Domači GPON ONT modem

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COMTREND

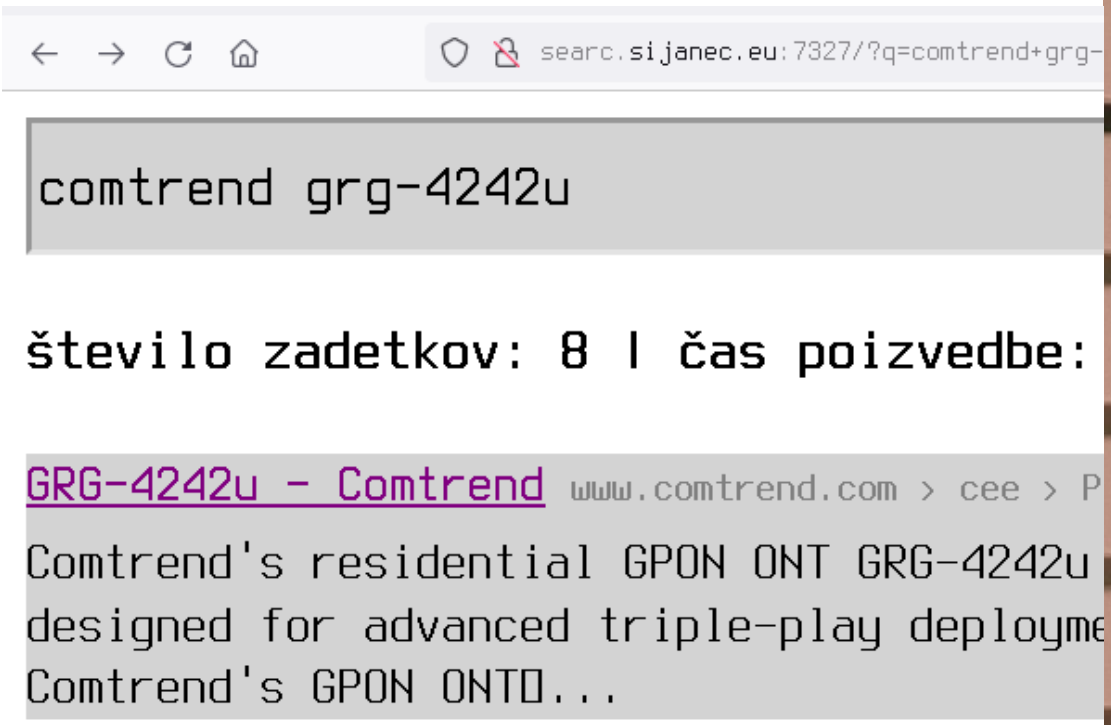

PON
FXS
FE
GE
RESET
USB
POWER
ON/OFF

Namen

- modem, ki *prevaja* internetni promet med mediji
- omogoča operaterju, da ima več nadzora nad omrežjem
- olajša uporabniku povezavo, ker je *ethernet* razširjen in poznan, GPON pa ne
- poceni strojna oprema

