genEGSE

Generic Telemetry interpreter

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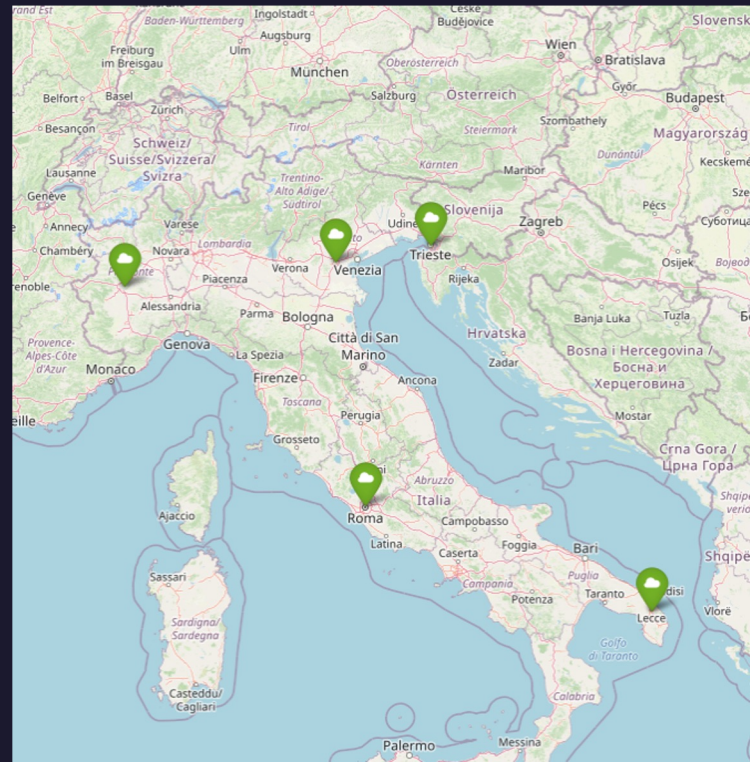
The Laboratory

The Laboratory of Astroinformatics and Digital Planetology (LAPD) is “collective” of (data) scientist founded to share knowledge, experience and libraries.

The project will be presented is the first native LAPD software.



Zoom out

genEGSE is the first tile of a largest project.

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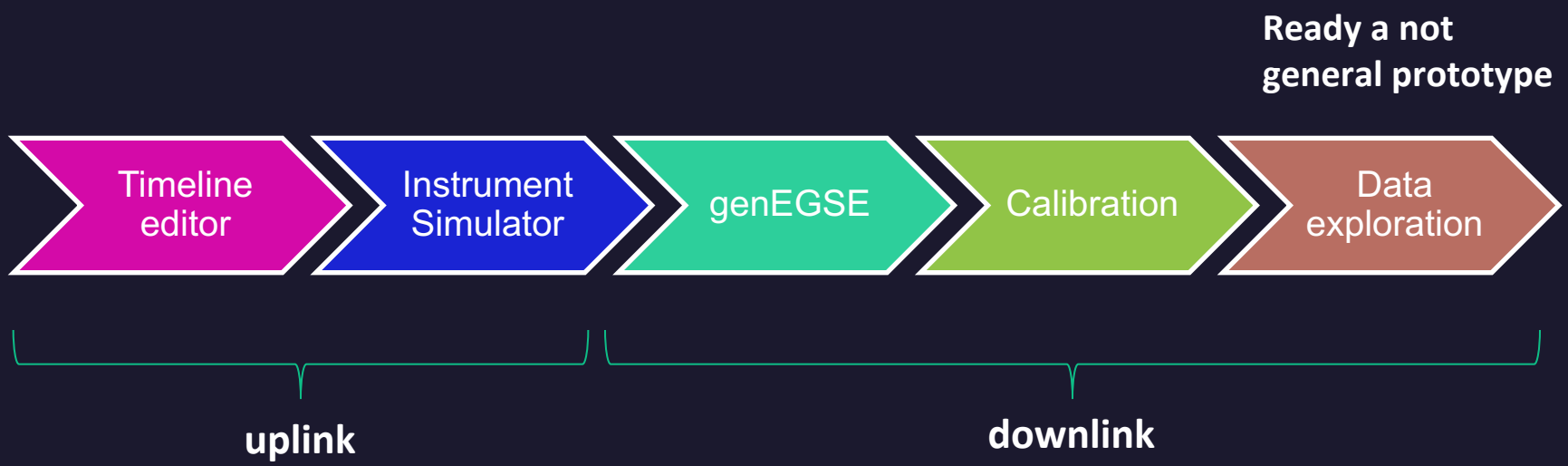


