Realising URRLC for Smart Energy Network Services

Professor Anastasios (Tasos) Dagiuklas

SuITE Research Group

London South Bank University, UK
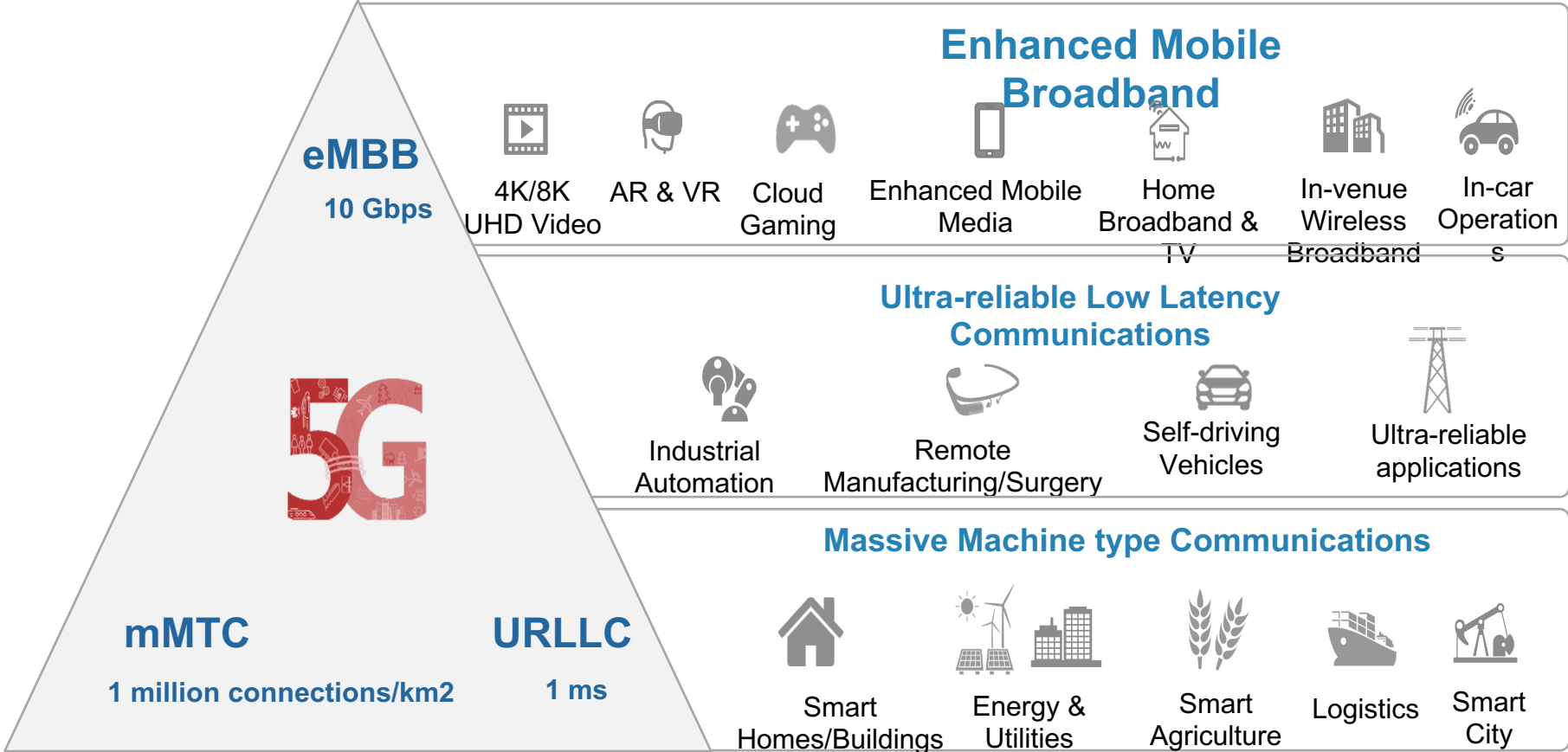

Professor Panagiotis Alefragis
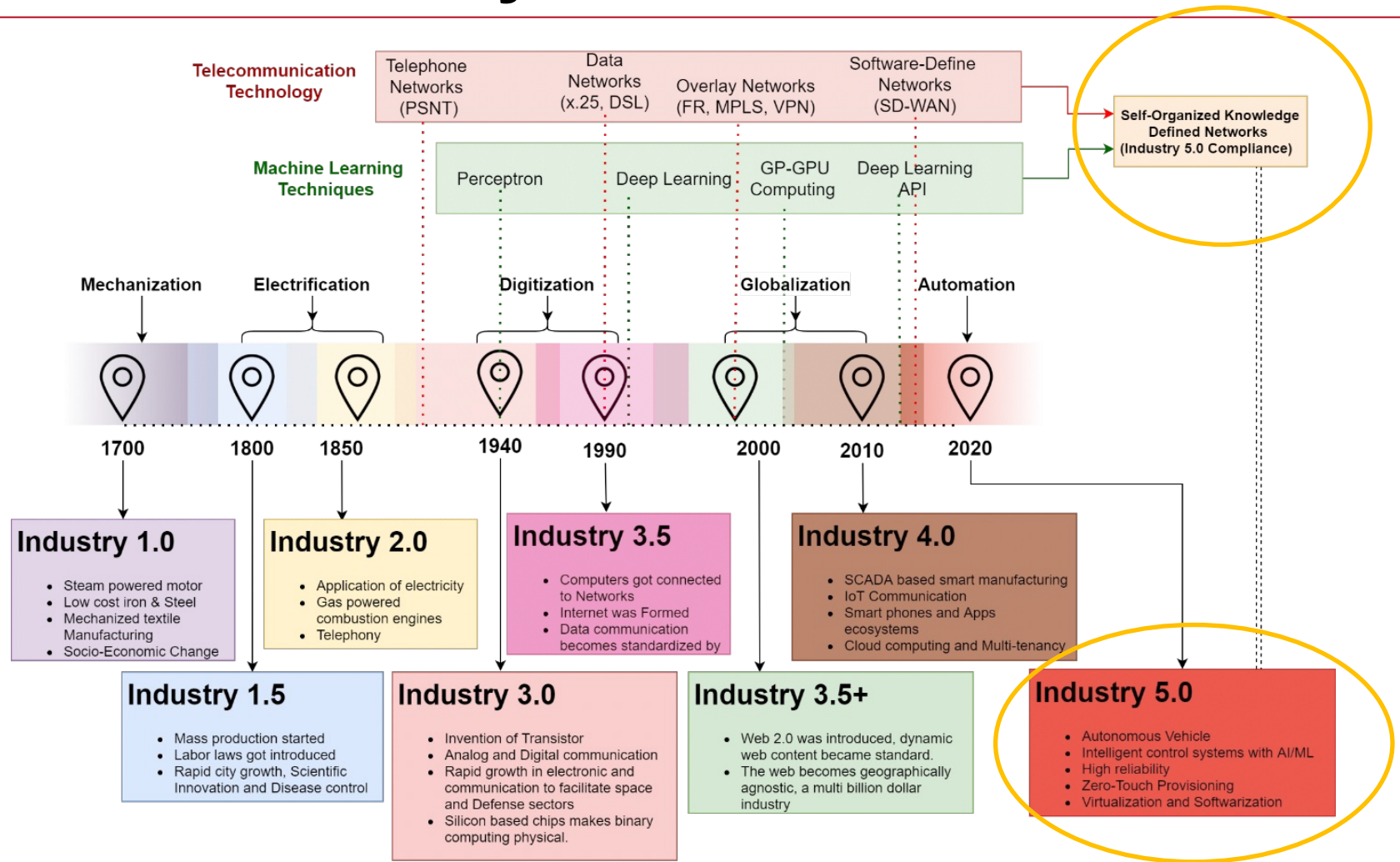
University of Peloponese, Greece

