ETSI Conference on
Non-Terrestrial Networks,
A Native Component of 6G

ETHER: A 6G Architectural Framework for 3D Multi-Layered Networks

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Outline

- ETHER Overview
- Technical Information
- Reference Architecture
- Use Cases
- Planned Standardization Activities

ETHER Overview

- **Project Name:** ETHER – sElf-evolving terrestrial/non-Terrestrial Hybrid nEtwoRks
- **Project website:** ether-project.eu
- **Stream:** SNS-2022-STREAM-B-01-03: Communication Infrastructure Technologies and Devices
- **Goal:** ETHER is going to provide a framework for the terrestrial/non-terrestrial network ecosystem that involves an efficient and zero-touch resource management, provides solution for key radio access network (RAN) challenges, and identifies the business opportunities for potential stakeholders

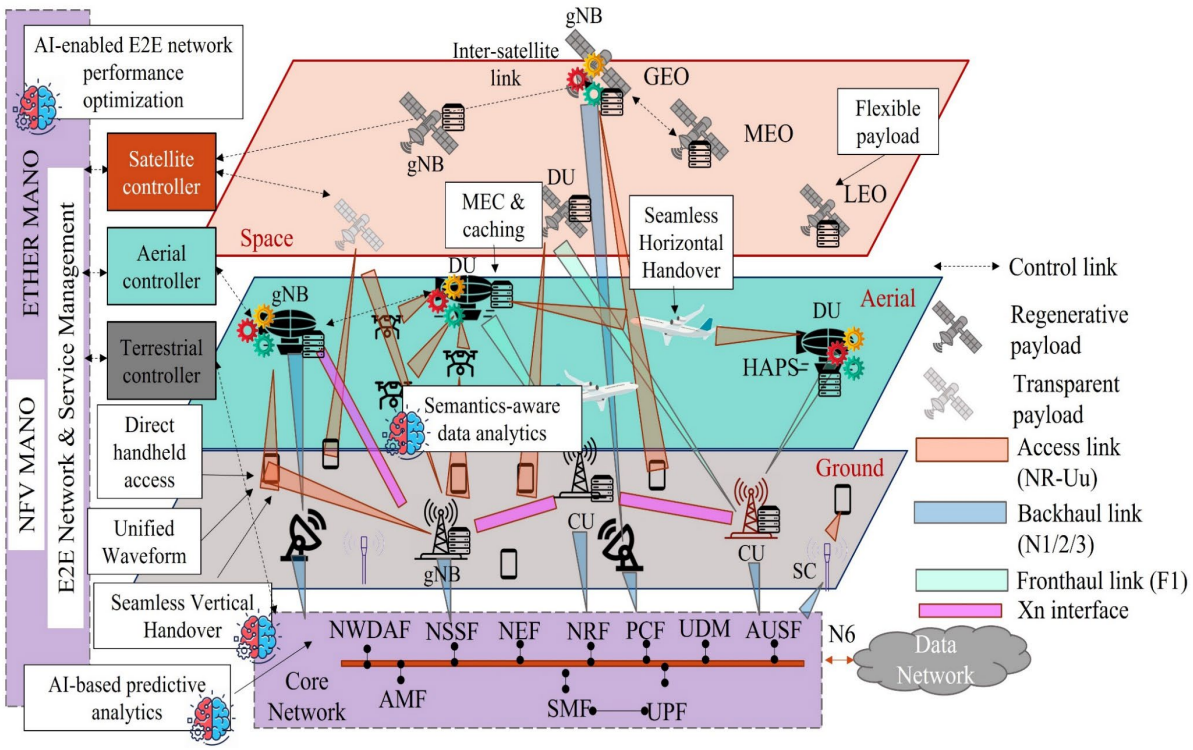
Number	Role	Short name	Legal name	Country
1	COO	uni.lu	UNIVERSITE DU LUXEMBOURG	LU
2	BEN	AUTH	ARISTOTELIO PANEPISTIMIO THESSALONIKIS	EL
3	BEN	CA	COLLINS AEROSPACE IRELAND, LIMITED	IE
4	BEN	AVA	AVANTI HYLAS 2 CYPRUS LIMITED	CY
5	BEN	SIOT	SATELIO IOT SERVICES, SL	ES
6	BEN	Ubiwhere	UBIWHERE LDA	PT
7	BEN	I2CAT	FUNDACIO PRIVADA I2CAT, INTERNET I INNOVACIO DIGITAL A CATALUNYA	ES
8	BEN	NBC	NEARBY COMPUTING SL	ES
9	BEN	NCSR "D"	NATIONAL CENTER FOR SCIENTIFIC RESEARCH "DEMOKRITOS"	EL
10	BEN	LIU	LINKOPINGS UNIVERSITET	SE
11	BEN	OPL	ORANGE POLSKA SPOLKA AKCYJNA	PL
12	AP	MARTEL GMBH	MARTEL GMBH	CH
13	AP	Net AI	NET AI TECH LTD	UK

