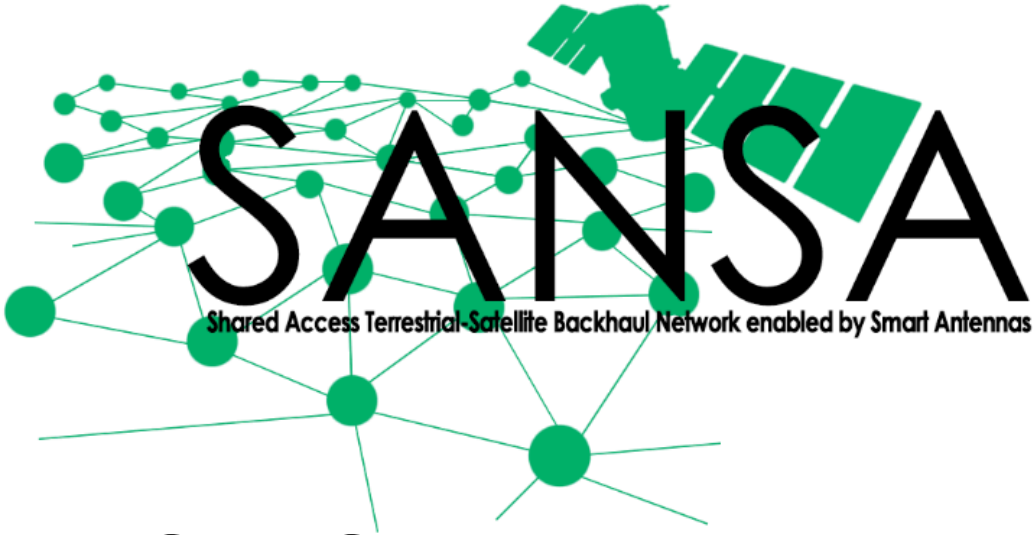

The SANSA network concept

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5G PPP – 1st 5G Architecture Workshop
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Outline

- Motivation
- SANSA concept, relation with 5G use cases
- Enablers
- Network architecture
- SANSA in 5G architecture proposals
- Conclusions

