An optimized application-context relocation approach for Connected and Automated Mobility (CAM)

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Outline

1. Introduction and Background
2. Application-context relocation
3. Proof-of-concept
4. Conclusion

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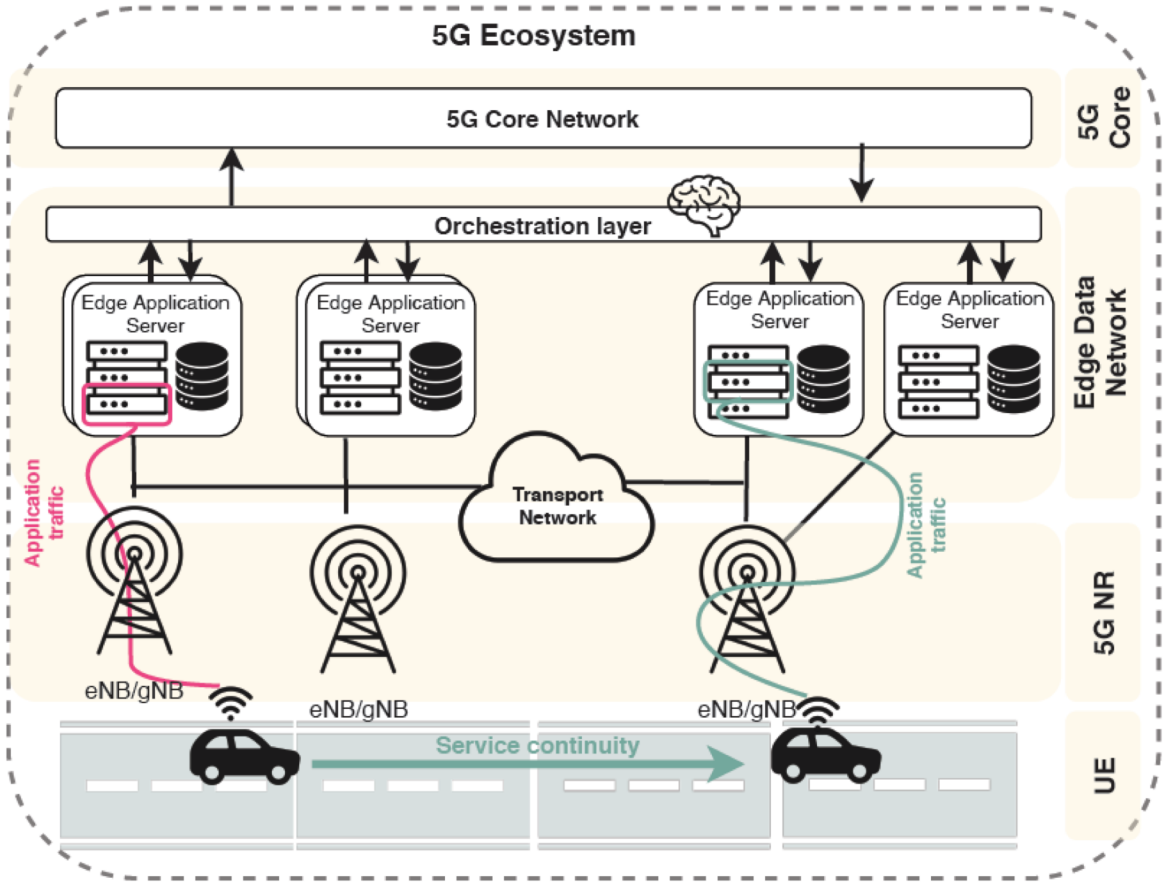
Introduction and Background (1/2)

- managed and orchestrated edge infrastructure environment → part of the 5G ecosystem
  - Multi-Access Edge Computing (MEC) infrastructure
- vehicle connects to CAM services to retrieve contextual driving information
- high mobility → service relocation needed
- 3GPP Architecture for Enabling Edge applications and ETSI NFV MANO



Introduction and Background (2/2)

- how and when to perform application-context relocation?

