing the IDS with a SYN packet, send an **RST packet with the new sequence number** and close down its notion of the connection

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Other Types of Evasion

Encryption

When the attacker has already established an encrypted session with the victim, it results in the most effective evasion attack

Flooding

The attacker sends loads of unnecessary traffic to produce noise, and if IDS does not analyze the noise traffic well, then the true attack traffic may go undetected

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Module Flow

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01 IDS, Firewall and Honeypot Concepts	02 IDS, Firewall and Honeypot Solutions	03 Evading IDS
04 Evading Firewalls		05 IDS/Firewall Evading Tools
06 Detecting Honeypots	07 IDS/Firewall Evasion Counter-measures	08 Penetration Testing

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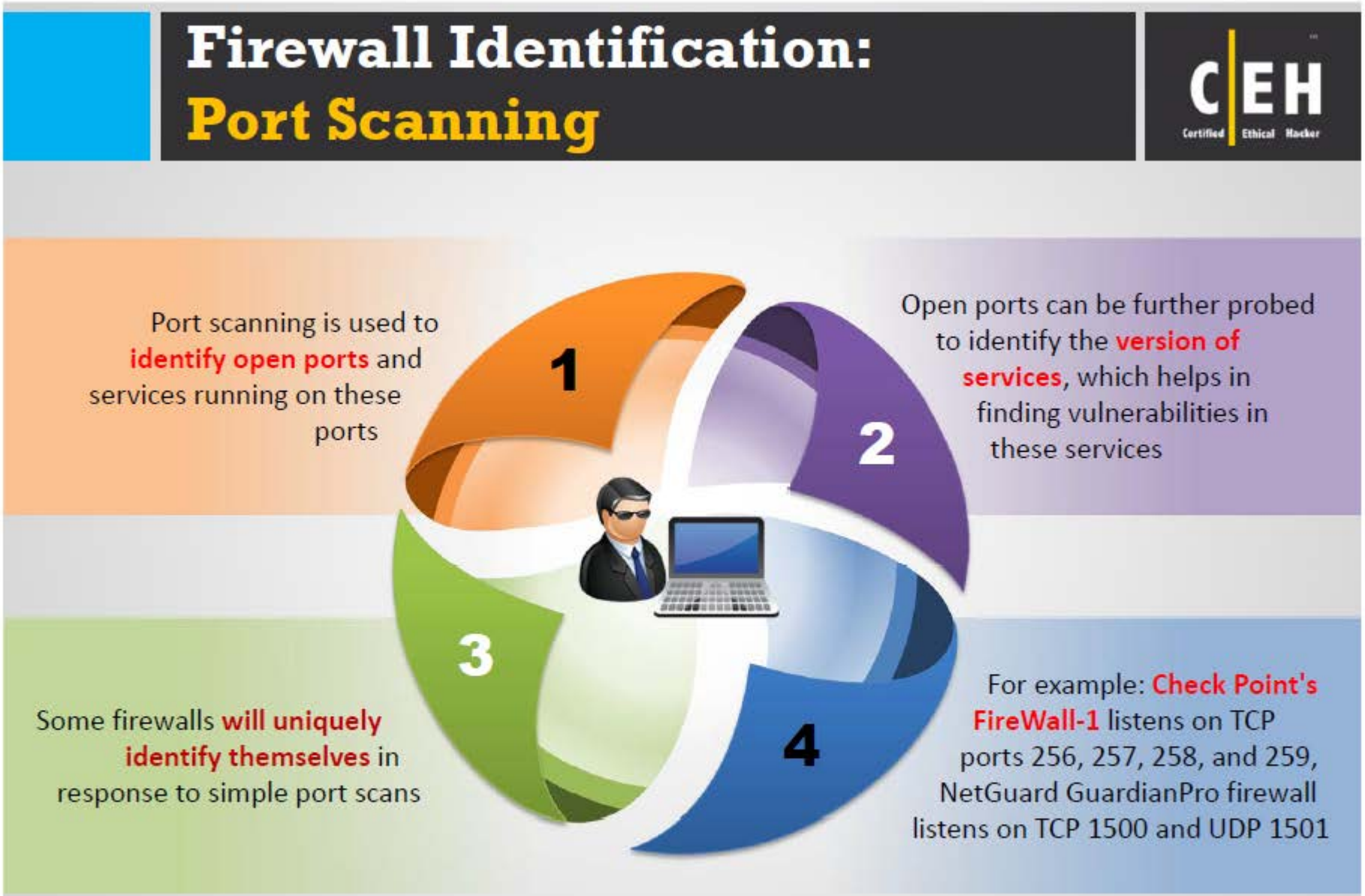
Firewall Identification: Port Scanning



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Firewall Identification: Firewalking

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01 A technique that uses TTL values to determine gateway ACL filters and map networks by analyzing IP packet responses

02 Attackers send a TCP or UDP packet to the targeted firewall with a TTL set to one hop greater than that of the firewall

03 If the packet makes it through the gateway, it is forwarded to the next hop where the TTL equals one and elicits an ICMP "TTL exceeded in transit" to be returned, as the original packet is discarded

04 This method helps locate a firewall, additional probing permits fingerprinting and identification of vulnerabilities

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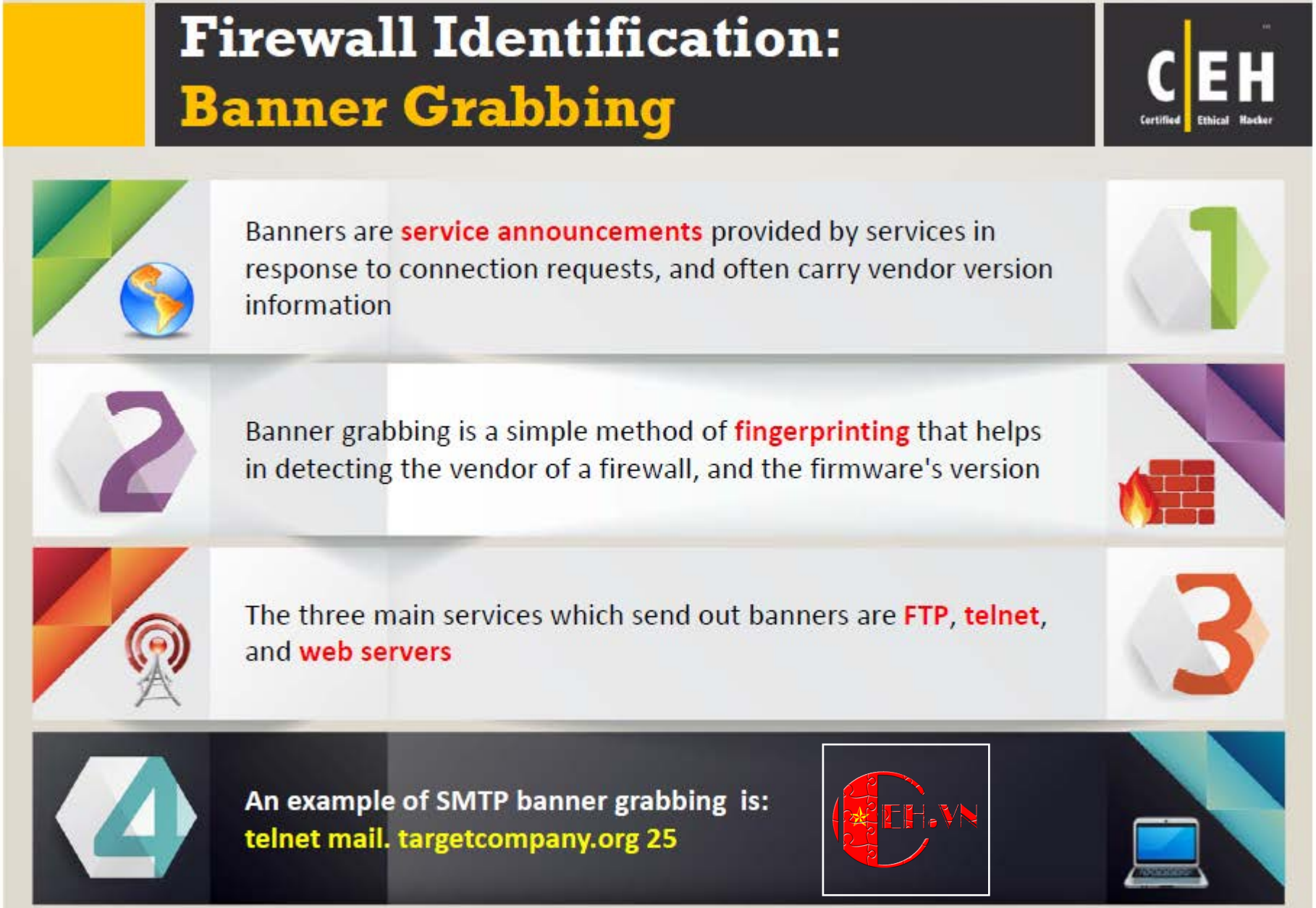
Firewall Identification: Banner Grabbing



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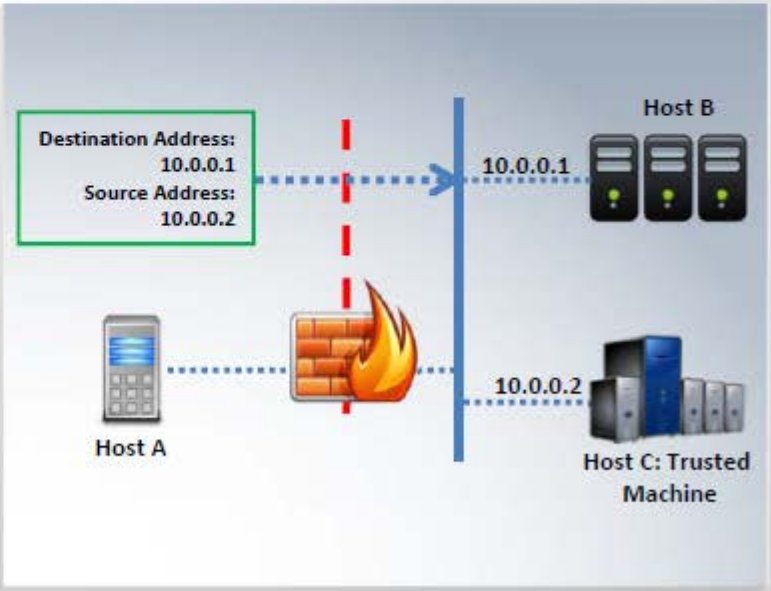
IP Address Spoofing

- IP address spoofing is a hijacking technique in which an attacker **masquerades as a trusted host** to conceal his identity, spoof a Web site, hijack browsers, or gain unauthorized access to a network
- Attackers modify the **addressing information** in the IP packet header and the source address bits field in order to bypass the firewall

