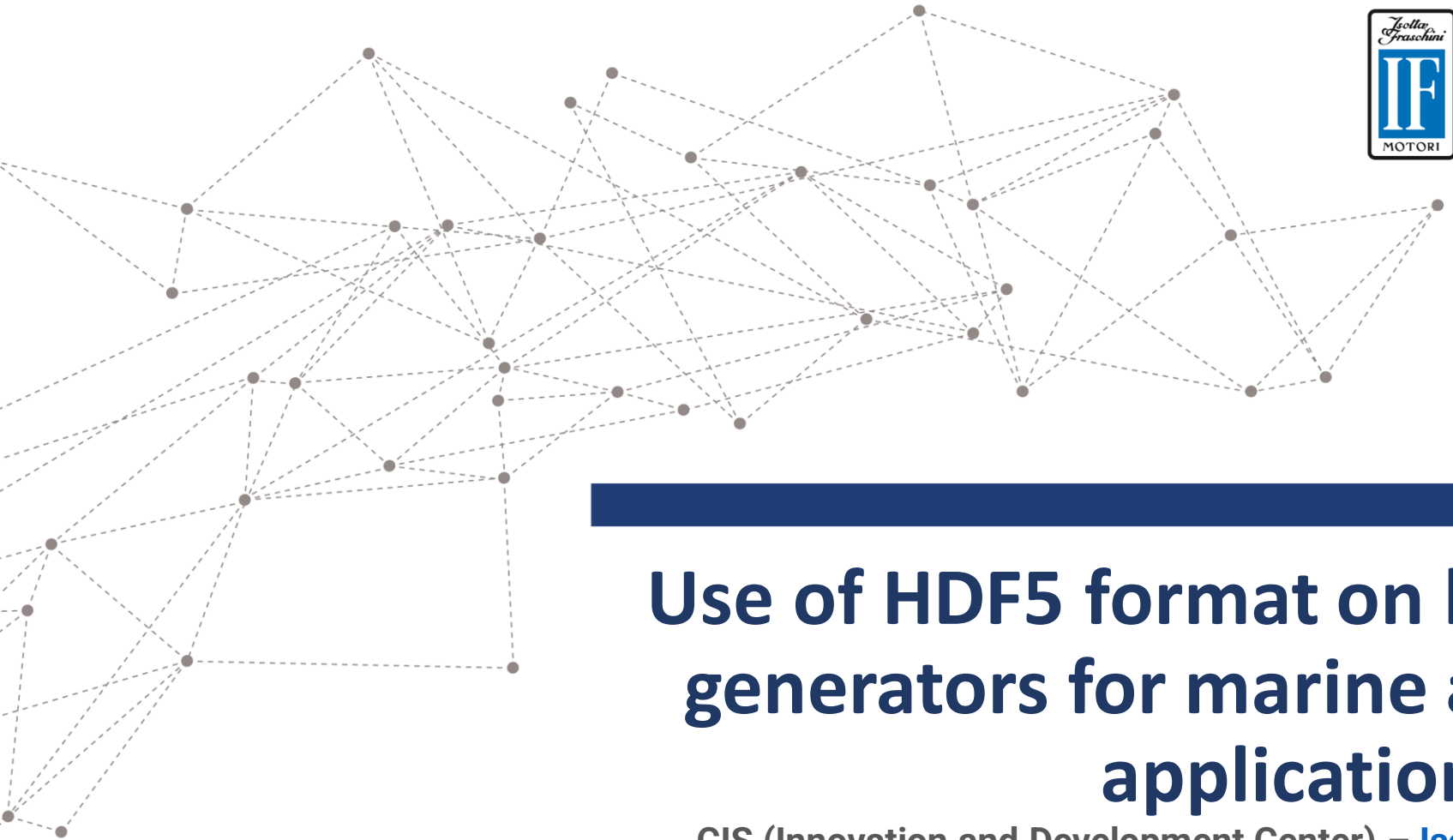

a FINCANTIERI Company

Use of HDF5 format on board of power generators for marine and terrestrial applications

CIS (Innovation and Development Center) – Isotta Fraschini Motori [ITALY]

