

5G Networks for Industry Verticals

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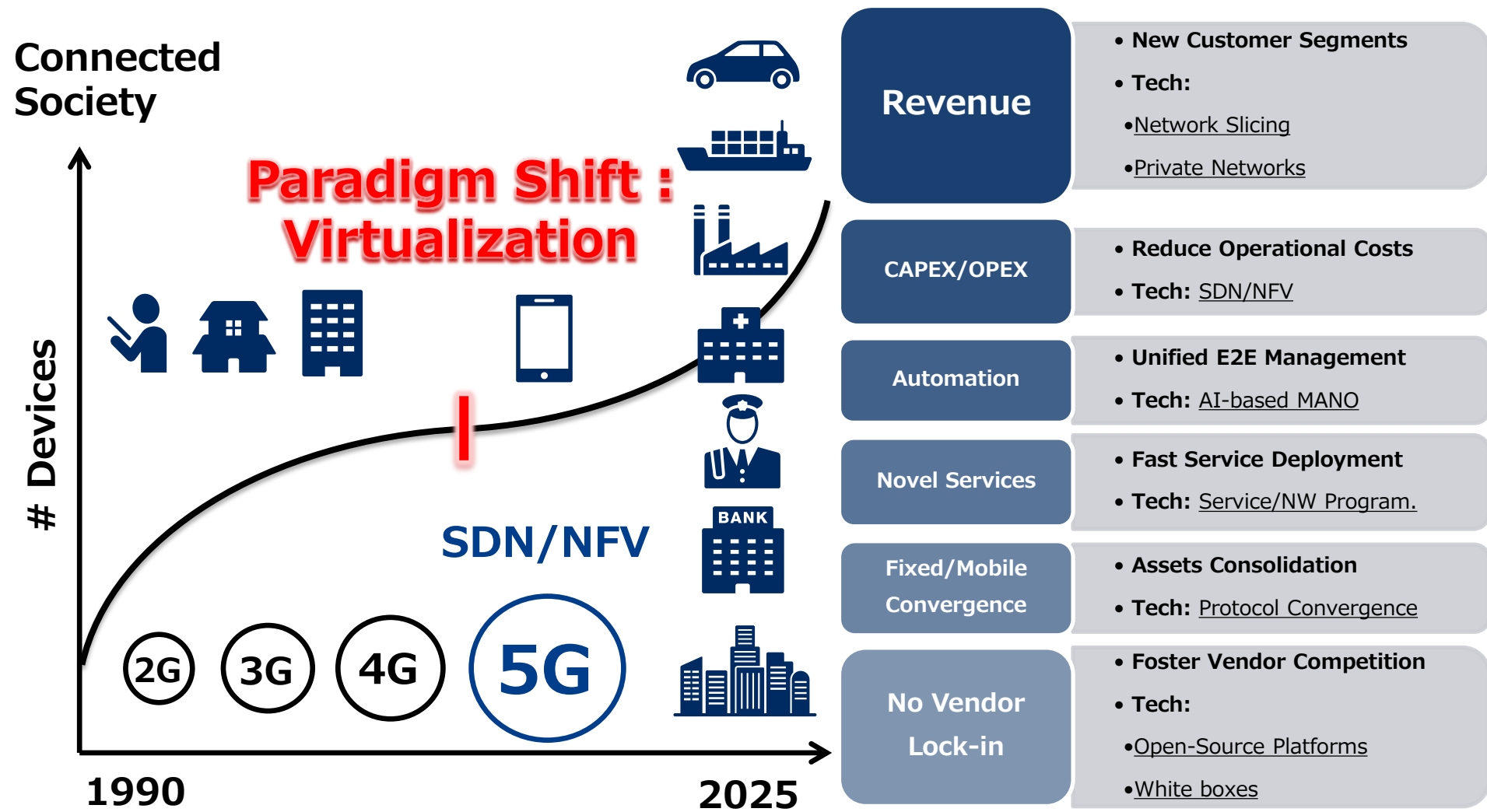
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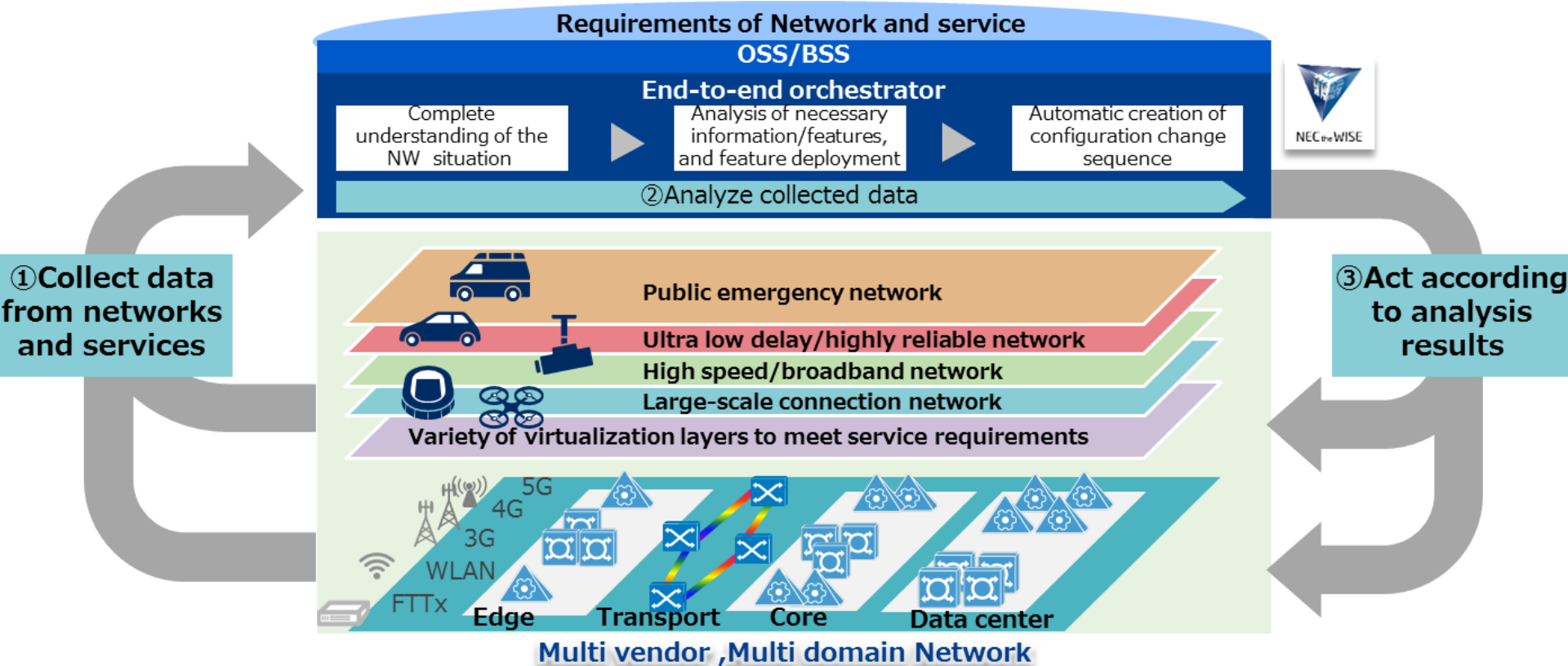
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5G for Verticals – Technology Disruption Point



