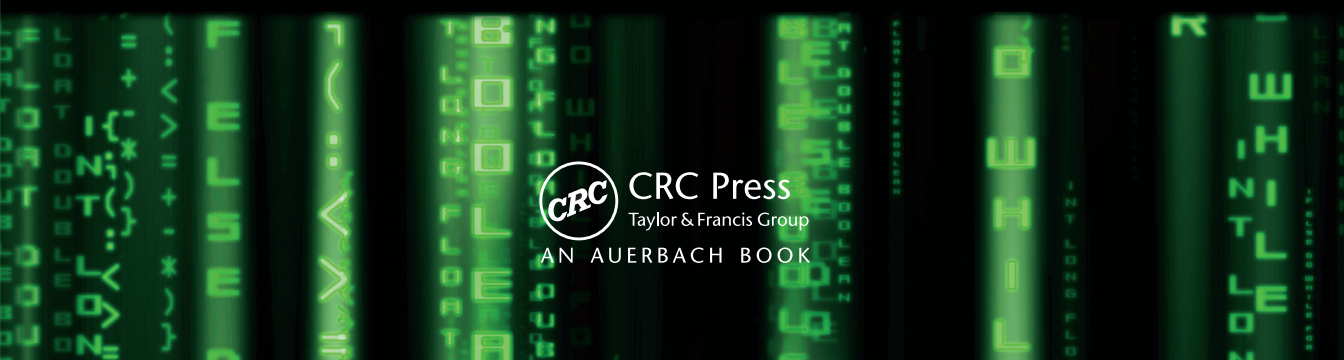
ETHICAL HACKING AND PENETRATION TESTING GUIDE

RAFAY BALOCH



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Preface

Ethical hacking strikes all of us as a subject that requires a great deal of prerequisite knowledge about things like heavy duty software, languages that includes hordes of syntaxes, algorithms that could be generated by maestros only. Well that's not the case, to some extent. This book introduces the steps required to complete a penetration test, or ethical hack. Requiring no prior hacking experience, the book explains how to utilize and interpret the results of modern day hacking tools that are required to complete a penetration test. Coverage includes Backtrack Linux, Google Reconnaissance, MetaGooFil, dig, Nmap, Nessus, Metasploit, Fast Track Autopwn, Netcat, and Hacker Defender rootkit. Simple explanations of how to use these tools and a four-step methodology for conducting a penetration test provide readers with a better understanding of offensive security.

Being an ethical hacker myself, I know how difficult it is for people who are new into hacking to excel at this skill without having any prior knowledge and understanding of how things work. Keeping this exigent thing in mind, I have provided those who are keen to learn ethical hacking with the best possible explanations in the most easy and understandable manner so that they will not only gain pleasure while reading, but they will have the urge to put into practice what have they learned from it.

The sole aim and objective of writing this book is to target the beginners who look for a complete guide to turn their dream of becoming an ethical hacker into a reality. This book elucidates the building blocks of ethical hacking that will help readers to develop an insight of the matter in hand. It will help them fathom what ethical hacking is all about and how one can actually run a penetration test with great success.

I have put in a lot of hard work to make this book a success. I remember spending hours and hours in front of my computer typing indefatigably, ignoring all the text messages of my friends when they asked me to come along and spend some time with them, which left me despondent, but now, when I see my book finally completed, it gives me immense pleasure that the efforts of a whole year have finally paid off.

This book came out as a result of my own experiences during my ethical hacking journey. Experiences that are worth sharing with all the passionate people out there.

It makes me elated to the core when I see my third book on the subject of hacking published, and I hope and pray that everyone likes it.

Best of luck to everyone out there.

Rafay Baloch

Acknowledgments

I am eternally indebted to the editor, Rich O'Hanley, for his encouragement and continuous support and my dear friend Prakhar Prasad for his help at various stages of this book.

I also thank Mohammed Ramadan for his help and support and Soroush Dallili for his ideas with file upload tricks. Many thanks to my friends Alex Infuhr and Giuseppe Trotta for their help with various sections of the "Web Hacking" chapter, Shahmeer Amir for his help with the "Wireless Hacking" chapter, and Tehseen Javed for his help with the "Linux Basics" chapter.

I also thank my mentors Prof. Asim Rizvi, David Vieira-Kurz, Ziaullah Mirza and last but not least, I thank the following keypersons: Mario Heiderich, Deepankar Arora, Nir Goldshlager, Britto Fleming Joe, Nishant Das Patnaik, Pepe Vila, Ray friedman, Armando Romeo, Tyler Borland, Zeeshan Haider, Nehal hussain, Rafael Souza, and Fatima Hanif.

I also thank my family members and relatives for always being supportive.

Author

Rafay Baloch is the founder/CEO of RHA InfoSec. He runs one of the top security blogs in Pakistan with more than 25,000 subscribers (http://rafayhackingarticles.net). He has participated in various bug bounty programs and has helped several major Internet corporations such as Google, Facebook, Twitter, Yahoo!, eBay, etc., to improve their Internet security. Rafay was successful in finding a remote code execution vulnerability along with several other high-risk vulnerabilities inside PayPal, for which he was awarded a huge sum of money as well as an offer to work for PayPal. His major areas of research interest are in network security, bypassing modern security defenses such as WAFs, DOM-based XSS, and other HTML 5–based attack vectors. Rafay holds CPTE, CPTC, CSWAE, CVA, CSS, OSCP, CCNA R & S, CCNP Route, and eWAPT certifications.

Chapter 1

Introduction to Hacking

There are many definitions for "hacker." Ask this question from a phalanx and you'll get a new answer every time because "more mouths will have more talks" and this is the reason behind the different definitions of hackers which in my opinion is quite justified for everyone has a right to think differently.