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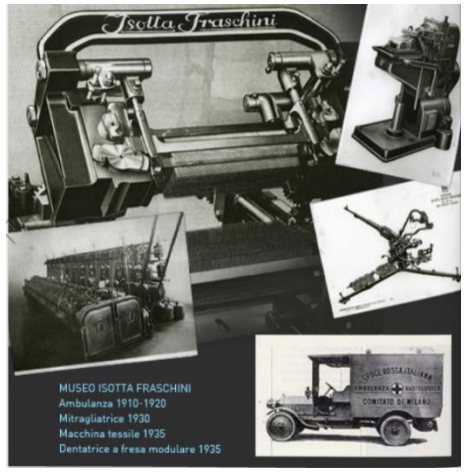
Revision: 1.0

Isotta Fraschini Motori
- The company history -

1900

Isotta Fraschini was **founded in 1900 as "Isotta Fraschini & C. by Cesare Isotta and the brothers Vincenzo Oreste Antonio Fraschini**. The company began to design and produce all the parts of vehicles on its own and in 1904 it became "**Isotta Fraschini S.p.A. Milano".**

1930



For many years Isotta Fraschini designed and produced exceptional engines for aeronautical, naval and vehicle use both for civil and military use. In the **1930s the factory moved some of its factories to the Saronno area** and **at the end of the war, however, the conversion of the company from military to civil failed and the company was placed in liquidation.**

1960

Important products were designed and manufactured in the railway, shipbuilding and industrial sectors. At the beginning of the **1960s a plant to produce highly successful Diesel engines was founded in Bari.**

1980

At the end of the **1980s Isotta Fraschini was merged with Fincantieri (100%).** Today in Bari , research and development, production continues and is the only world headquarters of the Isotta Fraschini Motori brand.

Isotta Fraschini Motori
- The company Today -

Isotta Fraschini Motori today deals with design and production of the following assets:

