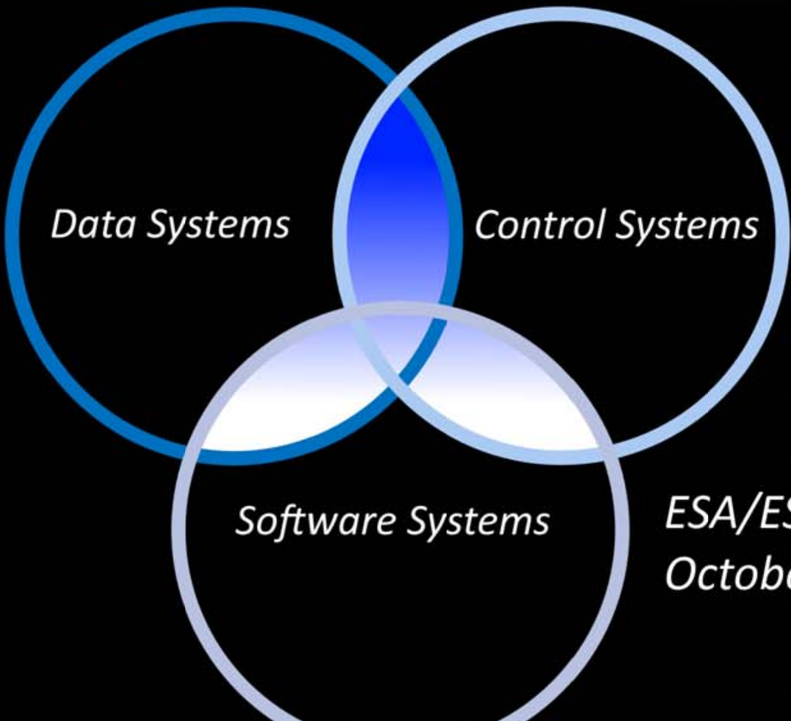
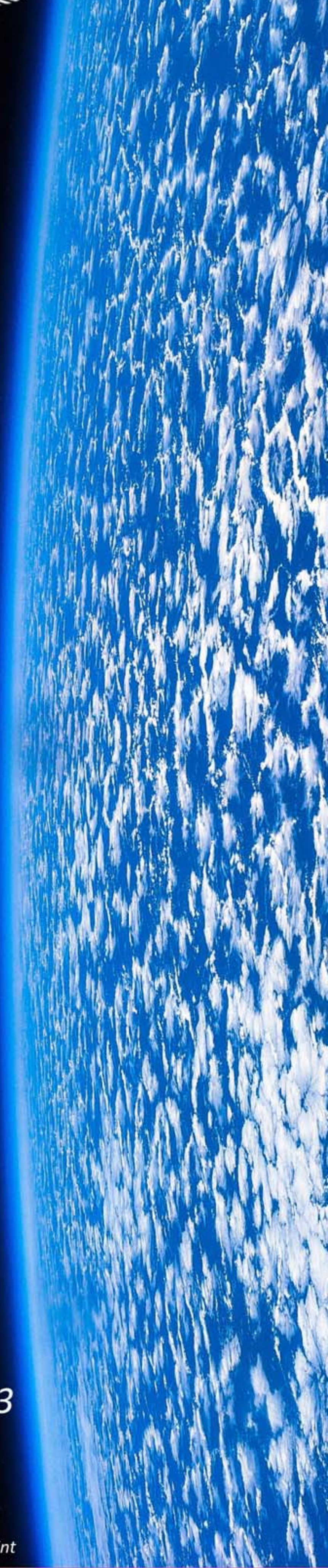
7th ESA Workshop on

Avionics **D**ata **C**ontrol **S**oftware **S**ystems



ESA/ESTEC
October 22-24, 2013



http://adcss.esa.int

SAVOIR

space avionics open interface architecture

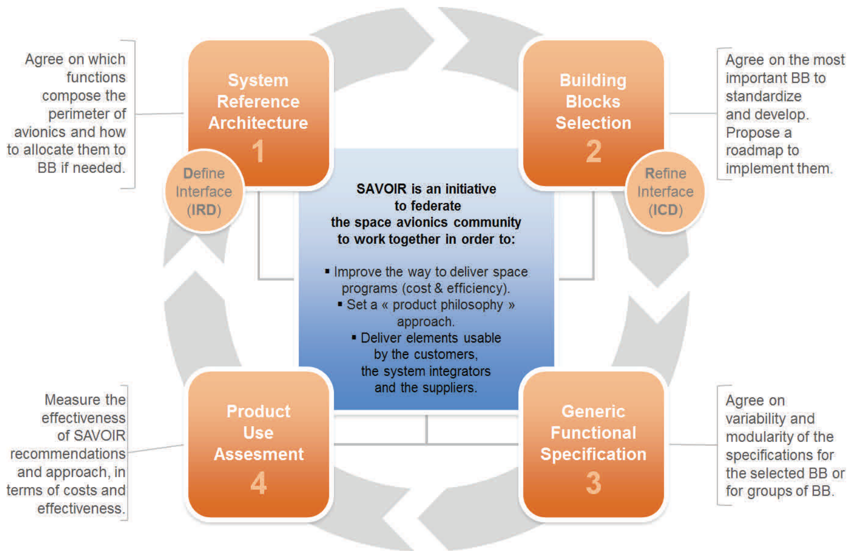
Space AVionics Open Interface aRchitecture is an initiative aiming at federating avionics communities in order to streamline avionics subsystems based on reference architectures, generic specifications and common build-in blocks

What are the primary outputs of SAVOIR

- Reference avionics architectures for spacecraft platform hardware and software
- Generic specifications for units such as On-Board Computers and Remote Terminal Units
- A set of standard avionics external and internal interface specifications
- The definition of building blocks composing the architecture
- The functional specification of selected building blocks comprising the architecture
- The implementation of selected building blocks at the right TRL level

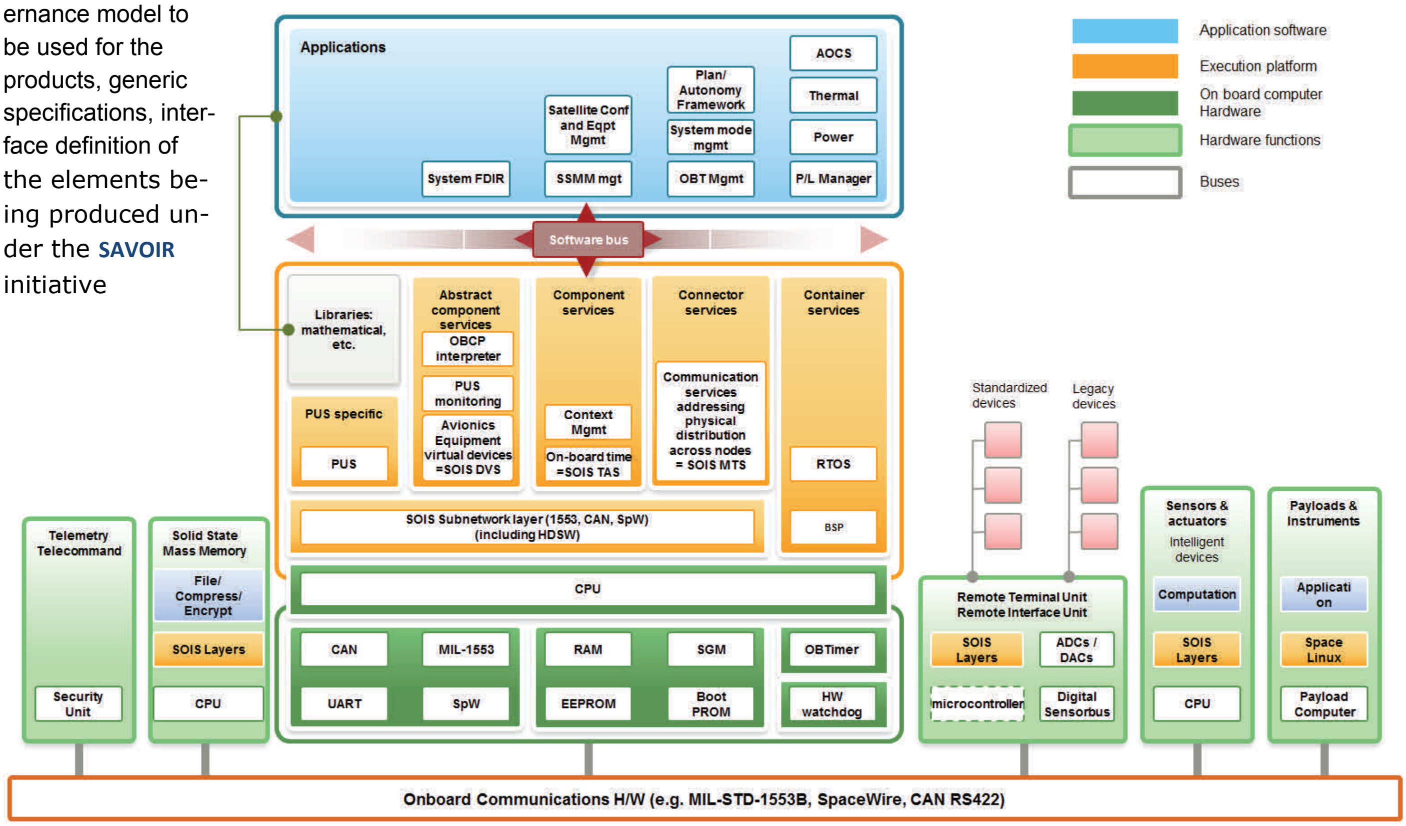
What are the objectives?

- To reduce the schedule and risk and thus cost of the avionics procurement and development, while preparing for the future
- To improve competitiveness of avionics suppliers
- To influence processes by standardizing at the right level in order to get equipment interchangeability (the topology remains specific to a project)
- To define the governance model to be used for the products, generic specifications, interface definition of the elements being produced under the **SAVOIR** initiative



What are the expected benefits of SAVOIR?

- For customers, streamline the procurement process of spacecraft avionics
- For system integrators, facilitate the integration of the spacecraft avionics
- For suppliers, prepare the technical conditions for a more efficient product line organization



7th ESA Workshop on Avionics, Data, Control and Software Systems

ADCSS 2013

Tuesday 22 October 2013 - Thursday 24 October 2013

European Space Research and Technology Centre (ESTEC)

Topics Scope

SAVOIR (22 October AM)

A significant effort is being deployed by Agencies and Industry to streamline the development, validation and operation phases of spacecraft, with particular focus on the Avionics. This effort is being coordinated by ESA in the form of the "Spacecraft Avionics Open Interface Architecture" (SAVOIR) initiative. SAVOIR brings together ESA and industry experts in an open forum and is gaining significant momentum. Based on establishment of reference architectures, it provides the ground for the identification of building blocks interacting through standardised interfaces, service access points and protocols across hardware and software boundaries. The session will be introduced by a general presentation of the overall concept complemented by more focused presentations dealing with lower level elements such as equipment specifications, interfaces to AOCS sensors and actuators together with advanced software concepts. The interaction between ground and space systems is tackled as well by considering implementation of file based operations and underlying concepts.

