

# A Generic EGSE

Workshop Simulation for European Space Programmes  
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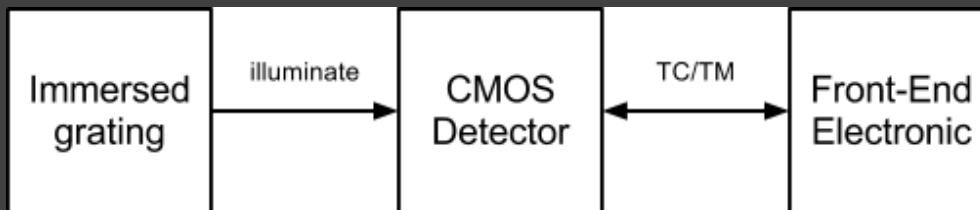
- Goal and solution
- Use case with TROPOMI
- Modular Distributed Architecture
- Hardware abstraction
- Protocol and physical interfaces
- EGSE Server

# Goal and solution

- Existing EGSEs: cumbersome to adapt to new test setup.
- Goal: new flexible EGSE to be used throughout development
  - From prototypes to Flight Model (FM).
  - Without continuous interference of SW engineers.
- Solution
  - Modular distributed architecture.
  - Hardware abstraction.
  - Standard protocol and light weight protocol conversion layer.
- Discussion of highlights of EGSE by means of TROPOMI use case.

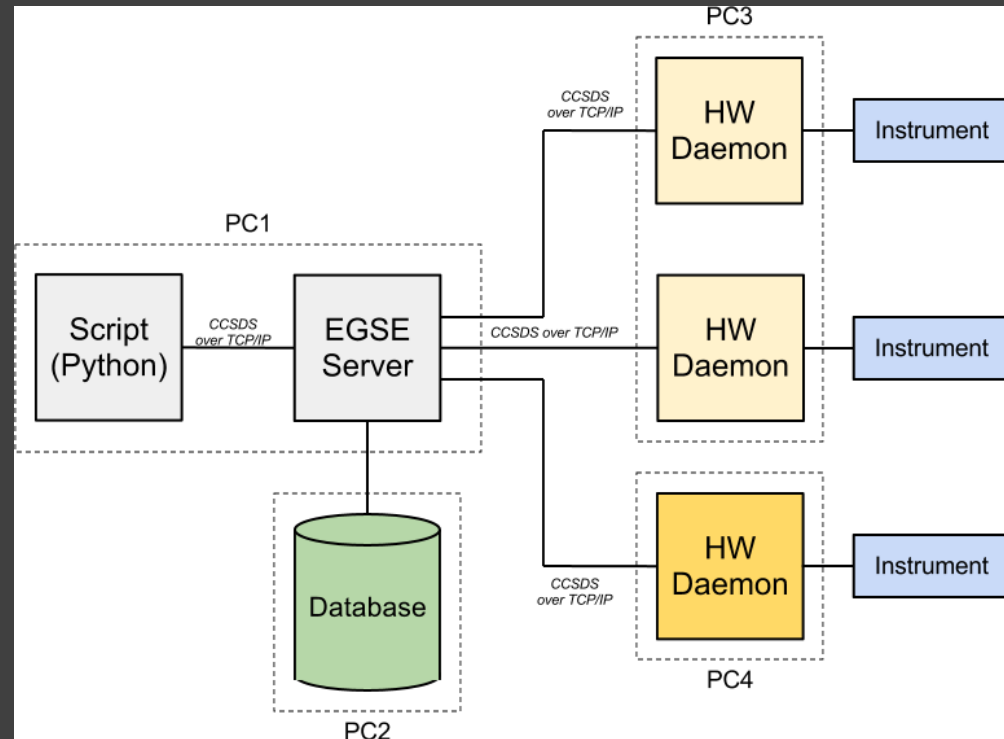
# TROPOMI

- TROPOMI: TROPOspheric Monitoring System
  - Ultraviolet, Visible, Near Infrared, Shortwave Infrared (Ozone, pollution).
  - SWIR (Short-Wave Infrared) spectrometer.
- SRON contribution
  - Immersed grating.
  - Front-End Electronic to communicate with the SWIR.



