



An innovative method for SpaceWire Test and Verification

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ARES-EMC

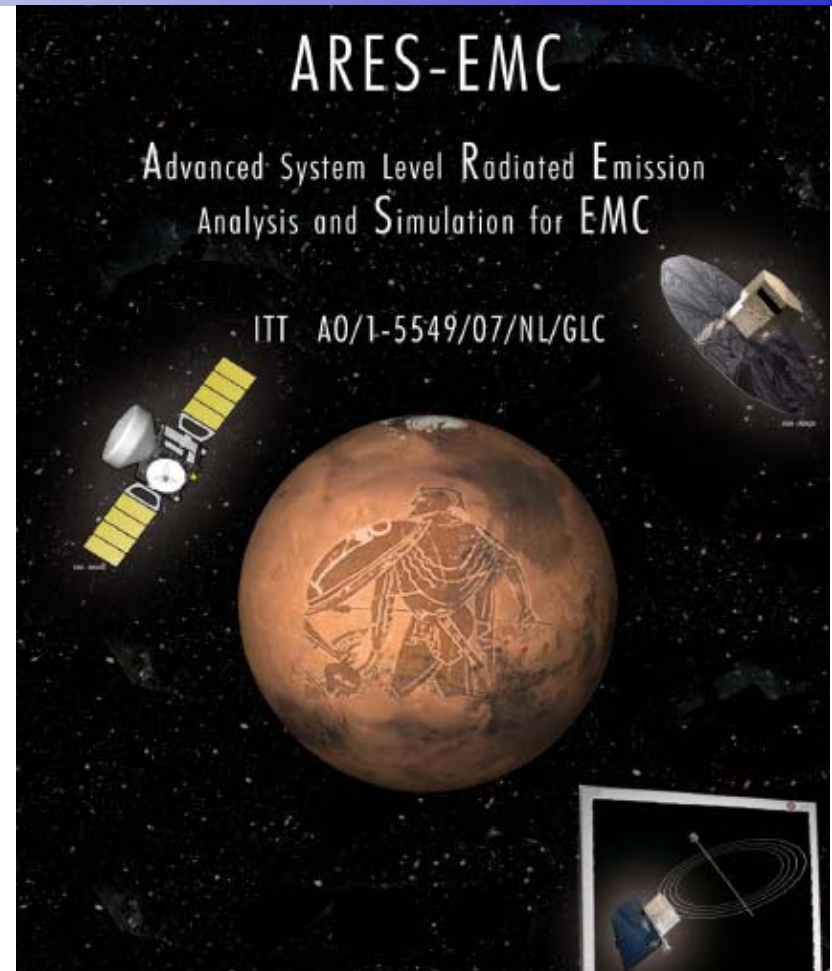
Carlo Gavazzi Space has positively closed the negotiation phase with ESA for the ITT AO/1-5549 “**A**dvanced System Level **R**adiated **E**mission Analysis and **S**imulation for **EMC**” that has as final scope the development of a tool for “system level susceptibility analyses” capable to treat field-to-wire coupling problems in a satellite.

The ITT has been issued by the directorate of TEC (EMC session)

The project team sees also as subCo:

EMSS GmbH. Software solutions for the simulation of electromagnetic fields.

Politecnico di Milano (Dipartimento of Elettrotecnica)



CARLO GAVAZZI SPACE
Ref. S7-053



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**10 th Spacewire Working Group meeting
ESA-ESTEC 20-21/02/2008**

ARES-EMC: objective

The Objective of the Invitation to Tender “Advanced System Level Radiated Emission Analysis and Simulation for EMC” is of relevant interest for several reasons:

- To allow an early verification of intra-spacecraft EM compatibility among power, data and P/L units when no real units are still available,
- To drive the design of the units and the harness routing in the spacecraft considering also EMC issues,
- The availability of a SW tool that allows the space agencies and the satellite/prime contractors to evaluate possible Non conformances or Requests for Waiver risen by subcontractors simulating their impacts on the (not existing yet) satellite,
- The risk reduction related to the EMC System level tests that are usually performed at the final phase of a space program

ARES-EMC: objective



The current situation concerning the availability of matured and validated software tools for the analysis and prediction of the radiated susceptibility in complex systems like a spacecraft in the low-medium frequency range is quite unhappy but....



