Proposals of the Energia space corporation for SpaceWire technology evolution

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Rocket and Space Corporation Energia named after Sergei Korolev

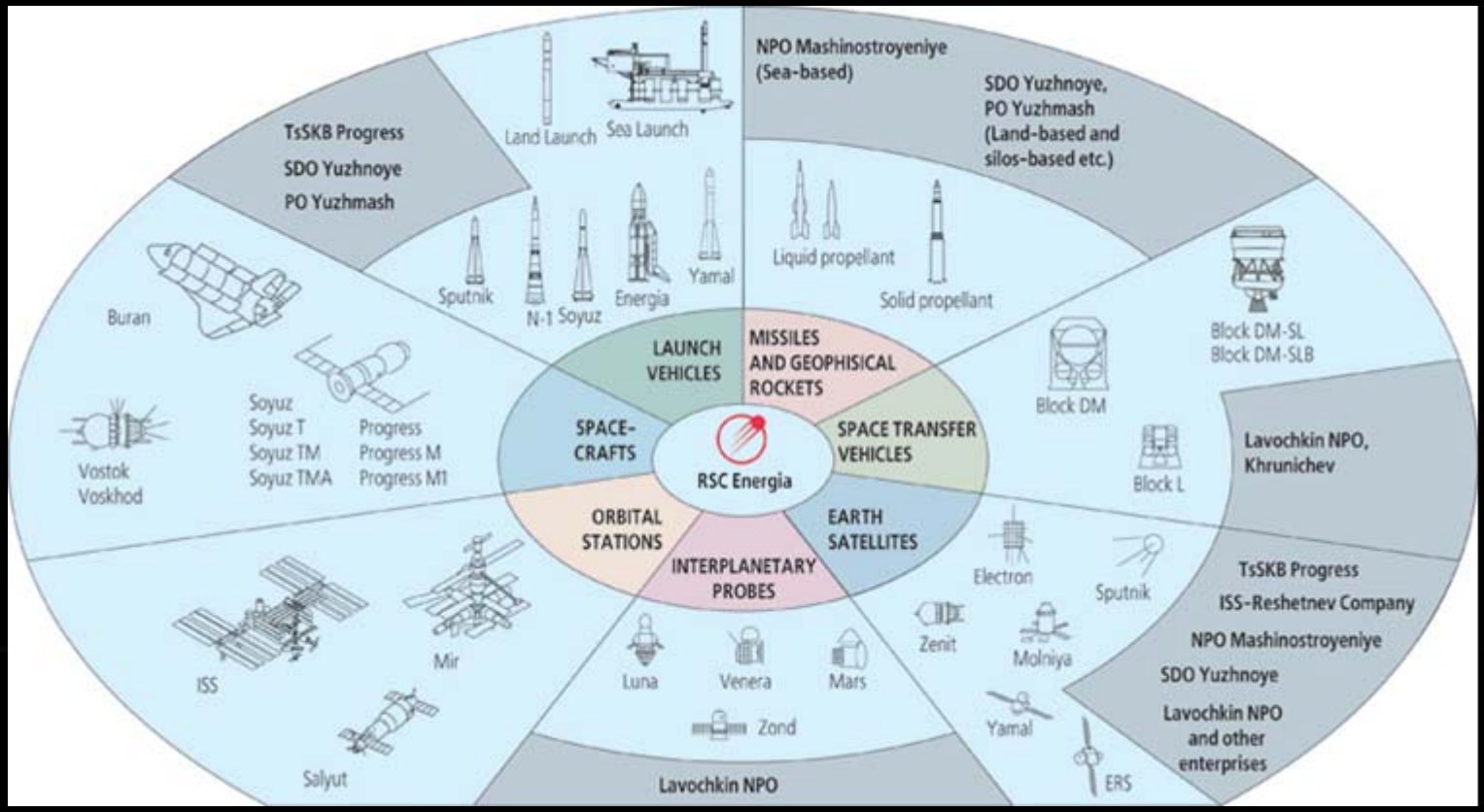
Rocket and Space Corporation Energia after S.P. Korolev Rocket is the strategic enterprise of Russia and the leading company engaged in manned space systems. A great deal of attention is focused on the development of new space technologies, including dedicated unmanned space systems for various applications, rocket systems for spacecraft orbital injection. Its presence is noticeable on the international market of rocket and space services. It is the leader in introducing space high technologies for manufacture of products not related to space industry.

