WEB HACKING 101

How to Make Money Hacking Ethically

Analysis of 30+ vulnerability reports that paid!

Peter Yaworski

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This version was published on 2016-11-11

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To Andrea and Ellie, thank you for supporting my constant roller coaster of motivation and confidence. Not only would I never have finished this book without you, my journey into hacking never would have even begun.

To the HackerOne team, this book wouldn't be what it is if it were not for you, thank you for all the support, feedback and work that you contributed to make this book more than just an analysis of 30 disclosures.

Lastly, while this book sells for a minimum of $9.99, sales at or above the suggested price of $19.99 help me to keep the minimum price low, so this book remains accessible to people who can't afford to pay more. Those sales also allow me to take time away from hacking to continually add content and make the book better so we can all learn together.

While I wish I could list everyone who has paid more than the minimum to say thank you, the list would be too long and I don't actually know any contact details of buyers unless they reach out to me. However, there is a small group who paid more than the suggested price when making their purchases, which really goes a long way. I'd like to recognize them here. They include:

1. @Ebrietas0
2. Mystery Buyer
3. Mystery Buyer
4. @nahamsec (Ben Sadeghipour)
5. Mystery Buyer
6. @Spam404Online
7. @Danyl0D (Danylo Matviyiv)
8. Mystery Buyer

If you should be on this list, please DM me on Twitter.

To everyone who purchased a copy of this, thank you!

Contents

1. Foreword

The best way to learn is simply by doing. That is how we - Michiel Prins and Jobert Abma - learned to hack.

We were young. Like all hackers who came before us, and all of those who will come after, we were driven by an uncontrollable, burning curiosity to understand how things worked. We were mostly playing computer games, and by age 12 we decided to learn how to build software of our own. We learned how to program in Visual Basic and PHP from library books and practice.

From our understanding of software development, we quickly discovered that these skills allowed us to find other developers' mistakes. We shifted from building to breaking and hacking has been our passion ever since. To celebrate our high school graduation, we took over a TV station's broadcast channel to air an ad congratulating our graduating class. While amusing at the time, we quickly learned there are consequences and these are not the kind of hackers the world needs. The TV station and school were not amused and we spent the summer washing windows as our punishment. In college, we turned our skills into a viable consulting business that, at its peak, had clients in the public and private sector across the entire world. Our hacking experience led us to HackerOne, a company we co-founded in 2012. We wanted to allow every company in the universe to work with hackers successfully and this continues to be HackerOne's mission today.

If you're reading this, you also have the curiosity needed to be a hacker and bug hunter. We believe this book will be a tremendous guide along your journey. It's filled with rich, real world examples of security vulnerability reports that resulted in real bug bounties, along with helpful analysis and review by Pete Yaworski, the author and a fellow hacker. He is your companion as you learn, and that's invaluable.

Another reason this book is so important is that it focuses on how to become an ethical hacker. Mastering the art of hacking can be an extremely powerful skill that we hope will be used for good. The most successful hackers know how to navigate the thin line between right and wrong while hacking. Many people can break things, and even try to make a quick buck doing so. But imagine you can make the Internet safer, work with amazing companies around the world, and even get paid along the way. Your talent has the potential of keeping billions of people and their data secure. That is what we hope you aspire to.

We are grateful to no end to Pete for taking his time to document all of this so eloquently. We wish we had this resource when we were getting started. Pete's book is a joy to read with the information needed to kickstart your hacking journey.

Happy reading, and happy hacking!

Remember to hack responsibly.

Michiel Prins and Jobert Abma Co-Founders, HackerOne

2. Introduction

Thank you for purchasing this book, I hope you have as much fun reading it as I did researching and writing it.

Web Hacking 101 is my first book, meant to help you get started hacking. I began writing this as a self-published explanation of 30 vulnerabilities, a by-product of my own learning. It quickly turned into so much more.

My hope for the book, at the very least, is to open your eyes to the vast world of hacking. At best, I hope this will be your first step towards making the web a safer place while earning some money doing it.

How It All Started

In late 2015, I stumbled across the book, We Are Anonymous: Inside the Hacker World of LulzSec, Anonymous and the Global Cyber Insurgency by Parmy Olson and ended up reading it in a week. Having finished it though, I was left wondering how these hackers got started.

I was thirsty for more, but I didn't just want to know **WHAT** hackers did, I wanted to know **HOW** hackers did it. So I kept reading. But each time I finsihed a new book, I was still left with the same questions:

- How do other Hackers learn about the vulnerabilities they find?
- Where are people finding vulnerabilities?
- How do Hackers start the process of hacking a target site?
- Is Hacking just about using automated tools?
- How can I get started finding vulnerabilities?

But looking for more answers, kept opening more and more doors.

Around this same time, I was taking Coursera Android development courses and keeping an eye out for other interesting courses. The Coursera Cybersecurity specialization caught my eye, particularly Course 2, Software Security. Luckily for me, it was just starting (as of February 2016, it is listed as Coming Soon) and I enrolled.

