USE OF CAN BUS IN THE VEGA LAUNCHER AUTONOMOUS TELEMETRY SYSTEMS
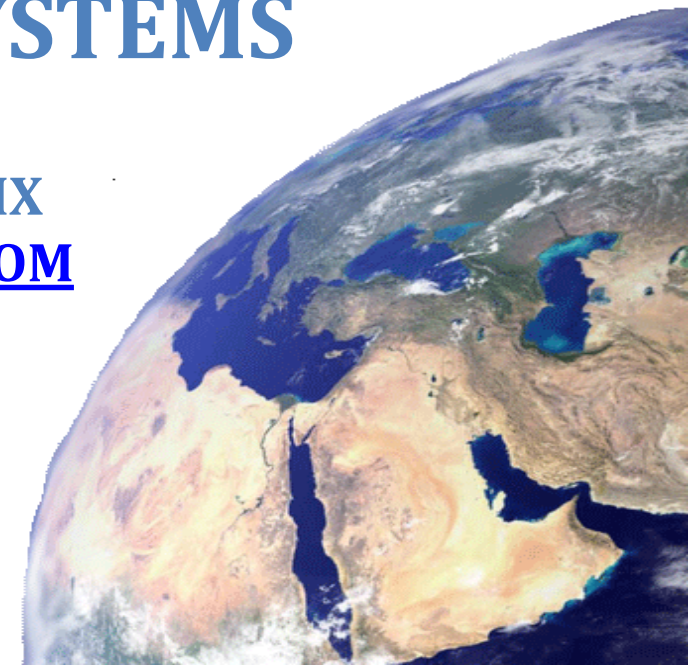
FRANCESCO ORTIX
WWW.TEMISSRL.COM

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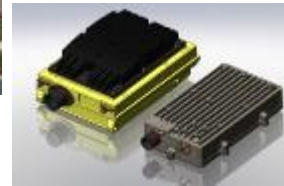# CAN Bus Application and Heritage

DST Prototype

Marshalling Sys.

A1GP

Flex FPU

FERRARI GT telemetry

MTX Nano

IPodout

MTX F

New headquarter "Pischiello"

ART srl

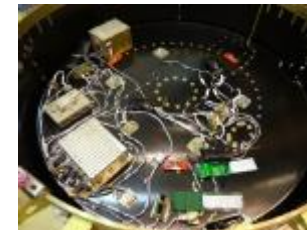| 2000 | 2000-2007 | 2008 | 2010 | 2012 | 2013 |

| 2006 | 2008 | | 2012 | |

TEMIS S.r.l.

**VEGA-LARES Project**

VEGA - ALTS Project

Why CAN bus?

The CAN protocol has been developed to have an high reliability, trusted and deterministic delay communication over automotive application. Today the CAN protocol is used to manage and connect every electronic box in all car of recent production. It has been demonstrated the robustness and reliability of protocol and relevant electrical bus, for this reason it manages:
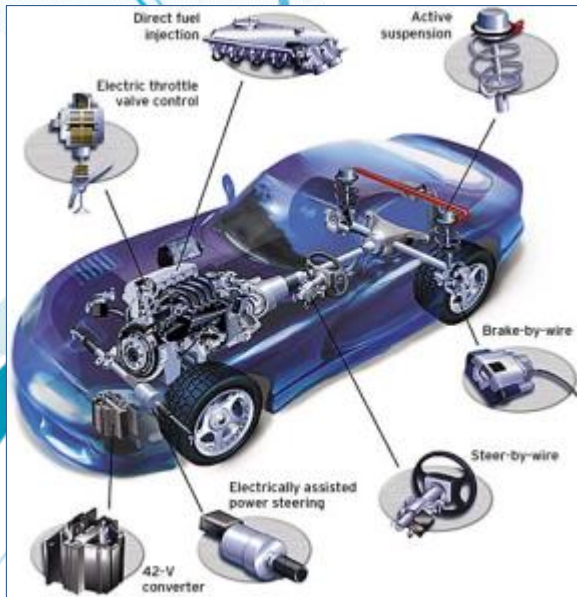
CAN bus
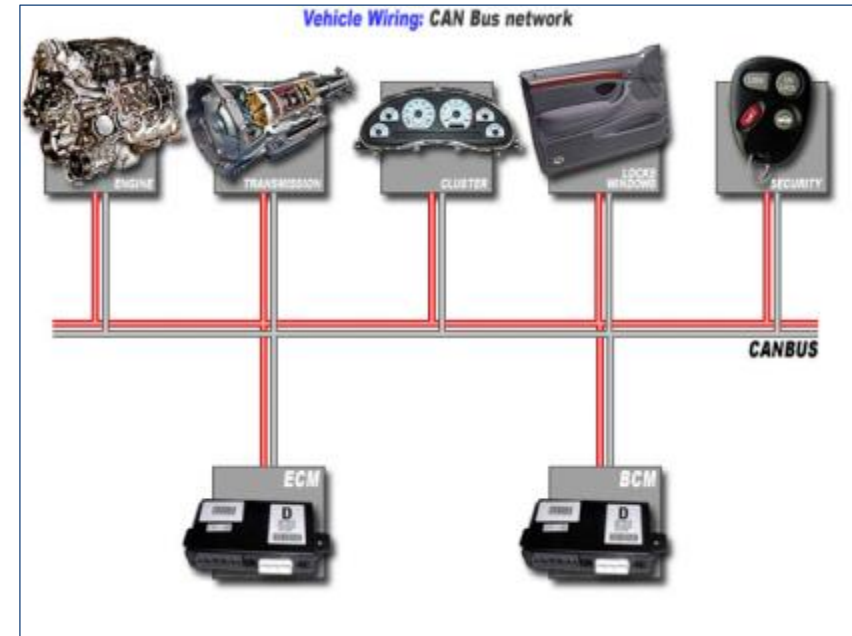
➤ **Safety critical / Reliability Critical** ➡ **Accident detection and AIRBAG actuation**