- For example, let's consider **three hosts**: A, B and C
- Host **C is a trusted machine** of host B
- Host A masquerades to be as host C by **modifying the IP address** of the malicious packets that he intends to send to the host B
- When the **packets are received**, host B thinks that they are from host C, but are actually from host A



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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

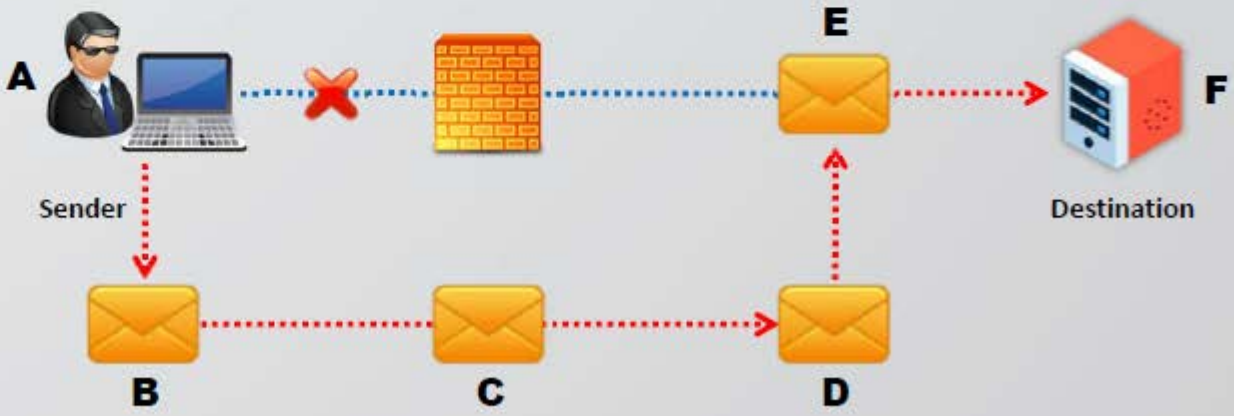
Source Routing

Source routing allows the sender of a packet to partially or completely **specify the route**, the packet takes through the network

As the packet travels through the nodes in the network, each **router examines** the destination IP address and **chooses the next hop** to direct the packet to the destination

In source routing, the **sender** makes some or all of these decisions on the router

The figure shows source routing, where the originator dictates eventual route of traffic



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Tiny Fragments

01 Attackers create **tiny fragments** of outgoing packets forcing some of the TCP packet's header information into the next fragment

02 The IDS filter rules that specify **patterns will not match** with the fragmented packets due to broken header information

03 The attack will succeed if the **filtering router examines only the first fragment** and allow all the other fragments to pass through

04 This attack is used to **avoid user defined filtering rules** and works when the **firewall checks only for the TCP header information**

IP-3ar0JI0B0K	MK=1, Fragment Offset=0							
Source Port				Destination Port				
Sequence Number								
Acknowledgement Sequence Number								
Data Offset	Reserved	-	ACK	-	-	-	-	Window
Checksum								Urgent Pointer=0
0								

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Bypass Blocked Sites Using IP Address in Place of URL

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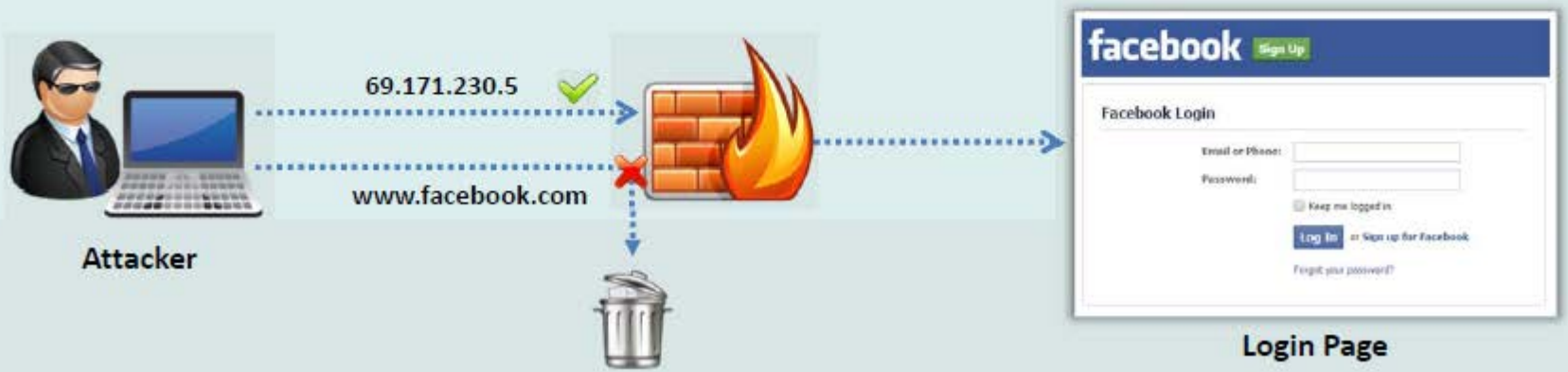
01 This method involves typing the IP address directly in browser's address bar in place of typing the blocked website's domain name

02 For example, to access Orkut, type its IP address instead of typing domain name

03 Use services such as Host2ip to find the IP address of the blocked website

04 This method fails if the blocking software tracks the IP address sent to the web server



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Bypass Blocked Sites Using Anonymous Website Surfing Sites

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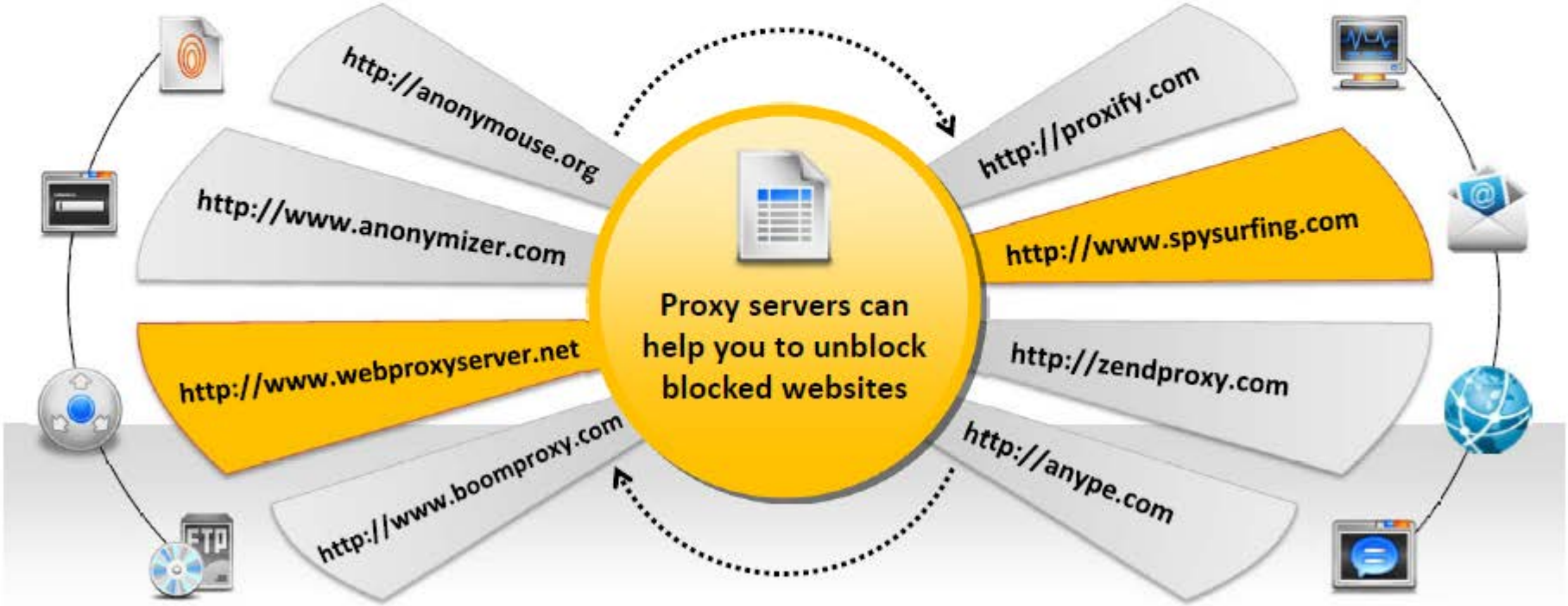
- Many websites around the net enable **surfing the Internet** anonymously
- Some websites provide options to **encrypt the URL's** of the websites

- These proxy websites will **hide the actual IP address** and will show another IP address, which could **prevent the website from being blocked** thus allowing access to them



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Bypass a Firewall Using Proxy Server

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Find an appropriate proxy server

On the Tools menu of any Internet browser, go to LAN of Network Connections tab, and then click LAN/Network Settings

Under Proxy server settings, select the use a proxy server for LAN

In the Address box, type the IP address of the proxy server

In the Port box, type the port number that is used by the proxy server for client connections (by default, 8080)

Click to select the bypass proxy server for local addresses check box if you do not want the proxy server computer to be used when connected to a computer on the local network

Click OK to close the LAN Settings dialog box

Click OK again to close the Internet Options dialog box

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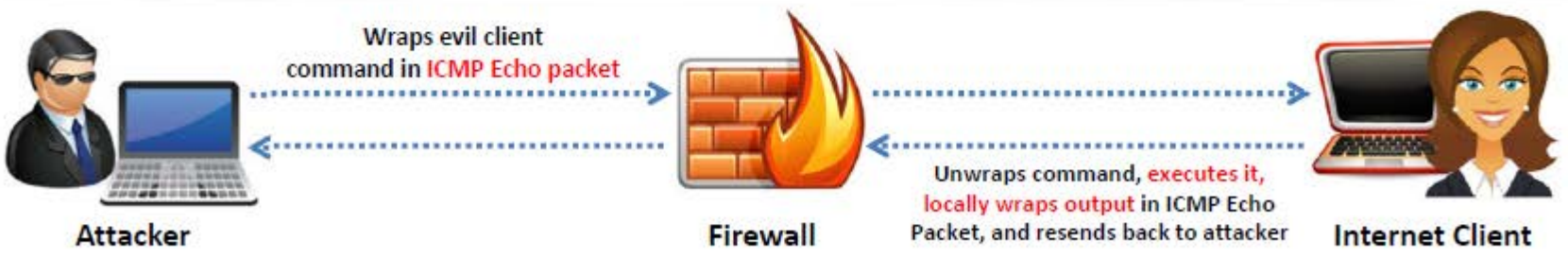
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Bypassing Firewall through ICMP Tunneling Method

