

## SWITS 2026 ABSTRACT

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Title - KBF-PAN: Secure Path Awareness for Multi-Domain Satellite Networks.

Hybrid terrestrial–non-terrestrial networks (TN–NTN) are becoming essential for delivering global connectivity, but they still lack scalable methods to ensure that packets follow authorized and trustworthy routes across multi-operator satellite domains. Current path-validation schemes were built with terrestrial deployments in mind and impose computational costs that are impractical for highly dynamic satellite networks. To address this gap, we present KBF-PAN, a secure path-aware networking framework that, to the best of our knowledge, is the first to deliver lightweight path authorization, proof of transit, source authentication, and packet integrity across hybrid TN–NTN environments.

KBF-PAN couples a centralized path-authorization mechanism with per-hop HMAC-based cryptographic verification, encoding two keyed Bloom filters directly within standard SRv6 HMAC TLVs. By doing so, the framework retains full IPv6 compatibility and avoids the need for protocol extensions or alternative network architectures. We implement KBF-PAN in P4 on BMv2 and conduct a thorough evaluation across both terrestrial and LEO satellite scenarios, including constellation-scale emulation built on StarryNet. The results show that KBF-PAN achieves complete per-hop authentication while cutting latency by up to 33% relative to state-of-the-art baselines in terrestrial settings, and that it sustains bounded processing overhead under simulated satellite conditions.