A few lectures in, I finally understood what a buffer overflow was and how it was exploited. I fully grasped how SQL injections were achieved whereas before, I only knew the danger. In short, I was hooked. Up until this point, I always approached web security from the developer's perspective, appreciating the need to sanitize values and avoid using user input directly. Now I was beginning to understand what it all looked like from a hacker's perspective.

I kept looking for more information on how to hack and came across Bugcrowd's forums. Unfortunately they weren't overly active at the time but there someone mentioned HackerOne's hacktivity and linked to a report. Following the link, I was amazed. I was reading a description of a vulnerability, written to a company, who then disclosed it to the world. Perhaps more importantly, the company actually paid the hacker to find and report this!

That was a turning point, I became obsessed. Especially when a homegrown Canadian company, Shopify, seemed to be leading the pack in disclosures at the time. Checking out Shopify's profile, their disclosure list was littered with open reports. I couldn't read enough of them. The vulnerabilities included Cross-Site Scripting, Authentication and Cross-Site Request Forgery, just to name a few.

Admittedly, at this stage, I was struggling to understand what the reports were detailing. Some of the vulnerabilities and methods of exploitation were hard to understand.

Searching Google to try and understand one particular report, I ended on a GitHub issue thread for an old Ruby on Rails default weak parameter vulnerability (this is detailed in the Application Logic chapter) reported by Egor Homakov. Following up on Egor led me to his blog, which includes disclosures for some seriously complex vulnerabilities.

Reading about his experiences, I realized, the world of hacking might benefit from plain language explanations of real world vulnerabilities. And it just so happened, that I learn better when teaching others.

And so, Web Hacking 101 was born.

Just 30 Examples and My First Sale

I decided to start out with a simple goal, find and explain 30 web vulnerabilities in easy to understand, plain language.

I figured, at worst, researching and writing about vulnerabilities would help me learn about hacking. At best, I'd sell a million copies, become a self-publishing guru and retire early. The latter has yet to happen and at times, the former seems endless.

Around the 15 explained vulnerabilities mark, I decided to publish my draft so it could be purchased - the platform I chose, LeanPub (which most have probably purchased through), allows you to publish iteratively, providing customers with access to all updates. I sent out a tweet thanking HackerOne and Shopify for their disclosures and to tell the world about my book. I didn't expect much.

But within hours, I made my first sale.

Elated at the idea of someone actually paying for my book (something I created and was pouring a tonne of effort into!), I logged on to LeanPub to see what I could find out about the mystery buyer. Turns out nothing. But then my phone vibrated, I received a tweet from Michiel Prins saying he liked the book and asked to be kept in the loop.

Who the hell is Michiel Prins? I checked his Twitter profile and turns out, he's one of the Co-Founders of HackerOne. **Shit.** Part of me thought HackerOne wouldn't be impressed with my reliance on their site for content. I tried to stay positive, Michiel seemed supportive and did ask to be kept in the loop, so probably harmless.

Not long after my first sale, I received a second sale and figured I was on to something. Coincidentally, around the same time, I got a notification from Quora about a question I'd probably be interested in, How do I become a successful Bug bounty hunter?

Given my experience starting out, knowing what it was like to be in the same shoes and with the selfish goal of wanting to promote my book, I figured I'd write an answer. About half way through, it dawned on me that the only other answer was written by Jobert Abma, one of the other Co-Founders of HackerOne. A pretty authoritative voice on hacking. **Shit.**

I contemplated abandoning my answer but then elected to rewrite it to build on his input since I couldn't compete with his advice. I hit submit and thought nothing of it. But then I received an interesting email:

> Hi Peter, I saw your Quora answer and then saw that you are writing a book about White Hat hacking. Would love to know more.
>
> Kind regards,
>
> Marten CEO, HackerOne

Triple Shit. A lot of things ran through my mind at this point, none of which were positive and pretty much all were irrational. In short, I figured the only reason Marten would email me was to drop the hammer on my book. Thankfully, that couldn't have been further from the truth.

I replied to him explaining who I was and what I was doing - that I was trying to learn how to hack and help others learn along with me. Turns out, he was a big fan of the idea. He explained that HackerOne is interested in growing the community and supporting hackers as they learn as it's mutually beneficial to everyone involved. In short, he offered to help. And man, has he ever. This book probably wouldn't be where it is today or include half the content without his and HackerOne's constant support and motivation.

Since that initial email, I kept writing and Marten kept checking in. Michiel and Jobert reviewed drafts, provided suggestions and even contributed some sections. Marten even went above and beyond to cover the costs of a professionally designed cover (goodbye plain yellow cover with a white witches' hat, all of which looked like it was designed by a four year old). In May 2016, Adam Bacchus joined HackerOne and on his 5th day working there, he read the book, provided edits and was explaining what it was like to be on the receiving end of vulnerability reports - something I've now included in the report writing chapter.

