DOH in Godlua Backdoor

Godlua Botnet

On April 24, 2019, our Threat Detection System highlighted a suspicious ELF which is a Lua-based Backdoor, we named it Godlua Backdoor as the Lua byte-code file loaded by this sample has a magic number of “God”.

Common defense practice to deal with botnets

Kill the C2s – Bots become headless

Godlua Backdoor is one of the most sophisticated botnet we have seen to play the mouse cat game

Hardcoded c2 name,

Getting c2 from Pastebin.com,

Getting c2 from GitHub.com

DNS TXT

DNS over HTTPS

Reference:

[1] https://blog.netlab.360.com/an-analysis-of-godlua-backdoor-en/

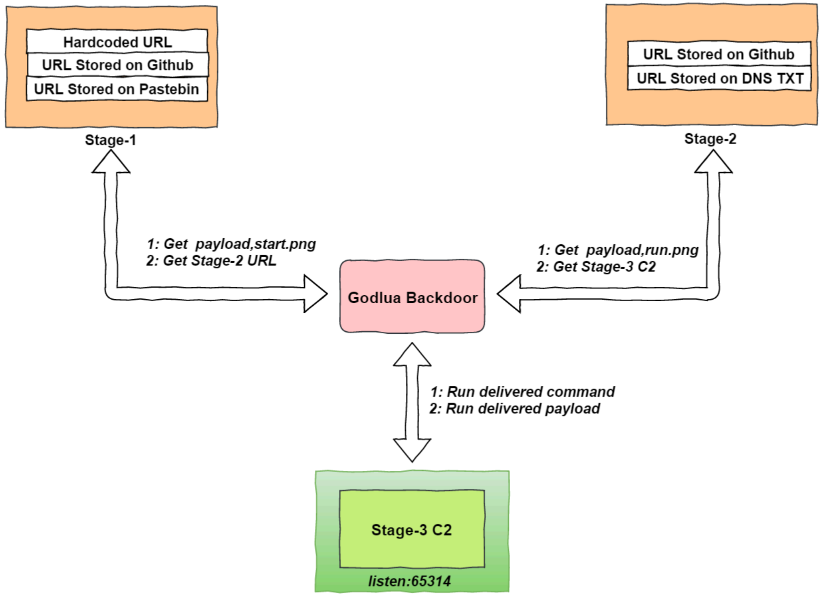
Godlua C2 redundant mechanism

In order to get the real C2 address, Godlua goes through 3 stages

Stage1: retrieve a “start.png” from either a hardcoded ciphertext, Github project description, or Pastebin text. Decrypt the “start.png” and execute it to get a stage-2 URL

Stage2: retrieve a “run.png” from either a Github project file or DoH. Decrypt the “run.png” and execute it to get a C2 domain

Stage3: request Cloudflare DoH API to get the corresponding C2 address



Godlua Stage-1

The backdoor uses 3 different methods to store the Stage-1 URL: hardcoded ciphertext, Github project description, and Pastebin text.

For example - request https://pastebin.com/raw/vSDzq3Md, and get the following content /tbLY0TsMUnC+iO9aYm9yS2eayKlKLQyFPOaNxSCnZpBw4RLGnJOPcZXHaf/aoj

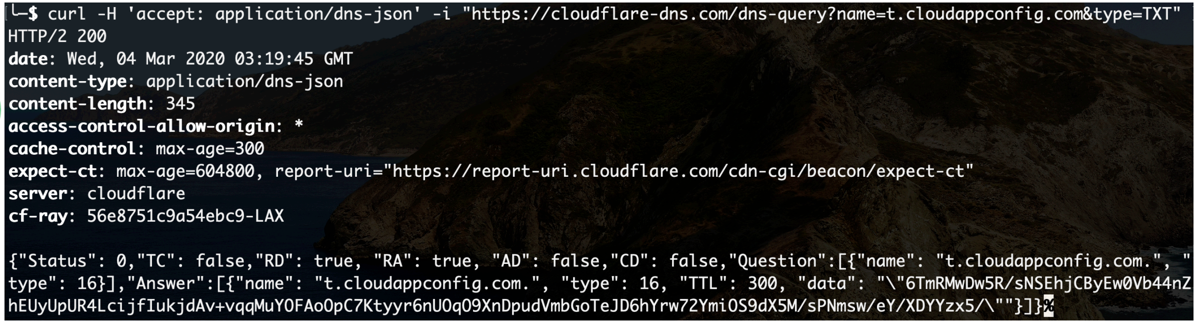
After decryption a Stage-1 URL shows up:
https://img2.cloudappconfig.com/%s.png

