

Satellite Communication Technologies

Chapter 9 of the SRIA

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*This presentation is based on Networld2020 SRIAv3.0 Chapter 9.
It reflects the Author views and not necessarily those of the Networld2020*

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- Content of the Chapter
- Vision and Architecture
- Research challenges
- Conclusions and take away messages



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- Satellite Communications (Chapter 9 of the SRIA 2021-2027)
 - 9.2 System architectures
 - 9.3 Evolution of Networking Architectures
 - 9.4 Hybrid infrastructures: Broadcast/Multicast/Unicast/Storage – EdgeCasting
 - 9.5 Smart Satellite Networking
 - 9.6 Optical based Satellite Communications
 - 9.7 Software Defined Payloads
 - 9.8 Radio Access Network beyond 5G and 6G
 - 9.9 Antennas
 - 9.10 Spectrum usage
 - 9.11 Artificial Intelligence for SatCom
 - 9.12 Security
 - 9.13 Communication, Computation and Storage
 - 9.14 Plug and Play Integrated Satellite and Terrestrial Networks



Unified networks and access technologies for Smart Services

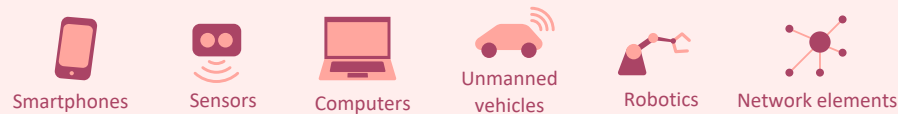
CONSUMERS INDUSTRY PROFESSIONAL APPLICATIONS (REQUIREMENTS)