The maturity reached by software tools in the high frequency range of the EM fields that allows their use in telecom satellite acts as a strong stimulus to try to develop and validate a software system tool that can provide helpful information to the space architects/designers/specialists in all the phases of the development activity of a satellite considering the randomness and the uncertainties of the system to be analyzed in term of EM sources, victims and structures.

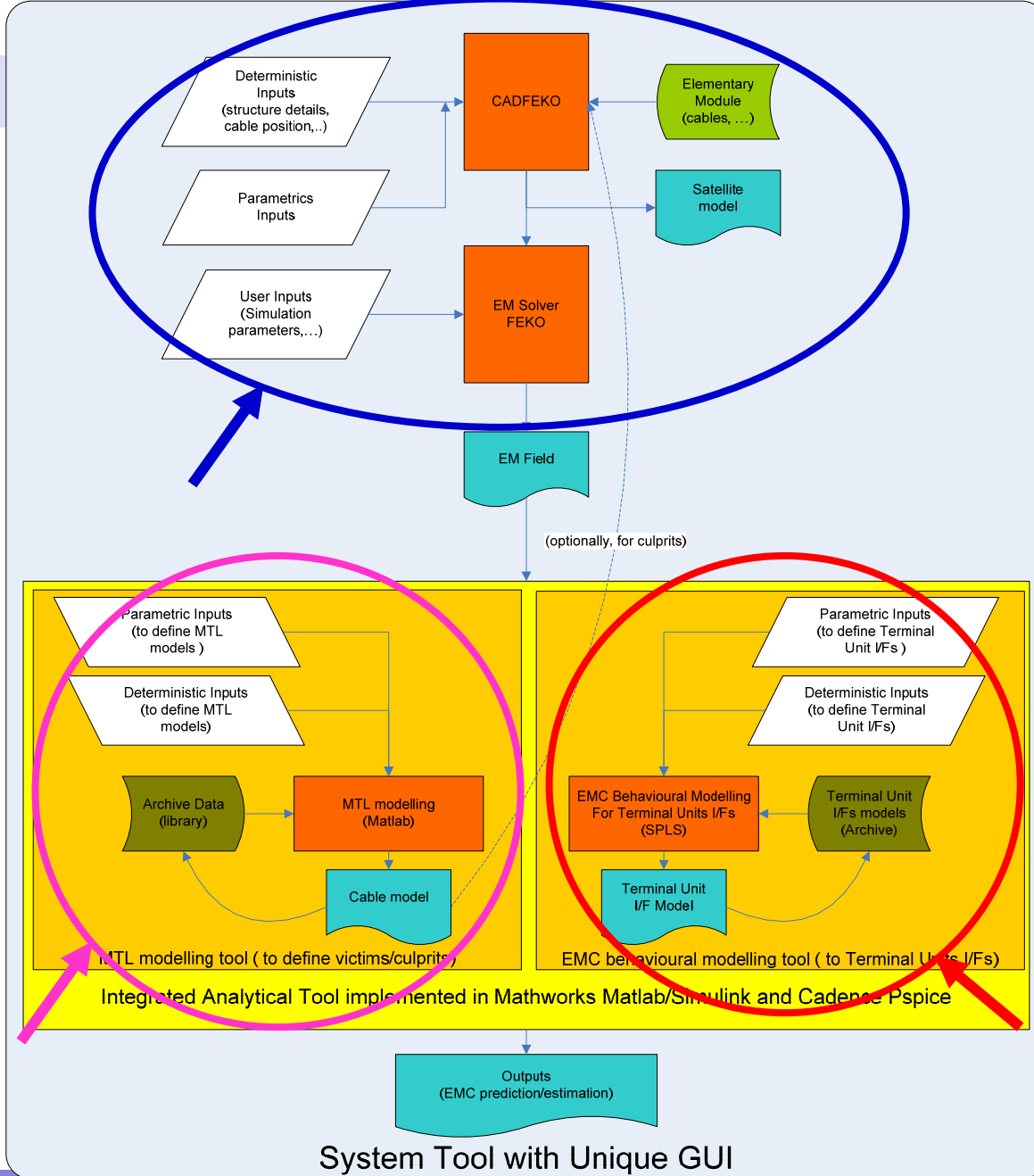
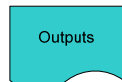
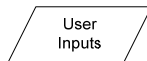
ARES-EMC :Architecture

