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MACHINE LEARNING-BASED, NETWORKING AND COMPUTING INFRASTRUCTURE RESOURCE MANAGEMENT OF 5G AND BEYOND INTELLIGENT NETWORKS: THE MARSAL VISION

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MARSAL project network architecture

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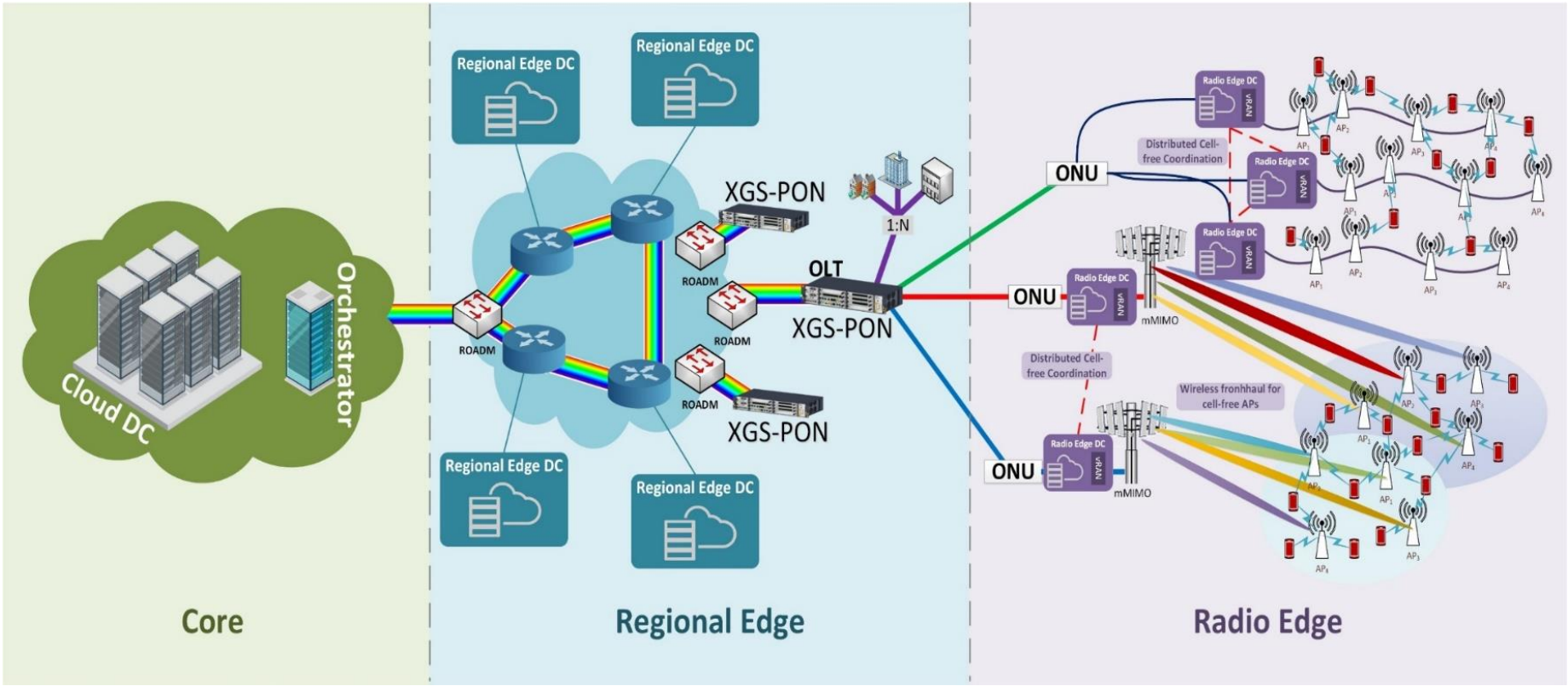

MARSAL project concept

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MARSAL

MARSAL focuses on three pillars to enable a new generation of ultra-dense, cost-efficient, flexible and secure networks

network design

- ✓ distributed processing cell-free concept
- ✓ wireless mmWave solutions
- ✓ in-line with the O-RAN Alliance

virtual elastic infrastructure design

- ✓ Elastic Edge Computing
- ✓ optimization of MEC functionality
- ✓ optimization of network slicing

network security design

- ✓ ML-based mechanisms that guarantee privacy and security in multi-tenancy environments
- ✓ both end-users and tenants