Motivation

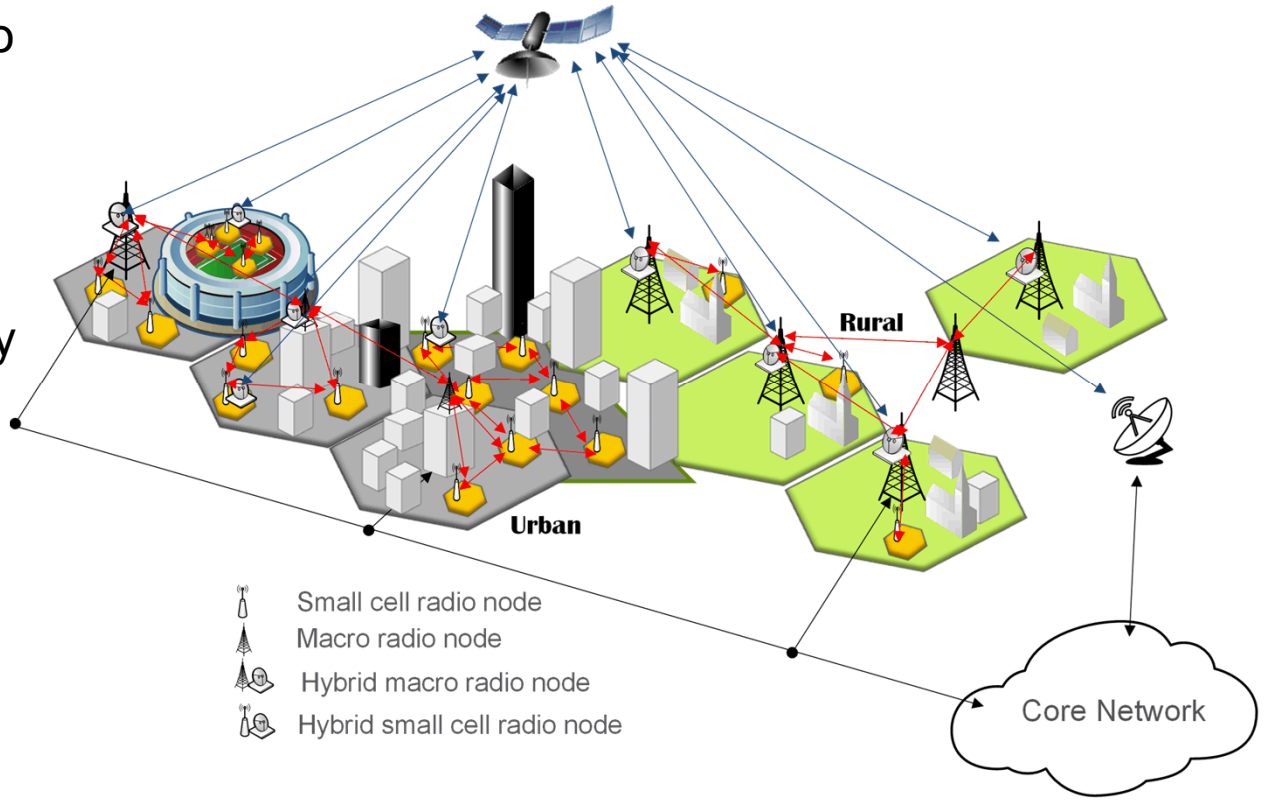
- Future 5G networks requirements:
  - 1000x capacity improvement
  - 99.999% availability
  - 100% coverage
  - 90% reduction in network energy usage
  - Efficient use of the spectrum
- Optical fiber and terrestrial wireless backhaul will hardly meet 100% coverage.
- Traditional fixed wireless backhaul limitations:
  - Requires exhaustive radio planning
  - Cannot react to link failures or to changes in the traffic profiles
  - Inefficient network designs

➢ **Novel dynamic solutions capable of adapting to traffic demands and with extended coverage are required for 5G backhaul networks**

SANSA concept

- SANSA proposes a **self-organizing hybrid terrestrial-satellite backhaul network** operating at Ka band based on the following key principles:

  - A seamless integration of the satellite segment into terrestrial backhaul networks.
  - A terrestrial wireless network capable of reconfiguring its topology according to traffic demands.
  - Aggressive frequency reuse within the terrestrial segment and between terrestrial and satellite segments



SANSA concept II

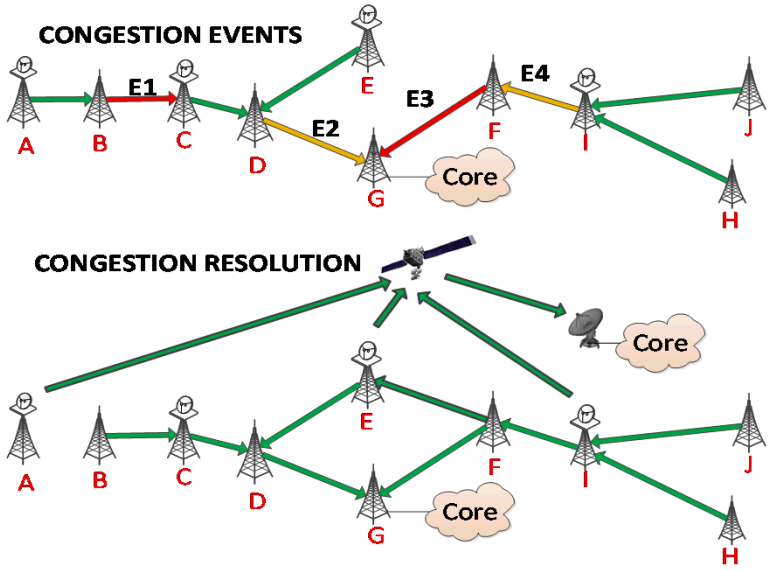
- **The satellite integration provides**
  - Extended coverage (50bps everywhere, low ARPU networks, moving hotspots)
  - Back-up connections (reliable communications)
  - Terrestrial data offloading (temporary urban hotspots-broadband access in dense areas or in a crowd)
  - Set of redundant paths contributing to the network dynamicity
  - Efficient broadcasting towards terrestrial content delivery networks (pervasive video)