In the early 1990s, the word "hacker" was used to describe a great programmer, someone who was able to build complex logics. Unfortunately, over time the word gained negative hype, and the media started referring to a hacker as someone who discovers new ways of hacking into a system, be it a computer system or a programmable logic controller, someone who is capable of hacking into banks, stealing credit card information, etc. This is the picture that is created by the media and this is untrue because everything has a positive and a negative aspect to it. What the media has been highlighting is only the negative aspect; the people that have been protecting organizations by responsibly disclosing vulnerabilities are not highlighted.

However, if you look at the media's definition of a hacker in the 1990s, you would find a few common characteristics, such as creativity, the ability to solve complex problems, and new ways of compromising targets. Therefore, the term has been broken down into three types:

1. *White hat hacker*—This kind of hacker is often referred to as a security professional or security researcher. Such hackers are employed by an organization and are permitted to attack an organization to find vulnerabilities that an attacker might be able to exploit.
2. *Black hat hacker*—Also known as a *cracker*, this kind of hacker is referred to as a *bad guy*, who uses his or her knowledge for negative purposes. They are often referred to by the media as *hackers*.
3. *Gray hat hacker*—This kind of hacker is an intermediate between a white hat and a black hat hacker. For instance, a gray hat hacker would work as a security professional for an organization and responsibly disclose everything to them; however, he or she might leave a backdoor to access it later and might also sell the confidential information, obtained after the compromise of a company's target server, to competitors.

Similarly, we have categories of hackers about whom you might hear oftentimes. Some of them are as follows:

Script kiddie—Also known as *skid*, this kind of hacker is someone who lacks knowledge on how an exploit works and relies upon using exploits that someone else created. A script kiddie may be able to compromise a target but certainly cannot debug or modify an exploit in case it does not work.

(From http://cdn.kaskus.com and http://the-gist.org.)

Elite hacker—An elite hacker, also referred to as *l33t* or *1337*, is someone who has deep knowledge on how an exploit works; he or she is able to create exploits, but also modify codes that someone else wrote. He or she is someone with elite skills of hacking.

Hacktivist—Hacktivists are defined as group of hackers that hack into computer systems for a cause or purpose. The purpose may be political gain, freedom of speech, human rights, and so on.

Ethical hacker—An ethical hacker is as a person who is hired and permitted by an organization to attack its systems for the purpose of identifying vulnerabilities, which an attacker might take advantage of. The sole difference between the terms "hacking" and "ethical hacking" is the permission.

Important Terminologies

Let's now briefly discuss some of the important terminologies that I will be using throughout this book.

Asset

An asset is any data, device, or other component of the environment that supports information-related activities that should be protected from anyone besides the people that are allowed to view or manipulate the data/information.

Vulnerability

Vulnerability is defined as a flaw or a weakness inside the asset that could be used to gain unauthorized access to it. The successful compromise of a vulnerability may result in data manipulation, privilege elevation, etc.

Threat

A threat represents a possible danger to the computer system. It represents something that an organization doesn't want to happen. A successful exploitation of vulnerability is a threat. A threat may be a malicious hacker who is trying to gain unauthorized access to an asset.

Exploit

An exploit is something that takes advantage of vulnerability in an asset to cause unintended or unanticipated behavior in a target system, which would allow an attacker to gain access to data or information.

Risk

A risk is defined as the impact (damage) resulting from the successful compromise of an asset. For example, an organization running a vulnerable apache tomcat server poses a threat to an organization and the damage/loss that is caused to the asset is defined as a risk.

Normally, a risk can be calculated by using the following equation:

$$\text{Risk} = \text{Threat} * \text{vulnerabilities} * \text{impact}$$

What Is a Penetration Test?

A penetration test is a subclass of ethical hacking; it comprises a set of methods and procedures that aim at testing/protecting an organization's security. The penetration tests prove helpful in finding vulnerabilities in an organization and check whether an attacker will be able to exploit them to gain unauthorized access to an asset.

Vulnerability Assessments versus Penetration Test

Oftentimes, a vulnerability assessment is confused with a penetration test; however, these terms have completely different meanings. In a vulnerability assessment, our goal is to figure out all the vulnerabilities in an asset and document them accordingly.

In a penetration test, however, we need to simulate as an attacker to see if we are actually able to exploit a vulnerability and document the vulnerabilities that were exploited and the ones that turned out to be false-positive.

Preengagement

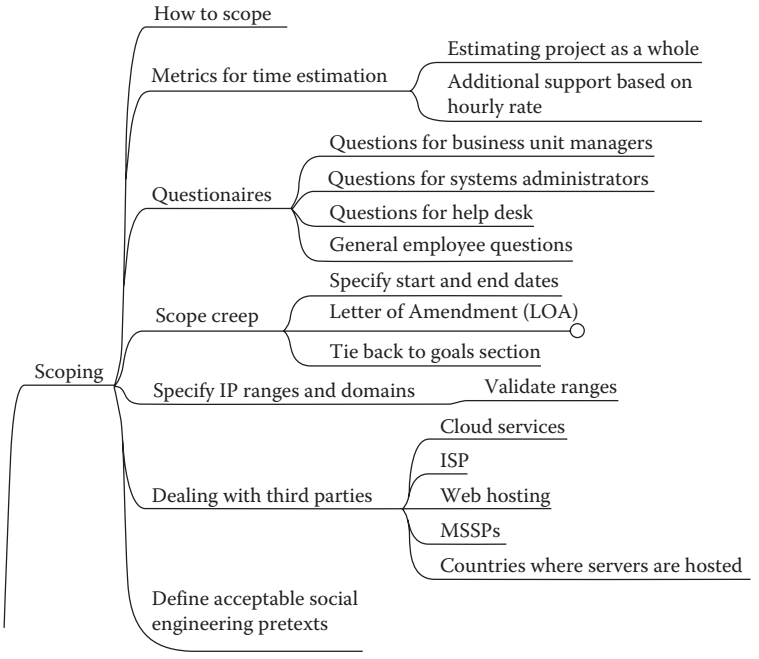
Before you start doing a penetration test, there is whole lot of things you need to discuss with clients. This is the phase where both the customer and a representative from your company would sit down and discuss about the legal requirements and the "rules of engagement."