Efficient Network Management

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- Dynamic service orchestration & adaptive resource allocation became a necessity for network operators to manage the rapid growth of users and data-intensive applications
- ISPs are required to maintain and to improve the service performance and reduce the operating costs by optimizing the VNFs' placement
- The division of the network infrastructure in multiple domains remains the main obstacle in resource management optimization due to the high complexity required to be.
- VNFs should be placed in optimal setting → SFC problem becomes complex

SCHEMA III

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SCHEMA (Service CHain Energy-Efficient Management):

- Multi-agent, energy-aware, distributed RL-based, service orchestration framework
- Minimizes service latency in multi-domain B5G/6G networks. Multiple RL agents are employed that perform VNF orchestration in each network domain
- Inter-domain migration is achieved, offering benefits of both local and global SFC orchestration.

SCHEMA III

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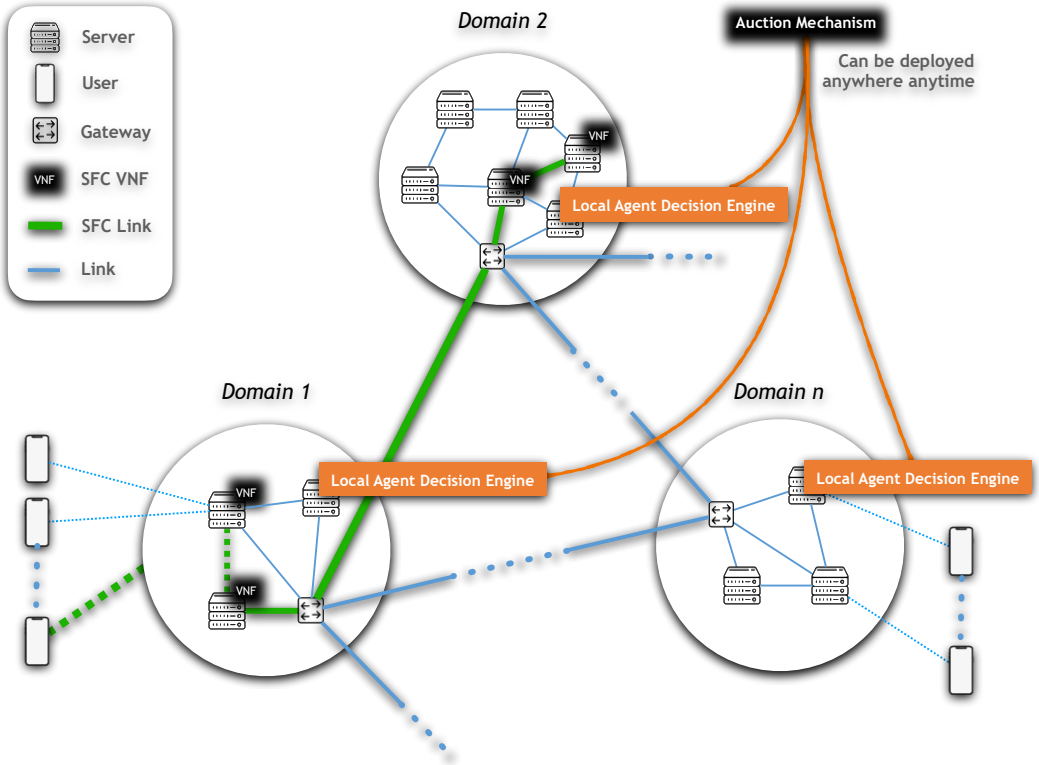
SCHEMA III enables VNF management and orchestration in multi-cloud networks by instantiating intra-domain RL agents for local VNF placement and a shared system that enables inter-domain VNF migration



Domains: Servers with finite computational resources and specific energy consumption

