Autonomous Cars, 5G Mobile Networks and Smart Cities: Beyond the Hype

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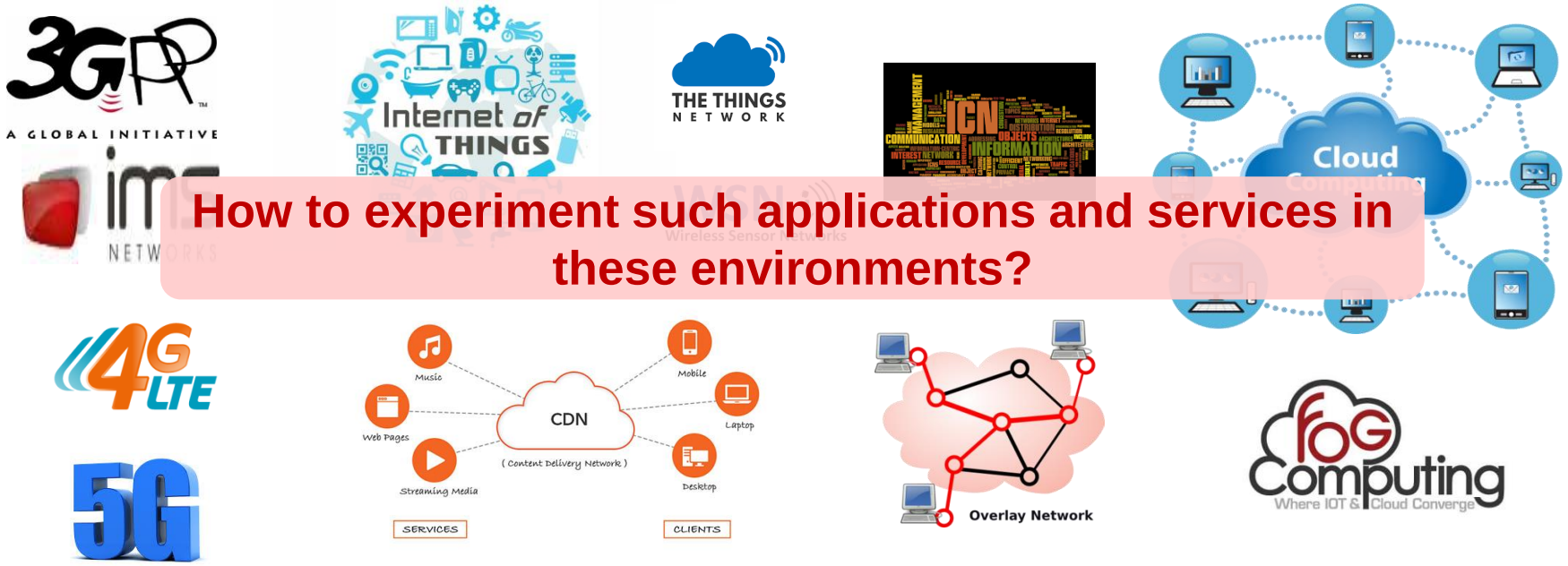
Research Scope

Target Nodes/Networks for Provisioning are Getting More and More Distributed, Dynamic, and Heterogeneous



How to experiment such applications and services in these environments?