Rules of Engagement

Every penetration test you do would comprise of a rules of engagement, which basically defines how a penetration test would be laid out, what methodology would be used, the start and end dates, the milestones, the goals of the penetration test, the liabilities and responsibilities, etc. All of them have to be mutually agreed upon by both the customer and the representative before the penetration test is started. Following are important requirements that are present in almost every ROE:

- A proper "permission to hack" and a "nondisclosure" agreement should be signed by both the parties.
- The scope of the engagement and what part of the organization must be tested.
- The project duration including both the start and the end date.
- The methodology to be used for conducting a penetration test.
- The goals of a penetration test.
- The allowed and disallowed techniques, whether denial-of-service testing should be performed or not.
- The liabilities and responsibilities, which are decided ahead of time. As a penetration tester you might break into something that should not be accessible, causing a denial of service; also, you might access sensitive information such as credit cards. Therefore, the liabilities should be defined prior to the engagement.

If you need a more thorough documentation, refer to the "PTES Pre-engagement" document (http://www.pentest-standard.org/index.php/Pre-engagement)



Milestones

Before starting a penetration test, it's good practice to set up milestones so that your project is delivered as per the dates given in the rules of engagement.

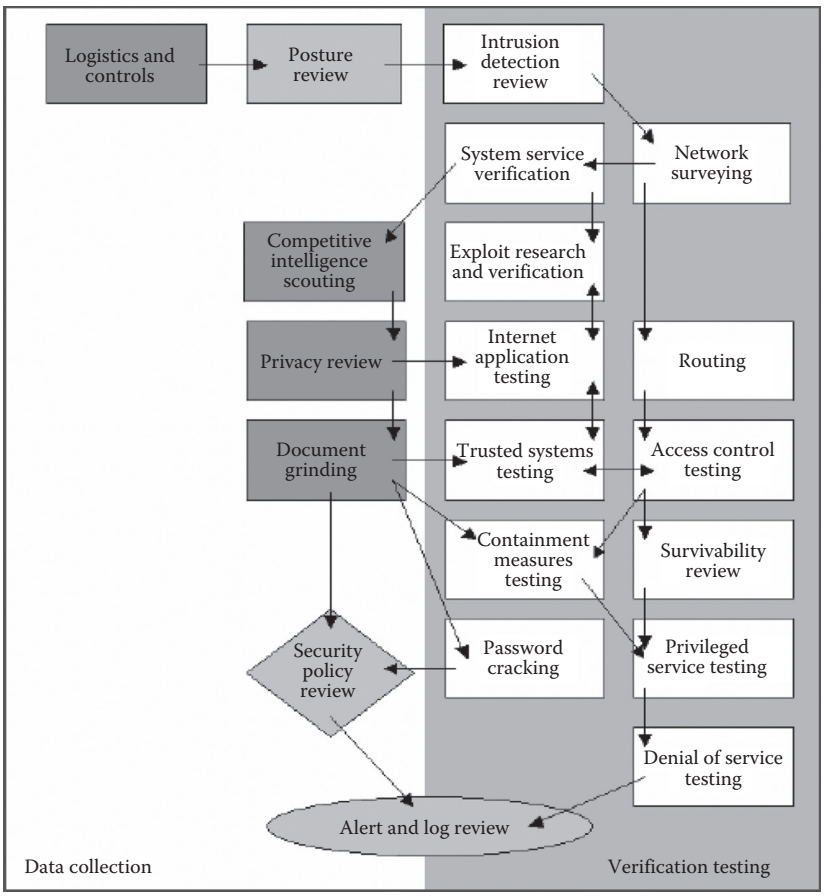
You can use either a GANTT chart or a website like Basecamp that helps you set up milestones to keep track of your progress. The following is a chart that defines the milestones followed by the date they should be accomplished.

Start	End	Month	Year	Phases
12th May 2013	18th	May	2013	Scope Definition
19th May 2013	27th	May	2013	Reconnaisance
28th May 2013	2th	June	2013	Scanning
3rd june 2013	16th	june	2013	Exploitation
17th June 2013	21th	June	2013	POST Exploitation
21st June 2013	28th	June	2013	Reporting

Penetration Testing Methodologies

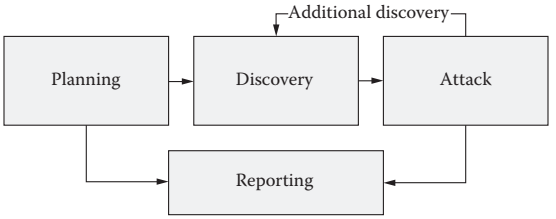
In every penetration test, methodology and the reporting are the most important steps. Let's first talk about the methodology. There are several different types of penetration testing methodologies that address how a penetration test should be performed. Some of them are discussed in brief next.

OSSTMM



An open-source security testing methodology manual (OSSTMM) basically includes almost all the steps involved in a penetration test. The methodology employed for penetration test is concise yet it's a cumbersome process which makes it difficult to implement it in our everyday life. Penetration tests, despite being tedious, demands a great deal of money out of company's budgets for their completion which often are not met by a large number of organizations.