I mention all this because throughout this journey, HackerOne has never asked for anything in return. They've just wanted to support the community and saw this book was a good way of doing it. As someone new to the hacking community, that resonated with me and I hope it does with you too. **I personally prefer to be part of a supportive and inclusive community.**

So, since then, this book has expanded dramatically, well beyond what I initially envisioned. And with that, the target audience has also changed.

Who This Book Is Written For

This book is written with new hackers in mind. It doesn't matter if you're a web developer, web designer, stay at home mom, a 10 year old or a 75 year old. I want this book to be an authoritative reference for understanding the different types of vulnerabilities, how to find them, how to report them, how to get paid and even, how to write defensive code.

That said, I didn't write this book to preach to the masses. This is really a book about learning together. As such, I share successes **AND** some of my notable (and embarrassing) failures.

The book also isn't meant to be read cover to cover, if there is a particular section you're interested in, go read it first. In some cases, I do reference sections previously discussed, but doing so, I try to connect the sections so you can flip back and forth. I want this book to be something you keep open while you hack.

On that note, each vulnerability type chapter is structured the same way:

- Begin with a description of the vulnerability type;
- Review examples of the vulnerability; and,
- Conclude with a summary.

Similarly, each example within those chapters is structured the same way and includes:

- My estimation of the difficulty finding the vulnerability
- The url associated with where the vulnerability was found
- A link to the report or write up
- The date the vulnerability was reported
- The amount paid for the report
- An easy to understand description of the vulnerability
- Take aways that you can apply to your own efforts

Lastly, while it's not a prerequisite for hacking, it is probably a good idea to have some familiarity with HTML, CSS, Javascript and maybe some programming. That isn't to say you need to be able to put together web pages from scratch, off the top of your head but understanding the basic structure of a web page, how CSS defines a look and feel and what can be accomplished with Javascript will help you uncover vulnerabilities and understand the severity of doing so. Programming knowledge is helpful when you're looking for application logic vulnerabilities. If you can put yourself in the programmer's shoes to guess how they may have implemented something or read their code if it's available, you'll be ahead in the game.

To do so, I recommend checking out Udacity's free online courses **Intro to HTML and CSS** and **Javacript Basics**, links to which I've included in the Resources chapter. If you're not familiar with Udacity, it's mission is to bring accessible, affordable, engaging and highly effective higher education to the world. They've partnered with companies like Google, AT&T, Facebook, Salesforce, etc. to create programs and offer courses online.

Chapter Overview

Chapter 2 is an introductory background to how the internet works, including HTTP requests and responses and HTTP methods.

Chapter 3 covers Open Redirects, an interesting vulnerability which involves exploiting a site to direct users to visit another site which allows an attacker to exploit a user's trust in the vulnerable site.

Chapter 4 covers HTTP Parameter Pollution and in it, you"ll learn how to find systems that may be vulnerable to passing along unsafe input to third party sites.

Chapter 5 covers Cross-Site Request Forgery vulnerabilities, walking through examples that show how users can be tricked into submitting information to a website they are logged into unknowingly.

Chapter 6 covers HTML Injections and in it, you'll learn how being able to inject HTML into a web page can be used maliciously. One of the more interesting takeaways is how you can use encoded values to trick sites into accepting and rendering the HTML you submit, bypassing filters.

Chapter 7 covers Carriage Return Line Feed Injections and in it, looking at examples of submitting carriage return, line breaks to sites and the impact it has on rendered content.

Chapter 8 covers Cross-Site Scripting, a massive topic with a huge variety of ways to achieve exploits. Cross-Site Scripting represents huge opportunities and an entire book could and probably should, be written solely on it. There are a tonne of examples I could have included here so I try to focus on the most interesting and helpful for learning.

Chapter 9 covers Server Side Template Injection, as well as client side injections. These types of vulnerabilities take advantage of developers injecting user input directly into templates when submitted using the template syntax. The impact of these vulnerabilities depends on where they occur but can often lead to remote code executions.

Chapter 10 covers structured query language (SQL) injections, which involve manipulating database queries to extract, update or delete information from a site.

Chapter 11 covers Server Side Request Forgery which allows an attacker to user a remote server to make subsequent HTTP requests on the attacker's behalf.

Chapter 12 covers XML External Entity vulnerabilities resulting from a sites parsing of extensible markup language (XML). These types of vulnerabilities can include things like reading private files, remote code execution, etc.

Chapter 13 covers Remote Code Execution, or the ability for an attacker to execute arbitrary code on a victim server. This type of vulnerability is among the most dangerous since an attacker can control what code is executed and is usually rewarded as such.

Chapter 14 covers memory related vulnerabilities, a type of vulnerability which can be tough to find and are typically related to low level programming languages. However, discovering these types of bugs can lead to some pretty serious vulnerabilities.

Chapter 15 covers Sub Domain Takeovers, something I learned a lot about researching this book and should be largely credited to Mathias, Frans and the Dectectify team. Essentially here, a site refers to a sub domain hosting with a third party service but never actually claims the appropriate address from that service. This would allow an attacker to register the address from the third party so that all traffic, which believes it is on the victim's domain, is actually on an attacker's.