PROPULSION

ON BOARD GENERATOR

INDUSTRIAL ENGINES

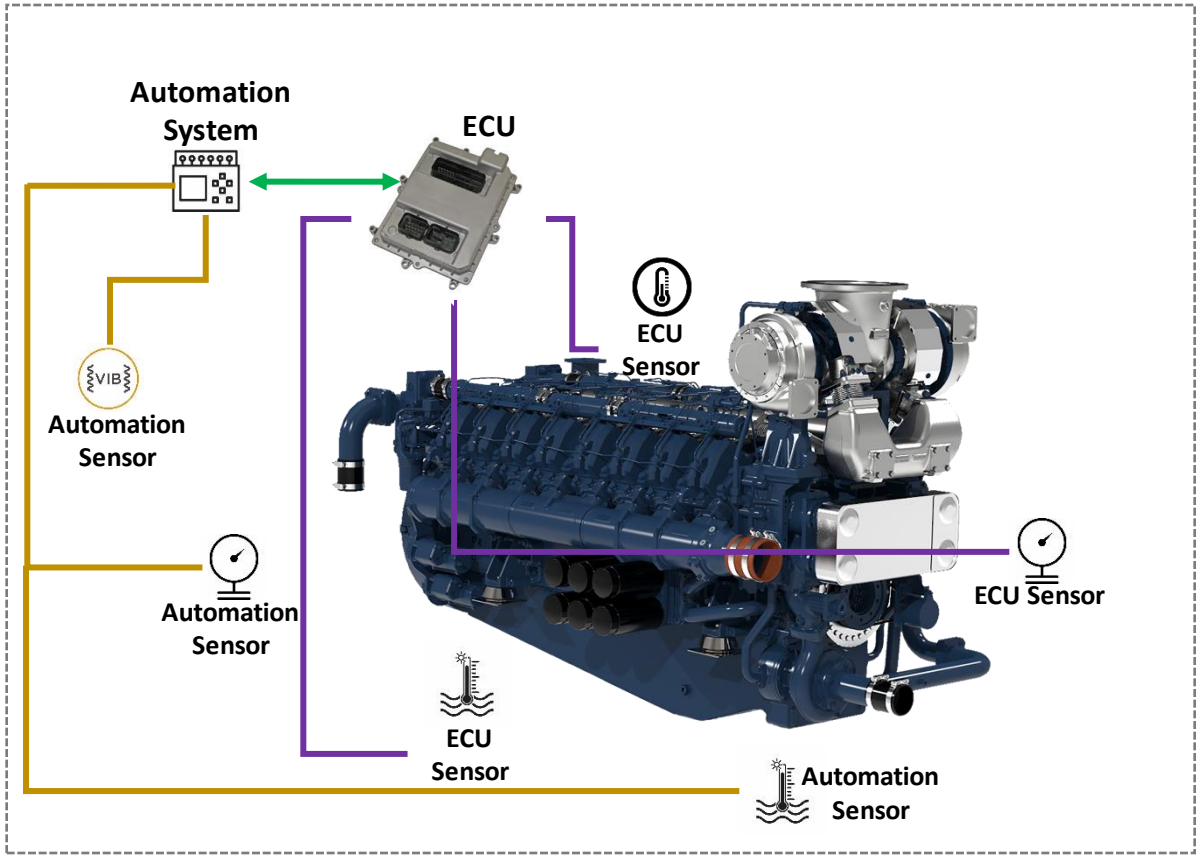
SPECIAL APPLICATION

IFM is specialized in providing systems in which the engines are used for generator sets in non-standard applications pumps.

Isotta Fraschini Motori has started the ***IFuture*** program aimed to

- design a new engine compatible with actual standards in terms of emissions, power requirements and able to work with different fuels, also renewable,
- develop and integrating new technologies on board, such as AI/ML and IoT systems for
  - improving performances,
  - improving maintenance operations, especially when mounted in "strategic" location,
  - optimizing the whole engine-life.

Isotta Fraschini Motori
- Typical use-case -



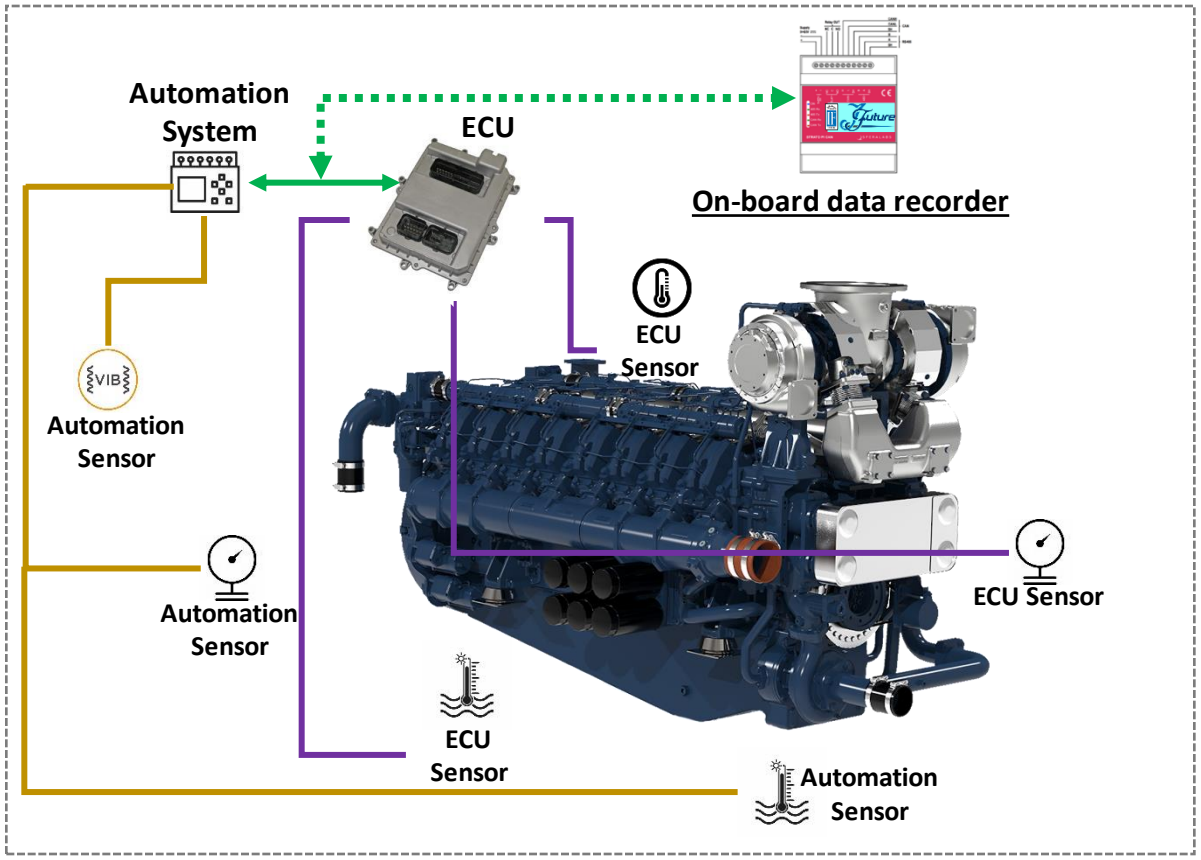
Engine *on-filed (power generator configuration)*