Presentation

- Knowledge Defined Networking

- Cognitive Routing as Service

- Edge Automation

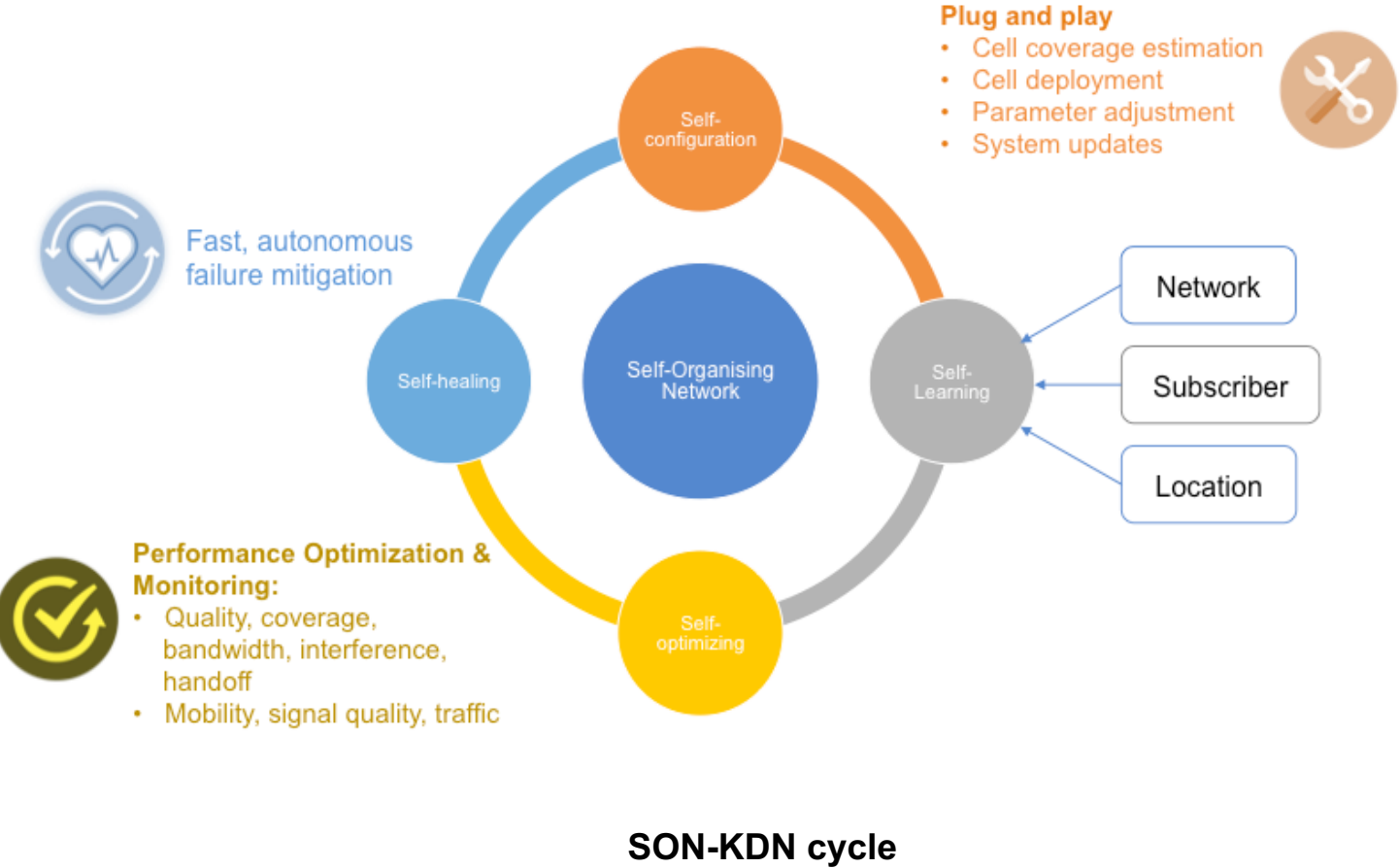- Energy Network Service Use Case

5G Capabilities and Use Cases

eMBB
10 Gbps

mMTC
1 million connections/km2

URLLC
1 ms

Enhanced Mobile Broadband

4K/8K UHD Video · AR & VR · Cloud Gaming · Enhanced Mobile Media · Home Broadband & TV · In-venue Wireless Broadband · In-car Operations

Ultra-reliable Low Latency Communications

Industrial Automation · Remote Manufacturing/Surgery · Self-driving Vehicles · Ultra-reliable applications

Massive Machine type Communications

Smart Homes/Buildings · Energy & Utilities · Smart Agriculture · Logistics · Smart City

Source: ITU Recommendation

Towards Industry 5.0
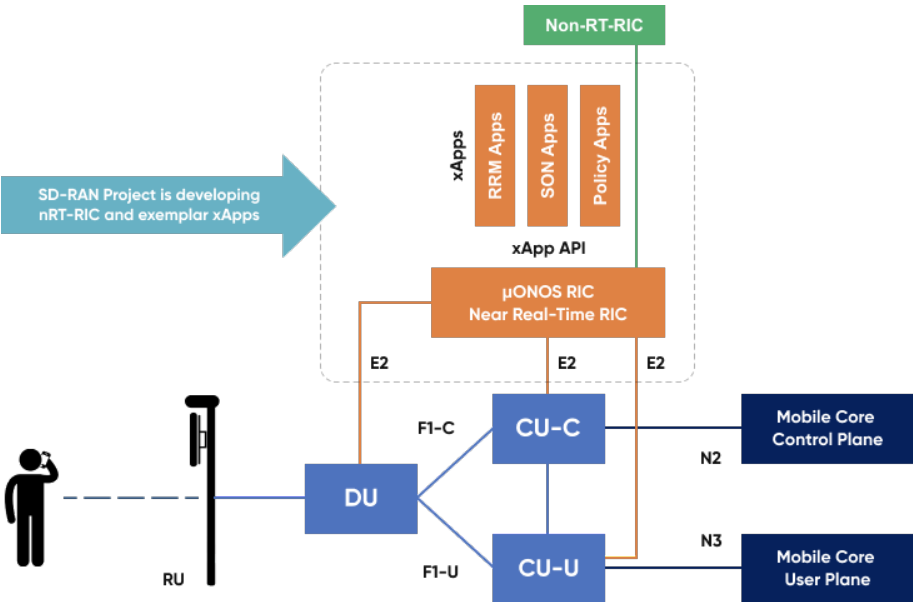
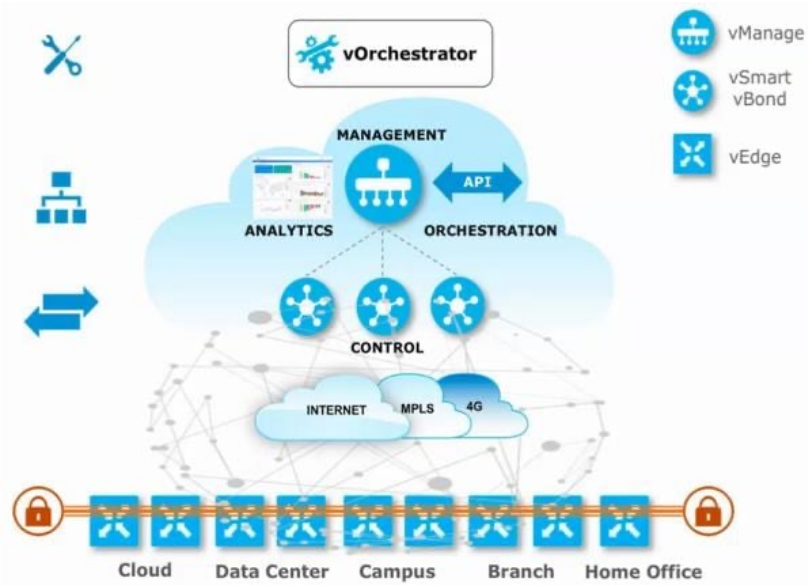# Knowledge Defined Networks