- MEC Application Orchestrator (MEAO)
  - prediction of resource availability in NFV infrastructure, i.e., MEC hosts → Long Short-Term Memory (LSTM)
  - TOPSIS algorithm from MCDM group to decide on application placement
    - predicted resource availability
    - latency and bandwidth on the communication link
    - geographical location of vehicle and MEC hosts

- Proof-of-Concept in real-life testbed: Smart Highway and Virtual Wall

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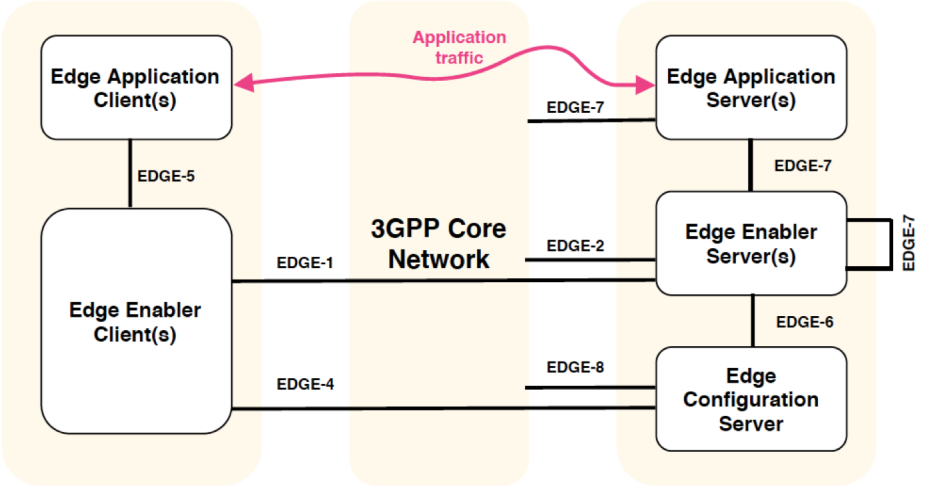
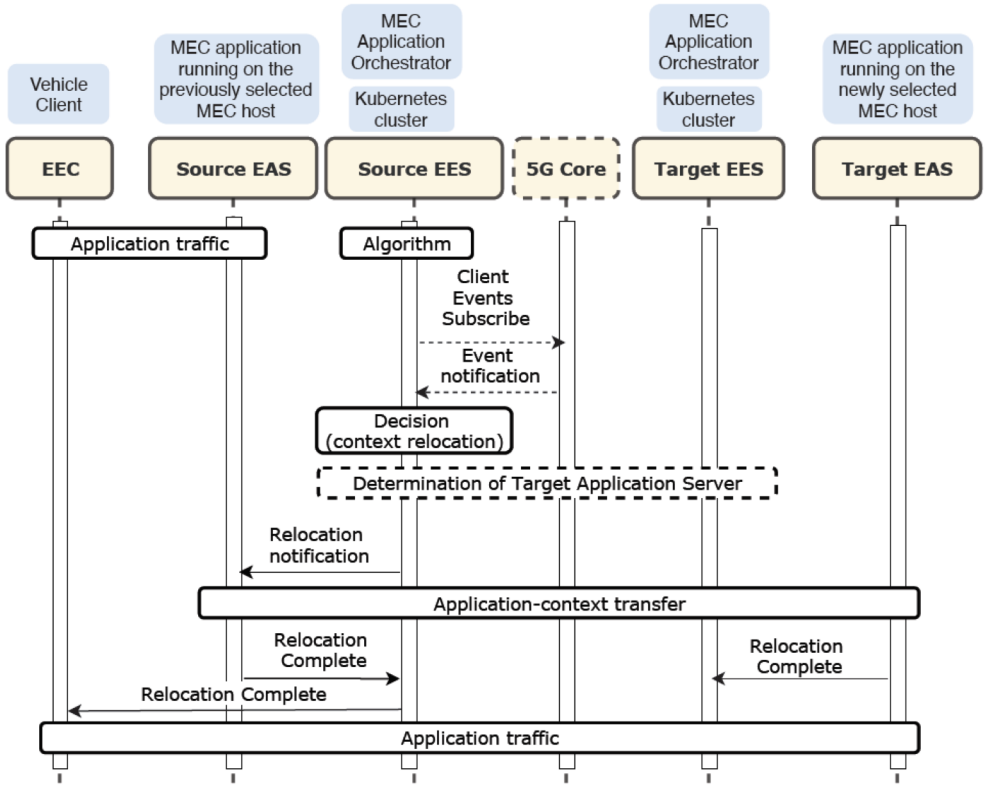
Application-context relocation