NIST

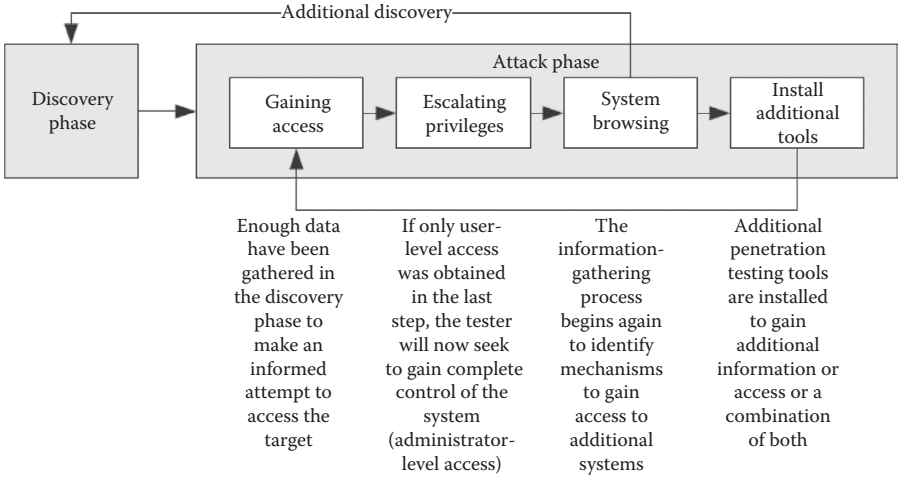


NIST, on the other hand, is more comprehensive than OSSTMM, and it's something that you would be able to apply on a daily basis and in short engagements. The screenshot indicates the four steps of the methodology, namely, planning, discovery, attack, and reporting.

The testing starts with the *planning* phase, where how the engagement is going to be performed is decided upon. This is followed by the *discovery* phase, which is divided into two parts—the first part includes information gathering, network scanning, service identification, and OS detection, and the second part involves vulnerability assessment.

After the discovery phase comes the *attack* phase, which is the heart of every penetration test. If you are able to compromise a target and a new host is discovered, in case the system is dual-homed or is connected with multiple interfaces, you would go back to step 2, that is, discovery, and repeat it until no targets are left. The indicating arrows in the block phase and the attack phase to the reporting phase indicate that you plan something and you report it—you attack a target and report the results.

The organization also has a more detailed version of the chart discussed earlier, which actually explains more about the *attack* phase. It consists of things such as "gaining access," "escalating privileges," "system browsing," and "install additional tools." We will go through each of these steps in detail in the following chapters.



OWASP

As you might have noticed, both the methodologies focused more on performing a network penetration test rather than something specifically built for testing web applications. The OWASP testing methodology is what we follow for all "application penetration tests" we do here at the RHA InfoSEC. The OWASP testing guide basically contains almost everything that you would test a web application for. The methodology is comprehensive and is designed by some of the best web application security researchers.

Categories of Penetration Test

When the scope of the penetration test is defined, the category/type of the penetration test engagement is also defined along with it. The entire penetration test can be Black Box, White Box, or Gray Box depending upon what the organization wants to test and how it wants the security paradigm to be tested.

Black Box

A black box penetration test is where little or no information is provided about the specified target. In the case of a network penetration test this means that the target's DMZ, target operating system, server version, etc., will not be provided; the only thing that will be provided is the IP ranges that you would test. In the case of a web application penetration test, the source code of the web application will not be provided. This is a very common scenario that you will encounter when performing an external penetration test.

White Box

A white box penetration test is where almost all the information about the target is provided. In the case of a network penetration test, information on the application running, the corresponding versions, operating system, etc., are provided. In the case of a web application penetration test the application's source code is provided, enabling us to perform the static/dynamic "source code analysis." This scenario is very common in internal/onsite penetration tests, since organizations are concerned about leakage of information.

Gray Box

In a gray box test, some information is provided and some hidden. In the case of a network penetration test, the organization provides the names of the application running behind an IP; however, it doesn't disclose the exact version of the services running. In the case of a web application penetration test, some extra information, such as test accounts, back end server, and databases, is provided.

Types of Penetration Tests

There are several types of penetration tests; however, the following are the ones most commonly performed:

Network Penetration Test

In a network penetration test, you would be testing a network environment for potential security vulnerabilities and threats. This test is divided into two categories: external and internal penetration tests.

An external penetration test would involve testing the public IP addresses, whereas in an internal test, you can become part of an internal network and test that network. You may be provided VPN access to the network or would have to physically go to the work environment for the penetration test depending upon the engagement rules that were defined prior to conducting the test.

Web Application Penetration Test

Web application penetration test is very common nowadays, since your application hosts critical data such as credit card numbers, usernames, and passwords; therefore this type of penetration test has become more common than the network penetration test.

Mobile Application Penetration Test

The mobile application penetration test is the newest type of penetration test that has become common since almost every organization uses Android- and iOS-based mobile applications to provide services to its customers. Therefore, organizations want to make sure that their mobile applications are secure enough for users to rely on when providing personal information when using such applications.

Social Engineering Penetration Test

A social engineering penetration test can be part of a network penetration test. In a social engineering penetration test the organization may ask you to attack its users. This is where you use speared phishing attacks and browser exploits to trick a user into doing things they did not intend to do.

Physical Penetration Test

A physical penetration test is what you would rarely be doing in your career as a penetration tester. In a physical penetration test, you would be asked to walk into the organization's building physically and test physical security controls such as locks and RFID mechanisms.

Report Writing

In any penetration test, the report is the most crucial part. Writing a good report is key to successful penetration testing. The following are the key factors to a good report:

- Your report should be simple, clear, and understandable.
- Presentation of the report is also important. Headers, footers, appropriate fonts, well-spaced margins, etc., should be created/selected properly and with great care. For example, if you are using a red font for the heading, every heading in the document should be in that style.
- The report should be well organized.

- Correct spelling and grammar is important too. A misspelled word leaves a very negative impact upon the person who is reading your report. So, you should make sure that you proofread your report and perform spell-checks before submitting it to the client.
- Always make sure that you use a consistent voice and style in writing a report. Changing the voice would create confusion in the reader; so you should choose one voice and style and stick to it throughout your report.
- Make sure you spend time on eliminating false-positives (vulnerabilities that are actually not present), because false-negatives will always be there no matter what you do. Eliminating the false-positives would enhance the credibility of the report.
- Perform a detailed analysis of the vulnerability to find out its root cause. A screenshot of a RAW http request or the screenshot that demonstrates the evidence of the finding would give a clear picture to the developer of the status.