SCHEMA III

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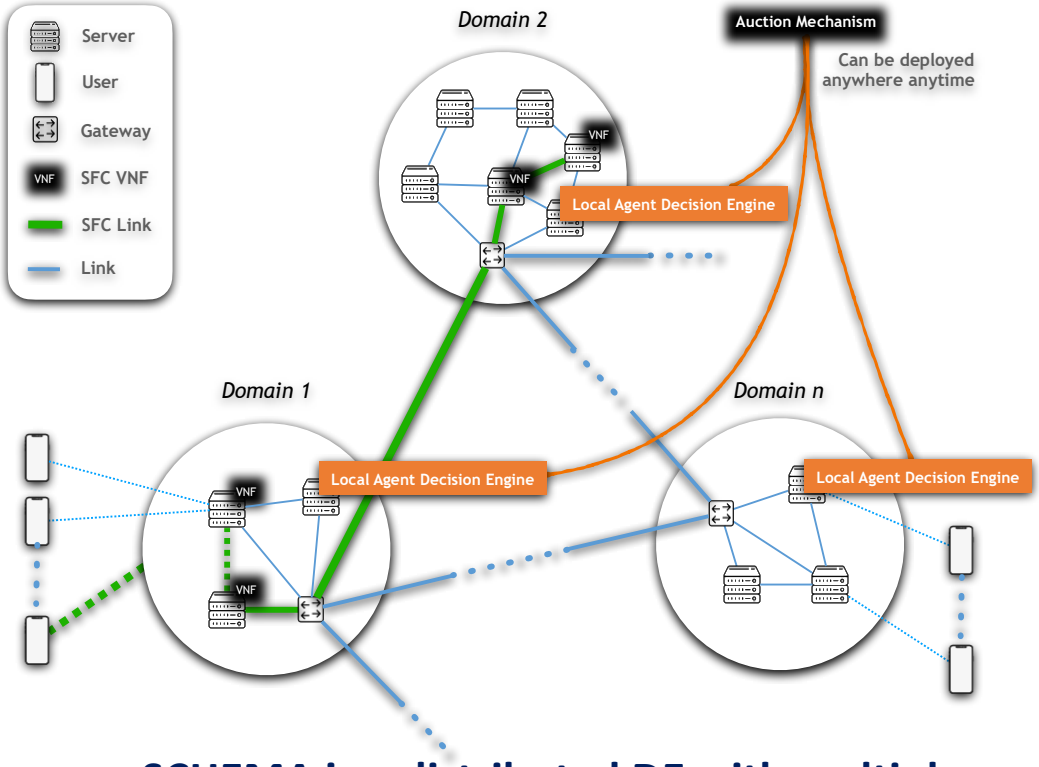
- Edge Domains provide low latency access to the end-users
- Services are comprised of a chain of VNFs
- SCHEMA is designed to operate in a totally decentralized way
- The Auction Mechanism, is a module introduced to enable inter-domain VNF migration



SCHEMA is a distributed DE with multiple agents, eliminating a centralized point of failure as the Auction Mechanism can be instantiated anywhere in the network

Distributed Solution

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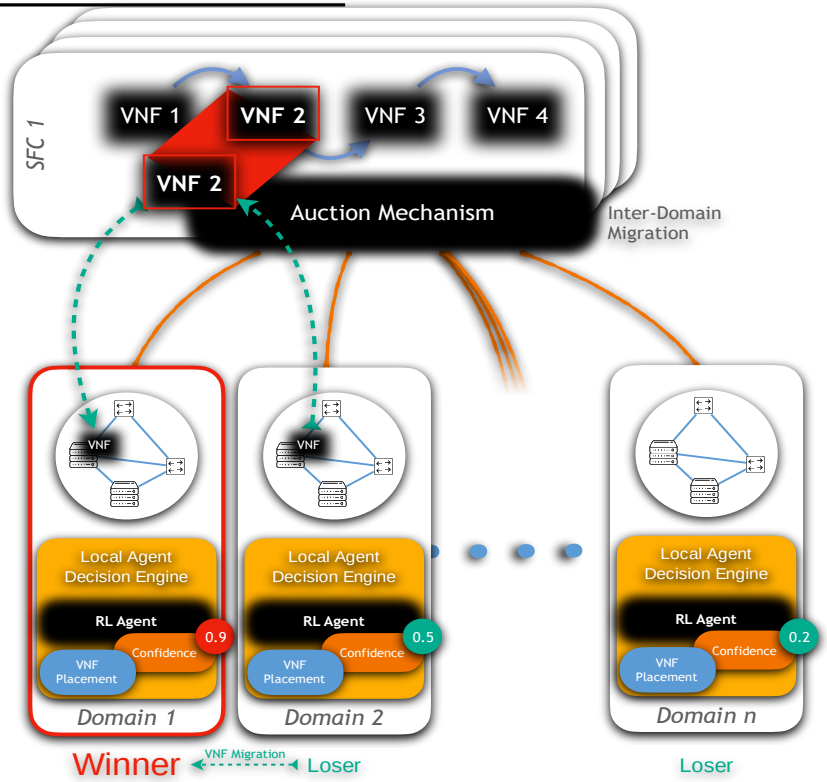
Auction Mechanism enables inter-domain VNF migration in a distributed multi-domain network