- It allows tunneling a **backdoor shell** in the data portion of ICMP Echo packets
- RFC 792, which delineates **ICMP operation**, does not define what should go in the data portion
- The **payload portion** is arbitrary and is not examined by most of the firewalls, thus any data can be inserted in the payload portion of the ICMP packet, including a **backdoor application**
- Some administrators keep **ICMP open** on their firewall because it is useful for tools like **ping** and **traceroute**
- Assuming that ICMP is allowed through a firewall, use **Loki ICMP tunneling** to execute commands of choice by tunneling them inside the payload of **ICMP echo packets**



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Bypassing Firewall through ACK Tunneling Method

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1. It allows tunneling a backdoor application with TCP packets with the ACK bit set
2. ACK bit is used to acknowledge receipt of a packet
3. Some firewalls do not check packets with ACK bit set because ACK bits are supposed to be used in response to legitimate traffic
4. Tools such as AckCmd (http://ntsecurity.nu) can be used to implement ACK tunneling

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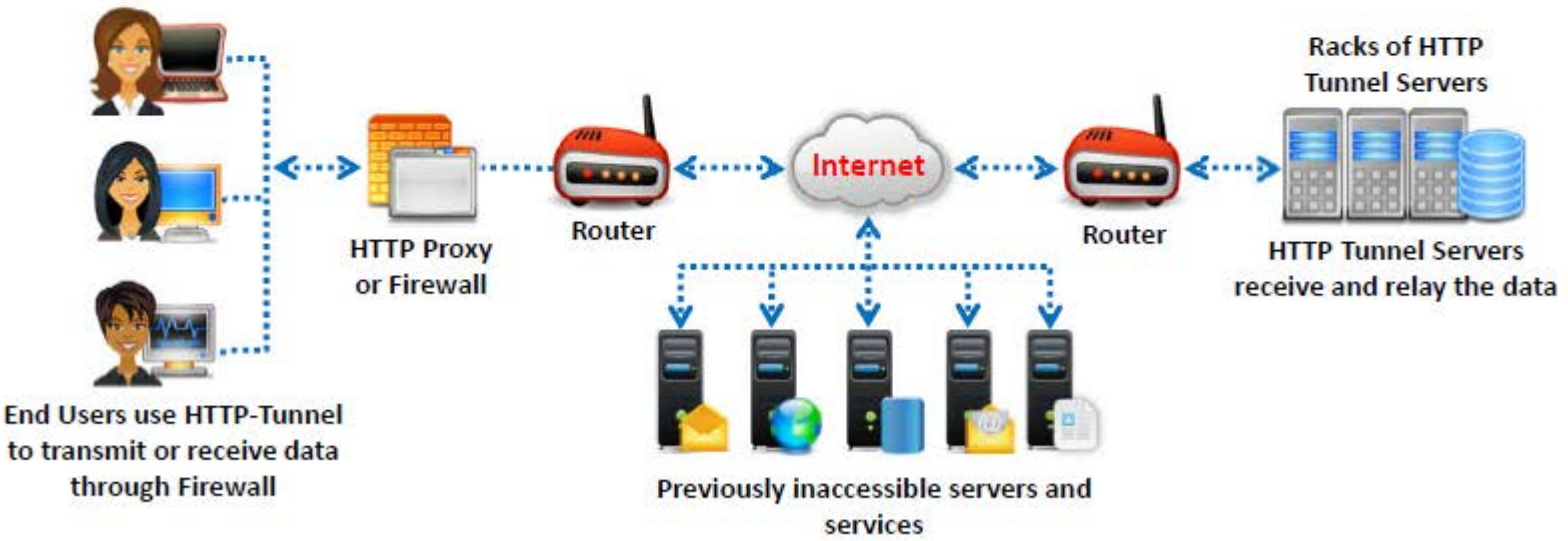
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Bypassing Firewall through HTTP Tunneling Method

1. HTTP Tunneling technology allows attackers to perform various Internet tasks despite the restrictions imposed by firewalls
2. This method can be implemented if the target company has a public web server with port 80 used for HTTP traffic, that is unfiltered on its firewall
3. Encapsulates data inside HTTP traffic (port 80)



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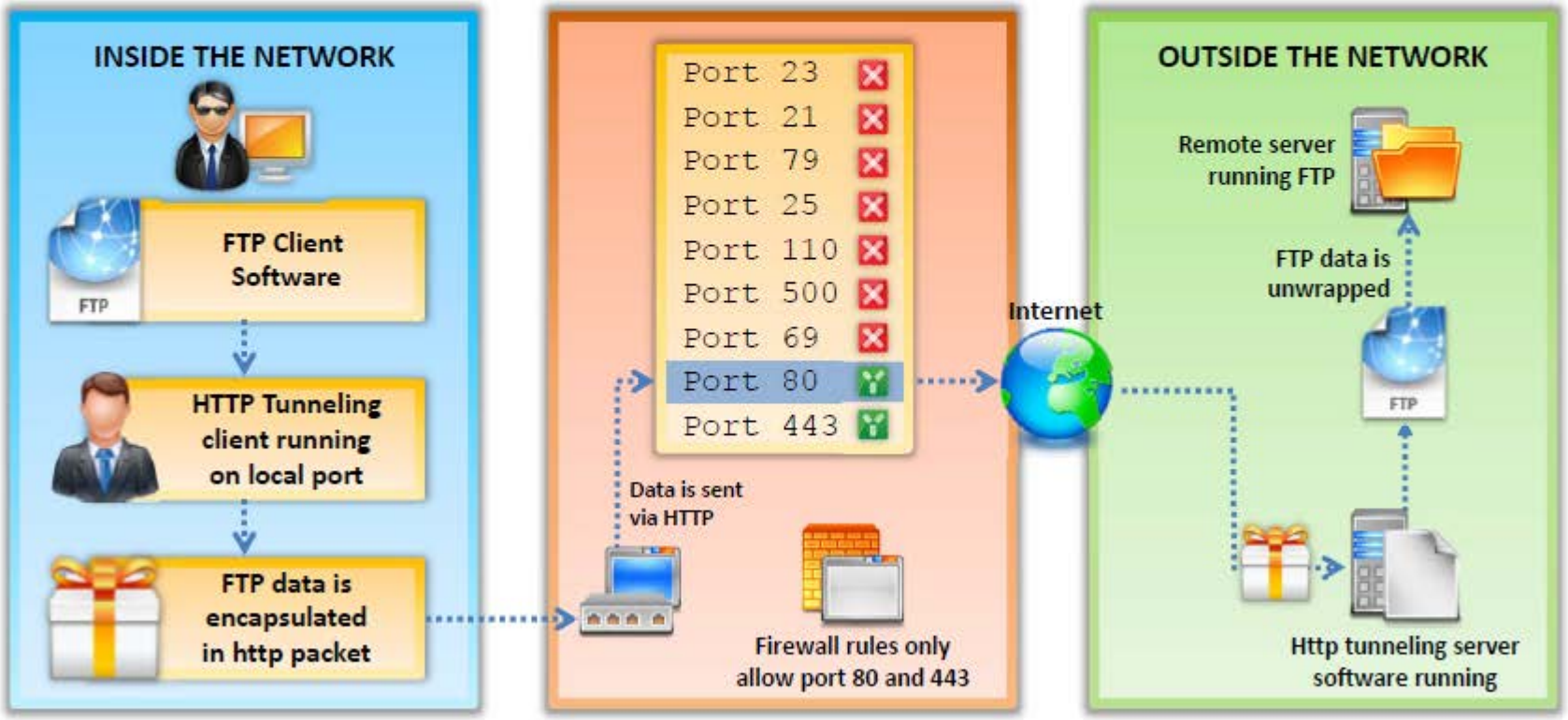
Why do I Need HTTP Tunneling

- Organizations firewall all ports except **80** and **443**, and you may want to use FTP
- HTTP tunneling will enable use of **FTP via HTTP protocol**



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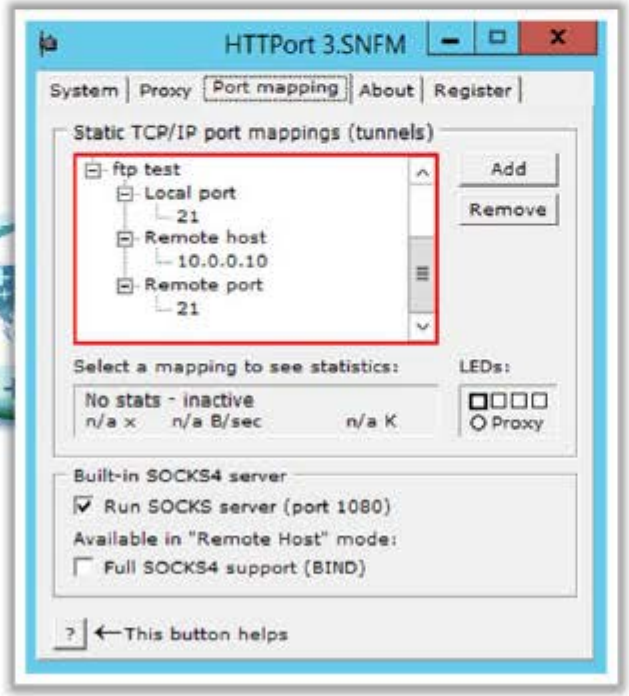
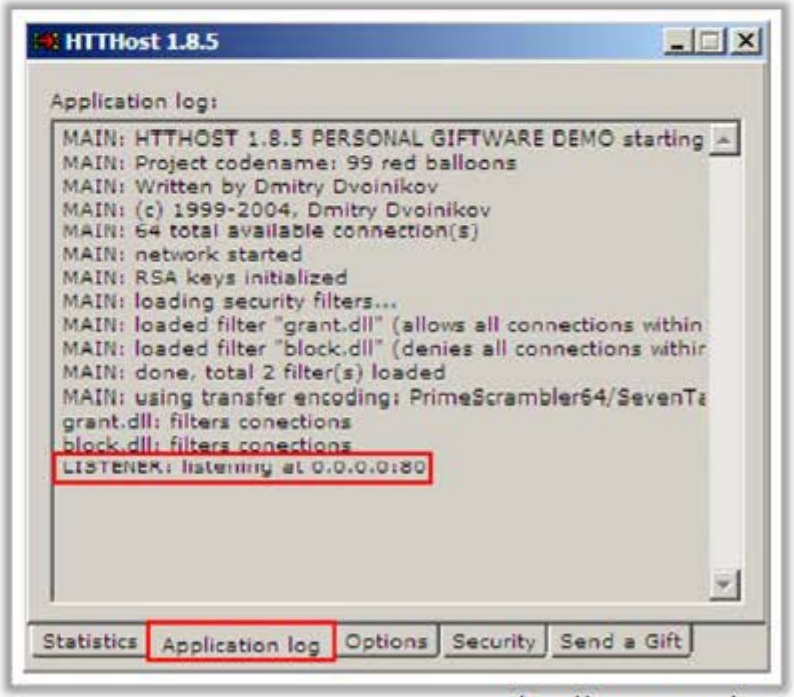
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

HTTP Tunneling Tools: HTTPort and HTTHost

- HTTPort allows you to **bypass your HTTP proxy**, which is blocking you from the Internet
- It allows you to use various **Internet software from behind the proxy**, ex. e-mail, instant messengers, P2P file sharing, ICQ, News, FTP, IRC, etc.





