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File Disclosure and Server-Side Request Forgery

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Outline

- File Disclosure
  - Impact and Overview
  - Paths 101
  - Path traversal attacks
  - Fixes
- Server-Side Request Forgery

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File Disclosure

- A file disclosure is the **impact of certain vulnerabilities**
- As the name suggests, it consists of the ability to **disclose/leak important files from a server**
- Because it is an impact, there are **multiple class of vulnerabilities** that **lead to file disclosure**
  - For example, remote code execution is another type of impact that could also result in a file disclosure

File Disclosure

- Files inside a server are critical information:
  - In many applications, files uploaded by users are the information that we want to protect
  - The disclosure of such files is a violation of the web app authentication itself

File Disclosure

- It is also possible to **steal configs files** from the webserver **which might contain credentials**
  - *Database configuration files* often contain the credentials to access the database
  - Files like the *tomcat-users.xml* contain the credentials to access the tomcat manager
  - Files like *flask configuration* or *web.config* in a .net application contain the secret used to sign the session

File Disclosure

- Finally, it is possible to **steal the source code** of the web application
  - For some business, the source code of the web application is its product/asset
  - An attacker in possession the source code is more effective
    - It is easier for the attacker to find other vulnerabilities, especially if the application was developed according to a "security by obscurity" model, and to exploit them

File Disclosure

- How can a web app disclose sensible files?
  - Basically, **everything that works with files can lead to a file disclosure vulnerability**
  - There are standard sinks, and some of them are a trivial
  - If a user-controlled input manages to go inside these sinks, the web app is at risk

File Disclosure

- Some sinks are trivial...
- Basically every function in every programming language that manages files
  - Every flavor of **`open/fopen`** in every language
  - Flask **`send_file`**
  - …
- Obviously, it is also possible to leak files if the web app suffers from code execution

File Disclosure

- Some sink
- Basically e amming language that mana
  - Every fla age
  - Flask **ser**
  - …
- Obviously, s if the web app suffers from code execution

```
fopen
tmpfile
bzopen
gzopen
SplFileObject->__construct
// write to filesystem (partially in combination with rea
chgrp
chmod
chown
copy
file_put_contents
lchgrp
lchown
link
mkdir
move_uploaded_file
rename
rmdir
```


File Disclosure

- Some sink
- Basically e … amming language that mana
  - Every fla … age
  - Flask **ser**
  - …
- Obviously … s if the web app suffers from code execution

```
readfile
readlink
realpath
stat
gzfile
readgzfile
getimagesize
imagecreatefromgif
imagecreatefromjpeg
imagecreatefrompng
imagecreatefromwbmp
imagecreatefromxbm
imagecreatefromxpm
ftp_put
ftp_nb_put
exif_read_data
read_exif_data
exif_thumbnail
exif_imagetype
```


File Disclosure

- Other sinks are less trivial
  - **cURL** is used as a http client. But it can also be used to open files

```
$fd = curl_init('file:///etc/passwd');
echo curl_exec($a);
```

  - **XML** parsing suffers from file disclosure: XML format has some special entities that permit to open and read files

File Disclosure

- Sometimes it is possible to leak important files just because they are publicly accessible
  - .git directory exposed
    - If you make your git directory open to the internet, everyone will be able to dump all files inside it
  - Web-server misrouting
    - Sometimes it is possible to trick a web server to return a .php file as an image...

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Paths 101

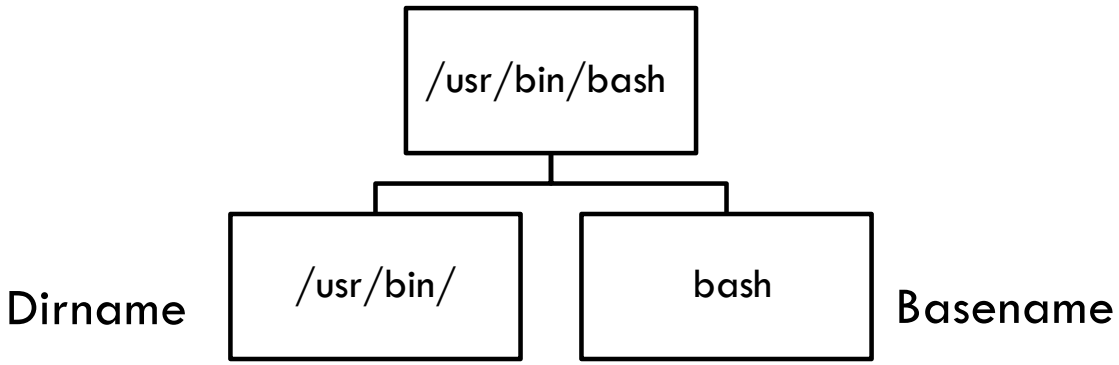
- Let us focus on what happens if a user-controlled input finds a way to an open-like function
- We first need to understand few things about how paths work