Chapter 16 covers Race Conditions, a vulnerability which involves two or more processes performing action based on conditions which should only permit one action to occur. For example, think of bank transfers, you shouldn't be able to perform two transfers of $500 when your balance is only $500. However, a race condition vulnerability could permit it.

Chapter 17 covers Insecure Direct Object Reference vulnerabilities whereby an attacker can read or update objections (database records, files, etc) which they should not have permission to.

Chapter 18 covers application logic based vulnerabilities. This chapter has grown into a catch all for vulnerabilities I consider linked to programming logic flaws. I've found these types of vulnerabilities may be easier for a beginner to find instead of looking for weird and creative ways to submit malicious input to a site.

Chapter 19 covers the topic of how to get started. This chapter is meant to help you consider where and how to look for vulnerabilities as opposed to a step by step guide to hacking a site. It is based on my experience and how I approach sites.

Chapter 20 is arguably one of the most important book chapters as it provides advice on how to write an effective report. All the hacking in the world means nothing if you can't properly report the issue to the necessary company. As such, I scoured some big name bounty paying companies for their advice on how best to report and got advice from HackerOne. **Make sure to pay close attention here**.

Chapter 21 switches gears. Here we dive into recommended hacking tools. The initial draft of this chapter was donated by Michiel Prins from HackerOne. Since then it's grown to a living list of helpful tools I've found and used.

Chapter 22 is dedicated to helping you take your hacking to the next level. Here I walk you through some awesome resources for continuing to learn. Again, at the risk of sounding like a broken record, big thanks to Michiel Prins for contributing to the original list which started this chapter.

Chapter 21 concludes the book and covers off some key terms you should know while hacking. While most are discussed in other chapters, some aren't so I'd recommend taking a read here.

Word of Warning and a Favour

Before you set off into the amazing world of hacking, I want to clarify something. As I was learning, reading about public disclosures, seeing all the money people were (and still are) making, it became easy to glamorize the process and think of it as an easy way to get rich quick. It isn't. Hacking can be extremely rewarding but it's hard to find and read about the failures along the way (except here where I share some pretty embarrassing stories). As a result, since you'll mostly hear of peoples' successes, you may develop unrealistic expectations of success. And maybe you will be quickly successful. But if you aren't, keep working! It will get easier and it's a great feeling to have a report resolved.

With that, I have a favour to ask. As you read, please message me on Twitter @yaworsk and let me know how it's going. Whether successful or unsuccessful, I'd like to hear from you. Bug hunting can be lonely work if you're struggling but its also awesome to celebrate with each other. And maybe your find will be something we can include in the next edition.

Good luck!!

3. Background

If you're starting out fresh like I was and this book is among your first steps into the world of hacking, it's going to be important for you to understand how the internet works. Before you turn the page, what I mean is how the URL you type in the address bar is mapped to a domain, which is resolved to an IP address, etc.

To frame it in a sentence: the internet is a bunch of systems that are connected and sending messages to each other. Some only accept certain types of messages, some only allow messages from a limited set of other systems, but every system on the internet receives an address so that people can send messages to it. It's then up to each system to determine what to do with the message and how it wants to respond.

To define the structure of these messages, people have documented how some of these systems should communicate in Requests for Comments (RFC). As an example, take a look at HTTP. HTTP defines the protocol of how your internet browser communicates with a web server. Because your internet browser and web server agreed to implement the same protocol, they are able to communicate.

When you enter http://www.google.com in your browser's address bar and press return, the following steps describe what happens on a high level:

- Your browser extracts the domain name from the URL, www.google.com.
- Your computer sends a DNS request to your computer's configured DNS servers. DNS can help resolve a domain name to an IP address, in this case it resolves to 216.58.201.228. Tip: you can use dig A www.google.com from your terminal to look up IP addresses for a domain.
- Your computer tries to set up a TCP connection with the IP address on port 80, which is used for HTTP traffic. Tip: you can set up a TCP connection by running nc 216.58.201.228 80 from your terminal.
- If it succeeds, your browser will send an HTTP request like:

```
GET / HTTP/1.1
Host: www.google.com
Connection: keep-alive
Accept: application/html, */*
```

- Now it will wait for a response from the server, which will look something like:

```
HTTP/1.1 200 OK
Content-Type: text/html

<html>
 <head>
  <title>Google.com</title>
 </head>
 <body>
  ...
 </body>
</html>
```

- Your browser will parse and render the returned HTML, CSS, and JavaScript. In this case, the home page of Google.com will be shown on your screen.

Now, when dealing specifically with the browser, the internet and HTML, as mentioned previously, there is an agreement on how these messages will be sent, including the specific methods used and the requirement for a Host request-header for all HTTP/1.1 requests, as noted above in bullet 4. The methods defined include GET, HEAD, POST, PUT, DELETE, TRACE, CONNECT and OPTIONS.