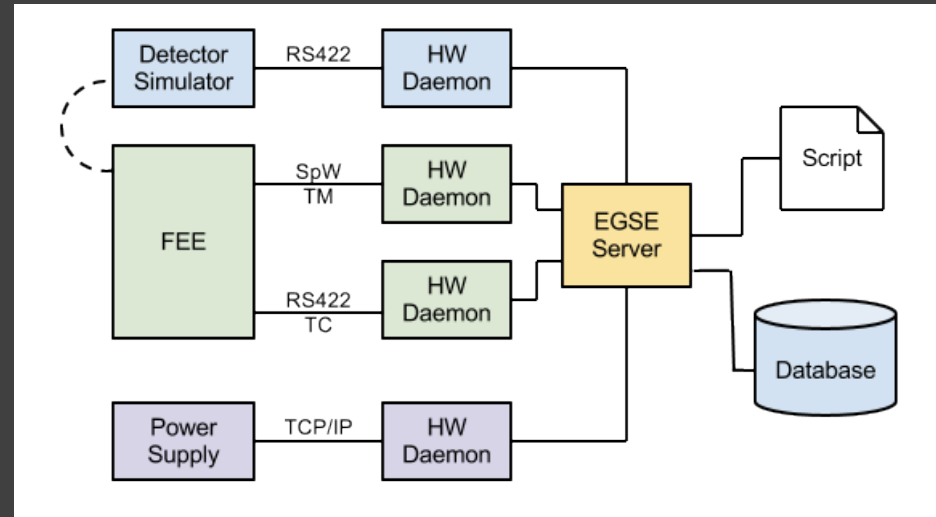
# Modular Distributed Architecture

- Distributed architecture:
  - EGSE Server
  - Database
  - Script
  - Hardware Daemons
- Modified CCSDS protocol over TCP/IP.
- Modularity.
- XML Configuration file.