Understanding the Audience

Understanding the audience that would be reading your penetration testing report is a very crucial part of the penetration test. We can divide the audience into three different categories:

1. Executive class
2. Management class
3. Technical class

While writing a report, you must understand which audience would read which part of your report; for example, the company's CEO would not be interested in what exploit you used to gain access to a particular machine, but on the flip side, your developers will probably not be interested in the overall risks and potential losses to the company; instead, they would be interested in fixing the code and therefore in reading about detailed findings. Let's briefly talk about the three classes.

Executive Class

This category includes the CEOs of the company. Since they have a very tedious schedule and most of the times have less technical knowledge, they would end up reading a very small portion of the report, specifically the executive summary, remediation report, etc., which we will discuss later in this chapter.

Management Class

Next, we have the management class, which includes the CISOs and CISSPs of the company. Since they are the ones who are responsible for implementing the security policy of the company, they would probably be a bit more interested in reading about overall strengths and weaknesses, the remediation report, the vulnerability assessment report, etc.

Technical Class

This class includes the security manager and developers, who would be interested in reading your report thoroughly. They would investigate your report as they are responsible for patching the weaknesses found and for making sure that the necessary patches are implemented.

Writing Reports

Now we are going to get into the essentials of the reporting phase, which will teach you about the structure of a report. We have discussed what a good report should look like. I pointed out that knowing your audience was essential. One of the key factors about a good report is that it should meet the needs for each audience and be presented in a clear and understandable manner.

The next major part of writing a report is the analysis, where we perform risk assessment and calculate the overall risk to the organization based upon our findings; along with this, your report should also provide remediation on how the risk can be averted.

Structure of a Penetration Testing Report

Let's look step by step on how a good report should be laid out. At the end of this chapter, I have provided links to some of the best reports which have been provided to the local mass.

Cover Page

We start with the cover page; this is where you would include details such as your company logo, title, and a short description about the penetration test. I would suggest you hire a good designer and work on a professional and appealing cover page because if your cover page looks great, it would make a good first impression upon the customer reading it.

Table of Contents

On the very next page, you should have an index so that the audience interested in reading a particular portion of the report can easily skip to that portion.

Table of Contents

Executive Summary

As the name suggests, an executive summary is the portion that is specifically addressed to executives such as the CEO or the CIO of the company. The executive summary is the most essential part of a penetration testing report; a good executive summary can make all the difference between a good report and a bad one.

Since the executive summary is specifically written to address the nontechnical audience, you should make sure that it's presented in such a way that it's easily comprehensible. Following are some of the essential points that you should take into consideration while writing an executive summary.

- Since executives are very busy, they have minimal time to invest in reading your reports. Therefore you should make sure that your executive summary is precise and to the point.
- Your executive summary should start with defining the purpose of the engagement and how it was carried out. Things such as the scope should be defined but very precisely.
- Next, you should explain the results of the penetration test and the findings.
- Following this, you should discuss the overall weaknesses in general and the countermeasures that were not implemented that caused the vulnerability in the first place.
- Next comes the analysis part; this is where you should write about the overall risk that was determined based upon our findings.
- And, finally, you should write about to what extent the risk would decrease after addressing the issues and implementing the appropriate countermeasures.

The following is an example of an executive summary that we wrote for a customer. I would suggest you spend some time reviewing the essential points discussed and compare them with the executive summary that follows.

EXECUTIVE SUMMARY

RHAinfoSec conducted a full webapplication penetration test on **foonetworks**, the goal was to analyze the security posture of the Webapplications and suggest countermeasures for all the findings requiring remediation.

The Application Penetration test was conducted on foonetworks from January 2013 onwards. The target subdomains were also included in the scope of penetration test, which were not provided by default since it was a full black box penetration test.

As a result of the engagement we managed to find lots of high risk vulnerabilities which confirmed that the security posture of the application is very low and proper security countermeasures have not been implemented inside the environment.

This report contains detailed analysis about the vulnerabilities that we found during the engagement along with the report also contains a remediation report which would help you improve the overall security posture of your application. The report also contains a detailed explanation about every vulnerability found along with the detailed countermeasures to fix the vulnerability.

The overall risk of compromise was analyzed to be 70%. Addressing the security issues that present inside the report would significantly increase the overall risk of compromise.

Remediation Report

Next up we have the remediation report, which contains the overall recommendations that once implemented would increase the security of the organization. This is specifically an area of interest for the management class, as they are the ones that are going to enforce the security policies of an organization.

As mentioned earlier, these guys may or may not be technical; therefore our remediation report should be very precise and easy to understand. Things that could improve overall security such as implementing SDLC, a firewall, and an intrusion detection system should be recommended. The following is an example of how a remediation report should look like:

REMEDIATION

The security control environment for foonetworks was found very poor, as a result of which there are certain security countermeasures we would like to suggest. With the goal of protecting the Web application's infrastructure, we would recommend you to perform the following actions.

