Systems Security Exercises

Intro to IT-security 2024

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Note: exercises marked with ⚠ are considered important. These contain subjects that are essential for the course and curriculum. Even if you don't work through the exercise, you are expected to know the subjects covered by these.

Exercises marked with ℹ are considered optional. These contain subjects that are related to the course and curriculum. You may want to browse these and if interested work through them. They may require more time than we have available during the course.

Contents

Preface

This material is prepared for use in courses and was prepared by Henrik Kramselund, http://www.zencurity.com . It describes the networking setup and applications for trainings and workshops where hands-on exercises are needed.

Further a presentation is used which is available as PDF from kramse@Github
Look for intro-to-it-security-system-security-exercisesin the repo security-courses.

These exercises are expected to be performed in a training setting with network connected systems. The exercises use a number of tools which can be copied and reused after training. A lot is described about setting up your workstation in the repo

https://github.com/kramse/kramse-labs

Prerequisites

This material expect that participants have a working knowledge of TCP/IP from a user perspective. Basic concepts such as web site addresses and email should be known as well as IP-addresses and common protocols like DHCP.

Have fun and learn

Exercise content

Most exercises follow the same procedure and has the following content:

- **Objective:** What is the exercise about, the objective
- **Purpose:** What is to be the expected outcome and goal of doing this exercise
- **Suggested method:** suggest a way to get started
- **Hints:** one or more hints and tips or even description how to do the actual exercises
- **Solution:** one possible solution is specified
- **Discussion:** Further things to note about the exercises, things to remember and discuss

Please note that the method and contents are similar to real life scenarios and does not detail every step of doing the exercises. Entering commands directly from a book only teaches typing, while the exercises are designed to help you become able to learn and actually research solutions.

Exercise 1

ℹ Mitre ATT&CK Framework 15min

MITRE ATT&CK™ is a globally-accessible knowledge base of adversary tactics and techniques based on real-world observations. The ATT&CK knowledge base is used as a foundation for the development of specific threat models and methodologies in the private sector, in government, and in the cybersecurity product and service community.

With the creation of ATT&CK, MITRE is fulfilling its mission to solve problems for a safer world — by bringing communities together to develop more effective cybersecurity. ATT&CK is open and available to any person or organization for use at no charge.

Source: Great resource for attack categorization

Objective:
See examples of attack methods used by real actors.

Purpose:
When analyzing incidents we often need to understand how they gained acccess, moved inside the network, what they did to escalate privileges and finally exfiltrate data.

Suggested method:
Go to the web site `https://attack.mitre.org/`, browse the matrix and read a bit here and there.

Browse the ATT&CK 101 Blog Post
`https://medium.com/mitre-attack/att-ck-101-17074d3bc62`

Hints:
The columns can be thought of as a progression. An attacker might perform recon first, then gain initial access etc. all the way to the right most columns.

Solution:
When you have researched a few details in the model you are done.

Discussion:
This is a large model which evolved over many years. You are not expected to remember it all, or understand it all.

Exercise 2

❶ Download Debian Administrators Handbook (DEB) Book 10min

Objective:
We need a Linux for running some tools during the course. I have chosen Debian Linux as this is open source, and the developers have released a whole book about running it.

This book is named The Debian Administrators Handbook, - shortened DEB

Purpose:
We need to install Debian Linux in a few moments, so better have the instructions ready.

Suggested method:
Create folders for educational materials. Go to download from the link `https://debian-handbook.info/` Read and follow the instructions for downloading the book.

Solution:
When you have a directory structure for download for this course, and the book DEB in PDF you are done.

Discussion:
Linux is free and everywhere. The tools we will run in this course are made for Unix, so they run great on Linux.

Debian Linux is a free operating system platform.

The book DEB is free, but you can buy/donate to Debian, and I recommend it.

Not curriculum but explains how to use Debian Linux

Exercise 3

⚠ Check your Debian VM 10min

Objective:
Make sure your Debian virtual machine is in working order.