5G Networks for Industry Verticals - Overview



5G Network Slice Broker

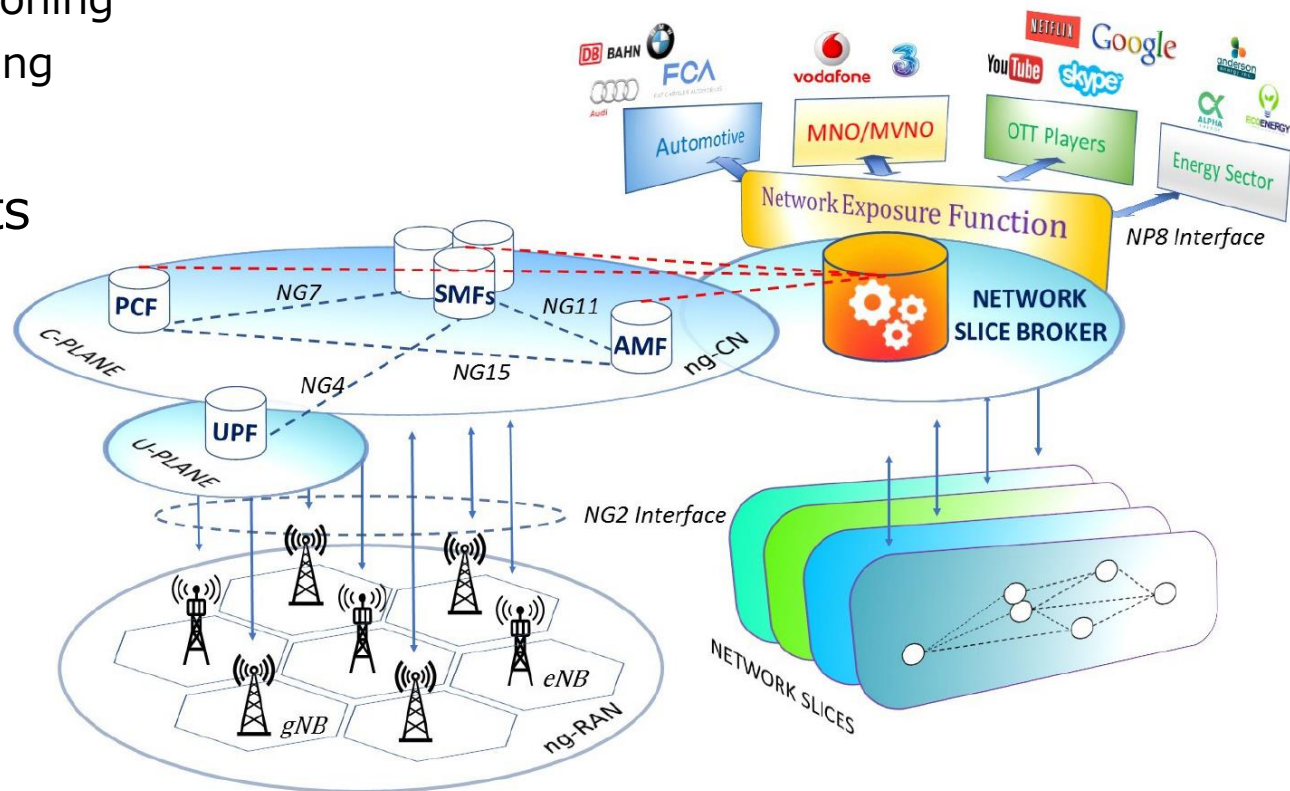
ONETS: On-demand 5G Network Slice Broker

