A Modern Architectural Approach towards Realizing NANCY's Innovative Objectives

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NANCY in a nutshell

Key performance Indicators

- >20% impro-vement
- High security & privacy
- Low latency (<1 ms)
- Flexible scalability
- Ultra-high reliability
- 100m e2e range
- Ultra-high availability
- > 20% ownership cost reduction
- AI reusability rate > 90%

Fundamental characteristics

- Blockchain modeling
- Attacks modeling
- Cell/grant free access
- Semantic Communi-cations
- Smart pricing

Technology enablers

- Multi-access edge computing
- Blockchain
- Post-quantum cryptography
- Caching/offloading policies

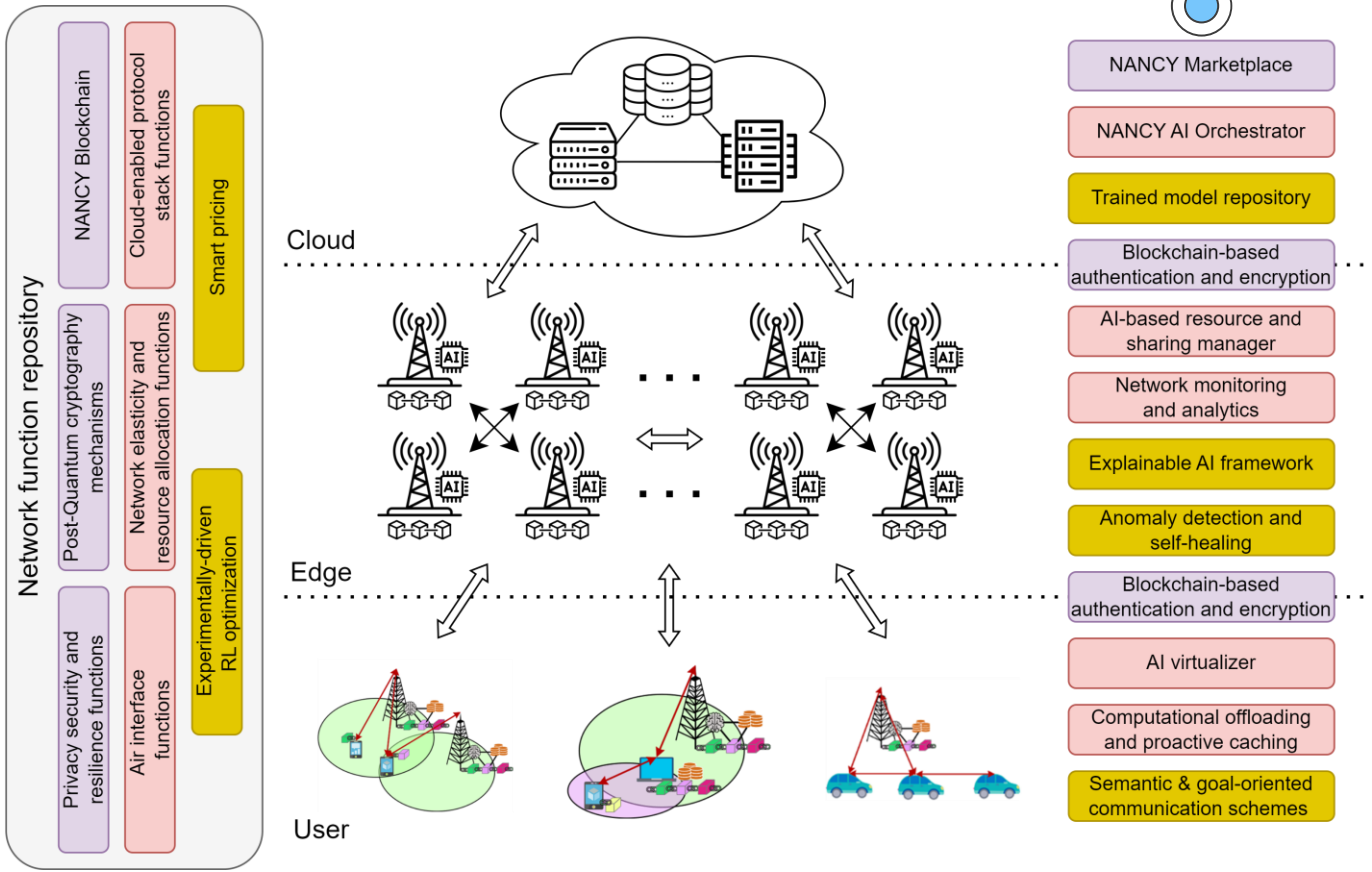
Key technology module

- Artificial intelligence
- Orchestration
- NG-SDN/NFV
- AI virtualisation

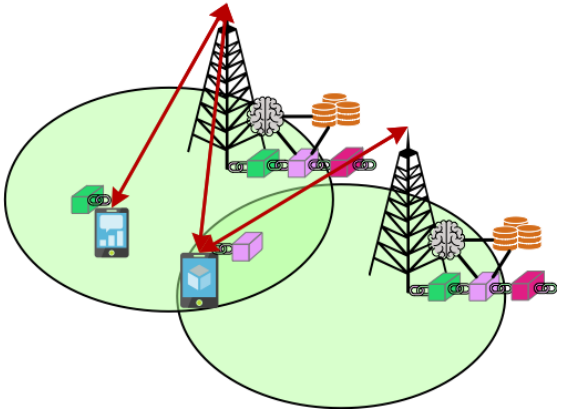
Usage scenarios

- Fronthaul network of fixed topology
- Advanced coverage expansion
- Advanced connectivity of mobile nodes