We need a Debian 11 Linux for running a few extra tools during the course.

Purpose:
If your VM is not installed and updated we will run into trouble later.

Suggested method:
Go to https://github.com/kramse/kramse-labs/

Read the instructions for the setup of a Debian VM.

Hints:

Solution:
When you have a updated Debian Linux, then we are good.

Discussion:
Linux is free and everywhere. The tools we will run in this course are made for Unix, so they run great on Linux.

Exercise 4

⚠ Investigate /etc 10min

Objective:
We will investigate the /etc directory on Linux

We need a Kali Linux and a Debian Linux VM, to compare

Purpose:
Start seeing example configuration files, including:

- User database `/etc/passwd` and `/etc/group`
- The password database `/etc/shadow`

Suggested method:
Boot your Linux VMs, log in

Investigate permissions for the user database files `passwd` and `shadow`

Hints:
Linux has many tools for viewing files, the most efficient would be less.

```
hlk@debian:~$ cd /etc
hlk@debian:/etc$ ls -l shadow passwd
-rw-r--r-- 1 root root   2203 Mar 26 17:27 passwd
-rw-r----- 1 root shadow 1250 Mar 26 17:27 shadow
hlk@debian:/etc$ ls
... all files and directories shown, investigate more if you like
```

Showing a single file: `less /etc/passwd` and press q to quit

Showing multiple files: `less /etc/*` then :n for next and q for quit

```
Trying reading the shadow file as your regular user:
user@debian-9-lab:/etc$ cat /etc/shadow
cat: /etc/shadow: Permission denied
```

Why is that? Try switching to root, using su or sudo, and redo the command.

Solution:
When you have seen the most basic files you are done.

Discussion:
Linux is free and everywhere. The tools we will run in this course are made for Unix, so they run great on Linux.

Exercise 5

⚠ Enable UFW firewall - 10min

Source: Picture is Eilean Donan castle entrance
`2048px-Eilan_Donan_Castle_Entrance.jpg` from `https://en.wikipedia.org/wiki/Eilean_Donan`

Objective:
Turn on a firewall and configure a few simple rules.

Purpose:
See how easy it is to restrict incoming connections to a server.

Suggested method:
Install a utility for firewall configuration.

You could also perform Nmap port scan with the firewall enabled and disabled.

Hints:
Using the ufw package it is very easy to configure the firewall on Linux.

Install and configuration can be done using these commands.

```
root@debian01:~# apt install ufw
Reading package lists... Done
Building dependency tree
Reading state information... Done
The following NEW packages will be installed:
  ufw
0 upgraded, 1 newly installed, 0 to remove and 0 not upgraded.
Need to get 164 kB of archives.
```

```
After this operation, 848 kB of additional disk space will be used.
Get:1 http://mirrors.dotsrc.org/debian stretch/main amd64 ufw all 0.35-4 [164 kB]
Fetched 164 kB in 2s (60.2 kB/s)
...
root@debian01:~# ufw allow 22/tcp
Rules updated
Rules updated (v6)
root@debian01:~# ufw enable
Command may disrupt existing ssh connections. Proceed with operation (y|n)? y
Firewall is active and enabled on system startup
root@debian01:~# ufw status numbered
Status: active

     To                         Action      From
     --                         ------      ----
[ 1] 22/tcp                     ALLOW IN    Anywhere
[ 2] 22/tcp (v6)                ALLOW IN    Anywhere (v6)
```

Also allow port 80/tcp and port 443/tcp - and install a web server. Recommend Nginx `apt-get install nginx`

Solution:
When firewall is enabled and you can still connect to Secure Shell (SSH) and web service, you are done.

Discussion:
Further configuration would often require adding source prefixes which are allowed to connect to specific services. If this was a database server the database service should probably not be reachable from all of the Internet.

Web interfaces also exist, but are more suited for a centralized firewall.