Model

- Comtrend GRG-4242u
- Cena: *Contact us*



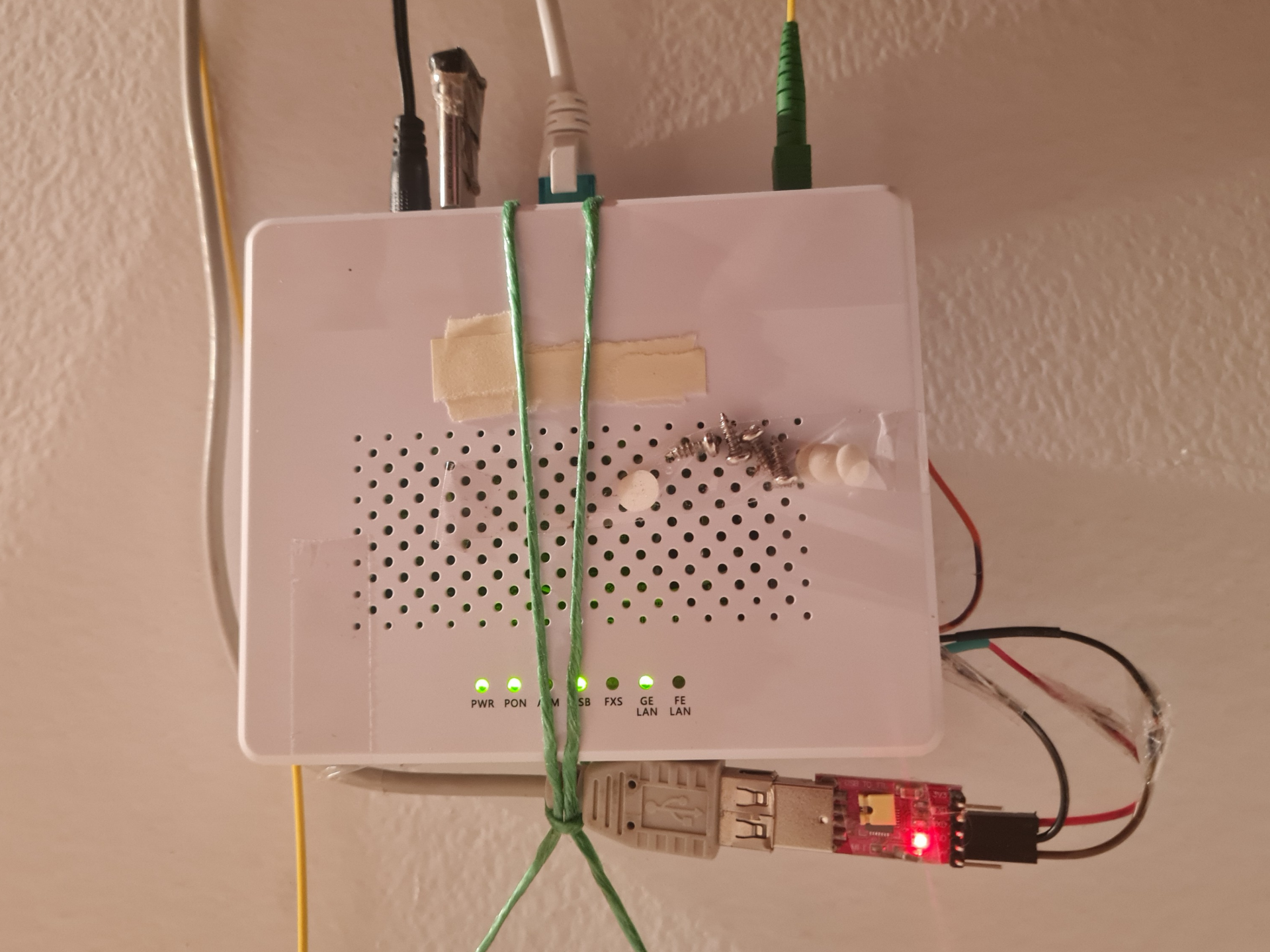
Specifikacije za operaterje

- Trojček preko optike: IGMP TV, analogni telefon, inet
- TR-069 idr., HTTP, SNMP, IPv6
- NTP, DDNS, DHCP, NAT, UPnP starševski nadzor (user:user)
- 1 Gb DDR3, 1 Gb flash
- GE + FE RJ45, USB 2.0, RJ11 s pripadajočim modemom
- odtočno 1,2 Gb/s @ 1310 nm SC/APC
  pritočno 2,4 Gb/s @ 1490 nm 20 km

Specifikacije za hekerje

- BMIPS4350, 100 MiB RAM, 318 MiB flasha
- FOSS: Linux 3.4.11-rt19 (2012), BusyBox v1.17.2, radvd 1.8 (CVE-2011-3601 CVSS 7.5), ...
- UART

slika je simbolična.


PWR
PON
SB
FXS
GE LAN
FE LAN

```
NAN5


Base: 4.16_04
CFE version 1.0.38-116.228-20 for BCM96848 (32bit,SP,BE)
Build Date: Wed May 16 14:42:10 CST 2018 (antony@localhost.localdomain)
Copyright (C) 2000-2013 Broadcom Corporation.

Boot Strap Register:  0xffcbc2
Chip ID: BCM5BEA1, MIPS: 600MHz, DDR: 533MHz, Bus: 300MHz
RDP: 428MHz
Main Thread: TP0
Total Memory: 134217728 bytes (128MB)
Boot Address: 0xb8000000

NAND ECC BCH-4, page size 0x800 bytes, spare size used 64 bytes
NAND flash device: MXIC MX30LF1G08AA, id 0xc2f1 block 128KB size 131072KB
MDIO Error: MDIO got failure status on phy 1
Board IP address                  : 192.168.1.1:ffffff00
Host IP address                   : 192.168.1.100
Gateway IP address                :
Run from flash/host/tftp (f/h/c)  : f
Default host run file name        : vmlinux
Default host flash file name      : bcm963xx_fs_kernel
Boot delay (0-9 seconds)          : 1
Boot image (0=latest, 1=previous) : 0
Default host ramdisk file name    :
Default ramdisk store address     :
Board Id (0-8)                    : 684880-1862
Number of MAC Addresses (1-32)    : 32
Base MAC Address                  : 1c:64:99:[redacted]
PSI Size (1-128) KBytes           : 64
Enable Backup PSI [0|1]           : 1
System Log Size (0-256) KBytes    : 0
Auxillary File System Size Percent: 0
Serial Number                     : [redacted]
WLAN Password                     : □□□□□□□□□□□□□□□□□□□□
PCB ID                            : 0
ACS Password                      : □□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□□
Main Thread Number [0|1]          : 0
GPON Serial Number                : "CMTJ[redacted]
GPON Password                     : "0x2020202020202020202020"
MC memory allocation (MB)         : 4
TM memory allocation (MB)         : 20
DHD 0 memory allocation (MB)      : 0
DHD 1 memory allocation (MB)      : 0
DHD 2 memory allocation (MB)      : 0
WLan Feature                      : 0x00
Voice Board Configuration (0-3)   : SI32181_LCCB
Partition 1 Size (MB)             : 0M
Partition 2 Size (MB)             : 0M
Partition 3 Size (MB)             : 0M
Partition 4 Size (MB) (Data)      : 4M

*** Press any key to stop auto run (1 seconds) ***
Auto run second count down: 0
Booting from latest image (address 0xbbd80000, flash offset 0x03d80000) ...
Decompression LZ4 Image OK!
Entry at 0x803fcd30
Starting program at 0x803fcd30
Linux version 3.4.11-rt19 (lucien@ccesw1) (gcc version 4.6.2 (Buildroot 2011.11) ) #1 SMP PREEMPT Mon Aug 31 17:54:32 CST 2020
reading nvram into inMemNvramData
ulPsiSize 0x40
backupPsi 0x1
```

```
..
#
# gponctl getSnPwd | grep -v Serial\ Number:

======== Serial Number & Password ========

   Password     : 20-20-20-20-20-20-20-20-20-20

==========================================

# gponctl getEncryptionKey

======= Encryption Key =======

   Encryption key: 00000000000000000000000000000000

==============================
```