Automated solution to decide in real-time on network slices requests

- Continuous Resource Forecasting and Learning
- Admission Control Decisions
- Network Slices Provisioning
- Per-Slice SLA Monitoring

3GPP Developments

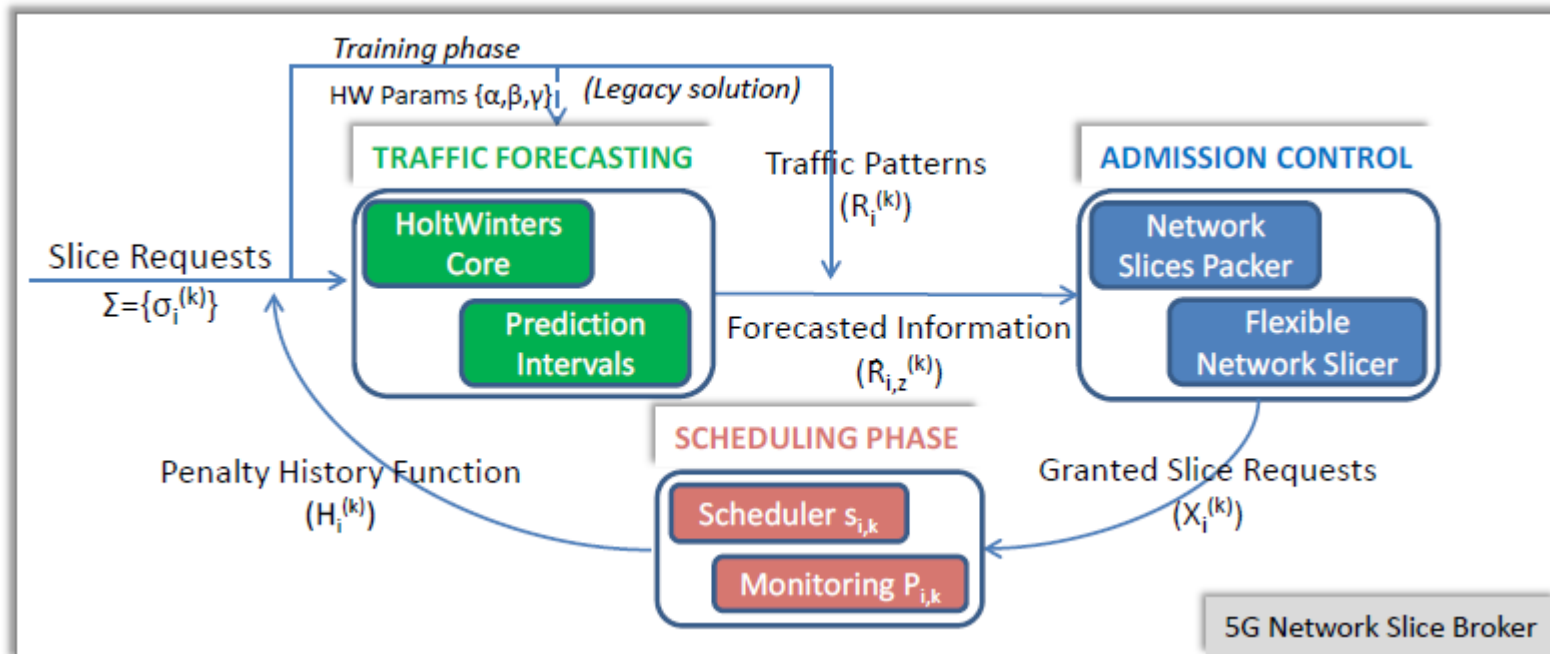
- SA2 Next Gen
- SA5 MANO



ONETS: 5G Network Slice Broker Solution

5G Network Slice Broker features:

- Resource monitoring: e.g., resource blocks, MCSs
- Machine Learning operations for traffic forecasting: online reinf. learning
- Admission Control for network slice requests (based on forecasting info)
- Support for multiple classes of Network Slices SLAs
 - Heterogeneous QoS traffic requirements (data rate, latency, ...)