On-field application (loads)

A typical application for power generation is a complex scenario where lots of information travels around:

- Two main logical modules:
  - ECU (Engine Control Unit)
  - Automation system based on PLC for aux operations
- huge amount of sensors such as:
  - pressures,
  - temperatures,
  - Viscosity,
  - Rpm,
  - Flows
  - Electrical parameters
  - Etc.
- Different protocols such as:
  - CAN bus,
  - MODBUS,
  - Etc.
- Between 100 and 500 time-variant variables (with different sample rate), based on engine configuration.
- Between 200 and 300 events/day (such as logical status, Boolean information, warnings, alarms), based on engine configuration.
- Operative scenarios could require a power generator in working mode for 24 hours/365 days per year.

On-board Data Recorder project
- Goals -



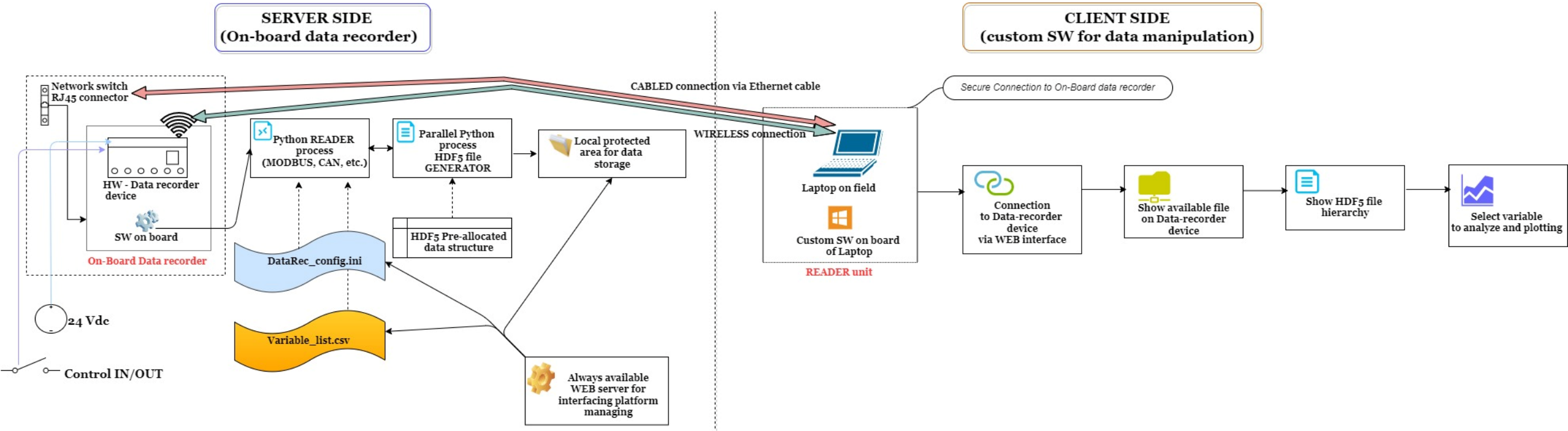
Engine *on-filed (power generator configuration)*

On-field application (loads)

The main need of the project was to equip the assets with a custom system for continuous data recording:

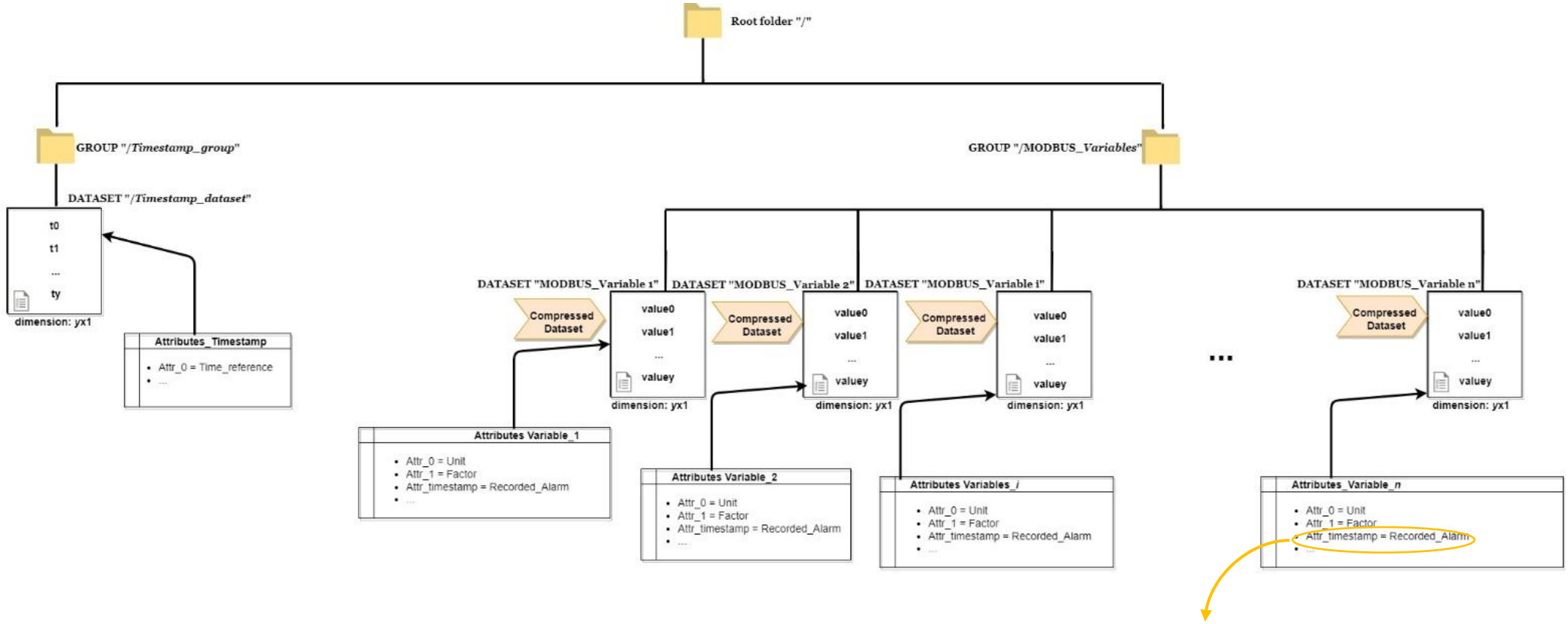
I. highly reconfigurable based on power generator configuration and application.
II. Easily to integrate on new assets and already on-field assets.
III. Highly reliable in terms of data storage, data protection, data availability and data integrity.
IV. Fully autonomous in terms of response to working conditions such as reboot states, etc.
V. Easily accessible and usable (no-expert users oriented such as maintenance operators).
VI. Capable to natively organize a huge amount of data for a ready-to-use interpretation.
VII. Data correctly time-referenced.

On-board Data Recorder project
- High level architecture -



On-board Data Recorder project
- HDF5 file structure -

Our typical HDF5 structure for MODBUS data recording is:

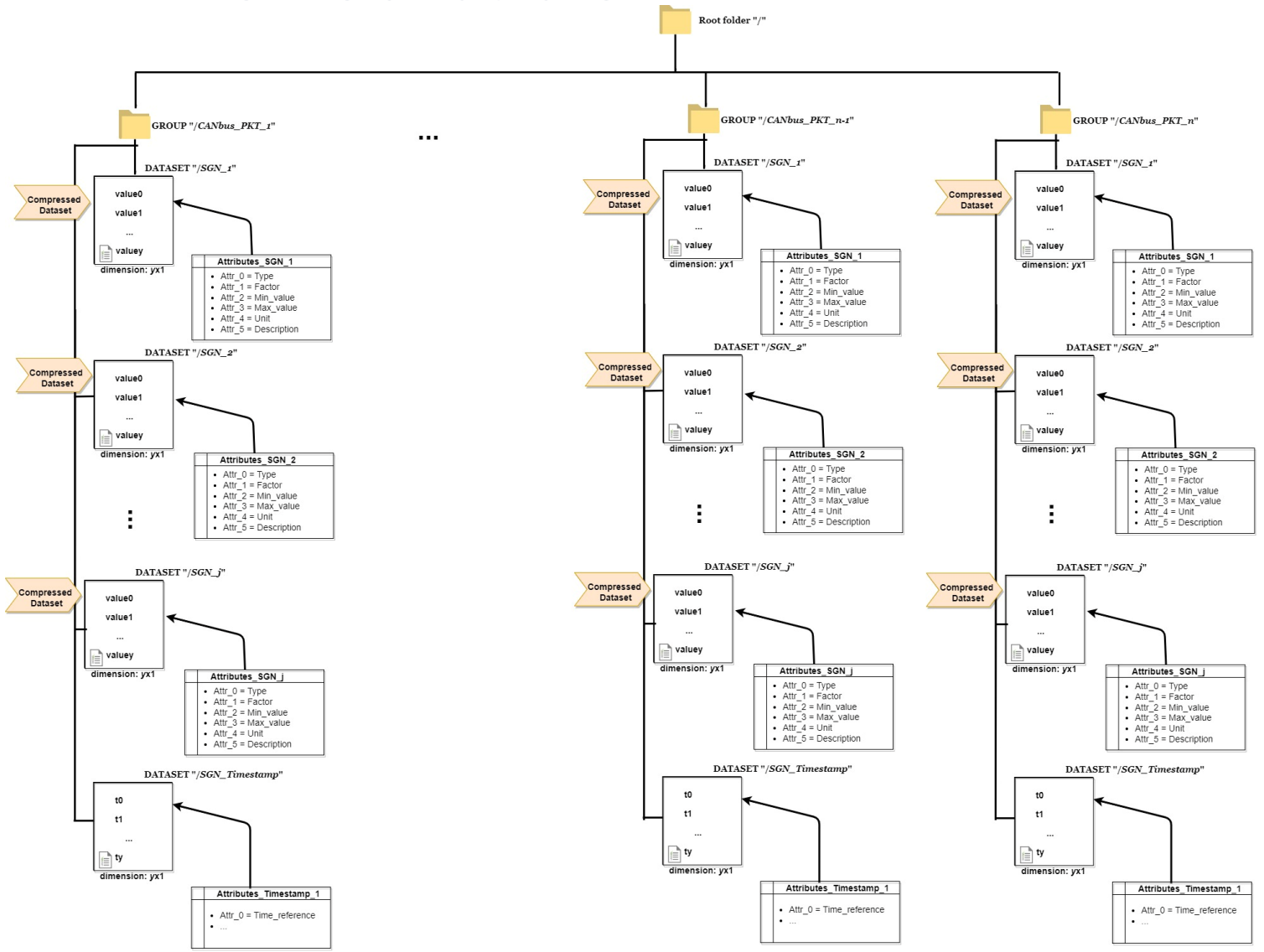


<u>The whole MODBUS register is caught at each acquisition with same sample-rate.</u>

For each acquisition the *threshold-algorithm* is applied and the last timestamp associated to alarm condition is stored.

