Second revision of STP-ISS Transport Protocol for Spacecraft On-board Networks

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A new transport protocol is being development under the grant agreement between SUAI and JSC “ISS”.

There are two STP-ISS protocol revisions;

STP-ISS works on top of SpaceWire

Three types of user messages:

- Control Commands
- Urgent messages
- Common messages
Features of STP-ISS revisions

STP-ISS revision 1

- Priority QoS
- Guaranteed QoS
- Best effort QoS
- Connectionless data transmission
- CRC check
- Reset & Flush
- Packet lifetime timer
- Protocol configuration possibility
- Maximum data length 2 Kb

STP-ISS revision 2 (additionally to rev. 1)

- Scheduling QoS
- Connection-oriented data transmission
- Flow Control
- Duplicate control commands detection
- Maximum data length 64 Kb for connection-oriented packets

- Backward compatibility is provided
Application messages

- Messages encapsulated into the SpaceWire packets;

- Data length may be:
  - **2 Kbytes** for Connectionless data transmission;
  - **64 Kbytes** for Connection-oriented data transmission

- **CRC-16** is used for protection of both payload and packet header
STP-ISS Quality of Service

Priority
- 9 priority levels
- Main QoS type
- Data with higher priority should be transmitted first

Guaranteed
- Positive acknowledges for the successful packet transmission
- Resend timer for each packet
- Duplicate control commands detection

Best Effort
- No acknowledges
- Error indication passed to the application

Scheduling
- Single schedule for STP-ISS network nodes
- Time-code reception – beginning of an epoch
- Each epoch – correction of time-slot duration
- Only the TX side is scheduled
A single schedule for all SpaceWire nodes working via STP-ISS.

Data transmission is possible only during the particular time-slots.

Schedule:
- The number of time-slots in one epoch is not limited
- The time-code value is not important
- Beginning of the epoch - time-code reception

Time-slot duration correction is performed once an epoch (if needed)
- Time-slot relevancy window
- Synchronization if there is significant difference in time-slot duration with Time Master
There are 3 logical buffers for each type of application messages

Buffer size recommendation
- Each buffer should be able to store at least 2 packets
Receive buffering

Connectionless data

Common message
Control Command
Urgent message

Types of packets from connectionless data transmission are:
- Application messages
- Service packets

Connection-oriented data

Message 1
Message 2
Message 5

Buffer space reservation is used for connection-oriented data (only for urgent and common messages)
- Each reserved space can store a few messages

NEW!
Transport connection

- **Virtual simplex connection** between two remote nodes (End-to-End)

- Big data transmission is supported *(up to 64 Kb)* with minimum overheads:
  - Urgent messages
  - Common messages

- Maximum number of TC – **16 transport connections**:
  - 8 for transmission
  - 8 for receiving

- STP-ISS supports Credit-based flow control mechanism
- Three-phase handshake for connection establishment
- Connection parameters are specified during the connection establishment
- There are Timers for each transport connection:
  - Timers for connection establishment and closing
  - Standby timer
- We did Transport Connection State Machine for error handling during the connection establishment and closing
Flow Control and Duplicate CC detection

**Flow control mechanism**

- It is used for each transport connection with Guaranteed QoS
- Each side counts the free buffer space and available credits
- Available credits are sent in ACKs (or ACK with a special flag)
- Credits synchronization performs after each N sent packets

**Duplicate control commands detection**

- Likely not to have duplicate control commands
- Duplicate control command appears if the ACK is lost
- RX side stores N last received control commands
- Each control command has a timer
- On timer expiration the corresponding control command is deleted from the list of last received commands
Mandatory implementation includes:

- Priority QoS (1 priority minimum)
- Best Effort QoS
- Transmit buffer (at least for one type of messages)
- Receive buffer (at least for one type of messages)
- Possibility to implement RX or TX side *only*

Extentions are:

- Guaranteed QoS
- Scheduling QoS
- Connection-oriented data transmission
- Duplicate control commands detection
## Protocol Comparison

<table>
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<th>Required features</th>
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<th>PTP</th>
<th>STUP</th>
<th>JRDDP</th>
<th>SpW-D + RMAP</th>
<th>STP</th>
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</tbody>
</table>
Thank you!
STP-ISS Modeling and Testing

- The reference code is intended to be used as the reference for the programmers, who will implement STP ISS in the onboard software.

- The SDL model is needed for the clear formal description of the STP-ISS internal mechanisms and specification analysis.

- The SDL specification could be used as a separate document describing the specified mechanisms, and it would be a useful part for the main protocol specification document.

- The SystemC model shows the STP-ISS protocol operation over SpaceWire network, and it gives an ability to test the network configuration and test networking features.