CAN Bus in Space (22 October PM & 23 October AM)

In space avionics we are witnessing a change from highly centralized intelligence to distributed autonomous functions, thanks to the availability of high capacity FPGAs and microcontrollers that offload tasks alternatively concentrated in the on- board computer. The glue of this change are the command and control buses, and a similar process led in the late 80s to the development and successive adoption of CAN as an automotive and industrial automation bus. The ADCSS CAN track will host keynote from the Managing Director of CAN in Automation, Holger Zeltwanger. It will include tutorials, exhibits together with presentations on CAN bus physical and protocol layers. Additionally an overview of modern design tools and method commonly used by automotive industry in design, development, production and maintenance of CAN bus networks for safety critical applications will be given.

Avionics Based on Ethernet Networks (23 October PM)

Ethernet is one of the most widely used communication interfaces for non-real-time terrestrial applications. Its use is still expanding in the industrial and automotive domains in part due to the introduction of enhancements to the original Ethernet specification to meet real time requirements. There are many variants of real-time Ethernet protocols (e.g. Profibus, Powerlink or AFDX) and recently the TTEthernet implementation from TTTech has received interest from the space environment by being adopted for the NASA Orion capsule. This session will overview the concepts behind TTEthernet and examine actual and potential use cases in space applications. Products and prototype implementations will be presented. The session will be introduced by Professor Hermann Kopetz; leading proponent in fault-tolerant and time-critical computing and the chief architect of TTP, the predecessor of TTEthernet."

High Performance Computing for GNC (24 October AM)

The objective of this track is to explore the requirements and possible solutions of complete avionics able to cope with very demanding autonomous closed loop controlled space applications. The complete avionics solution shall comprise the computer and data handling parts, the real-time software aspects, as well as the guidance, navigation and control algorithms. This track begins by giving current examples of missions with a high processing demand in GNC. Current demanding avionics applications are represented by Active Debris Removal (ADR) GNC systems and planetary exploration scenarios with stringent GNC requirements. Currently, ADR is by far the most demanding scenario in which we need high image processing power to be able to allow the closed loop control system to grab the target and de-orbit the entire compound target-chaser. In this scenario, the image processing algorithms will need to be allocated into highly powerful computing systems running specialised real-time software components. In both of the selected cases, there is a bottleneck in the processing of sensor information and the understanding of the environment. These use cases require sensors to extract basic GNC information such as relative position and velocity by applying a high-level understanding of the scene or object being observed. In the Active Debris Removal (ADR) case, this high-level understanding is the measurement of the relative attitude of a tumbling piece of debris, without needing any measurement aids such as optical markers or RF beacons. In the Lunar Landing case, this high-level understanding is the measurement of the relative position and velocity of the satellite with respect to the local terrain during descent. In both cases, the object being measured is poorly modelled and undergoing dynamic motion, and yet GNC information is required in a timely manner with minimum measurement errors.

Background: The continuous increase in available processing performance has enabled a matching increase in the performance and capabilities of spacecraft Guidance, Navigation and Control (GNC) systems. Automated systems such as the ATV have demonstrated significant capabilities that were only recently the sole domain of human-in-the-loop operations. This success continues to drive forward the potential applications of satellite autonomy and performances to meet new challenges, requiring ever greater levels of processing and autonomy.New missions are being proposed that once again were only recently assumed to require human operators due to the level of complexity involved. High-level understanding of dynamic and complex environments is now needed, with sufficient speed to enable closed-loop control. In some cases, human operations are not possible due to long communication delays, and in other cases the dynamic environment itself prevents continuous communications. With sufficient understanding of the environment, local decision-making can react faster, with greater accuracy and with potentially lower costs.

Objectives of the round table: The round table shall consider the two use cases with a view to clearly identifying the processing needs. The objective of the round table is to collect inputs, share experiences and discuss topics that encompass these needs. Open discussions shall highlight useful ideas as well as possible avenues for technology development. The round table will try to set light to the definition of the techniques and technologies required, departing from the exiting state of the art in ESA, as well as discuss about the design and optimization of the hardware and software areas in order to successfully perform the GNC functions on-board.

Software Factory (24 October PM)

Since decades, many attempts have been made to reuse software code, be it specific or generic. The approach has suffered many difficulties, while the concept of domain engineering was progressing around the notion of “variability factors”, i.e. the elements that allow parameterizing software within its domain of reuse. The “variability factors” become key elements of software architecture and make them robust to change within the domain of reuse. The maturity of these techniques has improved, and the pressure from software schedule is such that it is now mandatory to use reference architecture. In reference architecture, the software concepts become so systematic that tools can generate the code. Getting away from the pure code reuse, instead, these software concepts are reused, The approach is supported by automatic code generation and configuration (parameterized according to the variability factors). There is a paradigm shift from building generic software, to building generic software factories, from reusing code to reusing solutions. For space software, the notion of software factory includes in particular:

- definition of component models, including interface that can be parameterised in order to deploy automatically components on an infrastructure, itself configured automatically by the factory.

- model transformation from functional data to their physical implementation in the system data base. For example, the command “change mode” is transformed into the actual operation telecommand. Or the Electronic Data Sheet indicates how to access to particular sensors or actuators.

- parameterisation of specific “metier” viewpoint, such as the Packet Utilisation Standard

- “continuous build” of software iterations through automatic code regeneration (build) combined with automated testing. - supporting life cycle (e.g. Agile) The session will include presentations addressing various aspects of software factories, and will possibly address the maintenance of these huge tool sets through an example of open source solutions.

ADCSS 2013 TIMETABLE

Date	Title	Presenter	Track
22 October at 09:00	Welcome Speech	Mr. TOBIAS, Alberto	WELCOME
22 October at 09:20	Logic & Logistics of ADCSS	Ms. SINKA, Bertilla Mr. ARMBRUSTER, Philippe	WELCOME
22 October at 09:45	Introduction to SAVOIR	Mr. HJORTNAES, Kjeld	SAVOIR
22 October at 10:00	Status OBC and RTU generic specifications -reviews	Mr. MAGISTRATI, Giorgio	SAVOIR
22 October at 10:00	Coffee Break		BREAK
22 October at 11:00	Report from WG's: SAVOIR-SAFI	Mr. VAN HATTEM, Fabio	SAVOIR
22 October at 11:15	Report from WG's: SAVOIR-FAIRE	Mr. TERRAILLON, Jean-Loup	SAVOIR
22 October at 11:30	Report from WG's: SAVOIR-IMA	Ms. HERNEK, Maria	SAVOIR
22 Octoberat 11:45	Report from WG's: SOIS Status	Mr. TAYLOR, Chris	SAVOIR
22 October at 12:00	Recommendations for use of communication links within SAVOIR	Mr. HULT, Torbjorn	SAVOIR
22 October at 12:30	Reference Architecture for High Dependability On-Board Computers	Mr. SILVA, Nuno	SAVOIR
22 October at 12:50	Introduction of Exhibition	Mr. ARMBRUSTER, Philippe	
22 October at 13:00	Lunch Break		BREAK
22 October at 14:00	SOIS Electronic Data Sheets for Onboard Devices – Current Status	Mr. FOWELL, Stuart	SAVOIR
22 October at 14:30	PUS Status	Mr. VALERA, Serge	SAVOIR
22 October at 15:00	SAVOIR Roadmap	Mr. HJORTNAES, Kjeld	SAVOIR
22 October at 15:30	Coffee Break		BREAK
22 October at 15:45	Introduction to CAN Bus in Space	Mr. FURANO, Gianluca	CAN Bus in Space
22 October at 15:50	CAN/CANopen applications: Past, present, and future	Mr. ZELTWANGER, Holger	CAN Bus in Space
22 October at 16:20	The ECSS standard - CAN Bus extension for Space	Mr. NOTEBAERT, Olivier; Mr. BOLEAT, Christian	CAN Bus in Space
22 October at 16:40	ECSS Standard public review procedure	Mr. BURY, Stephen	CAN Bus in Space
22 October at 16:50	Where and when can we use CAN?	Mr. FURANO, Gianluca	CAN Bus in Space
22 October at 17:30	Roundtable CAN Session 1	Mr. TAYLOR, Chris Mr. FURANO, Gianluca Mr. MAGISTRATI, Giorgio	CAN Bus in Space
22 October at 18:00	Cocktail		SOCIAL EVENT
23 October at 09:00	Wrap up of CAN Session 1	Mr. MAGISTRATI, Giorgio	CAN Bus in Space
23 October at 09:10	Supporting developments - HW/SW stacks for ECSS CAN	Mr. VALVERDE CARRETERO, Alberto	CAN Bus in Space
23 October at 09:20	Supporting developments - IP Cores	Mr. FOSSATI, Luca	CAN Bus in Space
23 October at 09:30	Supporting developments testbeds - VECTOR Tools	Mr. FREDERIC, Vidy	CAN Bus in Space
23 October at 10:10	Supporting Developments - CAN Bus - Integrating Soft IP Cores into Rad Hard Products	Mr. ANDERSSON, Jan	CAN Bus in Space
23 October at 10:25	Supporting developments testbeds - Protocol Validation System	Mr. KOLLIAS, Vangelis	CAN Bus in Space
23 October at 10:35	Coffee Break		BREAK
23 October at 11:05	CAN in Space applications - Telecom Satellite - Payload	Mr. DALENQ, Jean	CAN Bus in Space
23 October at 11:25	CAN in Space applications - The EXOMARS CAN bus solutions	Mr. CARAMIA, Maurizio	CAN Bus in Space
23 October at 11:45	CAN In Space Applications - Thales Telecom Platform	Mr. BUSSEUIL, Jacques	CAN Bus in Space
23 October at 12:00	CAN in Space applications - Use of CAN Bus in the VEGA Launcher Autonomous Telemetry Systems.	Mr. ORTIX, Francesco	CAN Bus in Space
23 October at 12:20	CAN in Space applications - Small Satellite Platforms	Mr. STANTON, David	CAN Bus in Space
23 October at 12:40	Roundtable CAN Session 2	Mr. FURANO, Gianluca Mr. MAGISTRATI, Giorgio	CAN Bus in Space
23 October at 13:00	Lunch Break		BREAK