c4n 1 h45 r00?

- Login: root
  Password for root: >:-/

```
DYING GASP IRQ Initialized and Enabled
Serial: BCM63XX driver $Revision: 3.00 $
Magic SysRq with Auxilliary trigger char enabled (type ^ h for list of supported commands)
ttyS0 at MMIO 0xb0800640 (irq = 104) is a BCM63XX
ttyS1 at MMIO 0xb0800660 (irq = 105) is a BCM63XX
SysRq : HELP : loglevel(0-9) BRCM: show summary status on all CPUs(A) reBoot Cr
ash terminate-all-tasks(E) memory-full-oom-kill(F) kill-all-tasks(I) thaw-files
ystems(J) show-backtrace-all-active-cpus(L) show-memory-usage(M) nice-all-RT-ta
sks(N) powerOff show-registers(P) show-all-timers(Q) Sync show-task-states(T) U
nmount show-blocked-tasks(W) BRCM: show interrupt counts on all CPUs(Y)
All commands are case insensitive.

consoled:error:587.686:oalMsg_initWithFlags:115:connect to /var/smd_messaging_server_addr failed, rc=-1 errno=2
consoled:error:587.686:main:228:could not connect to CMS smd (ret=9002) == drop to shell for debug


BusyBox v1.17.2 (2020-08-31 18:10:51 CST) built-in shell (ash)
Enter 'help' for a list of built-in commands.

# cat /etc/passwd
admin:$1$DmTYjrz7$/7yJd4aenG/.iCyB5okvC0:0:0:Administrator:/:/bin/sh
poweruser:$1$mcMxUW7b$oCiocm5Cqr6DyT/t9hCy01:0:0:Technical Support:/:/bin/sh
user:$1$mG9dQV0M$eu3HAnbwlJ6nD8WmyEiIs1:0:0:Normal User:/:/bin/sh
nobody:$1$jRUYRgpH$tXtFtD/pxxN7PQZYReXmu0:0:0:nobody for ftp:/:/bin/sh
#
```

Pes čuvaj in obratni inženiring

- `/bin/ct_monitor &` + cutter

```
0x004005a5 libcms_msg.so
0x004005b3 libcms_util.so
0x004005c2 libbcm_crc.so
0x004005d0 libbcm_flashutil.so
0x004005e4 libcms_boardctl.so
0x004005f7 libcrypt.so.0
0x00400605 libdl.so.0
0x00400610 libcms_core.so
0x0040061f libcms_qdm.so
0x0040062d libnanoxml.so
0x0040063b libgponctl.so
0x00400649 libgponif.so
0x00400656 libomci.so
0x00400661 libomcipm_drv.so
0x00400672 libm.so.0
0x0040067c libvlanctl.so
0x0040068a libpwrctl.so
0x00400697 libethswctl.so
0x004006a6 libeponctl.so
0x004006b4 librdpactl.so
0x004006c2 libtmctl.so
0x004006ce libc.so.0
0x004006d8 libgcc_s.so.1
```

```
void devCtl_setWatchDogTime(int32_t param_1)
{
    (*gp0xffff8010)();
    (*gp0xffff8010)();
    fcn.00400920(param_1);
    return;
}
```