Adding a “start” string, the url changes to https://img2.cloudappconfig.com/start.png (actually a lua code), Godlua downloads and decrypts it, within it , a new domain t.cloudappconfig.com comes up, Godlua runs this lua code to go into Stage-2

DOH in Godlua Stage-2

Here at stage-2, Godlua retrieves a run.png from either a Github project file or through DoH, then decrypts the run.png and executes it to get a C2 domain

For example - with the previous domain t.cloudappconfig.com in hand, a DNS TXT DoH request sent to cloudflare DoH api *(name=t.cloudappconfig.com&type=TXT)* and the answer img1.cloudappconfig.com comes up



```
└─$ curl -H 'accept: application/dns-json' -i "https://cloudflare-dns.com/dns-query?name=t.cloudappconfig.com&type=TXT"
HTTP/2 200
date: Wed, 04 Mar 2020 03:19:45 GMT
content-type: application/dns-json
content-length: 345
access-control-allow-origin: *
cache-control: max-age=300
expect-ct: max-age=604800, report-uri="https://report-uri.cloudflare.com/cdn-cgi/beacon/expect-ct"
server: cloudflare
cf-ray: 56e8751c9a54ebc9-LAX

{"Status": 0,"TC": false,"RD": true, "RA": true, "AD": false,"CD": false,"Question":[{"name": "t.cloudappconfig.com.", "
type": 16}],"Answer":[{"name": "t.cloudappconfig.com.", "type": 16, "TTL": 300, "data": "\"6TmRMwDw5R/sNSEhjCByEw0Vb44nZ
hEUyUpUR4LcijfIukjdAv+vqqMuYOFAoOpC7Ktyyr6nUOqO9XnDpudVmbGoTeJD6hYrw72YmiOS9dX5M/sPNmsw/eY/XDYYzx5/\""}]}%
```

TXT record (Base64 + AES)
6TmRMwDw5R/sNSEhjCByEw0Vb44nZhEUyUpUR4LcijfIukjdAv+vqqMuYOFAoOpC7Ktyyr6nUOqO9XnDpudVmbGoTeJD6hYrw72Y
miOS9dX5M/sPNmsw/eY/XDYYzx5/

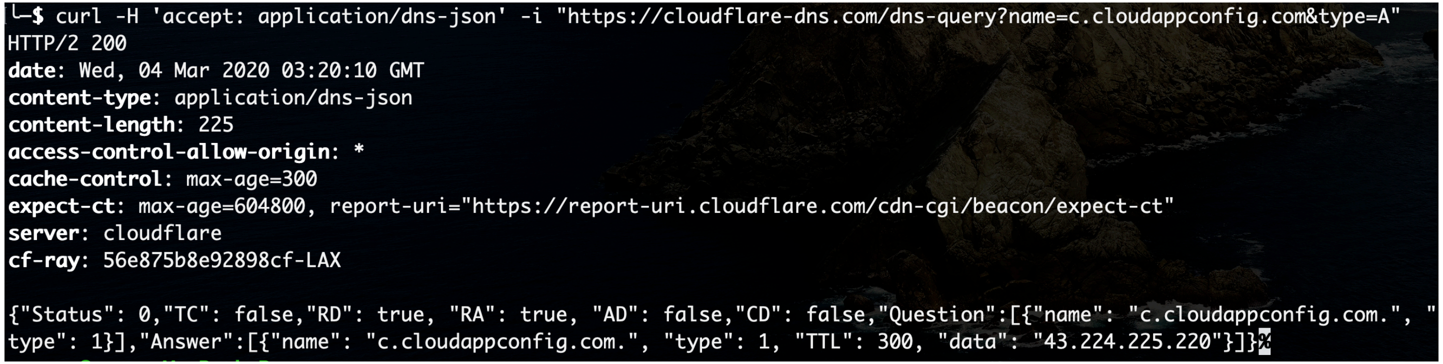
After decrypting the TXT record
{"u":"http:\/\/img1.cloudappconfig.com\/%s.png","c":"img1.cloudappconfig.com::43.224.225.220:"}