SON-KDN cycle

Presentation

- Knowledge Defined Networking

- Cognitive Routing as Service

- Edge Automation

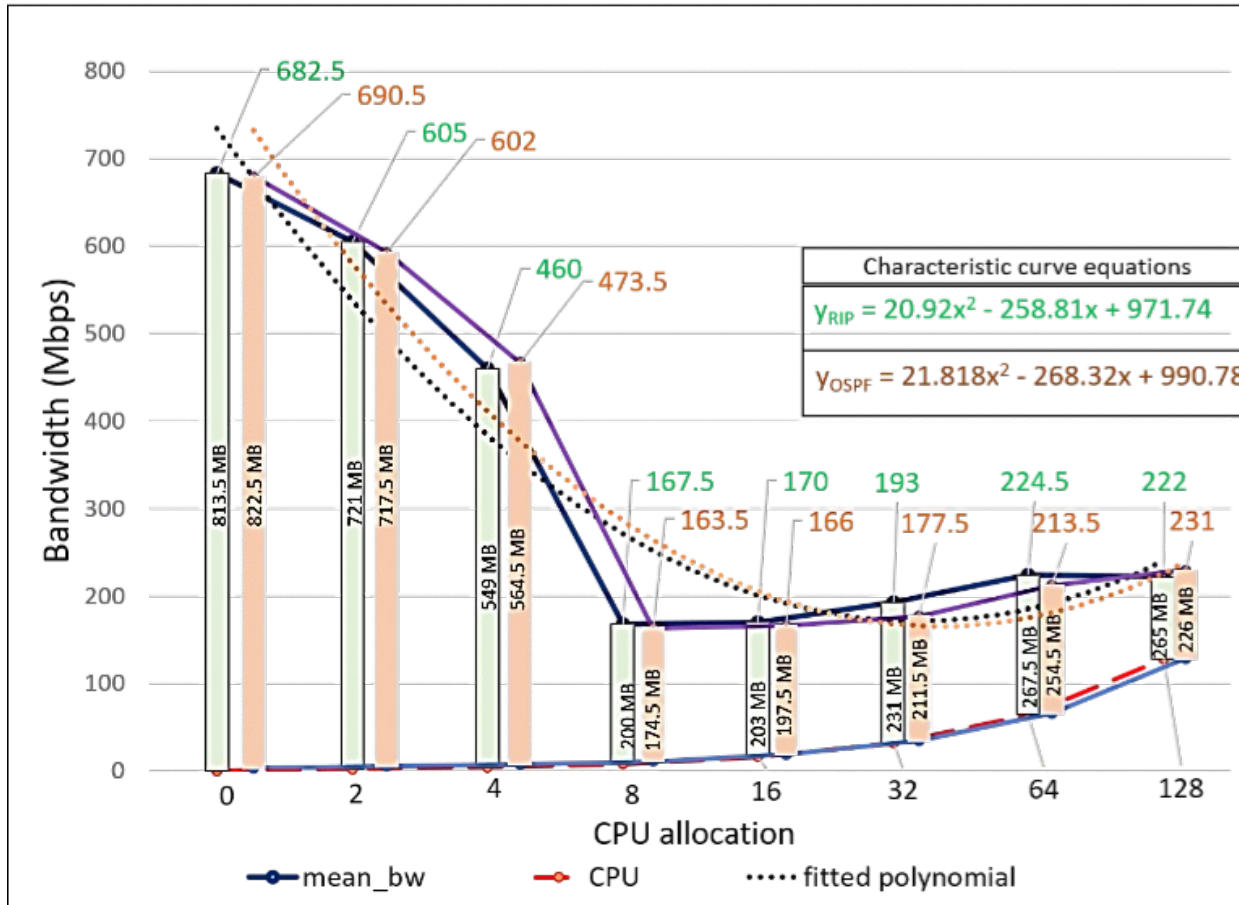- Energy Network Service Use Case

Industry Reference Architecture
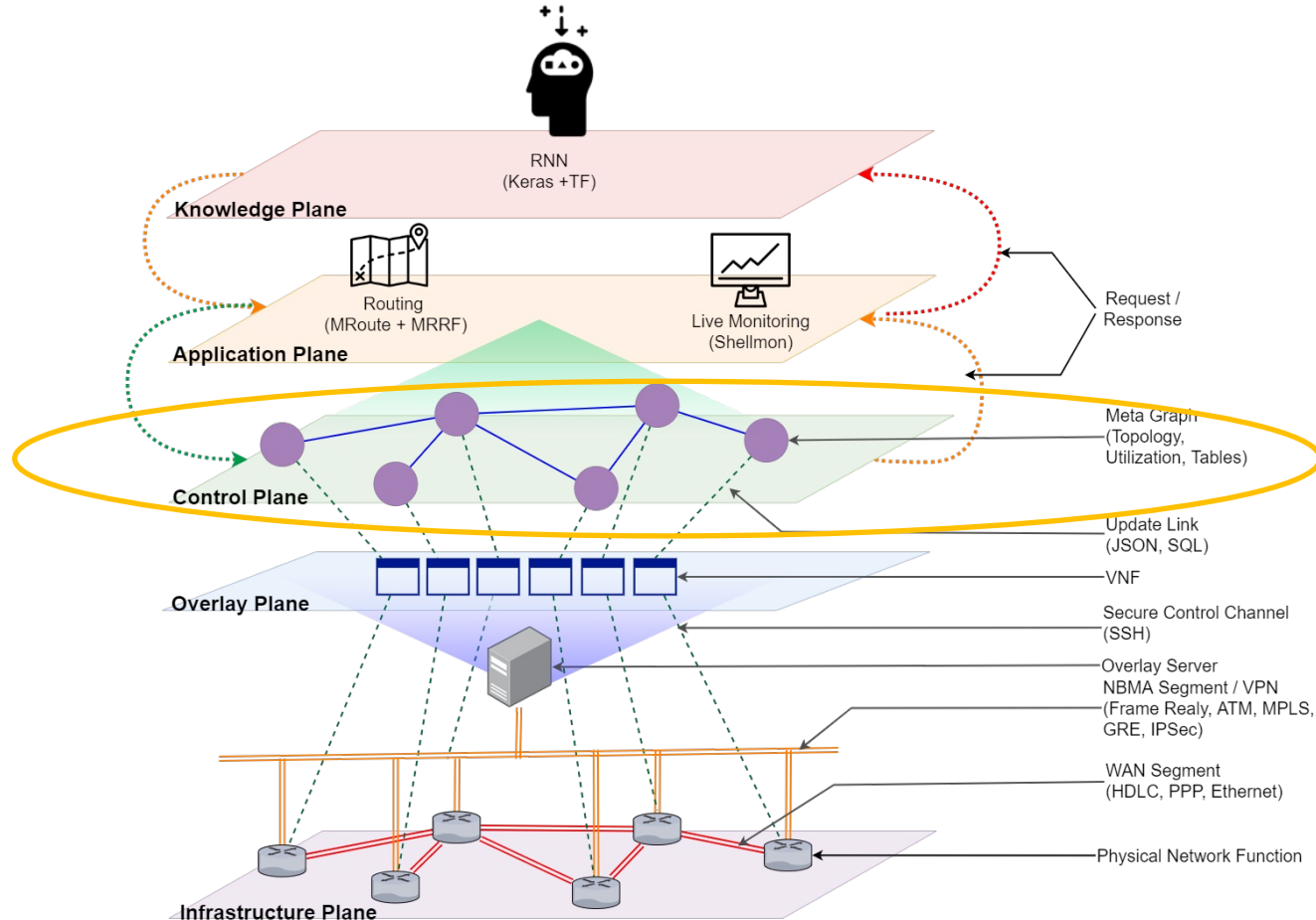
SD-RAN (ONF)