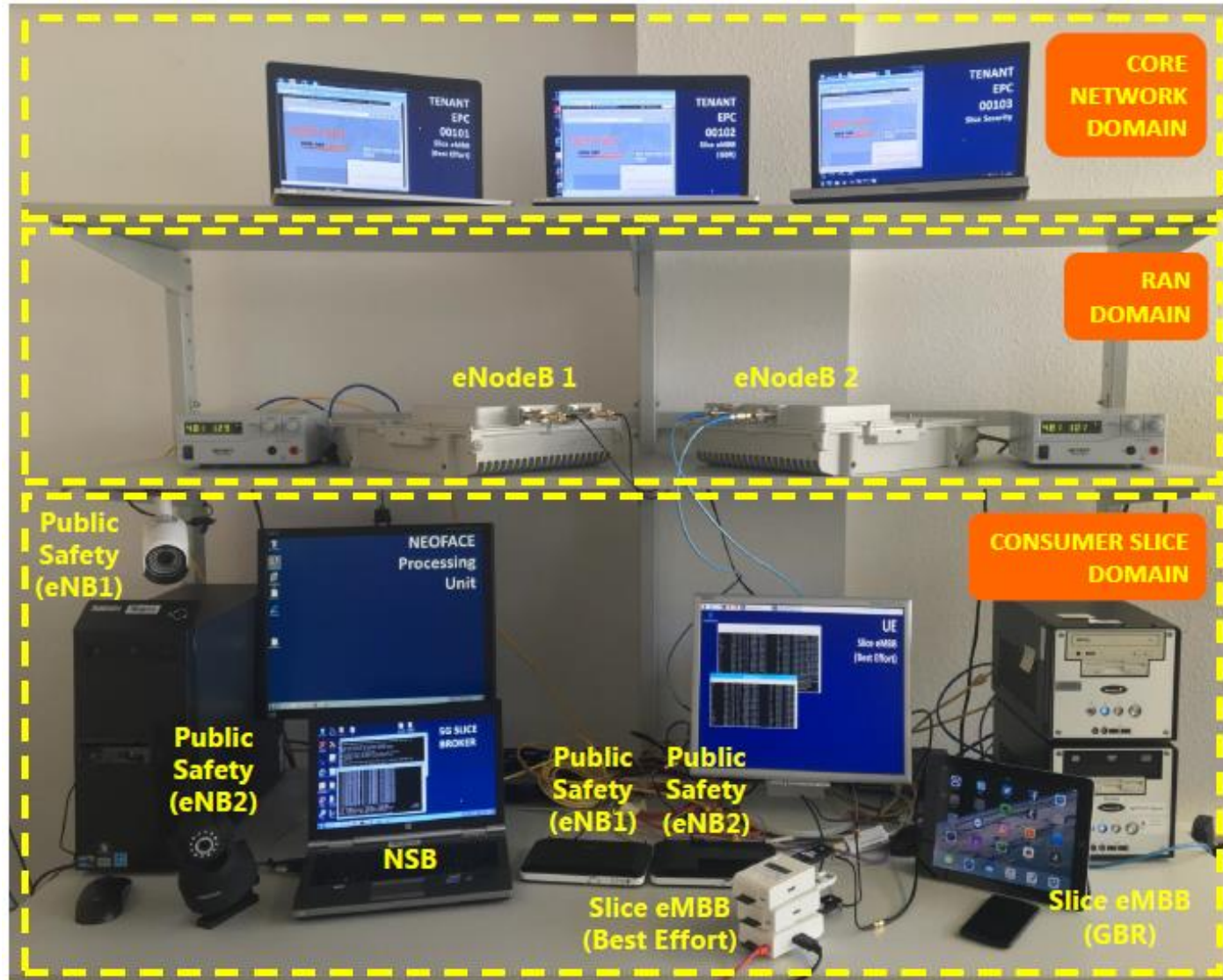
ONETS: 5G Network Slice Broker: Feasibility Study