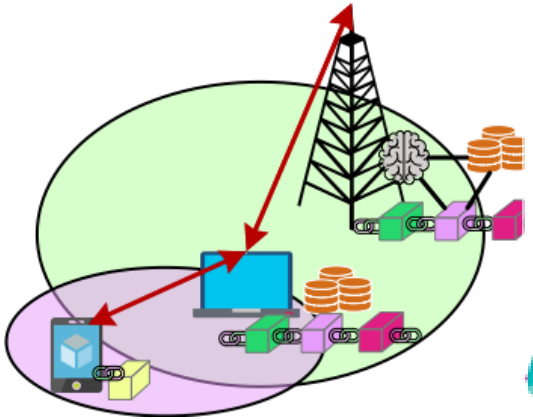
B-RAN Architecture



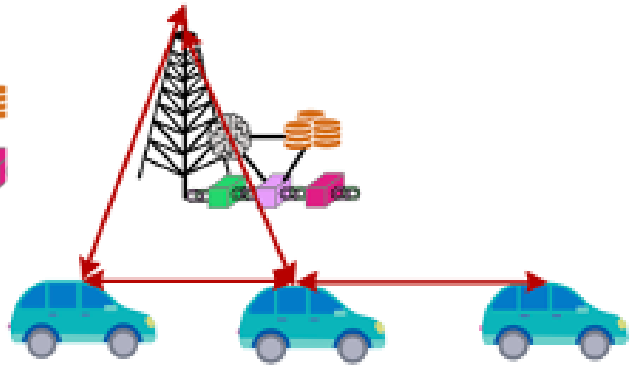
B-RAN Architecture supported usage scenarios



Fronthaul network of fixed topology



Advanced coverage expansion



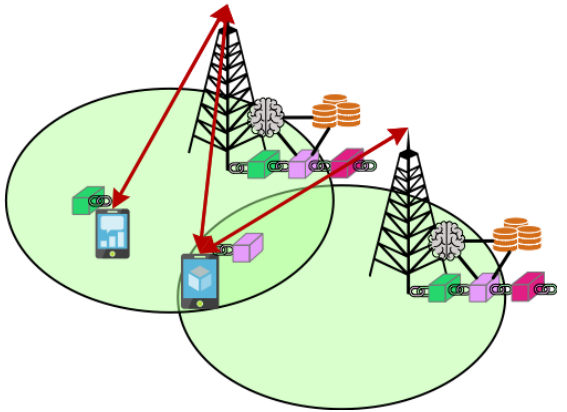
Advanced connectivity of mobile nodes

B-RAN Architecture supported usage scenarios

Case 1: "**Direct connectivity**" between a base station (BS) and a user equipment (UE).

Case 2.1: Both base stations (BS) belong to the same operator (OP). In this case, a simple "**CoMP**" scheme can be implemented.

Case 2.2: BS1 belongs to OP1 and BS2 belongs to OP2. In this case, the "**CoMP**" scheme requires establishing a deal between the two operators.



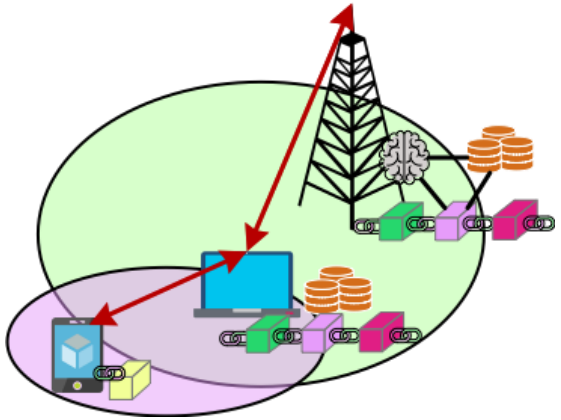
Fronthaul network of fixed topology

B-RAN Architecture supported usage scenarios

Case 1: B-RAN will enable "**Multi-Hop**" connectivity in the coverage expansion scenario. The first hop is between the BS and intermediate UE (iUE), while the second hop is formed between the iUE and the UE.

Case 2: "**Ad-hoc Mesh**" connectivity can be achieved with three or more devices connected between them in a mesh topology. For instance, a single UE can be connected to multiple iUEs that are connected between them and the BSs. The ad-hoc nature is covered by automatically providing connectivity when a UE requests access by the iUE. To achieve the mesh connectivity aspect, there are multiple options.