Technical Information

Objectives

O-1	Provide solutions for a **unified and sustainable RAN** for the integrated terrestrial and non-terrestrial network
O-2	Provide an **AI-based framework** for the self-evolving network slicing management and orchestration of the integrated network
O-3	**Architect a viable, highly energy- and cost-efficient**, flexible integrated terrestrial and non-terrestrial 6G network offering seamless and continuous connectivity
O-4	Demonstrate the effectiveness of ETHER solutions by **experimentation activities** that target practical applications
O-5	Identify the key **benefits** that will drive the **investment** in the integration of non-terrestrial with terrestrial networks

ETHER 3D Network



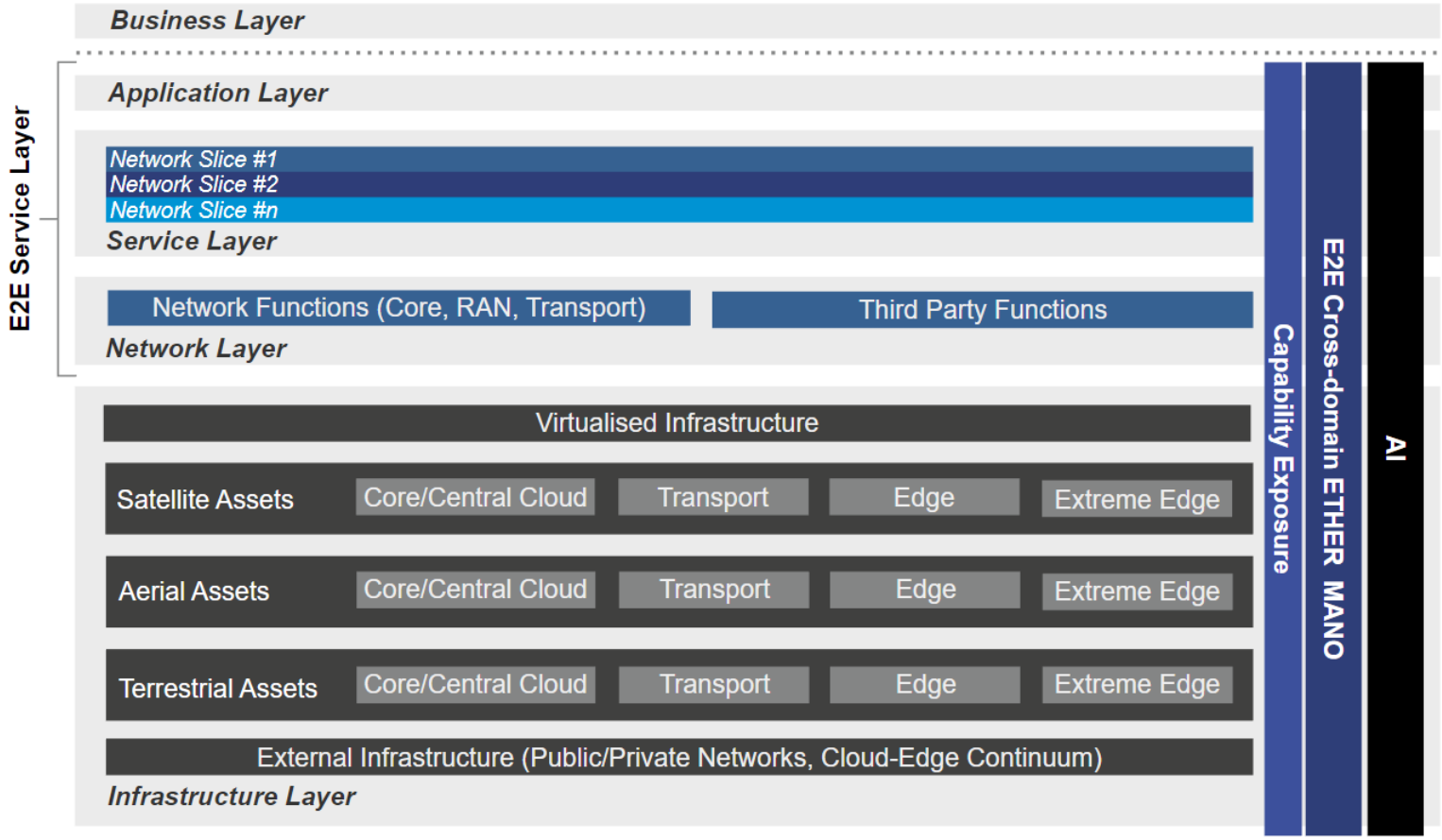
Technical Innovations

T-1	Integrated Architecture	**T-2**	Direct handheld device access at the Ka band from LEO satellites	**T-3**	Unified waveform design	**T-4**	Flexible payloads
