The Need for Speed – Just in Time Data Relay through Optical Communications Links

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The breadth of space-based assets collecting data with time critical information is increasing at a rapid pace. Multi-mission satellite platforms, hosted payloads and dedicated remote sensing platforms now generate huge amounts of data in real time that may have immediate time value. As resolutions and complexity of the data gathered increases, the amount of data that these commercial, civil and defense satellites are generating is vast and growing. Previously sensors deployed on these platforms primarily looked down but now these platforms feature sensors looking up or sideways generating even more data of interest. All have one thing in common and that is the need to relay data from the space-borne platform to an interested consumer to work with the "actionable" information. How is this data going to get to an end user in time to act? There is increasing demand to get sensor data to the decision maker in real time when it has the most relevance. So, who moves this data? Even with optical cross links, a trip to an earth station is not guaranteed. The "need for speed" now has an answer, SpaceLink.

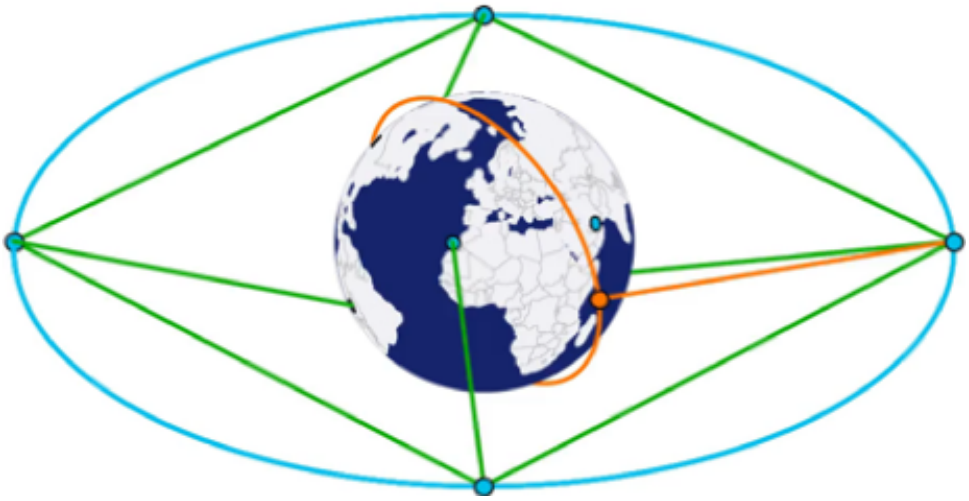

Figure 1. SpaceLink MEO satellites provides real-time continuous & secure U.S. downlink

Launching in 2024, the SpaceLink network of four Medium Earth Orbit (MEO) satellites and ground stations will provide a commercial relay service for continuous connectivity to Near-Earth spacecraft, space stations, and platforms, see Figure 2. SpaceLink initial Block 0 constellation will move data through Optical Intersatellite Links (OISLs), enabling users to transmit data at rates up to 10 gigabits per second (Gbps). SpaceLink ISLs enable continuous gateway coverage with operational services for anytime downlink of ITAR- restricted and proprietary user data into a US gateway, independent of the satellite location.