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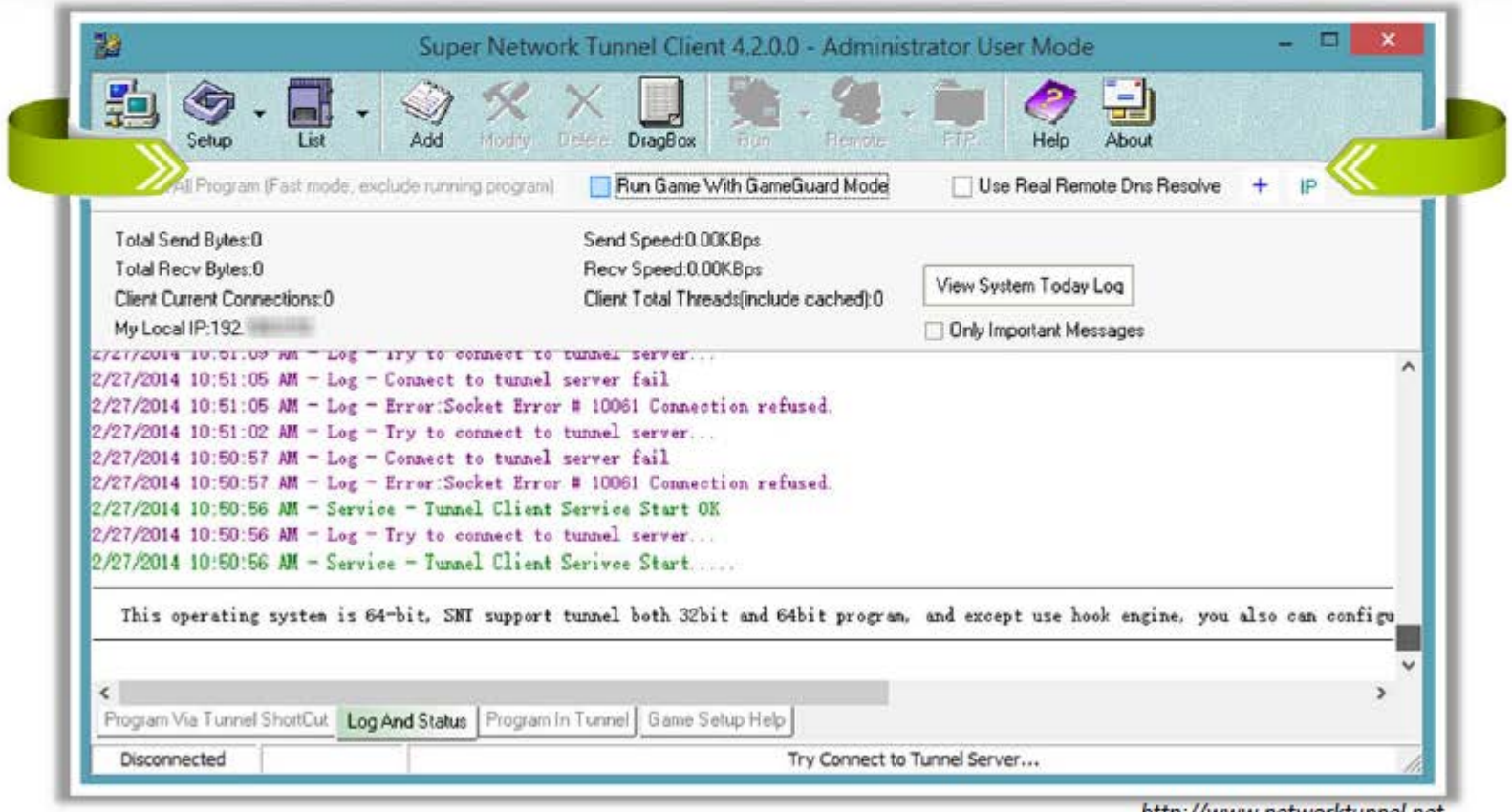
HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

HTTP Tunneling Tool: Super Network Tunnel

- A **two-way http tunnel** software connecting two computers
- Works like **VPN tunneling** but uses HTTP protocol to establish a connection



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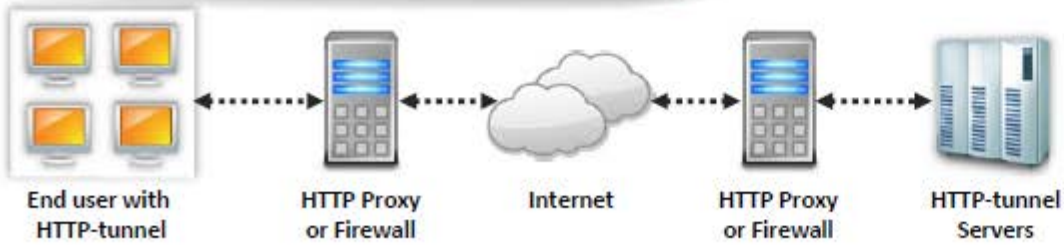
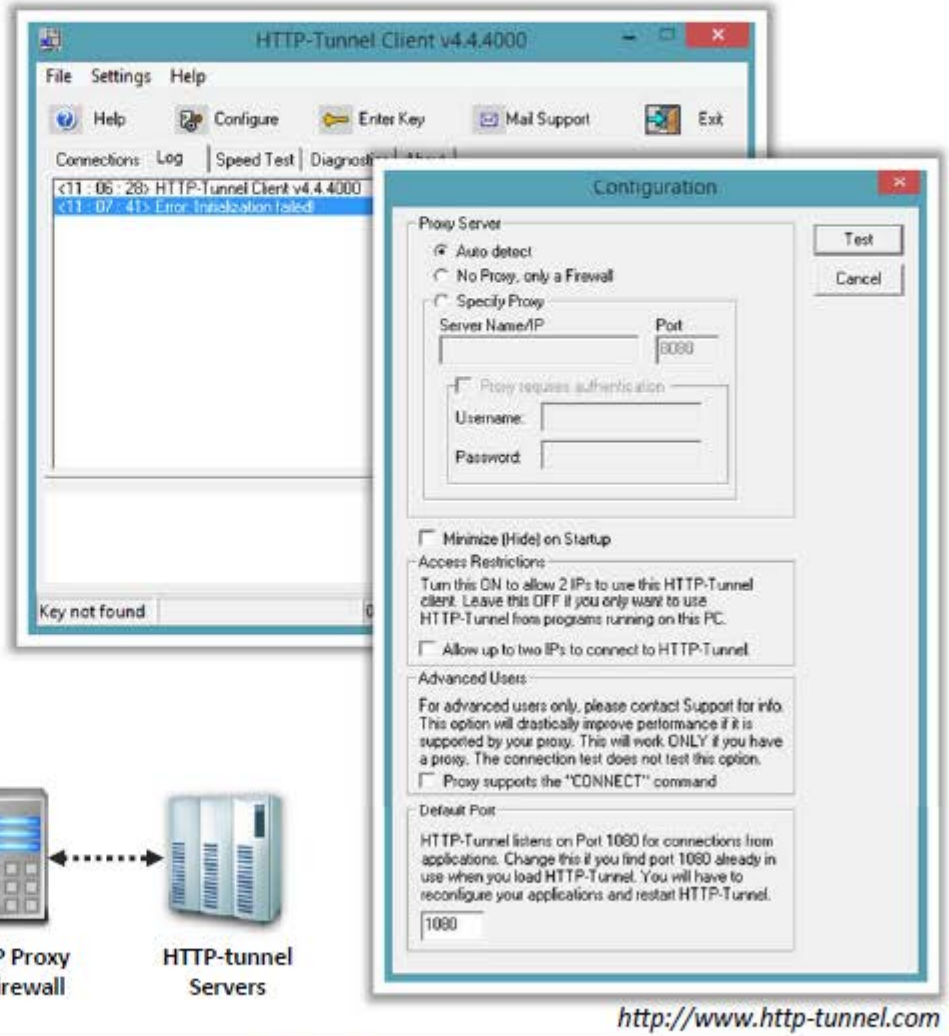
HTTP Tunneling Tool: HTTP-Tunnel

HTTP-Tunnel acts as a socks server, allowing you to use your Internet applications safely despite restrictive firewalls

SOCKet Secure (SOCKS) is an Internet protocol that routes network packets between a client and server through a proxy server





http://www.http-tunnel.com

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Bypassing Firewall through SSH Tunneling Method

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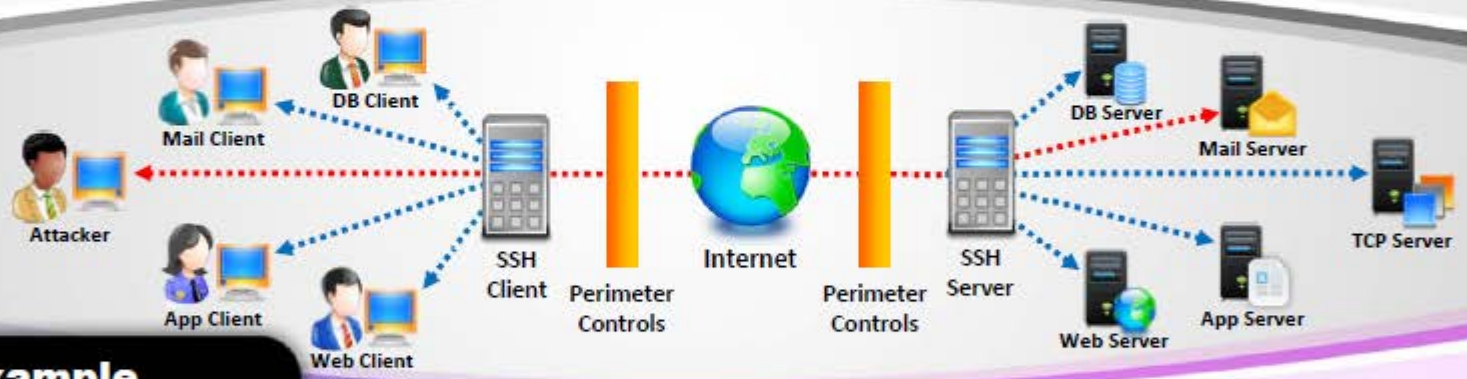
OpenSSH

Attackers use OpenSSH to **encrypt and tunnel** all the traffic from a local machine to a remote machine to avoid detection by perimeter security controls



Example

```
ssh -f user@certifiedhacker.com -L 5000:certifiedhacker.com:25 -N
```

`-f` => background mode, `user@certifiedhacker.com` => user name and server you are logging into, `-L 5000:certifiedhacker.com:25` => local-port:host:remote-port, and `-N` => Do not execute the command on the remote system