Paths 101

- An **absolute path** is a path that describes the location of a file regardless of the working directory
  - /etc/passwd
- A **relative path** is a path that describes the location of a file starting from the working directory
  - foo/bar

Paths 101

- Paths are composed by a **dirname** and a **basename**
  - The **dirname** is the portion of the path up to the last /
  - The **basename** is the portion of the path after the last /



Paths 101

- Every directory has two special subdirectories:
  - The **current directory**, whose name is .
    - /foobar/./ == /foobar/
  - And the **parent directory**, whose name is ..
    - /foobar/../ == /
- The parent directory is especially useful for file disclosure because it permits to access every directory inside the file system

Paths 101

- A path in its **shortest form** is called **normalized**
- For example:
  - */foo/bar* is normalized, there is no way to make it shorter
  - *//foo/bar* is not normalized, /foo/bar is shorter
  - */foo/./bar* is not normalized, /foo/bar is shorter
- What about /foo/test/../bar?

Paths 101

- What about /foo/test/../bar?
- Its shortest form would be /foo/bar, but what happens if /foo/test/ does not exist?
  - If the path is normalized before opened, then everything is fine: we can access /foo/bar without any problem
  - If the path is not normalized, then the open would fail because /foo/test/ does not exist, and so ..

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Path Traversal

- Path traversal is a vulnerability that leads to a file disclosure
- It happens when user-controlled input finds its way into an open or equivalent function
- If there are no security checks or security sanitization, an attacker could inject paths that are not meant to be opened

Path Traversal

- Path
- It h
- If th

```
<nowiki>
<?php
$template = 'blue.php';
if ( isset( $_COOKIE['TEMPLATE'] ) )
    $template = $_COOKIE['TEMPLATE'];
include ( "/home/users/web/templates/" . $template );
?>
</nowiki>
```

disc

le

way

intc

sanitization, an attacker could inject paths that are not meant to be opened

Path Traversal

- Path
- It h
- If th

```
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?>
</nowiki>
```

Entry point

disc … file

… way

intc …

… sanitization, an attacker could inject paths that are not meant to be opened

Path Traversal

- Path
- It h
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```
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?>
</nowiki>
```

Sink

disc

intc

way

sanitization, an attacker could inject paths that are not meant to be opened

Path Traversal

- There are a few cases that might happen:
  - **Plain** injection — open($input)
  - **Prepended** injection — open($input + '/foobar')
  - **Appended** injection — open('/foobar' + $input)
  - **Appended** and **prepended** — open('/foo'+$input+'/bar)

Full Plain Path Traversal

- open($input)
- Without security checks it is possible to leak every file on the filesystem
- Other problems:
  - Protocols like HTTP / gopher / ssh could be used, making it a Server-Side Request Forgery
  - For some functions, it is possible to execute arbitrary code. (For example if the injection is inside Perl's open)

Full Plain Path Traversal

- The exploit for this kind of injection is trivial
  - Just put the path of the file to disclose
- A useful test file on Unix systems is **`/etc/passwd`**
- Why?
  - It always exists and is accessible by every user of the system
  - Is a good target to properly check if there is an actual injection inside an open-like function

Appended Path Traversal

- open('/somedir/' . $input)
- It is the most common one
- It is basically a plain injection without the possibility to use other protocols
- If there is no protection, it is possible to leak every file in the filesystem

Appended Path Traversal

- To exploit this, append some ../ in order to get to the root directory
- In this way, it is possible to access every file of the filesystem

Appended Path Traversal


```
https://[redacted]/html/js/editor/editor.jsp?editorImpl=../../../WEB-INF/web.xml?
```

```
HTTP/1.1 200 OK
Content-Type: text/html
Server: Microsoft-IIS/8.5
X-Powered-By: ASP.NET
Date: Thu, 30 Mar 2017 20:24:43 GMT
Connection: close
Content-Length: 54193


<?xml version="1.0"?>

<web-app xmlns="http://java.sun.com/xml/ns/j2ee" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="2.4"
    <context-param>
        <param-name>contextClass</param-name>
        <param-value>com.liferay.portal.spring.context.PortalApplicationContext</param-value>
```


Appended Path Traversal


```
https://[redacted]/html/js/editor/editor.jsp?editorImpl=../../../WEB-INF/web.xml?
```

```
HTTP/1.1 200 OK
Content-Type: text/html
Server: Microsoft-IIS/8.5
X-Powered-By: ASP.NET
Date: Thu, 30 Mar 2017 20:24:43 GMT
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```
<?xml version="1.0"?>