SD-WAN (Cisco)

The role of virtualization on network performance

Ghosh, S., Dagiuklas, T. and Iqbal, M., 2018, December. Energy-aware IP routing over SDN. In *2018 IEEE Global Communications Conference (GLOBECOM)* (pp. 1-7). IEEE.
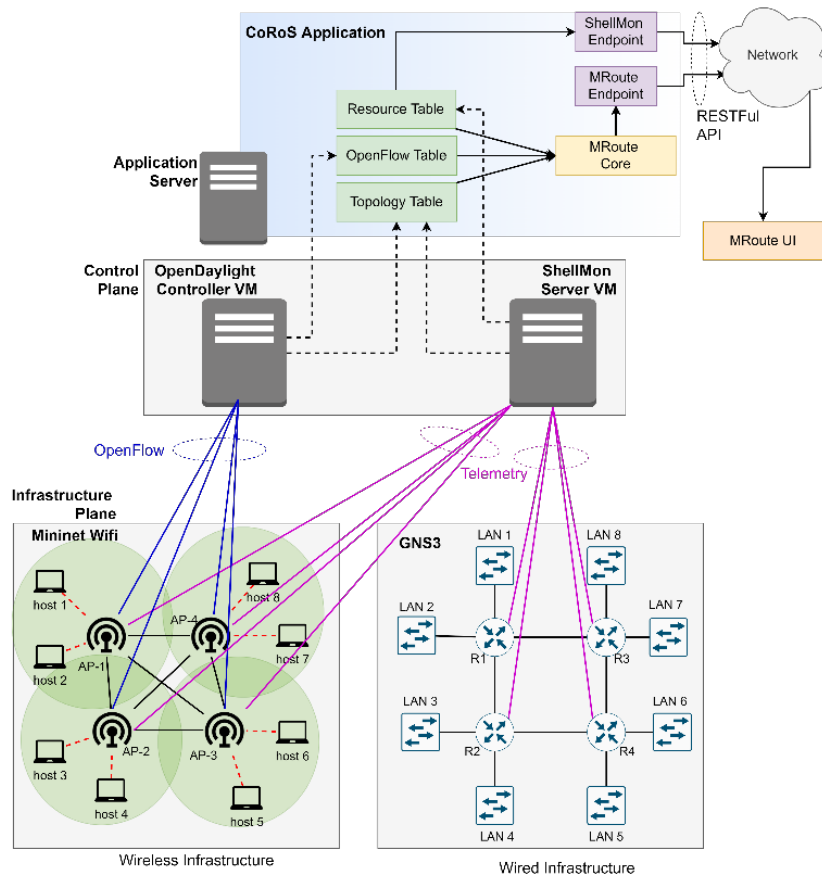
LSBU KDN Architecture

Ghosh, S., Dagiuklas, T., Iqbal, M. and Wang, X., 2022. A Cognitive Routing Framework for Reliable Communication in IoT for Industry 5.0. *IEEE Transactions on Industrial Informatics*.

Cognitive Routing as a Service

- Cognitive Routing as a Service
- Considers node and link costs
- Self-Organisation
  - Self-Optimisation
  - Self-Configuration
  - Self-Healing
  - Self-Learning

https://github.com/rishiCSE17/SO-KDN

Ghosh, S., Dagiuklas, T. and Iqbal, M., 2018, December. Energy-Aware IP routing over SDN. In *2018 IEEE Global Communications Conference (GLOBECOM)* (pp. 1-7). IEEE.

Khan, M.A., Ghosh, S., Busari, S.A., Huq, K.M.S., Dagiuklas, T., Mumtaz, S., Iqbal, M. and Rodriguez, J., 2021. Robust, Resilient and Reliable Architecture for V2X Communications. IEEE Transactions on Intelligent Transportation Systems.
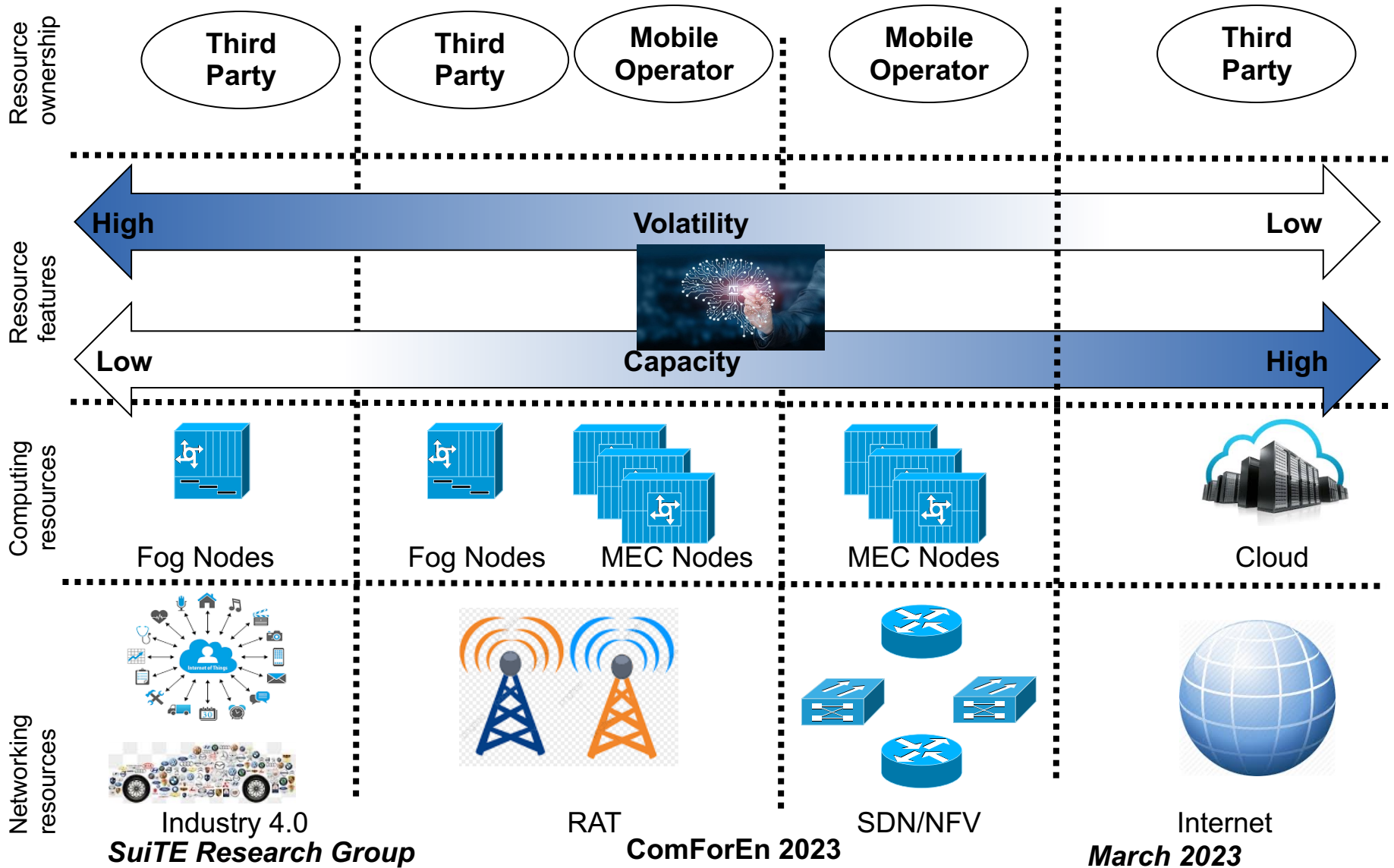
Ghosh, S., Iqbal, M. and Dagiuklas, T., 2021. A centralized hybrid routing model for multicontroller SD-WANs. *Transactions on Emerging Telecommunications Technologies, 32*(6), p.e4252.
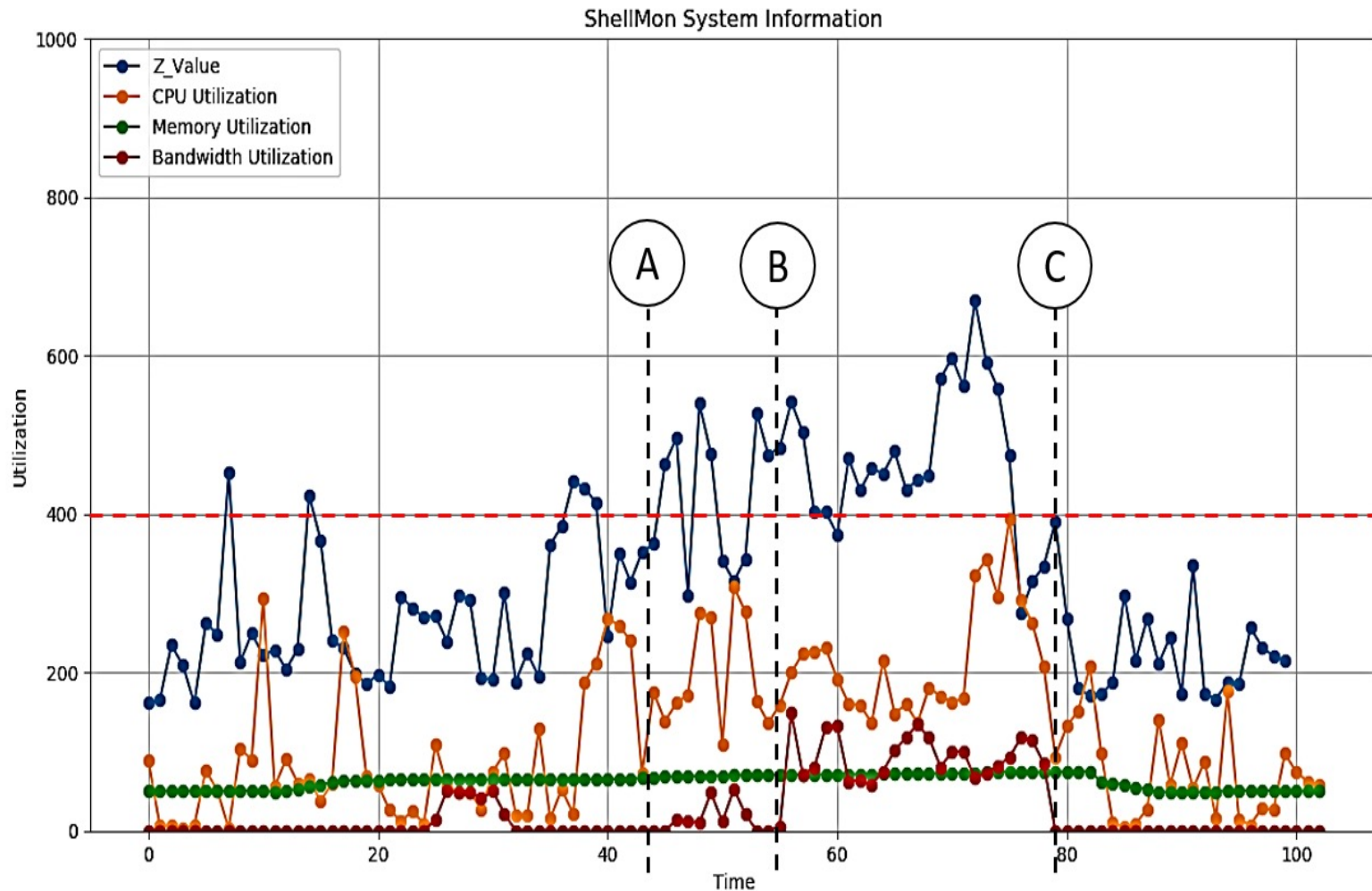
Presentation