- This forwards the local port 5000 to port 25 on certifiedhacker.com encrypted
- Simply point your email client to use localhost:5000 as the SMTP server

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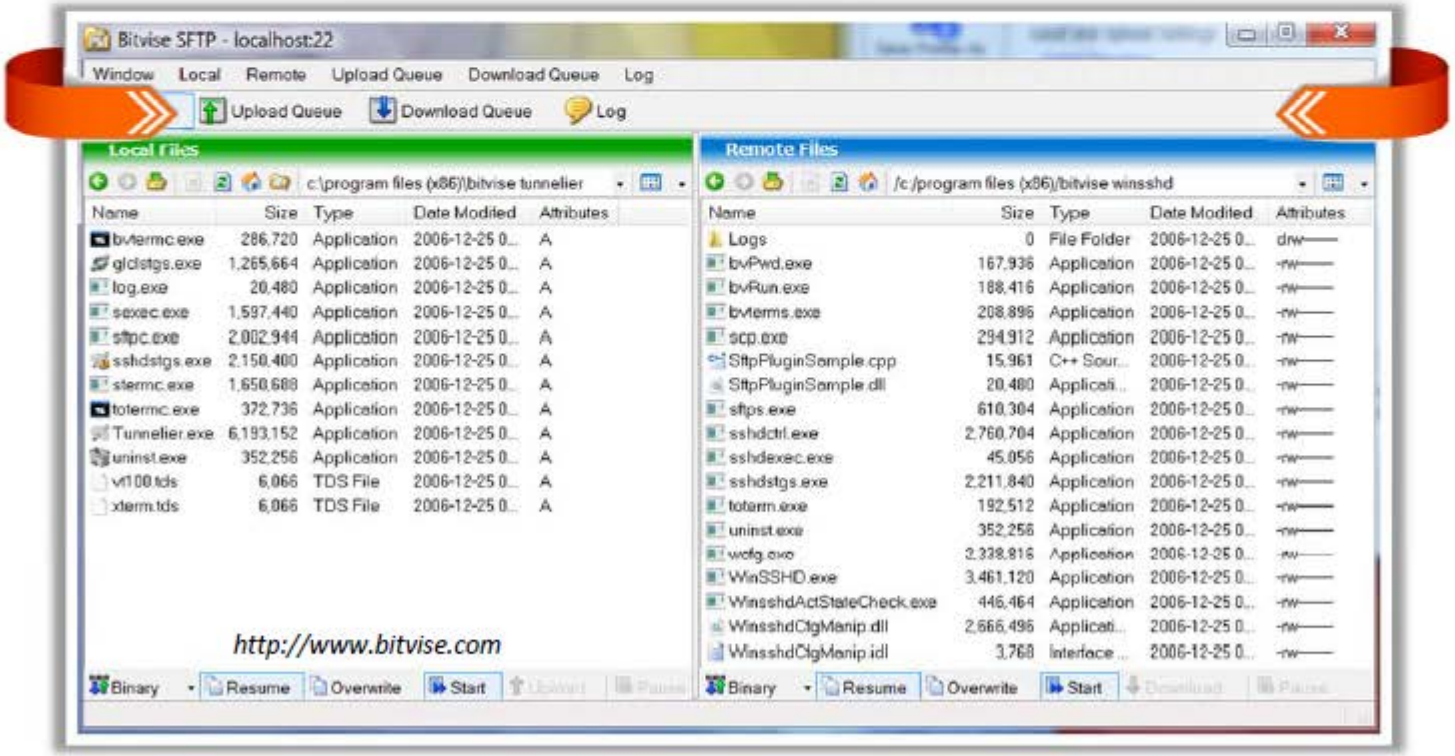
SSH Tunneling Tool: Bitvise

- Bitvise SSH Server provides secure **remote login capabilities** to Windows workstations and servers
- SSH Client includes powerful tunneling features including **dynamic port forwarding** through an integrated proxy, and also **remote administration** for the SSH Server



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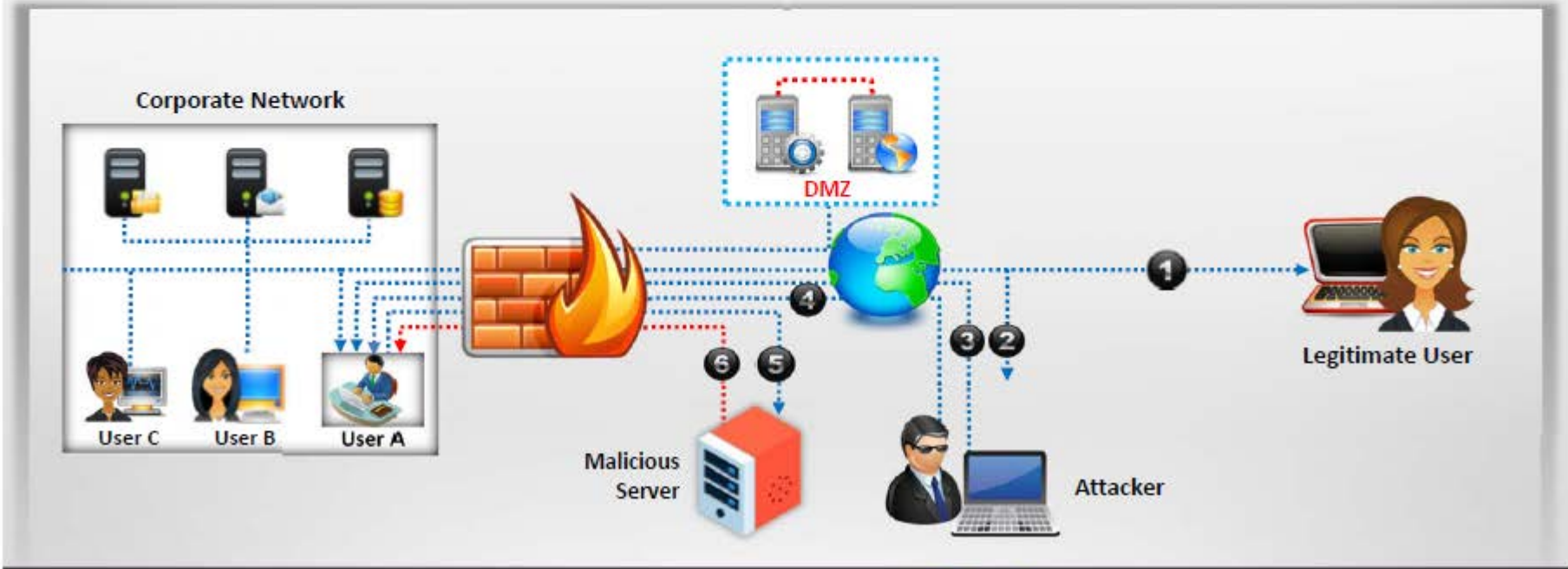
Bypassing Firewall through External Systems

1. Legitimate user works with some **external system** to access the corporate network
2. Attacker sniffs the **user traffic**, steals the **session ID** and **cookies**
3. Attacker **accesses the corporate network** bypassing the firewall and gets **Windows ID** of the running Netscape 4.x/ Mozilla process on user's system
4. Attacker then issues an **openURL() command** to the found window
5. User's web browser is redirected to the **attacker's Web server**
6. The malicious codes embedded in the attacker's web page are **downloaded and executed** on the user's machine



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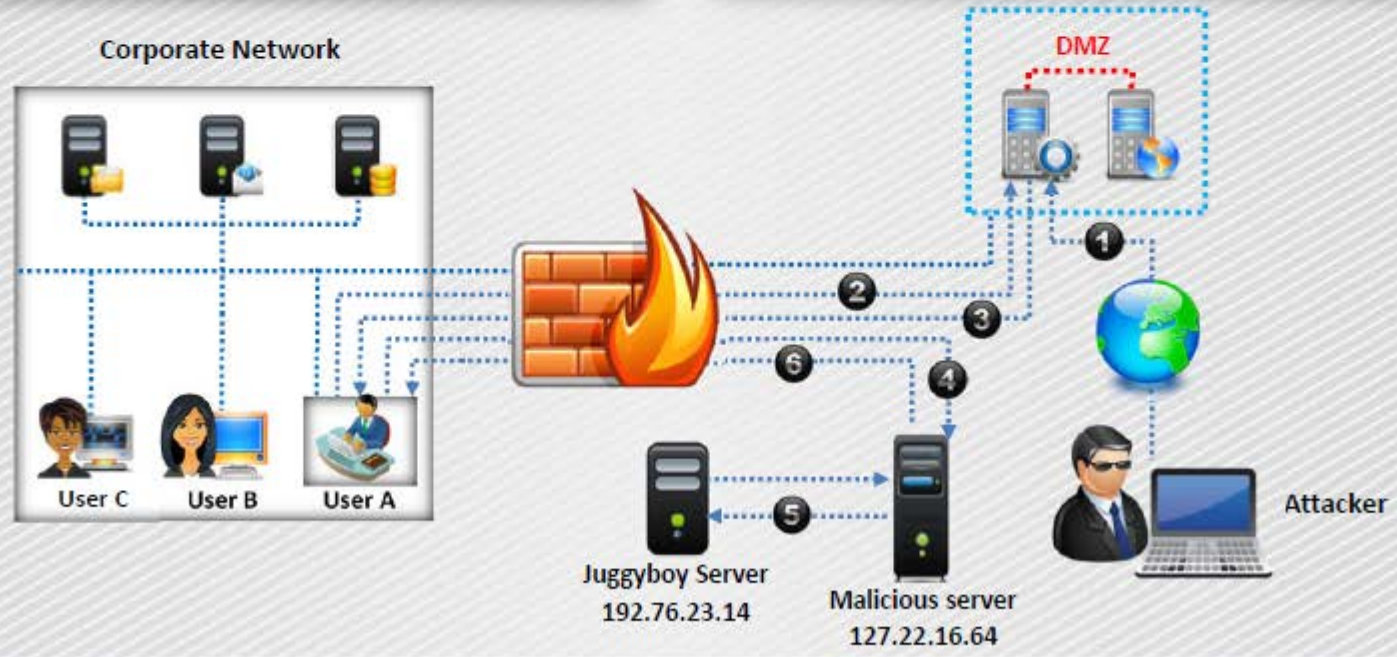
Bypassing Firewall through MITM Attack

1. Attacker performs **DNS server poisoning**
2. User A requests for WWW.juggyboy.com to the **corporate DNS server**
3. Corporate DNS server sends the **IP address** (127.22.16.64) **of the attacker**
4. User A accesses the **attacker's malicious server**
5. Attacker connects with the **real host and tunnels the user's HHTP traffic**
6. The malicious codes embedded in the attacker's web page are **downloaded and executed** on the user's machine



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Bypassing Firewall through Content