2 eNBs

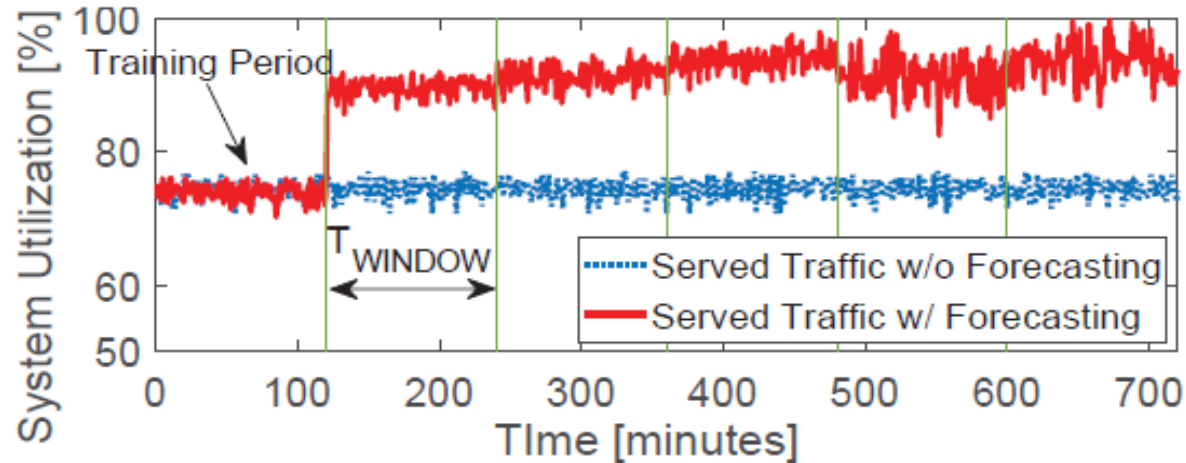
vEPC

3 slices

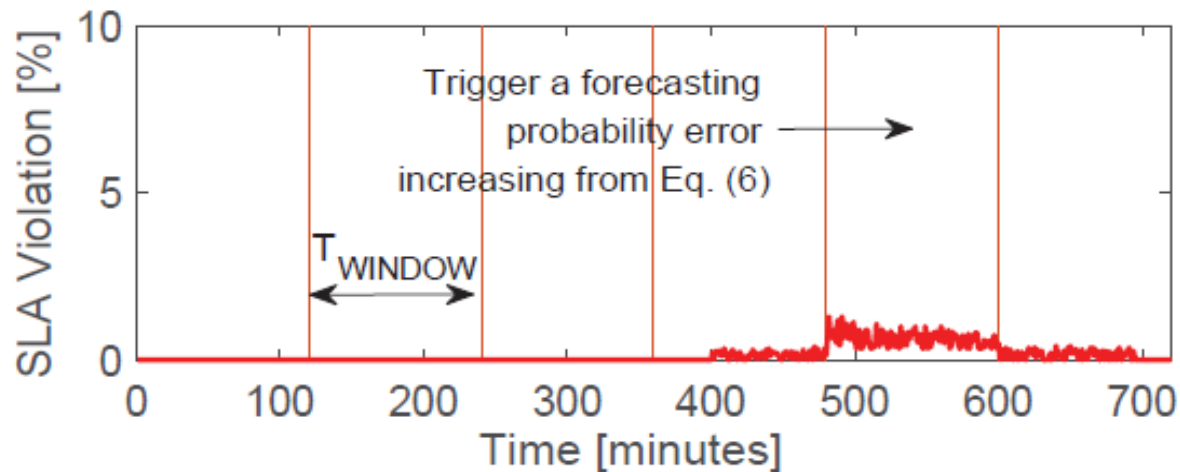
- eMBB – VoIP
- eMBB – FTP
- PS – NeoFace



ONETS: 5G Network Slice Broker: Feasibility Study



(a) System utilization



(b) SLA Violations

Mobile Traffic Forecasting for Maximizing 5G Network Slicing Resource Utilization, IEEE INFOCOM 2017

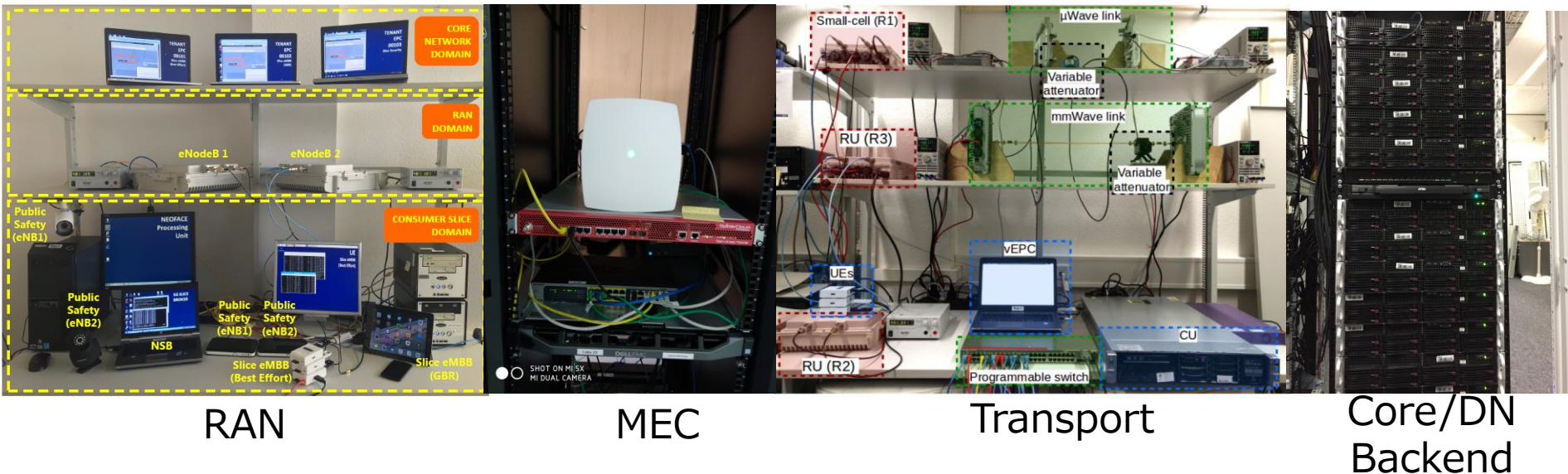
ONETS: 5G Network Slice Broker: Proof-of-Concept (PoC)