Data Levels

NASA	CODMAC	Description
Packet data	Raw Level 1	Telemetry data stream as received at the ground station, with science and engineering data embedded.
Level 0	Edited Level 2	Instrument science data (e.g., raw voltages, counts) at full resolution, time ordered, with duplicates and transmission errors removed.
Level 1A	Calibrated Level 3	NASA Level 0 data that have been located in space and may have been transformed (e.g., calibrated, rearranged) in a reversible manner and packaged with needed ancillary and auxiliary data (e.g., radiances with the calibration equations applied).
Level 1B	Resampled Level 4	Irreversibly transformed (e.g., resampled, remapped, calibrated) values of the NASA Level 1A, or possibly Level 0, instrument measurements (e.g., radiances, magnetic field strength).
Level 1C	Derived Level 5	NASA Level 1A or 1B data that have been resampled and mapped onto uniform space-time grids. The data are calibrated (i.e., radiometrically corrected) and may have additional corrections applied (e.g., terrain correction).
Level 2	Derived Level 5	Geophysical parameters, generally derived from NASA Level 1 data, and located in space and time commensurate with instrument location, pointing, and sampling.
Level 3	Derived Level 5	NASA Level 2 geophysical parameters mapped onto uniform space-time grids.

Introduction

genEGSE is a generic telemetry interpreter.

It use an abstraction layer for the structure of the telemetry.

The customization is done using a descriptor of the specific telemetry called Logical Model. The Logical Model is a formalization of the ICD.

The Logical Model

Logical Model vs ICD

Logical Model

dataType

Describes the general structure of data, output and format

Brick

Describes the single data field.
Could be explicit or implicit
The structure depends on the dataType.