- **The terrestrial network topology adaptation to the traffic demands provides:**
  - Resilience against failures and congestion (broadband access in dense areas or in a crowd, reliable communications)
  - Improved capacity (broadband access in dense areas or in a crowd)
  - Easy deployment:
    - Reduced need for an exhaustive radio planning of the terrestrial network.
    - Beamforming solutions eliminate the need of qualified personnel for antenna pointing
  - Power consumption reduction (nodes in sleep mode during low demand traffic periods).

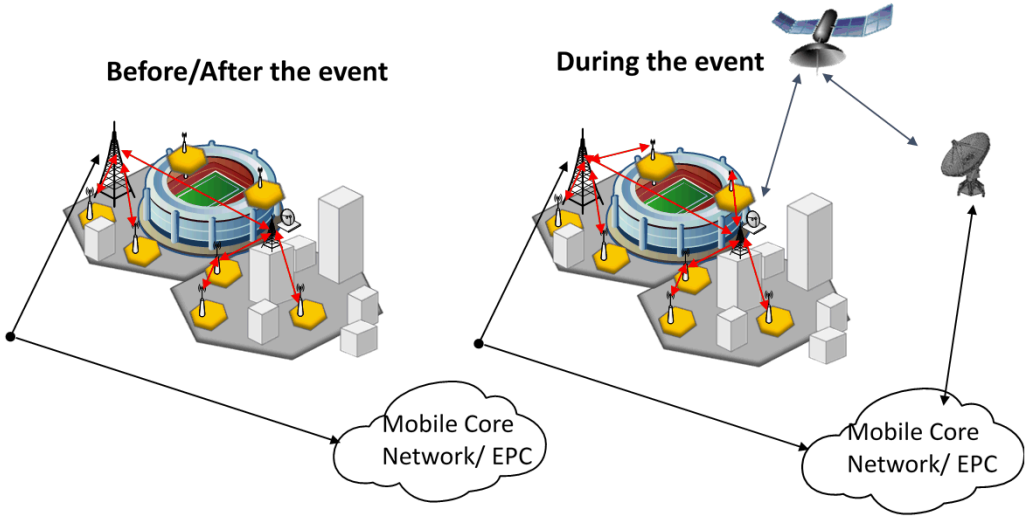
- **The aggressive frequency reuse provides efficient spectrum usage**