Adding a “run” string, the url changes to https://img1.cloudappconfig.com/run.png (actually a lua code)， Godlua downloads, decrypts and runs this lua code to go into Stage-3. As a result, the C2 domain c.cloudappconfig.com shows up.

DOH in Godlua Stage-3

Godlua requests the Cloudflare DOH API to get the DNS A record for the c2 domain c.cloudappconfig.com.

For example - Godlua DOH request *(name=c.cloudappconfig.com&type=A)*



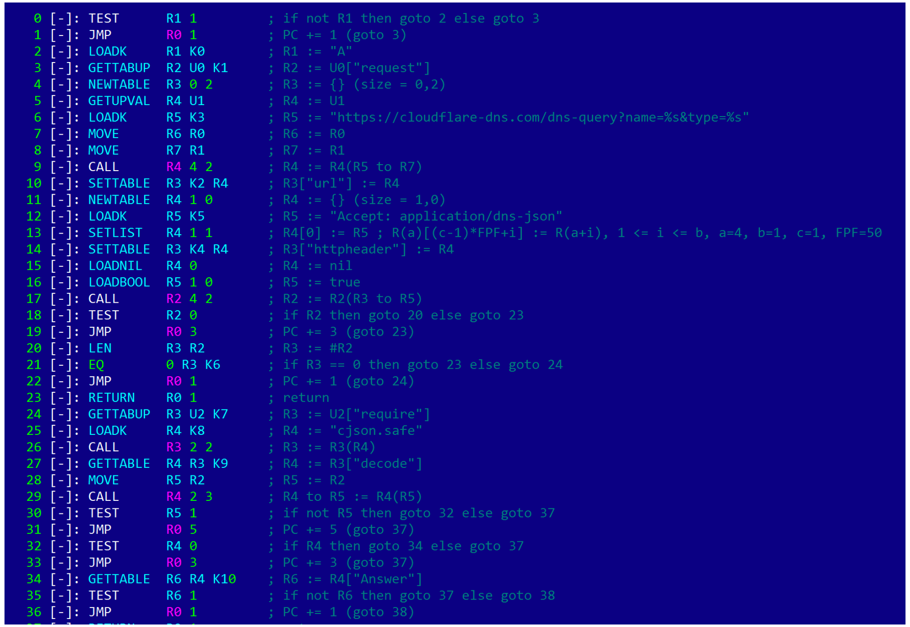
```
└─$ curl -H 'accept: application/dns-json' -i "https://cloudflare-dns.com/dns-query?name=c.cloudappconfig.com&type=A"
HTTP/2 200
date: Wed, 04 Mar 2020 03:20:10 GMT
content-type: application/dns-json
content-length: 225
access-control-allow-origin: *
cache-control: max-age=300
expect-ct: max-age=604800, report-uri="https://report-uri.cloudflare.com/cdn-cgi/beacon/expect-ct"
server: cloudflare
cf-ray: 56e875b8e92898cf-LAX

{"Status": 0,"TC": false,"RD": true, "RA": true, "AD": false,"CD": false,"Question":[{"name": "c.cloudappconfig.com.", "
type": 1}],"Answer":[{"name": "c.cloudappconfig.com.", "type": 1, "TTL": 300, "data": "43.224.225.220"}]}%
```

The result indicates c.cloudappconfig.com has a A record 43.224.225.220， with this final A record, Bots of the Godlua now can check in with the C2 and start communication.

