Case Study

Resilient TN/NTN integration and orchestration for real-time multimedia video streaming

The Challenge Coverage gaps, congestion and reactive processes

Emerging communication networks are expected to deliver seamless, high-quality experiences regardless of user locations. Yet terrestrial mobile networks still have significant coverage gaps and are facing the risk of increasing congestion in busy urban environments. When these networks degrade or fail, users lose connectivity entirely, with no automatic fallback.

For bandwidth-intensive applications such as real-time multimedia video streaming even a brief interruption is highly disruptive. Today, switching between network paths is largely reactive with systems responding only after a failure has already occurred, by which point the user experience has already deteriorated.

The missing capability is intelligent, proactive path management for real-time video streaming services: the ability to predict when a terrestrial link is about to degrade, assess the quality of available alternative paths in real time, and switch traffic seamlessly before the user notices anything is wrong. Non-terrestrial networks (NTN), in particular LEO satellite networks represent a promising backup layer; however satellite links are dynamic, with continuously varying channel conditions and short visibility windows. Designing and validating algorithms that exploit this backup layer successfully requires a realistic, programmable test environment that very few organisations can build independently.

The Approach A predictive path-switching framework

The University of Bristol, working through the JOINER Platform, has developed and is validating a predictive path-switching framework for resilient multimedia streaming over integrated terrestrial and non-terrestrial networks. The framework is being tested using two complementary industry emulation platforms — Keysight and NE-ONE — integrated into JOINER's national infrastructure.

The core approach treats the satellite link as a managed backup path alongside the primary terrestrial connection. Rather than taking actions upon the detection of failures, the system continuously monitors both the terrestrial segment and the space segment. Using machine learning-based predictive models, it anticipates terrestrial link degradation through falling throughput, rising latency, or congestion, and evaluates the current quality and capacity of available satellite links before making a switching decision. The system can predict satellite availability windows in advance, giving it a reliable foundation on which to build proactive scheduling and switching decisions.

The two test platforms are used in a complementary way. Keysight provides a 3GPP-native radiofrequency environment that faithfully emulates standardised handover procedures, making it ideal for validating NTN integration in line with current standards. Anyone operates at the IP layer, making it the preferred platform for designing novel switching logic, edge computing integration, and multi-path traffic management beyond what current standards prescribe. Together, the two platforms allow the testing of both scenarios and next-generation approaches within the same programme.

JOINER is critical to this work because it provides secure, remote, authenticated access to both platforms from anywhere in the UK. Collaborating institutions can flexibly access the testbed through JOINER without needing a physical presence in Bristol. JOINER also enables parallel experiment execution across multiple users and sites, dramatically accelerating the pace of validation. This level of realistic, multi-site, programmable infrastructure would be extremely difficult and costly for any single institution to replicate independently.

The Outcomes Proactive path-switching algorithms

Initial experiments have demonstrated that satellite connectivity is a practical and reliable means of maintaining service continuity when terrestrial links fail. Video playback remains smooth during ground-to-satellite path transitions, validating the feasibility of the approach in a realistic lab environment.

The project is producing proactive path-switching algorithms that are designed to eliminate residual disruption during handover. These algorithms leverage known LEO orbital data to anticipate satellite availability and combine it with real-time terrestrial monitoring to make switching decisions before any degradation reaches the user.

Beyond multimedia streaming, the techniques developed here are directly applicable to a wide range of use cases that depend on reliable connectivity. For example, emergency services communications in disaster zones, remote healthcare and ambulance telemetry, autonomous vehicle coordination, and any scenario in which terrestrial infrastructure may be unavailable or overwhelmed. Intelligent traffic steering and switching between terrestrial and satellite paths is relevant to any operator considering NTN as a primary or backup layer.

By making these test beds accessible, JOINER is providing a national resource for industry and academia. Any team working on NTN-related problems, including path switching, traffic steering, resource management, end-to-end orchestration, or resilience, can prototype and validate their algorithms against realistic conditions without needing access to live satellite infrastructure. This accelerates the translation of research into deployable solutions and positions the UK to contribute meaningfully to NTN.

The Partners Delivered in collaboration with the following organisations

The partners involved in this project:

- University of Bristol
- Keysight Technologies
- Calnex

Interested in learning more? Get in touch at joiner-project@bristol.ac.uk.