STP-ISS Transport Protocol for SpaceWire On-Board Networks: Development and Evolution

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ABSTRACT

The paper describes the development of a new transport protocol for the SpaceWire onboard networks. It starts from the overview and analysis of existing SpaceWire-oriented transport protocols. Then the paper considers the general industrial requirements for the Transport protocol, which should operate over the SpaceWire network technology. The main two chapters of the paper present the first and the second revisions of the new STP-ISS transport protocol, which has been developed in accordance with the results of the overview and technical requirements. In addition, the authors describe STP-ISS modeling process, which was very efficient for the STP ISS protocol development, testing, analysis and improvement.

Keywords: ISS Reshetnev, Networks, Protocol, Quality of Service, Satellites, Spacewire, STP-ISS, SUAI

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INTRODUCTION

SpaceWire is a data-handling network for spacecraft which combines simple, low-cost implementation, with high performance and architectural flexibility (Parkes, 2012). Its advantages over competing technologies have been demonstrated by its rapid take up by the normally conservative international space agencies and space industry. SpaceWire is now being used for more than 30 high profile missions and by all of the major space agencies and space industry across the world.

SpaceWire is ideal for data-handling applications but does not address avionics and other applications where responsiveness, robustness, determinism and durability are essential requirements. Mil-Std 1553 has long been the communications bus of choice for spacecraft avionics. Limited to 1 Mbits/s aggregate data rate and constrained to the bus topology, Mil-Std 1553 is struggling to cope with today’s spacecraft requirements (AIM GMBh, 2010; Condor Engineering, 2000). On-board payload data-handling is now dominated by the SpaceWire standard. The need in smaller spacecraft, planetary landers, etc., for integrated avionics and data-handling networks has raised the possibility of using SpaceWire for avionics applications.

The STP-ISS transport protocol development project has started in the beginning of 2013. The first task was to gather requirements for the transport protocol from the space industry. The detailed transport protocol requirements overview is represented in (Olenev 1, 2014). After this the authors made an overview of the existing transport protocols for different types of networks and mechanisms that provide different types of quality of service at a transport level. SpaceWire networks are unique and differ from the other types of networks, because SpaceWire uses wormhole routing (Dally, 2004), path and group adaptive routing and special types of control codes (ESA, 2008). So using of TCP/IP (Information Sciences Institute, 1981) as the most evident solution won’t provide any benefits, it may not be suitable for spacecrafts because of the high overhead it imposes on small packets and poor real-time characteristics (Mills, 2003). Therefore, this paper provides the short overview of the existing transport protocols for the SpaceWire networks as the protocols that are closely related to the field of STP-ISS protocol application. The overview of other protocols is currently available in our project report only. The authors elaborated requirements and protocols overview and produced the first revision of STP-ISS protocol. This first revision was simulated and verified by a number of different models. This part of work is described in details in (Sheynin, 2014).

The main goal for current paper is to describe the whole STP-ISS protocol design flow from gathering requirements to the IP-core implementation for rev.1 and introduce the second revision of the STP-ISS protocol.

SPACE ORIENTED TRANSPORT PROTOCOLS REVIEW

The space industry demands a Transport protocol running over SpaceWire which will provide reliability, real-time guaranteed services and determinism. The basic SpaceWire protocol standard covers three bottom layers of the OSI model and does not provide transport services (ESA, 2008). Nowadays there is a number of transport protocols intended to operate over SpaceWire, some of them are standardised. They are: RMAP, CCSDS PTP, STUP, JRDDP, STP and SpaceWire-D, which uses RMAP (see Figure 1). Each of them is intended to solve its particular tasks.

This section will give an overview of these protocols in order to elaborate if any of them meet the technical requirements.
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