➤ **Safety critical / Reliability Critical** ➡ **Wheel slip detection, ABS actuation/mgmt.**
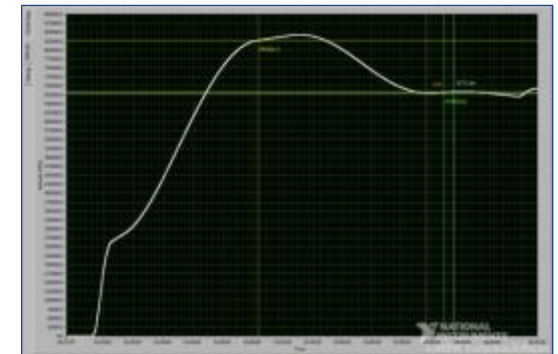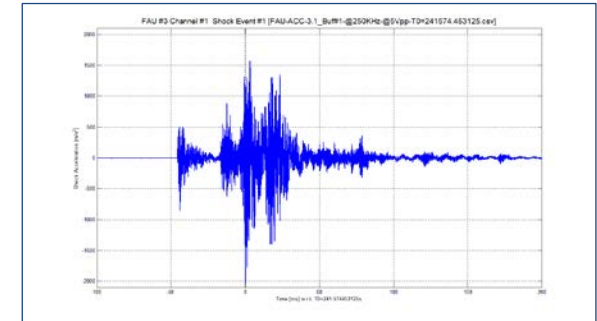
➤ **Robustness / Safety / Reliability** ➡ **Engine combustion control and health status**

Why CAN on VEGA avionics and telemetry

The choice of CAN protocol and bus for the modular avionic telemetry system developed either for VV01 and VV02 has been made for the same reasons and requirements.

CAN bus

> **Safety critical / Reliability Critical** ➡ **Scientific / Flight data acquisition**

> **Robustness / Safety / Reliability** ➡ **Launcher attitude sensing**

> **Robustness / Reliability** ➡ **Data handling timeline management (including remote upload)**

Funct. developed with CAN on VEGA #1

Modular telemetry approach, all the boards are managed internally by CAN bus network over CCP protocol. The main functions of the functionalities developed includes:

➢ Analog sensors acquisition up to 5kS/s (fully configurable)
➢ Analog high rate sensor acquisition up to 1MS/s (fully configurable)
➢ Analog PT100/PT1000 conditioning and acquisition
➢ Digital bi-level signal acquisition (TTL)
➢ Serial sensors acquisition (RS485 and sync. serial protocols)
➢ Inertial Measurement Unit acquisition
➢ GPS Sensor acquisition
➢ Multiple video cameras acquisition
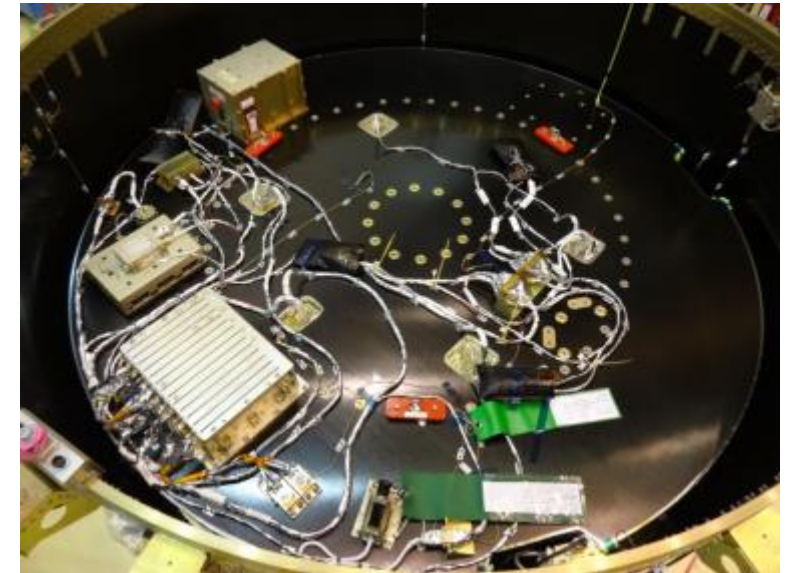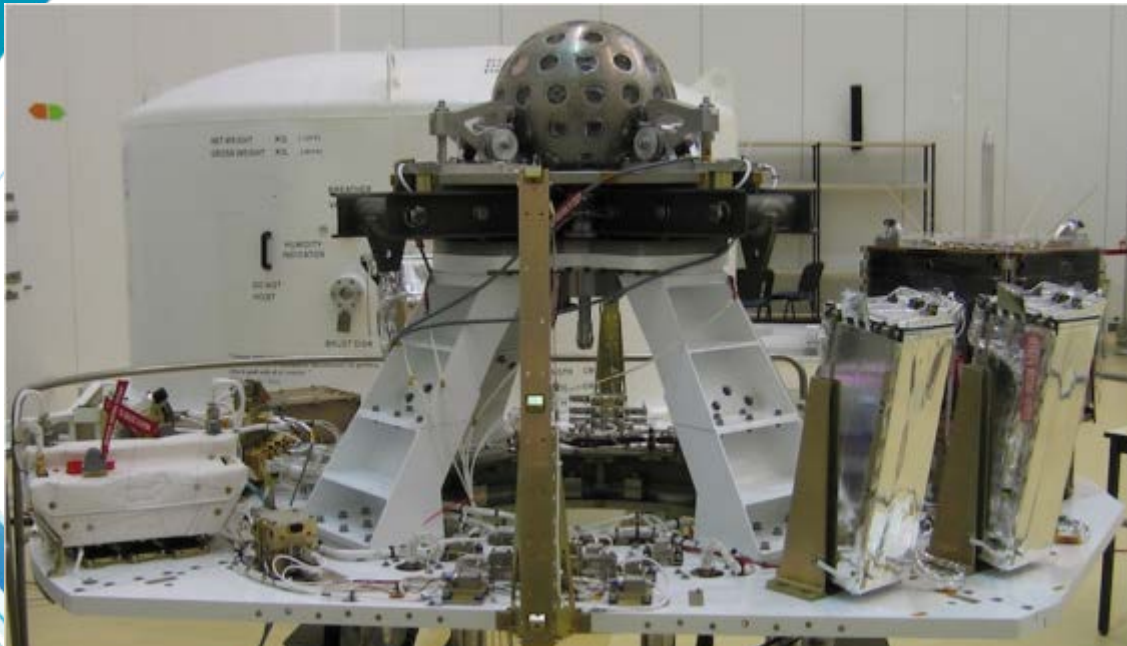
VV02 flight image
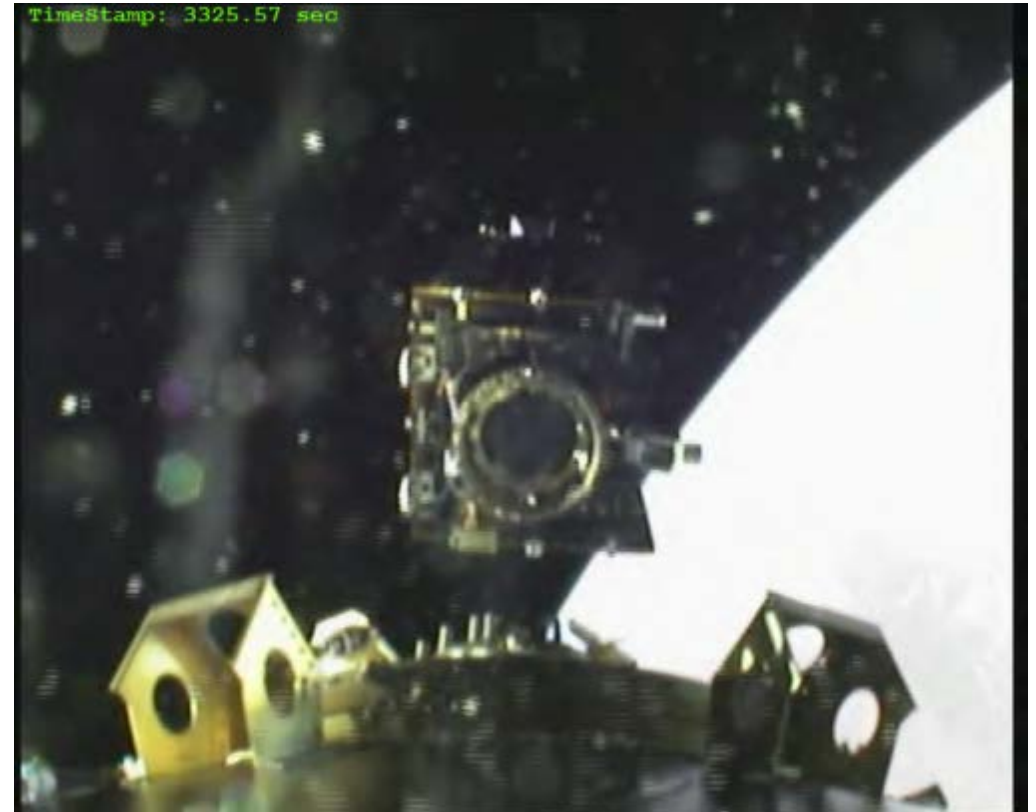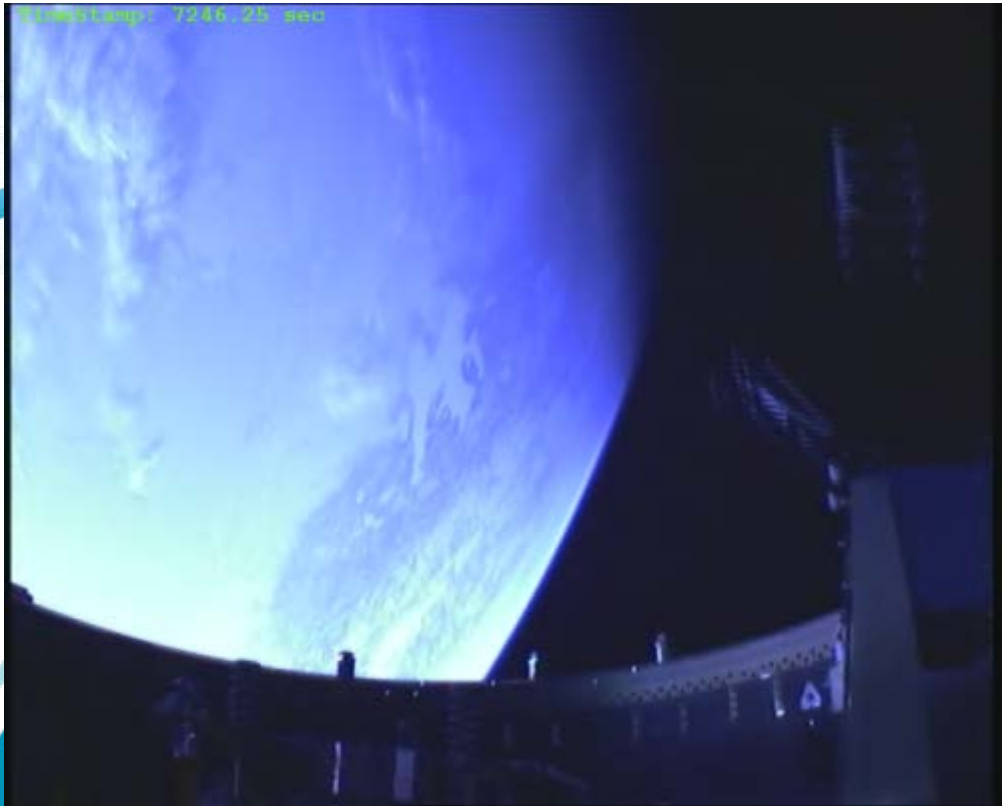
Funct. developed with CAN on VEGA #2