The **GET** method means to retrieve whatever information is identified by the request Uniform Request Identifier (URI). The term URI may be confusing, especially given the reference to a URL above, but essentially, for the purposes of this book, just know that a URL is like a person's address and is a type of URI which is like a person's name (thanks Wikipedia). While there are no HTTP police, typically GET requests should not be associated with any data altering functions, they should just retrieve and provide data.

The **HEAD** method is identical to the GET message except the server must not return a message body in the response. Typically you won't often see this used but apparently it is often employed for testing hypertext links for validity, accessibility and recent changes.

The **POST** method is used to invoke some function to be performed by the server, as determined by the server. In other words, typically there will be some type of back end action performed like creating a comment, registering a user, deleting an account, etc. The action performed by the server in response to the POST can vary and doesn't have to result in action being taken. For example, if an error occurs processing the request.

The **PUT** method is used when invoking some function but referring to an already existing entity. For example, when updating your account, updating a blog post, etc. Again, the action performed can vary and may result in the server taking no action at all.

The **DELETE** method is just as it sounds, it is used to invoke a request for the remote server to delete a resource identified by the URI.

The **TRACE** method is another uncommon method, this time used to reflect back the request message to the requester. This allows the requester to see what is being received by the server and to use that information for testing and diagnostic information.

The **CONNECT** method is actually reserved for use with a proxy (a proxy is a basically a server which forwards requests to other servers)

The **OPTIONS** method is used to request information from a server about the communication options available. For example, calling for OPTIONS may indicate that the server accepts GET, POST, PUT, DELETE and OPTIONS calls but not HEAD or TRACE.

Now, armed with a basic understanding of how the internet works, we can dive into the different types of vulnerabilities that can be found in it.

4. Open Redirect Vulnerabilities

Description

According to the Open Web Application Security Project, an open redirect occurs when an application takes a parameter and redirects a user to that parameter value without any conducting any validation on the value.

This vulnerability is used in phishing attacks to get users to visit malicious sites without realizing it, abusing the trust of a given domain to lead users to another. The malicious website serving as the redirect destination could be prepared to look like a legitimate site and try to collect personal / sensitive information.

A key to this is a user just needing to visit a URL and be redirected elsewhere. In other words, you're looking for a GET request with no user interaction other than visiting a link.

> **Links**
>
> Check out the OWASP Unvalidated Redirects and Forwards Cheat Sheet[1]

Examples

1. Shopify Theme Install Open Redirect

Difficulty: Low

Url: app.shopify.com/services/google/themes/preview/supply–blue?domain_name=XX

Report Link: https://hackerone.com/reports/101962[2]

Date Reported: November 25, 2015

Bounty Paid: $500

Description:

Shopify's platform allows store administrators to customize the look and feel of their stores. In doing so, administrators install themes. The vulnerability here was that a theme

[1] https://www.owasp.org/index.php/Unvalidated_Redirects_and_Forwards_Cheat_Sheet

[2] https://hackerone.com/reports/101962

installation page was interpreting the redirect parameter and return a 301 redirect to a user’s browser without validating the domain of the redirect.

As a result, if a user visited **https://app.shopify.com/services/google/themes/preview/supply–blue?domain_name=example.com**, they would be redirected to **http://example.com/admin**.

A malicious user could have hosted a site at that domain to try and conduct a phishing attack on unsuspecting users.

Takeaways

Not all vulnerabilities are complex. This open redirect simply required changing the redirect parameter to an external site which would have resulted in a user being redirected off-site from Shopify.

2. Shopify Login Open Redirect

Difficulty: Medium

Url: http://mystore.myshopify.com/account/login

Report Link: https://hackerone.com/reports/103772[3]

Date Reported: December 6, 2015

Bounty Paid: $500

Description:

This open redirect is very similar to the theme install vulnerability discussed above, but here, the vulnerability occurs after a user has logged in and using the parameter ?checkout_url. For example:

```
http://mystore.myshopify.com/account/login?checkout_url=.np
```

As a result, when a user visits the link and logs in, they would be redirected and sent to https://mystore.myshopify.com**.np/** which actually is not a Shopify domain anymore!

Takeaways

When looking for open redirects, keep an eye out for URL parameters which include url, redirect, next, etc. This may denote paths which sites will direct users to.

[3] https://hackerone.com/reports/103772

3. HackerOne Interstitial Redirect

Difficulty: Medium

Url: N/A

Report Link: https://hackerone.com/reports/111968[4]

Date Reported: January 20, 2016

Bounty Paid: $500

Description:

The interstitial redirect referenced here refers to a redirect happening without a stop in the middle of the redirect which tells you you are being redirected.

HackerOne actually provided a plain language description of this vulnerability on the report:

> Links with hackerone.com domain were treated as trusted links, including those followed by /zendesk_session. Anyone can create a custom Zendesk account that redirects to an untrusted website and provide it in /redirect_to_account?state= param; and because Zendesk allows redirecting between accounts without interstitial, you'd be taken to the untrusted site without any warning.
>
> Given that the origin of the issue is within Zendesk, we've chosen to identify the links with zendesk_session as external links which would render an external icon and an interstitial warning page when clicked.