Configuration of this firewall can be done using ansible, see the documentation and examples at `https://docs.ansible.com/ansible/latest/modules/ufw_module.html`

Should you have both a centralized firewall in front of servers, and local firewall on each server? Discuss within your team.

Exercise 6

ℹ Git tutorials - 15min

Objective:
Try the program Git locally on your workstation

Purpose:
Running Git will allow you to clone repositories from others easily. This is a great way to get new software packages, and share your own.

Git is the name of the tool, and Github is a popular site for hosting git repositories.

Suggested method:
Run the program from your Linux VM. You can also clone from your Windows or Mac OS X computer. Multiple graphical front-end programs exist too.

First make sure your system is updated, as root run:

```
sudo apt-get update && apt-get -y upgrade && apt-get -y dist-upgrade
```

You should reboot if the kernel is upgraded :-)

Second make sure your system has Git, ansible and my playbooks: (as root run, or with sudo as shown)

```
sudo apt -y install ansible git
```

Most important are Git clone and pull:

```
user@Projects:tt$ git clone https://github.com/kramse/kramse-labs.git
Cloning into 'kramse-labs'...
remote: Enumerating objects: 283, done.
remote: Total 283 (delta 0), reused 0 (delta 0), pack-reused 283
Receiving objects: 100% (283/283), 215.04 KiB | 898.00 KiB/s, done.
Resolving deltas: 100% (145/145), done.

user@Projects:tt$ cd kramse-labs/

user@Projects:kramse-labs$ ls
LICENSE  README.md  core-net-lab  lab-network  suricatazeek  work-station
user@Projects:kramse-labs$ git pull
Already up to date.
```

If you want to install the Docker system, you can run the Ansible playbook from the directory named docker-install.

Then run it with:

```
cd ~/kramse-labs/docker-install
ansible-playbook -v 1-dependencies
```

Hints:
Browse the Git tutorials on https://git-scm.com/docs/gittutorial
and https://guides.github.com/activities/hello-world/

We will not do the whole tutorials within 15 minutes, but get an idea of the command line, and see examples. Refer back to these tutorials when needed or do them at home.

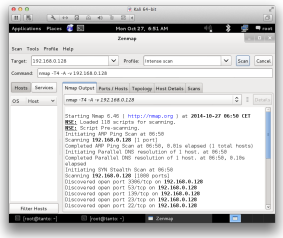
Note: you don't need an account on Github to download/clone repositories, but having an acccount allows you to save repositories yourself and is recommended.

Solution:
When you have tried the tool and seen the tutorials you are done.

Discussion:
Before Git there has been a range of version control systems,
see https://en.wikipedia.org/wiki/Version_control for more details.

Exercise 7

⚠ Discover active systems ping and port sweep 15min



Objective:
Use nmap to discover active systems and ports

Purpose:
Know how to use nmap to scan networks for active systems. These ports receive traffic from the internet and can be used for DDoS attacks.

Tip: Yes, filtering traffic further out removes it from processing in routers, firewalls, load balancers, etc. So making a stateless filter on the edge may be recommended.

Suggested method:
Install Nmap on your Debian VM, `apt install nmap` . Try different scans:

- Ping sweep to find active systems
- Port sweeps to find active systems with specific ports

Use the prefixes and IP addresses handed out by the instructor! They may be different from the ones below!

Hints:
Try nmap in sweep mode

Solution:
Use the command below as examples:

- Ping sweep ICMP and port probes: `nmap -sP 10.0.45.*`
- Port sweeps 80/tcp and 443/tcp: `nmap -p 80 10.0.45.*`
- Port sweeps UDP scans can be done: `nmap -sU -p 161 10.0.45.*`

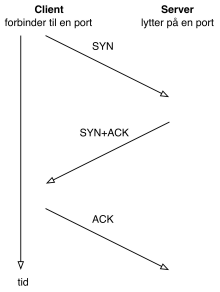
Discussion:
Quick scans quickly reveal interesting hosts, ports and services

Also now make sure you understand difference between single host scan 10.0.45.123/32, a whole subnet /24 250 hosts 10.0.45.0/24 and other more advanced targeteting like 10.0.45.0/25 and 10.0.45.1-10

We will now assume port 80/443 are open, as well as a few UDP services - maybe we can use them in amplification attacks later.

