Space Development Agency Optical Intersatellite Link (OISL) Standard

Developed by the

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This document is a draft of a proposed Space Development Agency Standards Document. As such, this document is subject to revision.

Revision History

Date	Version	Notes	Status
5/1/2020	N/A	Draft as issued for Transport Layer T0 RFP HQ085020R0001	DRAFT
6/5/2020	1	This version incorporates editorial changes only.	DRAFT

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SDA Draft OISL Standard

Table 1 presents a notional baseline for interoperable design parameters. This process is expected to be iterative to refine the set of finalized parameters. Many protocol items in Table 1 are noted as “to be defined by PDR”. SDA expects the complete set of selected vendors to have agreed on the basic interoperability requirements by SRR, have defined the first draft of an over-the-air interoperability ICD by PDR, and have reached a second, implementable draft by CDR. SDA acknowledges that the Tranche 0 ICD will not be feature-complete regarding objectives for future tranches.

Table 1 – Draft OISL Standard

Parameter	Threshold	Objective	Notes
A Wavelength: C-band	1553.33 nm (selectable)	The center frequency of the optical carrier shall be tunable from 193.1 + n×0.1 THz, where n is an integer ranging from -30 to +30 corresponding to wavelengths in vacuum ranging from 1528.77 nm to 1577.03 nm with 100 GHz channel spacing consistent with ITU-T G.694.1	ITU-T G.694.1 100GHz channel N=-1. The intent is for bidders to support two different frequencies in this range separated by at least 15 nm. The specific two wavelengths will be agreed upon between the winning bidders and SDA after award (nominally by PDR). Which wavelength is used for Tx and Rx must be switchable by command on orbit.
B Wavelength: C-band	1536.61 nm (selectable)		ITU-T G.694.1 100GHz channel N=+20

Polarization Type (LEO SV to LEO SV link)	LHCP Receive (Rx) compatible	LHCP Transmit (Tx)	See ANSI/IEEE Standard 149-1979, "IEEE Standard Test Procedures for Antennas". Designs need to be compatible with both polarization-maintaining and non-polarization-maintaining designs. It is acceptable to lose 3 dB due to mismatch if the threshold data rate is still met.
OISL Switchable TX/RX Pairing	Yes		
TX Power description	Each respondent will propose their min and max flux at 1000, 3000, and 5000 km		
Government required link margin	3 decibel (dB)		Bidders are encouraged to propose a combination of techniques including power, aperture, forward error correction, and other coding techniques to contribute to this required minimum link margin while maintaining interoperability.
Terminal Field of Regard (FOR) min. & max.	TBD		
Modulation Format	On-Off Keying (OOK) Non-Return-to-Zero (NRZ)		
Coding	LDPC-based forward error correction (FEC). To be defined by PDR.	In-flight re-programmability to support evolution from Tranche 0 experimental implementations to final objective interoperability standards.	Prior art includes DVB-S2 (BCH+LDPC), DOCSIS 3.1, 400ZR / 802.3ct, and CCSDS standards but OISLs are a distinct use case from existing standards.

Bit Error Rate (BER) after Forward Error Correction (FEC)	10^{-6}	10^{-9}	SDA desires low BERs because time-of-flight delays cause high retransmission latencies
Modem Latency	15 ms	5 ms	Defined as time from photons at aperture to bits at data interface
Link Training	None required.	None required.	Future higher-performance interoperability standards may require link training to enable higher data rate modes.
Physical Framing	Point-to-point link. Includes sequence numbers and automatic repeat request data. May include modulation/FEC rate signaling and/or management data. To be defined by PDR.	In-flight re-programmability to support evolution from Tranche 0 experimental implementations to final objective interoperability standards.	Prior art includes IEEE 802.3 and 802.11, 3GPP (LTE/LTE-A/5G), DOCSIS 3.1, and various ITU-T and CCSDS standards but OISLs are a distinct use case from existing standards and require large (20+ bit) sequence numbers.
Payload Datagram Encapsulation/Framing	Encapsulates/frames 802.3 Ethernet frames and possibly link management frames. Supports payload fragmentation/reassembly across physical transmission frames. To be defined by PDR.	In-flight re-programmability to support evolution from Tranche 0 experimental implementations to final objective interoperability standards.	Prior art includes ITU-T G.7041 Generic Framing Procedure, CCSDS Generic Framing Procedure, and HLDC
Link management	Protocol feature / extension negotiation, error rate reporting, FEC and modulation rate control, tracking data exchange, ranging and synchronization data, future extensibility. To be defined by PDR.	In-flight re-programmability to support evolution from Tranche 0 experimental implementations to final objective interoperability standards.	Prior art includes 3GPP (LTE/LTE-A/5G), IEEE 802.11, and CCSDS standards.

Coding and Modulation Re-programmability		Adaptive Coding and Modulation (ACM)	TBD @ SRR
OISL terminal-to-terminal timing accuracy	10 nanosecond	1 nanosecond (rms)	
OISL timestamping accuracy	10 nanosecond (rms)	1 nanosecond (rms)	Path to 0.3 ns (rms)
OISL ranging accuracy	3 m (rms)	30 cm (rms)	
OISL range rate accuracy	N/A	1 cm / second	
Point-ahead capability	TBD	TBD	
Acquisition time	100 sec	10 sec	Cold start. Proposers are required to be capable of acquiring without a beacon within the threshold acquisition time. After selection, SDA will work with selected proposers on options for accelerating acquisition time.
Sun Exclusion Angle	+/- 5 deg	+/- 3 deg	Operation with other bright objects (Earth, Moon, etc.) in the FOR
User terminal orbital altitude regime	750 – 1250 km		