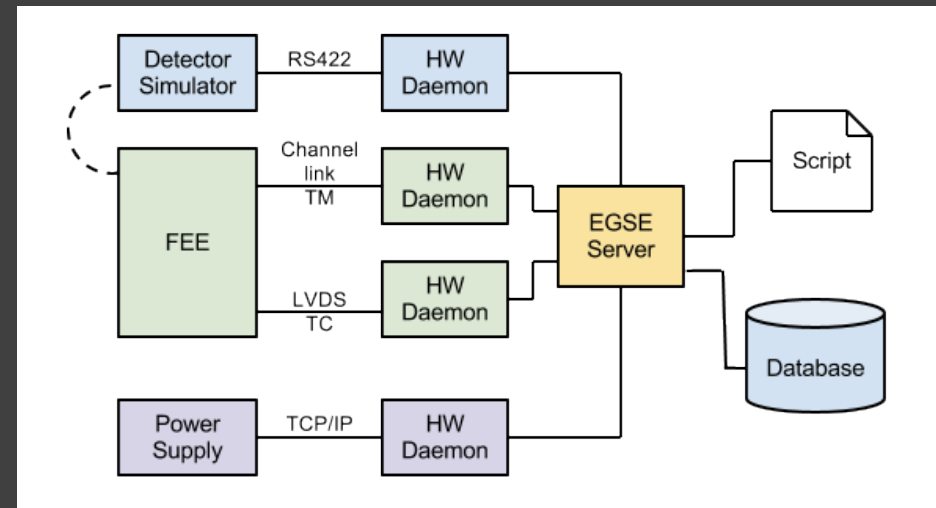


# Modular Distributed Architecture - TROPOMI

- Engineering Model
- FEE has two interfaces:
  - TM: SpaceWire
  - TC: RS422

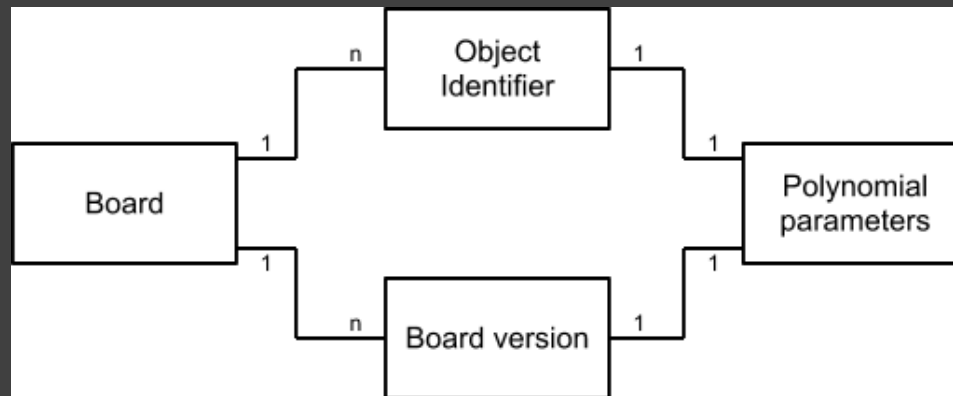


- Qualification/Flight Model
- FEE has two new interfaces:
  - TM: Channel link
  - TC: LVDS



# Hardware abstraction

- All hardware in SUT described in fairly simple database.
- The database contains:
  - boards: describe a hardware entity
  - object identifiers: describe a functionality in the HW
  - polynomial parameters: conversion RAW  $\Leftrightarrow$  ENG values
  - board versions: describes multiple version of a board



# Hardware abstraction - TROPOMI

The screenshot displays the 'Engineering database' interface with a 'Database record' dialog box open. The dialog is for a record named 'Dummy'. The fields are as follows:

- Name: Dummy
- Access: rw
- Address: 0x00000000
- Mask: 0xFFFFFFFF
- Content encoding: Unsigned integer
- Unit: (empty)
- Description (max 255 characters): (empty)

Below the description field, there are polynomial settings:

- Get polynome: 0 1 0 0
- Set polynome: 0 1 0 0

At the bottom, there are error and warning thresholds:

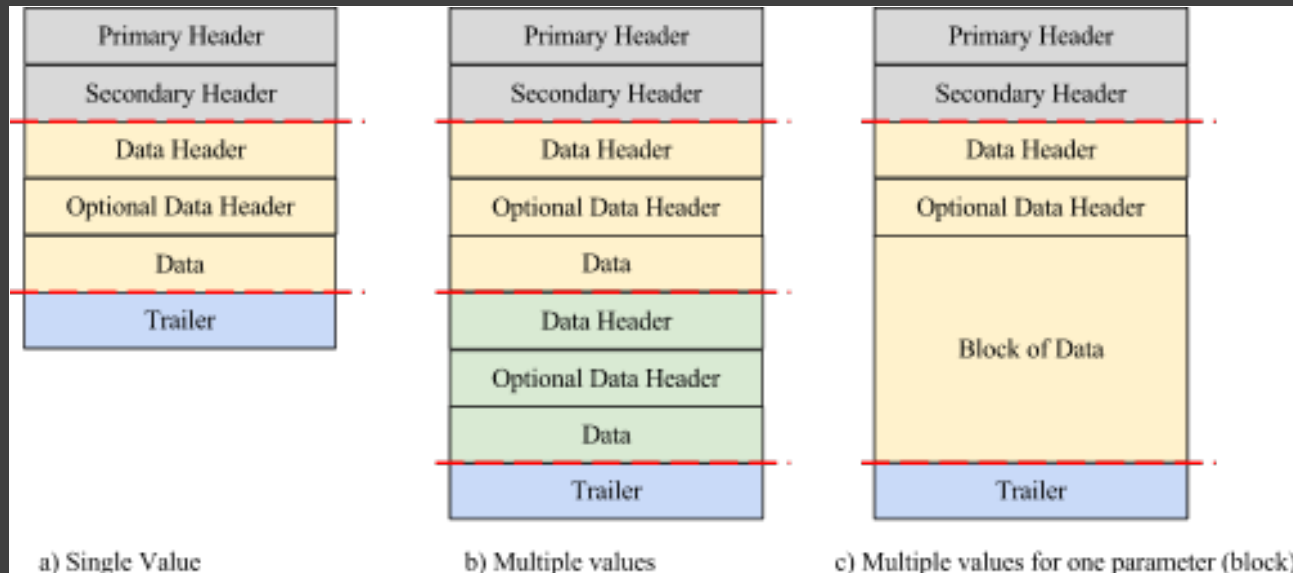
- Error upper: +∞
- Warning upper: +∞
- Warning lower: -∞
- Error lower: -∞