So, here, Mahmoud Jamal created company.zendesk.com and added:

```
<script>document.location.href = "http://evil.com";</script>
```

to the header file via the zendesk theme editor. Then, passing the link:

```
https://hackerone.com/zendesk_session?locale_id=1&return_to=https://support.hack\
erone.com/ping/redirect_to_account?state=company:/
```

which is used to redirect to generate a Zendesk session.

Now, interestingly, Mahmoud reporting this redirect issue to Zendesk originally who stated that they did not see any issue with it. So, naturally, he kept digging to see how it could be exploited.

[4] https://hackerone.com/reports/111968

Takeaways

As you search for vulnerabilities, take note of the services a site uses as they each represent a new attack vectors. Here, this vulnerability was made possible by combining HackerOne's use of Zendesk and the known redirect they were permitting.

Additionally, as you find bugs, there will be times when the security implications are not readily understood by the person reading and responding to your report. This is why it I have a chapter on Vulnerability Reports. If you do a little work upfront and respectfully explain the security implications in your report, it will help ensure a smoother resolution.

But, even that said, there will be times when companies don't agree with you. If that's the case, keep digging like Mahmoud did here and see if you can prove the exploit or combine it with another vulnerability to demonstrate effectiveness.

Summary

Open Redirects allow a malicious attacker to redirect people unknowingly to a malicious website. Finding them, as these examples show, often requires keen observation. This sometimes occurs in a easy to spot redirect_to=, domain_name=, checkout_url=, etc. This type of vulnerability relies of an abuse of trust, where by victims are tricked into visiting an attackers site thinking they will be visiting a site they recognize.

Typically, you can spot these when a URL is passed in as a parameter to a web request. Keep an eye out and play with the address to see if it will accept a link to an external site.

Additionally, the HackerOne interstitial redirect shows the importance of both, recognizing the tools and services web sites use while you hunt for vulnerabilities and how sometimes you have to be persistent and clearly demonstrate a vulnerability before it is recognized and accepted.

5. HTTP Parameter Pollution

Description

HTTP Parameter Pollution, or HPP, occurs when a website accepts input from a user and uses it to make an HTTP request to another system without validating that user's input. This can happen one of two ways, via the server (or back end) and via the client side.

On StackExchange, SilverlightFox provides a great example of a HPP server side attack; suppose we have the following website, https://www.example.com/transferMoney.php, which is accessible via a POST method taking the following parameters:

> amount=1000&fromAccount=12345

When the application processes this request, it makes its own POST request to another back end system, which in turn actually processes the transaction with a fixed toAccount parameter.

> **Separate back end URL:** https://backend.example/doTransfer.php
>
> **Separate back end Parameters:** toAccount=9876&amount=1000&fromAccount=12345

Now, if the back end only takes the last parameter when duplicates are provided and suppose a hacker alters the POST to the website to submit a toAccount param like this:

> amount=1000&fromAccount=12345&toAccount=99999

A site vulnerable to an HPP attack would forward the request to the other back end system looking like:

> toAccount=9876&amount=1000&fromAccount=12345&toAccount=99999

In this case, the second toAccount parameter submitted by the malicious user could override the back end request and transfer the money into the malicious user's submitted account (99999) instead of the intended account set by the system (9876).

This is useful if an attacker were to amend their own requests, which are processed through a vulnerable system. But it can be also more useful to an attacker if that attacker can generate a link from another website and entice users to unknowingly submit the malicious request with the extra parameter added by the attacker.

On the other hand, HPP client side involves injecting additional parameters to links and other src attributes. Borrowing an example from OWASP, suppose we had the following code:

```
<? $val=htmlspecialchars($_GET['par'],ENT_QUOTES); ?>
<a href="/page.php?action=view&par='.<?=$val?>.'">View Me!</a>
```

This takes a value for par from the URL, makes sure it's safe and creates a link out of it. Now, if an attacker submitted:

```
http://host/page.php?par=123%26action=edit
```

the resulting link would look like:

```
<a href="/page.php?action=view&par=123&amp;action=edit">View Me!</a>
```

This could lead to the application then accepting the edit action instead of the view action.

Both HPP server side and client side depend on which back end technology is being used and how it behaves when receiving multiple parameters with the same name. For example, PHP/Apache uses the last occurrence, Apache Tomcat uses the first occurrence, ASP/IIS uses all occurrences, etc. As a result, there is no single guaranteed handling for submitting multiple parameters with the same name and finding HPP will take some experimentation to confirm how the site you're testing works.

Examples

1. HackerOne Social Sharing Buttons

Difficulty: Low

Url: https://hackerone.com/blog/introducing-signal-and-impact

Report Link: https://hackerone.com/reports/105953[1]

Date Reported: December 18, 2015

Bounty Paid: $500

Description: HackerOne includes links to share content on popular social media sites like Twitter, Facebook, etc. These social media links include specific parameters for the social media link.