Exercise 8

⚠ Execute nmap TCP and UDP port scan 15min



Objective:
Use nmap to discover important open ports on active systems

Purpose:
Finding open ports will allow you to find vulnerabilities on these ports.

Suggested method:
Use `nmap -p 1-1024 server` to scan the first 1024 TCP ports and use Nmap without ports. What is scanned then?

Try to use `nmap -sU` to scan using UDP ports, not really possible if a firewall is in place.

If a firewall blocks ICMP you might need to add `-Pn` to make nmap scan even if there are no Ping responses

Hints:
Sample command: `nmap -Pn -sU -p1-1024 server` UDP port scanning 1024 ports without doing a Ping first

Solution:
Discover some active systems and most interesting ports, which are 1-1024 and the built-in list of popular ports.

Discussion:
There is a lot of documentation about the nmap portscanner, even a book by the author of nmap. Make sure to visit http://www.nmap.org

TCP and UDP is very different when scanning. TCP is connection/flow oriented and requires a handshake which is very easy to identify. UDP does not have a handshake and most applications will not respond to probes from nmap. If there is no firewall the operating system will respond to UDP probes on closed ports - and the ones that do not respond must be open.

When doing UDP scan on the internet you will almost never get a response, so you cannot tell open (not responding services) from blocked ports (firewall drop packets). Instead try using specific service programs for the services, sample program could be `nsping` which sends DNS packets, and will often get a response from a DNS server running on UDP port 53.

Exercise 9

⚠ Perform nmap OS detection 15min

Objective:
Use nmap OS detection and see if you can guess the brand of devices on the network

Purpose:
Getting the operating system of a system will allow you to focus your next attacks. Use more advanced features in Nmap to discover services.

Suggested method:
Look at the list of active systems, or do a ping sweep.

Then add the OS detection using the option `-O`

Better to use -A all the time, includes even more scripts and advanced stuff See the next exercise.

Hints:
The nmap can send a lot of packets that will get different responses, depending on the operating system. TCP/IP is implemented using various constants chosen by the implementors, they have chosen different standard packet TTL etc.

Getting more intimate with the system will allow more precise discovery of the vulnerabilities and also allow you to select the next tools to run.

Solution:
Use a command like `nmap -O -p1-100 10.0.45.45` or `nmap -A -p1-100 10.0.45.45`

Use `nmap -A` option for enabling service detection and scripts

Discussion:
nmap OS detection is not a full proof way of knowing the actual operating system, but in most cases in can detect the family and in some cases it can identify the exact patch level of the system.

Some services will show software versions allowing an attacker easy lookup at web sites to known vulnerabilities and often exploits that will have a high probability of success.

Make sure you know the difference between a vulnerability which is discovered, but not really there, a false positive, and a vulnerability not found due to limitations in the testing tool/method, a false negative.

A sample false positive might be reporting that a Windows server has a vulnerability that you know only to exist in Unix systems.

Exercise 10

❶ Nmap full scan - 15min

Objective:
Documenting the security level of a network often requires extensive testing. Below are some examples of the scanning methodology needed.

Purpose:
Doing a port scan often requires you to run multiple Nmap scans.

Suggested method:
Use Zenmap to do:

1. A few quick scans, to get web servers and start web scanners/crawlers
2. Full scan of all TCP ports, -p 1-65535
3. Full or limited UDP scan, `nmap -sU --top-ports 100`
4. Specialized scans, like specific source ports

Hints:
Using a specific source ports using -g/–source-port <portnum>: Use given port number with ports like FTP 20, DNS 53 can sometimes get around router filters and other stateless Access Control Lists

Solution:
Run multiple nmap and get results. At least TCP and UDP top-ports 10.