ADCSS 2013 TIMETABLE

Date	Title	Presenter	Track
23 October at 14:00	Introduction to Deterministic Networks	Prof. KOPETZ, Hermann	ABEN
23 October at 14:40	TTEthernet presentation	Mr. FIDI, Christian	ABEN
23 October at 15:10	MPCV CM Presentation	Mr. EGER, George W.	ABEN
23 October at 15:40	Coffee Break		
23 October at 16:00	Deterministic High Speed Communication in Space	Mr. HARTMANN, Jens	ABEN
23 October at 16:30	FLPP/AvionicX	Mr. JAVELLAUD, Guillaume	ABEN
23 October at 17:00	Implementation aspects of TTEthernet interfaces	Mr. PETERSEN, Anders	ABEN
23 October at 17:30	Roundtable ABEN	Mr. TAYLOR, Chris Mr. MAGISTRATI, Giorgio	ABEN
24 October at 08:30	Introduction to GNC	Mr. ORTEGA, Guillermo	GNC
24 October at 08:45	User cases: Active Debris Removal	Ms. INNOCENTI, Luisa	GNC
24 October at 09:05	User cases: Landing on the Moon, Mars, and asteroid	Mr. TRAMTOLA, Antonio	GNC
24 October at 09:25	Implementation options: navigation sensing suite	Mr. SOMMER, Josef	GNC
24 October at 09:45	Implementation options: CPU's, busses, networks	Mr. FOSSATI, Luca Mr. TRAUTNER, Roland	GNC
24 October at 10:00	Coffee Break		BREAK
24 October at 10:20	Implementation options: software	Mr. TRUJILLO, Salvador	GNC
24 October at 10:50	Implementation options: testing, verification and validation	Mr. BARRENA, Valentin	GNC
24 October at 11:20	Wrap up and Open discussion: do we have the technology available?	Mr. CROPP, Alexander	GNC
24 October at 12:00	Lunch Break		BREAK
24 October at 13:00	Introduction: software factory concepts	Mr. JUNG, Andreas	Software Factory
24 October at 13:10	Software product lines principles and examples	Mr. BOTTERWERK, Gotz	Software Factory
24 October at 13:30	Software factories from non-space experience	Mr. JULIOT, Etienne	Software Factory
24 October at 14:00	ESTEC lab experience: COrDeT & TASTE	Mr. PERROTIN, Maxime	Software Factory
24 October at 14:20	Ground software: CSDE: setting up a pipeline for continuous delivery	Mr. STANI, Emidio	Software Factory
24 October at 14:40	Ground software: Application of software factories in ASE-5	Mr. NIEVES SALOR, Moral	Software Factory
24 October at 15:00	Coffee Break		BREAK
24 October at 15:15	Flight Software: Astrium Standpoint	Mr. ROSSIGNOL, Alain	Software Factory
24 October at 15:30	Flight Software:Thales Standpoint	Mr. GARCIA, Gerald	Software Factory
24 October at 15:45	Flight Software: OHB standpoint	Mr. BRUENJES, Bernhard	Software Factory
24 October at 16:00	Roundtable: which software factory for Space?	Mr. TERRAILLON, Jean-Loup	Software Factory

7th ESA Workshop on Avionics, Data, Control and Software Systems - ADCSS 2013

Tuesday 22 October 2013 - Thursday 24 October 2013

European Space Research and Technology Centre (ESTEC)

Programme

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Tuesday 22 October 2013

Registration - Newton (22 October 08:30-09:00)

Register to the event, receive abstracts

- Conveners: Ms. Sinka, Bertilla (ESA/Data Systems Division)

Welcome to ADCSS 2013 - Newton (22 October 09:00-09:45)

time	title
09:00	**Welcome Speech** *Presenter: Mr. TOBIAS, Alberto (ESA)* Welcome Speech by Head of System, Software & Technology Department
09:20	**Logic & Logistics of ADCSS 2013** *Presenters: Ms. SINKA, Bertilla (ESA/Data Systems Division), Mr. ARMBRUSTER, Philippe (ESA/Data Systems Division)*

SAVOIR - Newton (22 October 09:45-15:45)

- Conveners: Mr. Hjortnaes, Kjeld (ESA/Software Systems Division); Mr. Benoit, Alain (ESA/Control Systems Division)

time	title
09:45	**Introduction to SAVOIR** *Presenter: Mr. HJORTNAES, Kjeld (ESA/Software Systems Division)*
10:00	**Status OBC and RTU generic specifications -reviews** *Presenter: Mr. MAGISTRATI, Giorgio (ESA/Data Systems Division)* One of the first aim of the SAVOIR initiative is the definition of an avionics reference architecture meeting the needs of the various mission domains. Generic Specifications for the two following building blocks have been produced: On-Board Computer (OBC) and Remote Terminal Unit (RTU). The two specifications have passed a review process. The presentation will recall the reference architecture and will present the OBC and RTU generic specifications.
10:30	Coffee Break
11:00	**Report from WG's (results oriented)**
	Mr. VAN HATTEM, Fabio - Savoir-SAFI Savoir SAFI working group studies the possibility of standardising functional interfaces for AOCS H/W. One of the main outputs of Savoir SAFI phase 1 has been a functional interface standardisation proposal for Star-Trackers.This standardisation proposal was elaborated between ESA and CNES agencies together with main European Spacecraft manufacturers (Astrium,ThalesAleniaSpace, OHB). Following SAFI phase 1 a support activity has been approved with the aim consolidate this standardisation proposal. Bringing European Star Trackers suppliers and Spacecraft manufacturers to agree on a standard for Star Tracker functional interface (only STR vs. OBSW communication).This functional interface standard will eventually be part of the Star Tracker ECSS standard as a NON-mandatory annex. The presentation will illustrate the current status of SAFI support activity.
	Mr. TERRAILLON, Jean-Loup - SAVOIR-FAIRE The SAVOIR-FAIRE working group is the sub group in charge of the on-board software reference architecture. It has produced a document describing architectural principles. The following work is supported by several industrial activities: - the COrDeT line of activities consolidate the architectural principles and propose a component model to express the application part of the architecture. They look also at some aspects of the execution platform. - OSRAC (1+2) have investigated the application functional chains and verified that they can be implemented with the proposed architecture, the component model and the execution platform services. The presentation will give an overview of the current activities status and achievements.

	Ms. HERNEK, Maria - Savoir-IMA status and progress SAVOIR IMA working group was launched in mid-2012 with the responsibility to investigate issues (hardware and software) related to the Integrated Modular Avionics introduction in the reference architectures. This include the hardware architecture (how to configure the existing architecture, to use the existing hardware, is there any missing hardware?) and the software architecture (is the on-board software reference architecture compatible with IMA, what is the impact of Time and Space Partitioning on the execution platform?). The presentation will report the result of on-going as well as concluded activities.
	Mr. TAYLOR, Chris - SOIS Status The CCSDS SOIS working was tasked with preparing a set of layered communication services which may be applied to the flight avionics. This work is now ostensibly complete and the standards are finding their way into practical application. This presentation provides a summary of the standards produced and the follow-on work being performed by the SOIS group.
12:00	**Recommendations for use of communication links within SAVOIR** *Presenter: Mr. HULT, Torbjorn (RUAG Space)* The SAVOIR architecture includes a number of preferred data buses, point-to-point lines and discrete signals. These links are used to interconnect spacecraft platform equipment, such as OBC and RTU, with platform sensors and actuators and also used to connect the spacecraft payload to the spacecraft platform. However, the usage of each link is not defined in detail and some links are better suited to fulfil specific user needs than other links. The presentation will give recommendations for which links to use for different users and the rationales for the recommendations.
12:30	**Reference Architecture for High Dependability On-Board Computers** *Presenter: Mr. SILVA, Nuno (Critical Software)* On-board computers (OBC) for space applications pose a major challenge for the industry due to their small production and limited in-service historical data (both for hardware and software). Thus, dependability statistical data, that can influence the specification, design and validation of OBCs, is quite limited. This study, initiated in the frame of ESA harmonization policy, represents the initiation phase of the development/procurement of on-board computers and means to improve dependability assurance. The study established generic requirements for the procurement or development of on-board computers, based on the SAVOIR specification, with a focus on well-defined reliability, availability, and maintainability requirements, as well as a generic methodology for planning, predicting and assessing the dependability of on-board computers hardware and software throughout their life cycle. Guidelines for creating evidences and arguments to support dependability assurance of on-board computers hardware and software throughout the complete lifecycle have been defined, including an assessment of feasibility aspects of the dependability assurance process and how the use of computer-aided environment can contribute to the on-board computer dependability assurance. The study is currently in the phase of applying the defined methodology and guidelines to a real case study. This presentation includes an overview of the on-board computers generic requirements, presents the defined dependability plan and approach, describes the dependability measures and methodology, introduces the dependability assurance guidelines for the production of evidences, and discusses the current application of the methodology and the collection of the evidences to a real case-study, leaving space for discussion and future improvement work.
12:50	**Introduction of Exhibition** *Presenter: Mr. ARMBRUSTER, Philippe (ESA/Data Systems Division)*
13:00	Lunch
14:00	**SOIS Electronic Data Sheets for Onboard Devices – Current Status** *Presenter: Mr. FOWELL, Stuart (SCISYS)* The presentation will summarise the requirements for SOIS Electronic Data Sheets for Onboard Devices, their planned usage in SAVOIR and NASA-cFE avionics architectures, the current status of prototyping by ESA, SCISYS and NASA, some of the technical and process issues to be addressed that have been thrown up, and finally the planned roadmap to the standardisation of their format by the CCSDS.

14:30	**PUS Status** *Presenter: Mr. VALERA, Serge (ESA/Software Systems Division)* Over the last 10 years, the PUS standard has been widely used in Europe by many ECSS Agencies and Industrial partners. A new version of that standard is currently being produced by ECSS, that takes into account: - the lessons learned from using the PUS, including the need for standardizing proven additional services implemented in current missions and required for future missions; -the availability of new standards, mainly ECSS and CCSDS, for which compliance is required. This presentation reports on the current status of this new version and the remaining work to be done prior to its publication in 2014.
15:00	**SAVOIR Roadmap** *Presenter: Mr. HJORTNAES, Kjeld (ESA/Software Systems Division)*
15:30	Coffee Break

CAN Bus in Space - Session 1 - Newton (22 October 15:45-18:00)

Introduction session on CAN bus with keynote speech.

- Conveners: Mr. Magistrati, Giorgio (ESA/Data Systems Division); Mr. Taylor, Chris (ESA/Data Systems Division); Mr. Furano, Gianluca (ESA/Data Systems Division)

time	title
15:45	**Introduction to CAN Bus in Space** *Presenter: Mr. FURANO, Gianluca (ESA/Data Systems Division)*
15:50	**CAN/CANopen applications: Past, present, and future** *Presenter: Mr. ZELTWANGER, Holger (CAN in Automation)* The CAN physical layer is very robust and the data link layer protocol guarantees a reliable data exchange. This is why CAN has been successful in many different application fields. The keynote speech provides an overview about the use of CAN in the past and today. It also gives an outlook into the future: CAN FD and partial networking are the keywords.
16:20	**The ECSS standard - CAN Bus extension for Space** *Presenters: Mr. NOTEBAERT, Olivier (Astrium Satellite SAS), Mr. BOLEAT, Christian (Astrium SAS)* The ECSS-E-50-15C standard “CAN bus extension protocol” extends the standard CAN bus specification to cover the aspects required to satisfy the particular needs of spacecraft data handling systems. This presentation will provide an overview of the requirements of the draft standard together with practical examples of its application on projects currently in development at Astrium Satellites such as the next generation E3000 for telecoms, Sentinel 1 for Earth observation and the Exomars rover for science and space exploration.
16:40	**ECSS Standard public review procedure** *Presenter: Mr. BURY, Stephen (ESA/ESTEC)*
16:50	**Where and when can we use CAN?** *Presenter: Mr. FURANO, Gianluca (ESA/Data Systems Division)* Standardization of on board command and control buses has achieved a good degree of maturity with the widespread adoption of MIL-STD-1553B and the increasing success of Spacewire. In this crowded space there is still room for other players in the sub-1Mbps range if we take into consideration some specific CAN bus characteristics that act as 'enablers' for some more modern architectures, where functions and intelligence decentralization has a driving role.
17:30	**Roundtable** *Presenters: Mr. TAYLOR, Chris (ESA/Data Systems Division), Mr. FURANO, Gianluca (ESA/Data Systems Division), Mr. MAGISTRATI, Giorgio (ESA/Data Systems Division)*

Cocktail - Foyer (18:00-19:30)

Wednesday 23 October 2013

CAN bus in Space - Session 2: CAN In Space - Applications - Newton (23 October 09:00-14:00)

Continuation of Session 1 with industry's position papers, presenattion of CAN tools and wrap up discussions.