Architecture: our System Tool is composed of a custom development of an Analytical Tool based on the SPLS Software tool of Orcad/CADENCE and Mathworks tools (Matlab/simulink) integrated with the FEKO EM solver developed by EMSS.

Components:

Modelling of Structure and EM Field,
 Modelling of harness,
 Modelling of Terminal I/Fs

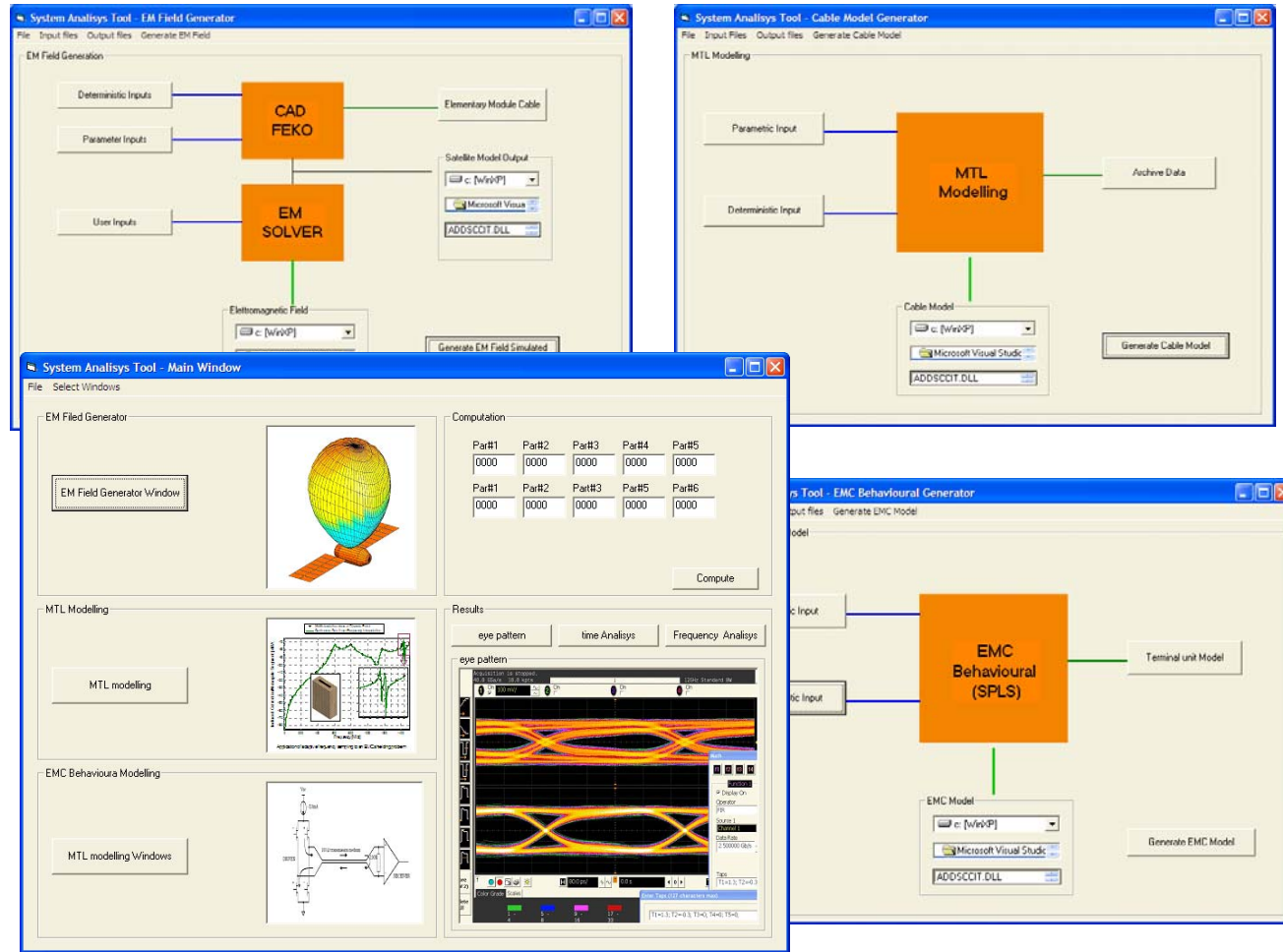
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ARES-EMC: architecture