- Its structure:

- Primary Design Bureau;
- Baikonur branch;
- ZAO Experimental Machinebuilding Plant, RSC Energia;
- ZAO Volzhskoye DB;
- ZAO PO Kosmos, RSC Energia;
- Developed social infrastructure.
- 38% of the Corporation equity is owned by the state.

CORE ACTIVITIES

- Manned Space Systems
- Unmanned Space Systems
- Rocket Systems
- Advanced Programs
- Provision of Services



CRUCIALLY IMPORTANT REQUIREMENTS FOR ONBOARD INTERFACES

- providing equipment scalability
- easy upgrading
- supporting real-time transmission of large amounts of data and time-critical commands and data within a broad range of data rates and transmission distances
- etc

Up to now it has been very difficult to develop an all-purpose interface.

SPACEWIRE AS A BASE FOR NEXT-GENERATION ONBOARD CONTROL SYSTEM

Parameters of SpaceWire interface are closest to meeting the requirements of the all-purpose interface but along with significant advantages, has certain drawbacks.

In Energia's opinion, the drawbacks of the SpaceWire are:

- The absence of galvanic isolation of users;
- Complexity of implementation in the case of signal encoding used in SpaceWire;
- Heavy, rarely used and difficult-to-install type of cable;
- High cost of cable and connectors;
- Insufficient length of data transmission paths.

PROBLEMS RELATED WITH THE ABSENCE OF GALVANIC ISOLATION

- Providing of electromagnetic equipment compatibility with independent power supply
- Restrictions of using SpaceWire as interface to exchange data only between boards and units in Energia hardware.

If the implementation of galvanic isolation be achieved it may to extend the area of SpaceWire application to the level of devices and systems and bring us close to the development of multi-purpose (all-purpose) onboard interface. Energia gave a tentative name to it - SpaceFibre (revision).

SPACE FIBRE (REVISION) DISTINCTIVE FEATURES

Layer	Description
Transport, Network, Packet, Exchange	similar to SpaceWire
Symbols	• similar to SpaceWire, but the structure and length of the symbols are different.
Signal	• 8b/10b encoding is used; • receiver and transmitter clock frequencies need pre-matching; • data transmission rate is constant (selected out of the range of 8–1000 Mbps); • galvanic isolation is easily implemented (isolation assembly is not included in the IP-core of the network controller)
Physical	• cable consisting of two shielded twisted pairs of copper wires in a common shield or a two-core fiber-optic cable.

KEY CHARACTERISTICS OF SPACE FIBRE (REVISION) IN COMPARISON WITH CHARACTERISTICS OF THE INTERFACES USED IN THE ENERGIA ONBOARD EQUIPMENT