Management and Orchestration Framework

- Release 17: 3GPP Architecture for Enabling Edge Applications
- mutual awareness between edge client applications and edge data network
  - Edge Enabler Client (EEC): Vehicle client
  - Source/Target Edge Application Server (EAS): MEC application
  - Source/Target Edge Enabler Server (EES): MEC application orchestrator + Kubernetes cluster
- EDGE-1/EDGE-4 reference points between vehicle and edge infrastructure
- EDGE-2/EDGE-7/EDGE-8 reference points between 3GPP Core and edge infrastructure

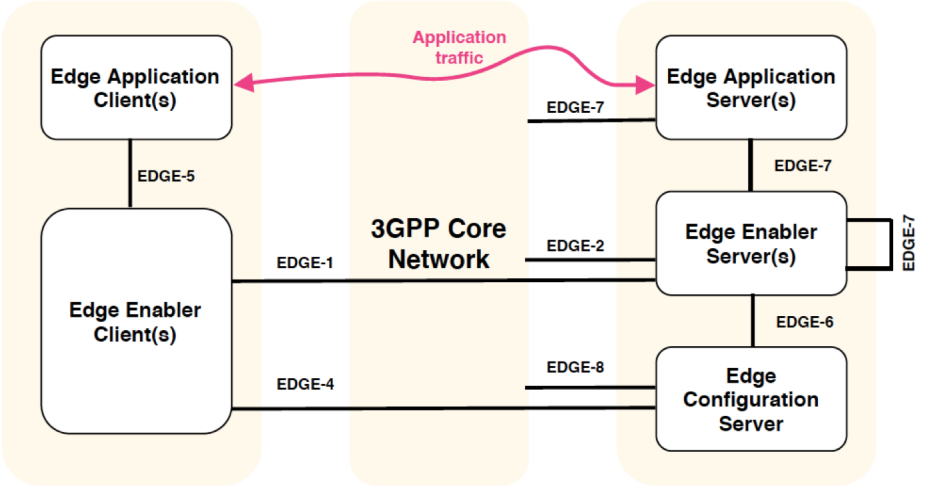


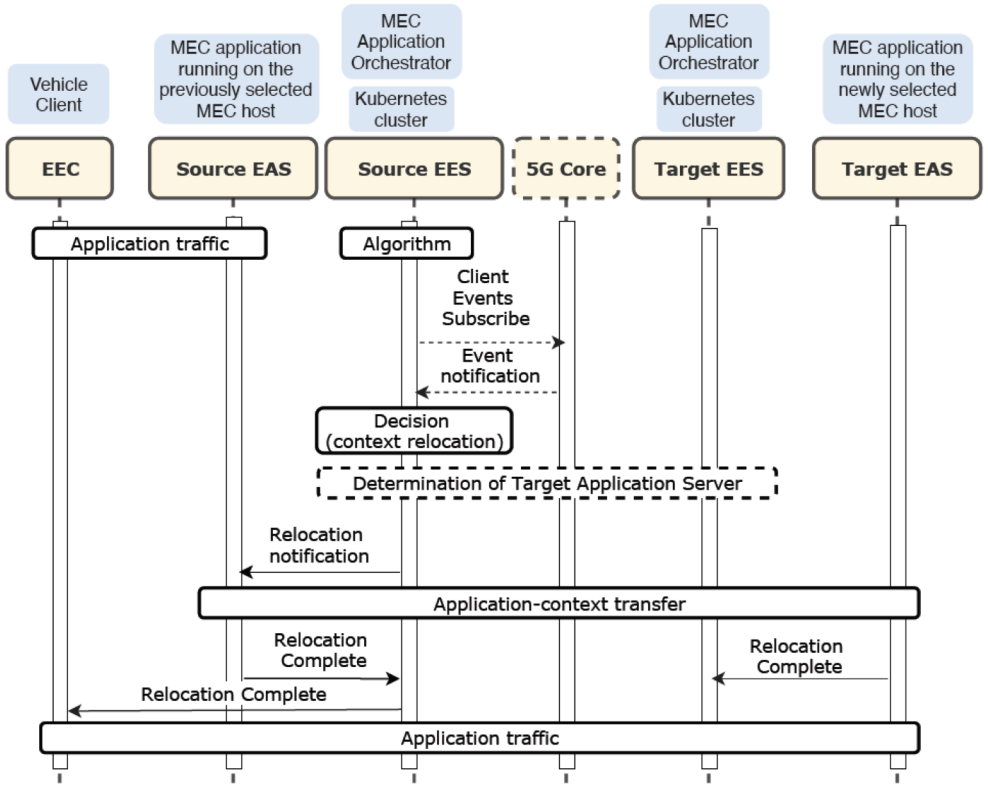


Application-context relocation

Optimized MEC host selection

- transfer of application-context from one edge to another:
  - identification of a corresponding target MEC host
  - performing transfer of application-context
  - reconfiguration of traffic rules and management policies
  - setting up a new communication path to the vehicle
- MCDM analysis and LSTM prediction help MEC orchestrator to make decision whether application-context should be transferred