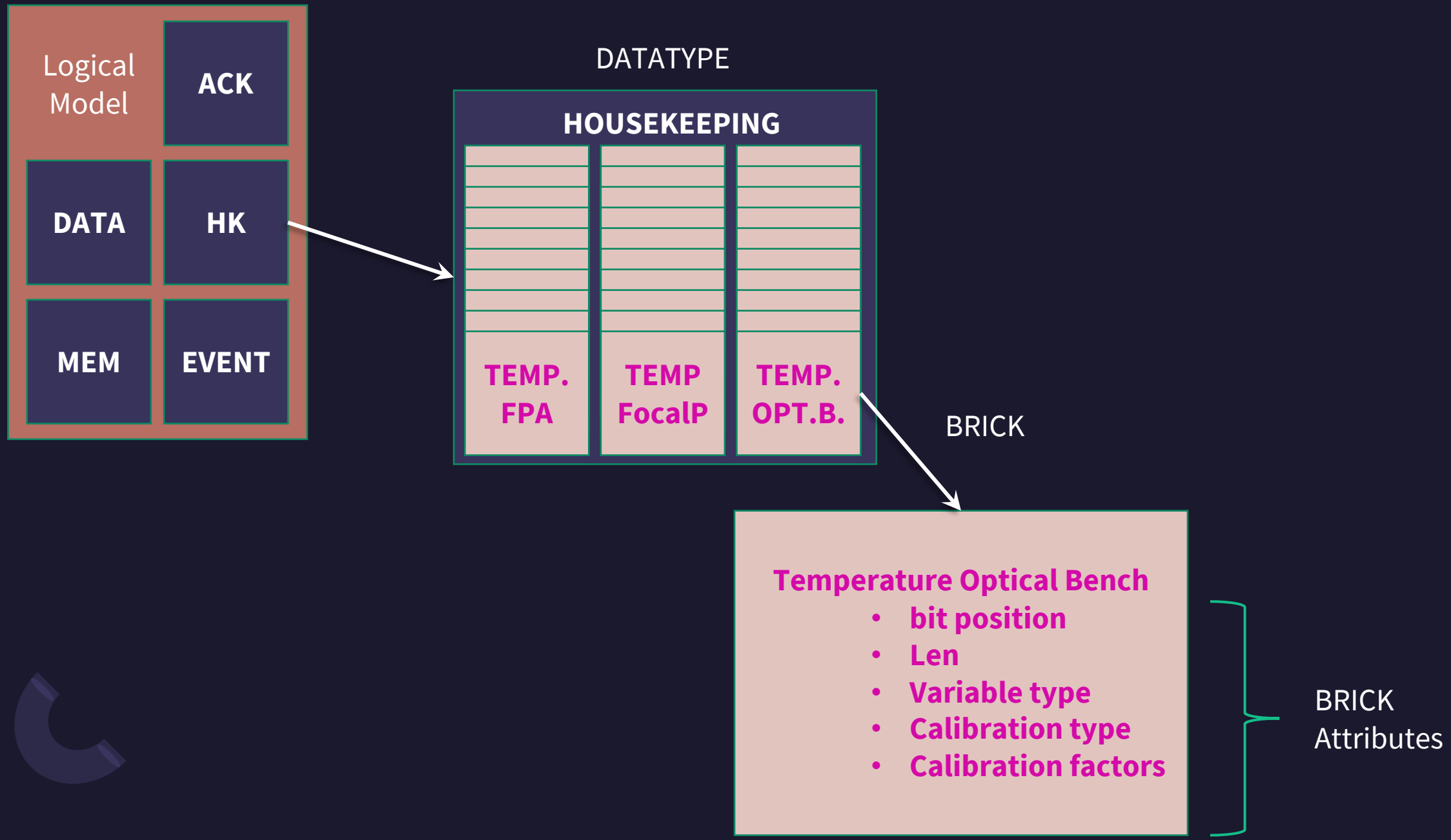
Attribute

Is the individual brick’s characteristics

ICD

APID

Field


Logical Model
ACK
DATA
HK
MEM
EVENT
DATATYPE
HOUSEKEEPING
TEMP. FPA
TEMP FocalP
TEMP. OPT.B.
BRICK
Temperature Optical Bench
• bit position
• Len
• Variable type
• Calibration type
• Calibration factors
BRICK Attributes

Logical Model

To develop the Logical Model, the following elements are necessary:

- **Dictionary:** a list of keywords to describe all Logical Model/ Brick attributes;
- **Grammar:** a set of rules to write the attributes and the possible values associated;
- **Syntax:** a set of rules on the order and hierarchy of attributes and their correlation.

Logical Model Examples

The logical model is written in non-standard YAML format

```yaml
name: SIMBIO-SYS
instrumentType: imager
metakernel: kernels/simbio.tm
missionid: -121
scosfile: scos.csv
ccsdsfile: ccsds.csv
apids:
  - !include simbio_apid_801.yaml
  - !include simbio_apid_804.yaml
  - !include simbio_apid_807.yaml
  - !include simbio_apid_809.yaml
  - !include simbio_apid_828.yaml
  - !include simbio_apid_844.yaml
```

YAML is a digestible data serialization language often used to create configuration files with any programming language.

```yaml
name: 801
datatype: ACK
ackfile: ack.txt
template: <utc> - TM(<s>,<sbs>) - [APID|<ap>] - Event N/A - <tp> [APID| <apid>, Sequence n.| <ssc>]
pid: 50
pcat: 1
servicetype: 1
description: Telecommand Verification
len: 4
format: bin:3,2*bin:1,uint:11,bin:2,uint:14
labels: spare,spare,spare,apid,spare,ssc
subtypes:
  - servicesubtype: 1
    description: Telecommand Accepted
    len: 0
  - servicesubtype: 2
    description: Telecommand Acceptance Failed
    len : 2
    format: uint:16
    messages:
      - id: 0
        msg: Illegal APID - either PID or PCAT is illegal
        len: 2
        format: 2*uint:8
        labels: service,subservice
        template: Failure ID| <id> - Recived| Service| <service>  SubService| <subservice>
      - id: 1
        msg: Incomplete or Invalid length
        len: 2
        format: 2*uint:8
        labels: service,subservice
        template: Failure ID| <id> - Recived| Service| <service>  SubService| <subservice>
      - id: 2
        msg: Incorrect checksum
        len: 6
        format: 2*uint:8,2*uint:16
        labels: service,subservice,reccheck,compcheck
        template: Failure ID| <id> - Recived| Service| <service>  SubService| <subservice> - Recieved Checksum| <reccheck> - Computed CheckSum| <compcheck>
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Message

Message: 2019-06-06T06:35:00.01357Z - TM(1,1) - [APID:801] - Event N/A - Telecommand Accepted [APID: 812, Sequence n.: 223]

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Implicit brick

Explicit brick

HK Calibration

For the Housekeeping is implemented a calibration module.
Three calibration modes was defined:

- Replace
- Proportion
- Ramp