Buttons at the bottom of the dialog are 'Next', 'Done', and 'Cancel'. In the background, a tree view shows a hierarchy: keithley > avs47 > 1 > keithley2400 > 1. A table with columns 'id' and 'description' is also visible, containing entries like '1 add', '2 clea', '3 cur', '4 cur', '5 cur', '6 cur', '7 cur'.



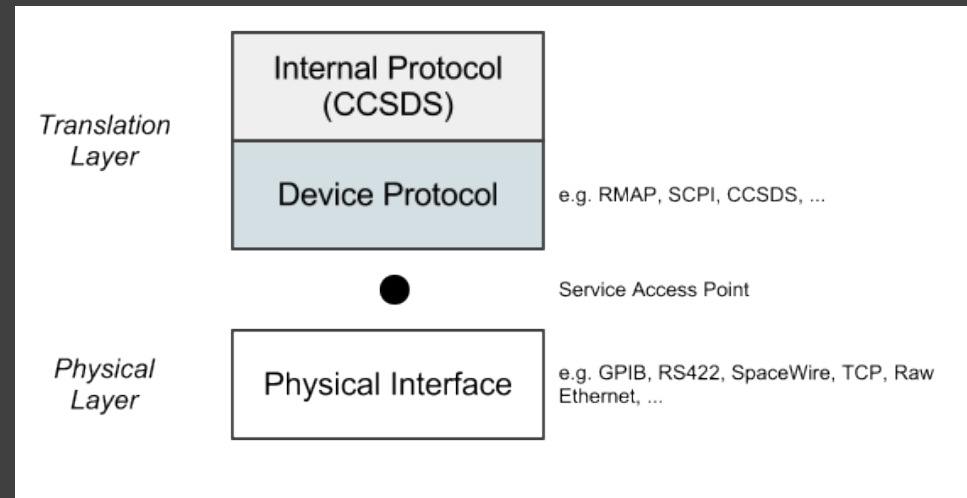
# Protocol and physical interfaces

- Internal protocol: CCSDS based
- A CCSDS packet contains:
  - An action (Set/Get)
  - A object identifier
  - One value or more

