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MODERNIZATION OF ONBOARD CONTROL COMPLEX ARCHITECTURE ON BASIS OF NETWORK TECHNOLOGIES

Master's Programme Spacecraft system design

The abstract of the Master's Thesis

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Introduction

Onboard control system (OCS), along with the ground is the main link in the control and management of spacecraft (SC) and is a collection of instruments and devices with information and software designed to control the movement and operation of the spacecraft avionics. Onboard power supply provides electrical and logical interface information between the nodes of the spacecraft.

At present, the organization and architecture of the automated control systems of spacecraft in the JSC "ISS" is built on a centralized control scheme, which is the basis specialized digital computer (STSVM) and interface MIL-STD-1553B. Opportunities for the development and modernization of a BCU with its information and logical interfaces have reached their limit.

For further development of the OCS SC developed JSC "ISS" must upgrade information and logical interface board to reconsider the topology network architecture as well as the SCU, which will in future get a unified platform of all spacecraft.

The aim of this work - the development of a new architecture onboard control complex and onboard information and communication network for use in spacecraft unified platform.

Modern architecture OCS SC production of JSC "ISS"

This chapter sets out principles for the onboard control complex spacecraft onboard equipment, a description of its architecture and interfaces used in modern spacecraft manufactured by JSC "ISS".

Approach to the implementation of modern architecture OCS SC formed in the JSC "ISS" in the late 70s. It is based on dual-circuit consisting of ground and airborne control loops, with a dynamic redistribution of roles and tasks between the circuits at different stages of the SC. OCS that implement this approach created the JSC "ISS" and successfully operated for more than 25 years in the 7-and space programs, such as "Ray", a series of "Express", "GLONASS". A distinctive feature of such systems is high in reliability and survivability of spacecraft autonomy.

Created as a result of this approach OCS "Kontur" was the full amount of experimental testing ground and qualifications. Flight operation of the OCS "Kontur" launched in 1982, with a total duration of the geostationary orbit is more than 100 years with a 20 SC.

OCS "Kontur" absorbed the experience of advanced development JSC "ISS" regarding the creation of spacecraft with a high level of autonomy and survivability, and combines hardware and software required for monitoring and control of spacecraft, its payload and service systems in the process:

- operations for assembly, integration and testing of the spacecraft;
- SC injection into orbit;
- modes of initial and in-orbit tests;
- all stages and modes of normal operation;
- exceptions and conservation regimes survivability.

