

SpaceFibre



SpaceFibre is the ESA standard (ECSS-E-ST-50-11C) for very high-speed serial communication links between the units of the satellite. It is compatible with SpaceWire at packet level, but the data-link and physical layers are completely re-defined in order to allow:

- **Link rate** in the order of magnitude of 1 Gb/s to tens of Gb/s, i.e., 10x to 100x higher data-rate with respect to SpaceWire
- **Quality-of-Service (QoS)**
- enhanced **Fault Detection, Isolation and Recovery (FDIR)**.

Integrated Quality-of-Service allows to have different types of traffic over the same SpaceFibre network and to satisfy the overall requirements of bandwidth and latency of each traffic source. For example, control and data can be running on the same SpaceFibre networks by allocating the correct Quality-of-Service for each traffic source.

SpaceFibre protocol is more complex with respect to SpaceWire and is composed of the following layers:

- **Physical Layer**, responsible of the serialization/de-serialization of the 10-bit symbols and the transmission/reception of such symbols over the physical medium, which is composed by a bi-directional link, either copper or optical fibre. On the receiver side, the physical layer is also responsible for the recovery of the clock from the input stream of bits.
- **Lane Layer**, responsible for establishing the communication across the SpaceFibre lane and to safely re-establish communications in case of a transient error. 8B/10B encoding is adopted, which produces a DC balanced signal that can be AC coupled to provide galvanic isolation.
- **The Multi-Lane Layer** allows the SpaceFibre link to be spread over multiple physical lanes, in order to increase the overall data-rate and to add link redundancy. When a lane fails, SpaceFibre traffic is automatically distributed over active lanes. The multi-lane layer is optional
- **The Data Link Layer** is responsible for providing QoS and managing the flow of information over a SpaceFibre link. QoS is implemented by introducing the concept of Virtual Channel (VC). VCs are independent channels which run over the same physical link. The number of VC is configurable and independent of the number of physical lanes used. The Data Link Layer frames the information to be sent over the link to support QoS and optionally scrambles the packet data to reduce electromagnetic emissions. The Data Link layer is also responsible for error recovery, by resending frames and control words that have been detected by the far-end of a link as erroneous or missing.
- **The Network Layer** is responsible for the transfer of application information over a SpaceFibre network. It provides two services: Packet Transfer service and Broadcast Message service. The Packet Transfer service transfers SpaceFibre packets over the SpaceFibre network, using the same packet format and routing concepts as SpaceWire uses. SpaceFibre supports both path and logical addressing. The Broadcast Message service is responsible for broadcasting short messages (8 bytes) to all nodes on the network.

IngeniArs has long experience on SpaceFibre technology also thanks to the participation of its collaborators within the ECSS standardization working group. IngeniArs SpaceFibre technology was developed mainly thanks to Horizon 2020 SME instrument project SIMPLE, which allowed to develop both the SpaceFibre IP Core ready for flight usage and the relevant test equipment to support the validation phases.