- Conveners: Mr. Taylor, Chris (ESA/Data Systems Division); Mr. Magistrati, Giorgio (ESA/Data Systems Division); Mr. Furano, Gianluca (ESA - ESTEC - TEC-EDD)

time	title
09:00	**Wrap up of Session 1** *Presenter: Mr. MAGISTRATI, Giorgio (ESA/Data Systems Division)*
09:10	**Supporting developments - HW/SW stacks for ECSS CAN** *Presenter: Mr. VALVERDE CARRETERO, Alberto (ESA/Data Systems Division)* The modularity of the ECSS CAN standard based on CANOpen opens a wide range of possibilities in terms of HW/SW partitioning schemes in its implementation. The standard can be fully implemented in HW (i.e. CCIPC and RCCIPC), fully implemented in SW using existing CANOpen stacks or anything in between. This presentation and the associated demo will analyze different scenarios, with different requirements and will try to provide some help and guidance in the design of an ECSS CAN node.
09:20	**Supporting developments - IP Cores** *Presenter: Mr. FOSSATI, Luca (ESA/Data Systems Division)* ESA/ESTEC maintains and distributes under ESA licenses a small catalogue of IP Cores which comprise typical digital functions used in space applications.The ESA IP cores can be licensed for space research and/or commercial use,under specific conditions (depending on the IP ownership) to companies basedin ESA member and participant states.This talk will focus mostly on two of the IP-Cores present in the catalogue: HurriCANe, implementing the CAN protocol, and CCIPC, implementing a subset of the CANOpen protocol.
09:30	**Supporting developments testbeds - VECTOR Tools** *Presenter: Mr. FREDERIC, Vidy (VECTOR Gmbh)* The idea of the CAN bus is getting 30 years old in 2013. Within this time the CAN bus has not only established itself as the standard communication protocol in automotive networks but is also in use in aerospace or industrial applications. Although there are also other bus systems used in these areas, the CAN bus will still keep its strong market position for quite a while. With the CAN-FD technology the capabilities of the CAN bus are expanded and make it even more interesting, also for other industries than automotive. Being involved in the development of the CAN bus from the very beginning Vector was also the first company with a CAN tool on the market called CANalyzer. Since over 25 years Vector continuously expanded its tool suites and adapted it to the needs of the market to become one of the leading tool suppliers for the automotive industry. Today's tools for (bus) analysis, simulation and automated testing are not only limited to CAN but are also capable of other busses and protocols like e.g. Flexray, MOST, IP/Ethernet, AFDX, CANaerospace, ARINC8xx, ARINC429 or CANopen.

10:10	**Supporting Developments - CAN Bus - Integrating Soft IP Cores into Rad Hard Products** *Presenter: Mr. ANDERSSON, Jan (Aeroflex Gaisler)* The Controller Area Network (CAN) was initially created for automotive applications as a method for enabling robust serial communication. The CAN bus was identified by the European Space Agency (ESA) as a possible replacement for the On-Board Data Handling (OBDH) bus in the late '90s, with the SMART-1 satellite as the first successful example of its usage in an ESA mission. Although the OBDH bus was not immediately abandoned it has been slowly phased out, but not directly to the benefit of the CAN bus, while more to the MIL-STD-1553B bus. Despite the fact that several flight ready components implement the CAN bus protocol, it has taken some time for the CAN bus to get real traction in Europe and the rest of the world. We are currently on the brink of a breakthrough for usage of CAN technology in space and Aeroflex Gaisler has been preparing itself for this moment in time by developing a large set of CAN products ranging from soft IP cores to rad-hard flight components, and from powerful software drivers to handy hardware debuggers and emulation systems such as RASTA. The CAN IP cores have been used in notable ASIC developments (GR712RC, UT699/UT700, AT9713E, COLE) as well as in custom FPGA developments targeting missions such as ExoMars, Sentinel, ISS etc. With the advent of the new flexible data rate concept these IP cores are to be improved to fully support CAN-FD and to provide additional services such as hardware assisted message filtering, in addition to the existing programmable DMA functionality and support for highly accurate time distribution, all to off-load the processor in highly integrated system-on-chip designs where network management is implemented. The ESA on-board reference network is a marriage between the high-speed backbone SpaceWire network and the low-speed spacecraft control bus based on the CAN bus. This has been the continuous target for our developments, always implementing both interfaces in the aforementioned ASICs, all based on our existing IP cores. The new features of the soft IP cores will of course also be included in all future rad-hard ASIC developments.
10:25	**Supporting developments testbeds - Protocol Validation System** *Presenter: Mr. KOLLIAS, Vangelis (TELETEL SA)* Presentation of the Protocol Validation System (PVS) by TELETEL, which is a new generation EGSE SCOE, already supporting SpaceWire and MIL-STD-1553, being now extended to support CAN. PVS can be used for rapid prototyping & evaluation of new network protocols/features, for interface simulation, functional testing and stress testing. Moreover it can be used for device simulation (SSMM, RTU, etc.) as well as for protocol analysis & recording. Based on an open architecture and modular design, PVS is a future-safe, cost-effective and already validated solution for demanding ESA activities towards the future evolution of S/C on-board data handling/networks. The presentation is focusing on the specific PVS extensions to support EGSE SCOEs for the use of CAN bus in space
10:35	Coffee Break/Product Demos
11:05	**CAN in Space applications - Telecom Satellite - Payload** *Presenter: Mr. DALENQ, Jean (Astrium)* A successful CAN bus for telecom payload needs to fulfill precisely the extreme satcom requirements: high reliability of electronic components, high availability of the system solution achieved by minor modifications of the system architecture. Considering all those constraints, physical layer, redundancy management and protocol have been tailored to define a robust, efficient and cheap CAN payload data bus. This paper presents the on-going activities lead by Astrium and Tesat to implement the CAN bus as payload data bus on Eurostar E3000 platform.
11:25	**CAN in Space applications - The EXOMARS CAN bus solutions** *Presenter: Mr. CARAMIA, Maurizio (Thales Alenia Space)* This paper presents the on-going activities and solutions related to the development, research and standardization processes of the CAN Bus solutions carried out in the EXOMARS projects and studies where Thales Alenia Space Italy (TAS-I) is leading the industrial activities in collaboration with the European Space Agency. The CAN communication bus has been successfully used for many years in automotive industry and its usage in space is being assessed and one implementation is already the baseline in the EXOMARS (Entry Descent & Landing and Rover Modules) avionics architecture. The improvements and application to other Space systems such as Telecom Satellites have been studied and are under definition in the frame of ESA study and in Thales Alenia Space R activities. Further, CAN bus for Space Applications is in the process of being standardized in a specific ECSS standard.

11:45 **CAN In Space Applications - Thales Telecom Platform**

Presenter: Mr. BUSSEUIL, Jacques (Thales Alenia Space)

The objective of this activity is the development of a 'CAN solution' to be used in platform and payload avionics of telecom satellites. The proposed CAN solution has to cover all the aspects related to the introduction of the CAN bus in telecom satellites, from the physical and protocol layer definition up to the test and validation procedure definition.
A breadboard system fully representative of the electrical architecture proposed for CAN, with both RS-485 and ISO transceivers, representative redundancy, data traffic, noise and faults injection capability will be developed allowing pre-qualification of the CAN solution proposed.
At the end of this study, the achieved results will represent the technical proof that a CAN SAT COM solution is feasible and it will be able to lead to money and time savings, bringing benefits in all engineering steps of the DH system development from design, integration up to verification.
This study will also provide a set of lessons learnt and recommendation that can be used to update the ECSS-E-ST-50-15 standard.

12:00 **CAN in Space applications - Use of CAN Bus in the VEGA Launcher Autonomous Telemetry Systems.**

Presenter: Mr. ORTIX, Francesco (Temis)

The suite of CAN bus and protocols has been developed to create a reliable, safety critical, deterministic time communication over automotive electronic box use for the complete management of stock cars. It has been demonstrated over time and by widespread diffusion on automotive market the effectiveness and efficiency of CAN protocol and electrical bus on safety critical systems (ABS management, AIRBAG management, engine control, etc.). Basing on this set of protocols TEMIS, thanks to the know-how acquired over 10 years of experience in the automotive CAN application and in Fomula1 cars, has selected a particular protocol over CAN (CAN Calibration Protocol or CCP) to develop an high configurable, modular acquisition and telemetry subsystem for avionic application. The CAN bus has been used for intra-board communication in the processing unit and for critical communication between ground segment and processing unit itself. Two configurations of such telemetry system have flown in the first and second VEGA flight (VV01, VV02) carrying video data, high bandwidth sensor acquisition, IMU acquisition, GPS acquisition preventing radio. The two systems, docked on the upper stage of VEGA launcher, communicated until lift-off via umbilical CAN connection of about 80 meters to the relevant EGSE (positioned in bunker under launch pad). The main functionalities achieved via CAN bus on the system goes from data handling timeline management to ultra fine timestamp of acquisition and events, including update and monitoring of system parameters even when integrated in launch pad. The test and validation of this CAN bus application has been performed using third party commercial COTS to gain low cost of development and fast time of production of EGSE/Test Equipment. Custom
software has been developed to support the operations and test over the entire
system. The flight data after the two missions reports that all internal communication of on-board system has been correctly performed over entire mission.

12:20 **CAN in Space applications - Small Satellite Platforms**

Presenter: Mr. STANTON, David (SSTL)

SSTL have been using CAN bus as their primary method of transferring commands and telemetry around their spacecraft of over a decade. The use of CAN bus is at the heart of their nominal and non-nominal concept of operations. The architecture allows complete access to spacecraft systems by the ground segment independent of the spacecraft onboard computer to allow versatile strategies for anomaly recovery and diagnosis. SSTL are extending their leverage of automobile technology to incorporate "fit for purpose" technologies such as LIN bus and the emerging CAN-FD bus as well as exploiting associated items such as consumer level high reliability parts. This paper will describe how the use of these technologies enables the radical cost and mass savings, as well as hugely increased performance, which are to be introduced into SSTL's new X-series spacecraft range.

12:40 **Roundtable**

Presenters: Mr. FURANO, Gianluca (ESA/Data Systems Division), Mr. TAYLOR, Chris (ESA/Data Systems Division), Mr. MAGISTRATI, Giorgio (ESA/Data Systems Division)

Wrap up round table.