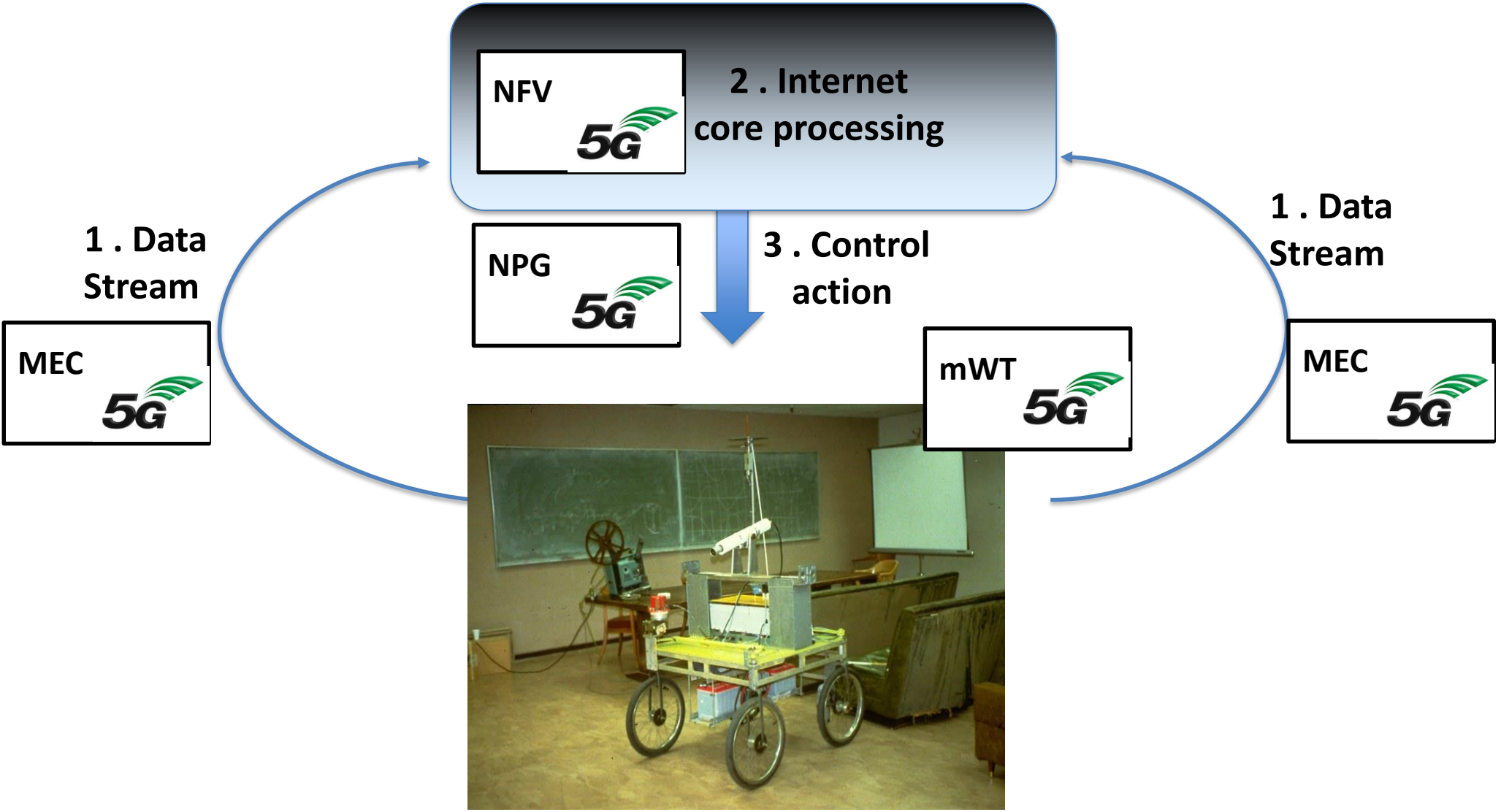
Research Scope (Cont.)

- **Application-level**
  - Applications topology: Component-based applications, service-based applications, business processes
  - Taking into account applications structures and applications lifecycle management
  - Models/Languages: SCA, BPEL, BPMN, Petri nets
- **Platform-level (Cloud, IoT, fog, mobile edge)**
  - Unified cloud resources description model, scalable and elastic micro-containers, generic provisioning operations
  - Standards: OCCI, TOSCA, REST
- **Network-level (3GPP 4G, 5G, CDN)**
  - Decompose the network into micro-domains, the use of overlay networks and gateways, virtualize the network functions, extend the ecosystem to the edge of the network
  - Technologies: NFV, SDN

5G Building Blocks (ETSI perspective)

- Network Functions Virtualization (NFV)
- Multi-access Edge Computing (MEC)
- Millimetre Wave Transmission (mWT)
- Next Generation Protocols (NGP)

Autonomous Cars in 5G Networks



Experimentation (Latency)

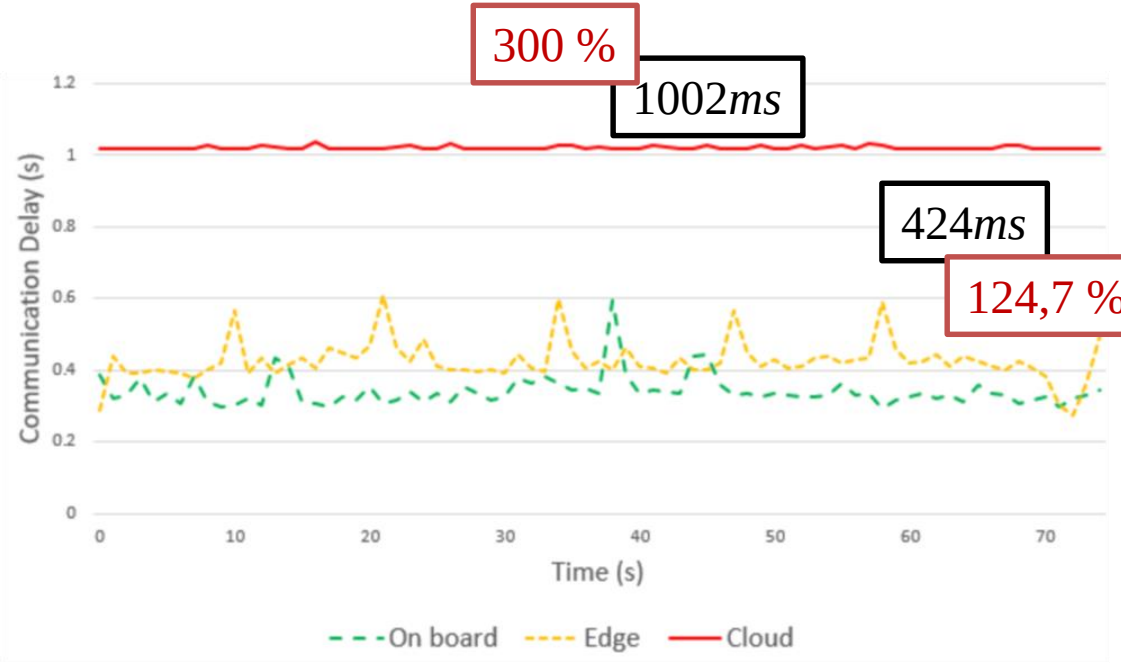
Experimentation Objective:
- Evaluating the gain in terms of latency.