T-5	Data analytics, edge computing, and caching	**T-6**	Horizontal/vertical handovers	**T-7**	Automated MANO for the integrated network	**T-8**	AI-driven E2E network performance optimization

ETHER High-Level Reference Architecture

The ETHER high-level reference architecture comprises:

- **Infrastructure layer**: Includes the TN and NTN physical and virtualized assets
- **Network layer**: Composed of network functions, such as 3GPP CN, RAN, and transport related functions
- **Service Layer**: Consisting of the Network Slice Instances (NSIs)
- **Application Layer**: Contains applications exploiting the capabilities offered by the NSIs
- **Business layer**: Consists of the relevant business actors, such as MNOs, SNOs, and vertical industries



The *E2E cross-domain ETHER MANO* coordinates these layers on multiple levels

ETHER Use Cases (1/3)

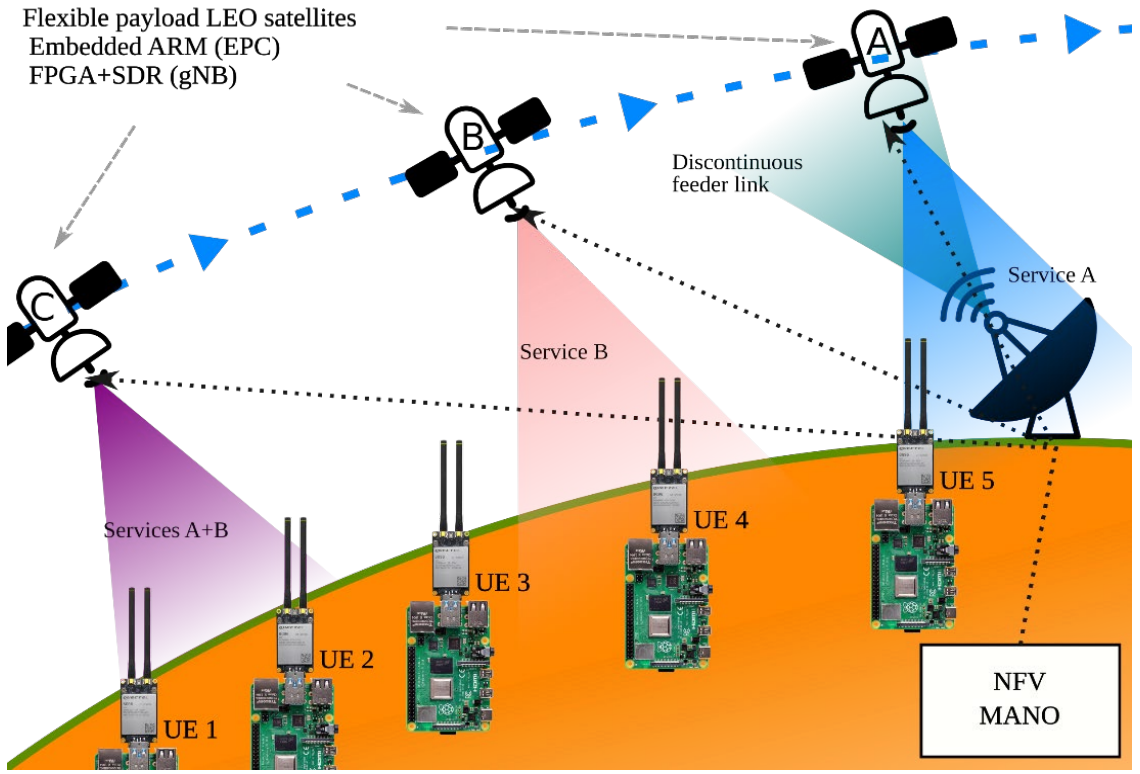
Use Case 1: Service provision to delay-tolerant IoT applications through LEO-satellite horizontal handovers