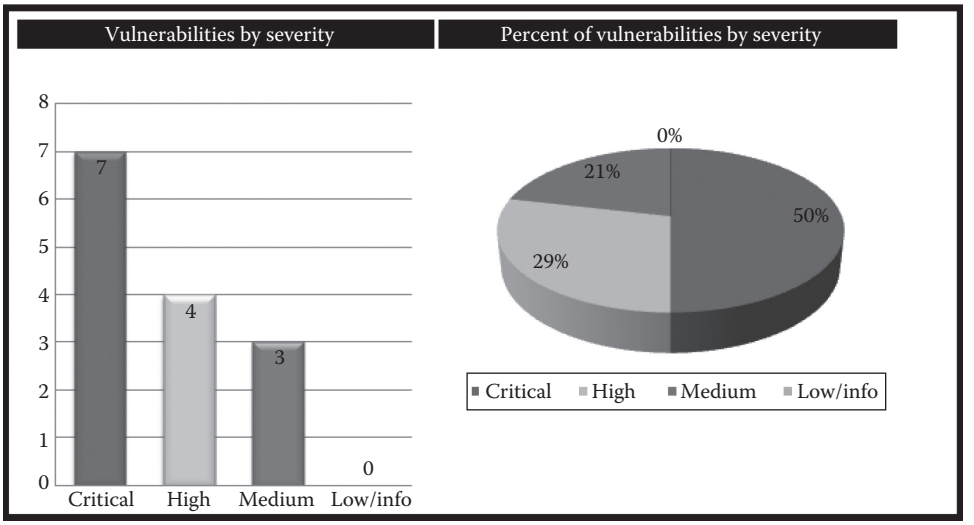
- A perfect plan for fixing the Critical, High, Medium, low risk vulnerabilities should designed and implemented. The vulnerabilities should be fixed in the descending order of priority.
- Secure development life cycle (SDLC) for developing web applications shall be implemented.
- A Web Application Firewall shall be implemented to detect, filter and block all the malicious packets.
- Security Audits shall be performed on the regular basis.
- Early security checks should be performed in the development process.

Vulnerability Assessment Summary

Next, we have the vulnerability assessment summary, sometimes referred to as "findings summary." This is where we present the findings from our engagement. Things such as the overall strengths and weaknesses and risk assessment summary can also be included under this section.

"A picture speaks a thousand words" is a brilliant quotation that all of us remember from our childhood, don't we? Behold, for now it's time to see the actual use of it. It always helps to include charts in your report, which would give the audience a better understanding of the vulnerabilities that were found. Security executives might be interested in this portion of the report as they would need to enforce the countermeasures.

There are different ways for representing vulnerability assessment outputs in the form of graphical charts. Personally, I include two graphs; the first one classifies the vulnerability assessment on the basis of the severity and the second one on percentage.



Next, I include a "vulnerabilities breakdown" chart, where I talk about the findings for a particular host followed by the number of vulnerabilities that were found.

Vulnerabilities breakdown						
S #	IP Address	Hostname	Critical	High	Medium	Low/Info
1	192.254.236.66	Services.rafayhackingarticles.net	3	14	7	0
2	192.254.236.67	Tools.rafayhackingarticles.net	2	6	4	0

Tabular Summary

A tabular summary is also a great way to present the findings of a vulnerability assessment to a customer. The following screenshot comes directly from the "NII Report" and summarizes the vulnerability assessment based upon the number of live hosts and also talks about the number of findings with high, moderate, or low risk.

Category	Description		
Systems vulnerability assessment summary			
Number of live hosts	50		
Number of vulnerabilities	29		
High, medium, and info severity vulnerabilities	14	6	9

Risk Assessment

Risk assessment as defined before is the analysis part of the report. It is very crucial for the customer because they would want to know the intensity of the damage the vulnerabilities are likely to cause; similarly, the security executives would also want to know how their team is performing.

Risk Assessment Matrix

When we talk about risk assessment analysis in terms of a penetration test, we compare the "likelihood of the occurring" and the "impact caused by the occurring."

The following is a "hazard risk assessment matrix" derived from MIL-STD-882B; it's an excellent method for demonstrating risk to the customer. In the following matrix the "frequency of occurrence," that is, the likelihood of how often the vulnerability is occurring, is compared with the four hazard categories "catastrophic," "critical," "serious," "minor," and this is something you should definitely include in your penetration testing report.

Hazard risk assessment matrix

	Hazard Categories			
Frequency of Occurrence	1 Catastrophic	2 Critical	3 Serious	4 Minor
(A) Frequent	1A	2A	3A	4A
(B) Probable	1B	2B	3B	4B
(C) Occasional	1C	2C	3C	4C
(D) Remote	1D	2D	3D	4D
(E) Improbable	1E	2E	3E	4E

Unacceptable High Medium Low

(From http://www.sms-ink.com.)

After including the risk assessment matrix, you should write a line or two describing the total risk.

> Based upon the comparison of the vulnerabilities that were determined, their likelihood and their impact we conclude the overall risk is high and the risk percentage was determined to be 82%.

Methodology

We have discussed a wide variety of methodologies and standards of penetration testing, such as OSSTMM, NIST, and OWASP. I would also like to include the methodology that was followed

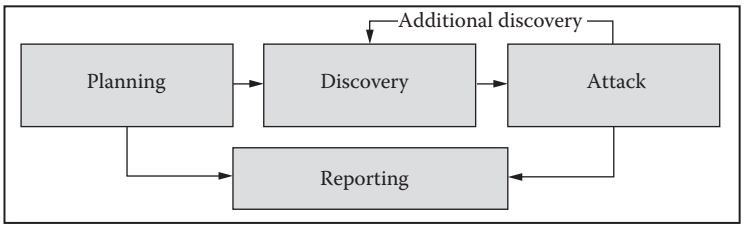
for conducting the penetration test; though its inclusion in the report is optional, it could add great value to your penetration report. In a scenario where you have been asked to follow a certain standard, talking about the methodology and its steps is a good idea.

The following is a screenshot from one of our penetration testing reports where the NIST methodology was followed in order to conduct the penetration test. Notice that we include the flowchart on how the methodology works and explain each step precisely.

Methodology

RHAinfoSec utilized the NIST methodology in this engagement against the targets within the foonetworks. The methodology focuses on assessing the security posture of the target network in order to create an effective and better security posture.

Nist penetration test methodology



The NIST is an international standard for penetration testing; the methodology has been divided into following phases:

Planning – In this phase, we plan how the assessments would be carried out.

Discovery – In this phase, the targets discovery, target enumeration, and vulnerability assessments are performed.

Attacking–In the attacking phase, the vulnerabilities that were found in the previous phase are attempted to be exploited. Once a system is exploited, an attempt to escalate privileges is made, the attacking phase contains two more steps, namely, system browsing and "Installing Additional Tools". During this process if a new target is discovered we move back towards the discovery phase.