Case 3: "**Point-to-Multipoint**" connectivity will be enabled in B-RAN by having one device serving multiple devices at the same time. For instance, a BS that is connected with two or more UEs or an iUE that is connected with two UEs.

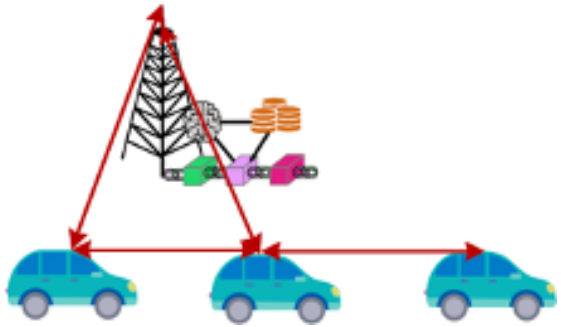


Advanced coverage expansion

B-RAN Architecture supported usage scenarios

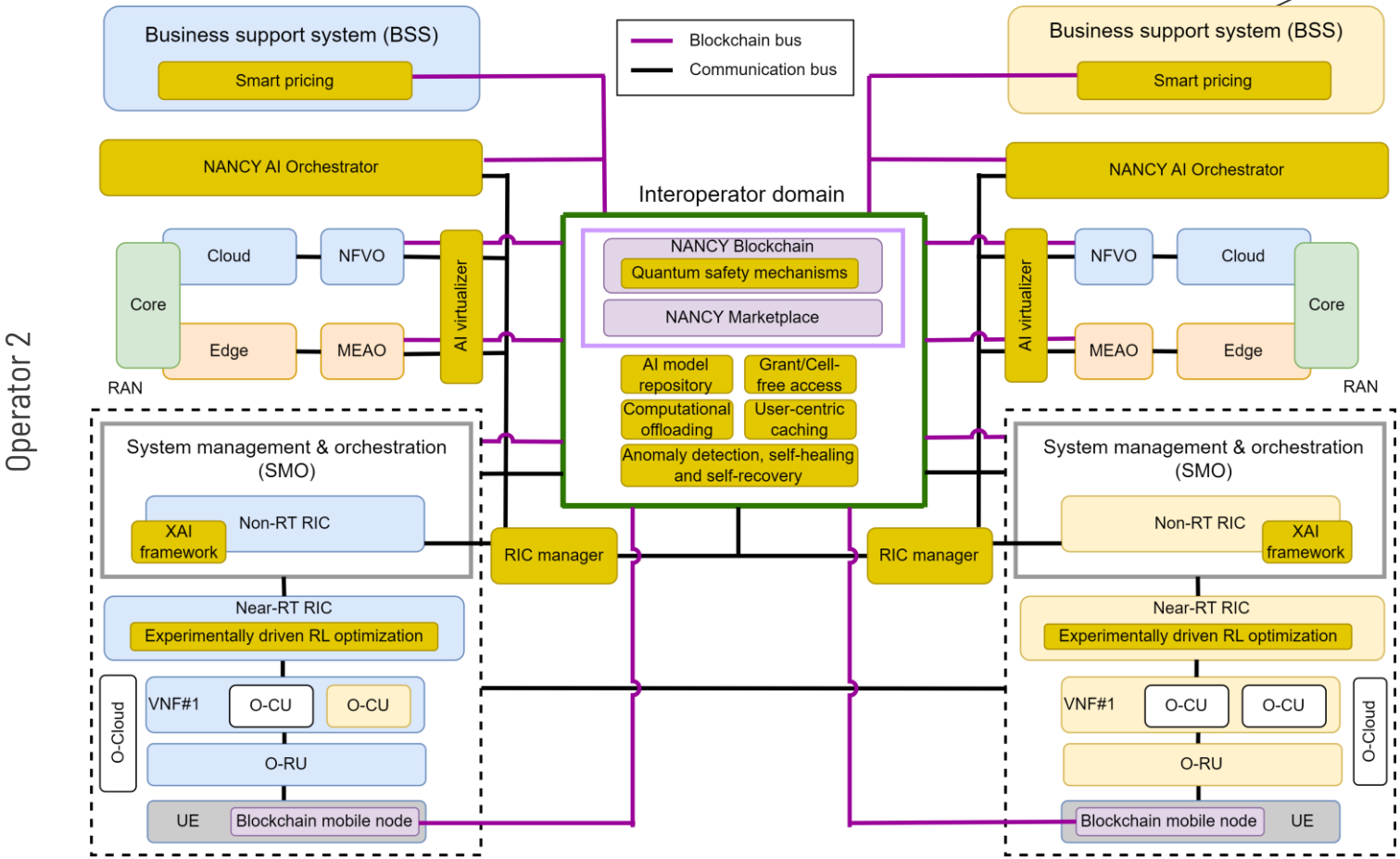
Case 1: B-RAN will enable secure "**vehicle-to-BS**" connectivity with enable high security and privacy, as well as intelligent network orchestration and mobility management.

Case 2: Since in "**vehicle-to-vehicle**" connectivity, nodes may not trust each other, they need to use pseudonyms when sharing data to increase the security and privacy.