GUI

A friendly and unique graphical interface will guide the tool users through all the menus, parameters and types selections, already available library models, new models saving options of the provided System Tool.



System Tool GUI



ARES-EMC: architecture

In order to validate the System Tool some test cases will be studied, simulated and tested: within the digital buses commonly used in space the proposal team has identified the following as the ones to be investigated:

RS422

SpaceWire

The RS422 represents a low-medium speed solution that has found a diffusion as low-cost, easy to use and robust enough I/F to control and monitor P/Ls with a limited data bandwidth request,

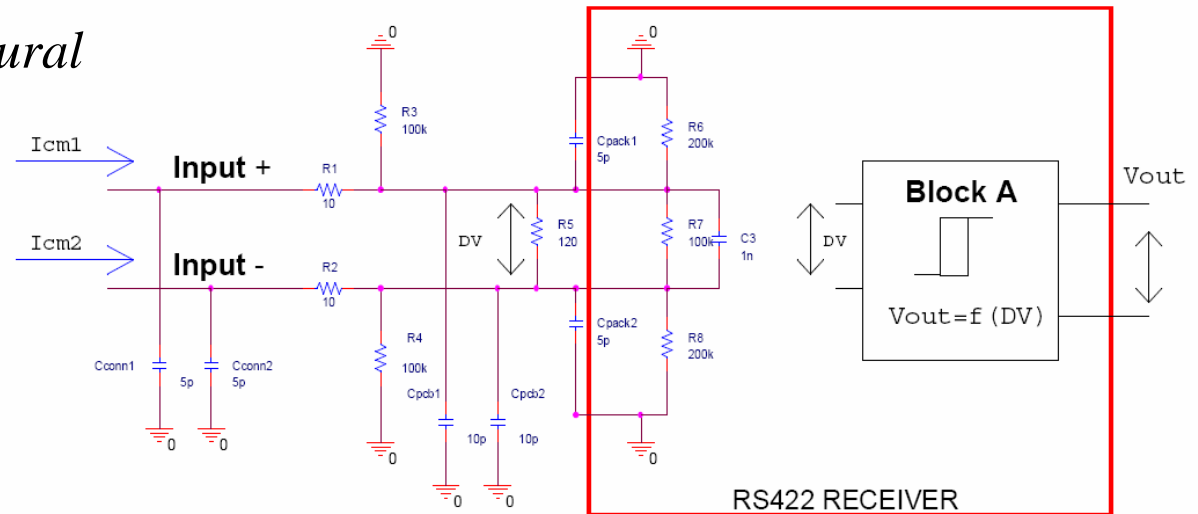
The **SpaceWire** is the leading data-handling network for use onboard spacecraft, furthermore the SpaceWire falls into an ESA standardization and finally the use of the SpaceWire standard can ensure that an equipment is compatible at both the component and sub-system levels. Processing units, mass-memory units and down-link telemetry systems using SpaceWire interfaces developed for one mission can be readily used for other missions.

ARES-EMC: architecture

The EMC behavioural model of the SpaceWire I/F will be developed: the behavioural model will be implemented using the CADENCE PSpice Simulator and Mathworks' Matlab/Simulink.