Functionalities implemented over CAN bus on TEMIS equipments:

➢ **On Board Data Handling Timeline management between equipments boards**
➢ **Timestamping of sensors data**

Commonalities over TEMIS avionics equipments and baseline approach:
➢ **Developed around CCP protocol over CAN bus**

➢ **Modular system approach**

➡ **Maximization of communication compatibility with other systems**
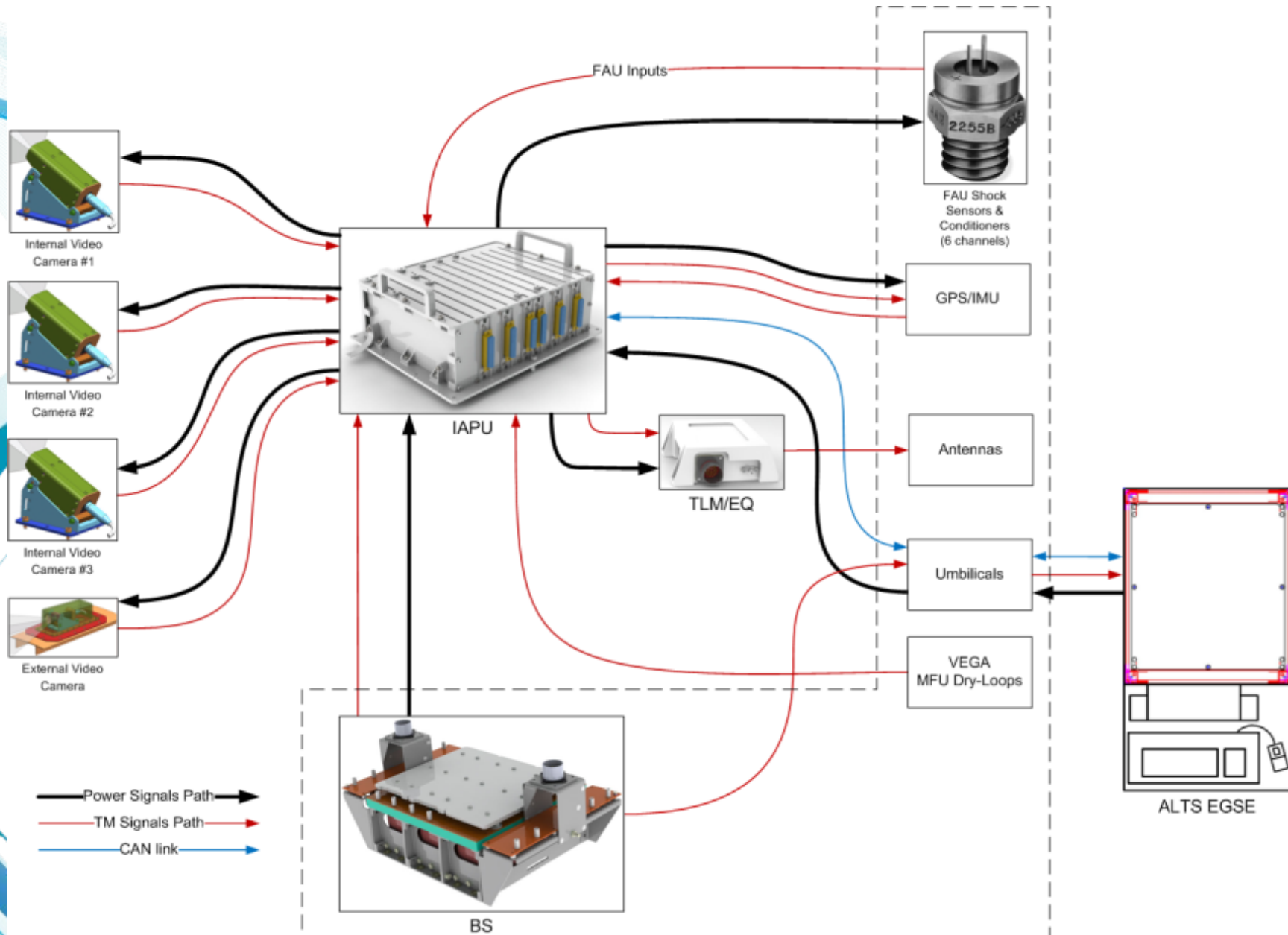
➡ **CAN protocol and bus permits the reconfiguration and management of heterogeneous devices and equipments (including EGSE)**

➢ **High availability of third-party interconnection boards and software (Vector boards, Vector diagnosis software, National Instruments boards, LabView software)**

Funct. developed with CAN on VEGA #3

Block Diagram of functionalities of TEMIS telemetry system on VEGA:

Internal Video Camera #1

Internal Video Camera #2

Internal Video Camera #3

External Video Camera

IAPU

BS

FAU Inputs

FAU Shock Sensors & Conditioners (6 channels)