<web-app xmlns="http://java.sun.com/xml/ns/j2ee" xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" version="2.4"
    <context-param>
        <param-name>contextClass</param-name>
        <param-value>com.liferay.portal.spring.context.PortalApplicationContext</param-value>
```


Prepended Path Traversal

- *open($input . 'someotherdata')*
- A little bit trickier than the previous one, normally in two forms:
  - An extension is enforced
    - file_get_content($input . '.txt')
  - Or a filename is enforced
    - file_get_contents($input . '/somefile.txt')

Prepended Path Traversal

- Allows the disclosure of files whose path finish with a hardcoded suffix
- There are some tricks

- Some languages support the file:// scheme.
- Particularly interesting because it is parsed as a URL
  - file://localhost**/path/to/file**?someotherdata == /path/to/file

```
ubuntu@ip-172-31-24-48:~$ curl file://localhost/etc/passwd\?someotherdata
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
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
```

- Some scripting languages internally use the C function open
- Because of how C handles strings, open will ignore everything after a NULL character (*\x00*)
- This trick worked very well for older versions of PHP, but now is patched

Path Traversal

- A **blacklist** is a common mitigation against these types of vulnerabilities
- A blacklist is used to look for "dangerous" words inside a user-supplied input
- If a dangerous word is found, the system rejects the input or sanitizes it, thus removing the dangerous word

Path Traversal

- Blacklists are insecure, because they are error prone
  - You will never able to insert all the edges cases!
- For example, does a blacklist that contains the word '*proc*' prevent access to the '*/proc/*' directory?
  - No, */dev/fd/* is a link to */proc/self/fd*, so you can access every file of */proc/* with the directory */def/fd/../../*

Path Traversal

- What if we blacklist single dangerous characters like . Or / ?
  - The problem here is congruency. Some languages, javascript in particular, don't handle well malformed unicode characters.
  - For example, the unicode character *u012e* (Į), when converted to ascii, is incorrectly transformed to the byte *x2e* (.)
  - You can see that if the blacklist is using unicode but the open function is using ascii there is a problem

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Fixes

- **Normalize paths**
- In this way there are no "nasty points" inside paths, and it is possible to **enforce a dirname**
  - Pay attention that the function used for normalization parses paths the same way of the open function
    - In this way, you will able to avoid problems caused by incongruences

Fixes

- Another good mitigation is **chroot**
- Chroots are "jails" enforced by the OS or by some programming languages
- If a path is set as a chroot, then every access outside this path would be denied by the OS/interpreter
- If an attacker manages to bypass all security checks, he will be stopped by the chroot

Fixes

- In summary
  - Blacklists are useless, as they can be bypassed in different weird ways
  - Whitelists work better, but defeat the purpose of passing user input inside an open function
  - Avoid incongruency, check paths the same way you open them

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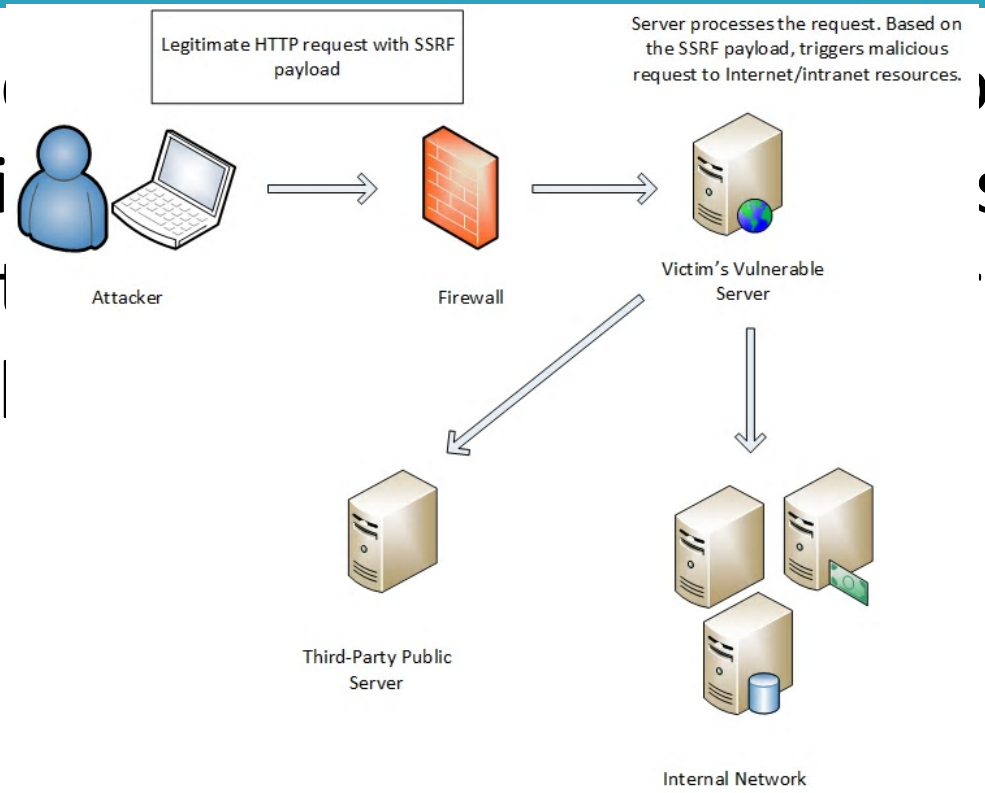
Server-Side Request Forgery

- A Server-Side Request Forgery (SSRF from now on) is a vulnerability in which an attacker abuses a functionality of an application to send requests from the server backend

Server-Side Request Forgery

- A Server-Si…om now on) is a vulnerabi…ses a functionali…equests from the server …



Server-Side Request Forgery

- The impact varies a lot, and it depends on the control present in the forged requests
  - Total TCP controlled request
  - Total HTTP controlled request
  - Control on some part of HTTP
  - Control only on the host/port

