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CompTIA Cybersecurity Analyst (CySA+) CS0-002 Cert Guide

Troy McMillan

Pearson

CompTIA Cybersecurity Analyst (CySA+) CS0-002 Cert Guide

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Troy has also appeared in the following training videos for OnCourse Learning: Security+; Network+; Microsoft 70-410, 411, and 412 exam prep; ICND1; and ICND2.

He delivers CISSP training classes for CyberVista, and is an authorized online training provider for (ISC)2.

Troy also creates certification practice tests and study guides for CyberVista. He lives in Asheville, North Carolina, with his wife, Heike.

CHAPTER 4

Analyzing Assessment Output

When assessments are performed there will be data that is gathered that must be analyzed. The format of the output generated by the various tools used to perform the vulnerability assessment may be intuitive, but in many cases it is not. Analysts must be able to read and correctly interpret the output to identify issues that may exist. This chapter is dedicated to analyzing vulnerability assessment output.

"Do I Know This Already?" Quiz

The "Do I Know This Already?" quiz enables you to assess whether you should read the entire chapter. If you miss no more than one of these six self-assessment questions, you might want to skip ahead to the "Exam Preparation Tasks" section. Table 4-1 lists the major headings in this chapter and the "Do I Know This Already?" quiz questions covering the material in those headings so that you can assess your knowledge of these specific areas. The answers to the "Do I Know This Already?" quiz appear in Appendix A.

Table 4-1 "Do I Know This Already?" Foundation Topics Section-to-Question Mapping

Foundation Topics Section	Question
Web Application Scanner	1
Infrastructure Vulnerability Scanner	2
Software Assessment Tools and Techniques	3
Enumeration	4
Wireless Assessment Tools	5
Cloud Infrastructure Assessment Tools	6

1. Which of the following is a type of proactive monitoring and uses external agents to run scripted transactions against an application?
   a. RUM
   b. Synthetic transaction monitoring

   c. Reverse engineering
   d. OWASP

2. Which of the following is an example of a cloud-based vulnerability scanner?
   a. OpenVAS
   b. Qualys
   c. Nikto
   d. NESSUS

3. Which step in the software development life cycle (SDLC) follows the design step?
   a. Gather requirements
   b. Certify/accredit
   c. Develop
   d. Test/validate

4. Which of the following is the process of discovering and listing information?
   a. Escalation
   b. Discovery
   c. Enumeration
   d. Penetration

5. Which of the following is a set of command-line tools you can use to sniff WLAN traffic?
   a. hping3
   b. Aircrack-ng
   c. Qualys
   d. Reaver

6. Which of the following is a data collection tool that allows you to use longitudinal survey panels to track and monitor the cloud environment?
   a. Prowler
   b. ScoutSuite
   c. Pacu
   d. Mikto

Foundation Topics

Web Application Scanner

Web vulnerability scanners focus on discovering vulnerabilities in web applications. These tools can operate in two ways: synthetic transaction monitoring or real user monitoring. In synthetic transaction monitoring, preformed (synthetic) transactions are performed against the web application in an automated fashion, and the behavior of the application is recorded. In real user monitoring, real user transactions are monitored while the web application is live.

Synthetic transaction monitoring, which is a type of proactive monitoring, uses external agents to run scripted transactions against a web application. This type of monitoring is often preferred for websites and applications. It provides insight into the application's availability and performance and warns of any potential issue before users experience any degradation in application behavior. For example, Microsoft's System Center Operations Manager (SCOM) uses synthetic transactions to monitor databases, websites, and TCP port usage.

In contrast, ***real user monitoring (RUM)***, which is a type of passive monitoring, captures and analyzes every transaction of every web application or website user. Unlike synthetic transaction monitoring, which attempts to gain performance insights by regularly testing synthetic interactions, RUM cuts through the guesswork, seeing exactly how users are interacting with the application.

Many web application scanners are available. These tools scan an application for common security issues with cookie management, PHP scripts, SQL injections, and other problems. Some examples of these tools are covered in this section.

Burp Suite

The ***Burp Suite*** is a suite of tools, one of which can be used for testing web applications. It can scan an application for vulnerabilities and can also be used to crawl an application (to discover content). This commercial software is available for Windows, Linux, and macOS. It can also be used for exploiting vulnerabilities. For more information, see https://portswigger.net/burp.

OWASP Zed Attack Proxy (ZAP)

The Open Web Application Security Project (OWASP) produces an interception proxy called ***OWASP Zed Attack Proxy (ZAP)***. It performs many of the same functions as Burp, and so it also falls into the exploit category. It can monitor the traffic between a client and a server, crawl the application for content, and perform vulnerability scans. For more information, see https://owasp.org/www-project-zap/.

Nikto

Nikto is a vulnerability scanner that is dedicated to web servers. It is designed for Linux but can be run in Windows through a Perl interpreter. This tool is not stealthy, but it is a fast scanner. Everything it does is recorded in your logs. It generates a lot of information, much of it normal or informational. It is a command-line tool that is often run from within a Kali Linux server and preinstalled with more than 300 penetration-testing programs. For more information, see https://tools.kali.org/information-gathering/nikto.

Arachni

Arachni is a Ruby framework for assessing the security of a web application. It is often used by penetration testers. It is open source, works with all major operating systems (Windows, macOS, and Linux), and is distributed via portable packages that allow for instant deployment. Arachni can be used either at the command line or via the web interface, shown in Figure 4-1.

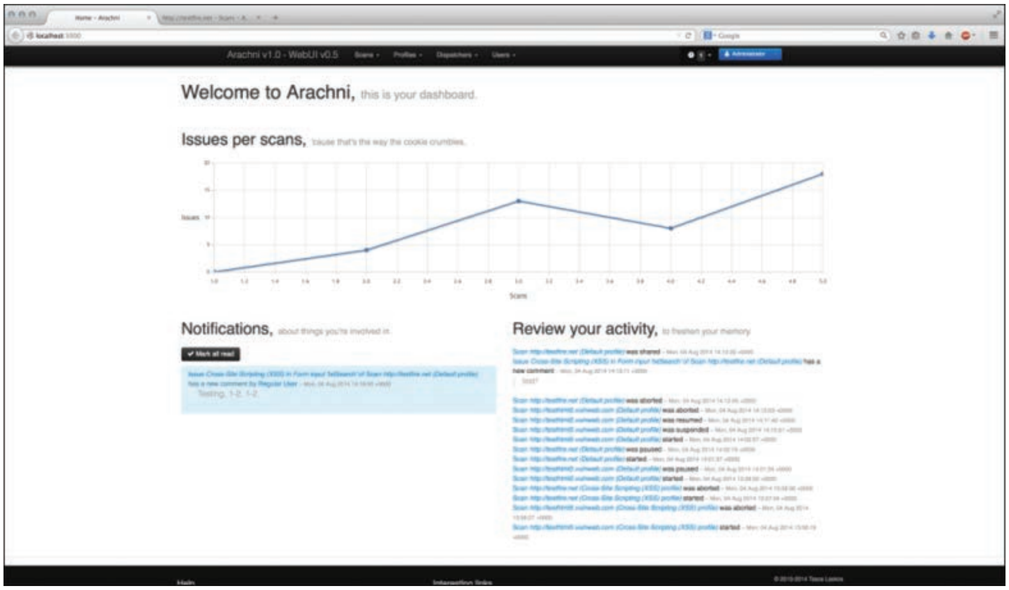

Arachni v1.0 - WebUI v0.5
Scans
Profiles
Dispatchers
Users
Welcome to Arachni, this is your dashboard.
Issues per scans, 'cause that's the way the cookie crumbles.
Issues
Scans
Notifications, about things you're involved in
Mark all read
Testing, 1-2, 1-2.
Review your activity, to freshen your memory