- Knowledge Defined Networking

- Cognitive Routing as Service

- Edge Automation
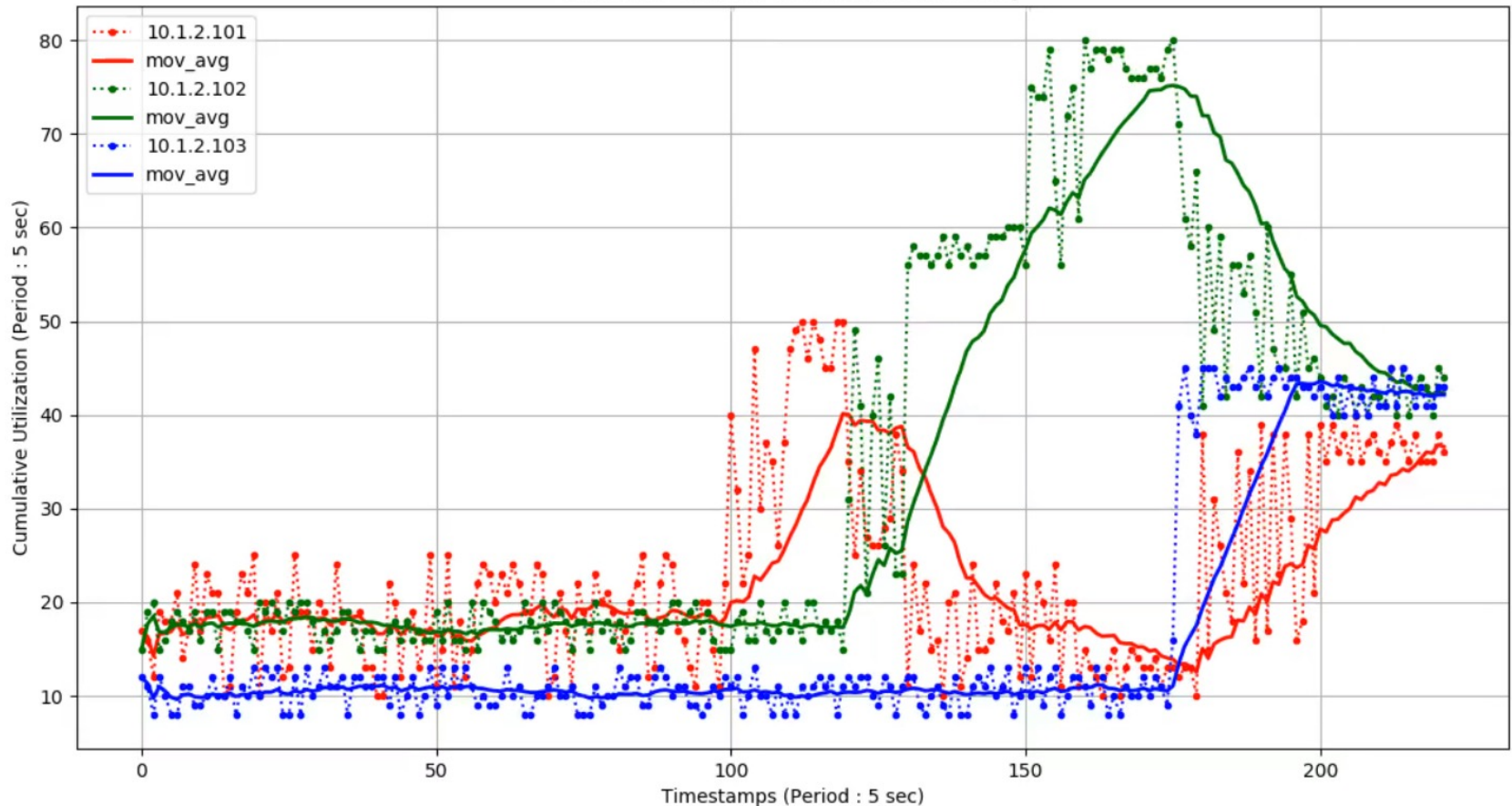
- Energy Network Service Use Case