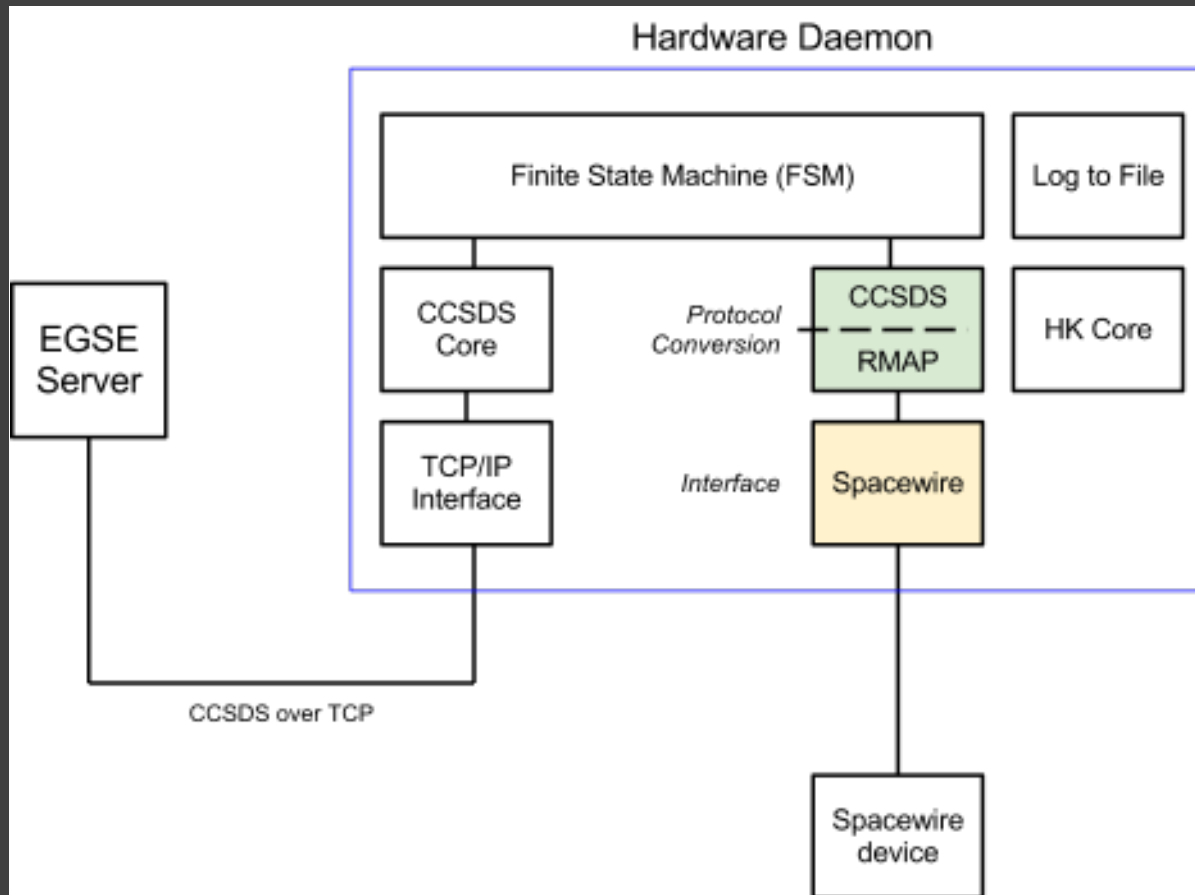


# Protocol and physical interfaces

- Most HW uses different protocol over different physical interface.
- Solution implemented in HW Daemons:
  - Translation layer which converts internal protocol into protocol of instrument/hardware.
  - Service Access Point connects device protocol to physical interface.
  - Physical layer with multiple physical interfaces.
- Protocol/Interface configured via XML.



# Protocol and physical interfaces



# EGSE server

- Serve as router to all HW daemons.
- Visualisation of HK, plots, database, scripts, ...
- Logging.
- No adaptation necessary for any project.
- Performance
  - Reached sustained 320 Mbit/s, including plotting, HK
  - Might be even better, not fully tested

# EGSE server - TROPOMI

The screenshot displays the EGSE server interface for TROPOMI, featuring a grid of monitoring plots and several data tables.

**Plots:**

- Video drift:** Shows video signal levels (vid1-vid4) over time (350-500s).
- Video noise:** Shows video signal levels with noise spikes over time (0-600s).
- DSIM temperature:** Shows temperature (U) over time (15:43:20-15:50:00).
- DAS drift:** Shows digital signal levels (vdd, vddo, vdet) over time (350-500s).
- DAS DC noise:** Shows digital signal levels with DC noise over time (350-500s).
- DAS AC noise:** Shows digital signal levels with AC noise over time (0-600s).
- FEE HK voltage drift:** Shows high voltage (5kV) and low voltage (10kV) drift over time (350-500s).
- FEE HK current drift:** Shows high current (amp12) and low current (amp34) drift over time (350-500s).
- FEE temp drift:** Shows temperature (5kV, 1kVdc, 10kVdc, 10kV, 10mA, vdd, vddo, roic) drift over time (350-500s).