Dashboard



Next Steps: E2E On-demand Network Slicing

End-to-end Network Slicing Solution comprising





5G-TRANSFORMER

5G Mobile Transport Platform for Verticals



Project Overview (<http://5g-transformer.eu>)

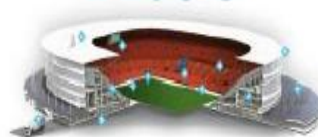
■ **Vision:** Mobile Transport Networks shall transform from today's rigid interconnection solutions into an **SDN/NFV-based 5G Mobile Transport and Computing Platform supporting diverse vertical industries.**

■ **Technical Approach:** bring “**Network Slicing**” into mobile transport networks by provisioning and managing slices tailored to the needs of verticals.

- Enable **Vertical Industries** to meet their service requirements within customized **network** (i.e. mobile transport infrastructure) **slices**;



Atos



Automotive

Healthcare

Media

M(V)NO

- Aggregate and **Federate transport networking and computing fabric**, from the edge up to the core and cloud, to create and manage **slices throughout a federated virtualized infrastructure.**

5G Transformer Project

5G Mobile Transport Platform for Verticals

- Vertical MANOs
- (Federated) Network Slicing

Verticals

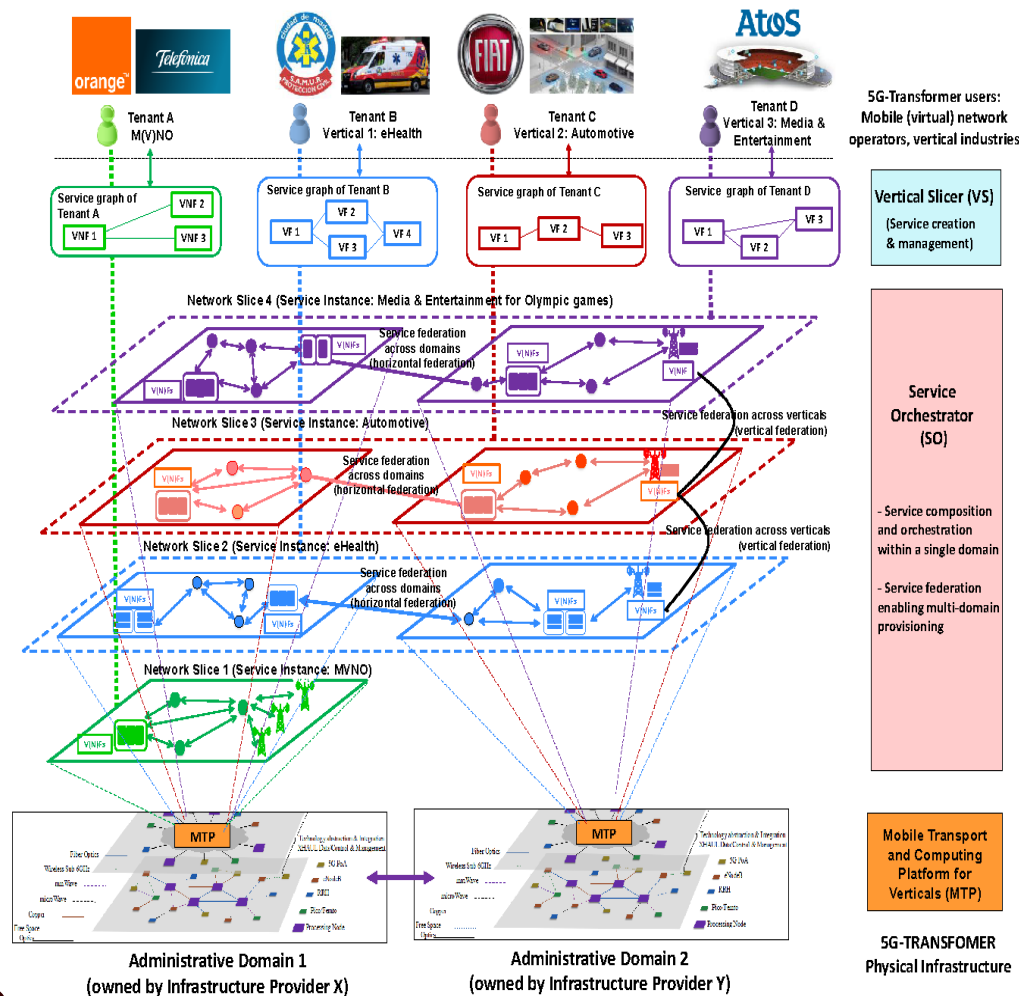
- Automotive: Chrysler Fiat
- E-Health: SAMUR (Emergency)
- Media: ATOS (Olympics)