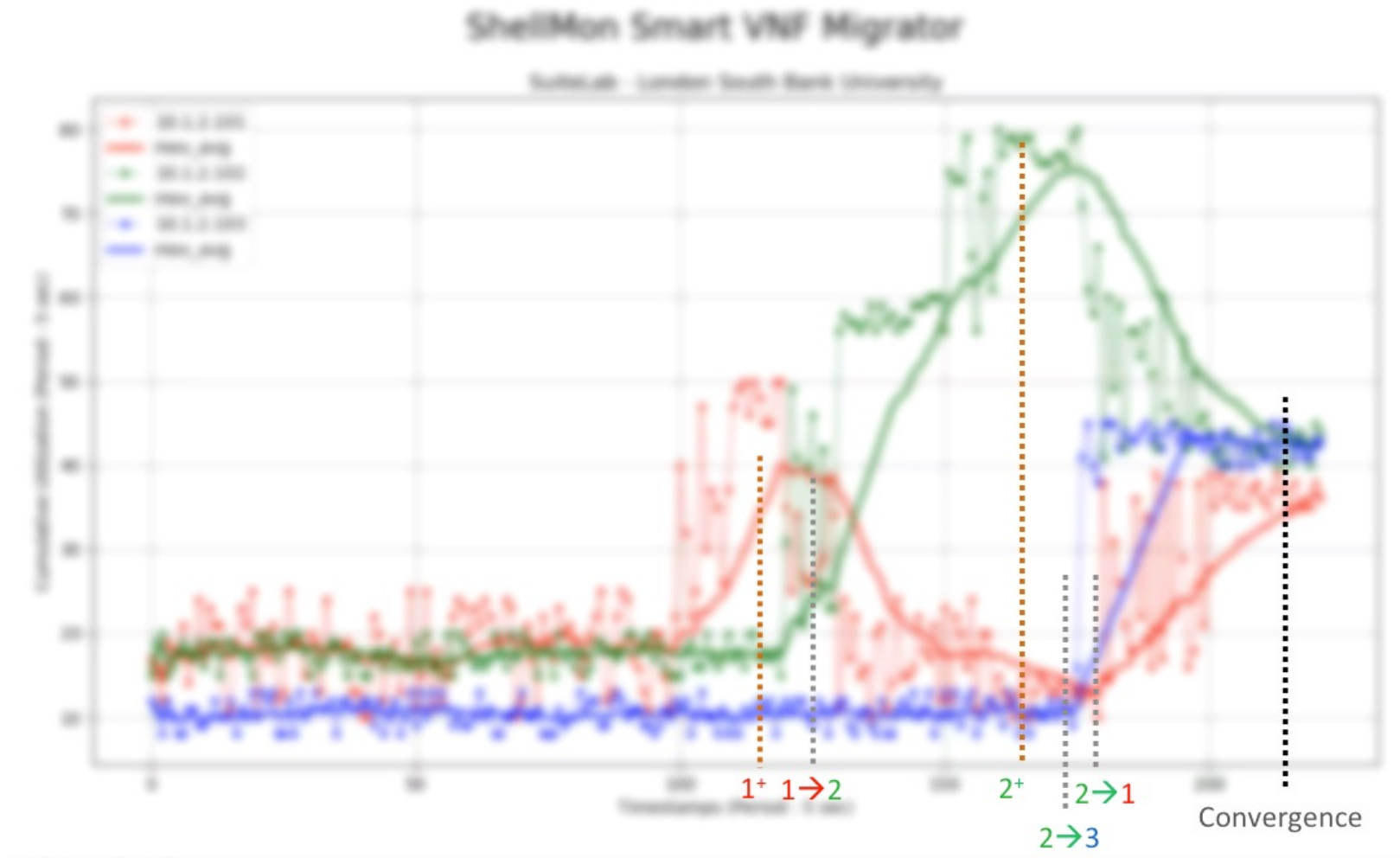# Edge Automation

Automation in Edge-(1)

Automation in Edge-(2)

ShellMon Smart VNF Migrator

SuiteLab - London South Bank University

Containerized VNF Migration-(2)

ShellMon Smart VNF Migrator

SuiteLab - London South Bank University

Presentation

- Knowledge Defined Networking

- Cognitive Routing as Service

- Edge Automation

- **Energy Network Service Use Case**

What is and WHY WE NEED aFFR?

- FFR service help network operators to maintain frequency stability in low-inertia situations

  - Green Deal: Increased penetration of DERs

  - Decommissioning of conventional thermal units ➔ The kinetic energy stored in rotating masses has been substantially reduced.

- A cloud-edge architecture for the FFR service provision can be implemented at the Local Energy Market (LEM) level

  - LEM can act as a Flexibility Service Provider (FSP)

  - 5G URLLC minimize the communication delays and provide reliable fast services

  - Democratize DER flexible capacity by allowing small-scale DER owners to actively participate in the wholesale electricity market