FIGURE 4-1 Arachni

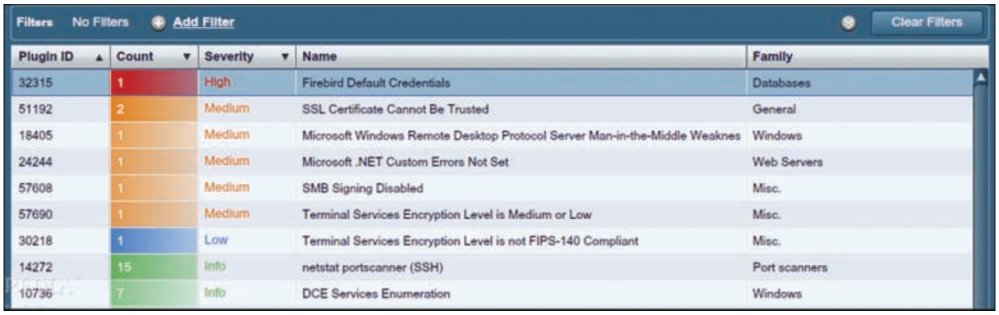
Infrastructure Vulnerability Scanner

An infrastructure vulnerability scanner probes for a variety of security weaknesses, including misconfigurations, out-of-date software, missing patches, and open ports. These solutions can be on premises or cloud based.

Infrastructure vulnerability scanners were covered in detail in Chapter 18.

Nessus

One of the most widely used vulnerability scanners is ***Nessus Professional***, a proprietary tool developed by Tenable Network Security. It is free of charge for personal use in a non-enterprise environment. By default, Nessus Professional starts by listing at the top of the output the issues found on a host that are rated with the highest severity, as shown in Figure 4-2.



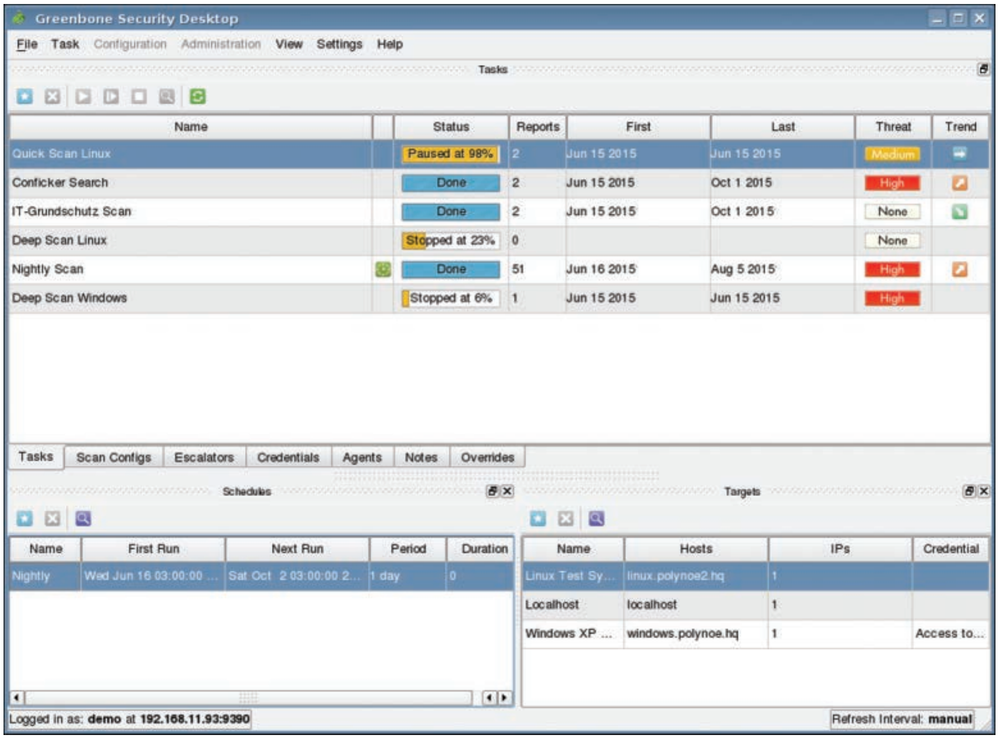
Plugin ID	Count	Severity	Name	Family
32315	1	High	Firebird Default Credentials	Databases
51192	2	Medium	SSL Certificate Cannot Be Trusted	General
18405	1	Medium	Microsoft Windows Remote Desktop Protocol Server Man-in-the-Middle Weaknes	Windows
24244	1	Medium	Microsoft .NET Custom Errors Not Set	Web Servers
57608	1	Medium	SMB Signing Disabled	Misc.
57690	1	Medium	Terminal Services Encryption Level is Medium or Low	Misc.
30218	1	Low	Terminal Services Encryption Level is not FIPS-140 Compliant	Misc.
14272	15	Info	netstat portscanner (SSH)	Port scanners
10736	7	Info	DCE Services Enumeration	Windows

FIGURE 4-2 Example Nessus Output

For the computer scanned in Figure 4-2, you can see that there is one high-severity issue (the default password for a Firebird database located on the host), and there are five medium-level issues, including two SSL certificates that cannot be trusted and a remote desktop man-in-the-middle attack vulnerability. For more information, see https://www.tenable.com/products/nessus.

OpenVAS

As you might suspect from the name, the ***OpenVAS*** tool is open source. It was developed from the Nessus code base and is available as a package for many Linux distributions. The scanner is accompanied with a regularly updated feed of network vulnerability tests (NVT). It uses the Greenbone console, shown in Figure 4-3. For more information, see https://www.openvas.org/.


Greenbone Security Desktop
File Task Configuration Administration View Settings Help
Tasks

Name		Status	Reports	First	Last	Threat	Trend
Quick Scan Linux		Paused at 98%	2	Jun 15 2015	Jun 15 2015	Medium	
Conficker Search		Done	2	Jun 15 2015	Oct 1 2015	High	
IT-Grundschutz Scan		Done	2	Jun 15 2015	Oct 1 2015	None	
Deep Scan Linux		Stopped at 23%	0			None	
Nightly Scan		Done	51	Jun 16 2015	Aug 5 2015	High	
Deep Scan Windows		Stopped at 6%	1	Jun 15 2015	Jun 15 2015	High	

Tasks Scan Configs Escalators Credentials Agents Notes Overrides
Schedules
Targets

Name	First Run	Next Run	Period	Duration
Nightly	Wed Jun 16 03:00:00 ...	Sat Oct 2 03:00:00 2...	1 day	0

Name	Hosts	IPs	Credential
Linux Test Sy...	linux.polynoe2.hq	1	
Localhost	localhost	1	
Windows XP ...	windows.polynoe.hq	1	Access to...