UNIFIED ACCESS TECHNOLOGIES



DEVICES



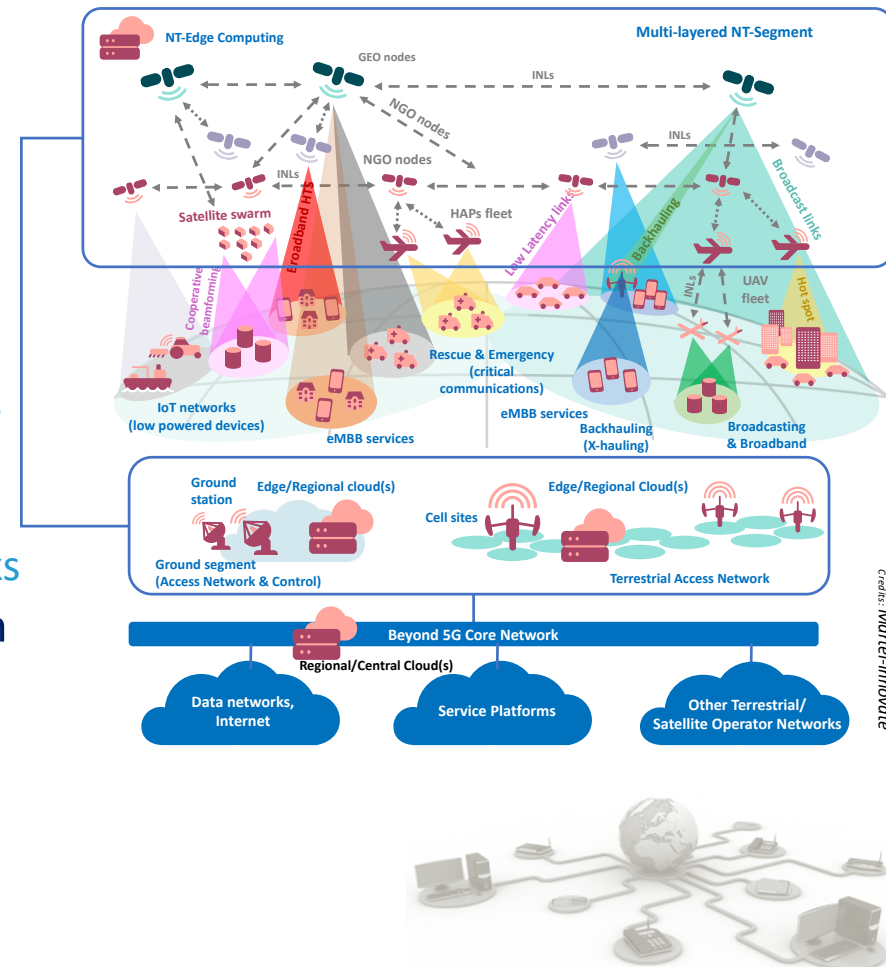
SERVICE UBIQUITY,
CONTINUITY, SCALABILITY, RELIABILITY,
AND COST EFFICIENCY

HETEROGENEOUS DEVICES

Credits: Martel-Innovate

3D multi-layered unified architecture

- A global, flexible infrastructure providing service ubiquity, continuity, scalability, reliability, and cost efficiency to heterogeneous devices
 - Multi-dimensional (3D)
 - Terrestrial (2D) + Non-Terrestrial
 - Multi-layered NTN
 - GSO, NGSO, HAPs, UAV constellations
 - space-borne and air-borne flying nodes
 - Inter-node vertical and horizontal links
 - Horizontal: same constellation nodes
 - Vertical: terrestrial/NTN, GSO/NGSO, NGSO/HAPs...
 - Unified architecture
 - No distinction between T and NT elements



Numerous challenges need to be addressed to develop the proper technical enablers

RESEARCH AREAS	RATIONALE AND IMPACTS
SYSTEM ARCHITECTURE: a single access network	<ul style="list-style-type: none"> • Three-dimensional unified T/NT architecture • Integrated and communicating hierarchical layers • Softwarization, Virtualization, and Disaggregation (ground and space)
CONSTELLATIONS: hierarchical design	<ul style="list-style-type: none"> • Hierarchical constellations: From single (layers) to multiple orbits (layers) • Incomplete constellations and nodes platooning (Low-cost design) • Beyond geographical coverage: user-centric beamless communications
SMART NTN : edge computing and storage	<ul style="list-style-type: none"> • Processing and communication in the sky – Smart Edge Flying Nodes • Non-Terrestrial Cloud • Space Information Networks (SIN)
RESOURCE OPTIMIZATION: infrastructure as a resource	<ul style="list-style-type: none"> • Beyond the bandwidth, time, power, and space concepts: infrastructure as a resource • Infrastructure reconfiguration: a network of networks • Network elements orchestration
SPECTRUM USE: coexistence, sharing, new freq.	<ul style="list-style-type: none"> • New spectrum (THz and optical): user/feeder/Inter-node • Optical communications: Horizontal and vertical links • Coexistence and Sharing: inter-segment (T & NT) and inter-layer
UNIFIED RAN DESIGN: flexibility and adaptability	<ul style="list-style-type: none"> • Waveform design T/NT channels: Doppler/Delay/Vertical handover • Distributed MIMO and beamforming (node cooperation) • Quantum Communications
SECURITY: a secure resilient network	<ul style="list-style-type: none"> • Resiliency by design • Quantum Key Distributions • Blockchain technologies
COMPONENTS: supporting technologies	<ul style="list-style-type: none"> • Antenna, Amplifiers • THz & Optical devices (Rx & Tx) • Software Defined Payload
ARTIFICIAL INTELLIGENCE: exploitation of NT dynamics	<ul style="list-style-type: none"> • System Complexity management • Network predictive configuration and maintenance • New physical layers, medium access layer, resource management, etc. approaches

- NTN recognized as a key enabler to achieve B5G and 6G KPIs:
 - Improvements of Coverage, Reliability, and Resiliency
 - Infrastructure flexibility and adaptability
 - Spectrum and energy efficient multicasting, broadcasting, and edge delivery
- Benefits of the NTN related development
 - Contribution to a greener and sovereign worldwide competitiveness of the European (NTN) industry
 - Contribution to an autonomous European Digital SNS industry with global reach
- Trends in R&I
 - Holistic architecture vision
 - Unification of Terrestrial and Non-Terrestrial networks
 - Technical, standardization, and regulatory needs



THANK YOU

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