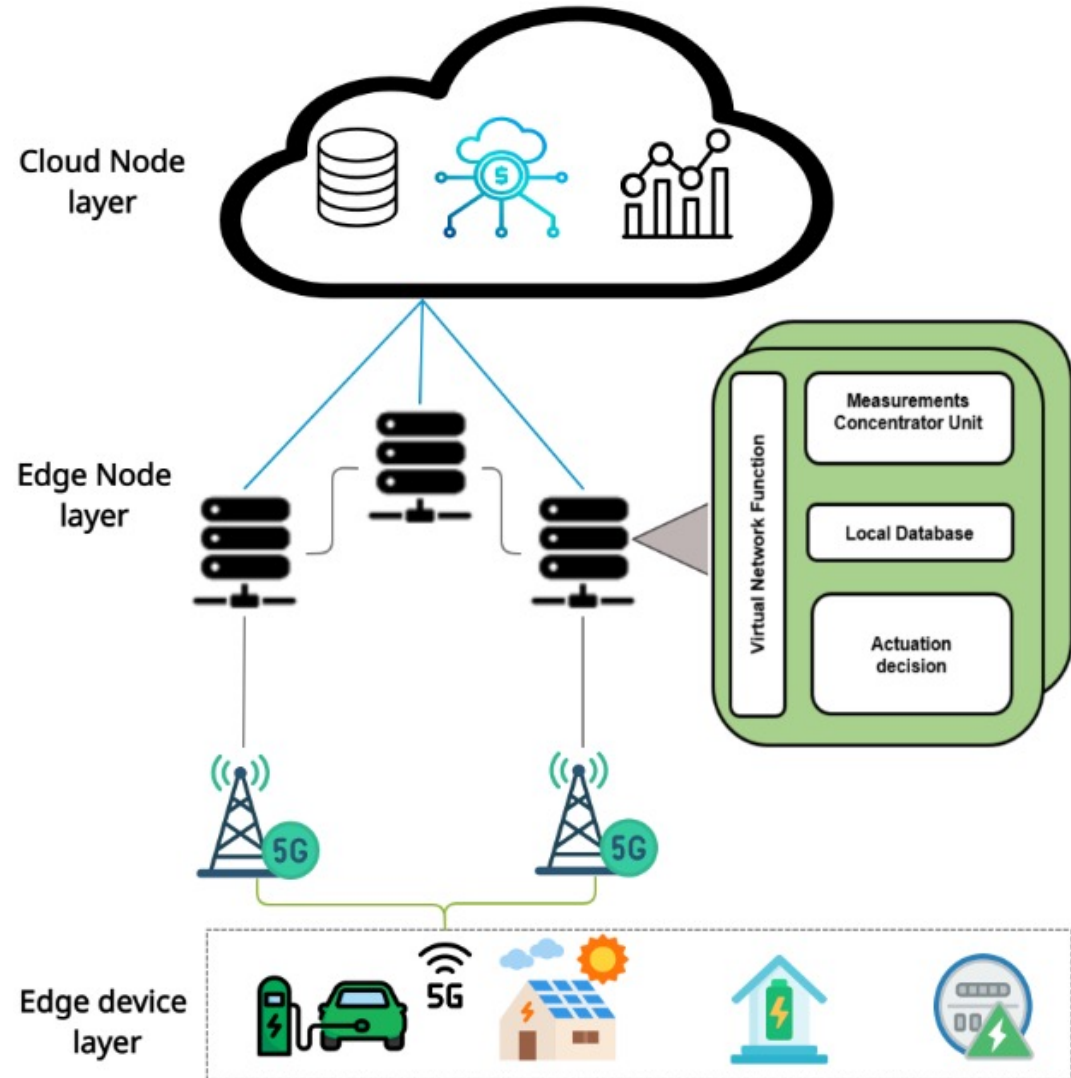# Simulation of FFR with Varying Controls and IBR Penetrations
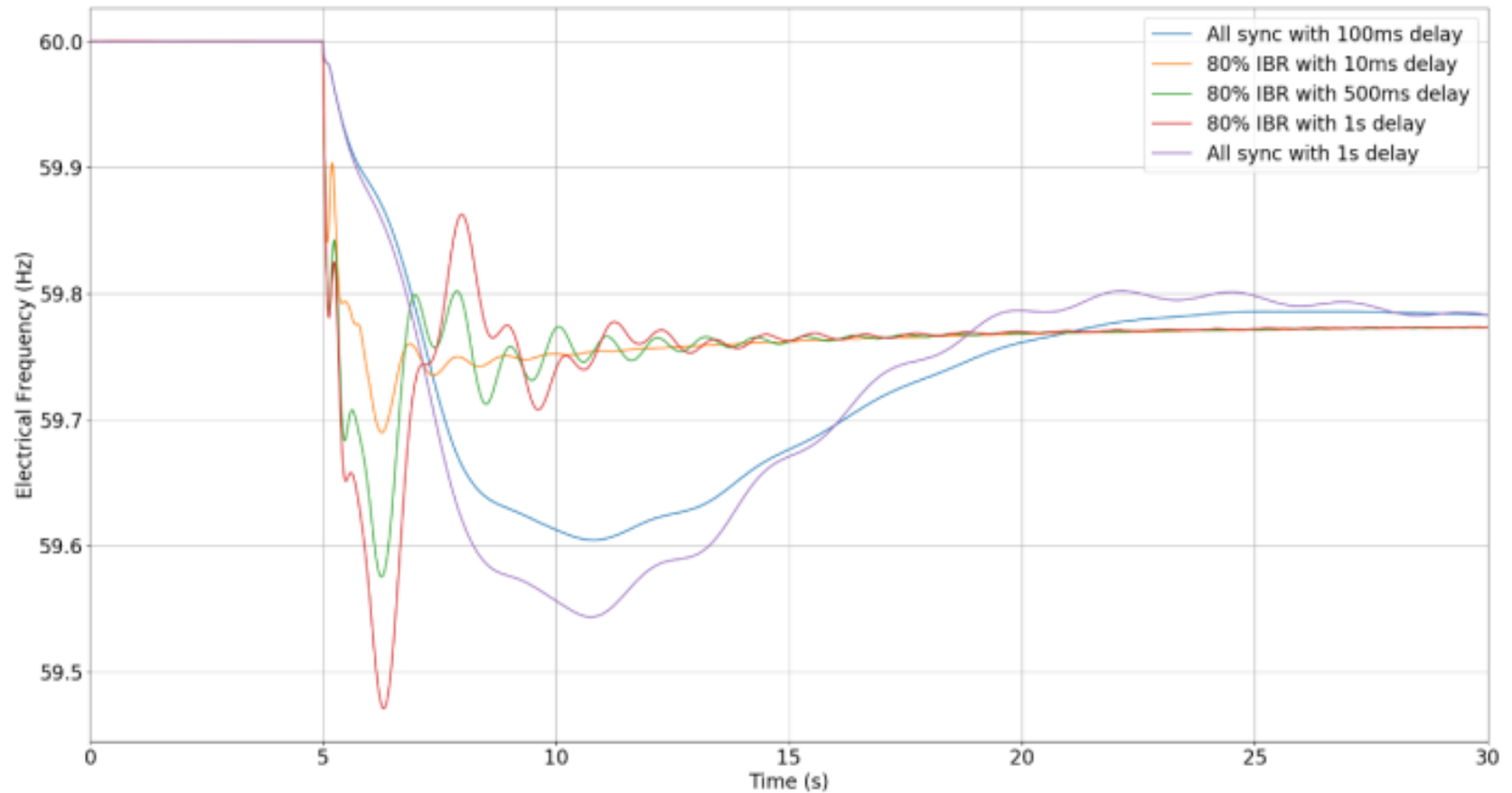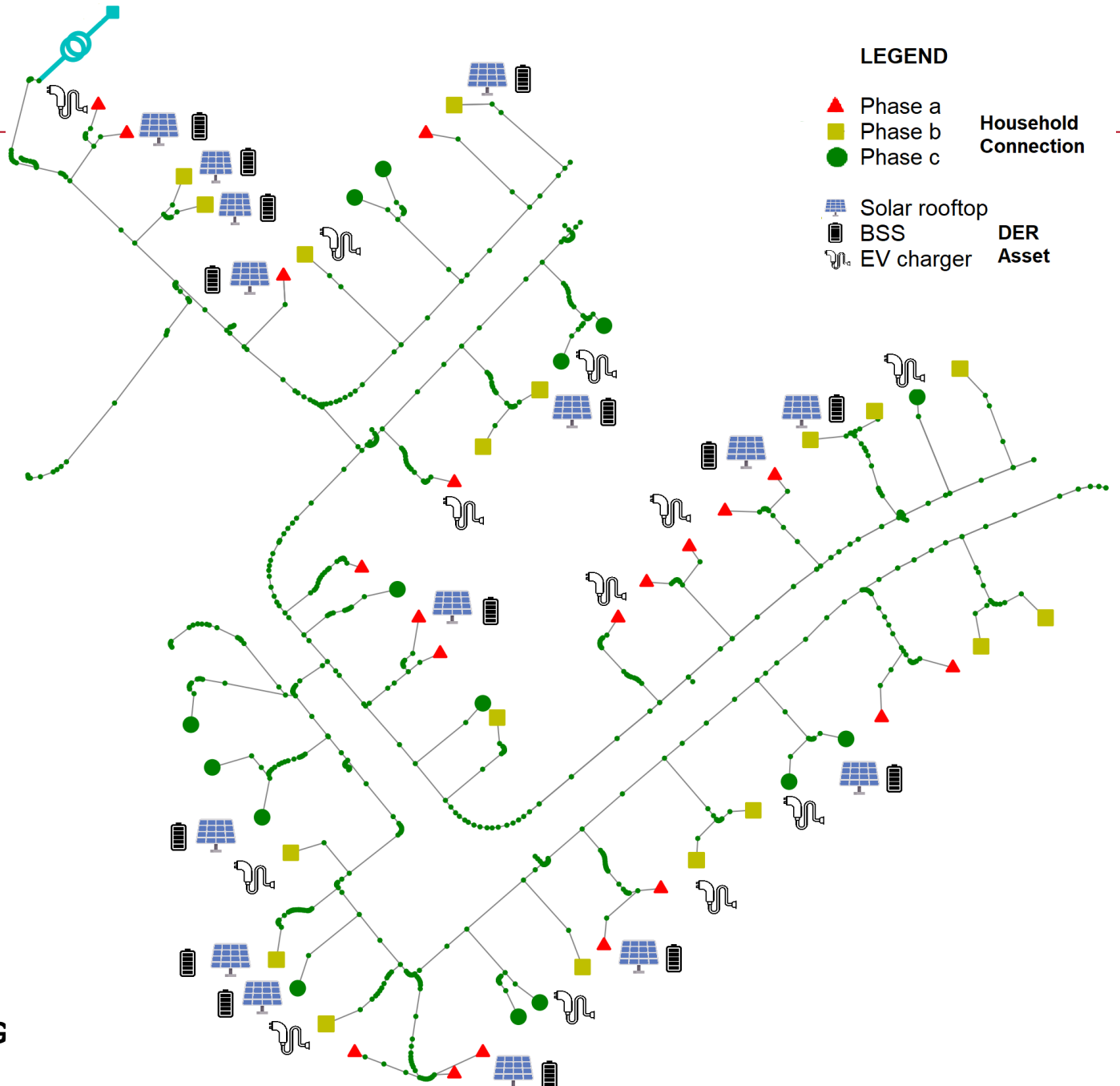
Cloud Edge Continuum for FFR
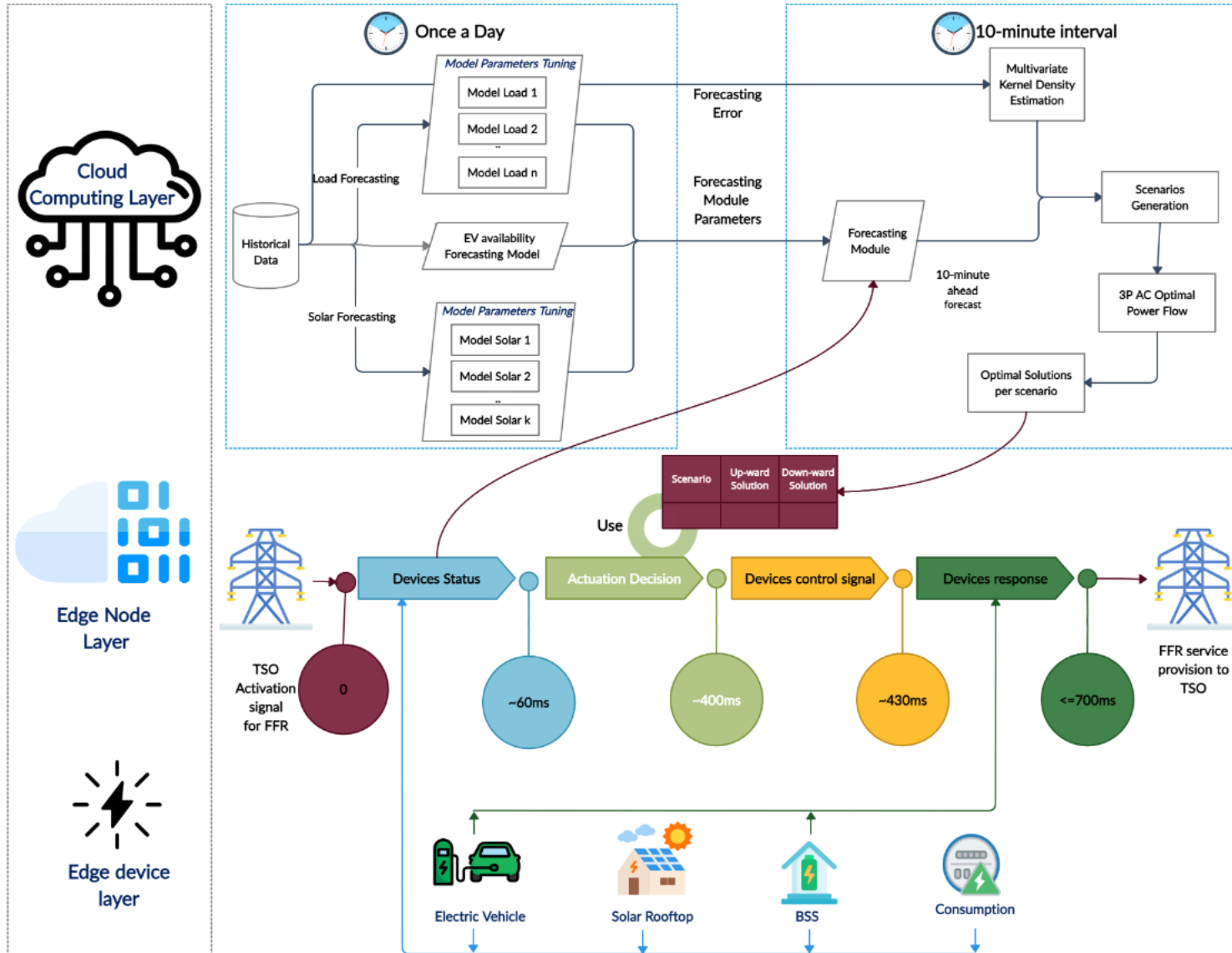
A-FFR service Using 5G URLLC