Assumptions:

- ❑ Feeder-link discontinuity
- ❑ Satellites with store-and-forward capability
- ❑ Delay-tolerant IoT applications

Key ETHER Innovations:

- ❑ Horizontal handovers
- ❑ ETHER MANO
- ❑ Flexible payloads
- ❑ Semantics-aware information handling for high energy efficiency



Demo KPIs:

- ❑ > 75 % higher energy efficiency leveraging the semantics-aware information handling combined with edge computing and caching

ETHER Use Cases (2/3)

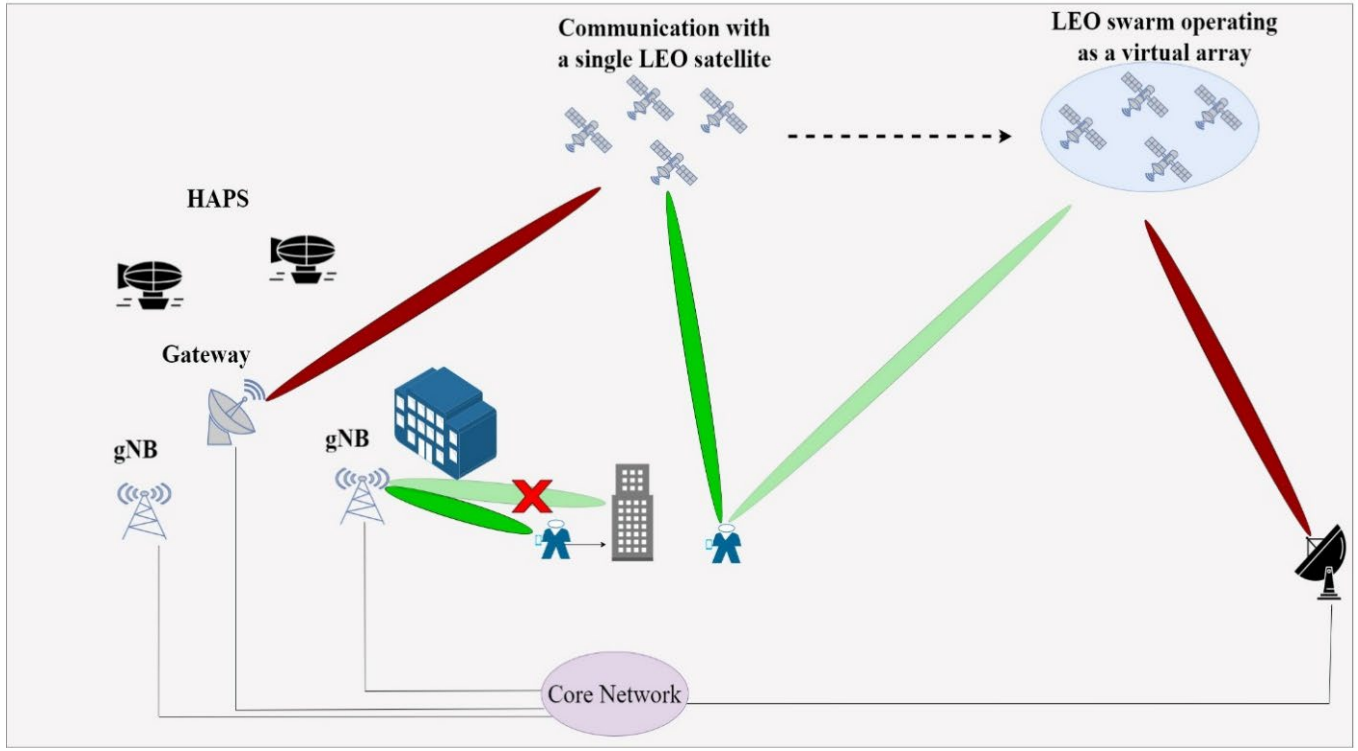
Use Case 2: Broadband direct handheld device access at the Ka band

