

Towards Zero-Touch in the Integration of Terrestrial and Non-Terrestrial Networks: From Intent-Based Networking to Agentic AI

F. Matera, M. Settembre, A. Gotta, A. Rago, G. Piro, L.A. Grieco, A. Detti, A. Vizzarri, F. Mazzenga, G. Soriano, S. Morosi

Speaker: Francesco Matera

fmatera@fub.it



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Outline

ITA NTN and NETWIN projects: the context

TN-NTN Integration: Opportunities and challenges

Management & Orchestration Framework according to current standardizations

Intent base Networks and Agentic AI

IPv6 (Segment Routing v6)

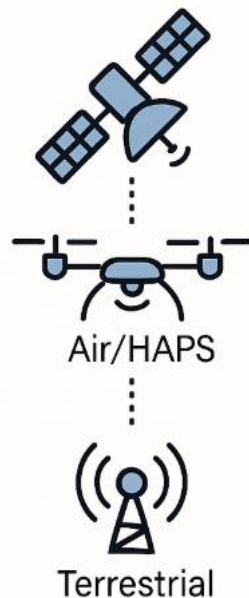
Conclusions



Main Opportunities and Challenges in TN-NTN Integration

Opportunities

- Ubiquitous coverage
- Resilience & redundancy
- 3D network capabilities
- New use cases
- Dynamic resource sharing
- Support for 6G vision



Challenges

- Latency & Doppler effects
- Heterogeneous architectures
- Dynamic orchestration complexity
- Spectrum coordination
- Standardization gaps & evolution



NTN Mobility Management, Propagation Delay & Handover



- **NTN > TN delay** → higher latency in mobility signaling process (e.g. measurement reporting, handover command)
- **Impact on Measurement Validity:** delays may cause obsolete info → wrong HO (premature, delayed, ping-pong)
- **GEO vs LEO**
 - GEO: high delay, stable position → fewer HO events.
 - LEO: lower delay, fast movement → frequent HO events, higher signaling load
- **Mitigation**
 - Incorporate satellite mobility and location assistance into HO decisions.
 - Adaptive timers/validity windows per orbit type.
 - ML-based prediction explored in literature to improve robustness



Finanziato
dall'Unione europea
NextGenerationEU



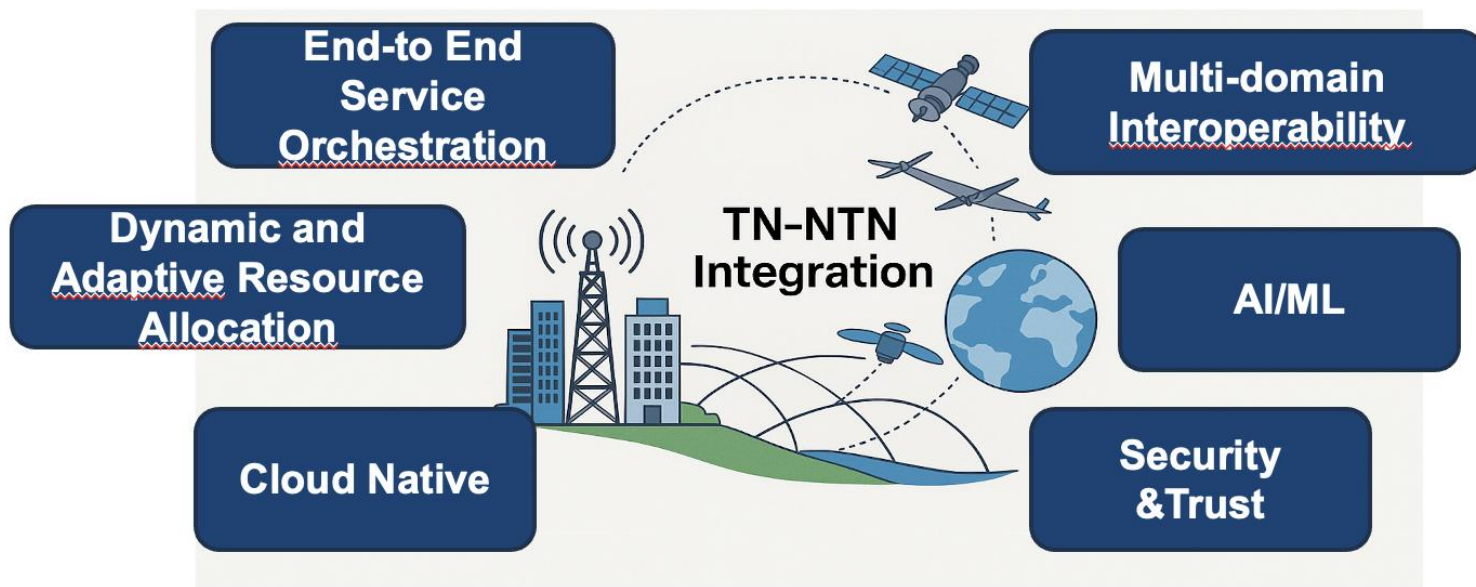
Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Novel approach to Management & Orchestration for TN and NTN Integration