Auction Initiation: Selection of the next service VNF and showcase to the distributed domains the requirements of the placement.

Distributed Operation: The distributed RL agents generate their local action to propose a local placement for the showcased VNF.



Distributed Solution

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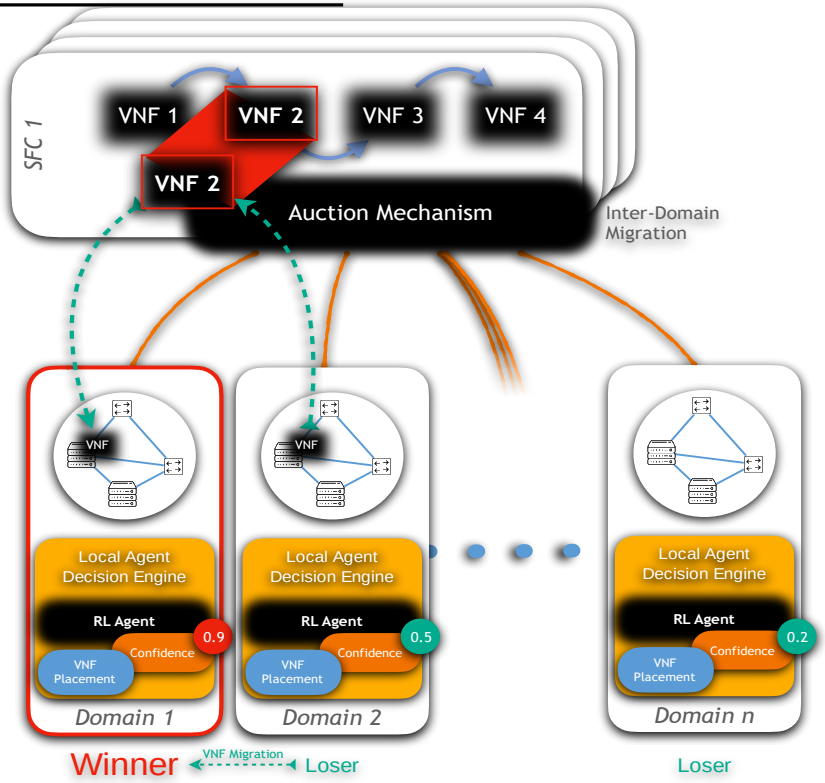
Auction Mechanism enables inter-domain VNF migration in a distributed multi-domain network

Global Operation: The Auction Mechanism receives the Confidence Metric of each domain and selects the highest bidder or the domain with the maximum Confidence Metric as a candidate to receive the VNF currently in auction. The Auction Mechanism notifies the candidate domain with an acknowledgment response.