Assumptions:

- ❑ Communication with a terrestrial small cell infeasible either due to lack of infrastructure (remote/rural areas) or bad link/high cell traffic
- ❑ Broadband communication required for the handheld device

Key ETHER Innovations:

- ❑ Vertical handovers across RATs
- ❑ Unified waveform design
- ❑ Terminal antenna design
- ❑ Distributed beamforming from LEO-satellite swarms



Demo KPIs:

- ❑ 100% coverage
- ❑ >70% more energy-efficient vertical handover w.r.t SOTA

ETHER Use Cases (3/3)

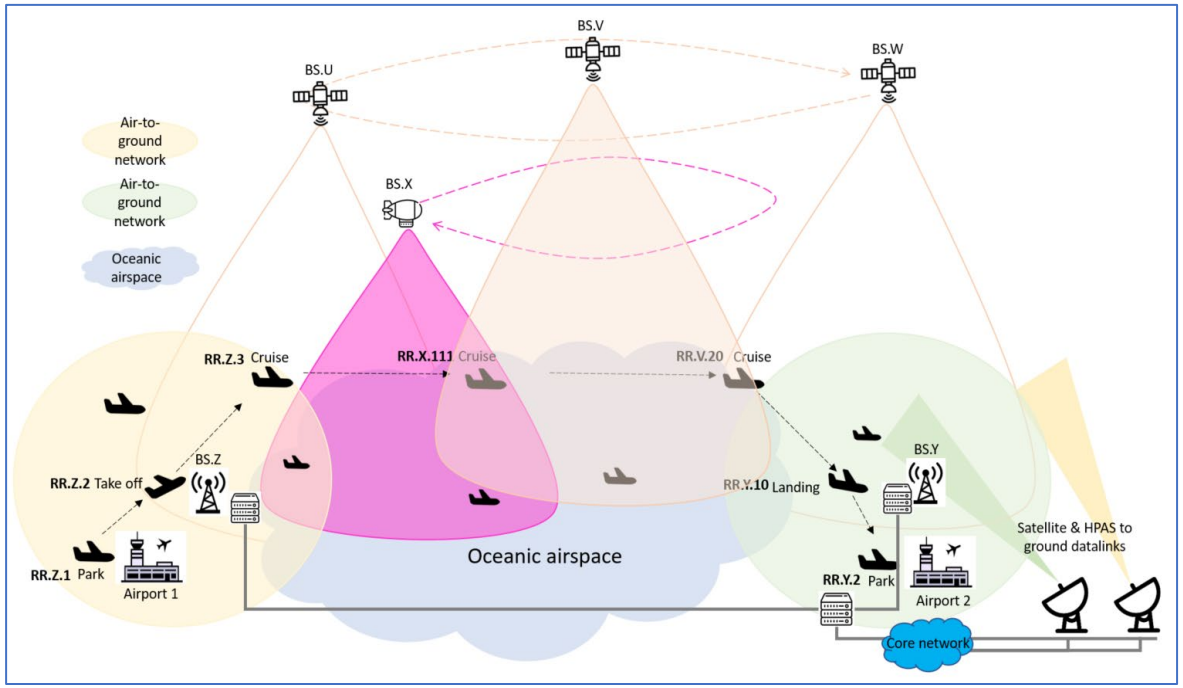
Use Case 3: Air-space safety critical operations