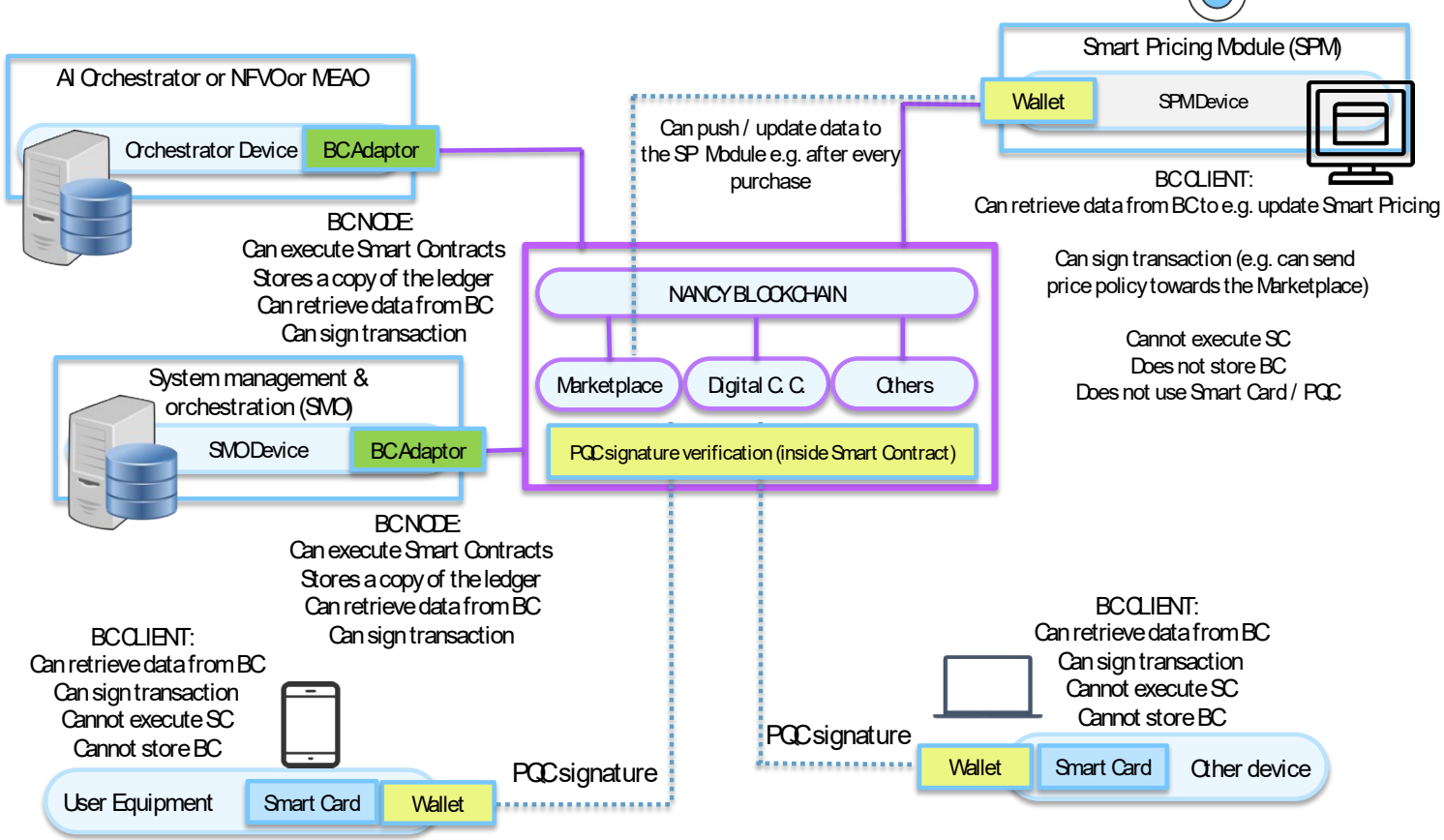


Advanced connectivity of mobile nodes

B-RAN Architecture



T3.1: Blockchain



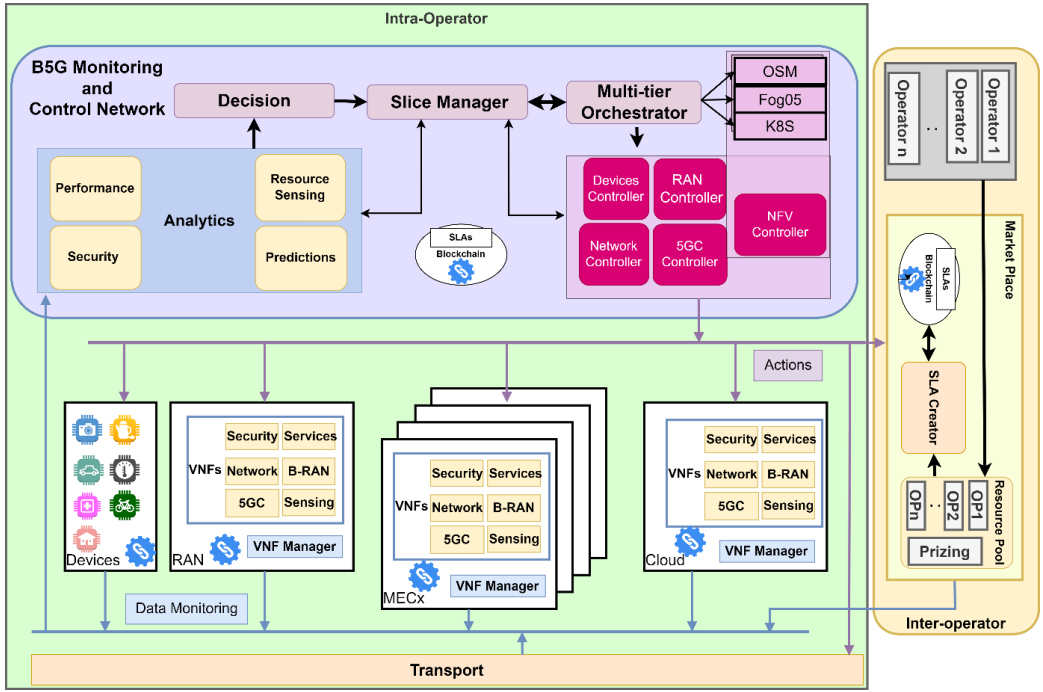
T3.1: AI orchestrator

Role:

- Introduces logical flexibility to NANCY architecture and provides a layer of abstraction.
- Enables resource orchestration between operators.
- Enables offloading, resource allocation, deployment, initialization, configuration, adaptation, and deletion.
- Optimizes radio, network, and compute resources autonomously, adapting to dynamic changes in the network, ensuring efficient network partitioning and meeting specific application requirements.

Dependencies:

- Receives the latest version of the available AI models from the AI model repository [R9].