SANSA concept III

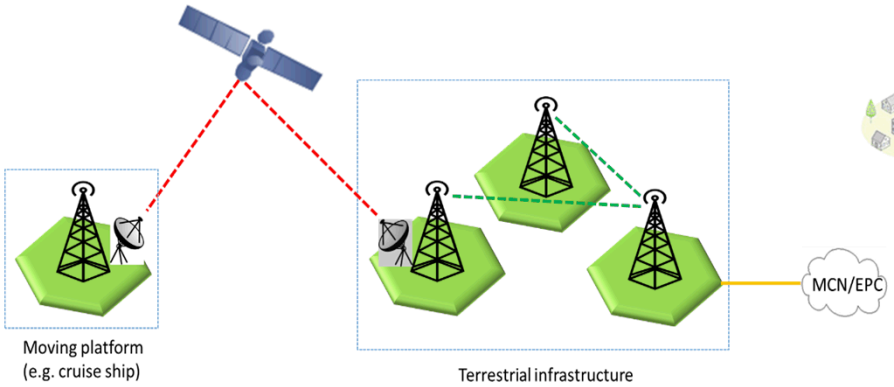
- Dynamic operation



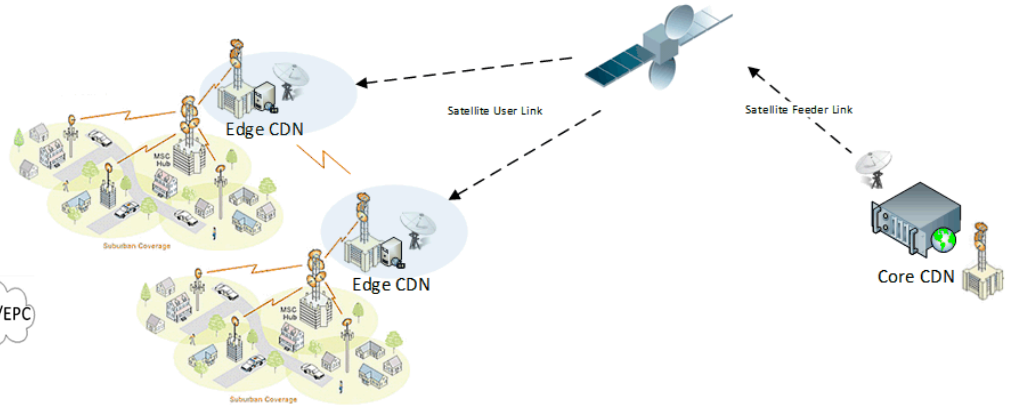
- Offloading through satellite in temporary hotspots



- Extended coverage/Moving platforms

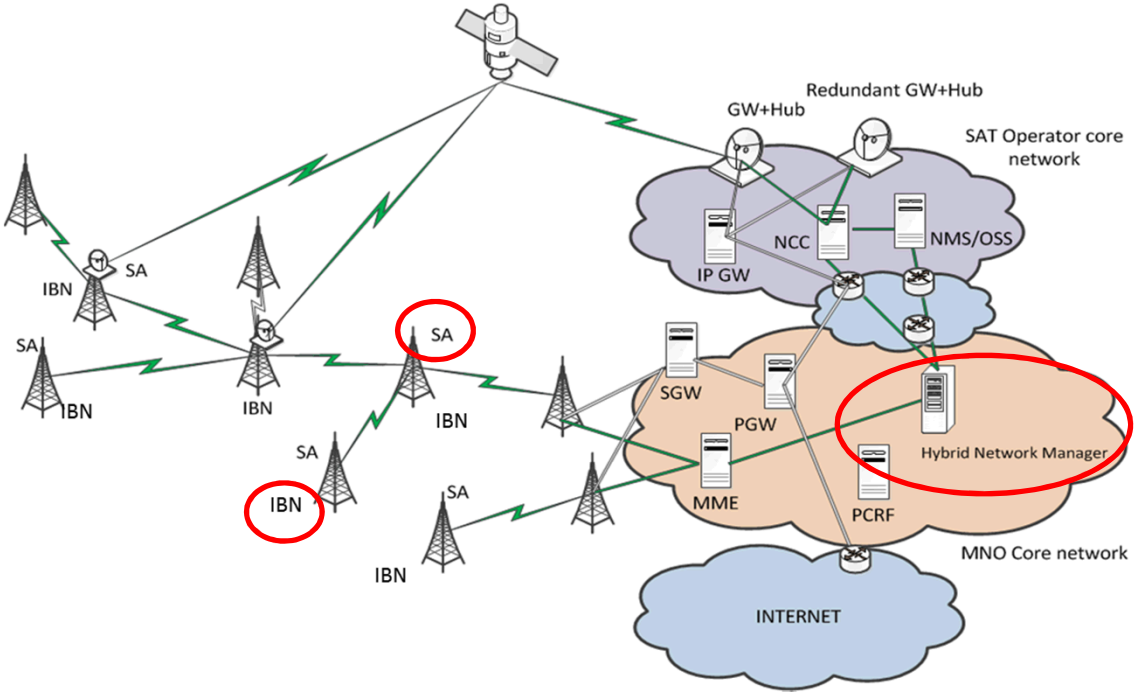


- CDN



Enablers

- **Smart antennas-SA**
  - With advanced beamforming capabilities (beam and multi-beam steering, null-steering)
  - Deployed in terrestrial nodes enabling:
    - Network topology reconfiguration
    - Spatial interference mitigation