Godlua's DoH request

The "get_dns_record" function used to request the Cloudflare DOH API.



```
 0 [-]: TEST      R1 1         ; if not R1 then goto 2 else goto 3
 1 [-]: JMP       R0 1         ; PC += 1 (goto 3)
 2 [-]: LOADK     R1 K0        ; R1 := "A"
 3 [-]: GETTABUP  R2 U0 K1     ; R2 := U0["request"]
 4 [-]: NEWTABLE  R3 0 2       ; R3 := {} (size = 0,2)
 5 [-]: GETUPVAL  R4 U1        ; R4 := U1
 6 [-]: LOADK     R5 K3        ; R5 := "https://cloudflare-dns.com/dns-query?name=%s&type=%s"
 7 [-]: MOVE      R6 R0        ; R6 := R0
 8 [-]: MOVE      R7 R1        ; R7 := R1
 9 [-]: CALL      R4 4 2       ; R4 := R4(R5 to R7)
10 [-]: SETTABLE  R3 K2 R4     ; R3["url"] := R4
11 [-]: NEWTABLE  R4 1 0       ; R4 := {} (size = 1,0)
12 [-]: LOADK     R5 K5        ; R5 := "Accept: application/dns-json"
13 [-]: SETLIST   R4 1 1       ; R4[0] := R5 ; R(a)[(c-1)*FPF+i] := R(a+i), 1 <= i <= b, a=4, b=1, c=1, FPF=50
14 [-]: SETTABLE  R3 K4 R4     ; R3["httpheader"] := R4
15 [-]: LOADNIL   R4 0         ; R4 := nil
16 [-]: LOADBOOL  R5 1 0       ; R5 := true
17 [-]: CALL      R2 4 2       ; R2 := R2(R3 to R5)
18 [-]: TEST      R2 0         ; if R2 then goto 20 else goto 23
19 [-]: JMP       R0 3         ; PC += 3 (goto 23)
20 [-]: LEN       R3 R2        ; R3 := #R2
21 [-]: EQ        0 R3 K6      ; if R3 == 0 then goto 23 else goto 24
22 [-]: JMP       R0 1         ; PC += 1 (goto 24)
23 [-]: RETURN    R0 1         ; return
24 [-]: GETTABUP  R3 U2 K7     ; R3 := U2["require"]
25 [-]: LOADK     R4 K8        ; R4 := "cjson.safe"
26 [-]: CALL      R3 2 2       ; R3 := R3(R4)
27 [-]: GETTABLE  R4 R3 K9     ; R4 := R3["decode"]
28 [-]: MOVE      R5 R2        ; R5 := R2
29 [-]: CALL      R4 2 3       ; R4 to R5 := R4(R5)
30 [-]: TEST      R5 1         ; if not R5 then goto 32 else goto 37
31 [-]: JMP       R0 5         ; PC += 5 (goto 37)
32 [-]: TEST      R4 0         ; if R4 then goto 34 else goto 37
33 [-]: JMP       R0 3         ; PC += 3 (goto 37)
34 [-]: GETTABLE  R6 R4 K10    ; R6 := R4["Answer"]
35 [-]: TEST      R6 1         ; if not R6 then goto 37 else goto 38
36 [-]: JMP       R0 1         ; PC += 1 (goto 38)
```

Reference:
[1] https://developers.cloudflare.com/1.1.1.1/dns-over-https/json-format/

Take aways

1. Godlua uses DoH to evade c2 detections. “Local” network no more has visibility into the C2 domains being request.

2. Godlua is the first botnet we have observed to utilize DoH. It is safe to assume Godlua will not be the last one given the fact the DoH is picking up.

3. DNS monitorning|blocking as a cost effective, easy-scaled security protecting mechanism has been used widely in security industry for a long time.
   - Various dns security providers and products available.
   - Our team is behind one of the biggest DNS service provider in China, and we block ~20k active malicious domains every day.

4. DoH will essentially renders the above defending mechanism useless.

Q&A