Characteristic	SpaceFibre (revision)	SpaceWire	Ethernet (100BaseTX)	MIL-STD-1553B	CAN	ARINC 429
Architecture	Point-to-Point, Star, Ring	Point-to-Point, Star, Ring	Point-to-Point, Star, Ring	Bus	Bus	Bus
Data rate, Mbps	8–1000	2–400	100	1	1	0,1
Transmission range, m	80–10	50–10	100	100	40	20
Physical medium	2 shielded twisted pairs in a common shield; Optic fiber	4 shielded twisted pairs in a common shield	2 shielded twisted pairs in a common shield; Optic fiber	Shielded twisted pair	Shielded twisted pair	Shielded twisted pair
Cable mass, g/m	34	80	34	25	25	25
Specific mass of the hardware, gram/port	80	70	109	–	–	–
Power consumption, W/port	0,1	0,2	0,7	2,3	–	–
Galvanic isolation	Yes	No	Yes	Yes	No	No
Absence of constraints on the number of nodes	Yes	Yes	Yes	No (32)	Yes	No (20)
Absence of network access collisions	Yes	Yes	No	Yes	No	Yes
Existence of the interrupt distribution system	Yes	Yes	No	No	No	No
Common system time support	Yes	Yes	No	No	No	No
Guaranteed message delivery	Yes	Yes	Limited	Yes	Yes	Yes
Non-participation of terminal computers in communication functions	Yes	Yes	No	No	No	No
Adaptive routing support	Yes	Yes	Limited	No	No	No
Initialization of transmissions by any user	Yes	Yes	Yes	No	Yes	No
Automatic reconnection and restart of transmissions after soft and hard errors	Yes	Yes	No	No	No	No
Availability of components	Not Yet!	Yes	Yes	Yes	Yes	Yes

CONTINUITY OF SPACE FIBER (REVISION)

- in the data exchange logic, with the confirmed flight tests of SpaceWire;
- in the encoding 8b/10b, with such existing communications systems as Fibre Channel, Serial Rapid IO, Serial ATA, PCI Express, IEEE 1394b, HyperTransport, InfiniBand and a number of others

- It will let to use a large number of their well-developed and studied physical mediums for SpaceFibre (revision) .

For example, the physical medium of the Fibre Channel presented in Table 3.

RUSSIAN EXPERTS VIEW ON DATA RATE RANGE OF SPACE FIBER (REVISION)

- Data rate range as a basic basic data rate range of the SpaceFibre (revision) - 8-80 Mbps;
- Data rate range as a general basic data rate range of the SpaceFibre (revision) - 8-1000 Mbps;

- 8b/10b-encoded signals do not have a DC component, it makes possible to implement a galvanic isolation.
- 8b/10b-encoded signals can will provide thermal stabilization for optical laser transmitters
- two physical lines, instead of four that are used in SpaceWire, will reduce the mass of the onboard cabling

PREMINILARY EXPECTATIONS FROM SPACEFIBRE (REVISION) ONBOARD INTERFACE

- achievement of commonality for interface hardware and software at all levels of onboard hardware, including:
  - at the intra-assembly level (the level at which data are exchanged between integrated circuits on the boards and between printed boards);
  - at the inter-assembly level (the level at which the data are exchanged in distributed equipment);
  - at the inter-system level (the level at which the data are exchanged between hardware of adjacent systems).
- establishment of soft- and hard-failure-tolerant, uniform, scalable network architectures of the onboard equipment with simultaneous minimization of power consumption, mass, and overall dimensions;
- simultaneous transmitting in real time large amounts of data and time-critical commands and data;

PREMINILARY EXPECTATIONS FROM SPACEFIBRE (REVISION) ONBOARD INTERFACE

- Implementation of data exchange both with galvanic isolation and without it;
- Achievement of homogeneous interface structure of the computing environment, and, as a consequence, develop multipurpose computer networks, which could be used at any tier of hierarchical structure of this equipment to address the whole gamut of its tasks, and determine the feasibility of using in the design of various hardware assemblies common technologies for their engineering, programming and debugging, which will significantly reduce their cost and development schedules.

SUMMARY and PROPOSAL OF ENERGIA SPACE CORPORATION FOR ESA/ESTEC

Energia space corporation believes that the SpaceWire technology is a good basis for developing an all-purpose onboard interface, first in its class, which will make it possible to develop onboard equipment operating at significantly higher levels of performance.

Energia space corporation proposes to review the concept of this all-purpose interface in order to study the feasibility of its international standardization as one of the promising trends in the evolution of SpaceWire technology.

THANK YOU

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50 Years of the First Human Space Mission