Logged in as: **demo** at **192.168.11.93:9390**

Refresh Interval: **manual**

FIGURE 4-3 OpenVAS

Software Assessment Tools and Techniques

Many organizations create software either for customers or for their own internal use. When software is developed, the earlier in the process security is considered, the less it will cost to secure the software. It is best for software to be secure by design. Secure coding standards are practices that, if followed throughout the ***software development life cycle (SDLC)***, help to reduce the attack surface of an application.

In Chapter 9, "Software Assurance Best Practices," you will learn about the SDLC, a set of ordered steps to help ensure that software is developed to enhance both security and functionality. As a quick preview, the SDLC steps are listed here:

Key Topic

Step 1. Plan/initiate project

Step 2. Gather requirements

Step 3. Design

Step 4. Develop

Step 5. Test/validate

Step 6. Release/maintain

Step 7. Certify/accredit

Step 8. Perform change management and configuration management/replacement

This section concentrates on Steps 5 and 7, which is where testing of the software occurs. This testing is covered in this chapter because it is a part of vulnerability management. This testing or validation can take many forms.

Static Analysis

Static code analysis is performed without the code executing. Code review and testing must occur throughout the entire SDLC. Code review and testing must identify bad programming patterns, security misconfigurations, functional bugs, and logic flaws.

Code review and testing in the planning and design phases include architecture security reviews and threat modeling. Code review and testing in the development phase include static source code analysis and manual code review and static binary code analysis and manual binary review. Once an application is deployed, code review and testing involve penetration testing, vulnerability scanning, and fuzz testing.

Static code review can be done with scanning tools that look for common issues. These tools can use a variety of approaches to find bugs, including the following:

Key Topic

- **Data flow analysis:** This analysis looks at runtime information while the software is in a static state.
- **Control flow graph:** A graph of the components and their relationships can be developed and used for testing by focusing on the entry and exit points of each component or module.
- **Taint analysis:** This analysis attempts to identify variables that are tainted with user-controllable input.
- **Lexical analysis:** This analysis converts source code into tokens of information to abstract the code and make it easier to manipulate for testing purposes.

Code review is the systematic investigation of the code for security and functional problems. It can take many forms, from simple peer review to formal code review. There are two main types of reviews:

Key Topic

- **Formal review:** This is an extremely thorough, line-by-line inspection, usually performed by multiple participants using multiple phases. This is the most time-consuming type of code review but the most effective at finding defects.

- **Lightweight:** This type of code review is much more cursory than a formal review. It is usually done as a normal part of the development process. It can happen in several forms:
  - **Pair programming:** Two coders work side by side, checking one another's work as they go.
  - **Email:** Code is emailed around to colleagues for them to review when time permits.
  - **Over the shoulder:** Coworkers review the code while the author explains his or her reasoning.
  - **Tool-assisted:** Perhaps the most efficient method, this method uses automated testing tools.

While code review is most typically performed on in-house applications, it may be warranted in other scenarios as well. For example, say that you are contracting with a third party to develop a web application to process credit cards. Considering the sensitive nature of the application, it would not be unusual for you to request your own code review to assess the security of the product.

In many cases, more than one tool should be used in testing an application. For example, an online banking application that has had its source code updated should undergo both penetration testing with accounts of varying privilege levels and a code review of the critical models to ensure that defects there do not exist.

Dynamic Analysis

Dynamic analysis is testing performed while the software is running. This testing can be performed manually or by using automated testing tools. There are two general approaches to dynamic testing:

Key Topic

- **Synthetic transaction monitoring:** A type of proactive monitoring, often preferred for websites and applications. It provides insight into the application's availability and performance, warning of any potential issue before users experience any degradation in application behavior. It uses external agents to run scripted transactions against an application. For example, Microsoft's System Center Operations Manager (SCOM) uses synthetic transactions to monitor databases, websites, and TCP port usage.
- **Real user monitoring (RUM):** A type of passive monitoring that captures and analyzes every transaction of every application or website user. Unlike synthetic monitoring, which attempts to gain performance insights by regularly testing synthetic interactions, RUM cuts through the guesswork by analyzing exactly how your users are interacting with the application.

Reverse Engineering

In 1990, the Institute of Electrical and Electronics Engineers (IEEE) defined ***reverse engineering*** as "the process of analyzing a subject system to identify the system's components and their interrelationships, and to create representations of the system in another form or at a higher level of abstraction," where the "subject system" is the end product of software development.

Reverse engineering techniques can be applied in several areas, including the study of the security of in-house software. In Chapter 16, "Applying the Appropriate Incident Response Procedure," you'll learn how reverse engineering is applied to the incident response procedure. In Chapter 12, "Implementing Configuration Changes to Existing Controls to Improve Security," you'll learn how reverse engineering applies to the malware analysis process. The techniques you will learn about in those chapters can also be used to locate security issues with in-house software.

Fuzzing

Fuzz testing, or ***fuzzing***, involves injecting invalid or unexpected input (sometimes called faults) into an application to test how the application reacts. It is usually done with a software tool that automates the process. Inputs can include environment variables, keyboard and mouse events, and sequences of API calls. Figure 4-4 shows the logic of the fuzzing process.

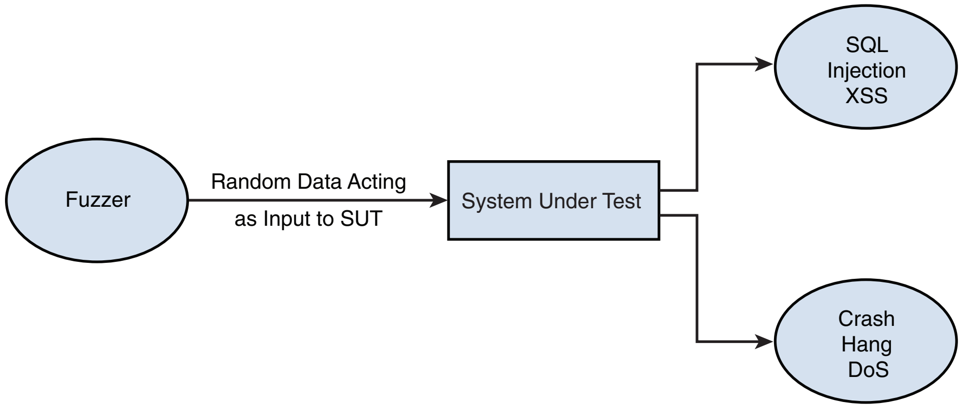


FIGURE 4-4 Fuzz Testing

Two types of fuzzing can be used to identify susceptibility to a fault injection attack:

Key Topic

- **Mutation fuzzing:** Involves changing the existing input values (blindly)
- **Generation-based fuzzing:** Involves generating the inputs from scratch, based on the specification/format

The following measures can help prevent fault injection attacks:

- Implement fuzz testing to help identify problems.
- Adhere to safe coding and project management practices.
- Deploy application-level firewalls.

