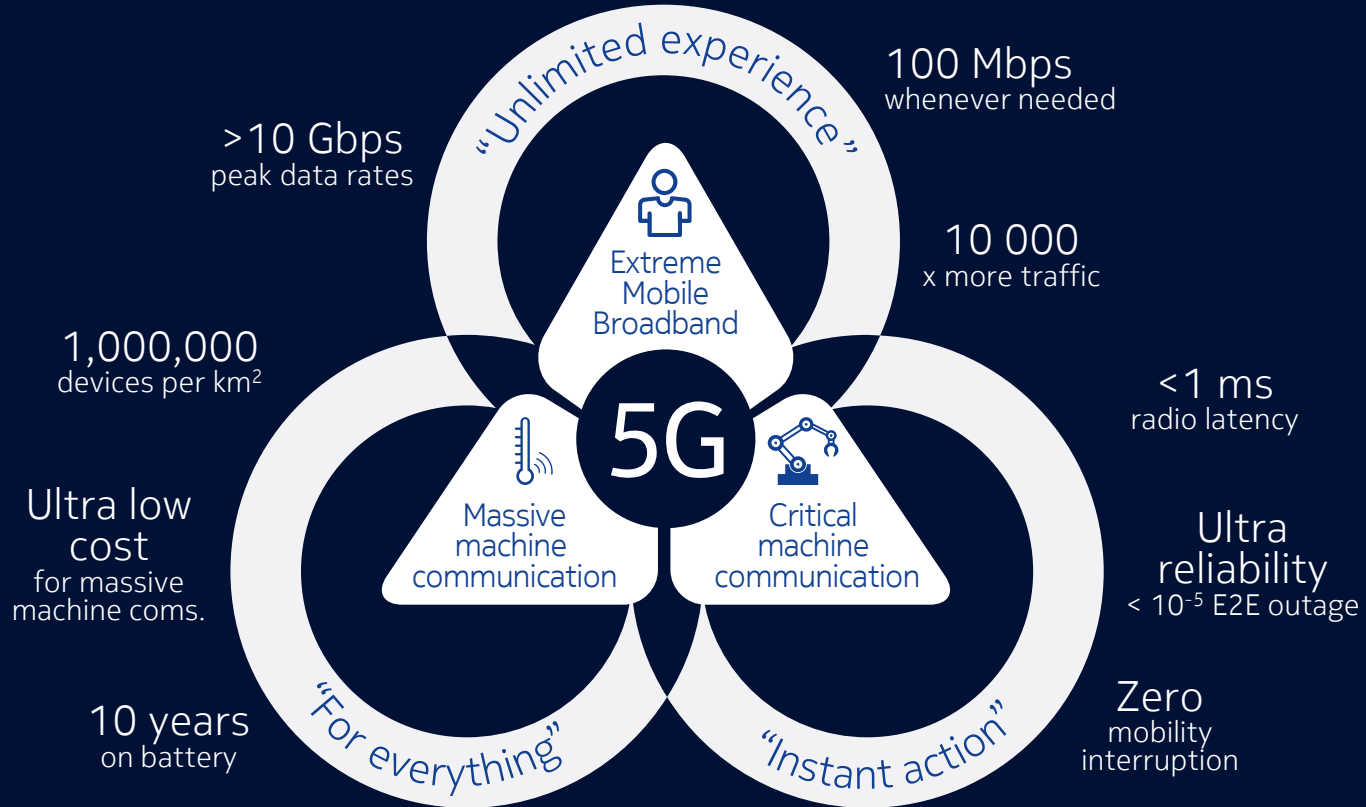


# 5G enabled autonomous cars

An overview on ETSI research groups that will help build the foundation for 5G tactile internet