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Advanced Analytics, Intelligent Functions and Cloud Native for TN–NTN Orchestration



Intelligent Elements

- MDAF – Management Data Analytics Function (3GPP)
- NWDAF – Network Data Analytics Function (core intelligence)
- RIC – RAN Intelligent Controller (optimization) O-RAN



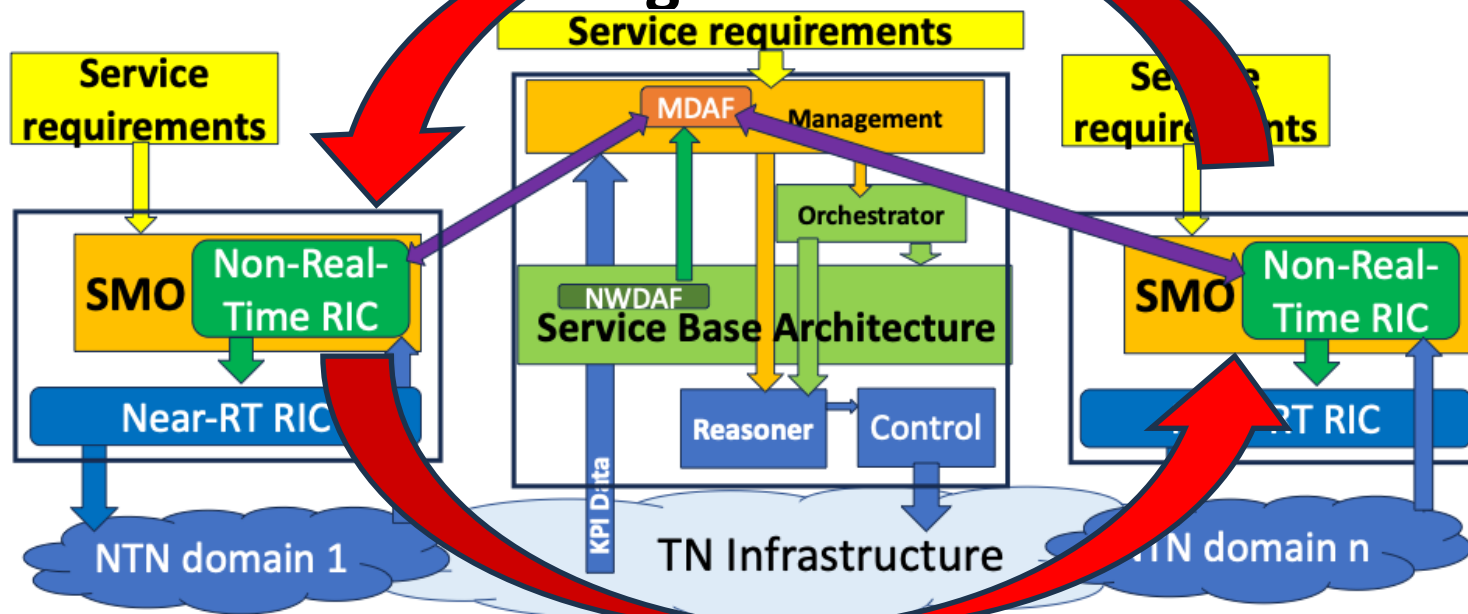
Cloud-Native Approach

- Microservices & containers
- Edge/cloud continuum
- Zero-Touch Mgmt (ETSI ZSM)