Reporting–In the reporting phase the vulnerabilities that were discovered are documented.

Detailed Findings

This is where you address the technical audience, specifically the security manager and the developers; also, this is where you are allowed to talk in depth about how the vulnerabilities were discovered, the root causes of the vulnerabilities, the associated risks, and the necessary recommendations.

Let's now briefly talk about four essentials that should be included in the "Detailed Findings" section.

Description

This is where you talk about the vulnerability itself; a brief explanation should be provided in this section.

Explanation

This is the section where you reveal where the vulnerability was found, how it was found, the root cause of the vulnerability, the proof of concept, or the evidence of the finding.

Risk

This is where you talk about the risks and the likely impact that the vulnerability carries.

Recommendation

This is where you address the developers on how to fix the vulnerability; you may also include general suggestions to avoid that particular class of vulnerability in future.

The following screenshot comes directly from one of our penetration testing reports. Our finding was "DOM-based XSS" vulnerability. In the "Description" section we discussed the vulnerability. In the "Explanation" section, we talked about where the vulnerability was found and what line of the JavaScript code is the root cause of the vulnerability. We then talked about general risks and the impact and finally the general remediations to avoid vulnerabilities of a similar class.

DOM Based Cross Site Scripting Vulnerability

Affected Hosts: foonetworks.com

Risk: Critical

Description: A DOM Based XSS is a type of Cross site scripting vulnerability which occurs when the user supplied input passed through a source is not filtered/escaped before it's passed through a vulnerable sink.

Explanation: A dynamic file is being included which handles "location.hash" on the document object model (DOM).

http://foonetworks.com/engine.js

The following lines indicate the vulnerable code:

Lines: 410 – 411:

```
if(t!=undefined){window.location.hash=t;}});
$(window).bind("load",function()
{if(window.location.hash){var _9=window.location.hash.substring(1);}
```

Risk

Since javacsript can access the DOM, an attacker can craft a special piece of javascript that would be able to steal the authentication cookies and send it the domain that he controls. In case of a DOM based XSS, the payload is always executed on the client side, this means this makes it difficult to trace the attacker from the forensics perspective, since the attack vector would not appear inside the log file.

Recommendations:

Any user-generated input should be HTML-encoded at any point where it is copied into application responses.

All HTML metacharacters should be replaced with the corresponding HTML entities.

Reports

Now that you know the basics and structure of how a penetration testing report is written, I would urge you to spend some time reviewing the following penetration testing sample reports.

- http://www.offensive-security.com/penetration-testing-sample-report.pdf
- http://www.niiconsulting.com/services/security-assessment/NII_Sample_PT_Report.pdf
- http://pentestreports.com/

Conclusion

In this chapter, we talked about basic terminologies that you will encounter on a daily basis as a penetration tester. We discussed about the types of penetration tests and the different penetration testing methodologies. We then talked about what makes a good penetration testing report. We also looked at how a penetration test report should be laid out in order to provide the target audience the necessary information.

Chapter 2

Linux Basics

In order to become a good ethical hacker or penetration tester, you need to be conversant with Linux, which is by far one of the most powerful operating systems. Linux is really good for ethical hacking and penetration testing because it is compatible with a wide variety of related tools and software, whereas other operating systems such as Mac and Windows support fewer of these software and tools. In this chapter, I will teach you some of the very basics of operating a Linux OS. If you are already familiar with Linux basics, you can skip this chapter.

One of the most common questions asked in many forums is "Which Linux distro should I use?" As there are tons of Linux distros such as Ubuntu, Fedora, Knoppix, and BackTrack you can use any Linux distro you want as all work in a similar manner. However, I suggest you use BackTrack if you really wish to dig deeper into this subject because it is all encompassing from a penetration tester's perspective.

Major Linux Operating Systems

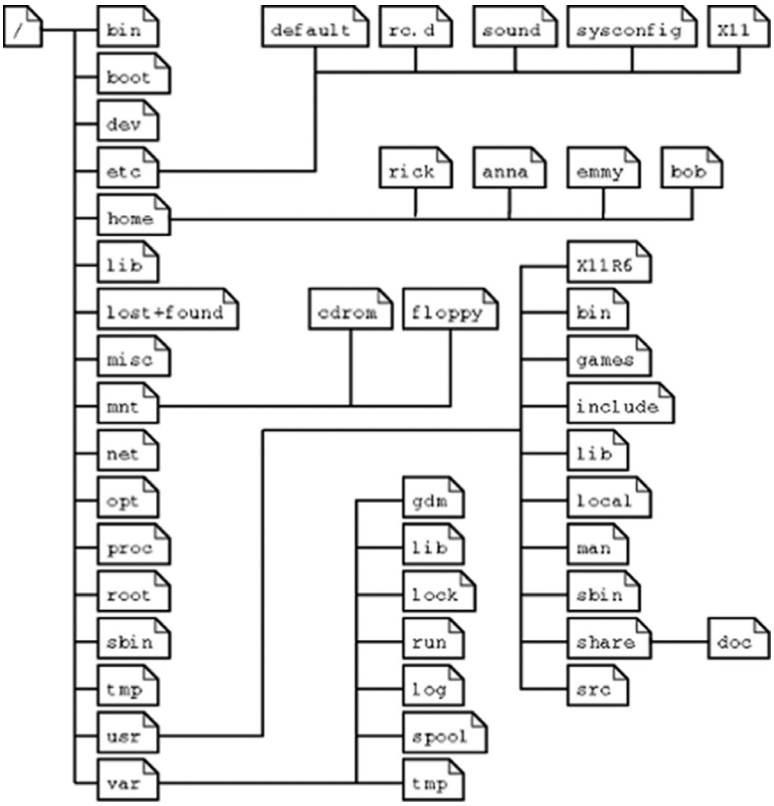
Before talking about BackTrack, let's take a look at some of the Linux-based distros that you will encounter very often:

Redhat Linux—Used mostly for administration purpose.
Debian Linux—Designed for using only in open source software.
Ubuntu Linux—Designed mostly for personal use.
Mac OS X—Used in all Apple computers.
Solaris—Used in many commercial environments.
BackTrack Linux—Used mostly for penetration testing.