In this method, the attacker **sends the content containing malicious code** to the user and tricks him/her to open it so that the malicious code can be executed

Examples:

Sending an email containing malicious executable file or Microsoft office document capable of exploiting **macro bypass exploit**

There are many file formats that can be used as **malicious content carrier**

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Module Flow

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01 IDS, Firewall and Honeypot Concepts	02 IDS, Firewall and Honeypot Solutions	03 Evading IDS
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06 Detecting Honeypots	07 IDS/Firewall Evasion Counter-measures	08 Penetration Testing

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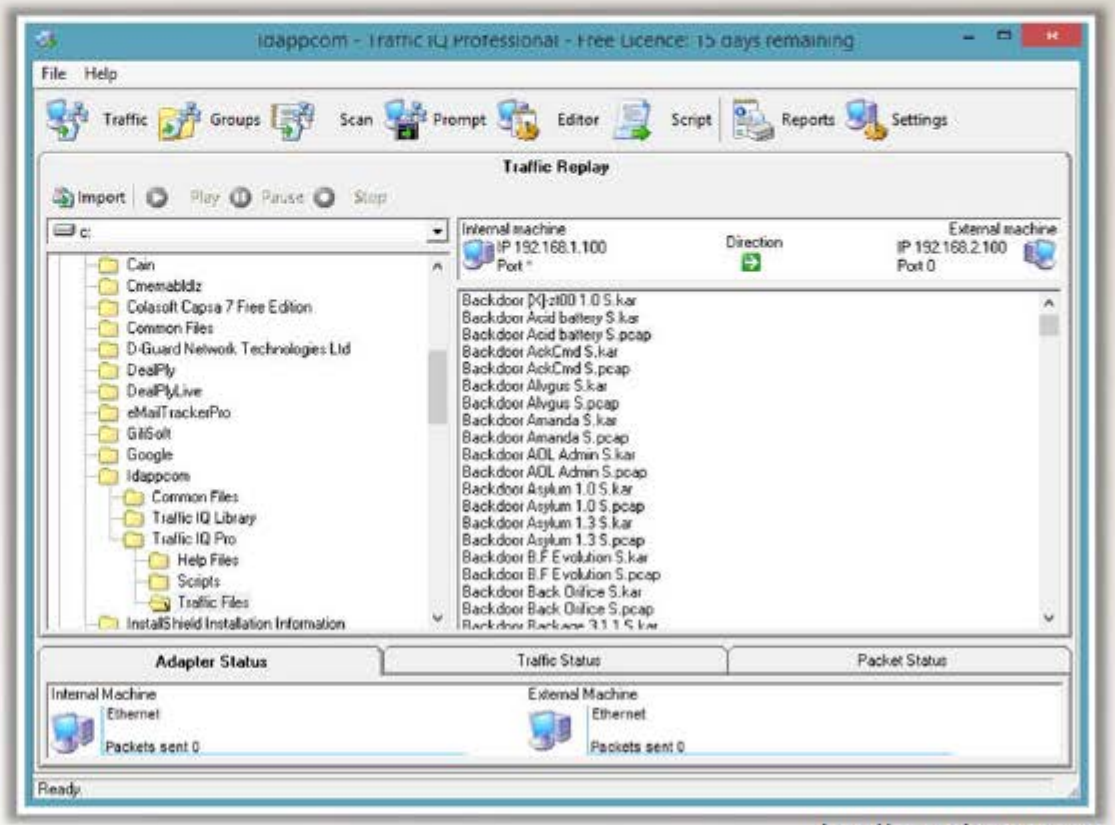
IDS/Firewall Evasion Tool: Traffic IQ Professional

Traffic IQ Professional enables security professionals to **audit and validate the behavior of security devices** by generating the **standard application traffic or attack traffic** between two virtual machines

Traffic IQ Professional can be used to **assess**, **audit**, and **test the behavioral characteristics** of any non-proxy packet-filtering device including:

- Application firewall systems **01**
- Intrusion detection systems **02**
- Intrusion prevention systems **03**
- Routers and switches **04**



http://www.idappcom.com

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IDS/Firewall Evasion Tool: tcp-over-dns

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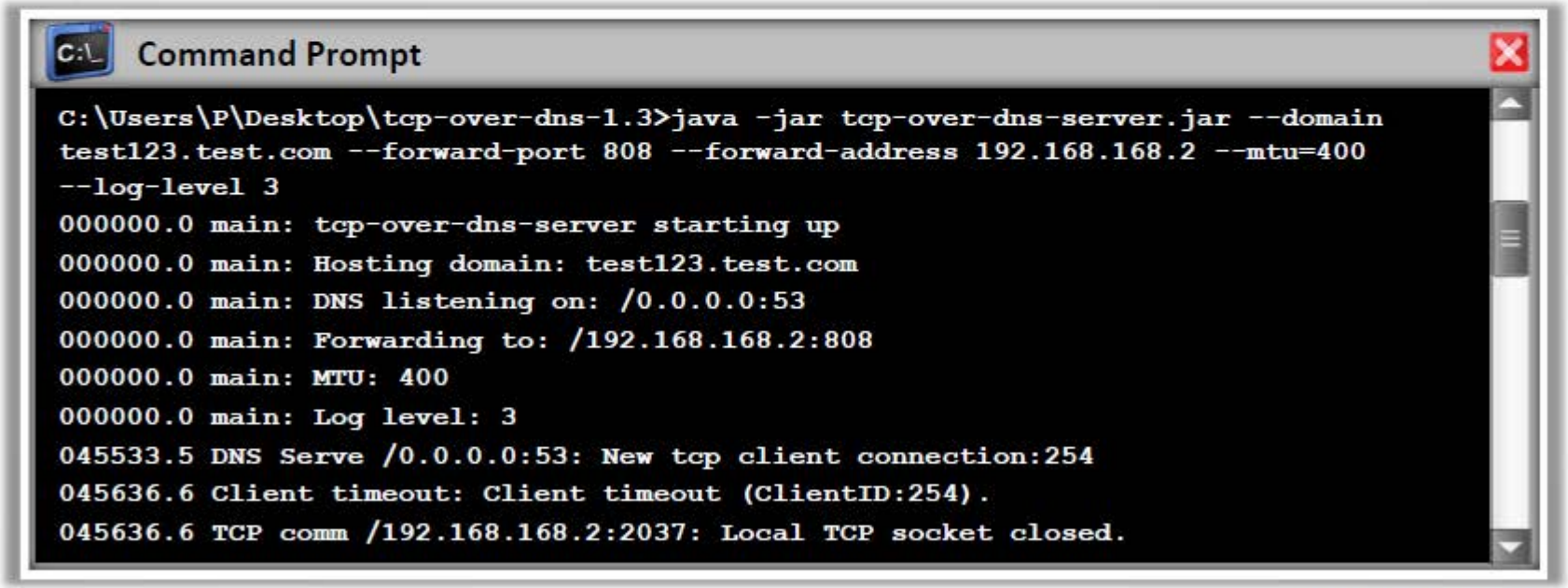
01 tcp-over-dns contains a special dns server and a special dns client

02 The client and server work in tandem to provide a TCP (and UDP!) tunnel through the standard DNS protocol



http://analogbit.com

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IDS/Firewall Evasion Tools

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Snare Agent for Windows
http://www.intersectalliance.com

AckCmd
http://ntsecurity.nu

Tomahawk
http://tomahawk.sourceforge.net

Your Freedom
http://www.your-freedom.net

Atelier Web Firewall Tester
http://www.atelierweb.com

Freenet
https://freenetproject.org

GTunnel
http://gardennetworks.org

Hotspot Shield
http://www.anchorfree.com

Proxifier
http://www.proxifier.com

Vpn One Click
http://www.vpnoneclick.com

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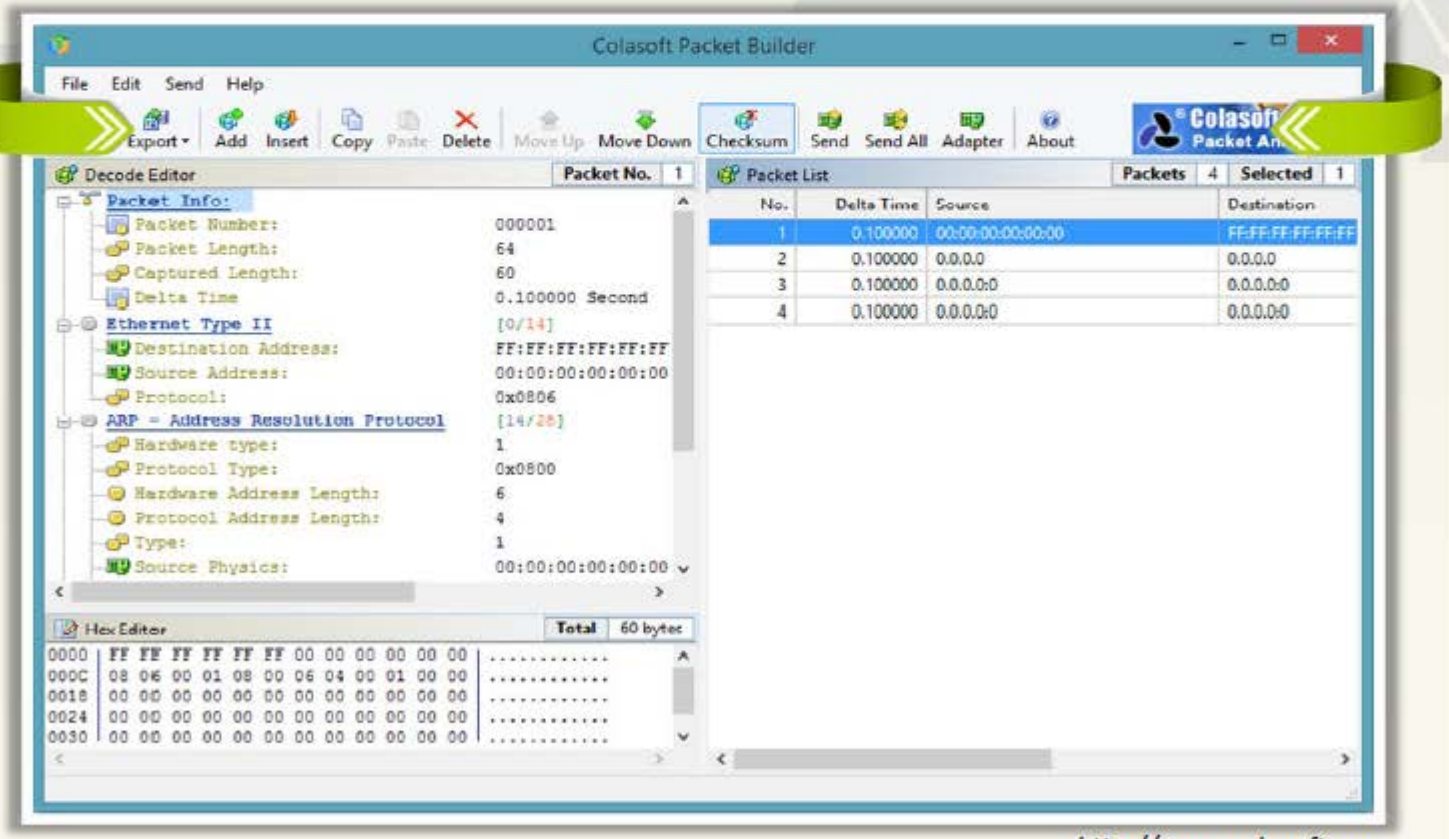
Packet Fragment Generator: Colasoft Packet Builder