GPS/IMU

TLM/EQ

Antennas

Umbilicals

VEGA MFU Dry-Loops

ALTS EGSE

Power Signals Path
TM Signals Path
CAN link

Block Diagram of functionalities of onboard equipment on VEGA:
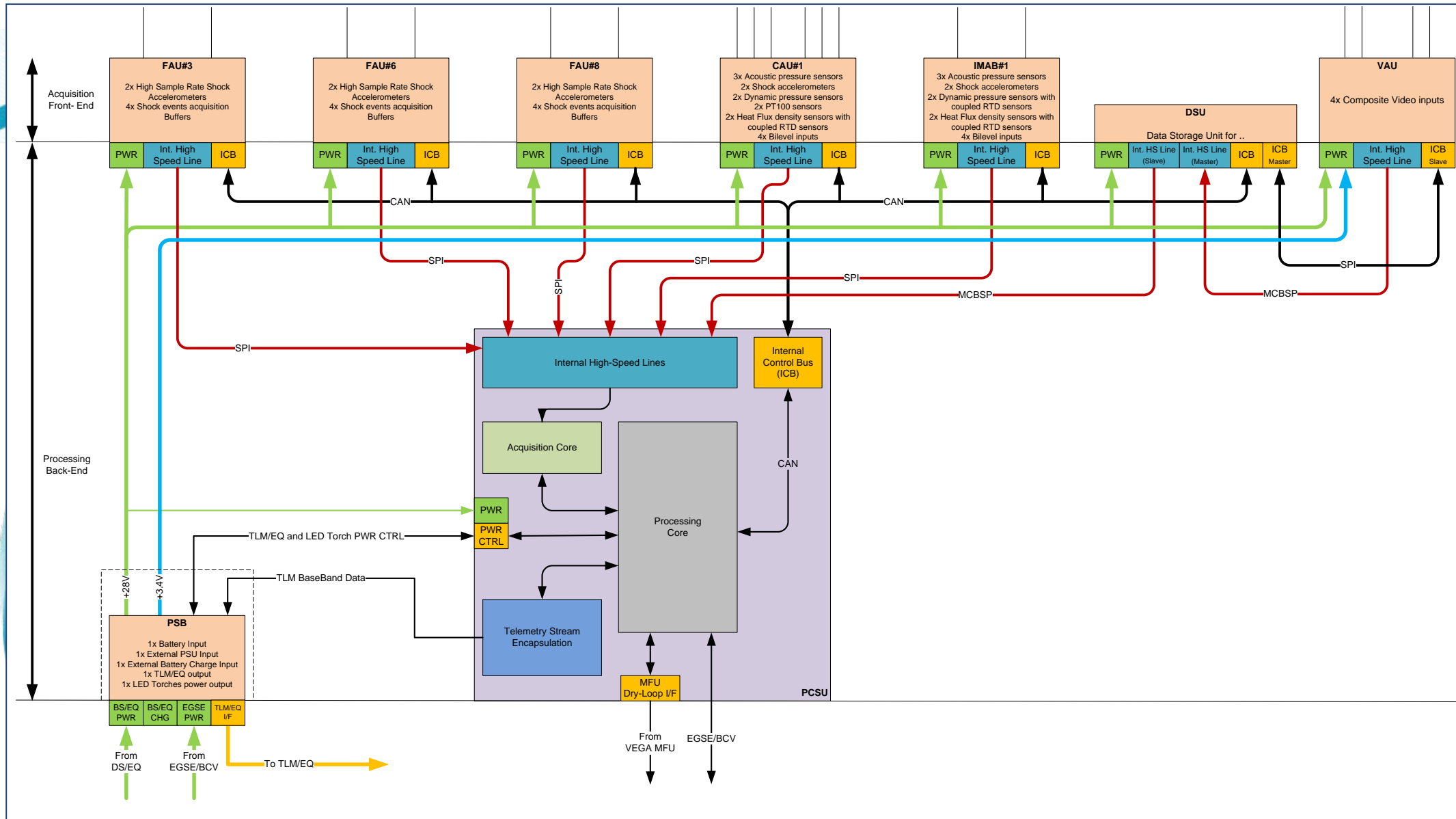
Ground Segment CAN Application 1

Apart the CAN communication between boards of payload modular system, the CAN bus has been selected to carry critical information, safety functionalities and the possibility to update data handling timeline and firmware updates in a safe way, even on the launch-pad