13:00 Lunch Break

Avionics Based on Ethernet Networks - Newton (23 October 14:00-18:15)

- Conveners: Mr. Taylor, Chris (ESA/Data Systems Division); Mr. Dufour, Jean-Francois (ESA/Data Systems Division)

time	title
14:00	**Introduction to Deterministic Networks** *Presenter: Prof. KOPETZ, Hermann (Technical University of Vienna)* This lecture starts by presenting some reasons for deterministic networks in high-dependability application, where the mean-time-to-fail (MTTF) of a critical system service must be higher than the MTTF of any of the constituent components. The required notion of determinism is examined and it is shown that predictable timeliness and consistent order are the important characteristics of a deterministic transport service. It is shown that the realization of consistent order requires a sparse time-base and agreement protocols for non-sparse events. The quality of the required fault-tolerant clock synchronization, the precision, determines the parameters of the sparse time base and in consequence the limits of the resolution of quasi-simultaneous events. The inherent conflict between fidelity of a digital model of the physical environment and consistency within the digital model can be reduced by an improved precision of the global time, but can never be fully resolved.
14:40	**TTEthernet presentation** *Presenter: Mr. FIDI, Christian (TTTech Computertechnik AG)* The presentation will target the utilization of additional synchronous, time-triggered Ethernet quality-of service (QoS) enhancements in IEEE802 Ethernet and ARINC664 networks to support both bandwidth time-partitioning and system-wide (or system-level) time-partitioning. Ethernet-based system architectures with time-driven communication capabilities enable tight control of jitter and strict determinism with far reaching consequences on embedded system virtualization, architecture design and optimization in spacecraft avionics. Extended embedded virtualization capabilities with time-partitioning of distributed embedded resources support design of new optimized generic integrated architectures, which are less complex to integrate, maintain, expand, reconfigure, certify, and modernize. Such generic architectures leading to cross industry platforms and therefore, not only through the availability of development-, flight-components and COTS testing equipment, a significant reduction of lifecycle costs can be achieved.
15:10	**MPCV CM Presentation- Webex** *Presenter: Mr. EGER, George W. (Locheed Martin)*
15:40	Coffee Break
16:00	**Deterministic High Speed Communication in Space** *Presenter: Mr. HARTMANN, Jens (Astrium EADS)* The user requirements on data throughput and –speed of avionic busses are calling for new media. Simplification and reuse of architectures and components to realize cost reduction are requested. In the past, different bus types were used to fulfill the technical requirements: on one hand determinism and exactly time correlated data , on the other hand high performance data management for sensors or payloads. For the deterministic part often the MIL1553 STD is used, limited to a bandwidth of 1Mbit. Ethernet or Space Wire are used for high speed communication. A promising candidate, providing one technology combining both determinism and high speed- for space applications, is the TTEthernet standard used and verified by commercial and aviation industries. This standard is baseline for the NASA's MPCV/ORION. A spin in of this technology standard, its maturation, the current experience in the frame of space projects (MPCV-ESM) and an industrialization roadmap will be described in the presentation.
16:30	**FLPP/AvionicX** *Presenter: Mr. JAVELLAUD, Guillaume (ESA/HQ)* Ethernet communication is at the base of the trade-offs of the future launcher programmes. These different programmes (ESA-FLPP, CNES-AvioniqueX, Ariane6) will be presented, together with the requirements specific to the data bus and telemetry. Trade-offs will be exposed and discussed (e.g. mil1553 vs AFDX vs TTEthernet
17:00	**Implementation aspects of TTEthernet interfaces** *Presenter: Mr. PETERSEN, Anders (RUAG Space AB)* This presentation will give an overview of RUAG Space AB undertaking in three different studies within FLPP and AvionicX and give our experience in using TTEthernet as a launcher communication network and how well it fit in such an architecture. Three different architectures and different implementations of TTEthernet have been studied, from a software implementation in the first study to more representative hardware and IP cores used in a custom FPGA design. Moreover the experiences in interfacing the IP core, use of ICDs and generating configuration files using TTTech tools will be reflected.
17:30	**Roundtable** *Presenters: Mr. TAYLOR, Chris (ESA/Data Systems Division), Mr. MAGISTRATI, Giorgio (ESA/Data Systems Division)*

Thursday 24 October 2013

Processing needs for advanced GNC Systems - Newton (24 October 08:30-13:00)

Advanced avionics

- Conveners: Mr. Ortega, Guillermo (ESA/Control Systems Division)

time	title
08:30	**Introduction** *Presenter: Mr. ORTEGA, Guillermo (ESA/Control Systems Division)*
08:45	**User cases: Active Debris Removal** *Presenter: Ms. INNOCENTI, Luisa (ESA-LAU-SF)* Studies at NASA and ESA indicate that the only means of sustaining the environment at a safe level for space operations will be by active removal of currently existing mass in orbit. Targets selected for active removal should have a high mass (as these targets have the largest environmental impact in case of collision), a high collision probability (i.e. they should be in densely populated regions), and should be in high altitudes (where the orbital lifetime of the resulting fragments is long). A Phase-A study to bring down a large EAS-owned piece of space debris will be held in 2014. Clean Space – Space Debris Remediation The Clean Space initiative was presented as part of the “Advancing ESA Technology Programmes” in view of the Ministerial Conference in 2012. Its aim is to devote increasing attention to the environmental impact of ESA’s activities, including its own operations as well as operations performed by European industry in the frame of ESA programmes. Clean Space Branch 4 specifically aims to develop key technologies for Space Debris Remediation and Active Debris Removal (ADR). Mission Outline The specific requirements of an ADR mission call for the development and validation of several technologies in the different mission phases: • Rendezvous with uncooperative target: sensor suite, telecommunications, operations concept • Attitude matching: forced motion GNC for acquiring a stable relative position with respect to the target, and perform the final approach • Capture: capture mechanism, capture operations • De-orbit manoeuvres: control of the composite (after capture) during orbital manoeuvres and controlled re-entry. This presentation will be focused on the high-performance computing needs for the close approach and the mating and capture mission arcs. These parts of the mission need complete avionics solution able to cope with very demanding autonomous closed loop controlled systems: the problem of pose estimation when the debris is tumbling is one of the most demanding ones in terms of avionics (computing power, and real-time software processing). In this context, features of the target should be acquired and analysed such as size, relative position, behaviour (movement and speed) and shape
09:05	**User cases: Landing on the Moon, Mars, and asteroid** *Presenter: Mr. TRAMTOLA, Antonio (TAS-I)* Landing on Mars, Moon and Asteroids: needed computational power and possible platform architecture. Landing on planets is a task which complexity depends on required accuracy. In the current Exomars project the accuracy is in the order of tens of Km: GNC algorithms, as developed by TAS-I for this type of missions, do not require significant computational power. They can be executed by a LEON processor (in the order of 80 MIPS @ 80Hz). If the accuracy in reaching the landing site increases to few hundreds of meters, the GNC requires additional sensors (camera, lidar) and/or dedicated navigation algorithms (i.e. Guided Entry).These elements increase the computational needs and currently available space qualified computing platforms becomes no more adequate. It is estimated that both atmospheric (Mars) and non-atmospheric (Moon, Asteroid) landing requires much more than 1000MIPs of computational power for Absolute Navigation, Relative navigation and Hazard detection. Among these, the Relative Navigation algorithms look the more demanding and drive the requested platform performances because they have to be executed at the control loop frequency (starting at 2 Hz and up to 10 Hz). In the Absolute Navigation, image processing can be used at lower frequency or even from time to time at specific points in the trajectory. The same applies to Hazard detection and Avoidance that is carried out at a well-defined altitude of the landing trajectory for the final correction. All these aspects have been considered and evaluated in two ESA studies (SAGE and VISNAV-EM-1) lead by TAS-I and also in the STEPS project (internal R co-founded by Regione Piemonte) on image processing with the objective of defining and testing a computing platform architecture which can be implemented using space qualified components .Such architecture uses a processor coprocessor configuration in which the coprocessor can be an additional more powerful processor or a FPGA or both FPGA+ Processor. These architectures will be presented pointing out the main features and the achievable performances.

09:25 **Implementation options: navigation sensing suite**

Presenter: Mr. SOMMER, Josef (Astrium Bremen)

The imperilment in space by debris or incapacitated spacecraft, in particular in nearly polar low earth orbits, has materialized latest after the collision between an Iridium and a superannuated Kosmos satellite in February 2009. Today all space agencies are working more or less intensive on concepts for space waste disposal. A key technology for this is a navigation system, which allows the approach to an uncooperative passive target in low earth orbits down to a distance, where capturing is possible. The final distance depends on the capture system and varies between 1m for a manipulator arm and several 10m for tether based systems like the net.

Today’s RVD systems require a cooperative target, i.e. there is a need for target pattern and/or a intersatellite RF link for data exchange (e.g. RGPS). For old or incapacitated spacecraft this is not available, so that the navigation must rely on active sensors (radar, laser scanner, flash light) or exploit environmental illumination or temperature (video camera and IR sensors). In close vicinity to the target, it is not sufficient to measure distance and line of sight, but the target attitude needs to be known as well. This requires onboard real time image processing, whereby the images may be generated by a video or IR camera, a laser scanner or an imaging radar.

The envisaged presentation shows the results achieved within Inveritas and RTES, Astrium internal projects subsidised by the Federal Ministry of Economics and Technology through the German Aerospace Center, DLR, Space Management,. It describes a navigation system layout for a rendezvous with an uncapacitated but known space vehicle (satellite or upper stage), i.e. the knowledge of the S/C geometry can be exploited for the onboard image processing. Three elements are of particular importance for the rendezvous navigation

• the navigation sensor (video camera, PMD camera, infrared camera, scanning Lidar, flash Lidar, radar)
• the processing of the raw data (image, point cloud)
• the processing/W requirements

First a short mission overview will be given and the top level requirements as a function of the typical mission phases will be derived. Then sensor candidates and their characteristics will be reviewed for potential application as a rendezvous sensor and needs for data processing are assessed. For the selected concept preliminary performance results are shown and processing needs are identified and compared to existing processing hardware or hardware under development. Finally the laboratory environment for navigation design and analysis including the use of a test facility for sensor testing may be described.

09:45 **Implementation options: CPU's, busses, networks**

Presenters: Mr. FOSSATI, Luca (ESA/Data Systems Division), Mr. TRAUTNER, Roland (ESA/Data Systems Division)

Future GNC systems feature increasingly complex functionality, requiring fast and efficient processing units and equally efficient interconnection to feed them with high rate sensor data. For what concerns the former point, ESA is working on complementary architectures spanning from a multi-core general purpose microprocessor (NGMP) to more specialised devices. This is complemented by the development of very high speed interfaces and links able to cope with multi-Gbps level data transfers.

The Next Generation MicroProcessor (NGMP) is a quad-core system-on-chip including four LEON4 SPARC32 cores with dedicated L1 caches and a shared L2 cache. It includes a DDR-type main memory interface and various high-performance I/O interfaces. Currently the architectural design is complete and has been manufactured in a commercial prototyping ASIC technology. Implementation of the NGMP as a space component is planned to start in 2014 and this in a suitable advanced Deep-Sub-Micron technology.

As far as specialised devices are concerned, the Control Loop Processor features two parallel processing chains enabling fully deterministic control of electromechanical systems, and this at high control loop frequencies. One distinctive feature is the usage of IEEE-754 compliant floating point arithmetic, a common representation to simulators and end flight code. Additionally, the device will be completed with a software development environment capable to generate executable code from a mathematical model. In the same category, it is worth mentioning ESA's push and efforts focusing on the development of a European source for next generation Digital Signal Processor (DSP) and high gate number FPGAs.

Finally the evolution of SpaceWire for higher data throughput communication channels (SpaceFibre) will be presented.