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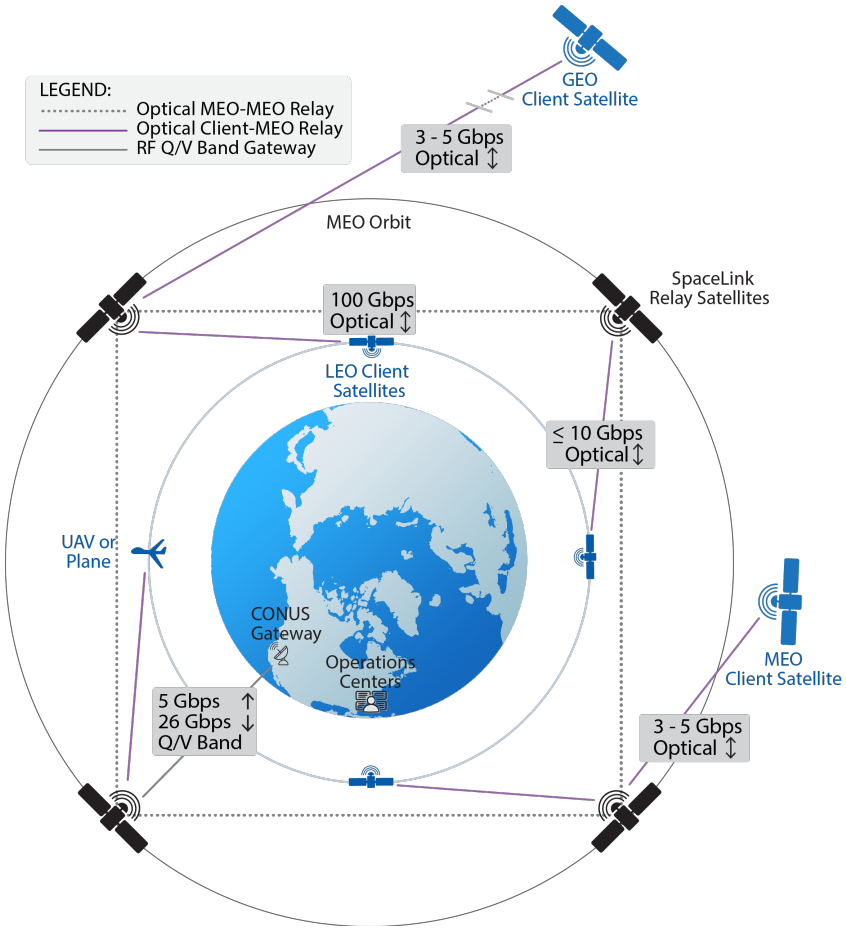

Figure 2. SpaceLink's network architecture (Block 0)

SpaceLink's hybrid optical/RF approach to its space and ground segments respectively is commercially unique, offering its customers secure, high-throughput, and high-availability services for their communication needs in near-Earth orbit. The SpaceLink network features compatibility with the Space Development Agency's (SDA) optical communications standard. A single user OISL terminal on a client spacecraft supports bidirectional data communications relay transmission through the SpaceLink system . Satellite TT&C are also accommodated in near real-time, leveraging the large uplink/downlink bandwidth. SpaceLink's RF/optical technologies and relay network can scale with increasing demand.

The relay satellites are equally spaced in 0° equatorial plane, deployed in Medium Earth Orbit (MEO) at 13,892 km altitude. In its initial operating capability (Block 0), the relay satellites with optical inter-satellite links provide full coverage to LEO user satellites and continuous access to SpaceLink's gateway network. The SpaceLink gateway network will be based in the U.S. and tied to a U.S. Network Operations Center. User satellites are in low Earth orbit (LEO), with Optical terminals, always in view of the SpaceLink relay satellites. SpaceLink's constellation of four satellites provides 100 Gbps of raw data transfer capacity with latencies as little as 150msec from reception to delivery. Utilizing SDA compatible Optical User Terminals, the SpaceLink constellation aggregates data from multiple sources and delivers that data to users using secure cloud-based networks. The SpaceLink relay network is designed to handle scheduled, ad-hoc and urgent requests.

SpaceLink plans to provide a Global Network delivering seamless coverage of the MEO satellite constellation. Gateway links to SpaceLink's relay satellites provide over 26 GHz of coverage in the Q and V bands to the Gateway Network. Data delivered to SpaceLink's Gateway Network is delivered rapidly to top tier cloud providers Amazon Web Services (AWS) and Microsoft Azure for secure and reliable data delivery. Because of its four-satellite architecture, data can be instantaneously and securely passed over optical links to the node closest to its U.S. access

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zones. Each access zone has two gateway sites each hosting two 10m multi-band antenna systems. The gateways are within an access zone with a minimum of 100km separation to mitigate any weather- related events. This enables 99.99% system availability.