Assumptions:

- ❑ Aircraft moving from one airport to another
- ❑ Coverage of the flight through terrestrial stations is imposible. Hence, cannot provide E2E aircraft communication services through terrestrial stations

Key ETHER Innovations:

- ❑ Vertical handovers across RATs
- ❑ ETHER MEC orchestrator
- ❑ Unified waveform design
- ❑ Predictive analytics
- ❑ E2E network performance optimization algorithms



Demo KPIs:

- ❑ 100% coverage
- ❑ Performance integrity 10^{-4} to 10^{-6}
- ❑ >80% more energy efficient resource allocation w.r.t. SOTA

Planned Standardization Activities (1/2)

- Standardization plans / objectives: Active participation from an early stage and contributions to relevant SDOs, based on the scope of the project, will be pursued by the project's partners. Two-fold objective:
  - Ensuring that ETHER work is well aligned with the on-going work at SDOs
  - Promoting ETHER approaches and innovations into the evolution roadmap of the relevant standards

- Project activities / technologies that may lead to standardization:

ETHER MANO	Individual components of the ETSI OSM will be updated to account for both the aerial and space layers	**AI-Based ETHER Joint Communication, Computational and Storage Resource Allocation Framework**	Expansion of these algorithms to also account for both aerial and space layers	**AI-Based ETHER Monitoring Framework for Integrated Multi-RAT Traffic**	NetAI's Microscope traffic monitor will be extended to account for heterogeneous terrestrial, aerial, and space traffic apart from terrestrial	**ETHER Core Network**	The proof-of-concept core network with store-and-forward capability for discontinuous link operation will be expanded to account for the satellite dynamics, relative mobility and UEs location management
ETHER MEC Orchestrator	Nearby's MEC Orchestrator will be extended to allow integration with NTNs and zero-touch automation	**ETHER Flexible Payload System**	Integrating the flexible payload system in an SDR board, also incorporating the ETHER MANO	**ETHER UE Antenna for Direct Handheld Device Access at the Ka Band**	Design of a handheld device antenna for broadband communication across the 3 layers		

Planned Standardization Activities (2/2)

- Potential targeted standardization bodies / groups:

3GPP SA1 (focus on use cases and service requirements)	SIOT, UBW	**3GPP SA2** (focus on system functional architecture)	SIOT, AVA, UBW	**3GPP SA5** (focus on management, orchestration, and charging)	UBW	**3GPP RAN WGs** (focus on radio access protocols and radio access network architecture)	SIOT, UBW	**ETSI SES/SCN**	AVA, UL	**ETSI ZSM**	NBC, I2CAT, UL
ETSI MEC	NBC, UL	**ETSI ENI**	NBC, UL	**IEEE P1918.1**	LIU	**NetworldEurope SatCom Working Group**	AVA	**Eurocontrol EASA, EUROCAE, RTCA**	CA	**O-RAN WG1-WG10**	NBC, NETAI
ITU-T SG13	OPL	**5G-PPP**	UBW, SIOT, AUTH	**AIOTI Standardization WG**	UBW, UL	**6G-IA**	UBW, AUTH, UL, MAR, NBC, SIOT, CA, I2CAT, NCSRD, OPL				

- Drawing upon as inputs: ETSI OSM, ETSI TeraFlowSDN, O-RAN

- Standardization planning and estimated time plan: 3-5 years after the ETHER starting date

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