10:00 Coffee Break

10:20 **Implementation options: software**

Presenter: Mr. TRUJILLO, Salvador (IKERLAN)

The presentation is based on the experience of MultiPARTES, a research project aimed at developing tools and solutions for building trusted embedded systems with mixed criticality components on multicore platforms. The approach is based on developing an innovative open-source multicore-platform virtualization layer based on the XtratuM hypervisor. A software development methodology and its associated tools are developed in order to enable trusted real-time embedded systems to be developed as partitioned applications in a timely and cost-effective way. MultiPARTES is a collaborative research project supported by the European Union under the 7th Framework Programme in the area of Information and Communication Technologies (ICT).

The presentation introduces the project and in particular the industrial use cases, showing what can be achieved out of the space domain. Technical results are given about the capability to handle heterogeneous multicore platforms, about the partitioning layer and about performance. The presentation concludes on the applicability of such a software implementation option to space GNC applications.

10:50 **Implementation options: testing, verification and validation**

Presenter: Mr. BARRENA, Valentin (GMV)

11:20 **Wrap up and Open discussion: do we have the technology available?**

Presenter: Mr. CROPP, Alexander (ESA/Control Systems Division)

12:00 Lunch

SW Factory - Newton (24 October 13:00-17:00)

SW Factory as a container for automated processing and generation of SW

- Conveners: Mr. Terraillon, Jean-Loup (ESA/Software Systems Division)

time title

13:00 **Introduction: software factory concepts**

Presenter: Mr. JUNG, Andreas (ESA/Software Systems Division)

This short introduction to the software factories session sets up the context that has led to addressing this topic. Many project issues, often system or schedule ones, materialize in the software. To cope with them, an efficient measure is to reduce architecture complexity. This leads to the definition of software reference architecture, expressed with components, engineered with models and substantially parameterized. These mechanisms allow systematic configuration of the software within product lines, and open the door to an extensive automation of the software production, supported by software factories.

A paradigm shift is emerging, from building generic software, to building generic software factories, from reusing code to reusing solutions.

13:10 **Software product lines principles and examples**

Presenter: Mr. BOTTERWERK, Gotz (LERO)

This presentation results from an academic approach to product lines performed by a research institute from experience in non-space domains.

13:30 **Software factories from non-space experience**

Presenter: Mr. JULIOT, Etienne (Obeo)

Automation of software engineering is done, in other domains than space, beyond automatic code generation. This presentation highlights experiences such as generation of the system configuration from product lines, early architecture definition and validation, links with system engineering. Use cases from the train, the aeronautic and the military domains are presented with an innovative way of relying on Domain Specific Language to leverage the know-how of stakeholders. Supporting tools are also addressed, showing the variety of tools involved, the complexity to keep them operational, and to maintain them in an efficient and long term way. The example of the Polarsys open source software factory illustrates a possible solution

14:00 **ESTEC lab experience: COrDeT & TASTE**

Presenter: Mr. PERROTIN, Maxime (ESA/Software Systems Division)

The Savoir-Faire concepts have been prototyped into a chain of tools. The COrDeT reference architecture component model is described with a Domain Specific Language that has been used to produce an editor. The model is enriched into a detailed design through model transformation rules. The TASTE tool integrates and generates the code, the monitoring and control screens, the links with the Spacecraft Database, potential links to SMP2 simulators. This includes configuration techniques such as the Electronic Data Sheet.

14:20	**Ground software: CSDE: setting up a pipeline for continuous delivery** *Presenter: Mr. STANI, Emidio (UNISYS)* Software development involves people, methodologies and tools. Not only it is important to have the right tool for the right project but also to share efficiently the information inside the team, which therefore needs to be well organized. Sharing best practices between teams improve efficiency in the delivery. The CSDE (Collaborative Software Development Environment) platform is based on a pipeline of continuous delivery, helping project team members to organize their work, from requirements gathering to software building, by making use of bug tracking, version control and continuous integration practices. The talk presents the potential of the current CSDE status and the future vision, addressing the software life cycle model, pipeline for continuous delivery, feedback within the team, continuous integration and knowledge sharing between teams.
14:40	**Ground software: Application of software factories in ASE-5** *Presenter: NIEVES, Salor Moral (Vitrociset)* Coding and testing represents a substantial part of a software project. Although manual coding allows greater flexibility and control in what is being developed, it implies manual testing and regression testing, which costs time. Therefore, code automation is becoming a necessity during development. Thanks to the use of libraries and tools implementing the concept of software factories, part of the code can be automatically generated from either configuration files or diagrams, removing the need to verify the correctness and testing of the generated code. This presentation describes the automatic code generation done in the scope of the ASE5 project. The system uses several 'software factories' in different aspects of the application, in particular: • The complete creation of the database scripts through the collaboration of the modeling methodology named ORM (i.e. Object Relational Modeling) and a tool named NORMA. • The almost complete generation of the persistence model classes through the use of the Hibernate library. • The complete creation of the base SSM Editor (i.e. Space System Model) application by using the EMF methodology. Only investing time in creating a XSD data model representation of the SSM, a simple graphical and tab editor with validation functions is generated. • The complete compiler developments for both ECSS-E-ST-70-32 (i.e. PLUTO) procedure language and its meta-language. The compilers are generated from their respective grammar definitions in EBNF using the software factory ANTLR. Through this automation system, the system can modify in a matter of minutes any of the involved information or target system (e.g. database contents, database engine, programming language) without having to perform any further work or testing. As a result, software factories have decreased the expected development time and allowed us to focus only in the logic of the application and not in the low-level coding.
15:00	Coffee Break
15:15	**Flight Software: Astrium Standpoint** *Presenter: Mr. ROSSIGNOL, Alain (Astrium)* This presentation shows the vision and needs of system integrators about software engineering automation.
15:30	**Flight Software:Thales Standpoint** *Presenter: Mr. GARCIA, Gerald (Thales)* This presentation shows the vision and needs of system integrators about software engineering automation.
15:45	**Flight Software: OHB standpoint** *Presenter: Mr. BERNHARD, Bruenjes* This presentation shows the vision and needs of system integrators about software engineering automation.
16:00	**Roundtable: which software factory for Space?** *Presenter: Mr. TERRAILLON, Jean-Loup (ESA/Software Systems Division)* The round table invite audience to build on the presentations in order to reply to some questions related to the strategy that Agencies and Industry should define in terms of software engineering automation, model based engineering life cycle and process, industrial and business needs, and tool support.

7th ESA Workshop on Avionics, Data, Control and Software Systems

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25 Years vector

Aeroflex Gaisler AB is a provider of system-on-chip (SoC) solutions for exceptionally competitive markets such as aerospace, military and demanding commercial applications. Aeroflex Gaisler's products consist of user-customizable 32-bit SPARC V8 processor cores, peripheral IP-cores and associated software and development tools. Aeroflex Gaisler solutions help companies develop highly competitive customer and application-specific SoC designs, as well as providing radiation-hardened components for the space market.

The key product is the LEON synthesizable processor model together with a full development environment and a library of IP cores (GRLIB). The LEON processor and the library of IP cores are highly configurable, and are suitable for system-on-chip designs. The processor combines high performance and an advanced architecture with low gate count and low power consumption. Implementing the SPARC V8 architecture (IEEE-1754), the LEON processor offers a truly open and well supported instruction set. The processor and the IP-core library can favorably be used in a large range of applications.

Aeroflex Gaisler's LEON-FT processor implements unique fault-tolerance features that allow it to function correctly in the severe space environment. The processor includes on-chip error-detection and error-correction logic to detect and remove any soft error caused by cosmic radiation.

Our personnel have extended design experience, and have been involved in establishing European standards for ASIC and FPGA development. We have a long experience in the management of ASIC development projects, and in the design of flight quality microelectronic devices. The company specializes in digital hardware design (ASIC/FPGA) for both commercial and aerospace applications.

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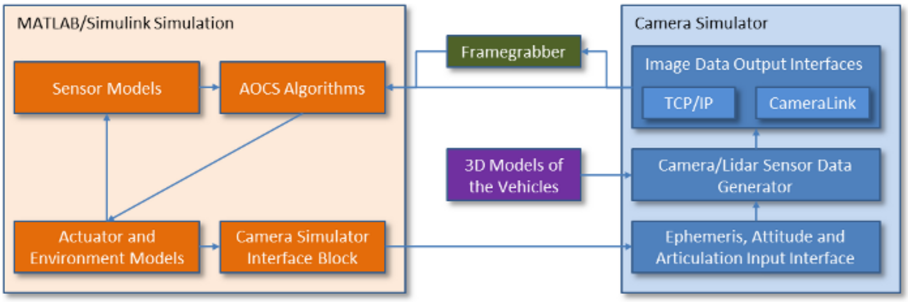
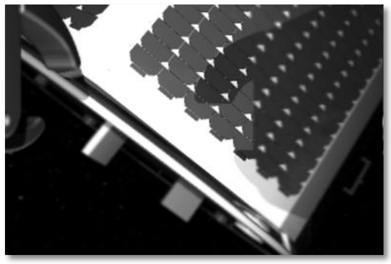
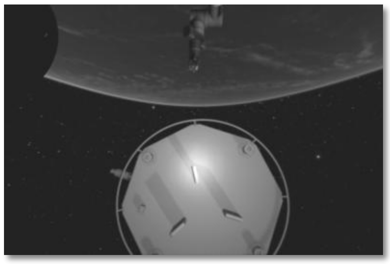
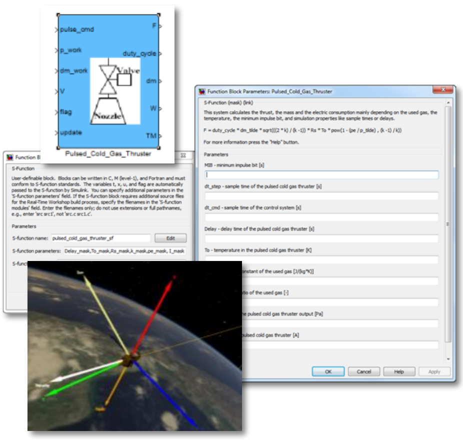
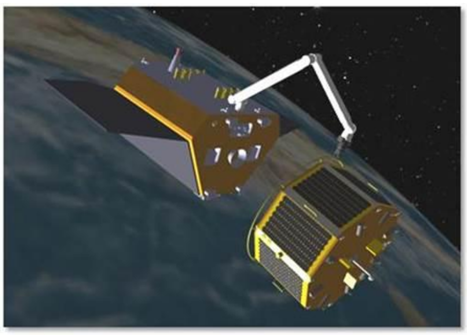




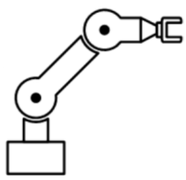






Closed-loop GNC simulator with coupled mission analysis

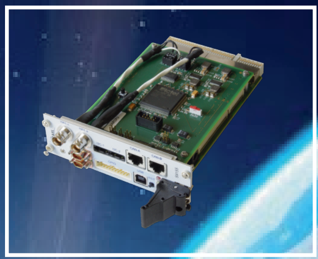
- Multi-body dynamics and robotic arm model
- Environment simulator (ECSS models and more)
- Equations of motion (various ref. systems)
- Built-in actuator and sensor models
- Fully integrated into Simulink environment
- Animation console with 3D stereoscopic display, 6D joystick view control and recording function
- Detailed perturbation analysis based on geometrical model
- Simulation console
- Telecommand console
- Model database



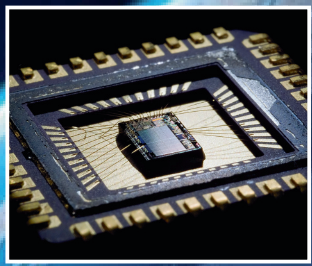
For our other products please visit our homepage http://www.astos.de

Spacecraft Data and Communication

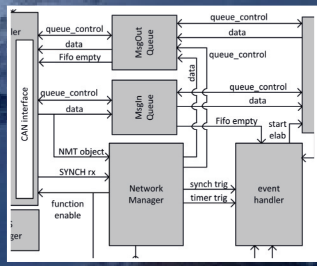
Flight Units



Development Modules



ASICs



IP Cores

SITAEL provides specialized design, development, production and qualification of flight equipment and components for satellite data processing, handling, storage and communications.
Involved into the Enabling and Critical Technologies harmonization process in collaboration with ESA and Prime Industries, SITAEL is able to produce on-board computers, TM/TC and Mass Memory modules in order to fulfill the most urgent needs of the Space Community.
For more than 20 years, SITAEL has been pioneering radiation hardening techniques for the design of Electronics and Microelectronics circuits suitable for space environment.
In this context, SITAEL provides turn-key design solutions for rad-tolerant analog, digital and mixed-signal ASICs and complex digital IP Cores, including screening and qualification service according to ESA and NASA standards.