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Proof-of-concept

Experimentation setup

- Virtual Wall, a testbed for large networking and cloud experiments, located in Gent, Belgium

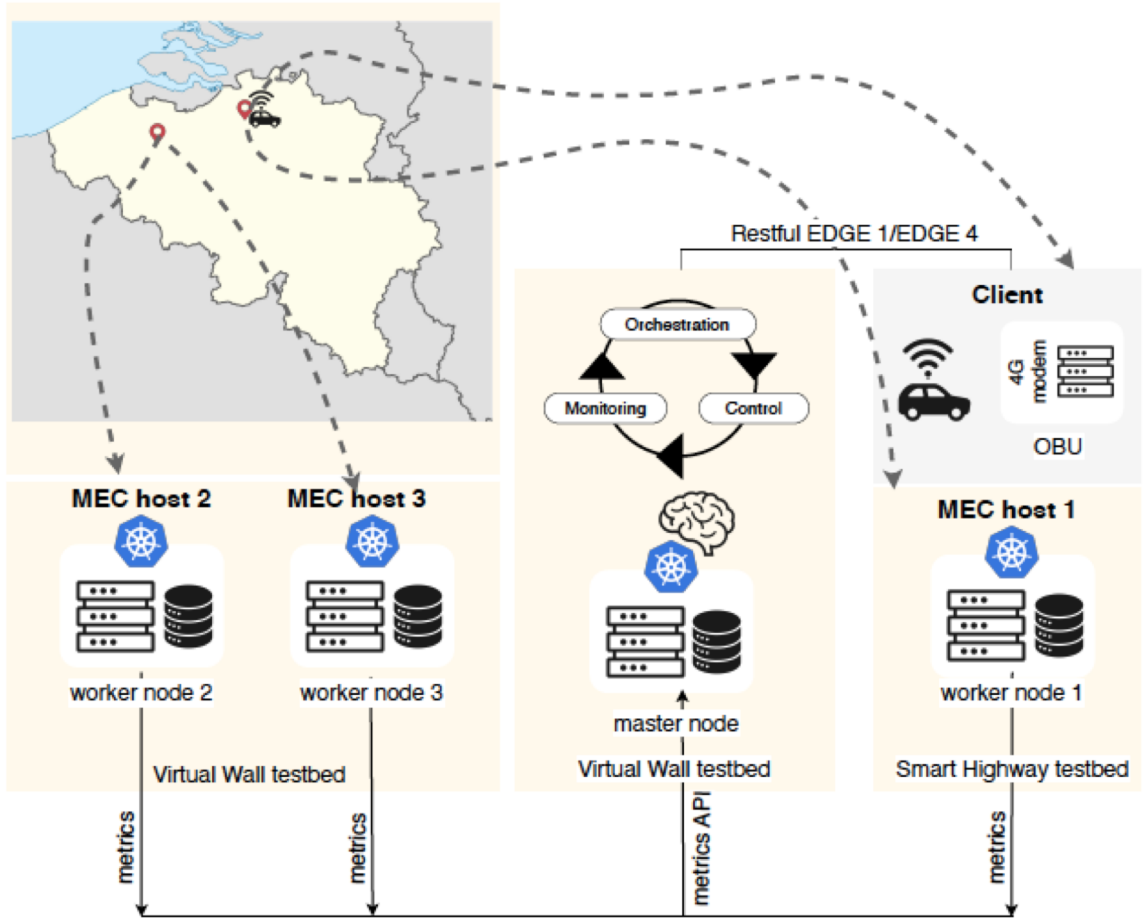
- Smart Highway, a test site built on top of the E313 highway for the purpose of Vehicle-to-Everything (V2X) research
- distributed edge cloud environment – MEC hosts (1, 2, and 3) + vehicle (OBU and 4G modem)