Operators

- Telefonica
- Orange

Vendors

- NEC
- Ericsson
- Nokia



5G-Transformer users:
Mobile (virtual) network operators, vertical industries

Vertical Slicer (VS)
(Service creation & management)

Service Orchestrator (SO)

- Service composition and orchestration within a single domain

- Service federation enabling multi-domain provisioning

Mobile Transport and Computing Platform for Verticals (MTP)

5G-TRANSFORMER Physical Infrastructure



Why 5G for Connected and Automated Driving?

Social issues

- Need to reduce the number of traffic accidents, alleviate traffic jams, and implement efficient traffic systems
- Need to dynamically ascertain changes in road conditions (e.g. fallen objects, accidents and traffic jams/congestion)

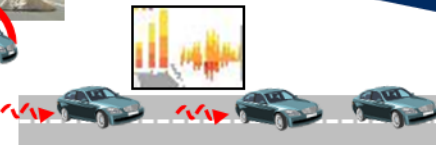
Solution

Real-time distribution of ITS data to widely disseminate road condition forecasts and offer greater safety and peace of mind when driving

Occurrence of unusual driving patterns
⇒ **Fallen object / accident detection**



Gathering of position and velocity data from multiple passing vehicles
⇒ **Traffic jam detection**



Detection of people & other objects



Server

- Fallen object / accident detection
- Traffic jam detection
- Road condition detection
- Detection of numbers of vehicle & people



