Platform-Based Embedded Solution for Small Satellite’s Onboard Computing

Alexander Fedotov (presenter)
Olga Mamoutova, Alexey Filippov PhD, Alexander Antonov PhD

Peter the Great St. Petersburg State Polytechnic University
Dpt. of Computer Systems & Software Engineering
Scientific-educational center “Embedded Microelectronic Systems”

17th FRUCT conference
Session: Embedded Systems and Networks II (Friday, 24 April 2015, 11:15-12:45)
What is a Spacecraft Bus of Small Satellite?

Like in a “big” traditional satellite, just smaller

- Communications payload
- Telemetry and command transponders
- Instruments of scientific experiments
- Electrical interfaces of power supply instruments
- Electrical interfaces of heating/cooling instruments
- Electrical interfaces of mechanical nodes
- Guidance and navigation instruments

C&DH – Command and Data Handling

Pictures: NASA, ESA, parabolicare.com
Command and Data Handling in small satellite

C&DH – State of the art:
- Computer network
- Distributed information processing
- Plug-and-Play network architectures
- Hardware architecture diversity – Problem!!!

Our solution: UMoMI

Universal Module for Managing the Information
Requirements to UMoMI

- **Capability** – provides resources for information processing
- **Flexibility** – those resources distinct in computing power
- **Customizability** – the module utilization can be tuned for particular task
- **Programmability** – the module can easily change its functionality
- **Networkability** – support of arbitrary network topologies and protocols
UMoMI Platform

Design concept – not the final implementation!

- Circuit board level platform
- Unified parameterized design
- SpaceWire network-oriented (PHY)
- FPGA for customization
- Two types of modules:
  - Interface/Processing
  - Router/Mass memory
- Architecture parameters: mix of predesigned HW/SW
- Desired functionality mapping
- Desired reliability/performance tradeoff
UMoMI – command and data processing

- **Service FPGA** – basic interface and control
- **Main SpaceWire** interface (duplicated)
- * **FPGA** – DSP tasks + duplicates service FPGA
- * **Secondary SpaceWire** interface (duplicated)
- * **Microcontroller** – computations and control
- * **Memory** array – MCU support + data buffer
- * **Analog and digital I/O** – interface to instruments and payload

UMoMI-R – router/mass memory

- Extended number of **SpaceWire interfaces**
- **Service FPGA** – network routing + control
- * **SSD array** – mass memory
- * – Optional components
EO Satellite: Functionality Mapping

Platform-Based Embedded Solution for Small Satellite’s Onboard Computing
Summary and Conclusions

• UMoMI is a unified parameterized design platform for modules of C&DH in a small satellite
• Promising solution to reduce development cost
• More technical details are located in the paper (reliability, performance and power concerns, some implementation hints, etc.)

Our contacts:  Olga Mamoutova mamoutova@kspt.icc.spbstu.ru
              Alexander Fedotov  afedotov@spbstu.ru
              Alexey Filippov, PhD filippov@eda-lab.ftk.spbstu.ru
              Alexander Antonov  antonov@eda-lab.ftk.spbstu.ru

Web: http://kspt.icc.spbstu.ru/EMS-center
Thanks for your attention
Future work & Perspectives

Implementation
- Schematics
- Development Kit
- Application

Application
- Blueprint
- Function Mapping
- Communication Satellite
- Satellite
Приехали, с вас 4 бакса