```yaml
- status: yes
  mode: proportion
  element:
    - TEMPERATURE_ON_ME_BOARD
    - PU_TEMPERATURE
  factor: 0.14652014652014653
  unit: K
- status: yes
  mode: proportion
  element:
    - VOLTAGE_AT_5V
    - VOLTAGE_AT_3.3V
  factor: 0.0014652014652014652
  unit: V
```

```yaml
- status: yes
  element:
    - ANTI_WIND-UP_METHOD
  mode: replace
  case:
    - id: 0
      value: P-Only
    - id: 1
      value: Ramp
- status: yes
  element:
    - TEMPERATURE_FPA_1
  mode: ramp
  mindn: 0
  maxdn: 4095
  minc: 517.204
  maxc: 145.2171
  unit: K
```

HK Calibration

HK for STC

Parameter	Raw Value	Calib Value
ACQUISITION TIME UTC	2019-06-06T06:35:34.176Z	2019-06-06T06:35:34.176Z
ACQUISITION TIME SCET	1/0624522932:35928	1/0624522932:35928
LAST EVENT	0	No Error
COMMANDED TEST MODE	0	NO TEST MODE
COMMANDED TEC STATUS	0	OFF
COMMANDED DETECTOR STATUS	0	OFF
COMMANDED TEC TREF	0	0
COMMANDED TEC N P	0	0
COMMANDED TEC N I	0	0
COMMANDED TEC N E	0	0
ANTI WIN-UP STATUS	0	OFF
ANTI WIND-UP METHOD	0	P-Only
COMMANDED TEC N SS	0	0
PE ADDRESS	0	0
PE ADDRESS CONTENT	0	0
TEMPERATURE FPA 1	2708	271.2111978 K
TEMPERATURE FPA 2	2712	277.6188913 K
TEMPERATURE PE	2373	276.8183794 K
TEMPERATURE FPA PACKAGE	2372	276.6367620 K
TEMPERATURE STC OPTICAL BENCH	2360	274.9285688 K
VOLTAGE AT 3.3V	3463	3.2577206 V
TEC CURRENT	1176	0.0007074 A

The software

Main info

- Developed in Python 3.10.4 (tested for back-compatibility up to 3.6)
- Mix between class and functional programming.
- 3272 line of code.
- Three modes of work:
  - **Standard run** – process all the telemetry file

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Integration in external pipeline