**Housekeeping Tables:**

- FEE PSU (U & I):**

psuv_fee_hpa	13.51	V	psui_fee_hpa	36.3	mA
psuv_fee_hna	-13.50	V	psui_fee_hna	25.8	mA
psuv_fee_lpa	8.50	V	psui_fee_lpa	92.8	mA
psuv_fee_lpda	7.50	V	psui_fee_lpda	53.2	mA
psuv_fee_lpd	6.50	V	psui_fee_lpd	130.2	mA
psuv_fee_lpd	9.09	V	psui_fee_lpd	9.4	mA
- FEE Digital Housekeeping:**

version	20008
boardid	10
spw_overf_cnt	0
spw_status	1
signal_gen_enables	0
datavalid_error	0
roic_config_error	0
frames_left	22041
- DSIM PSU:**

v_dsim_4v0dp	5.00	V	i_dsim_4v0dp	814.54	mA
v_dsim_9v0ap	9.01	V	i_dsim_9v0ap	107.26	mA
v_dsim_9v0an	-9.00	V	i_dsim_9v0an	18.36	mA
v_dsim_4v5an	4.49	V	i_dsim_4v5an	45.86	mA
- FEE ROIC external (U & I):**

hk_u_fee_hpa	13.47	V	hk_l_fee_hpa	36.24	mA
hk_u_fee_hna	-13.58	V	hk_l_fee_hna	25.56	mA
hk_u_fee_lpa	8.43	V	hk_l_fee_lpa	88.74	mA
hk_u_fee_lpda	7.40	V	hk_l_fee_lpda	53.81	mA
hk_u_fee_lpd	6.37	V	hk_l_fee_lpd	125.81	mA
hk_u_fee_lpd	9.00	V	hk_l_fee_lpd	9.00	mA
- FEE internal (U & I):**

hk_u_10pa	9.93	V	hk_l_10pa	2.27	mA
hk_u_10ma	-10.05	V	hk_l_10ma	6.53	mA
hk_u_5kpa	4.89	V	hk_l_5kpa	2.52	mA
hk_ref_a	5.00	V	hk_ref_d	-0.07	mA
hk_spare_d	-30	LSB	hk_gnd_d	-0.07	mA
- ROIC internal (U & I):**

hk_u_vdda	5.06	V	hk_l_vdda	21.7	mA
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- Video ADC values:**

adc_out_of_range	0
vidch1_curr	1.459
vidch2_curr	4.728
vidch3_curr	2.498
vidch4_curr	2.504
- DSIM HK:**

hk_u1v5dp	1.51	V	hk_u1v5ap	7.54	V
hk_u1v3d	3.32	V	hk_u1v3ap	5.05	V
hk_u1v0d	5.03	V	hk_u1v5an	-2.46	V
hk_u1v0d	5.04	V	hk_u1v5an	-7.46	V
hk_u1v5d	2.53	V	hk_u1v5an	5.04	V
- DSIM Temperatures:**

hk_temp_video	35.06	C	hk_temp_cold	33.13	C
hk_temp_dig	40.20	C	hk_temp_ana	34.08	C
das_adc0_temp	10.81	C	das_adc1_temp	12.25	C
- DAS:**

das_vdd_dc	5.11	V	das_vdd_ac	0.69	mV
das_vdda_dc	5.06	V	das_vdda_ac	0.03	mV
das_vddo_dc	5.06	V	das_vddo_ac	1.07	mV
das_vdet_dc	0.48	V	das_vdet_ac	-0.29	mV
das_retrcol_dc	35.57	k	das_spare0	3	lsb
das_retrpix_dc	6.06	k	das_sample_enable	1	
das_fifo_overflow	0				
- DAS Digital status:**

version	103		video_imp_en	0
eth_enable	1		video_ext_en	0
for_sock_enable	1		pir_en	1
for_sync_enable	1		vidc_enable	1
for_datavalid	0		emmon_cur_values	111
			emmon_fifo_overflow	0
			emmon_chri_enable	71