Distributed Solution

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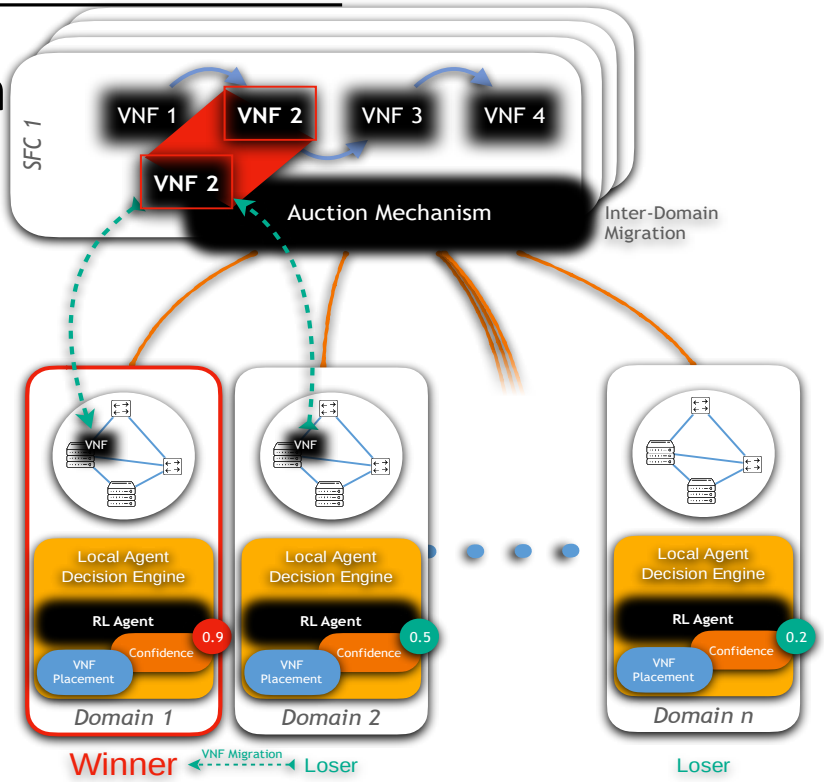
Auction Mechanism enables inter-domain VNF migration in a distributed multi-domain network

Orchestration: If the candidate domain is different from the current domain that hosts the VNF, the inter-domain migration is initiated. In reverse, the domain agent performs an intra-domain migration to the node with the highest Confidence Metric with a much lower cost in terms of both energy, time and overall cost.

Iteration: The procedure is repeated indefinitely.



Distributed Solution

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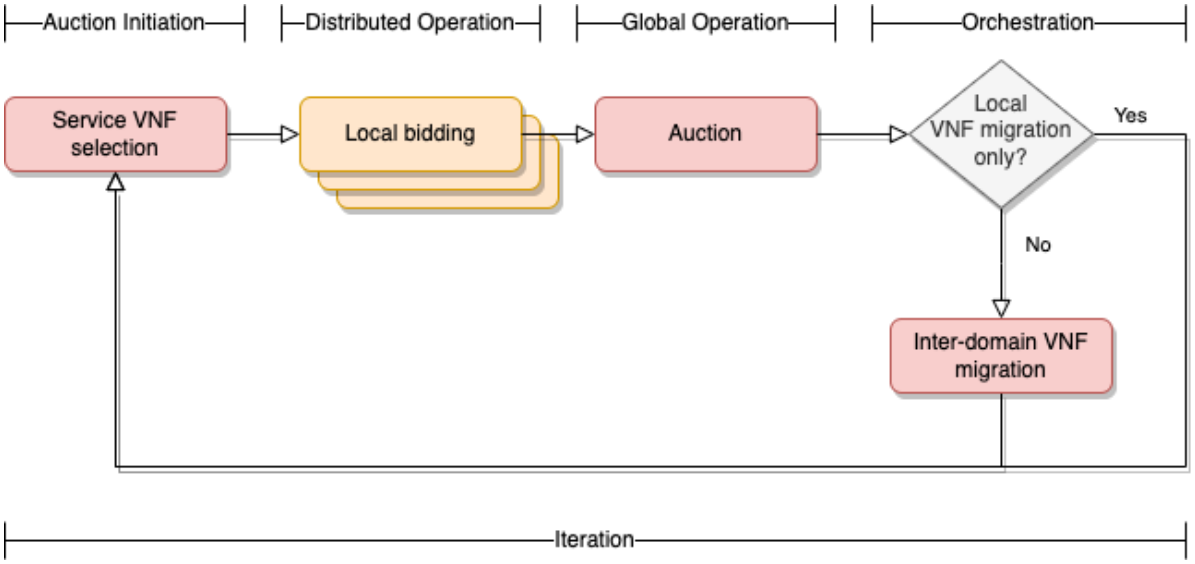

- The Auction Mechanism is responsible for the inter-domain communication making it non-essential for the local domain orchestration.
- The Auction Mechanism can be deployed quickly at any node of the network eliminating the single point of failure in the system.