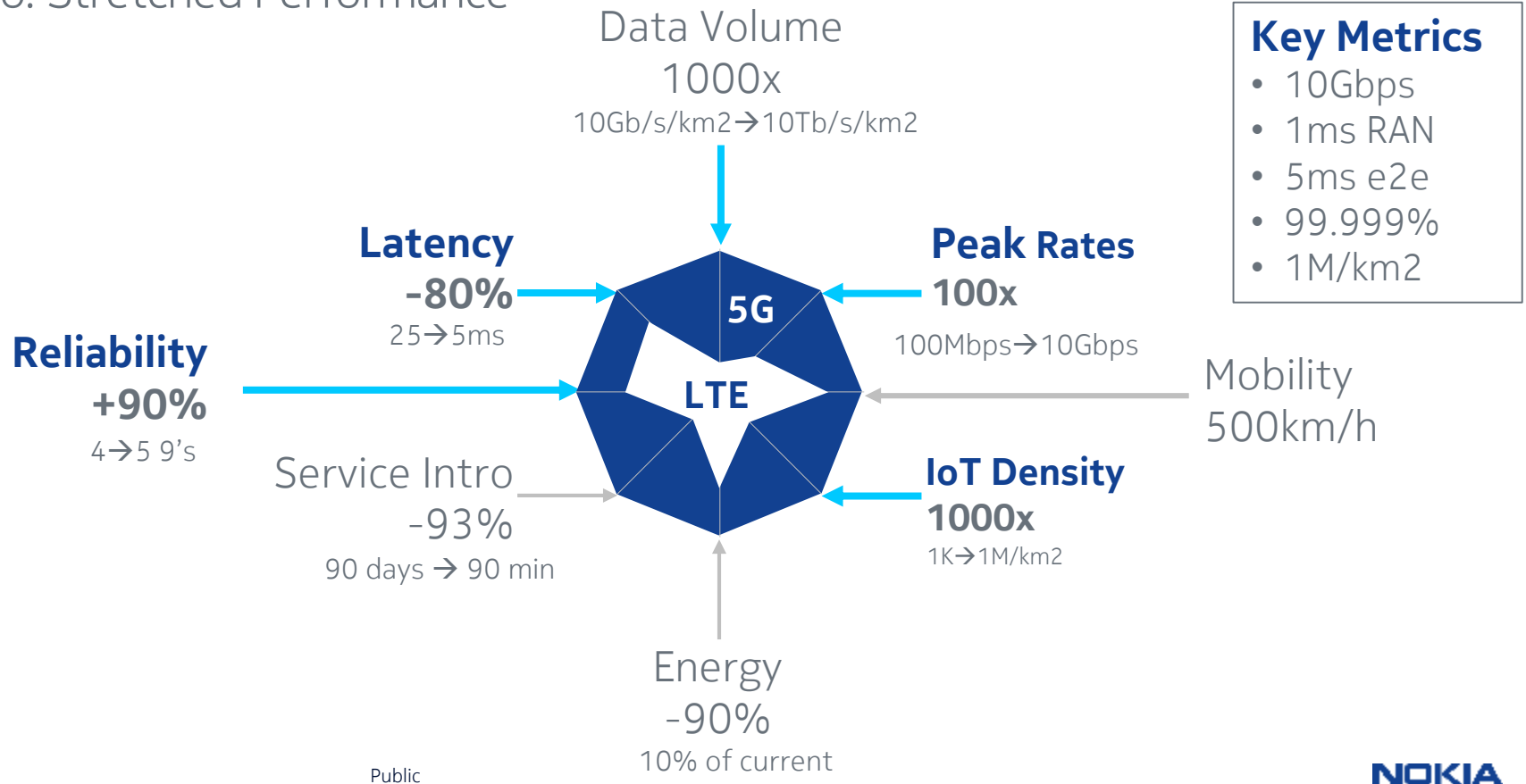
- Manuel P. Martínez
- 04-10-2016

# 5G will change the world



# Differences between 5G and LTE

## Two: Stretched Performance



# 5G for people and things

Expanding the human possibilities of technology



# 5G use cases - use case evolution towards 5G

## • 5G business starts now

### Automotive

- 1.2 million lost lives
- 90% of crashes by human error
- Time and energy waste by traffic
- Industry to re-define mobility

### Assisted driving

- Vehicle hazard warnings
- HD location updates and situational awareness for intelligent vehicles
- Automated traffic and parking steering

### Automated driving

- Cooperative advanced cruise control
- Vehicle Platooning
- Smart intersection control
- Dynamic environment zones

### Health

- 52 million deaths by non communicable diseases in 2030
- Aging societies - leveraging remote medical support

### Predictive health surveillance

- Remote diagnostic surveillance and risk assessment
- Early disease forecasting

### Remote treatment

- Robot assisted examination and tele-consultation in 4D and 5D
- Remote surgeries

### Events and tourism

- Tourism is 9.8% of world GDP with growing competition
- Event visitors expect better connectivity and apps