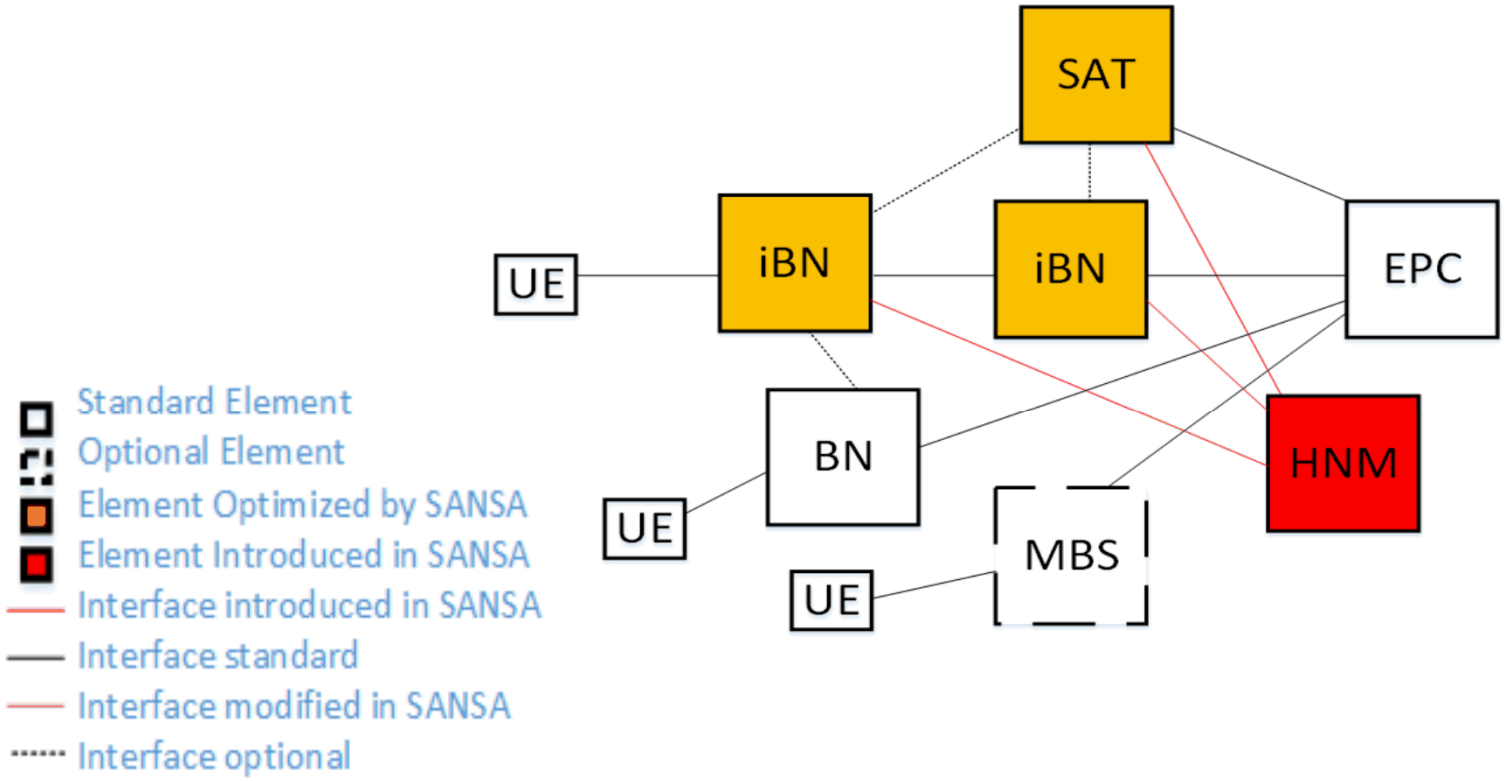


- **Dynamic and hybrid RRM**

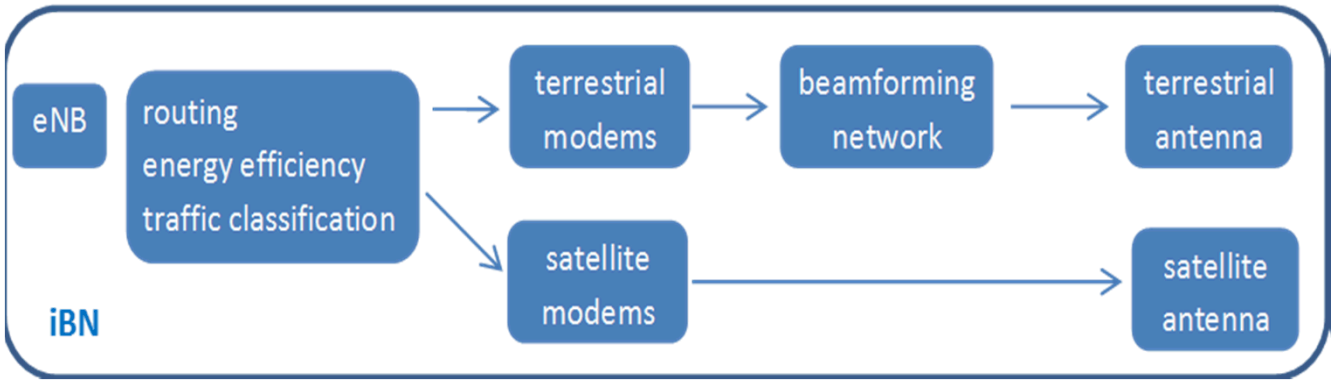
- **Hybrid network management**
  - Enabling the efficient and dynamic use of all the network resources in order to improve capacity and energy efficiency.
  - Consist of:
    - Centralized element (**Hybrid network manager**)
    - Distributed element deployed in each node equipped with SANSA solutions (**Intelligent backhaul node-IBN**)

Network architecture

- 3GPP LTE-based RAN and Evolved Packet Core are assumed.
- SANSA introduces IBNs and HNM in the Transport Network for enabling dynamic operation