Colasoft Packet Builder

Colasoft packet builder is a network packet crafter, packet generator or packet editor that network professionals use to **build (or craft) all types of custom network**



http://www.colasoft.com

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Packet Fragment Generators

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CommView
http://www.tamos.com

hping3
http://www.hping.org

Multi-Generator (MGEN)
http://cs.itd.nrl.navy.mil

Net-Inspect
http://search.cpan.org

Ostinato
https://code.google.com

fping 3
http://fping.org

NetScanTools Pro
http://www.netscantools.com

pktgen
http://www.linuxfoundation.org

PACKETH
http://packeth.sourceforge.net

Packet Generator
http://www.tamos.com

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Detecting Honeypots

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1. Attackers can determine the **presence of honeypots** by probing the services running on the system

2. Attackers craft **malicious probe packets** to scan for services such as HTTP over SSL (HTTPS), SMTP over SSL (SMPTS), and IMAP over SSL (IMAPS)

3. Ports that show a particular service running but deny a **three-way handshake connection** indicate the presence of a honeypot

4. **Tools to probe honeypots:**
   - Send-safe Honeypot Hunter
   - Nessus
   - Hping

Note: Attackers can also defeat the purpose of honeypots by using multi-proxies (TORs) and hiding their conversation using encryption and steganography techniques

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Honeypot Detection Tool: Send-Safe Honeypot Hunter

Send-Safe Honeypot Hunter is a tool designed for checking **lists of HTTPS and SOCKS proxies** for "honey pots"

Features:

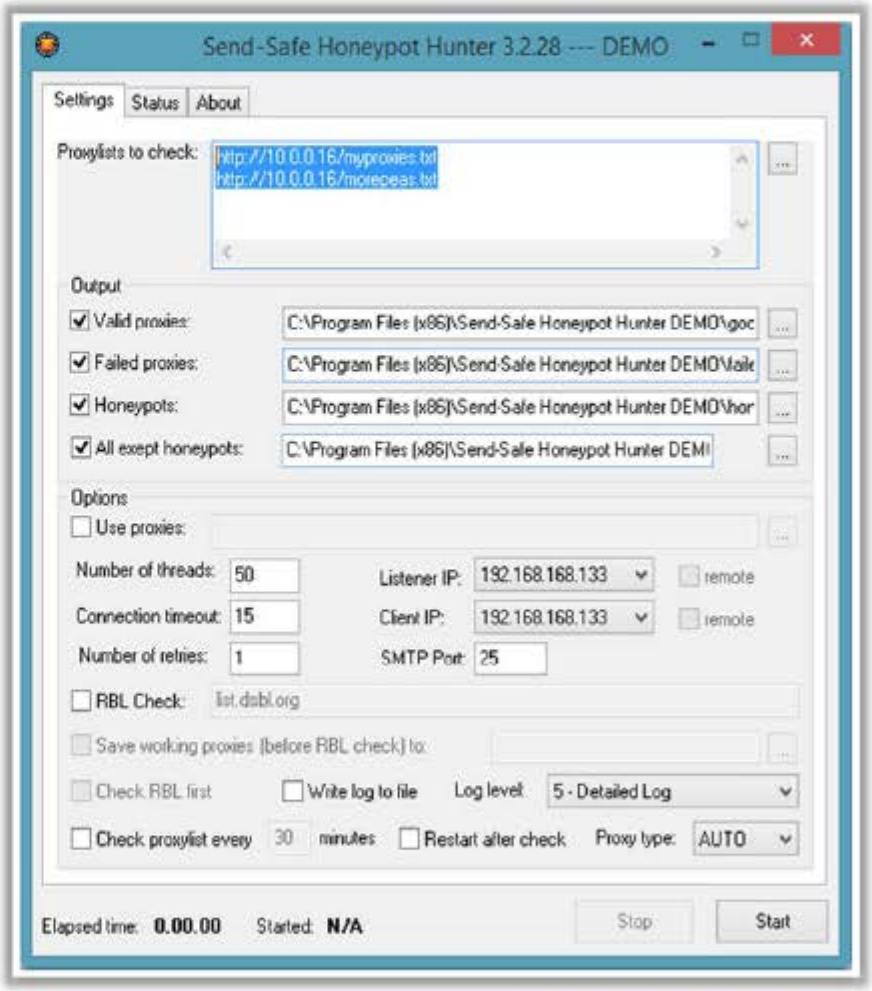
01 Checks lists of **HTTPS**, **SOCKS4**, and **SOCKS5 proxies** with any ports

02 Checks **several remote or local proxylists** at once

03 Can upload **"Valid proxies"** and **"All except honeypots"** files to FTP

04 Can process **proxylists** automatically every specified period of time

05 May be used for **usual proxylist** validating as well



http://www.send-safe.com

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Countermeasures

Shut down switch ports associated with the known attack hosts

Perform an in-depth analysis of ambiguous network traffic for all possible threats

Reset (RST) malicious TCP sessions

Look for the nop opcode other than 0x90 to defend against the polymorphic shellcode problem

Train users to identify attack patterns and regularly update/patch all the systems and network devices

Deploy IDS after a thorough analysis of network topology, nature of network traffic, and the number of host to monitor

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Countermeasures (Cont'd)

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Use a **traffic normalizer** to remove potential ambiguity from the packet stream before it reaches to the IDS

Ensure that IDSs **normalize fragmented packets** and allow those packets to be reassembled in the proper order

Define DNS server for client resolver in routers or similar network devices

Harden the security of all communication devices such as modems, routers, switches, etc.

If possible, block **ICMP TTL expired** packets at the external interface level and change the **TTL field to a large value**, ensuring that the end host always receives the packets

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Firewall/IDS Penetration Testing

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Firewall/IDS penetration testing helps in evaluating the Firewall and IDS for **ingress** and **egress** traffic filtering capabilities

Why Firewall/IDS Pen Testing?

- To check if firewall/IDS properly enforces an **organization's firewall/ IDS policy**
- To check the **amount of network information accessible** to an intruder
- To check if the **IDS and firewalls** enforces organization's network security policies
- To check the firewall/IDS for **potential breaches of security** that can be exploited
- To check if the firewall/IDS is good enough to **prevent the external attacks**
- To evaluate the **correspondence of firewall/IDS rules** with respect to the actions performed by them
- To check the effectiveness of the **network's security perimeter**
- To verify whether the **security policy is correctly enforced** by a sequence of firewall/IDS rules or not

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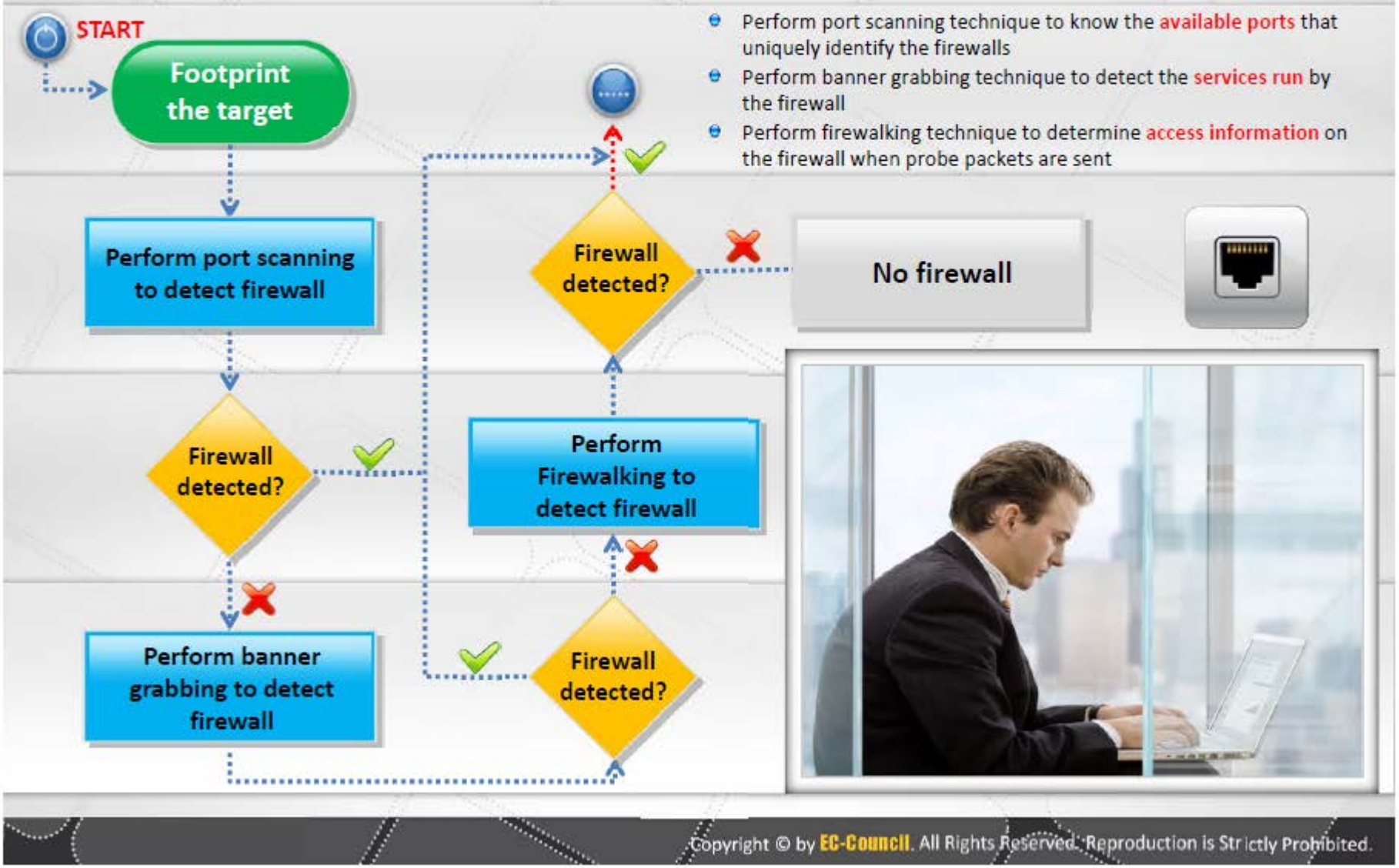
Firewall Penetration Testing