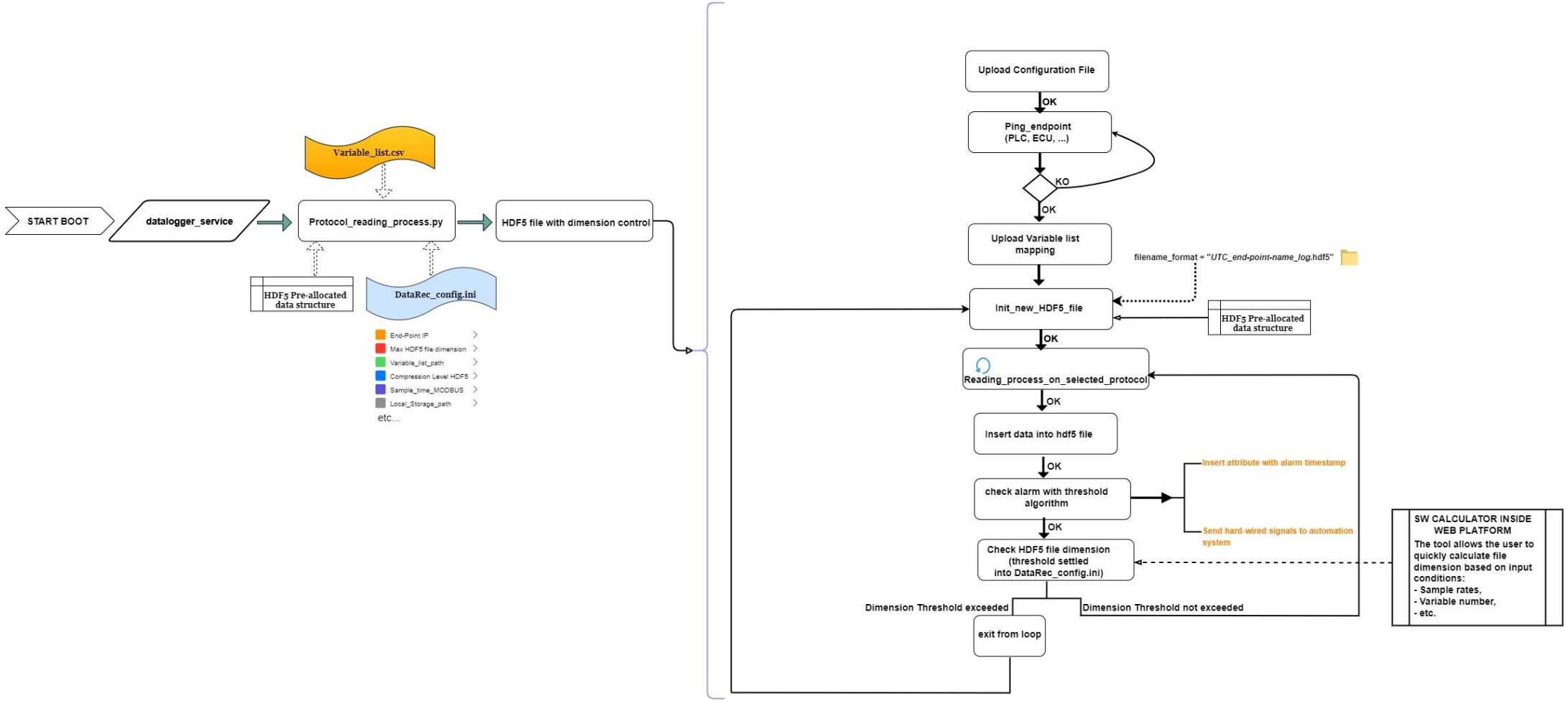
On-board Data Recorder project
- HDF5 file structure -

Our typical HDF5 structure for J1939-CAN bus data recording is:



Each CAN packet has a variable number of information (so called signals) inside. Each packet travels on the bus with its own sample rate and the data recorder must follow them and store the correct acquisition time for a right post-analysis.

On-board Data Recorder project
- SW architecture -



HDF5 file generation is managed with h5py library for python language.

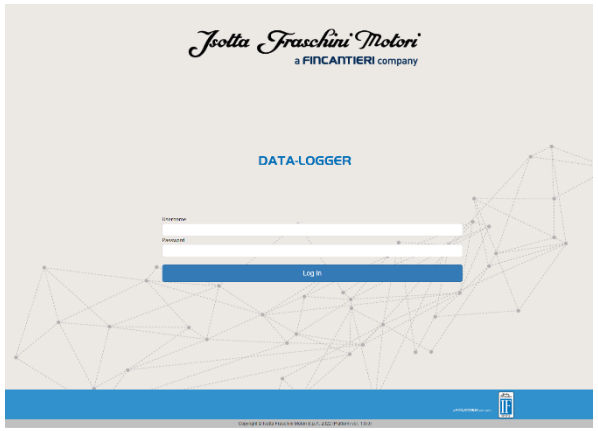
On-board Data Recorder project
- Benchmarking -

Test condition:

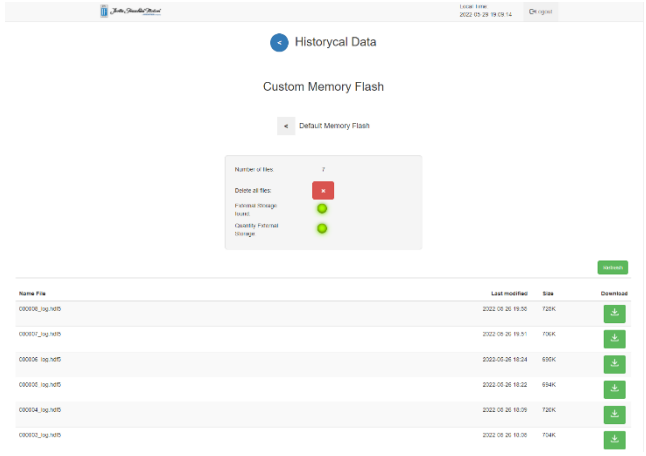
- Acquisition time-range → 14 min
- Resolution time → ≈ 1,5 sec
- Protocol → MODBUS (Automation System)
- Power Generator → 16V170 G ENGINE (Industrial Application)
- Acquired metrics for each variable → ≈ 560 time-variable

.txt file	.hdf5 file
14.4 MB	831.7 KB

On-board Data Recorder project
- Web Interface and Client Tool for visualization-

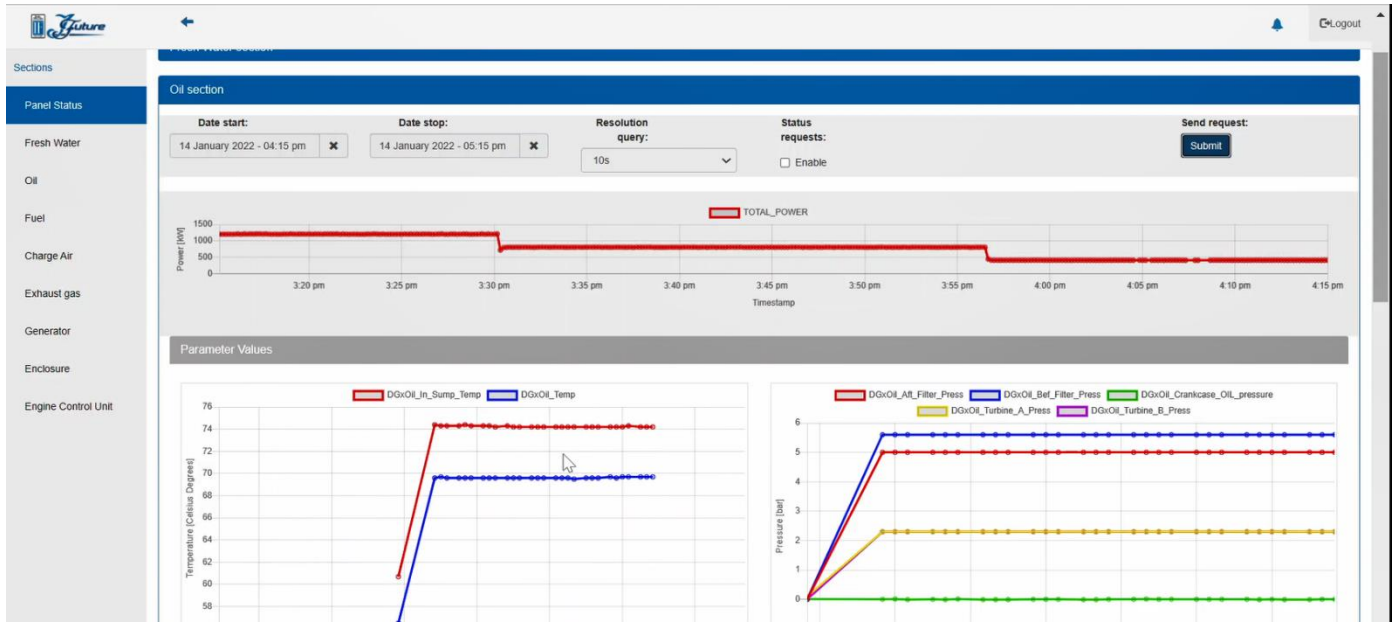


Data Recorder: Log-in page



Data Recorder: download hdf5 file page

Client Tool: hdf5 upload and variable selection



Client Tool: data visualization based on h5py library for python

Thanks for your time