```
genEGSE(inFile: str, configuration: str, logger:logging, debug=False, verbose=False, showConf: bool = False)
```

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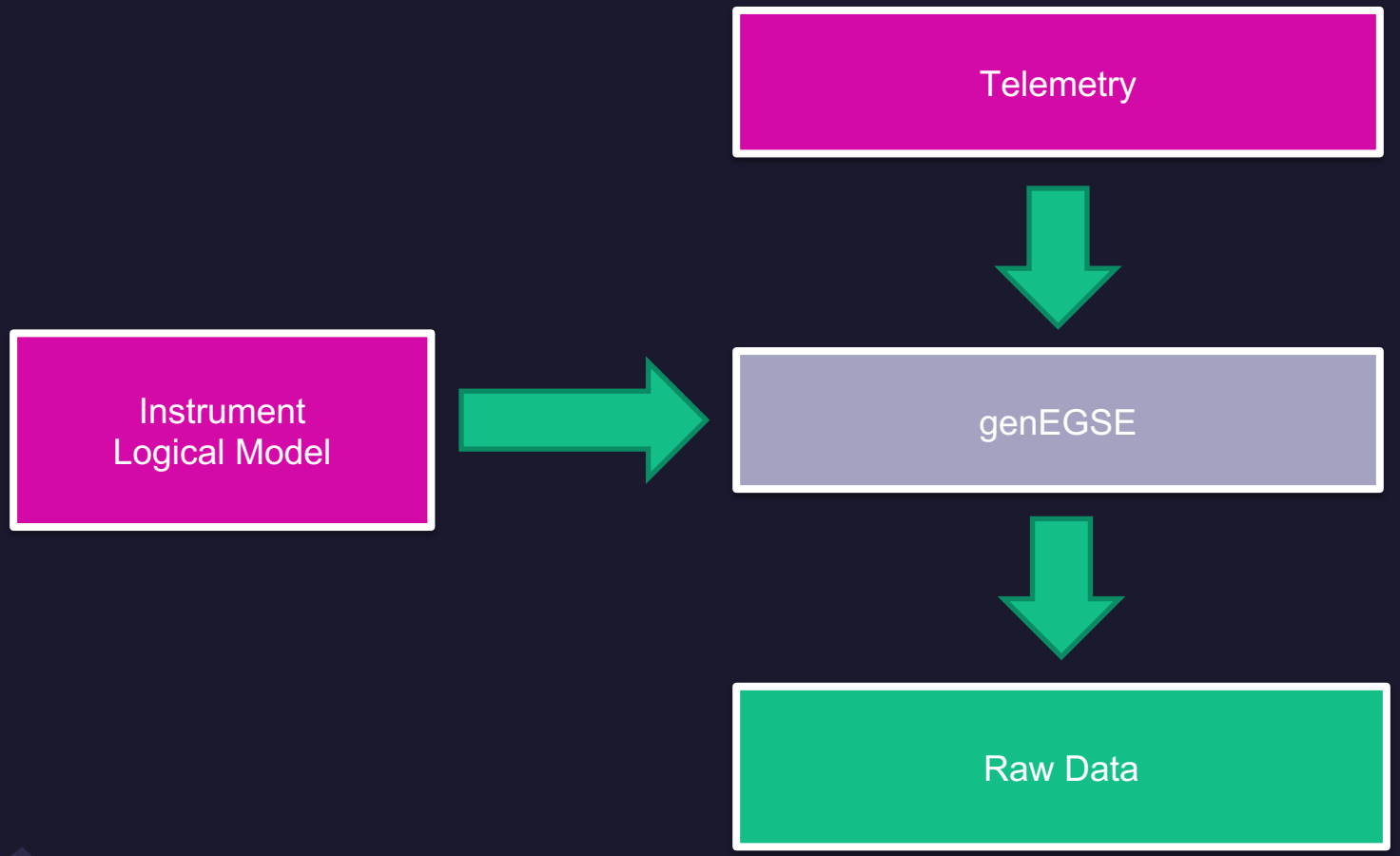
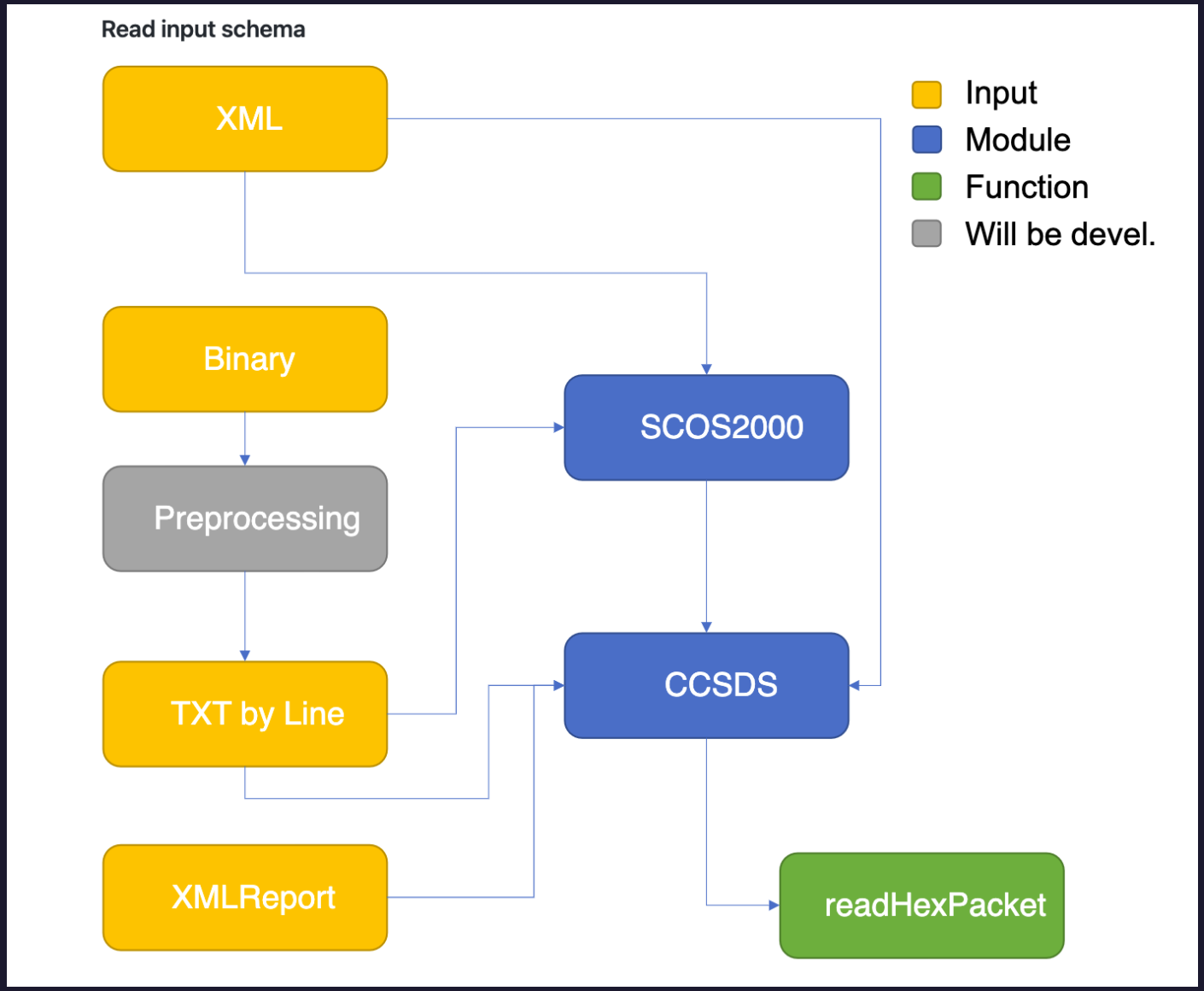
- 3272 line of code.
- Three modes of work:
  - **Standard run** – process all the telemetry file
  - **CLI mode** – Command Line Interface for the analysis of the packets and telemetry
  - **Validation Mode** – For the check of the Logical Model