Ascertain **road conditions** in real-time



Early-stage response measures



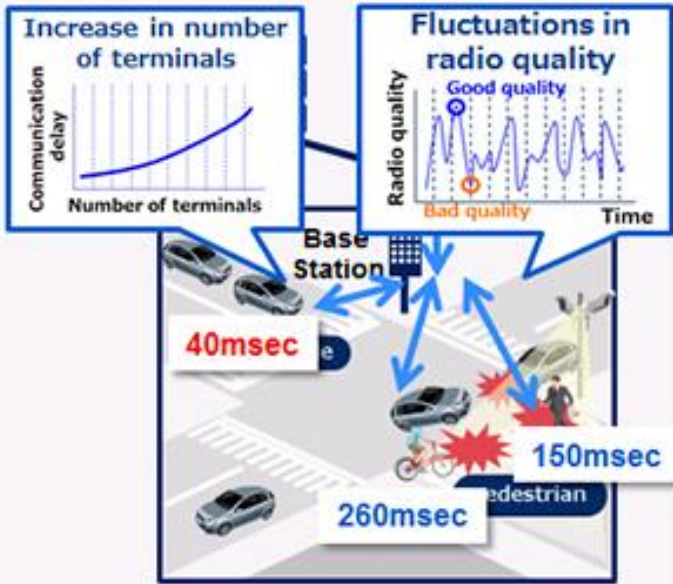
Real-time maps

Prioritizing Connected and Autonomous Driving Traffic

Adaptive Network Traffic Control Technology

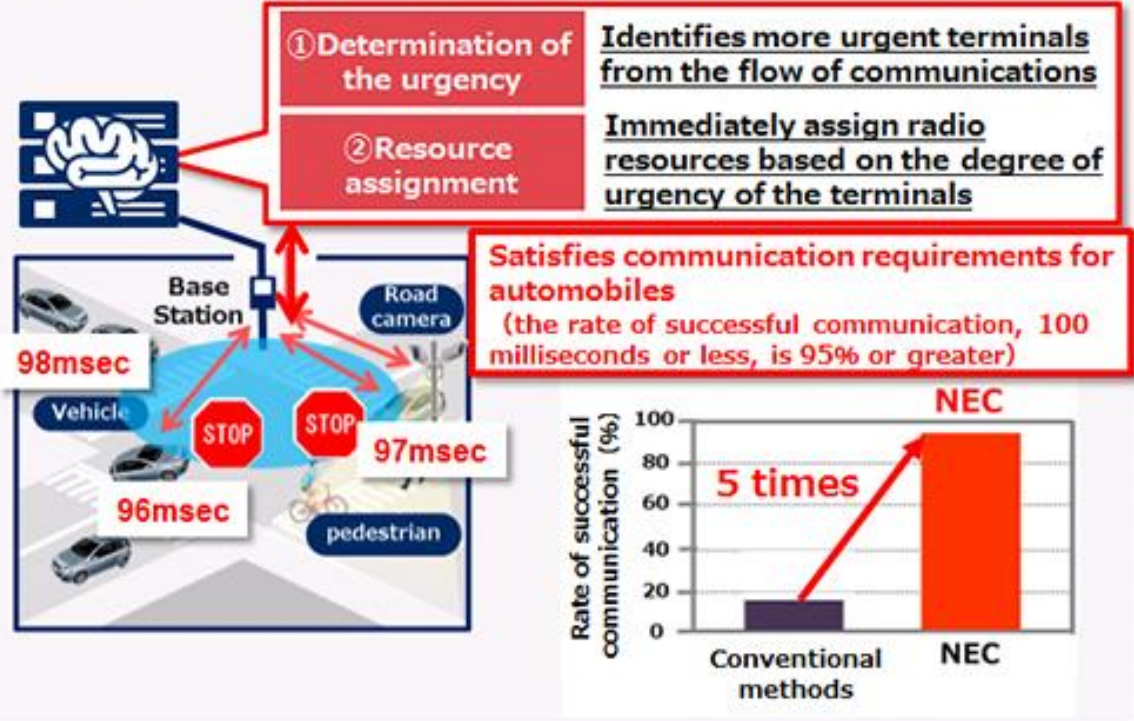
Before

The rising number of communication terminals and fluctuations in radio quality make it impossible to suppress fluctuations in communication delays



After

Fluctuations in communication delays are suppressed with the identification of more urgent terminals and with the immediate assignment of radio resources

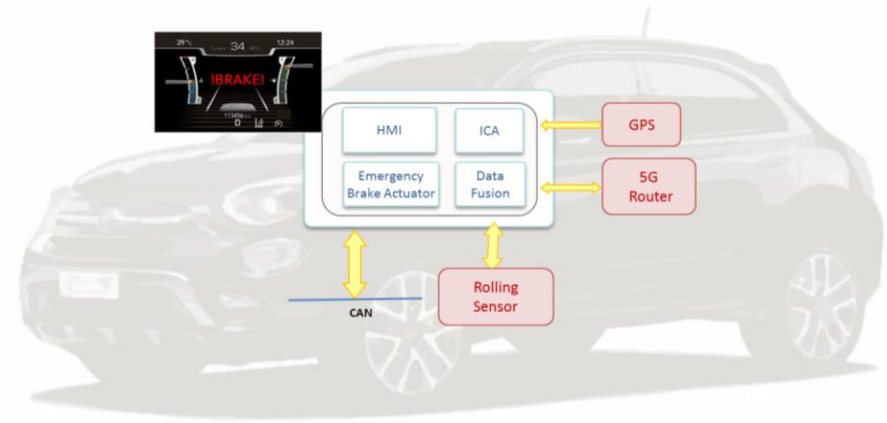
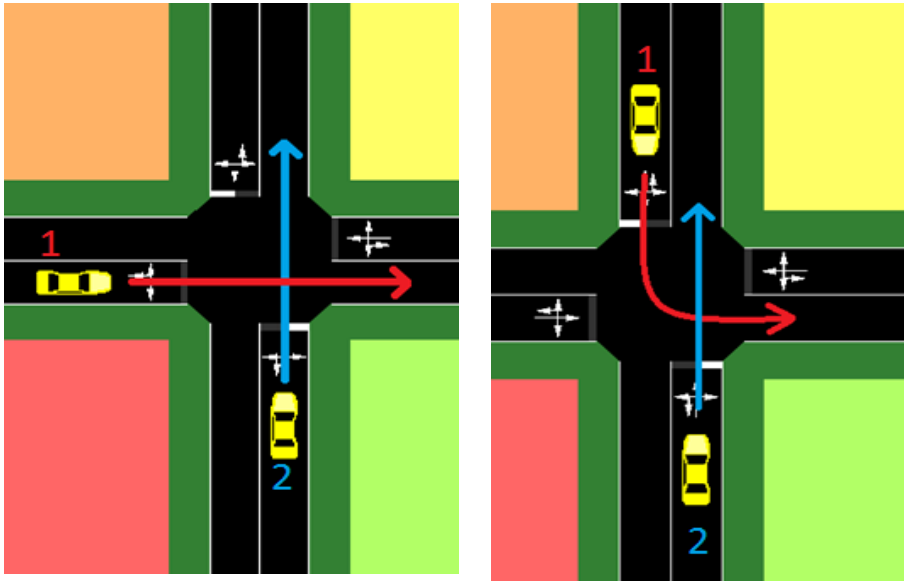


PR: https://www.nec.com/en/press/201802/global_20180205_02.html

Intersection Collision Avoidance

Performance Improvement Benchmarking Efforts

- V2V Time-to-Brake vs
- V2X Time-to-Brake



CENTRO
RICERCHE
FIAT



5G for Verticals in Action – Remote Construction



- **5 Cameras**
 - 2 4K cameras
 - 1 2K omnidirectional
 - 2 2K overhead cameras
- **Images transmitted to the remote operations room by**
 - Massive-element active antenna system
 - Beamforming
 - 28 GHz Band



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