### Augmented location experience

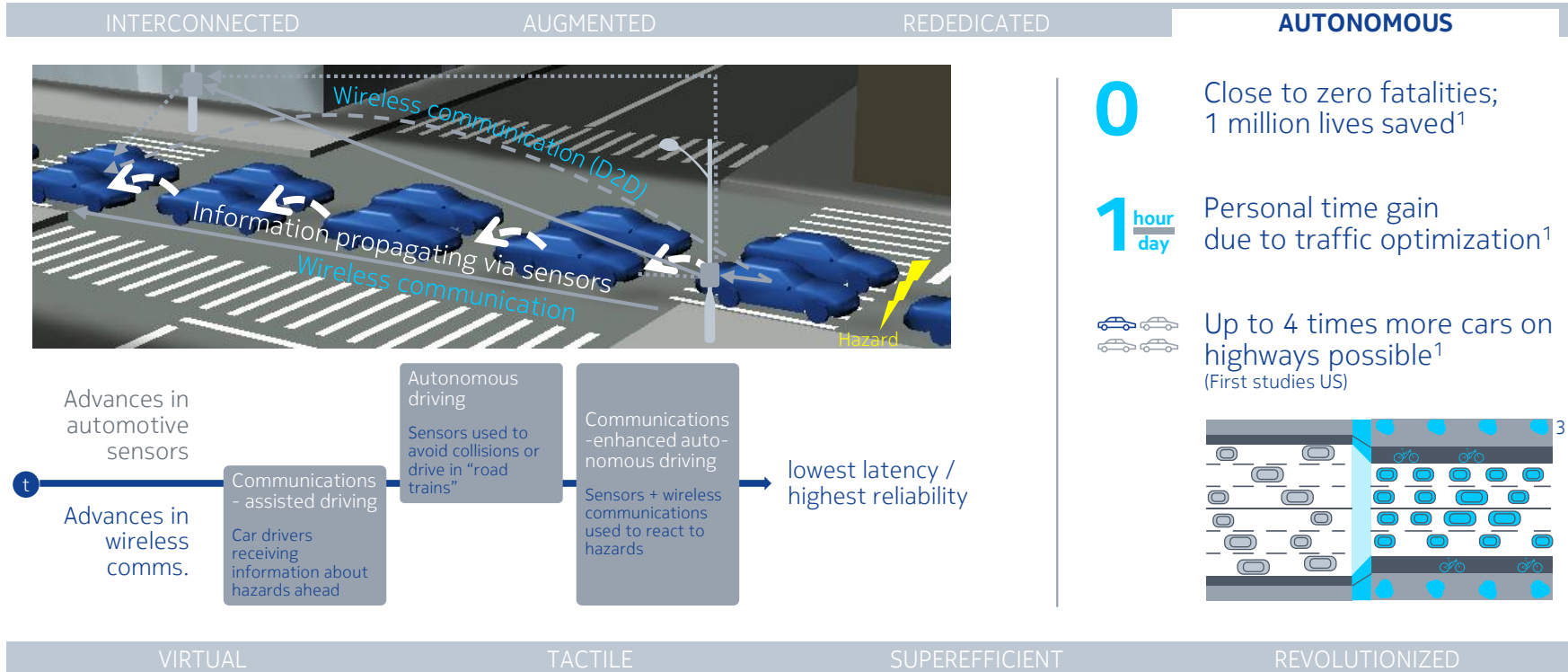
- Location finder
- Multicast
- Video replay on-demand
- Augmented reality

### Freely selectable 3D views

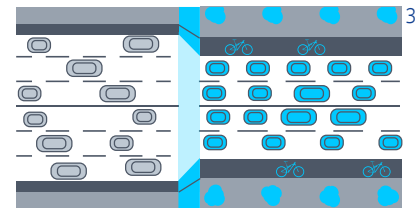
- Freepoint viewing
- Player perspective
- Virtual reality

# Autonomous cars

# Transforming urban space: autonomous vehicles



- 0** Close to zero fatalities; 1 million lives saved<sup>1</sup>
- 1 hour day** Personal time gain due to traffic optimization<sup>1</sup>
-  Up to 4 times more cars on highways possible<sup>1</sup> (First studies US)



ETSI NFV MANO

Network Function Virtualization – Management & Orchestration



# ETSI NFV MANO

## Network Function Virtualization – Management & Orchestration

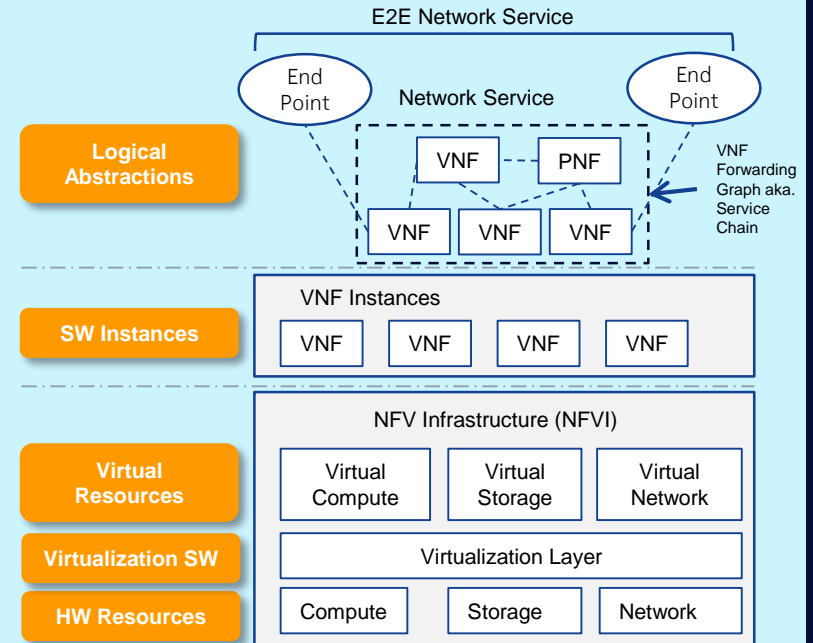
### Concept

- Follow IT “Softwarization” trend
- Turn physical network functions into pieces of software (Virtual Network Functions)
- An ISG (Industry Specification Group) has been created back in 2012
- MANO: Management and Orchestration