- Attempts to improve efficiency and adaptability through RL B-RAN optimization [R10].
- Achieves automation through task offloading [R14].



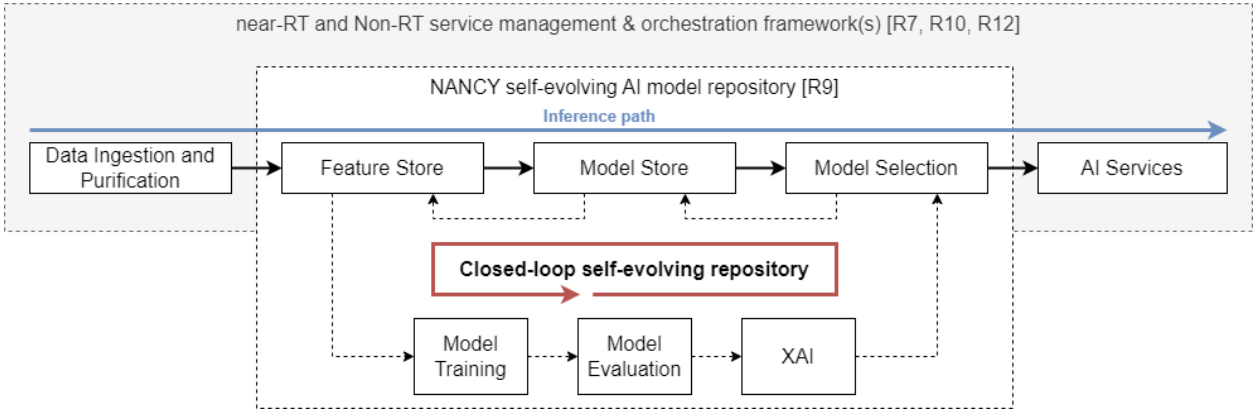
T3.1: AI model repository

Role:

- Supports optional dynamic model selection.
- Facilitates continuous retraining, updating, and enhancement of AI models.
- Efficiently manages a diverse range of heterogeneous data vital for both training and inference processes.
- Is accompanied by an API that enables continuous monitoring of model performance, detection of spurious correlations, and protection against potential adversarial threats.

Dependencies:

- Provides access to the trained AI models to all intelligent NANCY components.
- Integrates with both near-RL [R10, R12] and non-RL [R7, R12] service management and orchestration frameworks.



