Resilient NTN Security

6G Satellite–UAV Networks

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Introduction

6G non-terrestrial network (NTN) will deliver ubiquitous, resilient connectivity through the convergence of satellite, UAVs and terrestrial segments. As these networks become AI-native computation and intelligence are distributed toward the network edges. This enables service provision for safety-critical operations in environments beyond terrestrial networks, while network behaviour becomes highly dependent on AI-driven decisions taken under highly dynamic conditions.

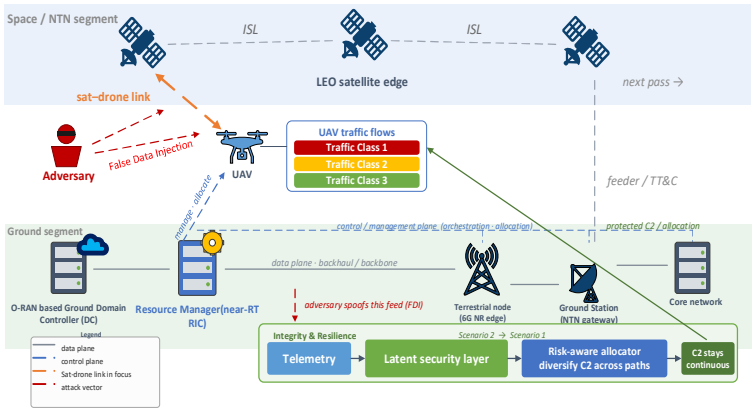
Research Challenge

6G non-terrestrial network (NTN), security, faces challenges with allocating resources across satellite–UAV–ground infrastructure, while staying robust to attackers that can interrupt the link.

Research Objectives

- Develop AI-native resource management that adapts to dynamic, partially observable 6G NTN conditions.
- Establish a security mechanism that preserves resilient decisions under adversarial data manipulation.

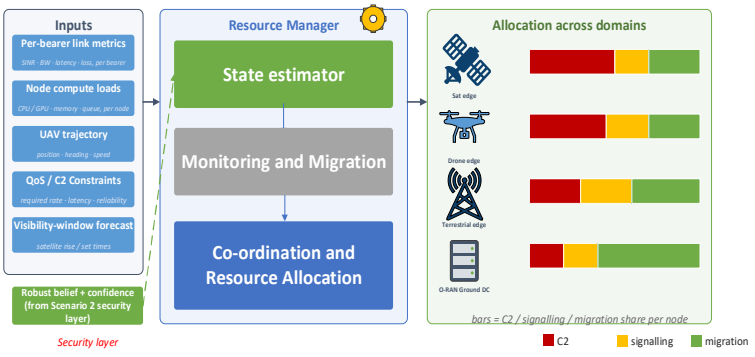
System Architecture and Design



High-level architecture for integrated satellite-UAV-ground scenarios

The architecture spans a space–air–ground continuum, a LEO satellite segment, UAVs performing on-board and split inference, and a ground segment comprising terrestrial gNBs, an NTN gateway, edge/central data centres and the 5G/6G core. A domain controller (near-real-time RIC) orchestrates the system, allocating resources across tiers.

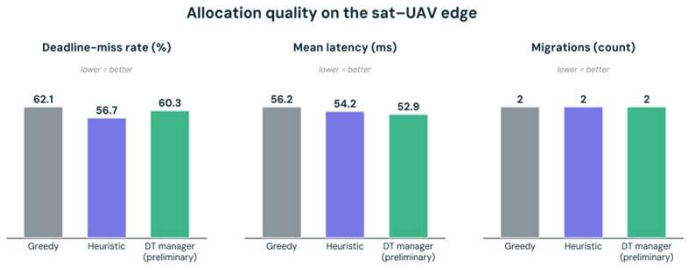
Resource Management



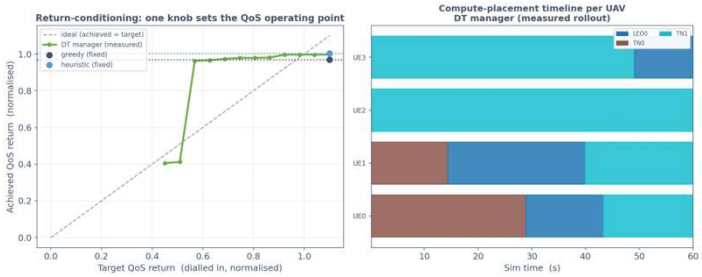
The resource manager across the edge continuum

AI techniques can be allocated and migrated across the satellite–UAV–ground edge under intermittent connectivity. Also, Decision Transformer algorithm will be used to determines node placement, compute and bandwidth splits, while preserving safety-critical links.

Results & Findings



The heuristic allocation cuts deadline-misses 62% → 57% vs greedy. **Proposed** Decision Transformer generalizes this in one policy (preliminary).



The manager is return-conditioned, one target knob sets the QoS operating point. Past the knee it locks onto the high-QoS regime, matching the greedy and heuristic baselines, yet stays tuneable. Throughout, it migrates UAV's resources across terrestrial and LEO edges as conditions shift.

Conclusion

Bringing resource management and security integrity together within a single AI-native framework offers a path toward 6G NTNs that are simultaneously efficient and resilient, enables sustaining safety-critical service in dynamic environments.

Next Steps

Future work will develop a unified simulation and evaluation environment for the integrated framework, incorporating an adaptive adversary model to stress-test resilience, and will benchmark both the resource-management and security components against established baselines under realistic 6G NTN operating conditions.

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Slide 1

TD1 CHEDDAR COLOURS

Dark Green
RGB: 13 / 38 / 48
HEX: #0D2630
CMYK: 87 / 30 / 71 / 40

Grey 1
RGB: 125 / 125 / 120
HEX: #7D7D78
CMYK: 40 / 30 / 37 / 2

Mint
RGB: 110 / 208 / 173
HEX: #6ED0AD
CMYK: 66 / 0 / 41 / 0

Grey 2
RGB: 218 / 223 / 213
HEX: #DADFD5
CMYK: 4 / 3 / 10 / 7
70%
40%
70%
40%

Lavendar
RGB: 122 / 120 / 230
HEX: #7A78E6
CMYK: 57 / 52 / 3 / 0
70%
40%

Off White
RGB: 245 / 245 / 240
HEX: #F5F5F0
CMYK: 3 / 2 / 2 / 0

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TD2 CHEDDAR Brand Font Guidelines

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Pull quotes
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Hyperlinks

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Use for:
Body copy (long-form text and general content)

Slide 1 (Continued)

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