SPACE WIRE PROTOCOL ANALYSER ON SPACE CUBE®

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Short Paper

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ABSTRACT

Protocol analyser for SpaceWire with RMAP (Remote Memory Access Protocol) has been developed for heterogeneous computer platforms. SpaceWire CUBA software (Space Cube Analysis Software) is a portable protocol analyser supporting RMAP, which is developed in collaboration among University of Dundee (UoD), NEC TOSHIBA Space Systems (NTSpace), Osaka University and ISAS/JAXA (Institute of Space and Astronautical Science / Japan Aerospace Exploration Agency).

SpaceWire CUBA software is now used for the development of routing devices for the integrated onboard computer of MMO (Mercury Magnetospheric Orbiter) of Bepicolombo project, which is the joint collaboration mission between JAXA and ESA, and the software supports participants to establish interoperability among SpaceWire community in Japan and Europe.

1 USER NEEDS FOR RMAP IN JAPANESE SATELLITES MARKET

Since RMAP was proposed on the basis of SpaceWire basic protocol, it has gained powerful access method between satellite system management units (SMUs) and payloads. The control software on SMU accesses resources inside payload components through system-wide linear address space like I/O mapped registers.

Japanese scientific satellites have had almost the same capability on their original access module, which is called PIM (Peripheral Interface Module), and the function has been proven to be easy-to-use and flexible for many years through various scientific achievements using satellites. Therefore we have found RMAP as suitable in order to standardize Japanese satellite onboard embedded networks for applying next generation high-speed transmission capability.

2 PROTOCOL ANALYZER FOR RMAP

SpaceWire specification is simple and clear, so we had succeeded in developing SpaceWire interface module by referring written specification and it passed compatibility trial between European SpaceWire community members in 2004 [1]. On the other hand, close investigation should be carried out for various operation cases in dynamic conditions including off-nominal state through space craft development process, and we need protocol analyzer for that purpose. Since RMAP was in reviewing phase, we had joint collaboration among UoD, ISAS/JAXA, Osaka Univ., and NTSpace in order to clarify the understandings acquired from proposed specification.

2.1 DEVELOPMENT AIMS OF THE PROTOCOL ANALYZER

The protocol analyzer software should be portable, because hardware used for the equipments are mostly commercial products and have short product life. In addition to that, Space Cube is used in Japanese SpaceWire community as a platform for space and high energy physics research and development activities [2], so we need to use the protocol analyser on Space Cube as well as the popular test equipment as STAR-Dundee SpaceWire-USB Brick. Figure 1 shows Space Cube.

Fig. 1. Space Cube®

Therefore, the aims of the analyser are:

a) To design and develop software to support the development and testing of SpaceWire units that can run on both the STAR-Dundee SpaceWire-USB Brick and Space Cube.

b) To support the SpaceWire RMAP protocol with this tool.

c) To define a suitable driver API (Application Programming Interface) based on the API used for the SpaceWire-USB Brick.

The software is based on UoD PETRI (The Powerful Easy-to-Use Transmit Receive Interface) software, and versatile API is developed in order to make the software

portable for various operating systems. The API is developed on Windows operating system for UoD USB-bricks and T-Kernel real-time operating system running on Space Cube, and the same protocol analyser software is now running on Windows personal computer and Space Cube by exploiting the API.

2.2 THE ARCHITECTURE OF SPACEWIRE CUBA SOFTWARE

The protocol analyzer, which is called SpaceWire CUBA Software, is realized on the common API. The API is developed on Windows operating system and T-Kernel real-time operating system, and almost the same program source code runs on both operating systems. The software architecture on T-Kernel real-time operating system is shown in figure 2. T-Kernel is open-source real-time operating system based on TRON architecture. Boot strap code and hardware interface routines are programmed in T-Monitor. File system, network system, and graphics user interface system are included in standard extension layer, which give complete personal computer capability on palm top size embedded computer. SpaceWire device driver has been developed for user own SpaceWire IP (Intellectual Property), which encapsulates hardware specific interfaces. Since T-Kernel is independent from microprocessor architecture and the API for CUBA software uses T-Kernel features, SpaceWire CUBA Software runs on various microprocessors on which T-Kernel is implemented.

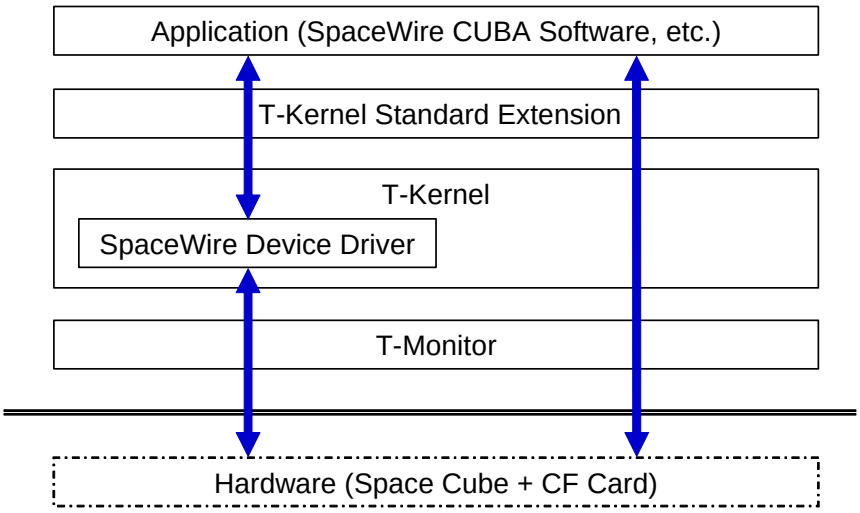

Fig. 2. SpaceWire CUBA Software architecture on T-Kernel

Figure 3 shows the working configuration of SpaceWire CUBA Software on Space Cube with PC terminal.

Fig. 3. SpaceWire CUBA Software on Space Cube

2.3 SATELLITE TESTING WITH SPACEWIRE CUBA SOFTWARE

SpaceWire CUBA Software is developed through joint collaboration among European and Japanese SpaceWire community, so it can be used as a reference through satellite development process especially for joint project like Bepi-Colombo/MMO. Since many members with various point of view participated in the development, detail understanding of SpaceWire and RMAP specification including off-nominal state are clarified through the development of the software and some concerns are reflected on the latest RMAP specification. Consequently, SpaceWire community members have already had benefits acquired though the development activity before using the software. SpaceWire CUBA Software is distributed from STAR-Dundee, Ltd. without any restriction for SpaceWire user community.

3 REFERENCES

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2. Masaharu Nomachi, Shigeru Ishii, and Hiroki Hihara, “SpaceWire activities in Japan”, The fourth SpaceWire Working Group meeting, ESA/ESTEC, July 20th 2005.