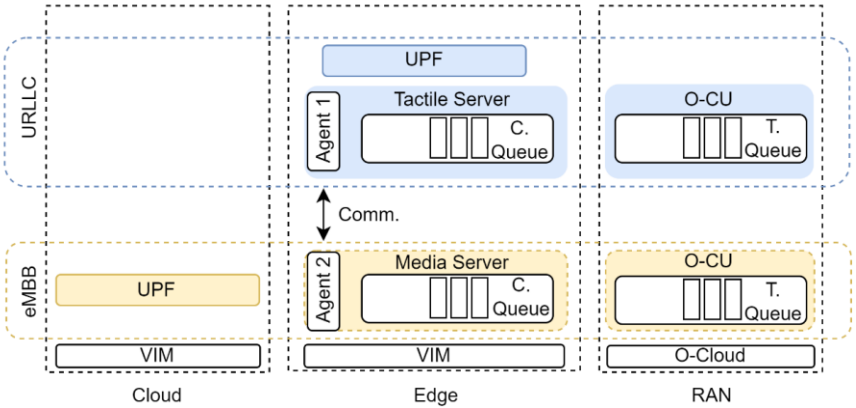
T3.1: AI Virtualizer

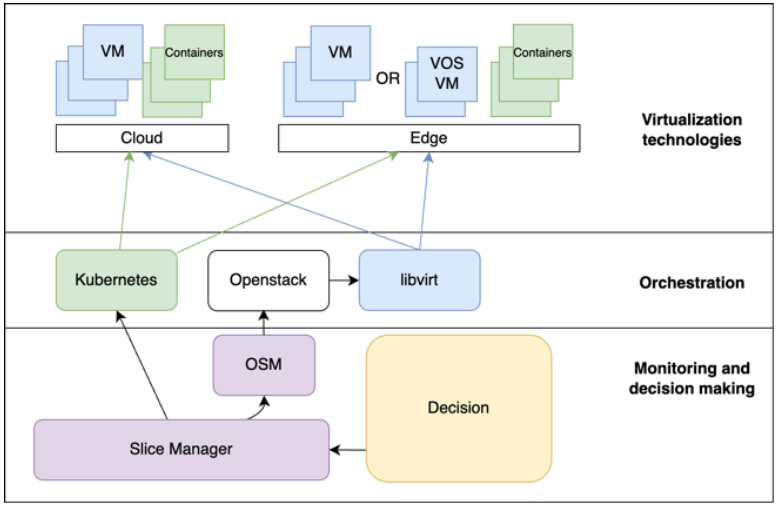
Role:

- Enhances the existing orchestrator's functionality through the incorporation of ML interactions.
- Optimizes resource utilization.
- Harnesses available resources to their fullest potential.
- Enhances the resource manager's adaptability and responsiveness.

Dependencies:

- The ML-OP and the Lifecycle of the AI Virtualizer is handled by the AI model repository [R9].
- Provides information on the network virtualized resources to the AI orchestrator [R7], RL B-RAN optimization [R10], computational offloading [R14], user centric caching [R15].





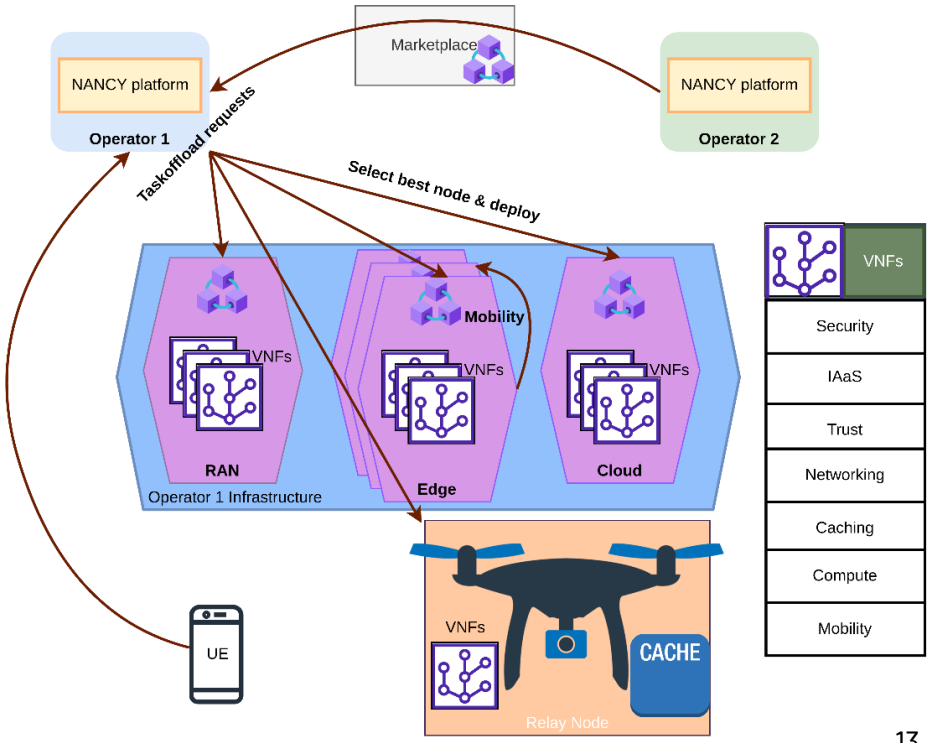
T3.1: Computational offloading

Role:

- Dynamically copes with increased system demands (computational capacity, security, latency or bandwidth).
- Deploys network and processing functions intra or inter-operator.
- Includes local offloading, full offloading, and partial offloading.

Dependencies:

- Optimizes the operation of B-RAN [R1].
- Works along with cooperative access mechanisms in D2D scenarios [R2].
- Its automation is dependent on the AI orchestrator [R7].
- Monitors deployed and offloaded VNFs to grant resource usage optimization [R8].
- Its ML-OP is handled by the AI model repository [R9].
- SDN anomaly detection is closely related with the autonomous deployment of the offloaded tasks [R13].
- Takes advantage of cached content to deliver faster and better services [R15].