```
usage: genEGSE.py [-h] [-i FILE] [-l File] [-L N] [-c File] [-a FILE] [-d] [-v] [-C] [-V] COMMAND  ...

Generic EGSE Interpreter

positional arguments:
  COMMAND                       Command to execute

optional arguments:
  -h, --help                    show this help message and exit
  -i FILE, --inputFile FILE     Telemetry input file
  -l File, --log File           Set the log file name and position
  -L N, --logLevel N            Set the log level
  -c File, --config File        Location and name of the configuration file
  -a FILE, --apid               FILE  APID file to validate
  -d, --debug                   Enable debug mode
  -v, --verbose                 Enable the verbose mode
  -C, --showConfig              Check ad display the configuration file
  -V, --version                 show program's version number and exit

Command List:

    run                         Run the pipeline
    cli                         Start the CLI interface
    validate                    Start the validation of the config file
```

Schema



Input format

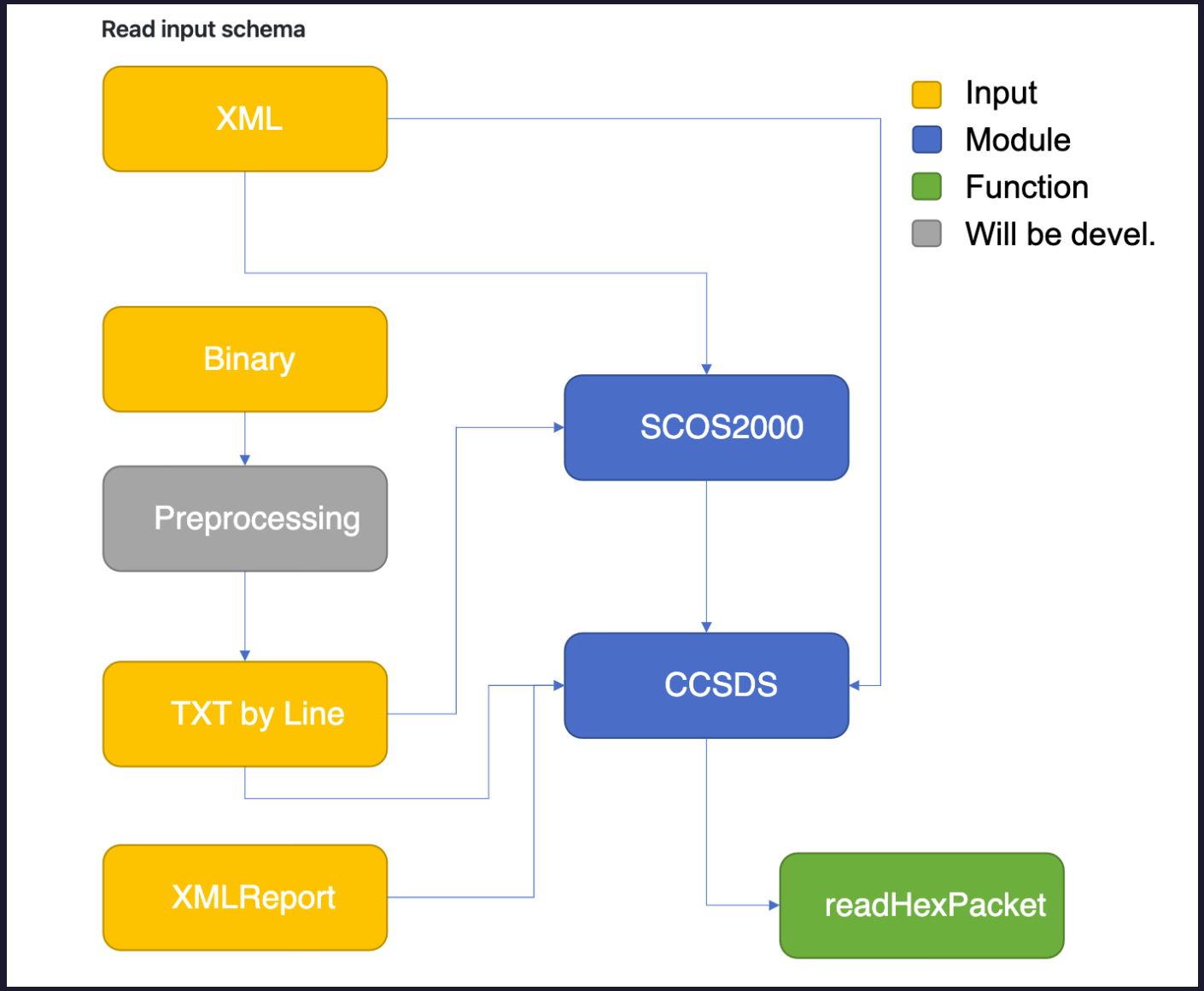


Input format

SCOSpy

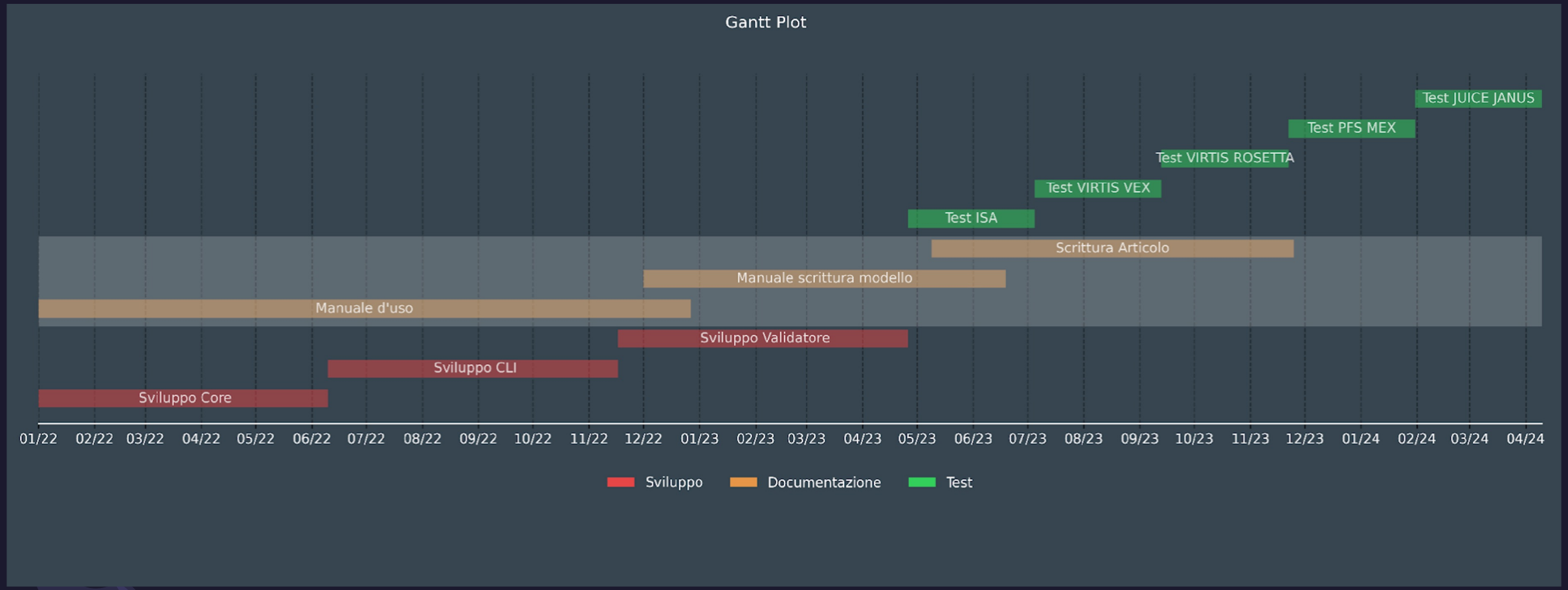
https://www.ict.inaf.it/gitlab/romolo.politi/scospy

https://github.com/RomoloPoliti-INAF/SCOSpy



