Spoofing JARM signatures. I am the Cobalt Strike server now!

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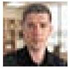

3 min read

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TL;DR: JARM is very useful fingerprinting tool, but can be deceived by replaying server hello's from other services.

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The JARM scanner created by

is quite an effective tool for system fingerprinting. It uses the Server Hello responses from a TLS handshake to generate a signature. These can then be used to find similar software or services. Ideal for finding C2 or other malicious servers that implement TLS. So, It doesn't come as a surprise that Shodan.io uses this fingerprinting mechanism in their scanners. Read the Salesforce post for more information about the JARM library, scanner and its uses.

The question, then, arises: Is it possible to spoof these JARM signatures? Let's find out! Salesforce stated in their post that scanning a Cobalt Strike server would result in the following signature `07d14d16d21d21d07c42d41d00041d24a458a375eef0c576d23a7bab9a9fb1`

That this signature isn't Cobalt Strike specific, was revealed in the Cobalt Strike blog. Let's still use it as a starting point anyway.

First I used the list of addresses published by Salesforce to find a server with a matching hash. I scanned it using jarmscan and created a packet capture of the response. The ssl handshake (filter: `ssl.handshake.type == 1`) filter in Wireshark will display all TLS client hello's sent by the scanner.

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No.	Time	Sc	Source Port	Protocol	De	Length	Info
4	0.123392	…	64773	TLSv1.2	…	470	Client Hello
15	1.380676	…	64774	TLSv1.2	…	470	Client Hello
26	1.632238	…	64775	TLSv1.2	…	402	Client Hello
38	1.884997	…	64776	TLSv1.2	…	388	Client Hello
50	2.146878	…	64777	TLSv1.2	…	429	Client Hello
62	2.408787	…	64778	TLSv1.1	…	470	Client Hello
75	2.671207	…	64779	TLSv1.3	…	483	Client Hello
88	2.923828	…	64780	TLSv1.3	…	483	Client Hello
101	3.177630	…	64781	TLSv1.2	…	473	Client Hello
111	3.428488	…	64782	TLSv1.3	…	456	Client Hello

Wireshark capture of 10 TLS Client Hello's

And in turn the "Cobalt Strike" server will return its Server Hello's. These are used by jarmscan to generate a unique signature (filter: `ssl.handshake.type == 2`).

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No.	Time	Sc	Source Port	Protocol	De	Length	Info
6	0.245771	…	443	TLSv1.2	…	147	Server Hello
17	1.506351	…	443	TLSv1.2	…	147	Server Hello
28	1.758667	…	443	TLSv1.2	…	147	Server Hello
41	2.015779	…	443	TLSv1.2	…	147	Server Hello
52	2.278894	…	443	TLSv1.2	…	147	Server Hello
65	2.537956	…	443	TLSv1.1	…	147	Server Hello
78	2.797243	…	443	TLSv1.3	…	250	Hello Retry Request
90	3.050883	…	443	TLSv1.3	…	218	Hello Retry Request
114	3.553612	…	443	TLSv1.3	…	218	Hello Retry Request

Wireshark capture of 10 TLS Server Hello's

These Server Hello's are the packets we want to replay. This can easily be done by setting up a TCP server listening for the specific Client Hello's, then replaying their corresponding Server Hello's captured from the alleged Cobalt Strike server. A rather lazy, but effective approach.

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I scanned the server on three separate occasions and found the duplicate bytes for every request. I used these bytes to identify each specific Client Hello.

Luckily Wireshark has an option to display packets as C Arrays. This made it pretty easy to get the Server Hello's working in my Golang spoofing application.

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By replaying these responses, slowly but steadily the fingerprint can be rebuilt.

```
if bytes.Contains(request, [] byte {
     0x00, 0x8c, 0x1a, 0x1a, 0x00, 0x16, 0x00, 0x33, 0x00,
     0x67, 0xc0, 0x9e, 0xc0, 0xa2, 0x00, 0x9e, 0x00, 0x39,
     0x00, 0x6b, 0xc0, 0x9f, 0xc0, 0xa3, 0x00, 0x9f, 0x00,
     0x45, 0x00, 0xbe, 0x00, 0x88, 0x00, 0xc4, 0x00, 0x9a,
     ... ...
 }) {
     fmt.Println("replaying: tls12Forward")
     conn.Write([] byte {
         0x16, 0x03, 0x03, 0x00, 0x5a, 0x02, 0x00, 0x00,
         0x56, 0x03, 0x03, 0x17, 0xa6, 0xa3, 0x84, 0x80,
         0x0b, 0xda, 0xbb, 0x3d, 0xe9, 0x3e, 0x92, 0x65,
         0x9a, 0x68, 0x7d, 0x70, 0xda, 0x00, 0xe9, 0x7c,
         ... ...
     })
 }
```

A full signature can be faked after implementing a reply for all ten different requests.

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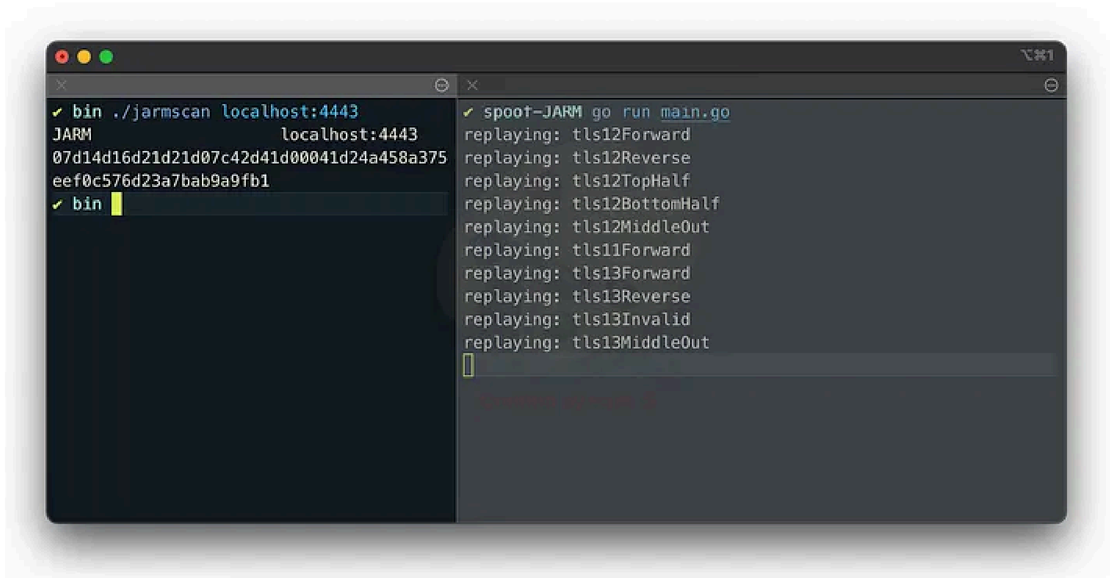

(Mis)usage of spoofed signatures

You’re probably thinking: So what? What is the use of spoofed TLS fingerprints? They could be used by malicious actors to hide their applications when tools like JARM scanners are deployed to identify services in a network or on the internet. It can also be used for good. A honeypot replaying the fingerprint of a specific service can be used to setup a digital smokescreen for attackers.

Notes

- jarmscan (jarm-go) is not a product of Salesforce. They’ve published JARM a Python based JARM scanner implementation. Jarmscan (the scanner used here) is a Golang based implementation by @RumbleDiscovery

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Source: https://grimminck.medium.com/spoofing-jarm-signatures-i-am-the-cobalt-strike-server-now-a27bd549fc6b