Results

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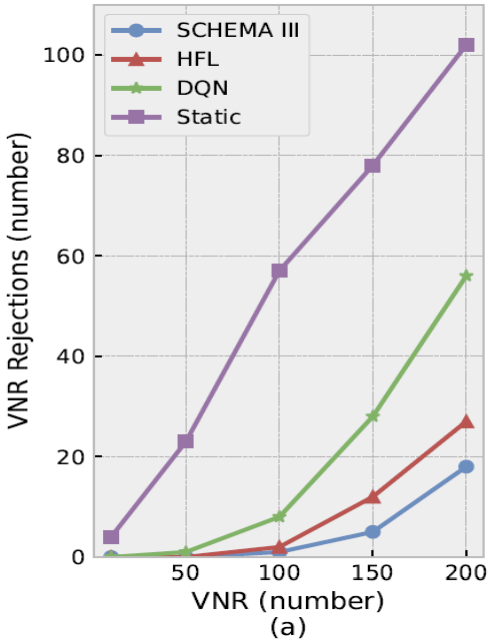
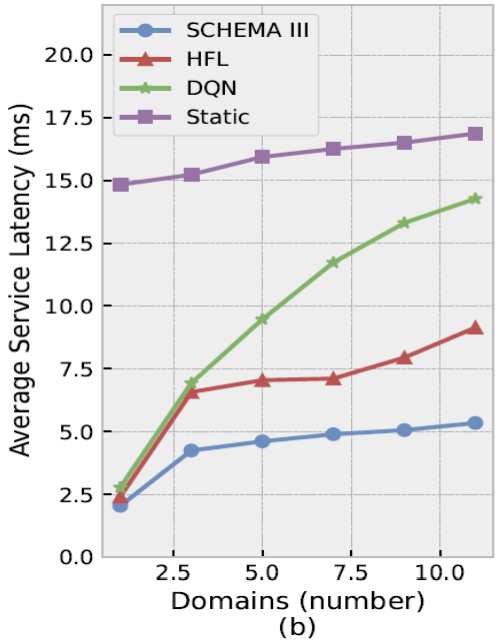
SCHEMA III performance is evaluated through the comparison with state-of-the-art VNE algorithms

- Number of rejected VNRs per total number of VNRs
- SCHEMA III has the least rejected VNRs overall
- The service latency is also evaluated
- The performance superiority of SCHEMA III can be attributed to the distributed architecture that distributes the state space in multiple agents





Results

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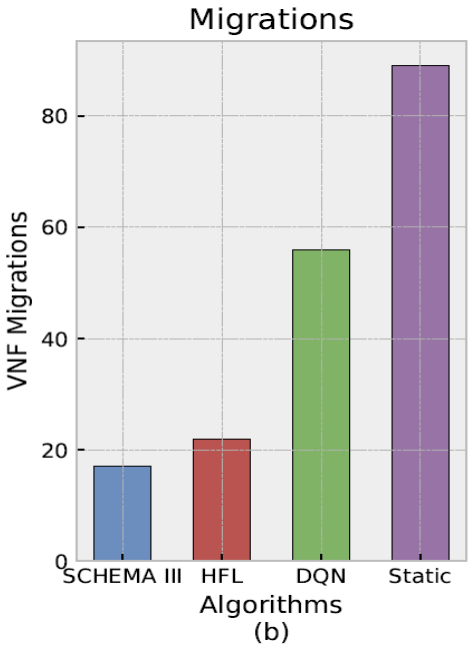
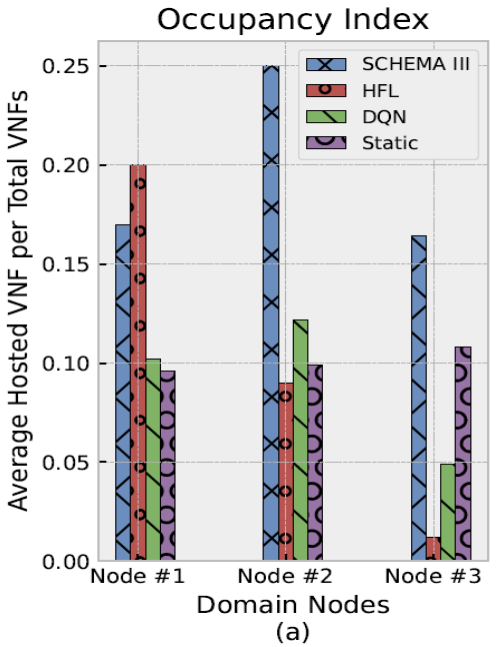
SCHEMA III performance is evaluated through the comparison with state-of-the-art VNE algorithms