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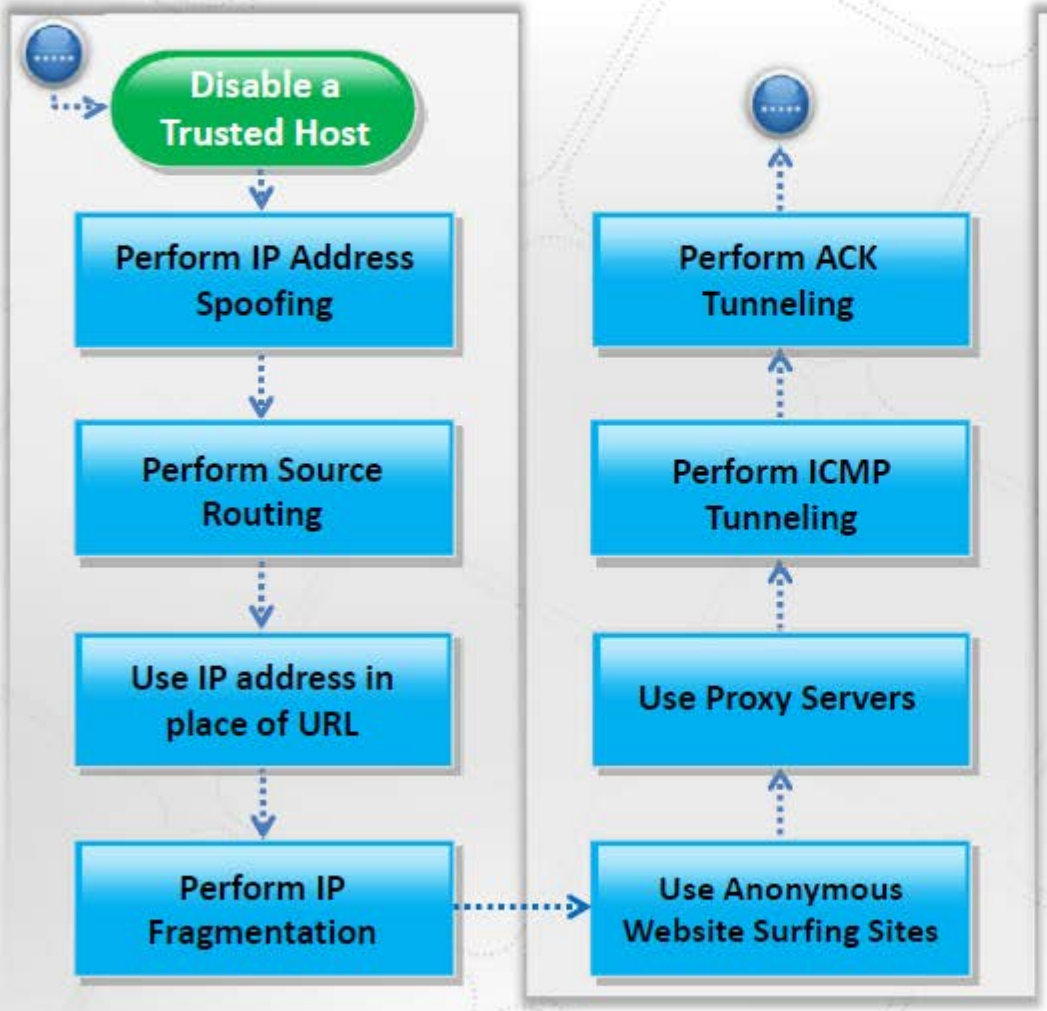
Firewall Penetration Testing (Cont'd)



- Perform **IP address spoofing** to gain unauthorized access to a computer or a network
- Perform **fragmentation attack** to force the TCP header information into the next fragment in order to bypass the firewall
- **Use proxy servers** that block the actual IP address and display another thereby allowing **access to the blocked website**
- Perform **ICMP tunneling** to tunnel a backdoor application in the data portion of ICMP Echo packets
- Perform **ACK tunneling** using tools such as **AckCmd** to tunnel backdoor application with TCP packets with the ACK bit set

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Firewall Penetration Testing (Cont'd)

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Perform HTTP Tunneling

- Perform HTTP tunneling using tools such as **HTTPort**, **HTTHost**, **Super Network Tunnel**, **HTTP-Tunnel**, etc. to tunnel the traffic across TCP port 80
- Perform SSH tunneling using tools such as **Bitvise** to encrypt and tunnel all the traffic from a local machine to a remote machine

Perform SSH Tunneling

- Gain **access to the corporate network** by sniffing the user's traffic and stealing the session ID and cookies
- Perform MITM attack in order to **own corporate DNS server** or to spoof DNS replies to it

Use External Systems

Perform MITM Attack → **Document All the Findings**

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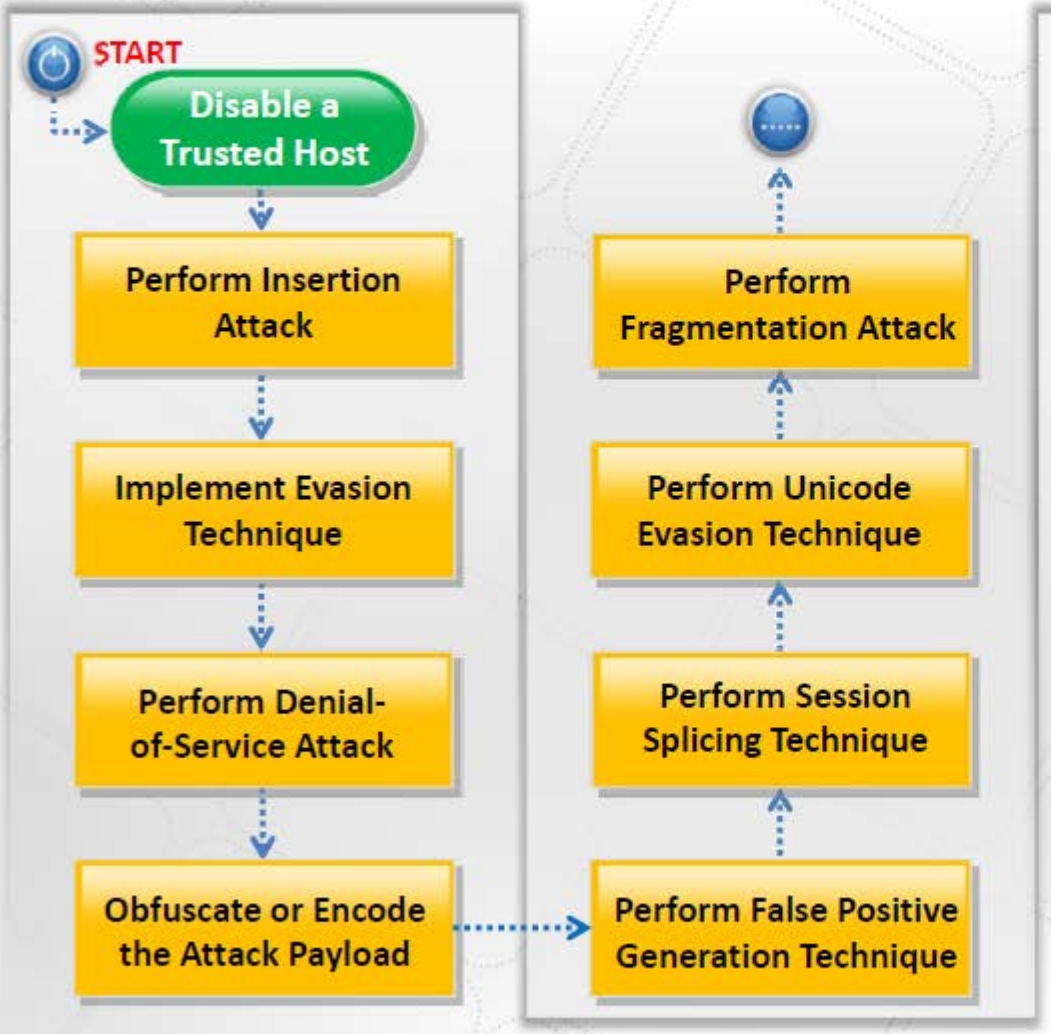
IDS Penetration Testing



- Perform **obfuscating technique** to encode attack packets that IDS would not detect but an IIS web server would decode and become attacked
- Try to bypass IDS by hiding attack traffic in a large volume of **false positive alerts** (false positive generation attack)
- Use **session splicing technique** to bypass IDS by keeping the session active for a longer time than the IDS reassembly time
- Try **Unicode representations** of characters to evade the IDS signature
- Perform **fragmentation attack with** IDS fragmentation reassembly timeout **less and more than** that of the Victim

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IDS Penetration Testing (Cont'd)

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- Perform Overlapping Fragments Technique
- Perform Time-To-Live Attack
- Perform Invalid RST Packets Technique
- Perform Urgency Flag Technique
- Perform Polymorphic Shellcode Technique
- Perform ASCII Shellcode Technique
- Perform Application-Layer Attack
- Perform Encryption and Flooding Techniques
- Perform Post Connection SYN Attack
- Perform Pre Connection SYN Attack

Document all the findings

- Perform **overlapping fragment technique** to craft a series of packets with TCP sequence numbers configured to overlap
- Try **invalid RST** packets technique to bypass IDS as it prevents IDS from processing the stream
- Perform **urgency flag evasion technique** to evade IDS as some IDSs do not consider the TCP protocol's urgency feature
- Try to bypass IDS by **encrypting** the shellcode to make it undetectable to IDS (polymorphic shellcode technique)
- Try to evade IDS pattern matching signatures by hiding the shellcode content using **ASCII codes** (ASCII shellcode technique)
- Perform **application layer attacks** as many IDSs fail to check the compressed file formats for signatures
- **Establish an encrypted session** with the victim or **send loads of unnecessary traffic** to produce noise that cannot be analyzed by the IDS

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HaCkRhIn0-TeaM wE FrEE t0 FIY HaCkRhIn0-TeaM

Module Summary

- An intrusion detection system (IDS) inspects all inbound and outbound network traffic for suspicious patterns that may indicate a network or system security breach
- Network-based intrusion detection systems typically consist of a black box that is placed on the network in the promiscuous mode, listening for patterns indicative of an intrusion
- Host-based intrusion detection systems usually include auditing for events that occur on a specific host
- Firewalls are software or hardware-based system designed to prevent unauthorized access to or from a private network
- A honeypot is an information system resource that is expressly set up to attract and trap people who attempt to penetrate an organization's network
- Firewall is identified by three techniques namely port scanning, banner grabbing, and firewalking
- Attackers can determine the presence of honeypots by probing the services running on the system
- Firewall/IDS penetration testing helps in evaluating the Firewall and IDS for ingress and egress traffic filtering capabilities

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