Scheme OCS “Kontur” is shown in Figure 1

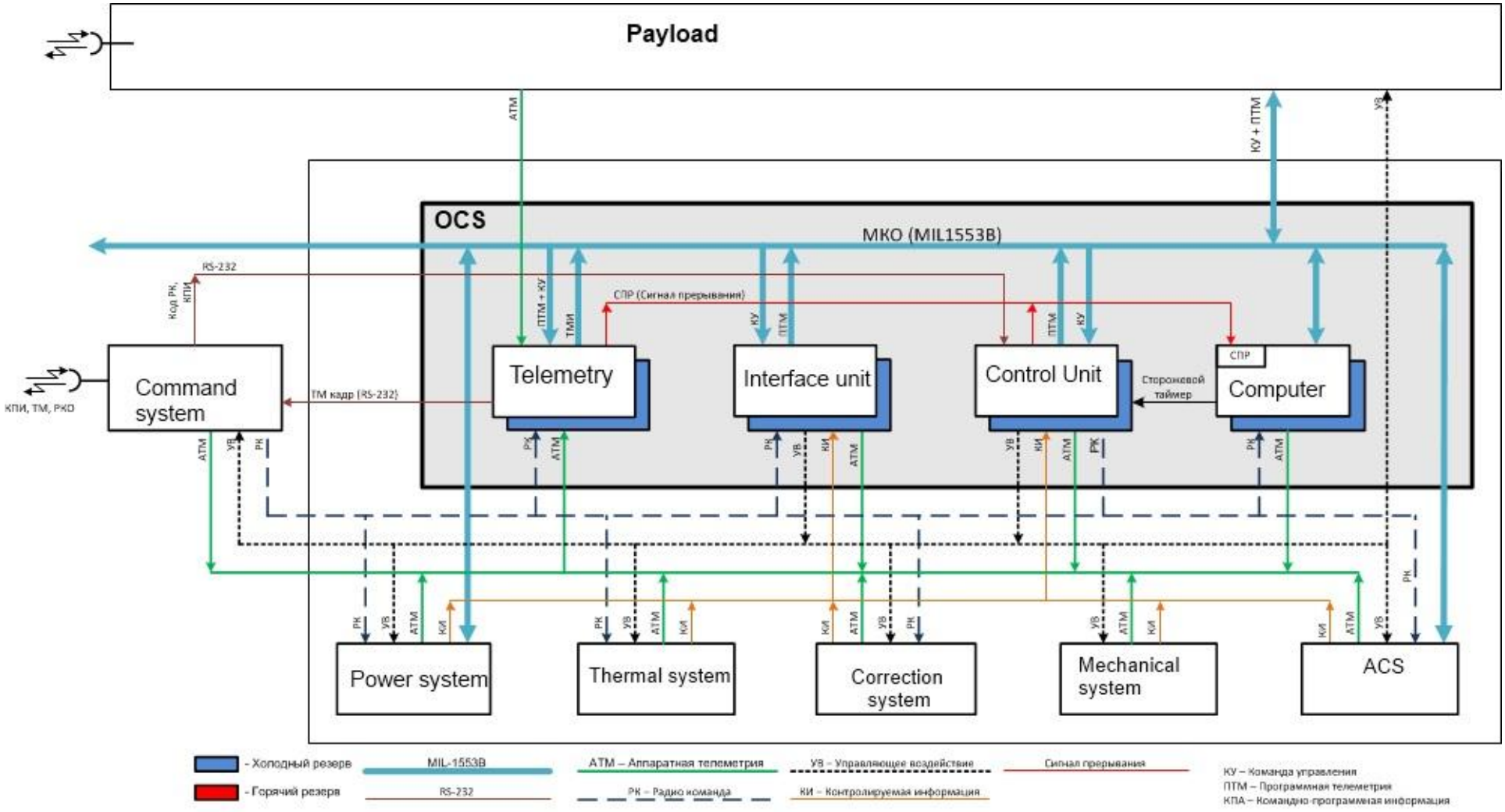

Figure 1. OCS «Kontur» scheme

Statement of the Problem

From the analysis of the technologies used today in the JSC "ISS" in part of information-logical interface are the key questions that need to be addressed in this paper:

- low number of subscribers;
- Low network bandwidth;
- linear bus topology data
- low scalability;
- Use of non-standardized interfaces.

The choice of technology for constructing the OCS

A possible solution to the shortcomings of the existing system architecture spacecraft control described above, is to develop a scalable, fault-tolerant architecture onboard control complex network-based communication technologies. This will create an integrated OCS network infrastructure platform spacecraft, which in a single hardware and software environment implements the transfer of all types of information (high-speed data streams, flow control commands, data packets of information and computational tools, system time marks, etc.), instead of passing each type of information for disparate interfaces.

By far the most suitable and promising interface is interface SpaceWire.

Standard SpaceWire ECSS-E-50-12C, developed by an international group under the auspices of the European European Centre for Research and Technology space (ESTEC) of the European Space Agency (ESA).