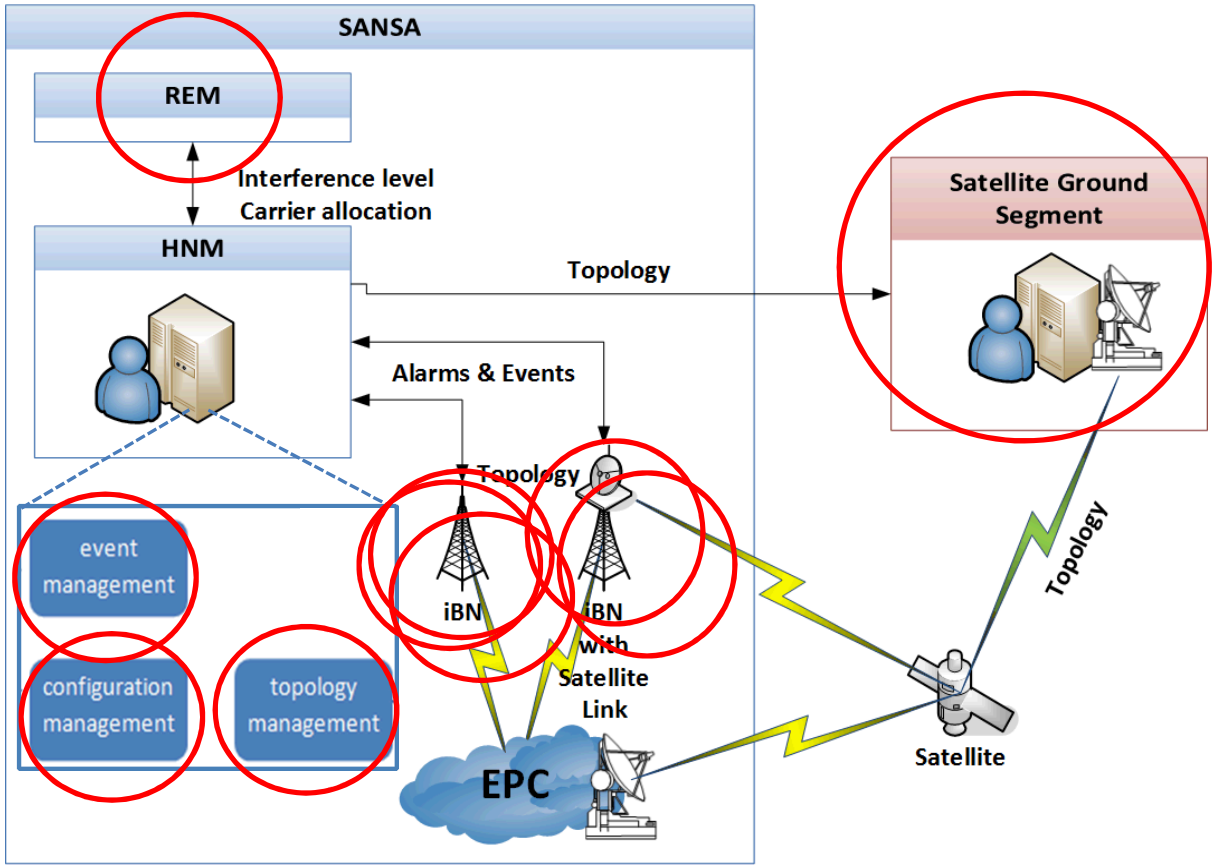


Intelligent Backhaul Node-IBN



- Load balancing hybrid backpressure routing algorithms
- Energy-aware routing schemes (On/Off policies)
- Traffic classification
- Physical layer monitoring (detection of congestion/failures)
- Interface with beamforming antenna solution