A vulnerability was discovered where a hacker could tack on another URL parameter to the link and have it point to any website of their choosing, which HackerOne would include in the POST to the social media site, thereby resulting in unintended behaviour.

The example used in the vulnerability report was changing the URL:

```
https://hackerone.com/blog/introducing-signal
```

to

[1] https://hackerone.com/reports/105953

https://hackerone.com/blog/introducing-signal?&u=https://vk.com/durov

Notice the added u parameter. If the maliciously updated link was clicked on by HackerOne visitors trying to share content via the social media links, the malicious link would look like:

https://www.facebook.com/sharer.php?u=https://hackerone.com/blog/introducing-signal?&u=https://vk.com/durov

Here, the last u parameter was given precedence over the first and subsquently used in the Facebook post. When posting to Twitter, the suggested default text could also be changed:

https://hackerone.com/blog/introducing-signal?&u=https://vk.com/durov&text=another_site:https://vk.com/durov

Takeaways

Be on the lookout for opportunities when websites are accepting content and appear to be contacting another web service, like social media sites.

In these situations, it may be possible that submitted content is being passed on without undergoing the proper security checks.

2. Twitter Unsubscribe Notifications

Difficulty: Low

Url: twitter.com

Report Link: merttasci.com/blog/twitter-hpp-vulnerability[2]

Date Reported: August 23, 2015

Bounty Paid: $700

Description:

In August 2015, hacker Mert Tasci noticed an interesting URL when unsubscribing from receiving Twitter notifications:

https://twitter.com/i/u?t=1&cn=bWV&sig=657&iid=F6542&uid=1134885524&nid=22+26

(I've shortened this a bit for the book). Did you notice the parameter UID? This happens to be your Twitter account user ID. Now, noticing that, he did what I assume most of us hackers would do, he tried changing the UID to that of another user and … nothing. Twitter returned an error.

Determined where others may have given up, Mert tried adding a second uid parameter so the URL looked like (again I shortened this):

[2] http://www.merttasci.com/blog/twitter-hpp-vulnerability

https://twitter.com/i/u?iid=F6542&uid=2321301342&uid=1134885524&nid=22+26

and … SUCCESS! He managed to unsubscribe another user from their email notifications. Turns out, Twitter was vulnerable to HPP unsubscribing users.

Takeaways

Though a short description, Mert's efforts demonstrate the importance of persistence and knowledge. If he had walked away from the vulnerability after testing another UID as the only parameter or had he not know about HPP type vulnerabilities, he wouldn't have received his $700 bounty.

Also, keep an eye out for parameters, like UID, being included in HTTP requests as I've seen a lot of reports during my research which involve manipulating their values and web applications doing unexpected things.

3. Twitter Web Intents

Difficulty: Low

Url: twitter.com

Report Link: Parameter Tamperting Attack on Twitter Web Intents[3]