Enumeration

Enumeration is the process of discovering and listing information. Network enumeration is the process of discovering pieces of information that might be helpful in a network attack or compromise. There are several techniques used to perform enumeration and several tools that make the process easier for both testers and attackers. Let's take a look at these techniques and tools.

Nmap

While network scanning can be done with more blunt tools, like ping, ***Nmap*** is stealthier and may be able to perform its activities without setting off firewalls and IDSs. It is valuable to note that while we are discussing Nmap in the context of network scanning, this tool can be used for many other operations, including performing certain attacks. When used for scanning, it typically locates the devices, locates the open ports on the devices, and determines the OS on each host.

After performing Nmap scans with certain flags set in the scan packets, security analysts (and hackers) can make certain assumptions based on the responses received. These flags are used to control the TCP connection process and so are present only in those packets. Figure 4-5 show a TCP header with the important flags circled. Normally flags are "turned on" as a result of the normal TCP process, but a hacker can craft packets to check the flags he wants to check.

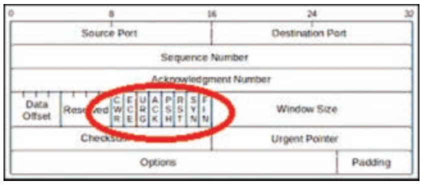


FIGURE 4-5 TCP Header

Figure 4-5 shows these flags, among others:

Key Topic

- **URG:** Urgent pointer field significant
- **ACK:** Acknowledgment field significant

- **PSH:** Push function
- **RST:** Reset the connection
- **SYN:** Synchronize sequence numbers
- **FIN:** No more data from sender

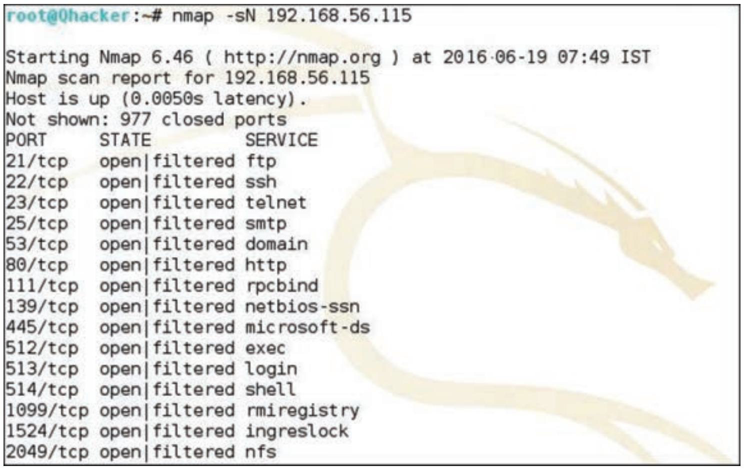
After performing Nmap scans with certain flags set in the scan packets, security analysts (and hackers) can make certain assumptions based on the responses received.

Nmap exploits weaknesses with three scan types:

Key Topic

- ***Null scan***: A Null scan is a series of TCP packets that contain a sequence number of 0 and no set flags. Because the Null scan does not contain any set flags, it can sometimes penetrate firewalls and edge routers that filter incoming packets with particular flags. When such a packet is sent, two responses are possible:
  - **No response:** The port is open on the target.
  - **RST:** The port is closed on the target.

  Figure 4-6 shows the result of a Null scan using the command **nmap -sN**. In this case, **nmap** received no response but was unable to determine whether that was because a firewall was blocking the port or the port was closed on the target. Therefore, it is listed as open|filtered.



```
root@Qhacker:~# nmap -sN 192.168.56.115

Starting Nmap 6.46 ( http://nmap.org ) at 2016-06-19 07:49 IST
Nmap scan report for 192.168.56.115
Host is up (0.0050s latency).
Not shown: 977 closed ports
PORT     STATE         SERVICE
21/tcp   open|filtered ftp
22/tcp   open|filtered ssh
23/tcp   open|filtered telnet
25/tcp   open|filtered smtp
53/tcp   open|filtered domain
80/tcp   open|filtered http
111/tcp  open|filtered rpcbind
139/tcp  open|filtered netbios-ssn
445/tcp  open|filtered microsoft-ds
512/tcp  open|filtered exec
513/tcp  open|filtered login
514/tcp  open|filtered shell
1099/tcp open|filtered rmiregistry
1524/tcp open|filtered ingreslock
2049/tcp open|filtered nfs
```

FIGURE 4-6 Null Scan

- ***FIN scan***: This type of scan sets the FIN bit. When this packet is sent, two responses are possible:
  - **No response:** The port is open on the target.
  - **RST/ACK:** The port is closed on the target.

Example 4-1 shows sample output of a FIN scan using the command **nmap -sF**, with the **-v** included for verbose output. Again, nmap received no response but was unable to determine whether that was because a firewall was blocking the port or the port was closed on the target. Therefore, it is listed as open|filtered.

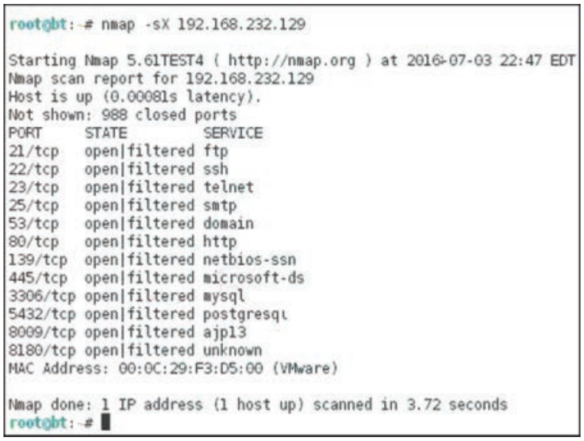
Key Topic

Example 4-1 FIN Scan Using **nmap –sF**

```
# nmap -sF -v 192.168.0.7

Starting nmap 3.81 at 2016-01-23 21:17 EDT
Initiating FIN Scan against 192.168.0.7 [1663 ports] at 21:17
The FIN Scan took 1.51s to scan 1663 total ports.
Host 192.168.0.7 appears to be up ... good.
Interesting ports on 192.168.0.7:
(The 1654 ports scanned but not shown below are in state: closed)
PORT      STATE          SERVICE
21/tcp    open|filtered  ftp
22/tcp    open|filtered  ssh
23/tcp    open|filtered  telnet
79/tcp    open|filtered  finger
110/tcp   open|filtered  pop3
111/tcp   open|filtered  rpcbind
514/tcp   open|filtered  shell
886/tcp   open|filtered  unknown
2049/tcp  open|filtered  nfs
MAC Address: 00:03:47:6D:28:D7 (Intel)

Nmap finished: 1 IP address (1 host up) scanned in 2.276 seconds
               Raw packets sent: 1674 (66.9KB) | Rcvd: 1655 (76.1KB)
```

- ***XMAS scan***: This type of scan sets the FIN, PSH, and URG flags. When this packet is sent, two responses are possible:
  - **No response:** The port is open on the target.
  - **RST:** The port is closed on the target.