File Edit View Windows Debug Help

Type flag name or address here

Functions

Name

- entry0
- fcn.00400920
- fcn.004009dc
- fcn.00400a70
- **main**
- sym._fini
- sym._init
- sym.imp.__uClibc_main
- sym.imp.devCtl_setWatchDogTime
- sym.imp.signal
  - Offset: 0x00400af0
  - Size: 0x20
  - Import: true
  - Nargs: 0x0
  - Nbbs: 0x1
  - Nlocals: 0x3
  - Call type: n32
  - Edges: 1
  - StackFrame: 32
  - Comment:
- sym.imp.sleep
- sym.stop_ct_watchdog

```
// WARNING: Unknown calling convention yet parameter storage is locked
// WARNING: [rz-ghidra] Matching calling convention n32 of function main fa

void main(int argc, char **argv)
{
    int32_t iVar1;
    int32_t in_t9;

    // signal(SIGKILL, signal)
    (**(code **)(in_t9 + 0x103f8))(9, *(undefined4 *)(in_t9 + 0x103ec));
    // signal(SIGHUP, signal)
    (**(code **)(in_t9 + 0x103f8))(1, *(undefined4 *)(in_t9 + 0x103ec));
    // signal(SIGTERM, signal)
    (**(code **)(in_t9 + 0x103f8))(0xf, *(undefined4 *)(in_t9 + 0x103ec));
    // signal(SIGQUIT, signal)
    (**(code **)(in_t9 + 0x103f8))(3, *(undefined4 *)(in_t9 + 0x103ec));
    // signal(SIGPIPE, SIG_IGN)
    (**(code **)(in_t9 + 0x103f8))(0xd, 1);
    // signal(SIGINT, SIG_IGN)
    (**(code **)(in_t9 + 0x103f8))(2, 1);
    iVar1 = *(int32_t *)(in_t9 + 0x103e8);
    while (*(int32_t *)(iVar1 + 0xb90) != 0) {
    // devCtl_setWatchDogTime()
        (**(code **)(in_t9 + 0x103fc))(0x3c);
    // sleep(5)
        (**(code **)(in_t9 + 0x10408))(5);
    }
    return;
}
```

```
b:/tmp/gcc83/build/stbgcc-8.3-0.4[0]# grep "#define\sSIG" mips-unknown-linux-gnu/sys-root/usr/include/bits/signum-generic.h
#define SIG_ERR  ((__sighandler_t) -1)  /* Error return.  */
#define SIG_DFL  ((__sighandler_t)  0)  /* Default action.  */
#define SIG_IGN  ((__sighandler_t)  1)  /* Ignore signal.  */
#define SIGINT          2       /* Interactive attention signal.  */
#define SIGILL          4       /* Illegal instruction.  */
#define SIGABRT         6       /* Abnormal termination.  */
#define SIGFPE          8       /* Erroneous arithmetic operation.  */
#define SIGSEGV         11      /* Invalid access to storage.  */
#define SIGTERM         15      /* Termination request.  */
#define SIGHUP          1       /* Hangup.  */
#define SIGQUIT         3       /* Quit.  */
#define SIGTRAP         5       /* Trace/breakpoint trap.  */
#define SIGKILL         9       /* Killed.  */
#define SIGBUS          10      /* Bus error.  */
#define SIGSYS          12      /* Bad system call.  */
#define SIGPIPE         13      /* Broken pipe.  */
#define SIGALRM         14      /* Alarm clock.  */
#define SIGURG          16      /* Urgent data is available at a socket.  */
#define SIGSTOP         17      /* Stop, unblockable.  */
#define SIGTSTP         18      /* Keyboard stop.  */
#define SIGCONT         19      /* Continue.  */
#define SIGCHLD         20      /* Child terminated or stopped.  */
#define SIGTTIN         21      /* Background read from control terminal.  */
#define SIGTTOU         22      /* Background write to control terminal.  */
#define SIGPOLL         23      /* Pollable event occurred (System V).  */
#define SIGXCPU         24      /* CPU time limit exceeded.  */
#define SIGXFSZ         25      /* File size limit exceeded.  */
#define SIGVTALRM       26      /* Virtual timer expired.  */
#define SIGPROF         27      /* Profiling timer expired.  */
#define SIGUSR1         30      /* User-defined signal 1.  */
#define SIGUSR2         31      /* User-defined signal 2.  */
#define SIGWINCH        28      /* Window size change (4.3 BSD, Sun).  */
#define SIGIO           SIGPOLL /* I/O now possible (4.2 BSD).  */
#define SIGIOT          SIGABRT /* IOT instruction, abort() on a PDP-11.  */
#define SIGCLD          SIGCHLD /* Old System V name */
b:/tmp/gcc83/build/stbgcc-8.3-0.4[0]# grep "#define\sSIG" mips-unknown-linux-gnu/sys-root/usr/include/bits/signum.h
#define SIGEMT           7      /* Emulator trap.  */
#define SIGPWR          19      /* Power failure imminent.  */
#define SIGUSR1         16
#define SIGUSR2         17
#define SIGCHLD         18
#define SIGWINCH        20
#define SIGURG          21
#define SIGPOLL         22
#define SIGSTOP         23
#define SIGTSTP         24
#define SIGCONT         25
#define SIGTTIN         26
#define SIGTTOU         27
#define SIGVTALRM       28
#define SIGPROF         29
#define SIGXCPU         30
#define SIGXFSZ         31
b:/tmp/gcc83/build/stbgcc-8.3-0.4[0]#
```

Broadcom / stbgcc-8.3 Public

Notifications Fork 1 Star 0

Code Issues Pull requests Security Insights

master 1 branch 3 tags Go to file Code

Ryceancurry Initial commit 8763726 on Jun 2, 2021 1 commit

README.md	Initial commit	last year

README.md

stbgcc-8.3

GCC 8.3 based releases (stbgcc)