Experimentation Metric:
- End to End Delay.

Experimentation Scenario:
- Comparing delays while varying placement domain.

Lesson learned:
- The first lesson learned is that placing components at the edge considerably reduce latency with regard of a placement in core network.

$$End\ to\ End\ Delay = Execution\ Time + Latency\ Delay$$



Experimentation (Mobility support)

Experimentation Objective:

- Evaluate the migration cost in terms of delay.

Experimentation Metric:

- The Migration duration (Md): the necessary time to(i) instantiate and start the hosting container in the target edge (t_i) and (ii) shut down the first container in the source edge node (t_s)

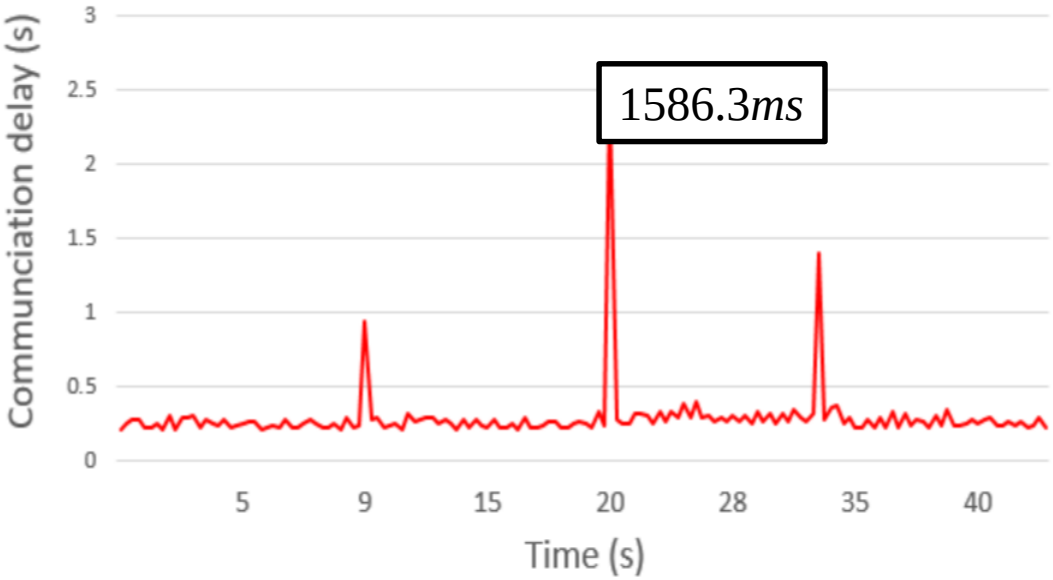
Experimentation Scenario:

- The car, while cruising, it sends a migration order to the Collecting-data module that needs to move from one edge node to another while still communicating with the Navigation module.

Lesson learned:

- Migration duration does not affect the good functioning of the autonomous car application under certain circumstances…

$$Migration\ duration = \ t_i + t_s$$



Experimentation (Transport Protocols)

Experimentation Objective:

- Investigate the suitability and the robustness of SIP as a signaling protocol for such highly dynamic environment.

Experimentation Metric:

- SIP packets per second

Experimentation Scenarios:

- Four scenarios were considered with various number of cars (one to five) making simultaneous SUBSCRIBE requests to the same OpenSips instance within a given PoP.

Lesson learned:

- SIP messaging is not suitable signaling protocol for such system.
- SIP 5G specification expects to support dynamicity and mobility of end devices which is not feasible using SIP as a signaling protocol.