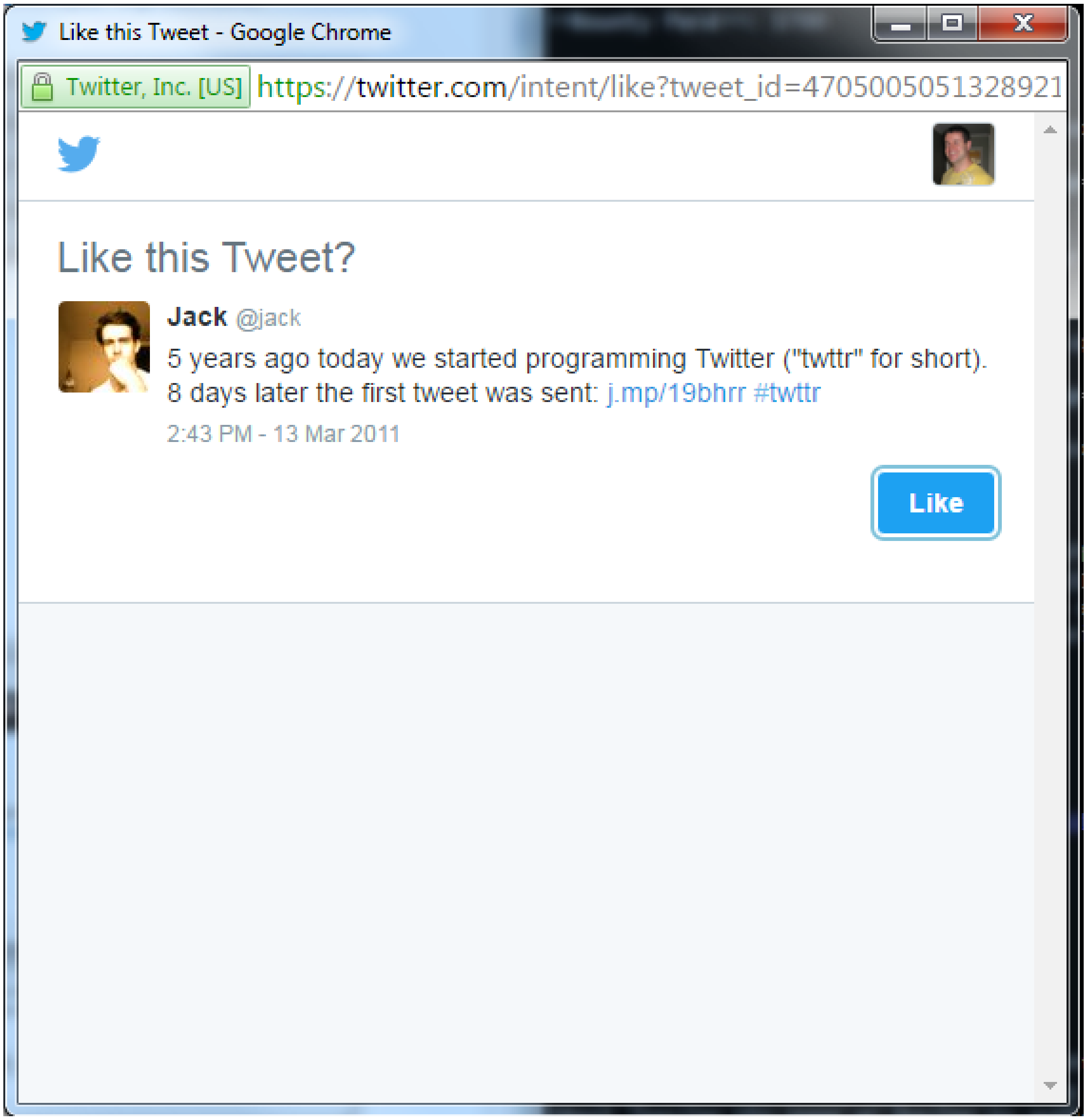
Date Reported: November 2015

Bounty Paid: Undisclosed

Description:

According to their documentation, Twitter Web Intents, provide popup-optimized flows for working with Tweets & Twitter Users: Tweet, Reply, Retweet, Like, and Follow. They make it possible for users to interact with Twitter content in the context of your site, without leaving the page or having to authorize a new app just for the interaction. Here's an example of what this looks like:

[3] https://ericrafaloff.com/parameter-tampering-attack-on-twitter-web-intents



https://twitter.com/intent/like?tweet_id=4705005051328921

Like this Tweet?

Jack @jack

5 years ago today we started programming Twitter ("twttr" for short). 8 days later the first tweet was sent: j.mp/19bhrr #twttr

2:43 PM - 13 Mar 2011

Twitter Intent

Testing this out, hacker Eric Rafaloff found that all four intent types, following a user, liking a tweet, retweeting and tweeting, were vulnerable to HPP.

According to his blog post, if Eric created a URL with two screen_name parameters:

https://twitter.com/intent/follow?screen_name=twitter&screen_name=erictest3

Twitter would handle the request by giving precedence to the second screen_name over the first. According to Eric, the web form looked like:

```
<form class="follow" id="follow_btn_form" action="/intent/follow?screen_name=eri\
crtest3" method="post">
  <input type="hidden" name="authenticity_token" value="...">
  <input type="hidden" name="screen_name" value="twitter">

  <input type="hidden" name="profile_id" value="783214">

  <button class="button" type="submit" >
    <b></b><strong>Follow</strong>
  </button>
</form>
```

A victim would see the profile of the user defined in the first screen_name, **twitter**, but clicking the button, they'd end up following **erictest3**.

Similarly, when presenting intents for liking, Eric found he could include a **screen_name** parameter despite it having no relevance to liking the tweet. For example:

https://twitter.com/intent/like?tweet_id=6616252302978211845&screen_name=erictest3

Liking this tweet would result in a victim being presented with the correct owner profile but clicking follow, they would again end up following **erictest3**.

Takeaways

This is similar to the previous Twitter vulnerability regarding the UID. Unsurprisingly, when a site is vulnerable to an flaw like HPP, it may be indicative of a broader systemic issue. Sometimes if you find a vulnerability like this, it's worth taking the time to explore the platform in its entirety to see if there are other areas where you might be able to exploit similar behaviour. In this example, like the UID above, Twitter was passing a user identifier, **screen_name** which was susceptible to HPP based on their backend logic.

Summary

The risk posed by HTTP Parameter Pollution is really dependent on the actions performed by a site's back end and where the polluted parameters are being submitted to.

Discovering these types of vulnerabilities really depends on experimentation, more so than other vulnerabilities because the back end actions of a website may be a complete black box to a hacker. More often than not, as a hacker, you will have very little insight into what actions a back end server takes after having received your input.

Through trial and error, you may be able to discover situations where a site is communicating with another server and then start testing for Parameter Pollution. Social media links are usually a good first step but remember to keep digging and think of HPP when you might be testing for parameter substitutions like UIDs.