About

GCC 8.3 based releases (stbgcc)

Readme

0 stars

3 watching

1 fork

Releases 3

stbgcc-8.3-0.4 Latest

on Sep 14, 2021

+ 2 releases

Packages

No packages published

stbgcc-8.3-0.4

Latest

alexchu-cpe released this Sep 14, 2021 stbgcc-8.3-0.4 8763726

Fix pthread_rwlock_timed*lock() compiler optimization bug

Build with docker centos-6.9 & gcc-6.3

```
b:/tmp[0]# cat helloworld.c
#include <stdio.h>
int main (void) {
        puts("Pozdravljen, clot!\n");
}
b:/tmp[0]# mips-linux-gcc -static helloworld.c
b:/tmp[0]#
```

```
#
# wget http://10.69.69.2/a.out
Connecting to 10.69.69.2 (10.69.69.2:80)
200 OK, File Get Success
# chmod +x a.out
# ./a.out
Pozdravljen, clot!

#
```

Assets 7

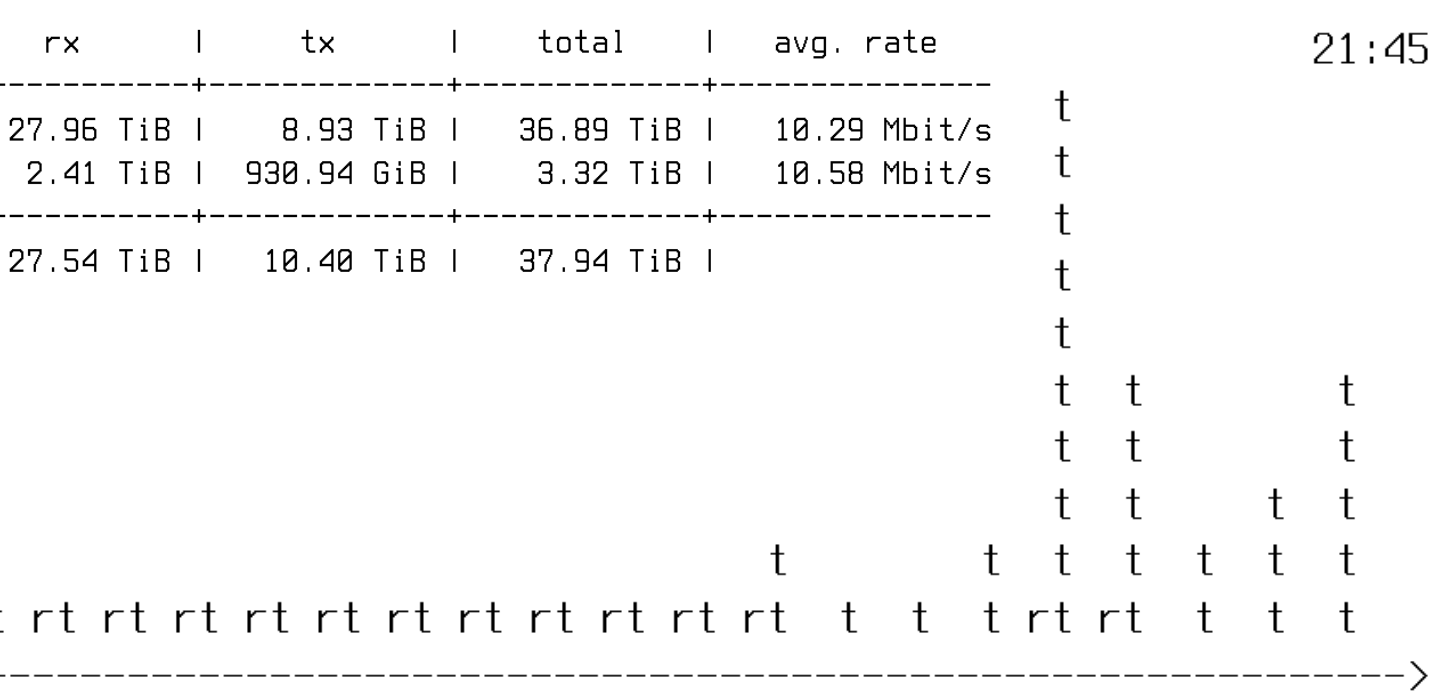
stbgcc-8.3-0.4.x86_64.deb	275 MB	Sep 13, 2021
stbgcc-8.3-0.4.x86_64.rpm	488 MB	Sep 14, 2021
stbgcc-8.3-0.4.x86_64.tar.bz2	433 MB	Sep 14, 2021
stbgcc-8.3-0.4.x86_64.tar.bz2.asc	488 Bytes	Sep 14, 2021
stbgcc-8.3-0.4_src.tar.gz	231 MB	Sep 14, 2021
Source code (zip)		Jun 2, 2021