### For Operators

### For 5G

### Overview



# ETSI NFV MANO

## Network Function Virtualization – Management & Orchestration

Concept

For Operators

For 5G

Overview

- Vendor locking
- CAPEX
- OPEX
- Energy consumption

# ETSI NFV MANO

## Network Function Virtualization – Management & Orchestration

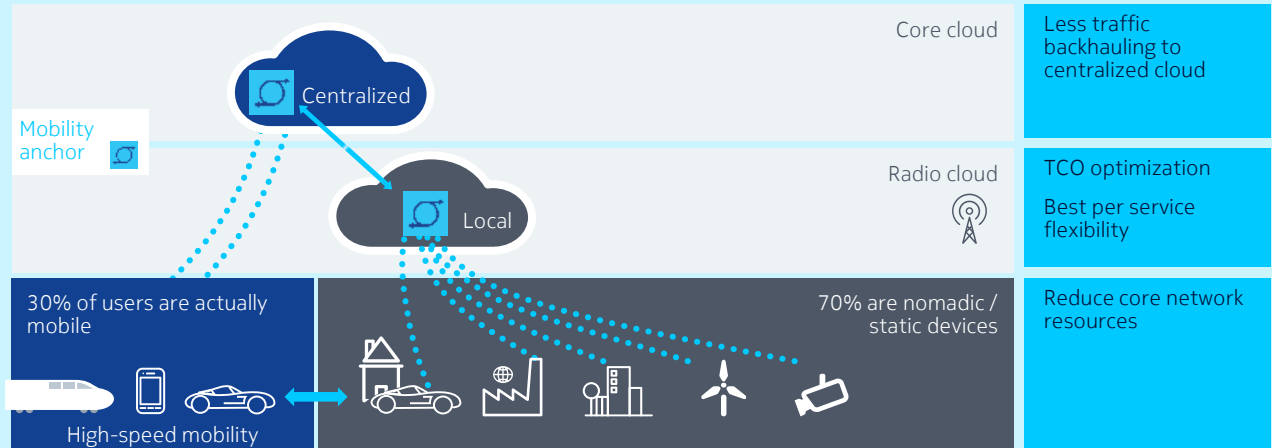
Concept

For Operators

For 5G

Overview

- Ensure connectivity
- QoE
- Availability
- Mobility on demand



# ETSI NFV MANO

## Network Function Virtualization – Management & Orchestration

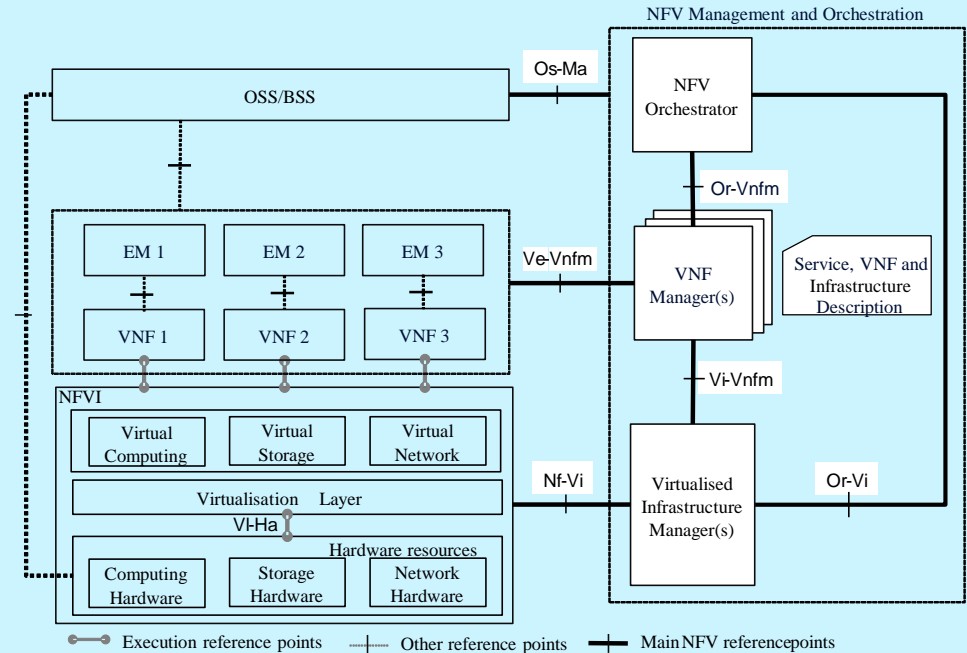
Concept

For Operators

For 5G

Overview

- VNF** Virtualized Network Function
- NFVI** NFV Infrastructure
- NFVO** NFV Orchestrator
- VNFM** VNF Manager
- VIM** Virtualized Infrastructure Manager