Discussion:
Recommendation it is highly recommended to always use:

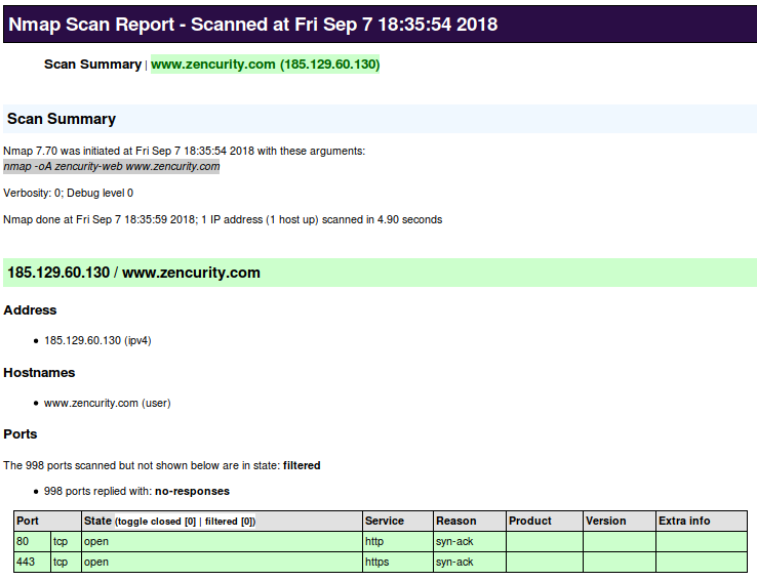
```
-iL <inputfilename>: Input from list of hosts/networks
-oA outputbasename: output in all formats, see later
```

Some examples of real life Nmaps I have run recently:

```
dns-scan: nmap -sU -p 53 --script=dns-recursion -iL targets -oA dns-recursive
bgpscan: nmap -A -p 179 -oA bgpscan -iL targets
dns-recursive: nmap -sU -p 53 --script=dns-recursion -iL targets -oA dns-recursive
php-scan: nmap -sV --script=http-php-version -p80,443 -oA php-scan -iL targets
scan-vtep-tcp: nmap -A -p 1-65535 -oA scan-vtep-tcp 10.1.2.3 192.0.2.123
snmp-10.x.y.0.gnmap: nmap -sV -A -p 161 -sU --script=snmp-info -oA snmp-10xy 10.x.y.0/19
snmpscan: nmap -sU -p 161 -oA snmpscan --script=snmp-interfaces -iL targets
sshscan: nmap -A -p 22 -oA sshscan -iL targets
vncscan: nmap -A -p 5900-5905 -oA vncscan -iL targets
```

Exercise 11

ℹ Reporting Nmap HTML 10min



Nmap Scan Report - Scanned at Fri Sep 7 18:35:54 2018

Scan Summary | www.zencurity.com (185.129.60.130)

Scan Summary

Nmap 7.70 was initiated at Fri Sep 7 18:35:54 2018 with these arguments:
nmap -oA zencurity-web www.zencurity.com

Verbosity: 0; Debug level 0

Nmap done at Fri Sep 7 18:35:59 2018; 1 IP address (1 host up) scanned in 4.90 seconds

185.129.60.130 / www.zencurity.com

Address

- 185.129.60.130 (ipv4)

Hostnames

- www.zencurity.com (user)

Ports

The 998 ports scanned but not shown below are in state: **filtered**

- 998 ports replied with: **no-responses**

Port		State (toggle closed [0] | filtered [0])	Service	Reason	Product	Version	Extra info
80	tcp	open	http	syn-ack			
443	tcp	open	https	syn-ack			

Objective:
Show the use of XML output and convert to HTML

Purpose:
Reporting data is very important. Using the oA option Nmap can export data in three formats easily, each have their use. They are normal, XML, and grepable formats at once.