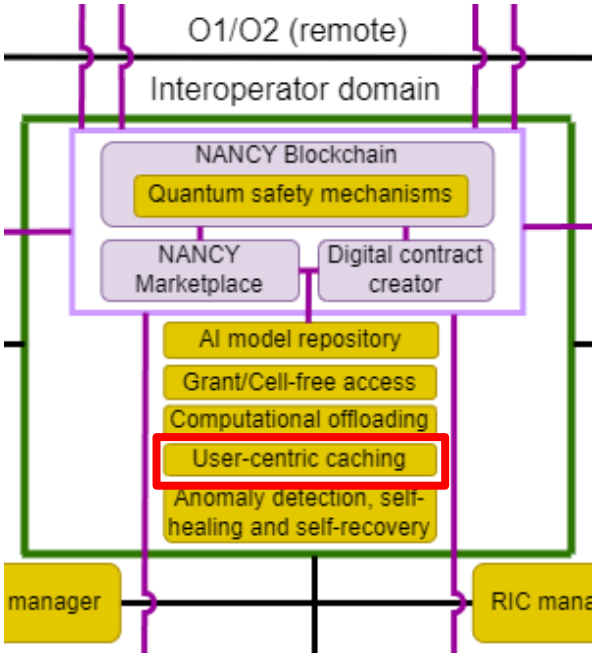
T3.1: User centric caching

Role:

- Selects the best node to bring the content and the content to be cached.
- Aids to achieve almost-zero latency connectivity.
- Lowers network congestion.
- Reduces of the data retrieval time.
- Optimizes content localization.
- Improves overall QoS.

Dependencies:

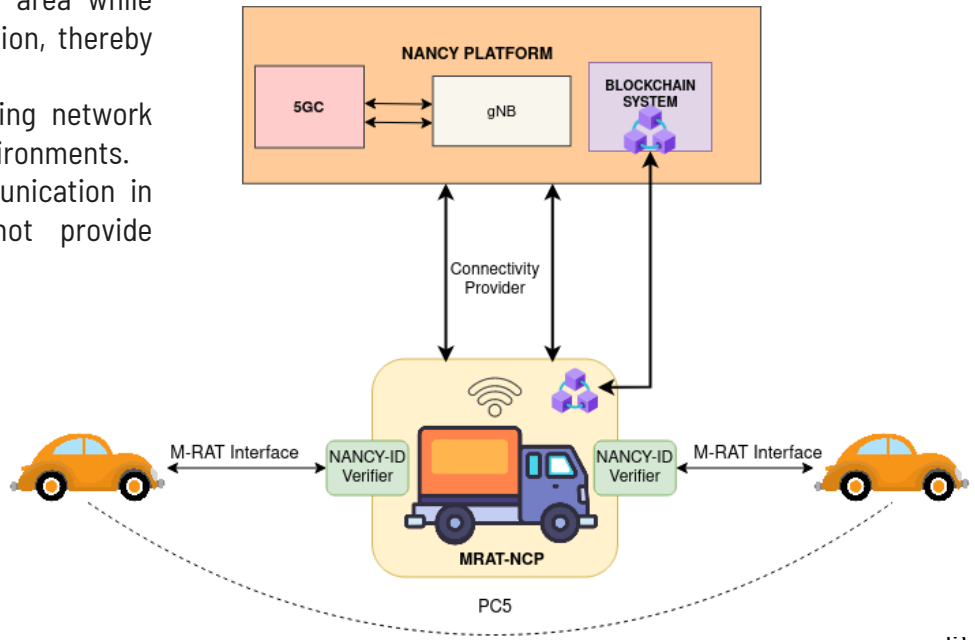
- Influenced by cell-free access for D2D, given that, if possible, connection should be retained as close as possible to the source to reduce latency and provide high-quality services. [R2]
- Its ML-OP is handled by the AI model repository [R9].
- Task offloading mechanisms are analysed rigorously to define high-priorities for the requested task, thus could be optimized by allocating it at a closer edge node. [R14]



T3.1: Cooperative/cell-free access

Role:

- Deploying multiple Multi Radio Access technology nomadic connectivity providers (MRAT-NCPs) throughout the service area to establish multi-hop networks when needed
- UEs will be able to move throughout the entire area while maintaining connectivity due to operator cooperation, thereby achieving greater network capacity.
- Data can hop from one node to another, achieving network reliability and extending coverage in challenging environments.
- Seamless coverage and seamless wireless communication in areas where the fixed infrastructure does not provide acceptable connectivity



Dependencies:

- Integrates cooperative access mechanisms in B-RAN [R1].
- Connects with the blockchain-related technologies to ensure security and privacy [R3].
- Receives the decisions of the smart pricing policies [R6].