```
---------- Welcome to genEGSE shell ---------

genEGSE> : help

genEGSE cli Commands
Type help <command> for more informations


clear     : Clear the console
command   : Load a Command file
config    : Display the configuration status.
data      : Load, display and manipulate data.
exit / q  : Exit from the shell
help / ?  : Show the command list
history   : Show the command history
packet    : Manipulate Packets

genEGSE> : help packet
packet              : Show the general info on the current packet
packet show         : Show the data in the current packet
packet next         : Point to the next packet
packet prev         : Point to the prvious packet
packet goto <num>   : Point to the packet # num
packet help         : Show this help

genEGSE> :
```

Project development



Next Steps

- Complete the Logical Model for the imager.
  - The DATA dataType is not yet complete
- Design different instrument type
- Optimized the code to reduce redundancy and streamline operations
- Improve the comments, log and verbosity
- Debug and test of the software

- Dictionary, grammar and syntax formalization
- Write documentation
- Develop additional commands
- Develop TUI, Web Interface (flask)
- Remote control of the pipeline
- Test on other instruments
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load config load data

Output

>config load default

INFO

...Default setting loads

>data load input/test.xml

INFO

[INFO] Found 1249 packets

>show

ERROR

[ERROR] Please select one of the available options. Use help, h or ? for the list of the options

genEGSE> Exec

Info & Navigation | Macro | History

General Info

Configuration File:	/Users/romolopoliti/.genEGSE/default.yaml
Data file:	input/test.xml

Packet Info

Instrument:	SIMBIO-SYS
APID:	807
Data Type:	EVENT
Service:	TM(5,1)

Current Packet 0 of 1249

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Open Issues

- License?
- Distribution?
- Connection to archive?
- Centralization?