# ETSI MEC

## Mobile Edge Computing

# ETSI MEC

## Mobile Edge Computing

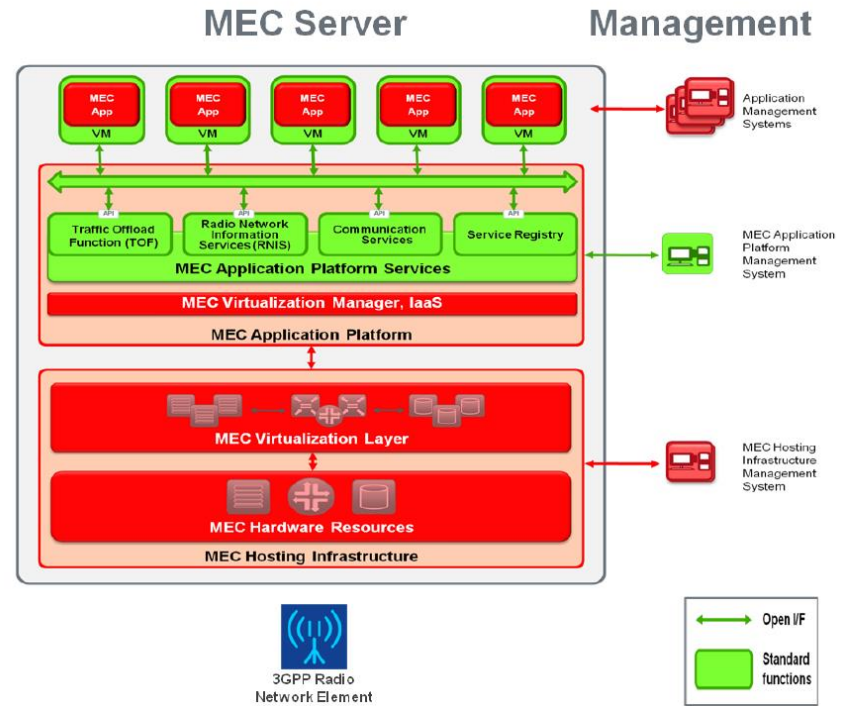
### Concept

- Open mobile network edge computing resources to third party applications.
- New environment with exciting characteristics:
  - Proximity
  - Ultra-low latency
  - High bandwidth
  - Network information
  - Location awareness
- An ISG (Industry Specification Group) has been created in 2014

### For Operators

### For 5G

### Overview



# ETSI MEC

## Mobile Edge Computing

Concept

For Operators

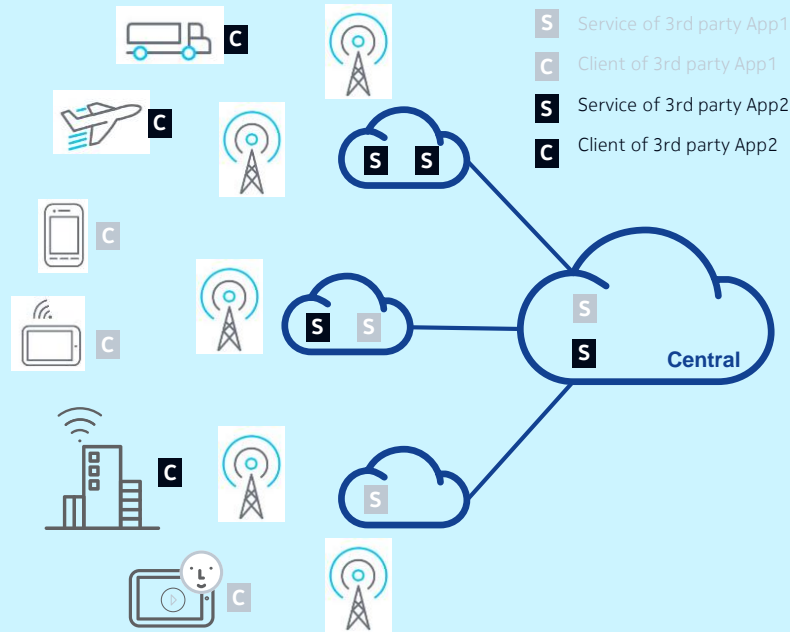
For 5G

Overview

Ability to deploy own applications next to users

Reduce backhaul traffic

New revenue streams



# ETSI MEC

## Mobile Edge Computing

### Concept

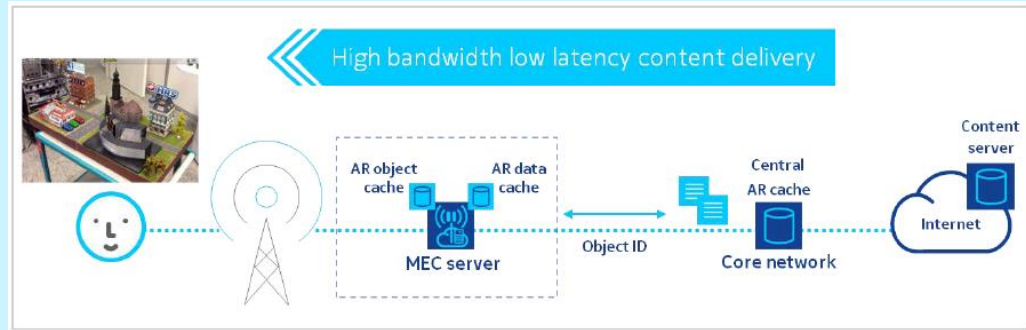
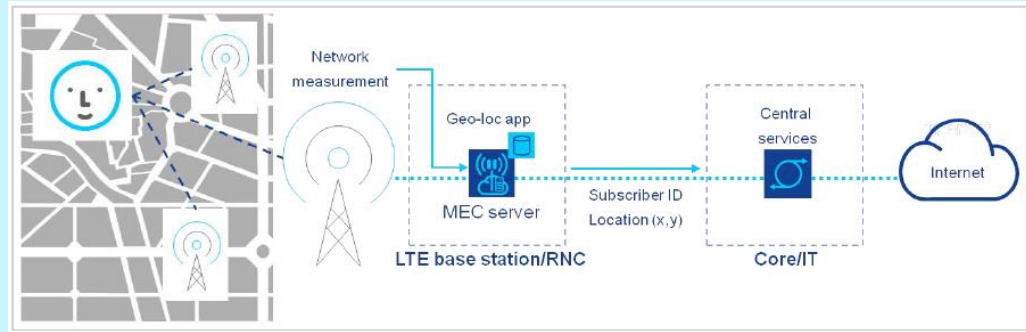
### For Operators

