THE APPLICATION OF SPACEWIRE IN THE DATA MANAGEMENT SYSTEM OF LSS IN WSO-UV MISSION

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Short Paper

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ABSTRACT

WSO-UV is a space astronomy project, which is under the development with joint efforts from Russia, China, Germany, Italy, Spain, the United Kingdom and a number of other countries in the world. There are three scientific instruments onboard WSO-UV: the High Resolution Echelle Spectrograph (HiRDES) lead by Germany; the Long Slit Spectrograph (LSS) lead by China; and the Slitless Spectroscopy Instrument for Surveys (ISSIS) lead by Spain. The Long Slit Spectrograph instrument is able to observe faint extra-galactic sources at the far-UV spectral range with high efficiency. SpaceWire is selected as the scientific data network onboard. The development team of LSS electronics comes from CSSAR, CAS, who are designing the data handling system based on SpaceWire at present.

This paper introduces the architecture of SpaceWire data network onboard, presents the solution for the SpaceWire interface of the data handling system of LSS, and describes the WSO-UV RDDP Transportation protocol, the QoS mechanism and design in detail.

1 INTRODUCTION

The "WSO-UV" Space Complex (SC) is intended to create a Space International Astrophysical Observatory on operational orbit. LSS is an important scientific instrument on the WSO-UV satellite. The phase A of LSS has been completed. The function of LSS is to acquire the low dispersion spectrum of the ultraviolet band at each point in the one dimension space at the same time. LSS has time tagged observation, integration observation, cycle-repeat observation, point source observation, plane source observation, simultaneous observation and other scientific observation modes. The functions of electronics unit of LSS are operation control and data handling. The electronics unit of LSS connects Science Data Management Unit (SDMU) via the SpaceWire bus of the Scientific Data Network (SDN). This paper briefly describes the SpaceWire interface hardware, protocol and design.

2 THE ARCHITECTURE OF SPACEWIRE NETWORK

LSS is connected to SDMU through the SpaceWire, as shown in figure 1[1]. SpaceWire is the primary data exchange channel between the SDMU and the scientific instruments.

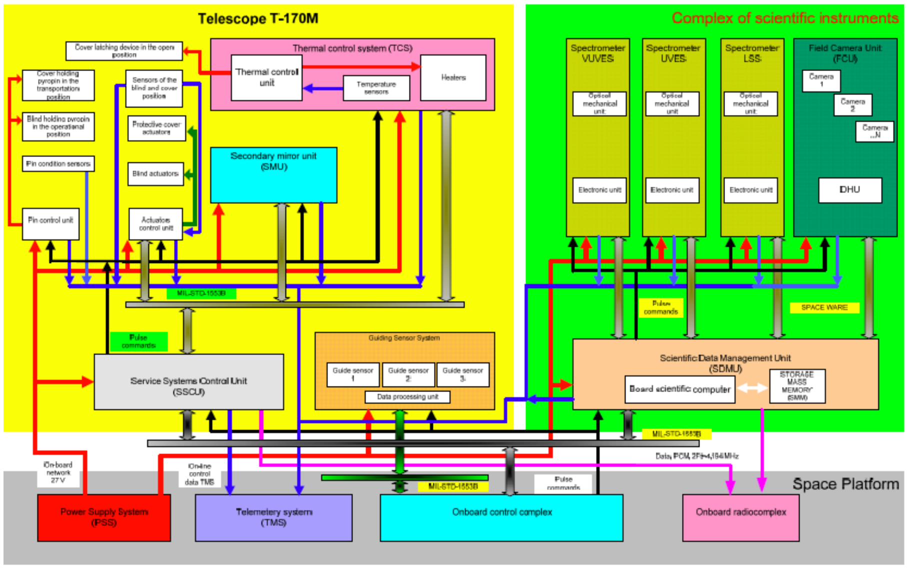

Figure 1 the architecture of SpaceWire network

Both the SDMU and all scientific instruments should be provided with two electronic control units, main and redundant (in cold redundant mode). The connection design of the SDMU and the scientific instruments should adopt the cross-strapped circuit.

3 THE SPACEWIRE INTERFACE

The SpaceWire interface unit of LSS can collect, organize and package the housekeeping data (HKTM) and observation data (STM) of Near Ultraviolet (NUV) Detector, Far Ultraviolet (FUV) Detector and Slit Viewer, and then send them to SDMU through SpaceWire, as well as receive onboard time-code and telecommands via SpaceWire.

3.1 THE CIRCUIT DESIGN OF SPACEWIRE INTERFACE

SpaceWire interface unit is composed of SpaceWire protocol controller, LVDS driver and receiver, dual-port RAM, control and interface logic circuit. The control and interface logic circuit is realized by FPGA to achieve the transport layer protocol of SpaceWire interface, and data exchange with the CPU. Figure 2 shows the SpaceWire interface block diagram.

SpaceWire interface is dual cold redundant. Each unit has three SpaceWire ports. The primary and redundant channels connect with SDMU. The remaining channel is standby or used for test. Atmel's AT7911E is applied in the design.

Synchronization is performed by SDMU periodically sending the time-code to the scientific instruments (8 times per second). The time-code conforms to ECSS-E-50-12A standard. Each eighth time-code xxx000 (binary) is associated to the onboard second mark (1Hz pulse) at accuracy 0…+20 microseconds (TBD) without error accumulation. The Onboard Time Code (OTC) is distributed by SDMU for each scientific instrument in the data packet per second, at the time interval of 0.4 to 0.9 sec after each second mark (1 Hz pulse).