Critical Data ➡ **System Housekeeping**

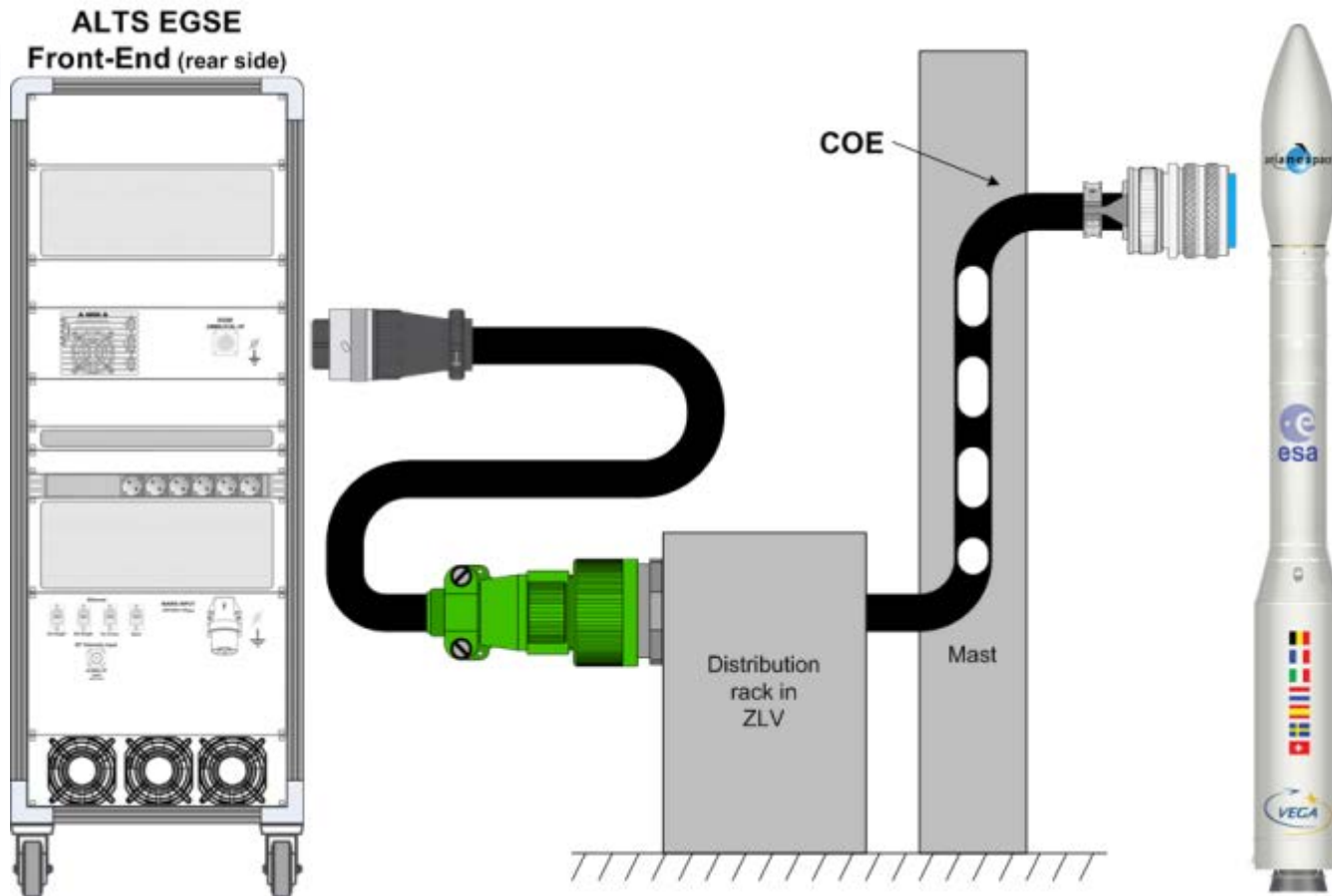**Safety Data** ➡ **RF TX and Battery Commands**
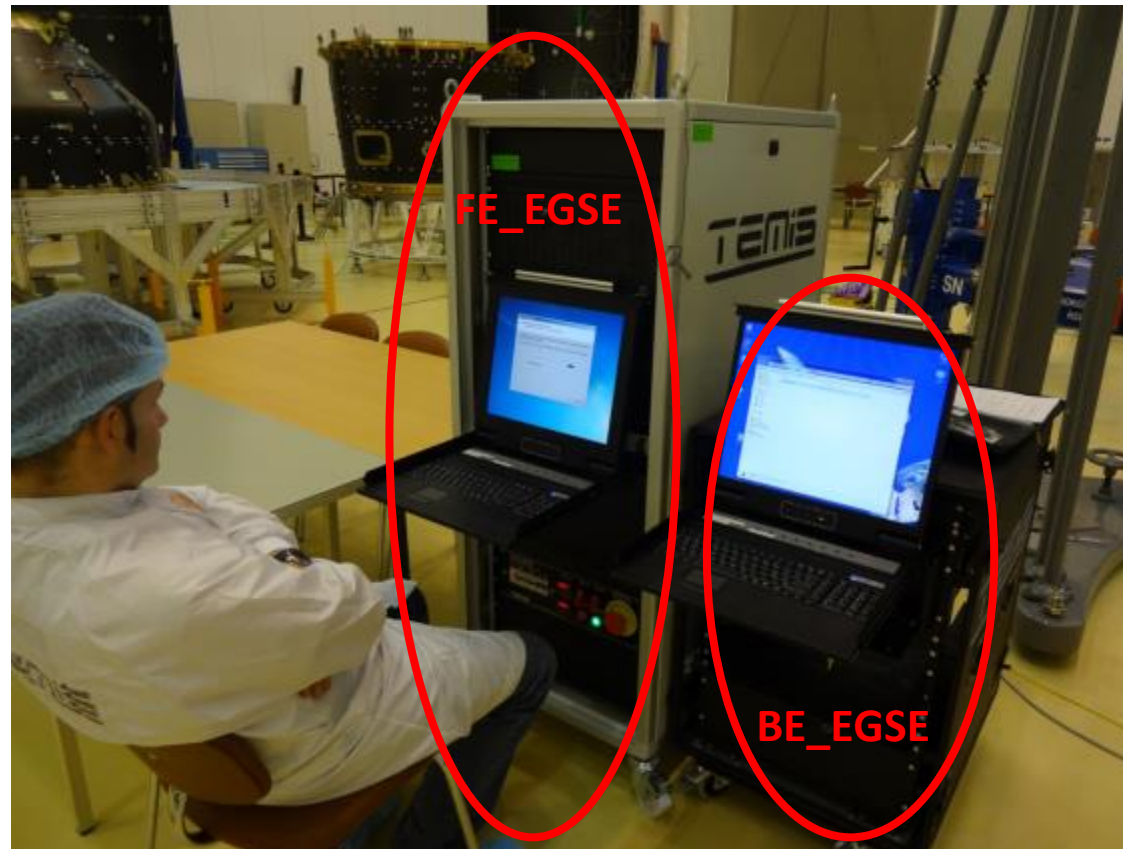
Safe Update ➡ **Data Handling/Firmware**

Ground Segment CAN Application 2

The Ground Segment Equipment for VV01 Lares A&H SubSystem and VV02 ALTS System was based around CAN connection from ground to the spacecraft. All the information and data was carried through a dedicated CAN electrical connection inside the umbilical.