Statistika uporabe omrežja

#	day	rx	tx	total	avg. rate
1	2023-01-10	286.56 GiB	147.57 GiB	434.13 GiB	43.16 Mbit/s
2	2022-03-22	138.54 GiB	285.15 GiB	423.69 GiB	42.12 Mbit/s
3	2023-01-07	149.34 GiB	185.11 GiB	334.44 GiB	33.25 Mbit/s
4	2022-07-28	140.84 GiB	129.43 GiB	270.27 GiB	26.87 Mbit/s
5	2022-03-23	187.65 GiB	79.54 GiB	267.19 GiB	26.56 Mbit/s

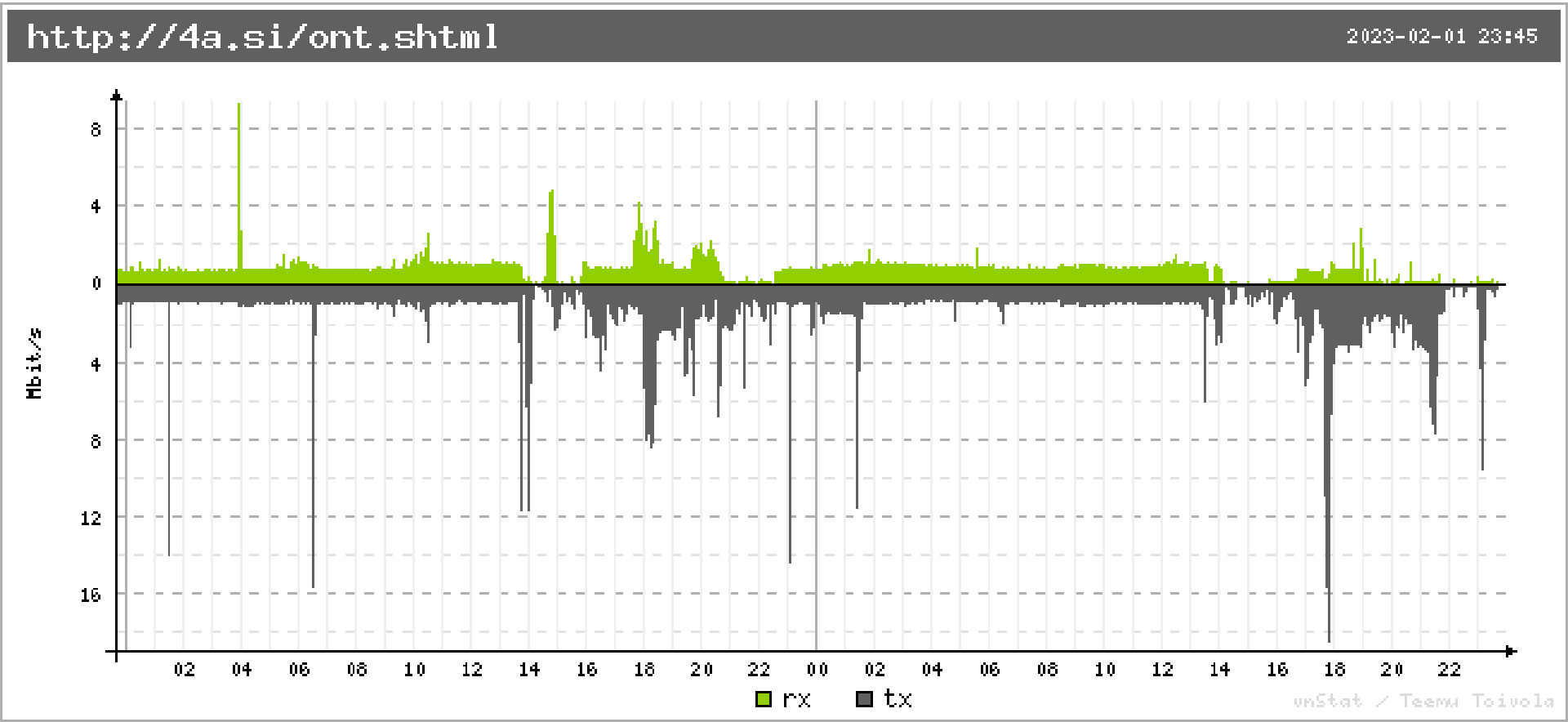
eth1

year	rx	tx	total	avg. rate
2022	27.96 TiB	8.93 TiB	36.89 TiB	10.29 Mbit/s
2023	2.41 TiB	930.94 GiB	3.32 TiB	10.58 Mbit/s
estimated	27.54 TiB	10.40 TiB	37.94 TiB	



vnStat(i)

- cross-compilation s toolchainom
- libsqlite3, zlib, libpng, libfreetype, libgd in vnstat