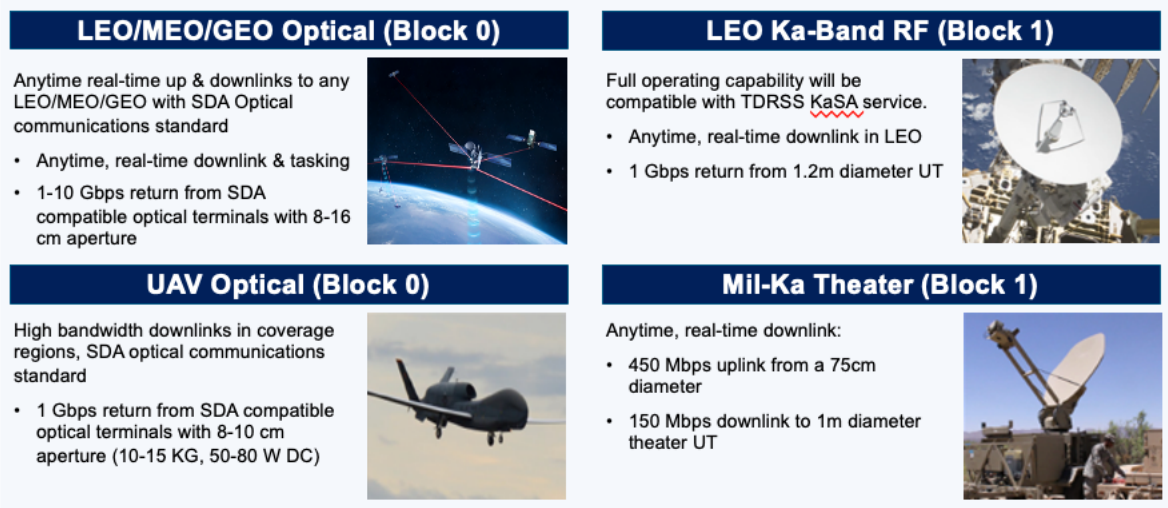

Figure 3. SpaceLink relay service capabilities

The SpaceLink constellation consist of 4 main components:

- Space Segment: Optical-RF hybrid solution with dual use robust constellation employing software defined payload, processor and modems, with 4 equatorial MEO satellites in initial deployment.
- Ground Segment: RF to ground gateway links licensed at Q/V band, with Mil-Ka to theater capability across global gateway network, using 2 US region with 6 gateway sites (Block 1)
- Client User Segment: Client user links utilizing either SDA-compatible high bandwidth optical relay terminals, or RF Ka-band relay terminals TDRS/WGS compatible. (Block 1)
- Network Segment: Client data distribution and asset tasking leveraging cloud distribution services (AWS/Azure) and cloud edge processing services. SpaceLink has deployed schedule resource management with cybersecurity and encryption cover across network, payload and spacecraft operations center (NOC/POC/SOC).

Regarding Client Data Distribution, SpaceLink only needs to provide minimal local processing limited to conditioning & formatting for transport to cloud provider. Direct distribution to cloud edge processing will be achieved via SpaceLink gateways with secure fiber optic connectivity to cloud providers. Network peering and the POP are within the cloud service networks.

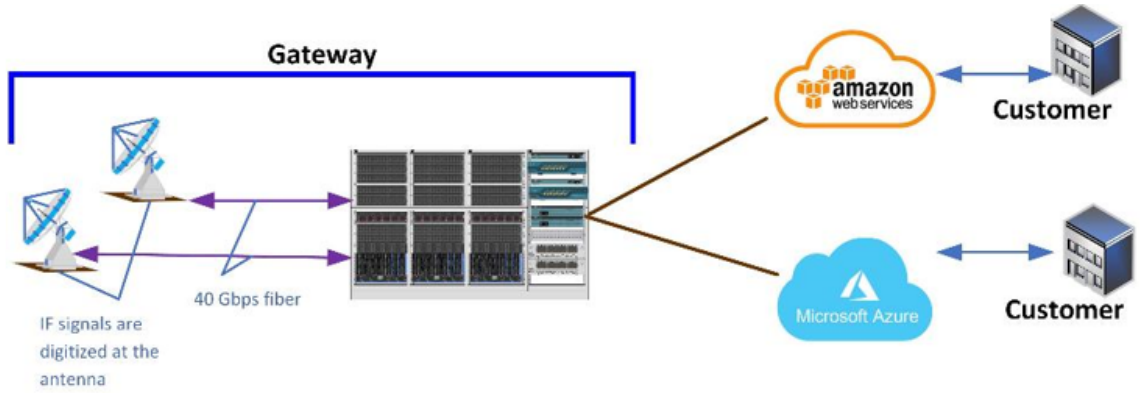

Figure 5. SpaceLink streamlined architecture

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