Ground Segment CAN Application 3

The EGSE for modular telemetry developed for VEGA mission application is a stand alone rack (FE_EGSE) to be installed on the launch-pad bunker. It communicates via CAN and RS485 link to the spacecraft and it is managed remotely (from BE_EGSE installed on launch ground control room) by means of redundant Ethernet connection
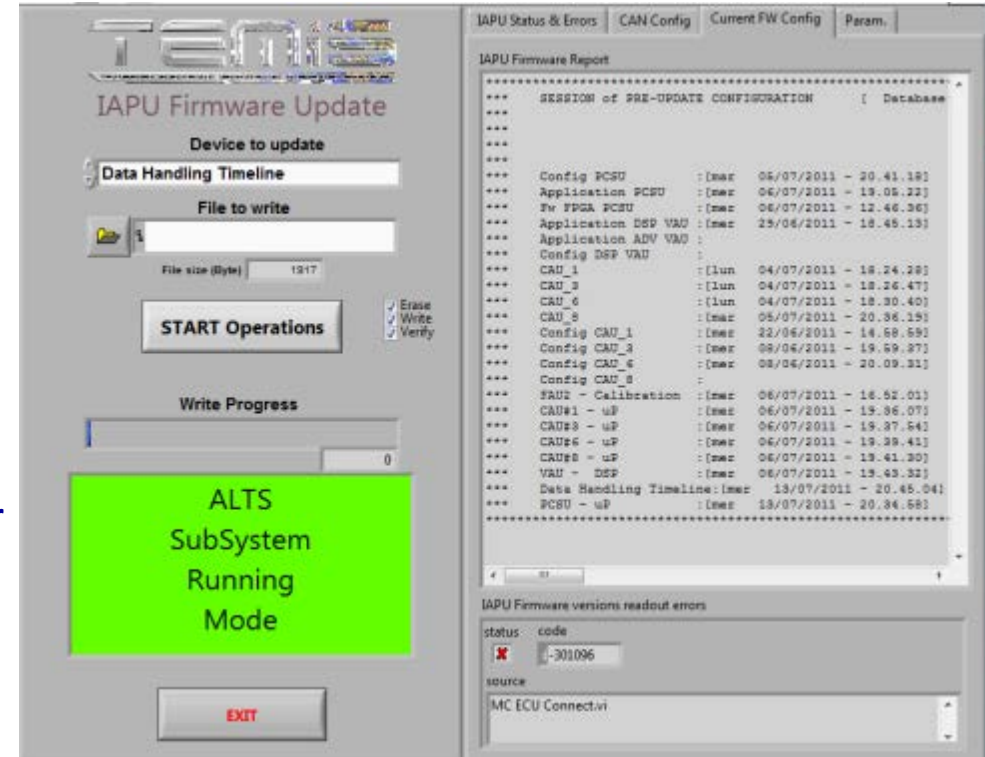
Ground Segment CAN Application 4

System housekeeping CAN bus -> BE_EGSE software

System Update: CAN bus -> Update data handling timeline and board firmware

Safety Data: CAN bus -> Actuate Battery Power and RF Transmitter

Other application of CAN in space by TEMIS

Temis is involved on the development and manufacturing of Common Electronics Unit (CEU) for DREAMS experiment as a payload of ExoMARS 2016 mission.

The unit will acquire an process and send to spacecraft all data from scientific sensors .
The unit implement a FLASH mass memory of 8 Gbit to store the telemetry between the data commits to spacecraft.

The development status is approaching the manufacturing of EM model.
The manufacturing of FM is foreseen in February 2014

Summary

CAN Bus Heritage on VEGA Flights:

Pros:

- Quality of connection into avionic telemetry – about 15 CAN packets at 1Mbps every 15ms with no errors during all missions and test phases (13,5Mpackets during flight operation)

- Safe onboard actuation of data handling timeline – postprocess of data with no errors

- Quality of connection on the CAN link between onboard system and launchpad – about 100 CAN packets at 250kbps every 10 ms with no errors during all ground test and preflight phases. (288Mpackets during VV02 prefilght operations)

- Umbilical CAN link length of 100 meters at 250kbps without errors on 2 missions

- Safe update of data handling timeline and board firmware , even on launchpad

- Continuous verification of system status

- Actuation of equipment under safety regulations (e.g. RF TX and battery power)

Cons:

- Impadance controlled cable (120ohm) needed for CAN links

- Maximum operative datarate of 1Mbps

- Mission reliability of CAN bus verified for launcher time slot (2.5hours for 2 missions)

Via G.Donizetti, 20

20011 – Corbetta (MI) – Italy

Phone: +39.02.90380812

Fax: +39.02.9010059

E-mail: info@temissrl.com