- The detailed design of functional components, interfaces and cloud aspects remains under study in standardization bodies, in line with the **ETSI ZSM** vision of AI-driven automation.
- The ETSI **TeraFlow modular** controller could also evolve to include an NTN component, for instance leveraging Free Space Optics (FSO) for NTN management.”



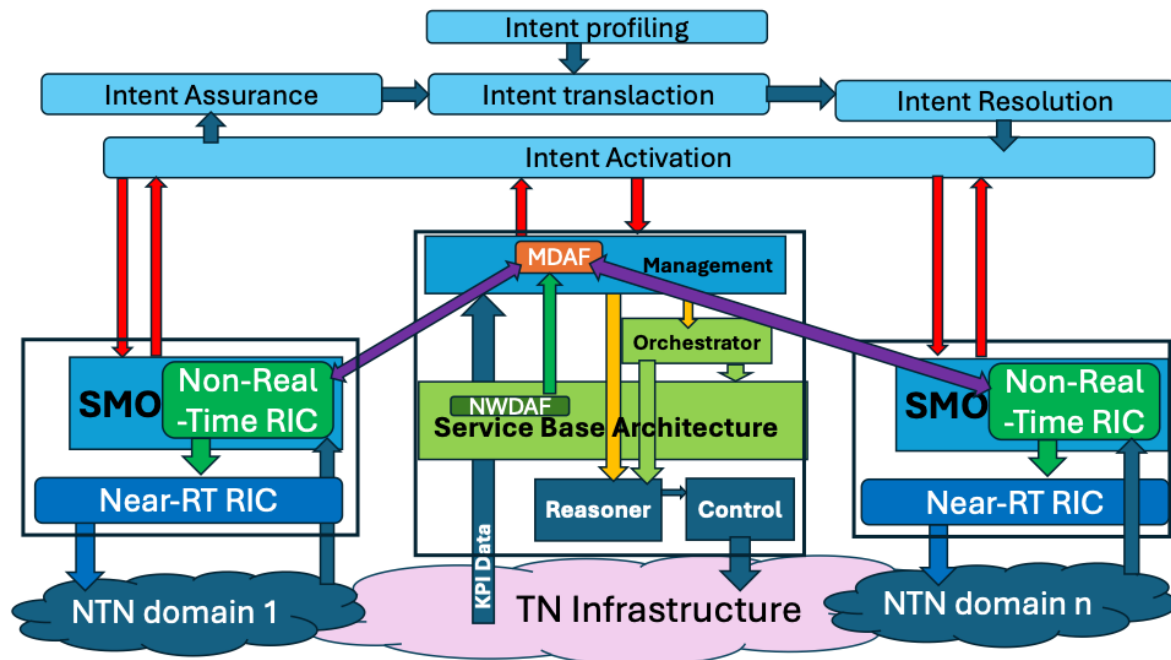
Management & Orchestration for TN and NTN Integration according to current standardization



Can each domain operate independently?
Who decides for all?