- number of VNF migration needed during 1200 simulated iterations
- SCHEMA III prevents VNE re-configurations
- SCHEMA III tends to consolidate the VNFs to minimize the number of hops to the end-user and, consequently, to reduce the average latency





MARSAL factsheet

MARSAL

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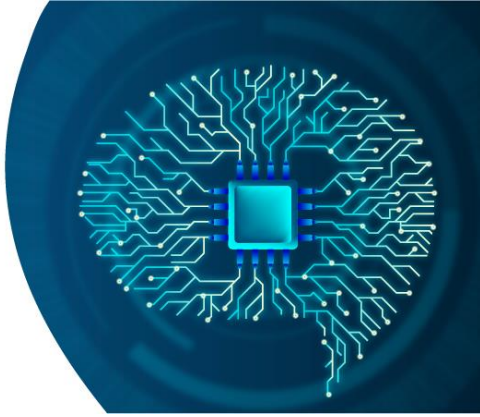
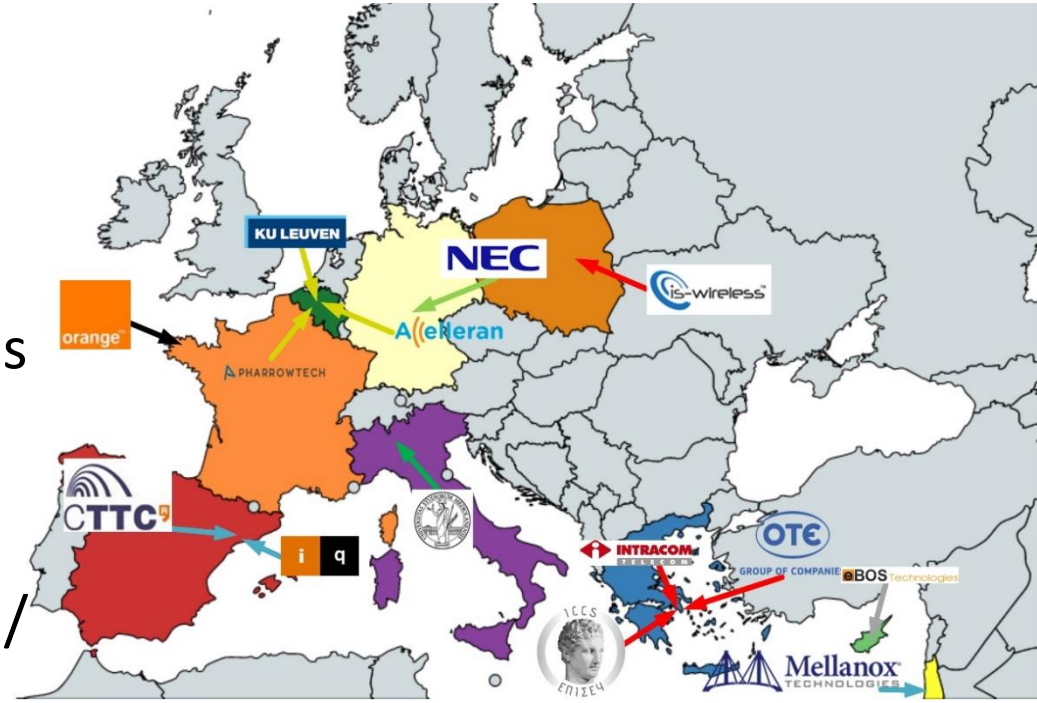


- ✓ **Grant Agreement:** 871780
- ✓ **Duration:** 42 months
- ✓ **Starting date:** 01/01/2021
- ✓ **EC funding:** 6,126,683.75 Euros
- ✓ **Total PMs:** 703.5
- ✓ **URL:** https://www.marsalproject.eu/



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Thank you!

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