Figure 4-7 shows the result of this scan, using the command **nmap -sX**. In this case nmap received no response but was unable to determine whether that was because a firewall was blocking the port or the port was closed on the target. Therefore, it is listed as open|filtered.



```
root@bt:~# nmap -sX 192.168.232.129

Starting Nmap 5.61TEST4 ( http://nmap.org ) at 2016-07-03 22:47 EDT
Nmap scan report for 192.168.232.129
Host is up (0.00081s latency).
Not shown: 988 closed ports
PORT     STATE         SERVICE
21/tcp   open|filtered ftp
22/tcp   open|filtered ssh
23/tcp   open|filtered telnet
25/tcp   open|filtered smtp
53/tcp   open|filtered domain
80/tcp   open|filtered http
139/tcp  open|filtered netbios-ssn
445/tcp  open|filtered microsoft-ds
3306/tcp open|filtered mysql
5432/tcp open|filtered postgresql
8009/tcp open|filtered ajp13
8180/tcp open|filtered unknown
MAC Address: 00:0C:29:F3:D5:00 (VMware)

Nmap done: 1 IP address (1 host up) scanned in 3.72 seconds
root@bt:~# █
```

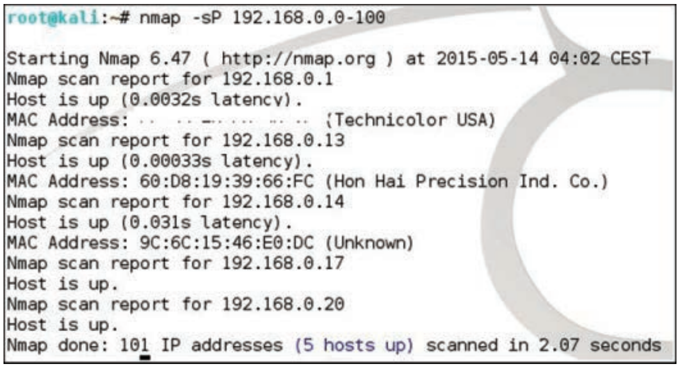
FIGURE 4-7 XMAS Scan

Null, FIN, and XMAS scans all serve the same purpose, to discover open ports and ports blocked by a firewall, and differ only in the switch used. While there are many more scan types and attacks that can be launched with Nmap, these scan types are commonly used during environmental reconnaissance testing to discover what the hacker might discover and take steps to close any gaps in security before the hacker gets there. For more information on Nmap, see https://nmap.org/.

Host Scanning

Host scanning involves identifying the live hosts on a network or in a domain namespace. Nmap and other scanning tools (such as ScanLine and SuperScan) can be used for this. Sometimes called a ping scan, a host scan records responses to pings sent to every address in the network. You can also combine a host scan with a port scan by using the proper arguments to the command. During environmental reconnaissance testing, you can make use of these scanners to identify all live hosts. You may discover hosts that shouldn't be there. To execute this scan from **nmap**, the command is **nmap -sP 192.168.0.0-100**, where 0-100 is the range of IP addresses to be scanned in the 192.168.0.0 network. Figure 4-8 shows an example of the output from this command. This command's output lists all devices that are on. For each one, the MAC address is also listed.

Key Topic



```
root@kali:~# nmap -sP 192.168.0.0-100

Starting Nmap 6.47 ( http://nmap.org ) at 2015-05-14 04:02 CEST
Nmap scan report for 192.168.0.1
Host is up (0.0032s latency).
MAC Address: [illegible] (Technicolor USA)
Nmap scan report for 192.168.0.13
Host is up (0.00033s latency).
MAC Address: 60:D8:19:39:66:FC (Hon Hai Precision Ind. Co.)
Nmap scan report for 192.168.0.14
Host is up (0.031s latency).
MAC Address: 9C:6C:15:46:E0:DC (Unknown)
Nmap scan report for 192.168.0.17
Host is up.
Nmap scan report for 192.168.0.20
Host is up.
Nmap done: 101 IP addresses (5 hosts up) scanned in 2.07 seconds
```

FIGURE 4-8 Host Scan with Nmap

hping

hping (and the newer version, hping3) is a command-line-oriented TCP/IP packet assembler/analyzer that goes beyond simple ICMP echo requests. It supports TCP, UDP, ICMP, and RAW-IP protocols and also has a traceroute mode. The following is a subset of the operations possible with **hping**:

Key Topic

- Firewall testing
- Advanced port scanning
- Network testing, using different protocols, TOS, fragmentation
- Manual path MTU discovery
- Advanced traceroute, under all the supported protocols
- Remote OS fingerprinting
- Remote uptime guessing
- TCP/IP stacks auditing

What is significant about hping is that it can be used to create or assemble packets. Attackers use packet assembly tools to create packets that allow them to mount attacks. Testers can also use hping to create malicious packets to assess the response of the network defenses or to identify vulnerabilities that may exist.

A common attack is a DoS attack using what is called a ***SYN flood***. In this attack, the target is overwhelmed with unanswered SYN/ACK packets. The device answers each SYN packet with a SYN-ACK. Since devices reserve memory for the expected response to the SYN-ACK packet, and since the attacker never answers, the target system eventually runs out of memory, making it essentially a dead device. This scenario is shown in Figure 4-9.

Key Topic

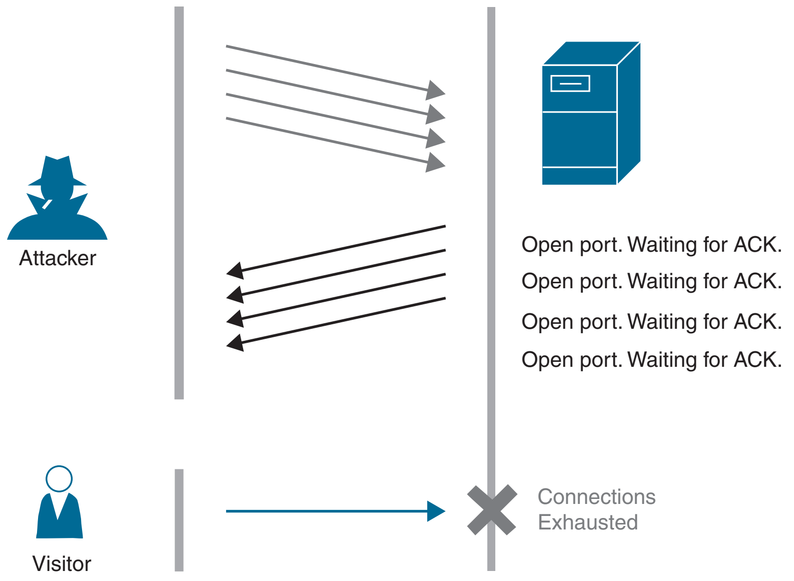

Attacker
Open port. Waiting for ACK.
Open port. Waiting for ACK.
Open port. Waiting for ACK.
Open port. Waiting for ACK.
Visitor
Connections Exhausted

FIGURE 4-9 SYN Flood

Example 4-2 demonstrates how to deploy a SYN flood by executing the **hping** command at the terminal.