Server-Side Request Forgery

- SSRFs are dangerous because they allow bypassing the firewall
- If the internal network is not properly designed, it Is possible to access to sensible hosts, like internal web applications and control panels

Server-Side Request Forgery

- If the vulnerable web application is hosted on a cloud instance, things become more interesting
- Some instances have access to specials URLs that often contain critical data such as API key, used to manage the instances themselves

Server-Side Request Forgery

- For example, AWS instances can access the metadata API, at the url http://169.254.169.254/
- This host contains sensible information such as the IAM security credentials and general information about the vulnerable instance

Server-Side Request Forgery

- If there is no output, the SSRF is called blind SSRF
- It is less dangerous than a normal SSRFs
- With a blind SSRF it is possible to
  - Map the internal network
  - Trigger actions on hosts behind the firewall

Server-Side Request Forgery

- It is possible to map the internal network by trying url/ports, and by looking at the response time
  - This can be done if the response time of the vulnerable endpoint depends on the response time of the SSRF request

Server-Side Request Forgery

- To find an SSRf, you should:
  - Find suspicious endpoints: If you see a url inside a parameter try to put a URL controlled by you. You can use a tool like ngrok
  - If you have a pingback at your host, then probably you have an SSRF. Then you should try to insert internal hostnames, like "localhost" or common internal IPs (192.168.1.1,10.0.0.1, and so on..)
  - Examine the response time!

Server-Side Request Forgery

alyssa_herrera submitted a report to **U.S. Dept Of Defense**. Mar 15th (2 years ago)

Summary:

An end point on [redacted] allows an internal access to the network thus revealing sensitive data and allowing internal tunneling

Description:

OAuth Plugin allows you to provide a url that gives a snap shot of the web page. We can pass internal URLS and conduct SSRF.

Impact

Critical

Step-by-step Reproduction Instructions

https://[redacted]/plugins/servlet/oauth/users/icon-uri?consumerUri=http://169.254.169.254/latest/meta-data/hostname

We can see the follow data

ip-172-31-12-254.[redacted].compute.internal

https://[redacted]/plugins/servlet/oauth/users/icon-uri?consumerUri=http://169.254.169.254/latest/meta-data/public-ipv4

[redacted]

Server-Side Request Forgery

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https://[redacted]/plugins/servlet/oauth/users/icon-uri?consumerUri=http://169.254.169.254/latest/meta-data/public-ipv4

[redacted]

Server-Side Request Forgery

- Every piece of code that can issue a connection can lead to this vulnerability
- Common functions/libraries are:
  - PHP open-like functions
  - CURL
  - Python's urllib
  - ...

Server-Side Request Forgery


```
def send_email(request):
    try:
        recipients = request.GET['to'].split(',')
        url = request.GET['url']
        proto, server, path, query, frag = urlsplit(url)
        if query: path += '?' + query
        conn = HTTPConnection(server)
        conn.request('GET',path)
        resp = conn.getresponse()
```


Server-Side Request Forgery

Snipped of code from Graphite

```
def send_email(request):
    try:
        recipients = request.GET['to'].split(',')
        url = request.GET['url']
        proto, server, path, query, frag = urlsplit(url)
        if query: path += '?' + query
        conn = HTTPConnection(server)
        conn.request('GET',path)
        resp = conn.getresponse()
```


Server-Side Request Forgery

- Generally speaking, SSRFs are really difficult to avoid
- The most effective way is to check the user-supplied host against a whitelist
- Another good mitigation is to make requests from a host isolated from the internal network

File Disclosure and Server-Side Request Forgery

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