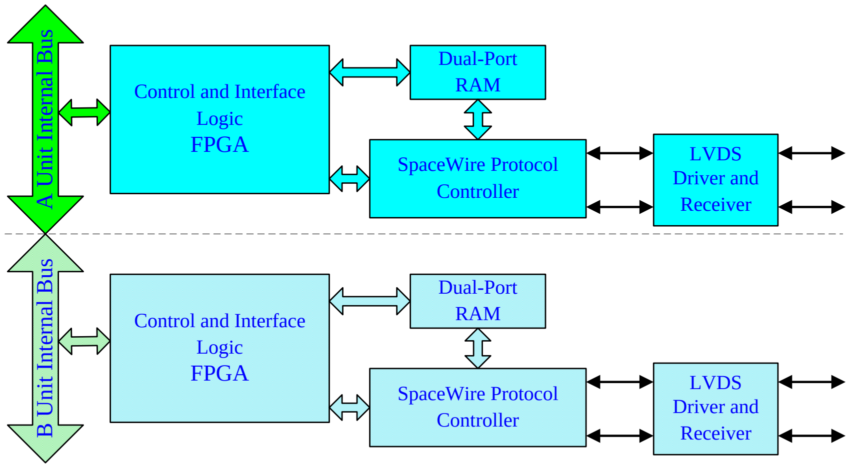

Figure 2 SpaceWire interface block diagram

All of the telecommands from SDMU to LSS, housekeeping and science data from LSS to SDMU should be transmitted as packets corresponding to the ECSS-E-70-41A in the TP envelop. The size of the telecommand, housekeeping and science data packets should be defined the same and preliminarily equal to 1024 byte (without TP envelop).

3.2 THE TRANSPORT LEVEL PROTOCAL

The SDN transport level protocol conforms to WSO Reliable Data Delivery Protocol (WSO-RDDP) [3]. It is first used in NASA Geostationary Operational Satellite R Series (GOES-R). The RDDP complies with ECSS-E-50-12A [2] and adds the following capabilities to the SpaceWire link: multiplexed logical connections, reliable data delivery; missing packet detection, out of sequence packet reordering. All WSO-RDDP packets include 8-byte header, followed by a variable length payload data, and then one byte CRC data. Figure 3 shows how the WSO-RDDP packet is encapsulated within the standard SpaceWire packet.

Destination Logical Address	Protocol ID	Source Logical Address	Packet Control
Packet Length(MSB)	Packet Length(LSB)	Channel Number	Sequence Number
Data	Data	Data	Data
Data	Data	Data	Data
Data	Packet CRC	EOP	

Figure 3 WSO-UV RDDP Packet Format

3.3 QoS MECHANISM

Each scientific instrument will send a HKTM packet to SDMU per second. To guarantee HKTM traffic reliability and timeliness, reference [4], we should complete QoS mechanism for the HKTM and STM packet transmission. The STM packets achieve assured QoS classes mentioned in SpaceWire-RT which provides a service reliably but not timely. If the guaranteed specified moment of the HKTM packet issuing within the second interval is required, each scientific instrument can be allocated its own time slot. For WSO-UV mission the QoS mechanism for HKTM provides a service which is both reliable and timely and is similar with the scheduled system in SpaceWire-RT. As HKTM and STM share the same transmission channel, we allocate different destination logic addresses to HKTM and STM, and request that logic address 32 has higher priority than logic address 48 to ensure timeliness.

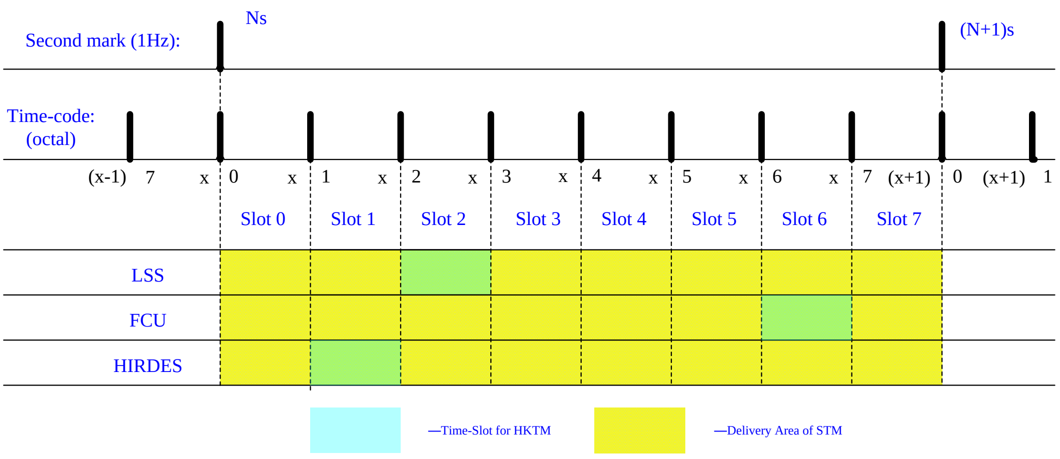

Figure 4 Packets within the second interval

As shown in Figure 4, HKTM packets are transmitted to SDMU independently and isochronously; STM packets are delivered in asynchronous mode, and are interlaced with HKTM packets.

4 CONCLUSION

The solution and designs for the SpaceWire interface, RDDP transportation protocol, the QoS mechanism are effective and meet the requirements. The above designs of LSS can also apply in the other missions in future.

5 REFERENCES

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