Example 4-2 Deploying a SYN Flood with **hping**

```
$ sudo hping3 -i u1 -S -p 80 -c 10  192.168.1.1
HPING 192.168.1.1 (eth0 192.168.1.1): S set, 40 headers + 0 data bytes
--- 192.168.1.1 hping statistic ---
10 packets transmitted, 0 packets received, 100% packet loss
round-trip min/avg/max = 0.0/0.0/0.0 ms
```

The command in Example 4-2 would send TCP SYN packets to 192.168.1.1. Including **sudo** is necessary because **hping3** creates raw packets for the task. For raw sockets/packets, root privilege is necessary on Linux. The parts of the command and the meaning of each are described as follows:

- **i u1** means wait for 1 microsecond between each packet
- **S** indicates SYN flag
- **p 80** means target port 80
- **c 10** means send 10 packets

Were this a true attack, you would expect to see many more packets sent; however, you can see how this tool can be used to assess the likelihood that such an attack would succeed. For more information, see https://tools.kali.org/information-gathering/hping3.

Active vs. Passive

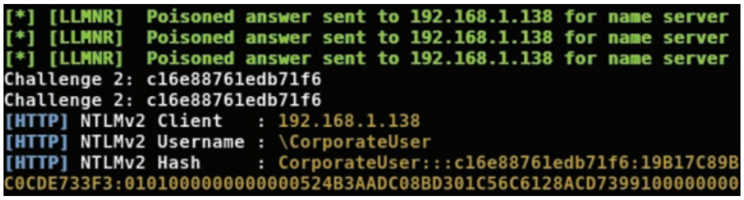
Chapter 3, "Vulnerability Management Activities," covered active and passive scanning. The concept of active and passive enumeration is similar. ***Active enumeration*** is when you send packets of some sort to the network and then assess responses. An example of this would be using nmap to send crafted packets that interrogate the accessibility of various ports (port scan). ***Passive enumeration*** does not send packets of any type but captures traffic and makes educated assumptions from the traffic. An example is using a packet capture utility (sniffer) to look for malicious traffic on the network.

Responder

Link-Local Multicast Name Resolution (LLMNR) and NetBIOS Name Service (NBT-NS) are Microsoft Windows components that serve as alternate methods of host identification. ***Responder*** is a tool that can be used for a number of things, among them answering NBT and LLMNR name requests. Doing this poisons the service so that the victims communicate with the adversary-controlled system. Once the name system is compromised, Responder captures hashes and credentials that are sent to the system after the name services have been poisoned.

Figure 4-10 shows that after the target was convinced to talk to Responder, it was able to capture the hash sent for authentication, which could then be used to attempt to crack the password.

Key Topic



```
[*] [LLMNR]  Poisoned answer sent to 192.168.1.138 for name server
[*] [LLMNR]  Poisoned answer sent to 192.168.1.138 for name server
[*] [LLMNR]  Poisoned answer sent to 192.168.1.138 for name server
Challenge 2: c16e88761edb71f6
Challenge 2: c16e88761edb71f6
[HTTP] NTLMv2 Client   : 192.168.1.138
[HTTP] NTLMv2 Username : \CorporateUser
[HTTP] NTLMv2 Hash     : CorporateUser:::c16e88761edb71f6:19B17C89B
C0CDE733F3:0101000000000000524B3AADC08BD301C56C6128ACD7399100000000
```

FIGURE 4-10 Capturing Authentication Hashes with Responder

Wireless Assessment Tools

To assess wireless networks for vulnerabilities, you need tools that can use wireless antennas and sensors to capture and examine the wireless traffic. As a security professional tasked with identifying wireless vulnerabilities, you must also be familiar with the tools used to compromise wireless networks. Let's discuss some of these tools.

Aircrack-ng

Aircrack-ng is a set of command-line tools you can use to sniff wireless networks, among other things. Installers for this tool are available for both Linux and Windows. It is important to ensure that your device's wireless chipset and driver support this tool.

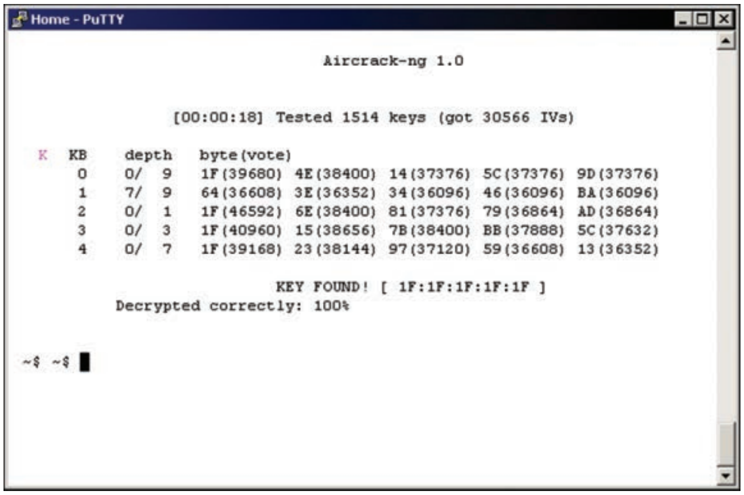
Aircrack-ng focuses on these areas of Wi-Fi security:

Key Topic

- **Monitoring:** Packet capture and export of data to text files for further processing by third-party tools
- **Attacking:** Replay attacks, deauthentication, fake access points, and others via packet injection
- **Testing:** Checking Wi-Fi cards and driver capabilities (capture and injection)
- **Cracking:** WEP and WPA PSK (WPA1 and 2)

As you can see, capturing wireless traffic is a small part of what this tool can do. The command for capturing is **airodump-ng**.

Figure 4-11 shows Aircrack-ng being used to attempt to crack an encryption key. It attempted 1514 keys before locating the correct one. For more information on Aircrack-ng, see https://www.aircrack-ng.org/.



```
                            Aircrack-ng 1.0

                   [00:00:18] Tested 1514 keys (got 30566 IVs)

   K  KB    depth   byte(vote)
       0    0/  9   1F(39680) 4E(38400) 14(37376) 5C(37376) 9D(37376)
       1    7/  9   64(36608) 3E(36352) 34(36096) 46(36096) BA(36096)
       2    0/  1   1F(46592) 6E(38400) 81(37376) 79(36864) AD(36864)
       3    0/  3   1F(40960) 15(38656) 7B(38400) BB(37888) 5C(37632)
       4    0/  7   1F(39168) 23(38144) 97(37120) 59(36608) 13(36352)

                         KEY FOUND! [ 1F:1F:1F:1F:1F ]
        Decrypted correctly: 100%

~$ ~$
```

FIGURE 4-11 Aircrack-ng

Reaver

Reaver is both a package of tools and a command-line tool within the package called **reaver** that is used to attack Wi-Fi Protected Setup (WPS). Example 4-3 shows the **reaver** command and its arguments.