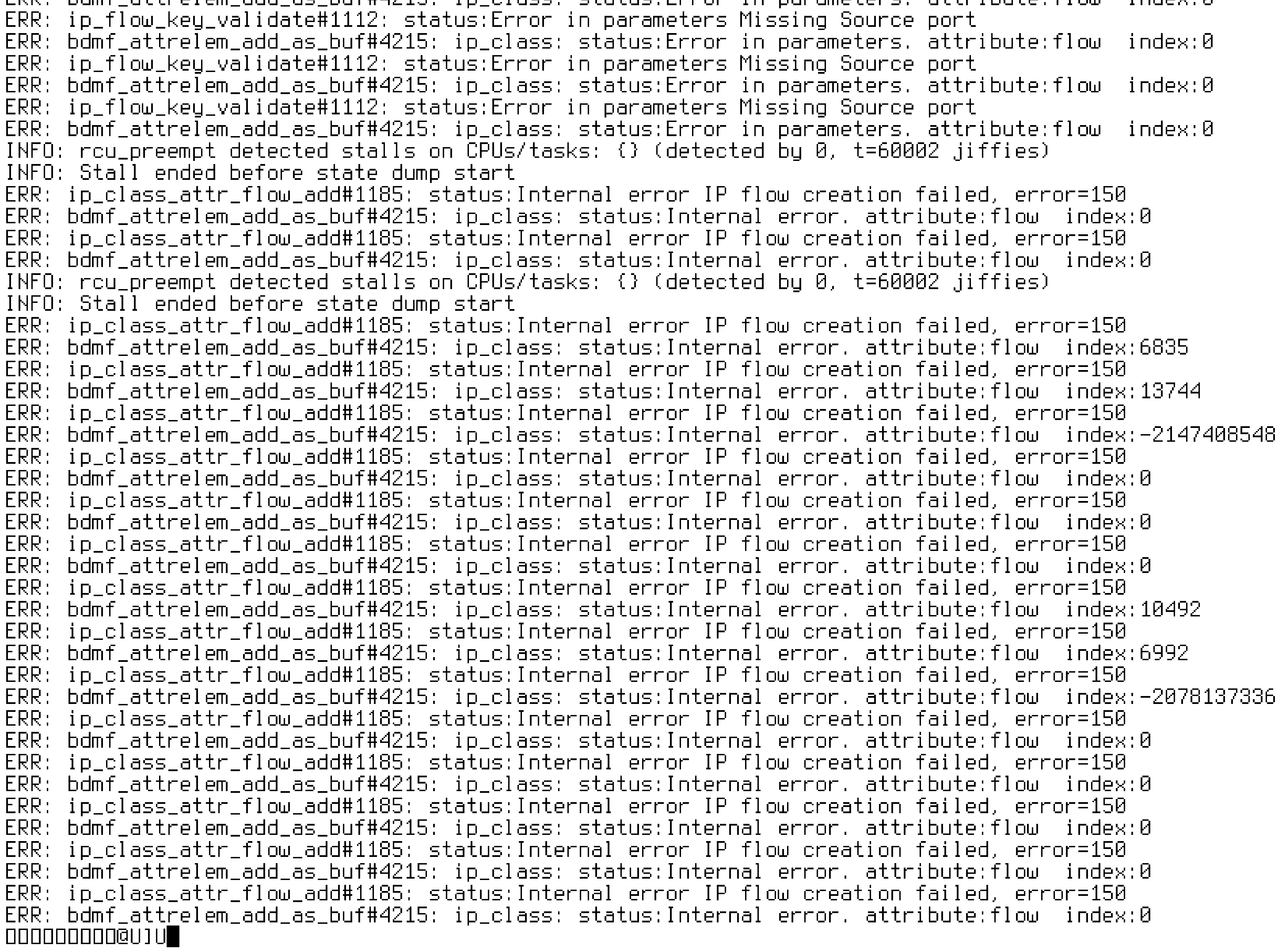
Še nekaj drugih prednosti

```
..
# tcpdump -vvvveni eth1.0 tcp port 1337
tcpdump: WARNING: eth1.0: no IPv4 address assigned
tcpdump: listening on eth1.0, link-type EN10MB (Ethernet), capture size 65535 bytes
23:56:29.415632 88:e6:4b:e3:c1:c6 > 00:1a:92:4b:00:40, ethertype IPv4 (0x0800), length 74: (tos 0x0, ttl 54, id 5140, o
ffset 0, flags [DF], proto TCP (6), length 60)
    83.212.126.242.36418 > 89.212.146.168.1337: Flags [S], cksum 0xfdaa (correct), seq 2843037134, win 64240, options [
mss 1436,sackOK,TS val 351137932 ecr 0,nop,wscale 7], length 0
23:56:29.415908 00:1a:92:4b:00:40 > 88:e6:4b:e3:c1:c6, ethertype IPv4 (0x0800), length 74: (tos 0x0, ttl 64, id 0, offs
et 0, flags [DF], proto TCP (6), length 60)
    89.212.146.168.1337 > 83.212.126.242.36418: Flags [S.], cksum 0x7edd (correct), seq 4293563424, ack 2843037135, win
 65160, options [mss 1460,sackOK,TS val 4153470828 ecr 351137932,nop,wscale 10], length 0
23:56:29.451483 88:e6:4b:e3:c1:c6 > 00:1a:92:4b:00:40, ethertype IPv4 (0x0800), length 66: (tos 0x0, ttl 54, id 5141, o
ffset 0, flags [DF], proto TCP (6), length 52)
    83.212.126.242.36418 > 89.212.146.168.1337: Flags [.], cksum 0xaa1b (correct), seq 1, ack 1, win 502, options [nop,
nop,TS val 351137968 ecr 4153470828], length 0
23:56:31.290789 88:e6:4b:e3:c1:c6 > 00:1a:92:4b:00:40, ethertype IPv4 (0x0800), length 69: (tos 0x0, ttl 54, id 5142, o
ffset 0, flags [DF], proto TCP (6), length 55)
    83.212.126.242.36418 > 89.212.146.168.1337: Flags [P.], cksum 0x2977 (correct), seq 1:4, ack 1, win 502, options [n
op,nop,TS val 351139807 ecr 4153470828], length 3
23:56:34.264886 00:1a:92:4b:00:40 > 88:e6:4b:e3:c1:c6, ethertype IPv4 (0x0800), length 66: (tos 0x0, ttl 64, id 35566,
offset 0, flags [DF], proto TCP (6), length 52)
    89.212.146.168.1337 > 83.212.126.242.36418: Flags [F.], cksum 0x91ad (correct), seq 1, ack 4, win 64, options [nop,
nop,TS val 4153475677 ecr 351139807], length 0
23:56:34.300698 88:e6:4b:e3:c1:c6 > 00:1a:92:4b:00:40, ethertype IPv4 (0x0800), length 66: (tos 0x0, ttl 54, id 5143, o
ffset 0, flags [DF], proto TCP (6), length 52)
    83.212.126.242.36418 > 89.212.146.168.1337: Flags [F.], cksum 0x8434 (correct), seq 4, ack 2, win 502, options [nop
,nop,TS val 351142817 ecr 4153475677], length 0
23:56:34.300933 00:1a:92:4b:00:40 > 88:e6:4b:e3:c1:c6, ethertype IPv4 (0x0800), length 66: (tos 0x0, ttl 64, id 35567,
offset 0, flags [DF], proto TCP (6), length 52)
    89.212.146.168.1337 > 83.212.126.242.36418: Flags [.], cksum 0x85c6 (correct), seq 2, ack 5, win 64, options [nop,n
op,TS val 4153475713 ecr 351142817], length 0
^C
7 packets captured
7 packets received by filter
0 packets dropped by kernel

# 
```