SITAEL

www.sitael.com

iSAFT
SPACEWIRE / MIL-STD-1553 / CAN Recorder

Record,

Observe,

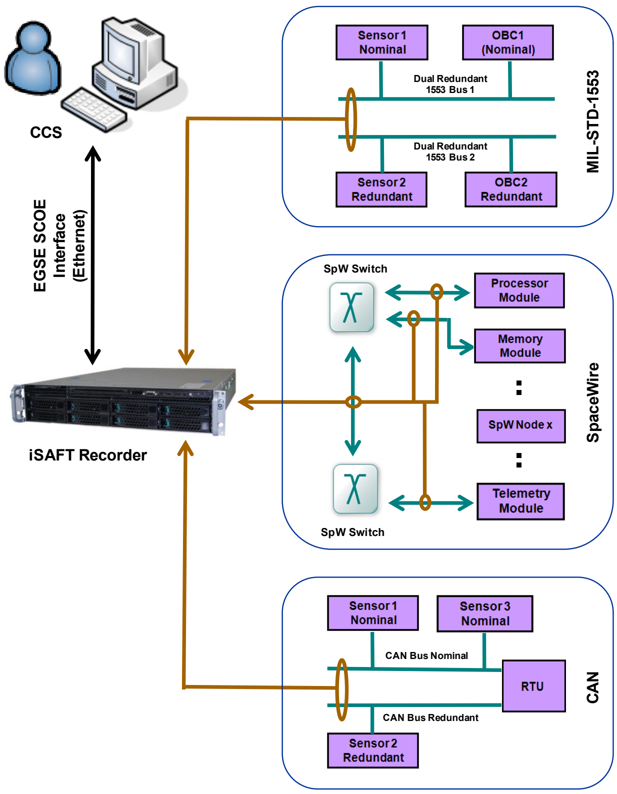
Validate!

iSAFT SpaceWire / MIL-STD-1553 / CAN Recorder is an advanced, integrated, high performing, modern network traffic capture, recording and analysis tool for the validation of satellite/spacecraft on-board communication protocols and data networks implementing the SpaceWire, MIL-STD-1553 and/or CAN protocol family.

The iSAFT SpW / MIL-STD-1553 / CAN Recorder is capable of capturing data packets on multiple SpW links, MIL-STD-1553 and/or CAN buses, time stamping, recording, and delivering them to a powerful Protocol Analyzer for further processing & analysis. Operating on a multi-Gbytes powerful HW platform, the SW environment is based on the iSAFT graphical tool chain, thus allowing the management, filtering & searching of the recordings. It is used for troubleshooting and problem solving at various development stages, minimizing the impact on cost and schedule.

FEATURES

- Powerful HW platform (high processing power, multi-Gbytes storage capacity), advanced file and recordings management (auto-archive, disk cleanup, file system and disk optimization, etc.).
- iSAFT graphical tool chain (Runtime engine, iSAFT Console, offline analysis with the Wireshark Protocol Analyzer, recordings management).
- Capturing & recording of large volumes of traffic from multiple SpW links, MIL-STD-1553 and/or CAN buses.
- Off-line analysis of multi-gigabyte traffic logs. Chronological merging of recorded traffic (i.e. from both SpW and 1553) for complex topologies.
- Event-trace trigger & selective tracing (filtering) support, available plug-ins and statistics for various protocols.
- Graphical tools for local/remote control, data recording, managing, searching and filtering the recordings.
- Export of traffic recordings to XML, PostScript®, CSV, or plain text, user selected protocol fields per packet.
- Interfaces with EGSE Central Checkout System.
- Open APIs to 3rd-party applications, support for customization, adaptations to customer needs.



Based on an open architecture and modular design, iSAFT Recorder is a future-safe, cost-effective and already validated solution for demanding EGSE activities. One iSAFT Recorder station can **simultaneously record data from different networks**, store data on its hard disks, manage recorded files, interface to Central Checkout System (CCS) through EGSE SCOE interfaces, etc. It completely replaces the need for multiple separated elements in your testbed (dedicated SpW or 1553 recorders, separate IRIG receivers/sources, dedicated stations for data recording and connection to CCS, etc.). It is fully compliant with all standards and certifications required to install it on a flight equipment/mission EGSE (FMEA, hazard/safety analysis, CE compliance, etc.).

Ensuring Reliable Networks **TTTech**

TTTech was established in 1998 as a spin-off of the Vienna University of Technology ("TU Wien") based on 30 years of research in Europe and the US. This extensive research and development work provides a mature basis for our core technology to build applications in safety-critical areas. Today our company has offices in nine different countries with almost 300 employees worldwide. It serves four main business segments:

- Automotive
- Aerospace (including Space and Defense)
- Industrial
- Off-Highway

Professor Hermann Kopetz is one of the co-founders of TTTech.

For space applications TTTech offers the following building blocks for deterministic Ethernet connectivity:

- Chip IP cores supporting up to dual fault-tolerance
- PC-based scheduling and verification tools
- Lab equipment for development and testing
- Technical support

Recent corporate milestones include:

2013

- Signed memorandum of understanding for the collaboration with NXP on the development of automotive Ethernet switch solutions
- TTTech starts cooperation with Astrium Space Transportation focusing on human spaceflight & launchers

2012

- TTTech provides commercial off-the-shelf (COTS) products based on TTP for the Embraer Legacy 450 and 500 flight control computers developed by BAE Systems
- Awarded as one of Austria's national "Jobs Through Innovation" champions

2011

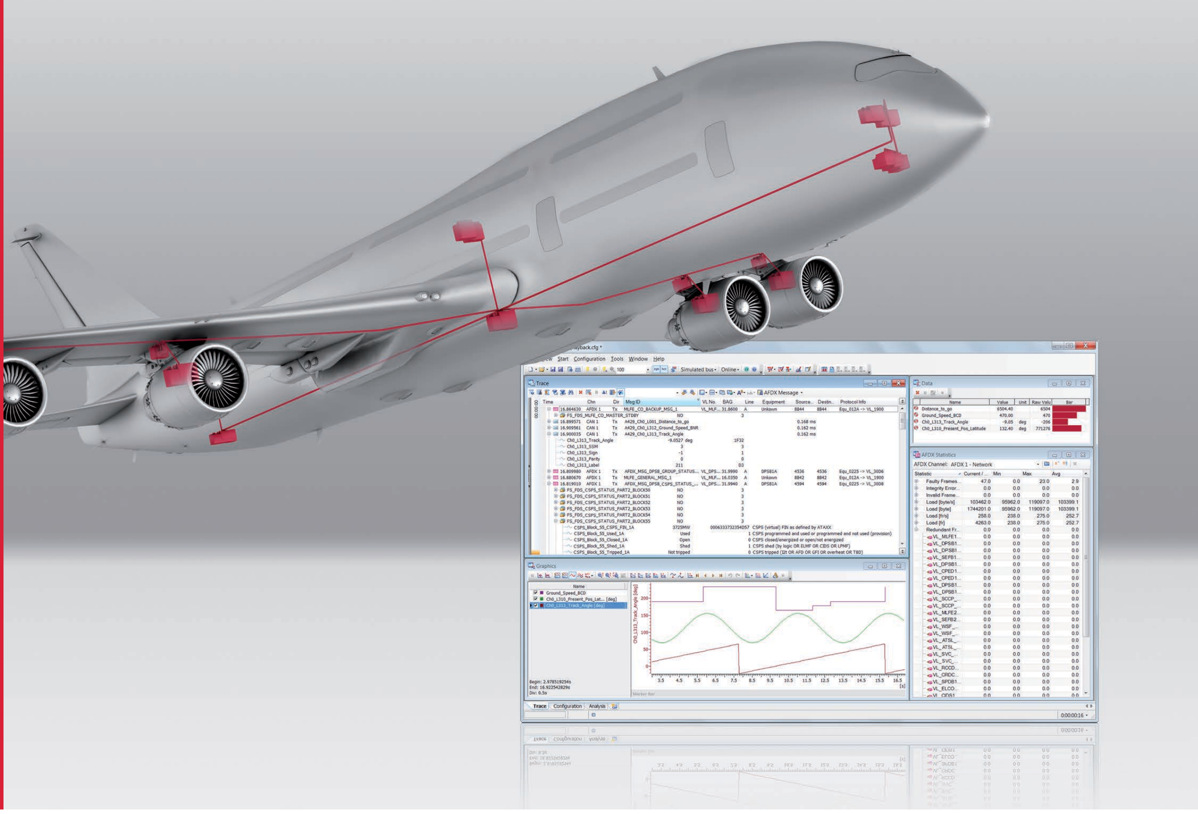
- TTTech's TTP selected by Rockwell Collins for the CSeries aircraft program
- SAE International releases Deterministic Ethernet Standard (SAE AS6802)

2010

- TTTech receives the Dun & Bradstreet Rating 1 distinction, certifying that the company has the highest level of creditworthiness
- Vector and TTTech Automotive partner in development of software for electronic control units

2009

- New Boeing 787 Dreamliner takes first flight with TTTech solutions
- NASA and TTTech sign "Space Act Agreement" to partner in design of highly dependable integrated embedded systems



Develop and Test Avionics Networks Efficiently and Reliably

Vector is the leading manufacturer of software tools and software components for networking of electronic systems based on CAN, AFDX®, Ethernet, ARINC 429 / 825 and CANopen.

Customers from the aerospace, automotive engineering, the commercial vehicle, transportation and control technologies around the world trust in the solutions and products from the independently-owned Vector Group.