File Structure inside of Linux

On a Linux system, most everything is a file, and if it is not a file, then it is a process.

Here is a general diagram for file structure in Linux.



There are certain exceptions in a Linux file system

Directories—Files that are lists of other files.
Special file—The mechanism used for inout and output. /dev are special files.
Links—A system to make file or directory visible in multiple parts of the systems.
Sockets—A special file type, similar to TCP/IP sockets providing inter-process networking.
Pipes—More or less like sockets; they form a way for process to communicate with each other with out using network socket.

File types in a long list:

Symbol	*Meaning*
-	Regular file
d	Directory
l	Link
c	Special file

s	Socket
p	Named pipe
b	Block device

Subdirectories of the root directory:

Directory	*Content*
`/bin`	Common programs, shared by the system, the system administrator, and the users.
`/boot`	The startup files and the kernel, vmlinuz. In some recent distributions also grub data. Grub is the GRand Unified Boot loader and is an attempt to get rid of the many different boot-loaders we know today.
`/dev`	Contains references to all the CPU peripheral hardware, which are represented as files with special properties.
`/etc`	Most important system configuration files are in/etc., this directory contains data similar to those in the Control Panel in Windows
`/home`	Home directories of the common users.
`/initrd`	(on some distributions) Information for booting. Do not remove!
`/lib`	Library files, includes files for all kinds of programs needed by the system and the users.
`/lost+found`	Every partition has a lost+found in its upper directory. Files that were saved during failures are here.
`/misc`	For miscellaneous purposes.
`/mnt`	Standard mount point for external file systems, for example, a CD-ROM or a digital camera.
`/net`	Standard mount point for entire remote file systems.
`/opt`	Typically contains extra and third-party software.
`/proc`	A virtual file system containing information about system resources. More information about the meaning of the files in proc is obtained by entering the command man proc in a terminal window. The file proc.txt discusses the virtual file system in detail.
`/root`	The administrative user's home directory. Mind the difference between /, the root directory and /root, the home directory of the root user.
`/sbin`	Programs for use by the system and the system administrator.
`/tmp`	Temporary space for use by the system, cleaned upon reboot, so don't use this for saving any work!
`/usr`	Programs, libraries, documentation, etc., for all user-related programs.
`/var`	Storage for all variable files and temporary files created by users, such as log files, the mail queue, the print spooler area, space for temporary storage of files downloaded from the Internet, or to keep an image of a CD before burning it.

File Permission in Linux

Although there are already a lot of good security features built into Linux-based systems, based upon the need for proper permissions, I will go over the ways to assign permissions and show you some examples where modification may be necessary. Wrong file permission may open a door for attackers in your system.

Group Permission

Owner—The Owner permissions apply only the owner of the file or directory; they will not impact the actions of other users.
Group—The Group permissions apply only to the group that has been assigned to the file or directory; they will not affect the actions of other users.
All User/Other—The All Users permissions apply to all other users on the system; this is the permission group that you want to watch the most.

Each file or directory has three basic permission types:

Read—The Read permission refers to a user's capability to read the contents of the file.
Write—The Write permissions refer to a user's capability to write or modify a file or directory.
Execute—The Execute permission affects a user's capability to execute a file or view the contents of a directory.

Let's see how it works.
File permission is in following format.
Owner Group Other/all

```
root@Net:~# ls -al
```

We will talk about aforementioned command later on in this chapter.

```
-rwxr-xr-x 1 net tut 77 Oct 24 11:51 auto run
drwx------ 2 ali tut 4096 Oct 25 2012 cache
```

File auto run permission

-—No special permissions
rwx—Owner (net) having read, write, and execute permission while group (tut) having read and execute and other also having same permission.

File cahe permission

d—Represent directory
rwx—Owner (ali) having read, write, and execute permission while group (tut) and other/all does not have any permission for accessing or reading this file.

Linux Advance/Special Permission

l—The file or directory is a symbolic link
s—This indicated the setuid/setgid permissions. Represented as a s in the read portion of the owner or group permissions.

t—This indicates the sticky bit permissions. Represented as a t in the executable portion of the all users permissions
i—chatter Making file unchangeable

There are two more which mostly used by devices.

c—Character device
b—Block device (i.e., hdd)

Let's go through some examples

Link Permission

root@net:~#ln -s new /root/link
root@net:~#ls -al
lrwxrwxrwx 1 ali ali 3 Mar 18 08:09 link -> new
link is created for a file name called new (link is symbolic for file name new)

Suid & Guid Permission

setuid (*SUID*)—This is used to grant root level access or permissions to users

When an executable is given setuid permissions, normal users can execute the file with root level or owner privileges. Setuid is commonly used to assign temporarily privileges to a user to accomplish a certain task. For example, changing a user's password would require higher privileges, and in this case, setuid can be used.

setgid (*SGID*)—This is similar to setuid, the only difference being that it's used in the context of a group, whereas setuid is used in the context of a user.
root@net:~#chmod u+s new
root@net:~#ls -al
-rwSr--r-- 1 ali ali 13 Mar 18 07:54 new

Capital **S** shows Suid for this file.

root@net:~#chmod g+s guid-demo
root@net:~#ls -al
-rw-r-Sr-- 1 ali ali 0 Mar 18 09:13 guid-demo

Capital **S** shows Guid for guid-demo file and capital S is in group section.

Stickybit Permission

This is another type of permission; it is mostly used on directories to prevent anyone other than the "root" or the "owner" from deleting the contents.

root@net:~#chmod +t new
root@net:~#ls -al
-rw-r--r-T 1 ali ali 13 Mar 18 07:54 new

Capital **T** shows that stickybit has been set for other user (only owner or root user can delete files)