### For 5G

### Overview

Exciting new use cases:

- Active device Location Tracking
- Augmented Reality Content Delivery
- Distributed content and DNS caching
- ...





# ETSI MEC

## Mobile Edge Computing

Concept

For Operators

For 5G

Overview

### Opening the operator's environment towards 3rd party developers

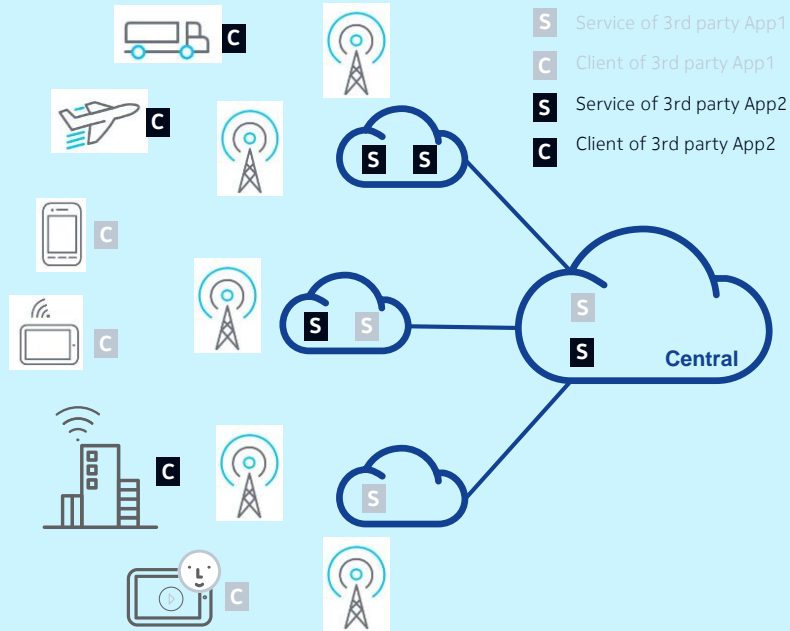
- Requires similar orchestration of applications like the VNF or NS

### Business opportunities

- IoT
- Virtual Reality, Augmented Reality
- Device offloading

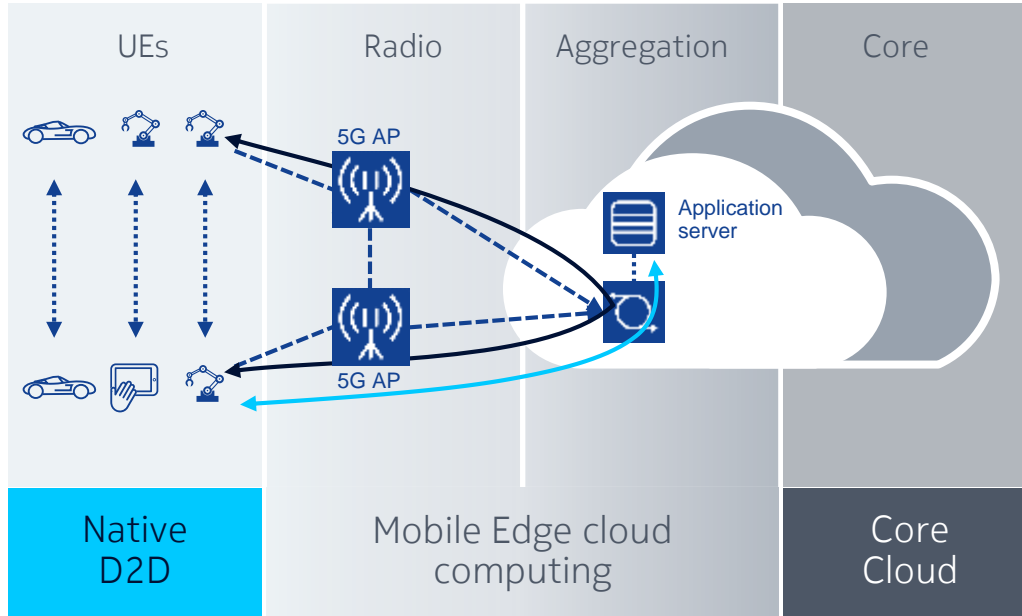
### 3rd party apps' requirements

- Dynamic deployment and scaling: on-demand and predictive decisions and actions
- Optimal resource usage
- Automated workflows