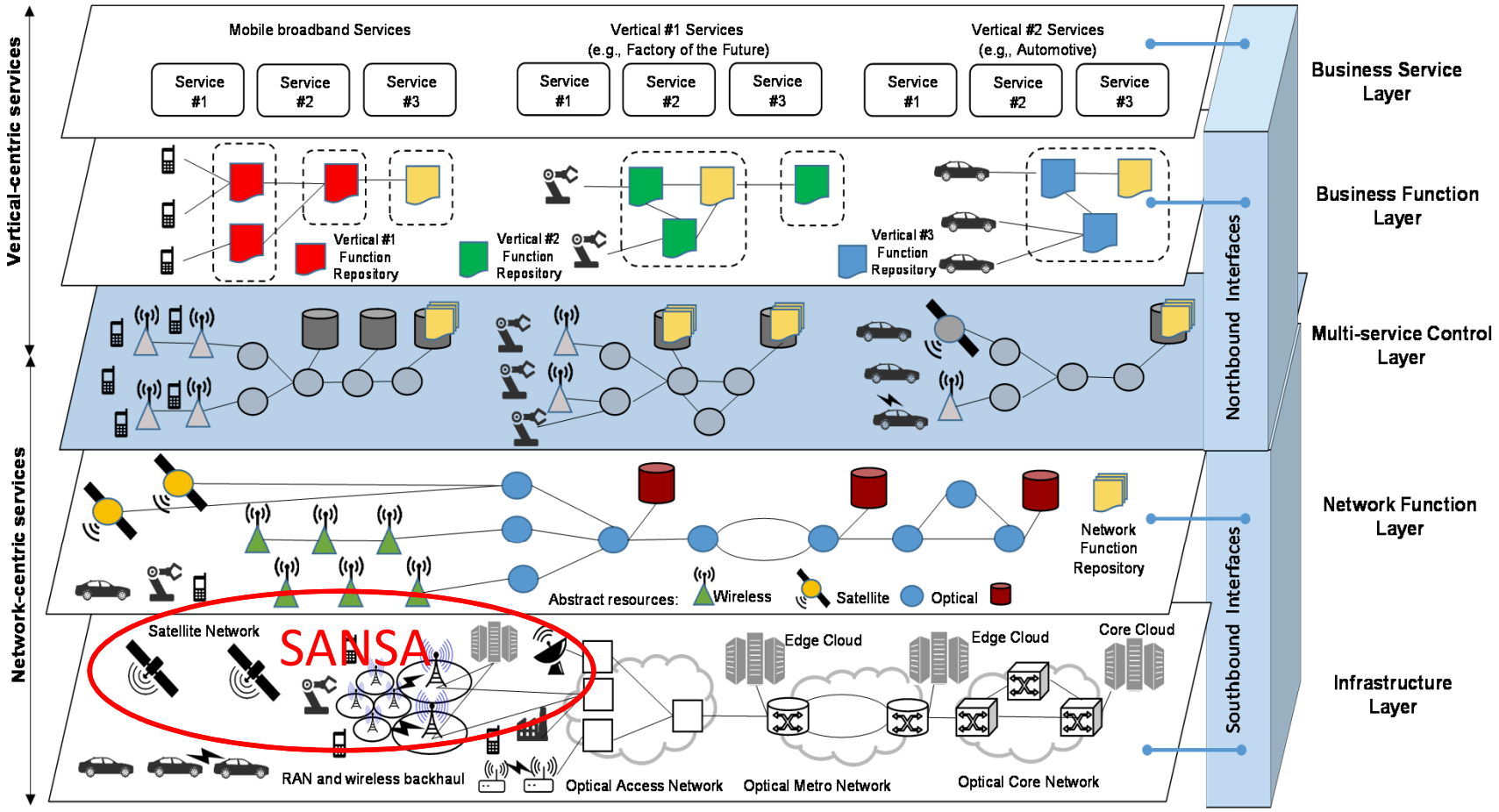
Hybrid Network Manager-HNM



- **Topology management**: Calculation of alternate topologies to counter-measure link events and improve the overall efficiency of the network. Distribution of new topology information to all nodes.
- **Configuration management:** Parameter modifications in satellite/terrestrial terminals at the remote iBNs
- **Events management:** Reception of monitoring events sent by iBNs. Extract result actions derived from rules.
- **Radio environment mapping:** Coordination of all radio resources (tx power, frequencies etc.). Assists topology manager in the evaluation of potential topologies

4-HNM configuration manager sends
required parameter modifications to iBNs
alternate topology assisted by the REM
and/or satellite ground segment

SANSA in 5G Architecture



**Reprinted from 5GPPP white paper on "5G empowering vertical industries".*

SANSA integration

Softwarize/virtualize of SANSA infrastructure

- Integration at the Network Function Layer
  - iBN functionalities as 5G network services
  - HNM as 5G network services
- Multi-service control layer
  - Leverage SANSA satellite-terrestrial infrastructure to enable the management and orchestration of multiple virtual networks
    - Virtual terrestrial network slices.
    - Virtual satellite network slices.
    - Virtual satellite-terrestrial network slices.
- Open Issues
  - Higher level of dynamicity at the infrastructure layer and in-band transport signaling (control and data plane share the same channel in practice)
    - Hybrid Network Function Layer
      - Distributed functionality may be good to quickly react to topology changes

Conclusions

- SANSA proposes a dynamic and hybrid (terrestrial-satellite) solution in order to boost the performance of mobile wireless backhaul networks
- SANSA will improve capacity, energy efficiency and resilience against link failure or congestion while easing the network deployment and assuring at the same time an efficient use of the spectrum
- SANSA has two main enabling technologies:
  - Smart antennas which enable the reconfiguration of the network topology according to traffic needs
  - Hybrid network management (HNM-IBN) scheme which allows a dynamic and efficient use of all the terrestrial and satellite resources
- SANSA can be integrated in overall 5G architecture through virtualization of HNM and IBN functions
- A hybrid (centralized-distributed) Function Layer may be required to support dynamicity and reduce in-band control signaling

SANSA

Shared Access Terrestrial-Satellite Backhaul Network enabled by Smart Antennas

Thank you for your kind attention !

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