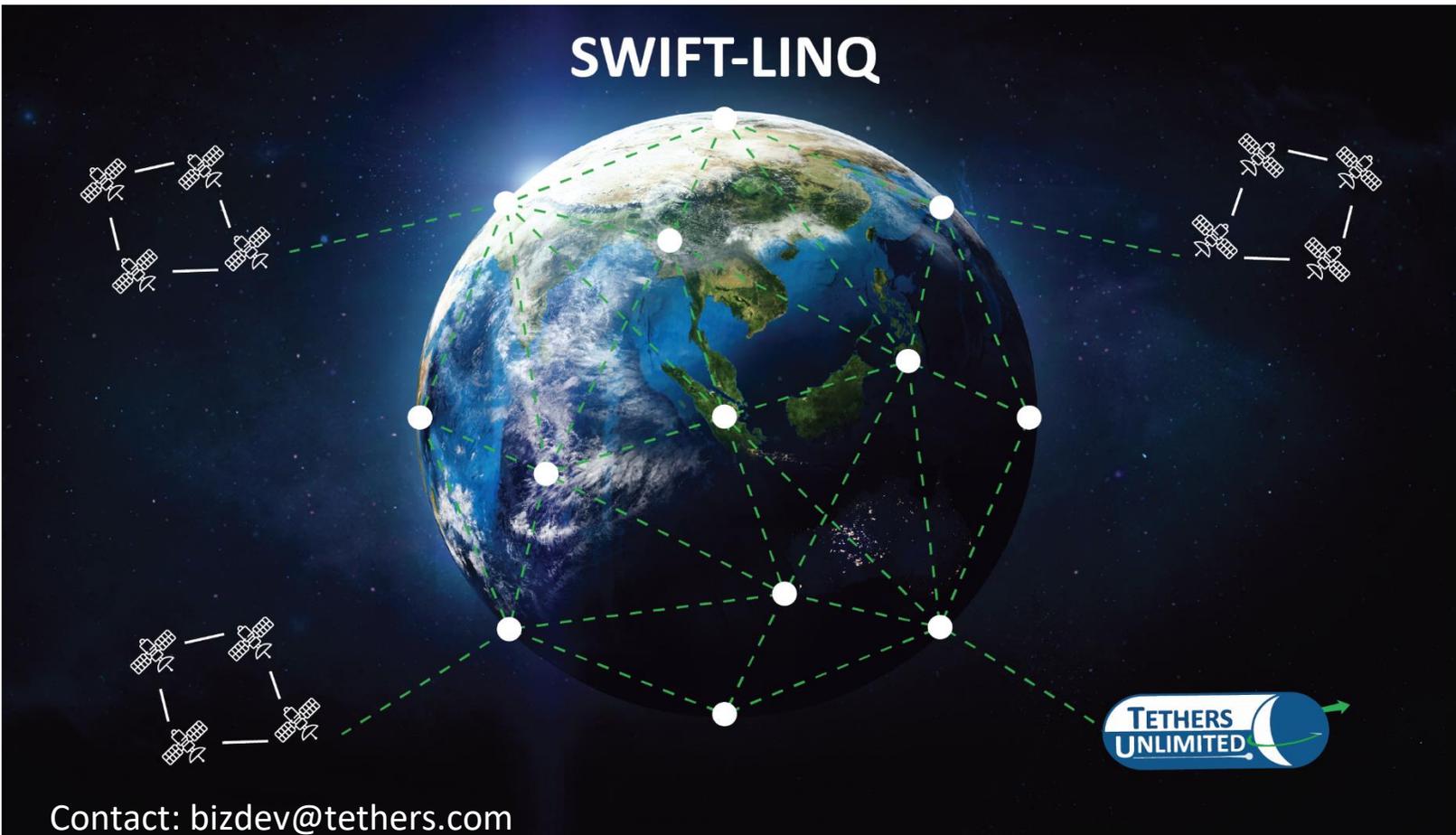


Technical White Paper

TDMA in Space Environments with SWIFT-LINQ



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Executive Summary

The Problem

- Difficulty forming mesh-networks in space
- Orbital Dynamics cause doppler issues
- SWaP Limitations for satellites
- Limited RF Spectrum allocations

The Solution

- SWIFT-LINQ with TDMA: TUI's secure mesh-networking system

TUI's Benefits

- Easy to implement
- Adaptable, resilient, and self-healing
- Works with multiple sized frequency allocations
- Low SWaP

Problem Definition

Traditional satellite architectures rely on ground networks to exchange information between satellites, resulting in long latencies and slow data rates. Satellites have size, weight, connection interferences, and power restrictions and must operate in extreme radiation and thermal environments. These factors make standard commercial networking solutions difficult or impossible. The problem also lies within existing constellations with intersatellite links. If a node is unavailable due to adversaries or faults the communication is disrupted and results in data loss.

These factors must be overcome to successfully implement a multi-satellite network. TUI's SWIFT-LINQ system offers a high-level solution to the common problems faced when integrating mesh-networks.

High Level Solution

Connecting satellites together to communicate to one another grows the capabilities of what satellites can do. Sharing data from one to another enables collaborative missions and enhances the operational capabilities of satellites. Rapid satellite-to-satellite networking can improve the resilience, throughput, and responsiveness of key satellite services.

Size, spectrum, and orbital dynamics are all factors that need to be addressed to form and maintain an efficient space network. Since RF spectrum is very valuable and is authorized in very small bands, this precludes the use of many commercial terrestrial network solutions that use wide-bandwidth frequency allocations.

Orbital dynamics can have an impact on mesh networking as well. The speed at which satellites move in their orbits is an important factor to consider. Satellites in a LEO constellation can be moving at over 14 kilometers per second relative to each other. This causes severe doppler effects and hence requires compensation for space applications.

TDMA eliminates these complex constraints. It allows several users to share the same frequency channel by dividing the signal into different time slots. Satellites transmit in rapid succession, one after the other, each using its own time slot to communicate within the allocated bandwidth. Hence, TDMA is more resilient to spectrum allocation limitations, making it more versatile to use with any size spectrum allocation. Additionally, by placing guard times around each time slot, a TDMA system can easily compensate for doppler effects.

Joining satellites together and forming mesh networks requires a multiplexing scheme in which each satellite node can communicate to each other without interference. TDMA provides options for missions looking to build any sized mesh networks quickly without large, costly frequency allocations.

Business Benefits

TUI's SWIFT-LINQ solution provides consistent and superior resiliency for satellite networks and ground station latency. With its self-healing system, SWIFT-LINQ allows satellites to communicate with one another and through multiple different ground stations which increases resiliency and communication abilities. TUI's SWIFT-LINQ TDMA solution can readily adjust to the transmission of information using its' robust communication abilities and offers high compatibility in advanced frameworks.

This solution offers quicker durations to launch, smaller size, high adaptability, and is an easy-to-implement solution across multiple missions. With TUI's speed of delivery, ease of use and configuration, implementing SWIFT-LINQ for your next mission is a no-brainer!



Summary

TUI's SWIFT-LINQ mesh networking solution is reliable, easy-to-implement and an adaptable system that is already flying in space. SWIFT-LINQ overcomes the common challenges of cost, space, weight, and power restrictions.

Tethers Unlimited SWIFT-LINQ system with TDMA allows for easy deployment and implementation of mesh networks. We want to offer YOU this adaptable and implementable solution. Contact bizdev@tethers.com to use SWIFT-LINQ for your next mission.