# Fast traffic forwarding | Enabling a new generation of latency critical services

## Lowest latency packet forwarding to UEs



Moving virtual networks

Mission-critical services, e.g. in V2X or industrial applications

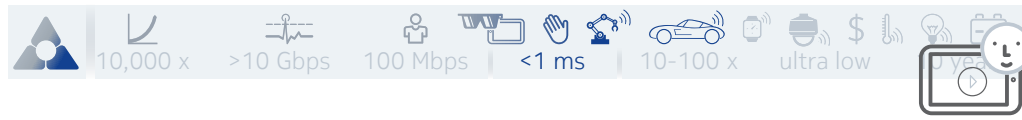
Central cloud based	> 50 ms latency
Mobile Edge LTE	≈ 10 ms
5G Edge	≈ 2,5 ms
5G D2D	≈ 1 ms

Vehicle2Infra trial on German motorway

Pioneer in Mobile Edge Computing

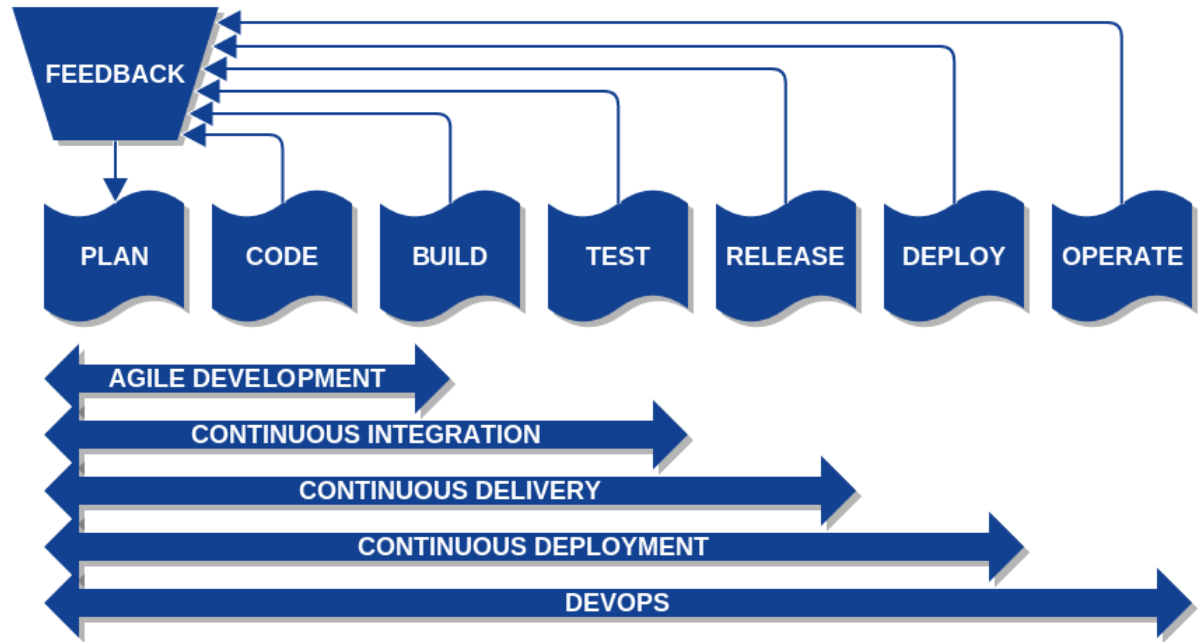
Autonomous driving live demo

ETSI ISG Chair

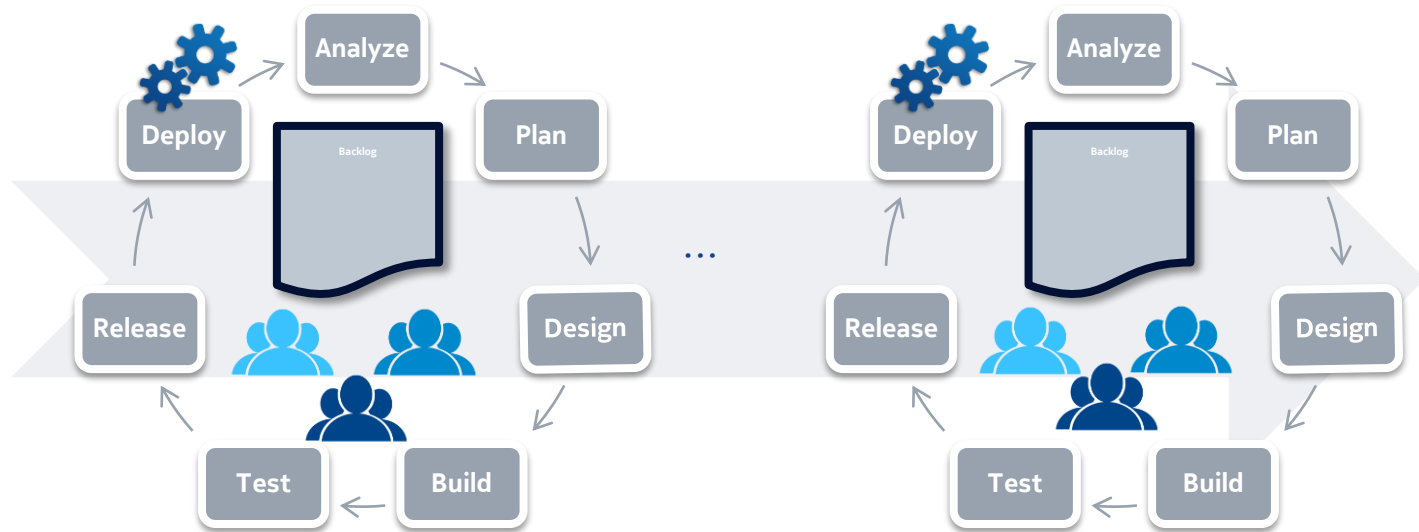


# DevOps

# DevOps



# DevOps



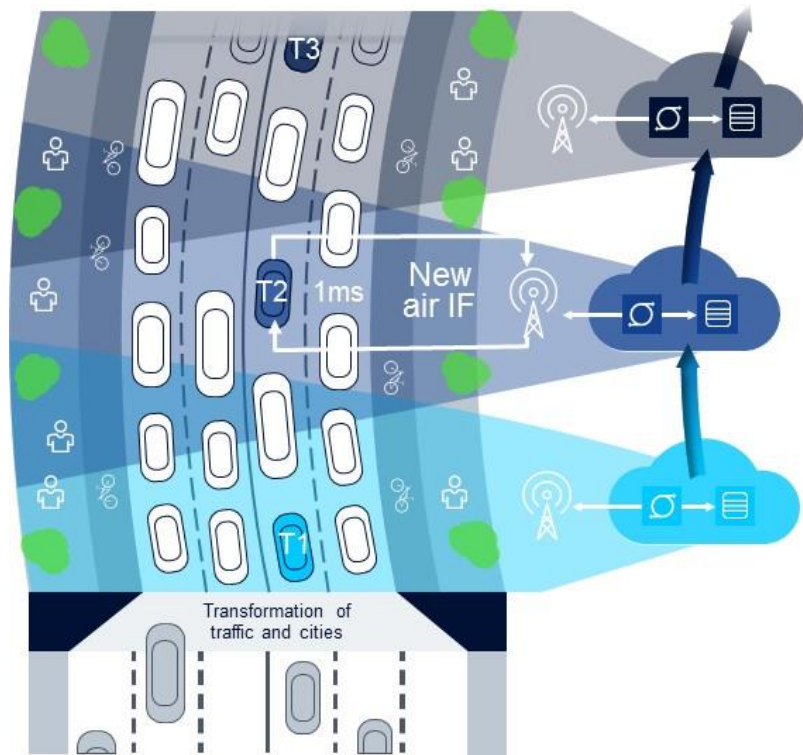
# Devops transformation addressing telco-specific challenges

Challenges	Steps towards DevOps
Fan out: delivery into x (e.g. 150) <b>different</b> target production systems.	<ul style="list-style-type: none"><li>•Common <b>cloud environment</b> to reduce testing effort</li><li>•<b>One branch</b> strategy</li></ul>
In Telco Ecosystem <b>maintenance window</b> is usually needed for the update which opposes the frequent deployment.	<ul style="list-style-type: none"><li>•<b>Easier deploy</b> and update processes<ul style="list-style-type: none"><li>•Continuous integration, delivery and deploy</li></ul></li><li>•<b>Continuous improvement</b> based on measurement and feedback</li></ul>
Value chain (development – operation) not under control of one party: <b>different companies</b> <ul style="list-style-type: none"><li>•This might be reflected in the <b>processes</b></li><li>• <b>Contract</b> between Nokia and the operator should be ingenious enough to enable CD.</li></ul>	<ul style="list-style-type: none"><li>•<b>Cultural change</b> (ie. new way of working)<ul style="list-style-type: none"><li>•on customer i/f and</li><li>•in processes</li></ul></li><li>•Transformation into <b>XaaS supplier</b> as well as <b>Revenue sharing</b> with the operators.</li></ul>
<b>Legacy</b> applications with heavy weight developing- and update processes.	Architectural renewal.

# Conclusion

# 5G autonomous driving - world's first demo

High traffic throughput, safety and energy efficiency



0

Close to zero fatalities;  
1 million lives saved

1 hour  
day

Personal time gain  
due to traffic optimization



Up to 4 times more cars on  
existing roads possible

- Autonomous cars, solely steered by 5G live network
- 1 ms latency and ultra reliability for fast moving vehicles
- 5G architecture for overall car traffic performance