Control complexity of your AFDX® and CAN systems with Vector support:

> Accelerate validation and verification of your system with proven standard tools
> Analyze and test multibus networks
> Increase your test integration efficiency

More information at: www.avionics-networking.com

Facts about Vector

> Foundation in 1988
> Delivery of the first CANalyzer license in 1992
> Delivery of the first licenses for CANoe and CANape in 1996
> AFDX® License agreement with Airbus in 2012
> 25 years of networking experience
> 1,200 employees at 15 business sites in 10 countries worldwide
> The group's revenue in 2012 was 224 million Euros

AFDX® is an Airbus' registered trademark

Vector Informatik GmbH
Germany • USA • Japan • Austria • France •
UK • Sweden • China • Korea • India

FUTURE EVENTS

2013

Clean Space Workshop
29 October 2013, Satellite Application Catapult centre, Harwell-Oxford Campus
http://www.esa.int/Our_Activities/Space_Engineering/Clean_Space

TEC-EED / SW Final Presentation Days
11-12 December 2013, ESA/ESTEC, The Netherlands

2014

Mass Memories Day
23 January 2014, ESA/ESTEC, The Netherlands

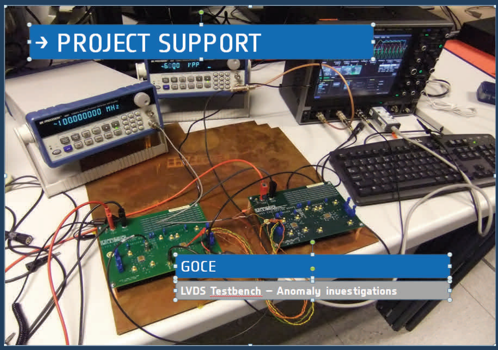
9th International ESA Conference on Guidance, Navigation & Control Systems (GNC 2014)
2–6 June 2014, Oporto, Portugal
http://congrexprojects.com/2014-events/14a01/home

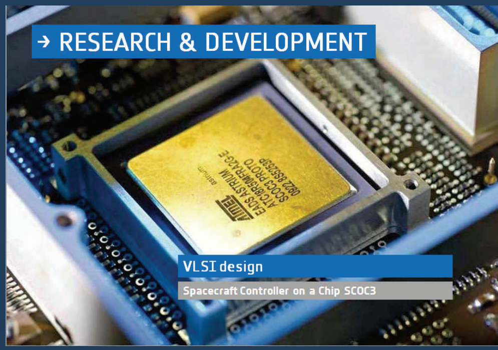
International SpaceWire Conference
11-13 June 2014, Greece
http://spacewire.esa.int

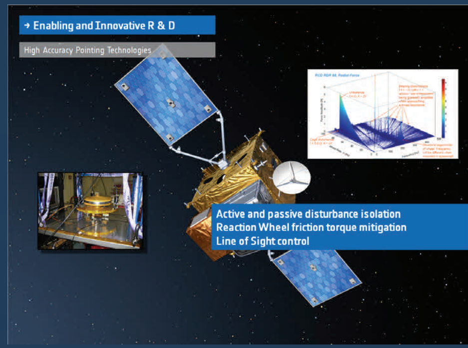
TEC-ED / SW Final Presentation Days
3-5 June 2014, ESA/ESTEC, The Netherlands

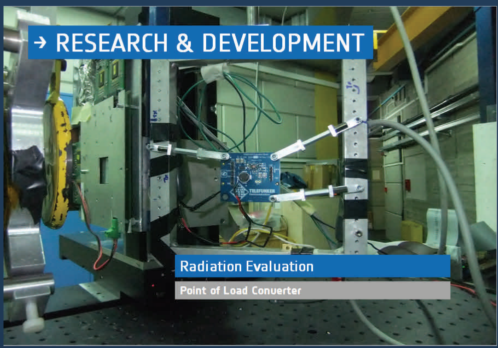
8th ESA Workshop on Avionics, Data, Control and Software Systems (ADCSS 2014)
27-29 October 2014, ESA/ESTEC, The Netherlands

International Conference on Wireless for Space and Extreme Environments (WiSEE 2014)
30-31 October 2014, ESA/ESTEC, The Netherlands

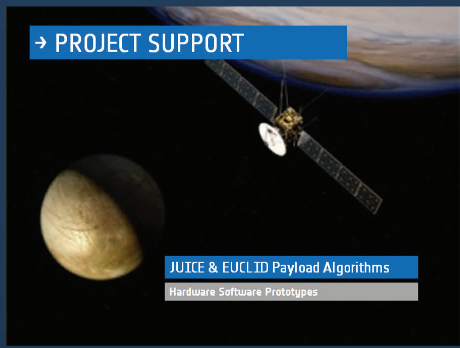

→ PROJECT SUPPORT
GOCE
LVDS Testbench – Anomaly investigations

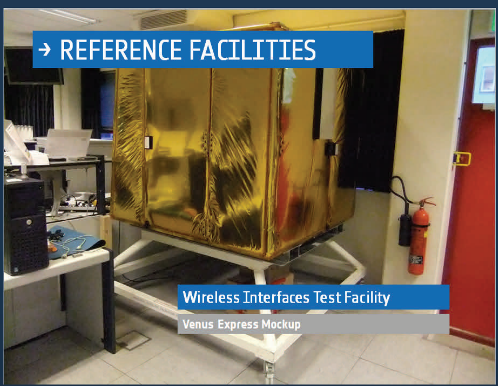

→ RESEARCH & DEVELOPMENT
VLSI design
Spacecraft Controller on a Chip SCOC3


→ Enabling and Innovative R & D
High Accuracy Pointing Technologies
Active and passive disturbance isolation
Reaction Wheel friction torque mitigation
Line of Sight control

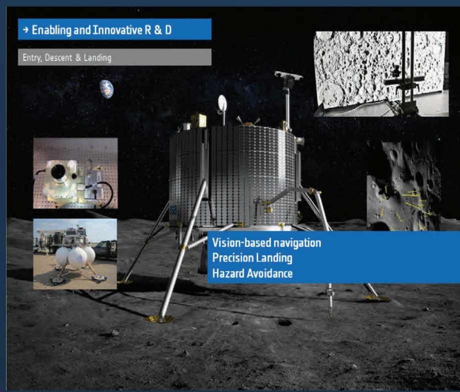

→ RESEARCH & DEVELOPMENT
Radiation Evaluation
Point of Load Converter


→ RESEARCH & DEVELOPMENT
VLSI Design and manufacturing
Multi-project wafers

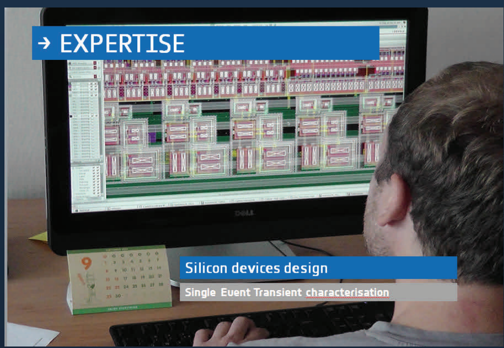

→ PROJECT SUPPORT
JUICE & EUCLID Payload Algorithms
Hardware Software Prototypes

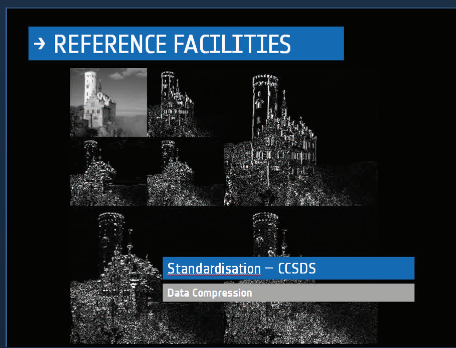

→ REFERENCE FACILITIES
Wireless Interfaces Test Facility
Venus Express Mockup

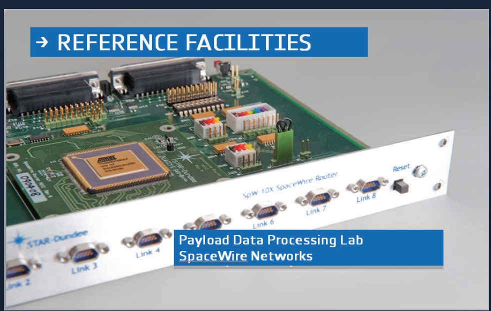

→ RESEARCH & DEVELOPMENT
Future European Projects
SAVOIR
space avionics open interface architecture
SAVOIR Product Lines
Reference Architecture, Product Specification

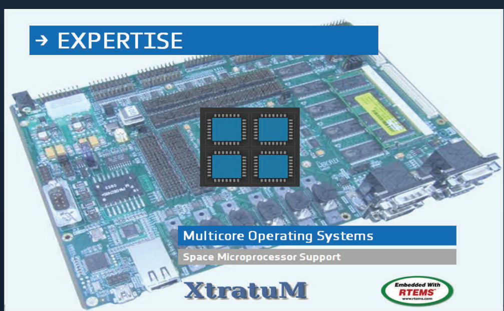

→ Enabling and Innovative R & D
Entry, Descent & Landing
Vision-based navigation
Precision Landing
Hazard Avoidance

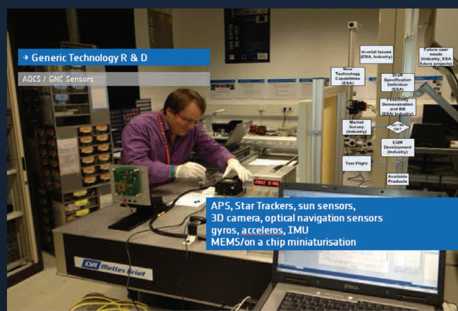

→ PROJECT SUPPORT
esa
European Space Agency
GALILEO Fault Detection
Isolation Recovery
Requirement Verification


→ EXPERTISE
Silicon devices design
Single Event Transient characterisation

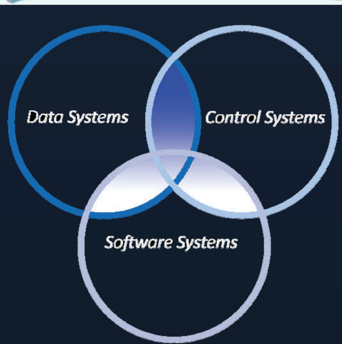

→ REFERENCE FACILITIES
Standardisation – CCSDS
Data Compression

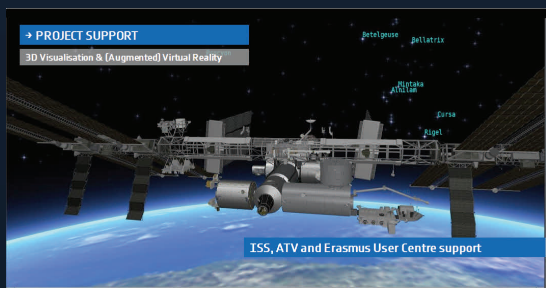

→ REFERENCE FACILITIES
Payload Data Processing Lab
SpaceWire Networks


→ EXPERTISE
Multicore Operating Systems
Space Microprocessor Support
XtratuM
RTEMS


→ Generic Technology R & D
AOCS / GNC Sensors
APS, Star Trackers, sun sensors,
3D camera, optical navigation sensors
gyros, acceleros, IMU
MEMS/on a chip miniaturisation


→ EXPERTISE
Modelling & Simulation
Hands-on experience, maintain and extend skills


Data Systems
Control Systems
Software Systems


→ PROJECT SUPPORT
3D Visualisation & (Augmented) Virtual Reality
ISS, ATV and Erasmus User Centre support