Key Topic

Example 4-3 Reaver: Wi-Fi Protected Setup Attack Tool

```
root@kali:~# reaver -h
Reaver v1.6.5 WiFi Protected Setup Attack Tool
Copyright (c) 2011, Tactical Network Solutions, Craig Heffner
<cheffner@tacnetsol.com
Required Arguments:
    -i, --interface=<wlan>          Name of the monitor-mode interface
                                    to use
    -b, --bssid=<mac>               BSSID of the target AP
Optional Arguments:
    -m, --mac=<mac>                 MAC of the host system
    -e, --essid=<ssid>              ESSID of the target AP
    -c, --channel=<channel>         Set the 802.11 channel for the
                                    interface (implies -f)
    -s, --session=<file>            Restore a previous session file
    -C, --exec=<command>            Execute the supplied command upon
                                    successful pin recovery
    -f, --fixed                     Disable channel hopping
    -5, --5ghz                      Use 5GHz 802.11 channels
    -v, --verbose                   Display non-critical warnings
                                    (-vv or -vvv for more)
    -q, --quiet                     Only display critical messages
    -h, --help                      Show help

Advanced Options:
    -p, --pin=<wps pin>             Use the specified pin (may be
                                    arbitrary string or 4/8 digit
                                    WPS pin)
    -d, --delay=<seconds>           Set the delay between pin
                                    attempts [1]
    -l, --lock-delay=<seconds>      Set the time to wait if the AP
                                    locks WPS pin attempts [60]
    -g, --max-attempts=<num>        Quit after num pin attempts
    -x, --fail-wait=<seconds>       Set the time to sleep after 10
                                    unexpected failures [0]
    -r, --recurring-delay=<x:y>     Sleep for y seconds every x pin
                                    attempts
    -t, --timeout=<seconds>       Set the receive timeout period [10]
    -T, --m57-timeout=<seconds>   Set the M5/M7 timeout period [0.40]
    -A, --no-associate            Do not associate with the AP
                                  (association must be done by another
                                  application)
    -N, --no-nacks                Do not send NACK messages when out
                                  of order packets are received
    -S, --dh-small                Use small DH keys to improve crack
                                  speed
    -L, --ignore-locks            Ignore locked state reported by the
                                  target AP
    -E, --eap-terminate           Terminate each WPS session with an
                                  EAP FAIL packet
    -J, --timeout-is-nack         Treat timeout as NACK (DIR-300/320)
    -F, --ignore-fcs              Ignore frame checksum errors
    -w, --win7                    Mimic a Windows 7 registrar [False]
    -K, --pixie-dust              Run pixiedust attack
    -Z                            Run pixiedust attack

Example:
    reaver -i wlan0mon -b 00:90:4C:C1:AC:21 -vv
```

The Reaver package contains other tools as well. Example 4-4 shows the arguments for the **wash** command of the Wi-Fi Protected Setup Scan Tool. For more information on Reaver, see https://tools.kali.org/wireless-attacks/reaver.

Key Topic

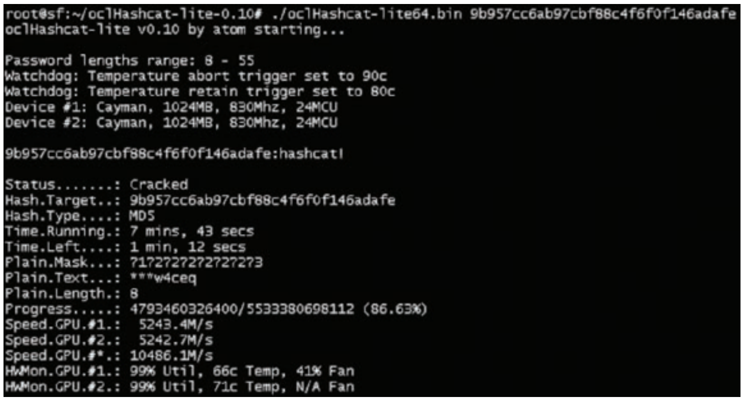
Example 4-4 **wash**: Wi-Fi Protected Setup Scan Tool

```
root@kali:~# wash -h

Wash v1.6.5 WiFi Protected Setup Scan Tool
Copyright (c) 2011, Tactical Network Solutions, Craig Heffner

Required Arguments:
    -i, --interface=<iface>              Interface to capture packets
                                         on
    -f, --file [FILE1 FILE2 FILE3 ...]   Read packets from capture
                                         files

Optional Arguments:
    -c, --channel=<num>                  Channel to listen on [auto]
    -n, --probes=<num>                   Maximum number of probes
                                         to send to each AP in scan
                                         mode [15]
```

```
     -F, --ignore-fcs                    Ignore frame checksum errors
     -2, --2ghz                          Use 2.4GHz 802.11 channels
     -5, --5ghz                          Use 5GHz 802.11 channels
     -s, --scan                          Use scan mode
     -u, --survey                        Use survey mode [default]
     -a, --all                           Show all APs, even those
                                         without WPS
     -j, --json                          print extended WPS info as
                                         json
     -U, --utf8                          Show UTF8 ESSID (does not
                                         sanitize ESSID, dangerous)
     -h, --help                          Show help

Example:
     wash -i wlan0mon
```

oclHashcat

oclHashcat is a general-purpose computing on graphics processing units (GPGPU)-based multi-hash cracker using a brute-force attack. All versions have now been updated and are simply called hashcat. In GPGPU, the graphics processor is tasked with running the algorithms that crack the hashes. The cracking of a hash is shown in Figure 4-12.



```
root@sf:~/oclHashcat-lite-0.10# ./oclHashcat-lite64.bin 9b957cc6ab97cbf88c4f6f0f146adafe
oclHashcat-lite v0.10 by atom starting...

Password lengths range: 8 - 55
Watchdog: Temperature abort trigger set to 90c
Watchdog: Temperature retain trigger set to 80c
Device #1: Cayman, 1024MB, 830Mhz, 24MCU
Device #2: Cayman, 1024MB, 830Mhz, 24MCU

9b957cc6ab97cbf88c4f6f0f146adafe:hashcat!

Status.......: Cracked
Hash.Target..: 9b957cc6ab97cbf88c4f6f0f146adafe
Hash.Type....: MD5
Time.Running.: 7 mins, 43 secs
Time.Left....: 1 min, 12 secs
Plain.Mask...: ?1?2?2?2?2?2?2?3
Plain.Text...: ***w4ceq
Plain.Length.: 8
Progress.....: 4793460326400/5533380698112 (86.63%)
Speed.GPU.#1.:  5243.4M/s
Speed.GPU.#2.:  5242.7M/s
Speed.GPU.#*.: 10486.1M/s
HWMon.GPU.#1.: 99% Util, 66c Temp, 41% Fan
HWMon.GPU.#2.: 99% Util, 71c Temp, N/A Fan
```

FIGURE 4-12 oclHashcat

Cloud Infrastructure Assessment Tools

As moving assets to the cloud becomes the rule and not the exception, identifying and mitigating vulnerabilities in cloud environments steadily increase in importance. There are several monitoring and attack tools with which you should be familiar.