The modelling of EMC parasitic effects will be obtained starting from suitable experimental characterization that will be combined with the functional model of the Terminal Units Interfaces.

Example of EMC behavioural model (RS422)



ARES-EMC: architecture

The behavioural models will include the following features:

- Possible non linear behaviour of the termination in the full range of operability (from 10 to 200 Mbit/s as data rate for SpaceWire) that can be treated by means of multiple linear models to be associated with different frequency ranges.
- Statistical treatment of the system uncertainties (parasitic impedance to chassis ground, parasitic capacitance between path “+” and “-“ due to PCB and connector,...)
- To be suitable to be integrated in the selected EM field solver.

Furthermore it has to be underlined that the internal schematic or simulation model of a RS 422/SpW receivers are usually not available to the customers so CGS proposes to create a Parametric Macromodel of the RS 422/Spacewire receiver's core (see also IEEE TRANSACTIONS ON ADVANCED PACKAGING, VOL. 25, NO. 2, MAY 2002 Parametric Macromodels of Digital I/O Ports Igor S. Stievano, *Member, IEEE*, Ivan A. Maio, *Member, IEEE*, and Flavio G. Canavero, *Senior Member, IEEE*)

ARES-EMC: architecture

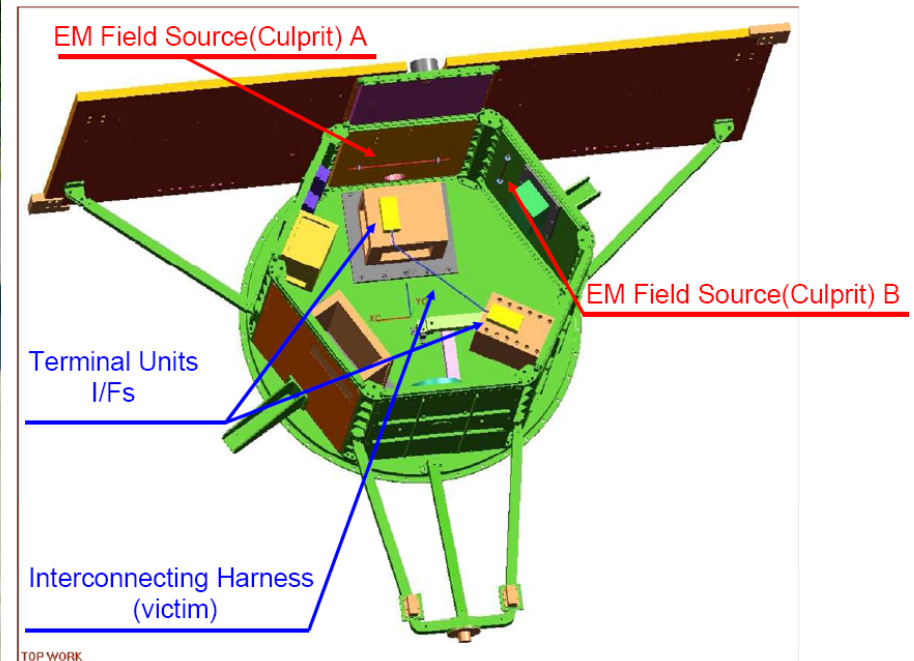
Substantially the Parametric Macromodel methodology aims to obtain a representations of the IC behaviour starting from the measurement of transient waveforms at the device ports.

The parametric approach to behavioural modelling has interesting features if compared to the traditional equivalent circuit simulation. It can take into account any physical effects significantly influencing voltages and currents of the IC ports and yields models that perform at a very good accuracy level with relatively high efficiency (in term of required computational time).

Furthermore depending on the frequency components present in the stimulus the transfer function of the RS 422/SpaceWire receiver can be investigated in all the frequency bandwidth of interest also well behind the nominal bandwidth of the receiver and taking into account the eventual nonlinearities of the device core.

ARES-EMC: validation

One of the most important phases of the work to be developed is the validation of the system tool: It will be performed on a metallic mock-up of the Italian AGILE satellite and real EM Field sources and Terminal Unit I/Fs will be used.