Intent Base Network approach



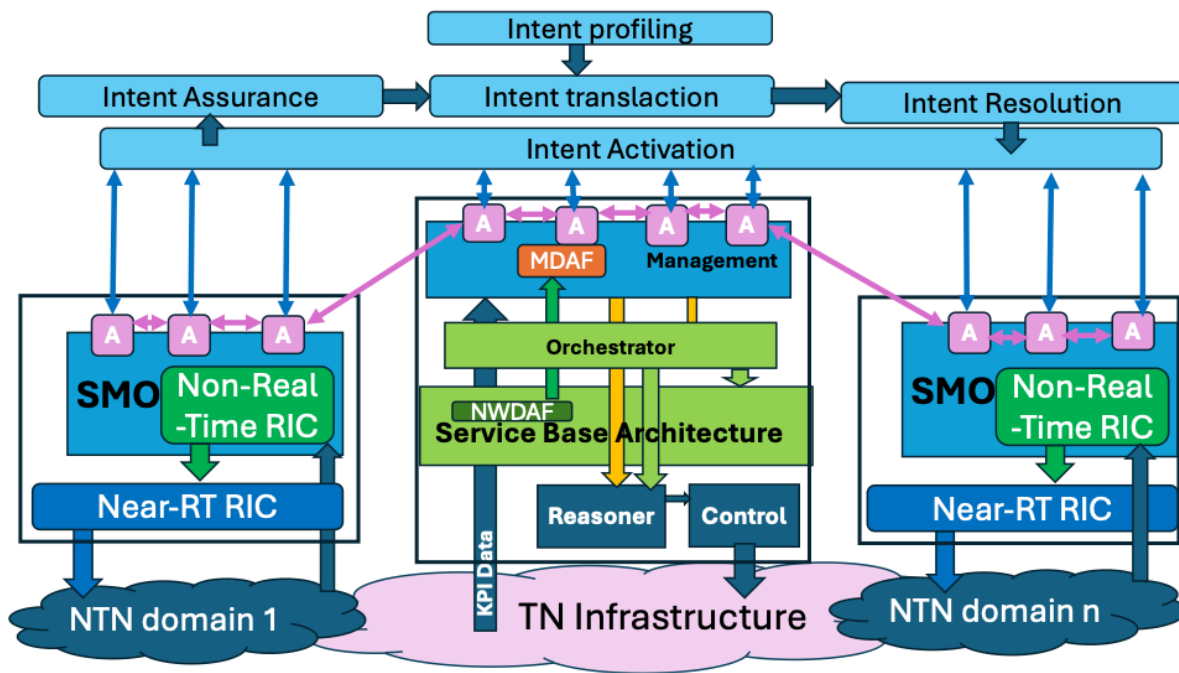
Starting from TM Forum
2022)

Zero touch by the loop in
Intent level

Large Language Model
(LLM) very useful for Intent
level



Intent Base Network with Agentic AI



ETSI, “Zero-touch network and service management (ZSM); Study on the utilization of agents in autonomous networks,” ETSI GR ZSM 020 V1.1.1, 2026

Communication between agents, using Agent to Agent (**A2A**),
Communication between agents and external tools and services: Model Context Protocol (**MCP**)