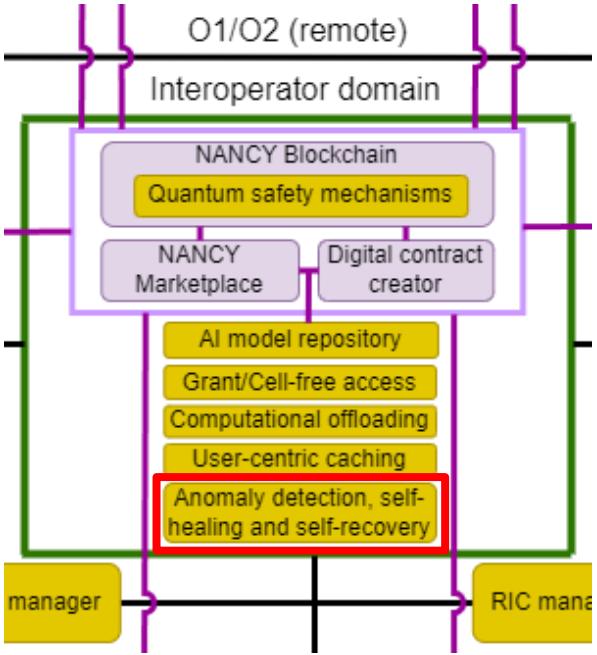
T3.1: Anomaly detection, self-healing, and self-recovery

Role:

- Provides network nodes with autonomous processes which can take decisions and prevent network faults on device and network level.
- Employs a distributed scheme where both the UEs and the Edge participate in the training process.

Dependencies:

- Receives input from the AI virtualizer [R8] to assess the amount and type of computational resources available for the FL training.
- Utilizes the ML models stored in the model repository [R9] and leverages the MLops to simplify and streamline the FL training.



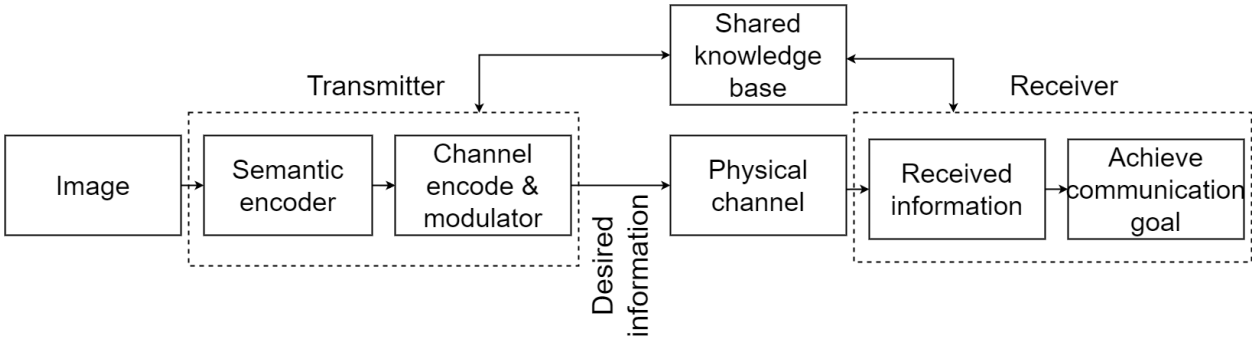
T3.1: Semantic communications

Role:

- Facilitates accurate transmission and understanding of information.
- Utilizes AI approaches for knowledge extraction and representation.
- Reduces communication overhead and enhances the energy efficiency.
- Targets specific communication goals.

Dependencies:

- Finds application in various usage scenario and use cases.
- Focuses on the point-to-point communication aspects.



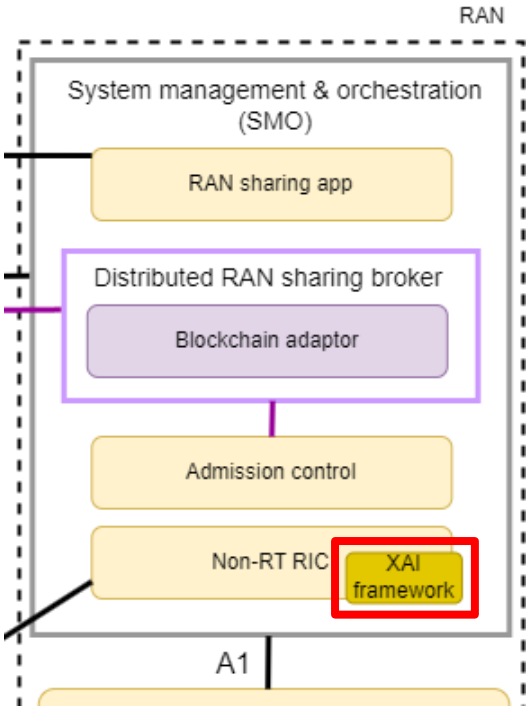
T3.1: XAI

Role:

- Explain the decisions that were made by the AI models.
- Focused on security and transparency aspects.
- Provides high transparency regarding the rationale behind the best possible allocation of the resources that are available at a given time.
- Helps in the identification of various attacks against the network.

Dependencies:

- Utilizes the ML models stored in the model repository [R9] and leverages the MLops to simplify and streamline the training.



Thank you for your attention!

Questions?

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