Suggested method:

```
sudo nmap -oA zencurity-web www.zencurity.com
xsltproc zencurity-web.xml > zencurity-web.html
```

Hints:
Nmap includes the stylesheet in XML and makes it very easy to create HTML.

Solution:
Run XML through xsltproc, command line XSLT processor, or another tool

Discussion:

Options you can use to change defaults:

```
--stylesheet <path/URL>: XSL stylesheet to transform XML output to HTML
--webxml: Reference stylesheet from Nmap.Org for more portable XML
```

Also check out the Ndiff tool

```
hlk@cornerstone03:~$ ndiff zencurity-web.xml zencurity-web-2.xml
-Nmap 7.70 scan initiated Fri Sep 07 18:35:54 2018 as: nmap -oA zencurity-web www.zencurity.
+Nmap 7.70 scan initiated Fri Sep 07 18:46:01 2018 as: nmap -oA zencurity-web-2 www.zencurit

 www.zencurity.com (185.129.60.130):
 PORT    STATE SERVICE VERSION
+443/tcp open  https
```

(I ran a scan, removed a port from the first XML file and re-scanned)

Exercise 12

❶ Nmap Scripting Engine NSE scripts 20min

Objective:
Show the use of NSE scripts, copy/modify a script written in Lua.

Purpose:
Investigate the scripts from Nmap, copy one, learn how to run specific script using options

Suggested method:

```
# cd /usr/share/nmap/scripts
# nmap --script http-default-accounts.nse www.zencurity.com
# cp http-default-accounts.nse http-default-accounts2.nse
# nmap --script http-default-accounts2.nse www.zencurity.com
Starting Nmap 7.70 ( https://nmap.org ) at 2018-09-07 19:45 CEST
...
```

This will allow you to make changes to existing scripts.

Hints:
We will do this quick and dirty - later when doing this at home, I recommend putting your scripts in your home directory or a common file hierarchy.

Solution:
Other examples

```
nmap --script http-enum 10.0.45.0/24
nmap -p 445 --script smb-os-discovery 10.0.45.0/24
```

Discussion:
There are often new scripts when new vulnerabilities are published. It is important to learn how to incorporate them into your scanning. When heartbleed roamed I was able to scan about 20.000 IPs for Heartbleed in less than 10 minutes, which enabled us to update our network quickly for this vulnerability.

It is also possible to run categories of scripts:

```
nmap --script "http-*"

     nmap --script "default or safe"
      This is functionally equivalent to nmap --script "default,safe". It loads all scripts th

     nmap --script "default and safe"
      Loads those scripts that are in both the default and safe categories.
```

or get help for a script:

```
# nmap -script-help http-vuln-cve2013-0156.nse
Starting Nmap 7.70 ( https://nmap.org ) at 2018-09-07 19:00 CEST

http-vuln-cve2013-0156
Categories: exploit vuln
https://nmap.org/nsedoc/scripts/http-vuln-cve2013-0156.html
  Detects Ruby on Rails servers vulnerable to object injection, remote command
  executions and denial of service attacks. (CVE-2013-0156)

  All Ruby on Rails versions before 2.3.15, 3.0.x before 3.0.19, 3.1.x before
  3.1.10, and 3.2.x before 3.2.11 are vulnerable. This script sends 3 harmless
  YAML payloads to detect vulnerable installations. If the malformed object
  receives a status 500 response, the server is processing YAML objects and
  therefore is likely vulnerable.

  References:
  * https://community.rapid7.com/community/metasploit/blog/2013/01/10/exploiting-ruby-
on-rails-with-metasploit-cve-2013-0156',
  * https://groups.google.com/forum/?fromgroups=#!msg/rubyonrails-security/61bkgvnSGTQ/nehwjA8
  * http://cvedetails.com/cve/2013-0156/
```

Some scripts also require, or allow arguments into them:

```
  nmap -sC --script-args 'user=foo,pass=",=bar",paths=/admin,/cgi-bin,xmpp-info.server_name=lo
```