OCS new scheme

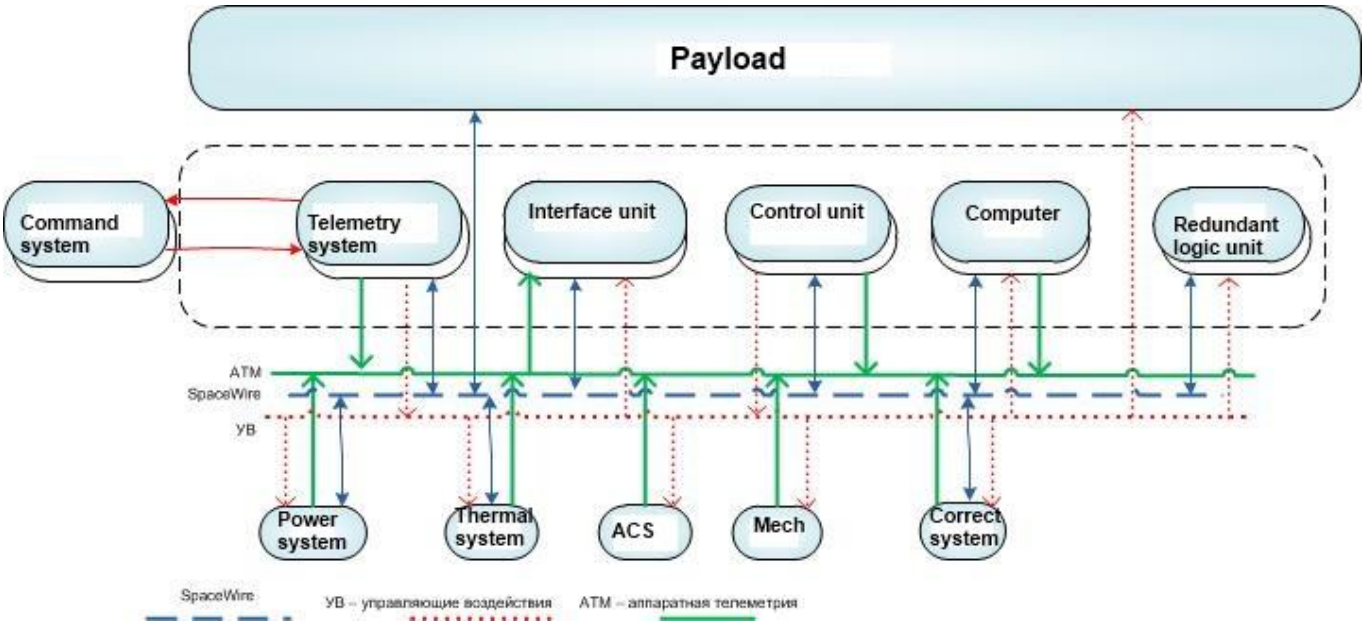

Figure 2. New OCS Scheme

Promising development of OCS is its implementation in the form of modular architecture - in the form of a stack of monoblock. Such an implementation will significantly reduce weight, power consumption, as well as the time required to develop and debug.

However, to date for the organization OCS-stack architecture with the necessary corresponding Russian ECB resistant to external factors with advanced space development for 2-3 years on the needs of generations of architecture OCS (in a phased introduction).

The results and prospects of development

The result of the new architecture is designed onboard control complex and onboard information and communication network for use in spacecraft unified platform.

At this stage, performed an analysis of modern architecture of OCS SC manufactured by JSC "ISS", produced by the choice of technology of building a modern OCS, whereby proposed new architectural building with the consideration of the advantages of the new interface, the requirements to ECB, the issues of SC functioning in emergency mode. Furthermore, additional requirements put forward to SC for the task, the possibility of fulfillment of the proposed requirements. Considered a phased migration to OCS, where the intermediate steps proposed architecture combined OCS and OCS using SpaceWire within a subsystem. Displaying the current state of development of the technology SpaceWire description prototypes developed by JSC "ISS" in conjunction with SPC ICA - SibSAU.

The results of the later stages can be used as input for the design of the onboard control complex with study questions on the composition, protocols, information-sharing logic, the logic of the original data on the functioning of the OCS in standard mode and survivability of spacecraft. As the results of the work will be worked out requirements for other components of the SC associated with the transition to the new MBP design principles.

Development and testing of this project is expected in the framework of small spacecraft (including student) initiative works, patent inventions.

Based on the proposed course of development of airborne systems management perspective is possible to create a separate research in the framework of the Youth KB JSC "ISS", including the involvement of interested young employees of other companies in the space industry in Russia.