PoC information				
Type	**MEC host 1 RSU**	**MEC host 2**	**MEC host 3**	**Vehicle NUC**
Testbed	Smart Highway	Virtual Wall	Virtual Wall	Smart Highway
Location	Antwerp	Ghent	Ghent	Antwerp
CPU (GHz)	1.280	2.252	2.252	1.9
RAM (GB)	32	48	48	8
Processor	Intel(R) Xeon(R) CPU E5-2620 v4 @ 2.10GHz	2x 8core Intel E5-2650v2 @ 2.6GHz	2x 8core Intel E5-2650v2 @ 2.6GHz	I7-8650U
Storage (GB)	1024	250	250	8

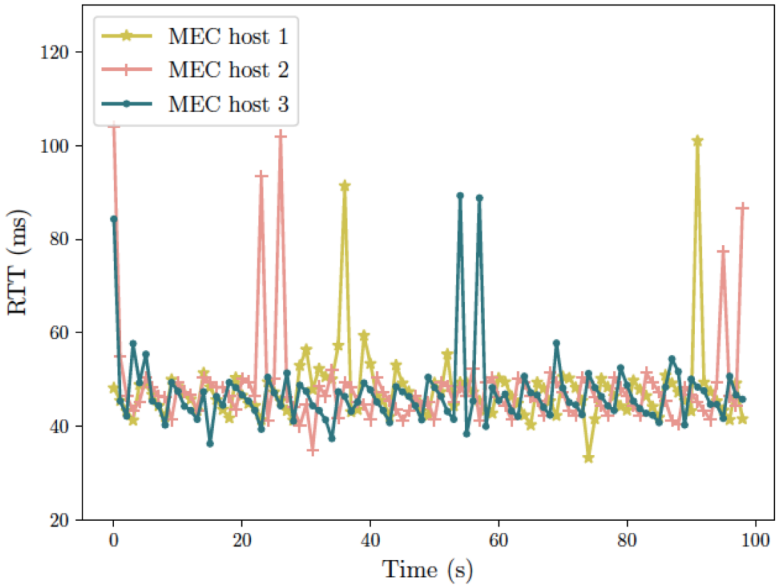
- Kubernetes cluster: worker nodes (MEC hosts) and master node (separate machine on Virtual Wall) with MEC application orchestrator
- client: Docker-based web application

Proof-of-concept

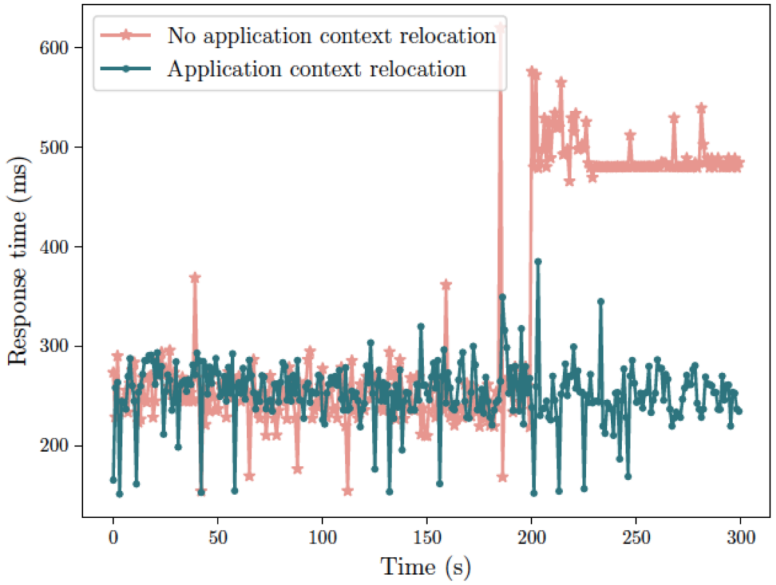
Results



(a) PoC setup.



(b) RTT.



(c) Response time.

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Conclusion

- management and orchestration framework for vehicular communications, based on the 3GPP architecture for enabling edge applications and ETSI NFV MANO presented
- enabling service continuity for CAM services by performing an optimized application-context relocation from one edge host to another
- vehicle connects to most suitable application server to retrieve important information about driving conditions on the road
- autonomous vehicles to derive decisions about maneuvering without assistance from the driver
- optimized and proactive application-context relocation helps to improve overall response time → preventing longer delays that cause outdated information about conditions on the road

Acknowledgement

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