- Cost effective
- Wired like reliability
- Private 5G between LEM participants
- Support of mobile DR (EV cars on public charging)

Benchmark NetWORK

SuiTE Research G

LEGEND

Phase a
Phase b
Phase c

Household Connection

Solar rooftop
BSS
EV charger

DER Asset

Scaling Analysis & CONCLUSIONS

- Sub-second response is possible even for 3 magnitude more complex networks if enough processing is available
- 5G URLLC is a viable candidate for replacing wired only networking in aFFR

Bachoumis, A., Andriopoulos, N., Plakas, K., Magklaras, A., Alefragis, P., Goulas, G., ... & Papalexopoulos, A. (2021). Cloud-edge interoperability for demand response-enabled fast frequency response service provision. *IEEE Transactions on Cloud Computing*, *10*(1), 123-133.
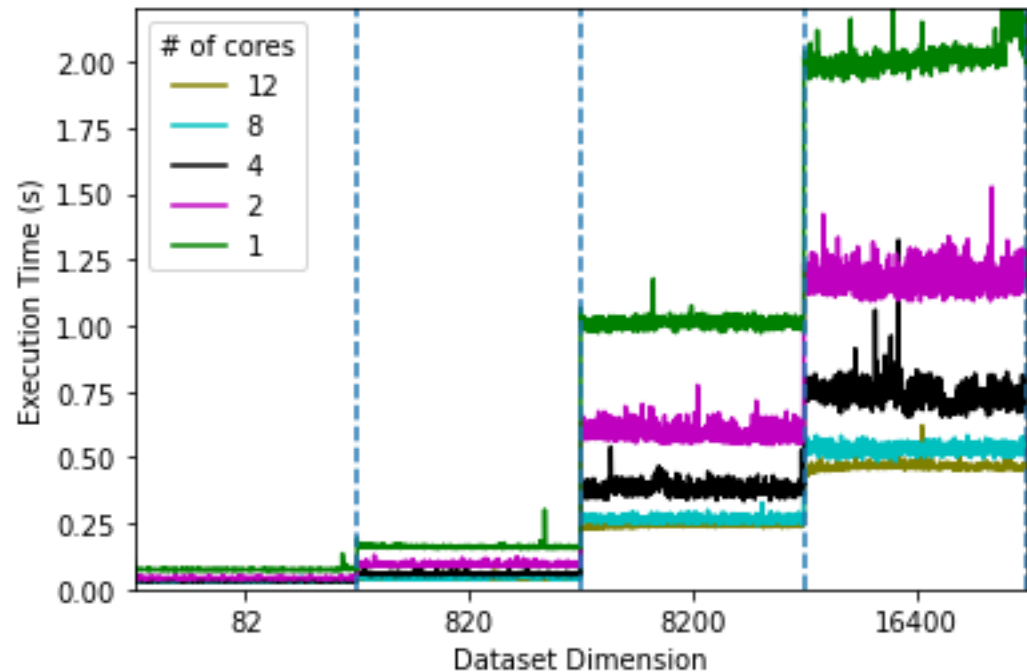
Questions

Email: tdagiuklas@lsbu.ac.uk
Email: alefrag@uop.gr
URL: www.suitelab.org