Še nekaj drugih prednosti

- Večja varnost in zasebnost, ker teče manj procesov
- Lažje diagnosticiramo težave z omrežjem
- Za zahtevnejšega uporabnika je uporaben direkten dostop do dnevniških zapisov:



```
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Error in parameters. attribute:flow  index:0
ERR: ip_flow_key_validate#1112: status:Error in parameters Missing Source port
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Error in parameters. attribute:flow  index:0
ERR: ip_flow_key_validate#1112: status:Error in parameters Missing Source port
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Error in parameters. attribute:flow  index:0
ERR: ip_flow_key_validate#1112: status:Error in parameters Missing Source port
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Error in parameters. attribute:flow  index:0
INFO: rcu_preempt detected stalls on CPUs/tasks: {} (detected by 0, t=60002 jiffies)
INFO: Stall ended before state dump start
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
INFO: rcu_preempt detected stalls on CPUs/tasks: {} (detected by 0, t=60002 jiffies)
INFO: Stall ended before state dump start
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:6835
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:13744
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:-2147408548
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:10492
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:6992
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:-2078137336
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
ERR: ip_class_attr_flow_add#1185: status:Internal error IP flow creation failed, error=150
ERR: bdmf_attrelem_add_as_buf#4215: ip_class: status:Internal error. attribute:flow  index:0
□□□□□□□□□@U]U█
```

Težave

- V primeru *hekanja* modema operater *ne bo vesel* porabljenega časa za podporo
- Neha delovati, ko operater hoče spremeniti nastavitve, pa TR-069/SNMP ne deluje (ponavadi je restart za nekaj sekund dovolj za ponovno vzpostavitev)
- Na modem lahko nekdo naloži zlonamerno programsko opremo in ga vrne operaterju

Beseda o SPF

- *Small form-factor pluggable*
- Na njem teče lastniška koda in OS (Linux)
- *Samo manjši ONT*
- Standardizirana komunikacija ki pa ni *ethernet*
- Ponavadi za uporabnika proti plačilu
- Za majhno funkcionalnost relativno dragi

Ideje za prihodnost

- Kloniranje modema (oz. S/N)
- Preizkušanje, kaj se zgodi, ko se na priključku pojavi nepričakovan S/N
- Implementacija TR-069 in SNMP strežnika, ki posluša zahteve operaterja
- Prošnja operaterju/proizvajalcu za izvorno kodo GPL orodij

Vprašanja?

Viri, literatura in dodatno

- https://hack-gpon.github.io/
- https://www.comtrend.com/cee/Product/236$prod.html
- https://www.comtrend.com/dbase/upload-img/download/DS_GRG-4242u_R1%203_031721.pdf
- http://splet.šijanec.eu./ont.shtml (moji zapisi)