ScoutSuite

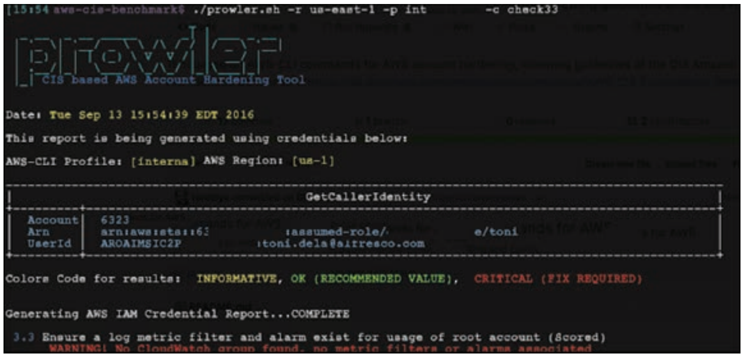
ScoutSuite is a data collection tool that allows you to use what are called longitudinal survey panels to track and monitor the cloud environment. It is open source and utilizes APIs made available by the cloud provider. The following cloud providers are currently supported/planned:

- Amazon Web Services (AWS)
- Microsoft Azure
- Google Cloud Platform
- Alibaba Cloud (alpha)
- Oracle Cloud Infrastructure (alpha)

Prowler

AWS Security Best Practices Assessment, Auditing, Hardening and Forensics Readiness Tool, also called ***Prowler***, allows you to run reports of various types. These reports list gaps found between your practices and best practices of AWS as stated in CIS Amazon Web Services Foundations Benchmark 1.1.

Figure 4-13 shows partial sample report results. Notice that the results are color coded to categorize any gaps found.



```
[15:54 aws-cis-benchmark$ ./prowler.sh -r us-east-1 -p int        -c check33

 |_| CIS based AWS Account Hardening Tool

Date: Tue Sep 13 15:54:39 EDT 2016
This report is being generated using credentials below:
AWS-CLI Profile: [interna] AWS Region: [us-1]
---------------------------------------------------------------------
|                        GetCallerIdentity                          |
+---------+---------------------------------------------------------+
| Account |  6323                                                   |
| Arn     |  arn:aws:sts::63          :assumed-role/       e/toni   |
| UserId  |  AROAIMSIC2P          :toni.dela@aitresco.com           |
+---------+---------------------------------------------------------+
Colors Code for results:  INFORMATIVE, OK (RECOMMENDED VALUE),  CRITICAL (FIX REQUIRED)

Generating AWS IAM Credential Report...COMPLETE
 3.3 Ensure a log metric filter and alarm exist for usage of root account (Scored)
      WARNING! No CloudWatch group found, no metric filters or alarms associated
```

FIGURE 4-13 Prowler

Pacu

Exploit frameworks are packages of tools that provide a bed for creating and launching attacks of various types. One of the more famous of these is Metasploit. ***Pacu*** is an exploit framework used to assess and attack AWS cloud environments. Using plug-in modules, it assists an attacker in

- Enumeration
- Privilege escalation
- Data exfiltration
- Service exploitation
- Log manipulation

Exam Preparation Tasks

As mentioned in the section "How to Use This Book" in the Introduction, you have several choices for exam preparation: the exercises here, Chapter 22, "Final Preparation," and the exam simulation questions in the Pearson Test Prep Software Online.

Review All Key Topics

Review the most important topics in this chapter, noted with the Key Topics icon in the outer margin of the page. Table 4-2 lists a reference of these key topics and the page numbers on which each is found.

Key Topic

Table 4-2 Key Topics in Chapter 4

Key Topic Element	Description	Page Number
Bulleted list	Software development life cycle (SDLC)	72
Bulleted list	Approaches to static code review	73
Bulleted list	Code review types	73
Bulleted list	Approaches to dynamic testing	74
Bulleted list	Fuzz testing types	75
Bulleted list	TCP flags	76
Bulleted list	Nmap scan types	77
Example 4-1	FIN scan using nmap	78
Figure 4-8	Host scan with nmap	80
Bulleted list	Operations possible with hping	80
Figure 4-9	SYN flood	81
Figure 4-10	Capturing authentication hashes with Responder	82

Key Topic Element	Description	Page Number
Bulleted list	Uses for Aircrack-ng	83
Example 4-3	Reaver: Wi-Fi Protected Setup Attack Tool	84
Example 4-4	wash: Wi-Fi Protected Setup Scan Tool	85

Define Key Terms

Define the following key terms from this chapter and check your answers in the glossary:

web vulnerability scanners, synthetic transaction monitoring, real user monitoring (RUM), Burp Suite, OWASP Zed Attack Proxy (ZAP), Nikto, Arachni, Nessus Professional, OpenVAS, Qualys, software development life cycle (SDLC), static code analysis, dynamic analysis, reverse engineering, fuzzing, enumeration, Nmap, Null scan, FIN scan, XMAS scan, host scanning, SYN flood, active enumeration, passive enumeration, Responder, Aircrack-ng, Reaver, oclHashcat, ScoutSuite, Prowler, Pacu

Review Questions

1. The ______________________________ produces an interception proxy called ZAP.
2. Match the tool on the left with its definition on the right.

Tools	Definitions
Burp	An interception proxy produced by OWASP
Nikto	A Ruby framework for assessing the security of a web application
ZAP	Vulnerability scanner that is dedicated to web servers
Arachni	Can scan an application for vulnerabilities and can also be used to crawl an application (to discover content)

3. List at least one of the advantages of the cloud-based approach to vulnerability scanning.
4. Arrange the following steps of the SDLC in the proper order.

   Gather requirements

   Certify/accredit

   Release/maintain

   Design

Test/validate

Perform change management and configuration management/replacement

Develop

Plan/initiate project

5. ________________________ analysis is done without the code executing.
6. List at least one form of static code review.
7. Match the type of code review on the left with its definition on the right.

Review Types	Definitions
Reverse engineering	Injecting invalid or unexpected input
Fuzzing	Analyzing a subject system to identify the system's components and their interrelationships
Real user monitoring	Running scripted transactions against an application
Synthetic transaction monitoring	Monitoring method that captures and analyzes every transaction

8. List at least one measure that can help prevent fault injection attacks.
9. Match the following tools with their definitions.

Tools	Definitions
nmap	Used to attack Wi-Fi Protected Setup (WPS)
hping	Tool that can be used for answering NBT and LLMNR name requests
Responder	Command-line-oriented TCP/IP packet assembler/analyzer
Reaver	When used for scanning, it typically locates the devices, locates the open ports on the devices, and determines the OS on each host

10. List at least one of the cloud platforms supported by ScoutSuite.