**Scripts:**

```

Run: /usr/bin/nc -l -p 451
Arguments:
[2011-03-11 14:51:50 (18131)] INFO: TEST ABORTED
[2011-03-11 14:52:50 (18131)] INFO: das_ethers: netber=210819 adas=5057658 nevent=3118012
[2011-03-11 14:52:50 (18131)] INFO: das_ethers: 0 ethernet packets dropped
[2011-03-11 14:52:50 (18131)] INFO: das_ethers: Exit.

Summary of limit violations:
fee_video1 : 3425 times (0 min, 0 max, 0 drift, 0 peak, 3425 rms)
fee_video2 : 3332 times (0 min, 0 max, 0 drift, 0 peak, 3332 rms)
fee_video3 : 3367 times (0 min, 0 max, 0 drift, 0 peak, 3367 rms)
fee_video4 : 3425 times (0 min, 0 max, 0 drift, 0 peak, 3425 rms)
das_vdet_ac : 780 times (0 min, 0 max, 0 drift, 0 peak, 780 rms)

[2011-03-11 14:52:51 (18131)] INFO: Checking event monitor data
[2011-03-11 14:53:31 (18131)] INFO: Done: data stored in
/data2/tropomi/emctest_201103/rs002_2011-03-11T14:49:21
[2011-03-11 14:53:31 (18131)] INFO: Sending SIGTERM to apuexec (pid=8135)

15:53:17.451 exit status=0
    
```

**Terminal Log:**

```

15:43:48.334 CRUI [S] Socket: The remote host closed the connection.
15:43:48.355 SSH [INFO] Script disconnected (Connection=rsad17*08)
15:44:08.245 SSH [INFO] Script connection from 127.0.0.1:40003 (Connection=rsad18*180)
15:52:50.638 SCRIPT [INFO] ScriptWindow:stop Calling terminate()
15:53:11.308 CRUI [S] Socket: The remote host closed the connection.
15:53:31.121 SSH [INFO] Script disconnected (Connection=rsad18*180)
    
```

**System Tray:** Shell - DSM daemon, Shell - EGSE Server, EGSE server - 1.6.3, Shell - RS422 daemon, tropomi@casslopeia: ~

# Script – Measurement of TROPOMI

- Set power supply on
- Set configuration to FEE
- Set HK enable
- Get telemetry
- Manipulate telemetry and push back to EGSE server

```
import egselib
import numpy

edb = egselib.EDB()
egse = egselib.EGSE(edb)

egse.set('digif:1:asltm_em', 1)
egse.set('fee:chnl_pwrap', 1)

egse.pauseHK(0)

simpleVal = egse.get('fee:heat')
blockVal = egse.get('fee:input')

result = numpy.fft.fft(blockVal)
magnitude = abs(result)
egse.plotPacket('plot:mag', magnitude)
```

# Generic EGSE in use (since 2009)

- TES Detector development Eureka (Xeus/IXO/Athena)
- MKID Detector development (IRAM/APEX)
- Readout development SHAMROC (EXOMARS)
- Optical Delay Line controller (Darwin)
- Calibration source control (Astro-H)
- TROPOMI
- Safari (Spica)
- Multiple PEP/PIPP projects
  
- Platform
  - Linux, OSX, Windows
  - C++, Qt/Qwt
  - Python/NumPy/PyQt
  - MySql

# Conclusion

- One EGSE to rule them all
- By means of built in flexibility at different levels
  - Control via script by user
  - Control of SUT by user
  - Control of consequent actions by user
  - HW abstraction via database by user
- Online analysis of level 0/1 telemetry immediately possible
- Really intuitive to use
- New project supported within hours



**Thank you for your attention !**