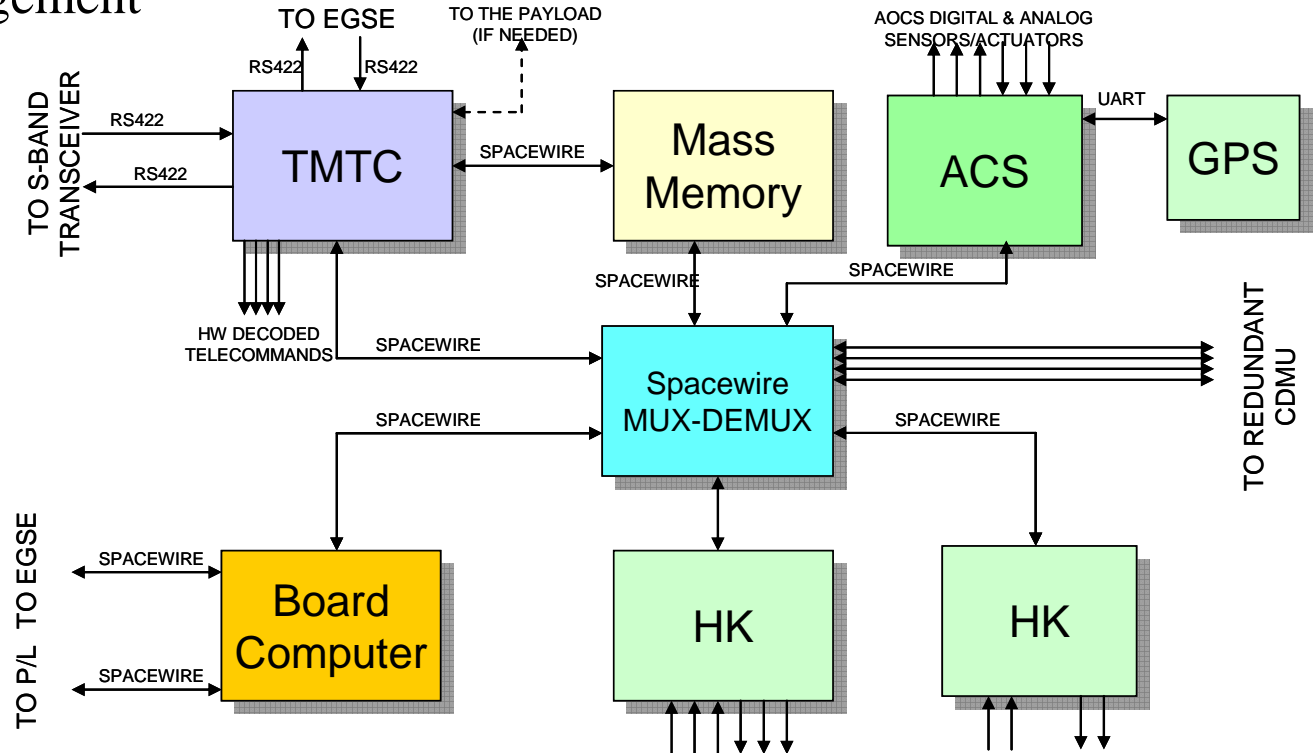
SpaceWire application in CGS: Formosat-X CDMU

Carlo Gavazzi Space is currently involved in the final testing phase of the Formosat-X (former ARGO) CDMU for the the National Space Organization (NSPO) of Taiwan.

The CDMU (**Command and Data Management Unit**) main tasks are:

- On Board Data Handling
- Attitude and Orbit Control
- Payload Management

CDMU ARCHITECTURE



ARES-EMC: conclusions

- An innovative SW system tool for the evaluation of EM susceptibility on a spacecraft will be available as the result of a ITT project.
- The SpaceWire bus is one of the proposed uses case.
- The SW system tool will be validated at component level (for the innovative parts like the EMC behavioural model of the Terminal Unit I/Fs) and at system level by means of measurements on a real satellite mock-up.

THANK YOU!

