SWARM NETWORK ARCHITECTURE OVERVIEW

Architecture

All Swarm satellites are in Low Earth Orbits (LEO), and most are in sun-synchronous orbits (circular orbits that are locked relative to one another as the Earth rotates the Sun) at 450-550km altitude, with an orbital period of ~94 minutes. The satellites have relatively fixed orbits, and the Earth rotates under the satellites, so every satellite sees every point on Earth 4-5 times per day. The satellites use both passive and active attitude control and propulsion techniques to stabilize their attitudes and spread out and maintain their position like a string of pearls (as in Fig. 1-2). The launched Swarm satellite orbits are displayed live on our website here: https://swarm.space/tracking/.

Swarm will launch 150 satellites into at least 7 different orbital planes to provide global continuous coverage, as in Fig. 2. Separation between adjacent orbital planes is maintained by using sun-synchronous orbits for each polar plane. These orbits share a common rate of precession, allowing them to maintain their relative spacing, and maintain reliable constant global coverage.

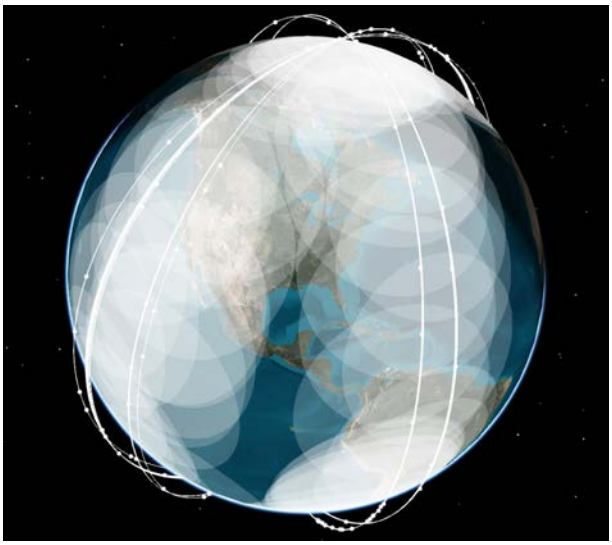

Figure 1: Swarm's current satellites spreading in orbit **Figure 2:** Fully deployed 150 satellite constellation

Data Relay Architecture

The Swarm network architecture consists of ground devices, which the Customers own and operate, and satellites and ground stations, which Swarm owns and operates, see Fig. 3. Swarm's user-operated ground device is the Swarm Modem, an embedded modem, which transmits messages to the satellites via an antenna. Data is sent from a third-party device to a Swarm Modem, and then relayed to the satellites, which stores the data onboard. The satellites then downlink the data to a Swarm-operated internet-connected ground station. All data is transmitted through the network using a store-and-forward mechanism, where data is stored on-board the satellite until it can be downlinked to a Swarm ground

station. The data is then transferred to Swarm's backend on a secure AWS cloud server, where the data is made available to the Customer.

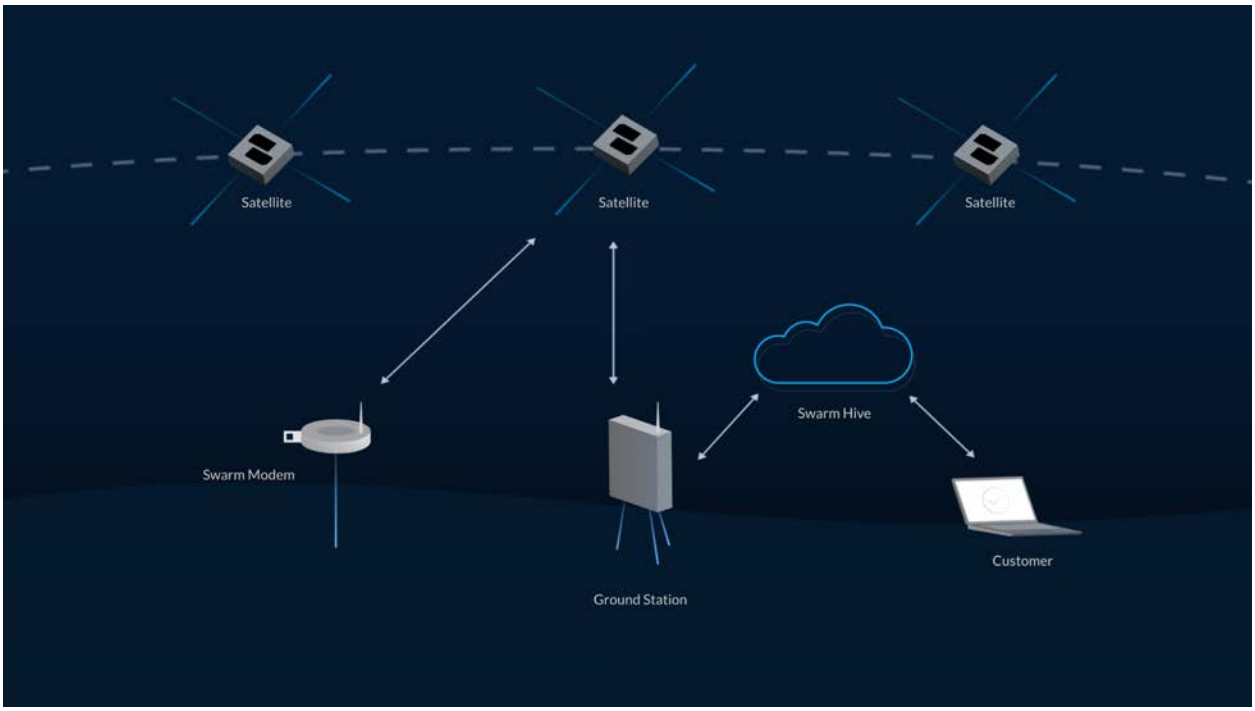

Figure 3: Swarm data architecture, where data is relayed from a 3rd party device, to the Swarm Modem, to the Satellites, and then downlinked to a Swarm ground station using a store-and-forward architecture. Data is stored on the Swarm backend (Hive), and available via APIs to the Customer.

Link Budget

The Swarm satellites have been designed to close the link at the radio horizon, which at our altitude of 500 km is roughly 2,700 km, as in Figs. 1 and 2. The Swarm link budget models how the energy transfers from the satellites to the ground devices, and vice versa. The Swarm link budget considers all losses, gains, and power levels of the system, including sufficient margin, providing confidence in how the communications link will work. We've demonstrated the Swarm link budget with our commercial satellites in orbit. Swarm does not plan to vary the data rate as the satellite passes directly overhead, where the path loss is minimized.

Communications Protocol

The Swarm system uses a modified form of FSK for the physical layer (1) and data link (2). We have developed a proprietary Swarm protocol for the network and session layers (3 and 5), and do not support the transport layer (4). The presentation and application layers (6 and 7) are supported by the Swarm backend.

Please email support@swarm.space if you have any further questions. The most recent version of the document is available at https://swarm.space/customerdocs/.