Finanziato
dall'Unione europea
NextGenerationEU



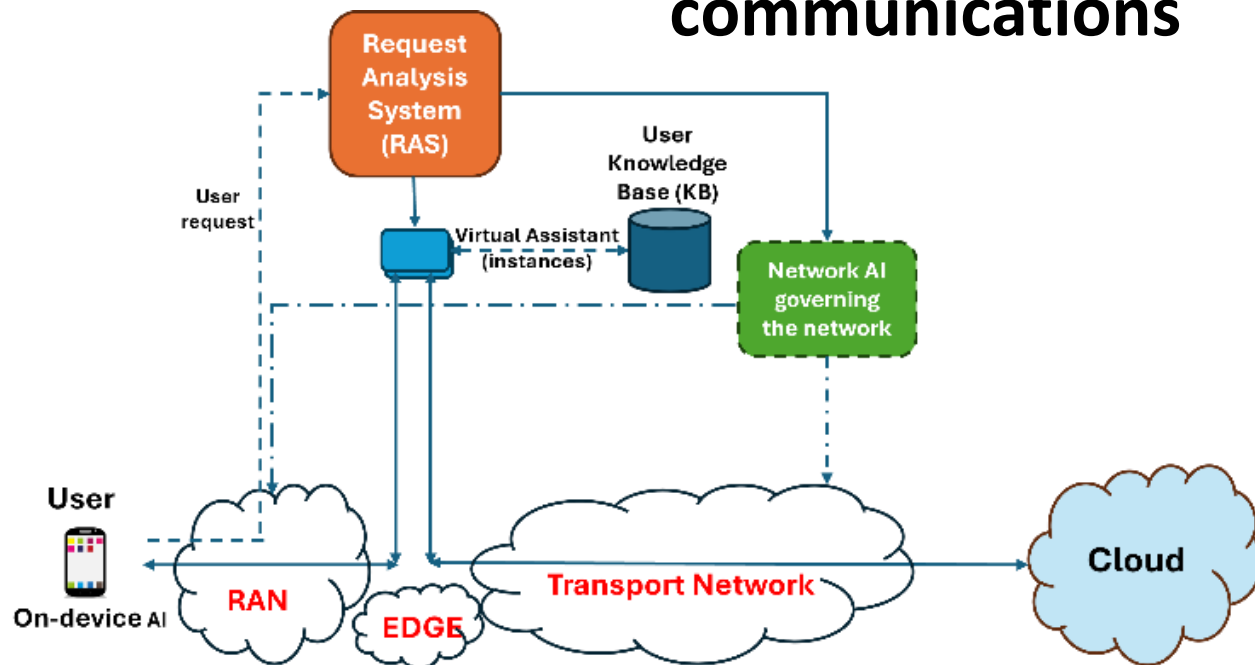
Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Agentic AI IBN with Virtual Assistant (VA)-mediated communications





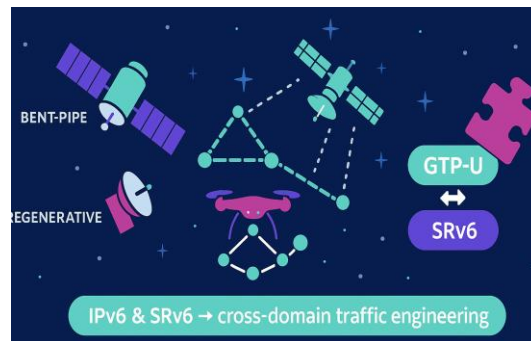
Internetworking & IPv6 in TN–NTN Integration

Payload Evolution

- Satellite payloads are evolving from non-regenerative bent-pipe systems to regenerative payloads → enable more IP-based RAN architectures in space

Segment Routing over IPv6 (SRv6) technique allows a packet's path to be defined as a list of "segments" that are encoded directly in IPv6 addresses.

- The segments can represent both topological way-points (nodes to be crossed along the path towards the destination) and specific operations on the packet to be performed in a node.
- Replacement/coexistence with **GTP-U** (Tunnelling)





Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Conclusions and Future works

Conclusions

- Cross-domain management considering the main recommendations from the organizations as 3GPP and ETSI, including also approaches typical of the AI, to understand network behaviors in complex contexts.
- Towards Intent Base Networks
- Agentic AI
- Towards **cloud-native design, and IPv6 (SRv6)**

Future directions

- Agentic AI: Integrated Sensing and Communications
- Security

This work was supported by the European Union under the Italian National Recovery and Resilience Plan (NRRP) of NextGenerationEU, partnership on “Telecommunications of the Future” (PE000000001 - program “RESTART”).



Finanziato
dall'Unione europea
NextGenerationEU



Ministero
dell'Università
e della Ricerca



Italiadomani
PIANO NAZIONALE
DI RIPRESA E RESILIENZA



Thank you for your attention

Francesco Matera



fmatera@fub.it



www.fub.it