Testing and optimizing 5G for industrial verticals

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February 2, 2022

Published in the proceedings of the 25th Seminar on Radio Communications.

Agenda

- Introduction
- The need for testing and optimizing 5G networks and services
- Methodology and analytics
- Tools
- Use cases
- Conclusions

About

qMON
www.qmon.eu

Telco grade system to deliver the next generation of quality assurance in mobile and cloud environments

rMON

Automation of remote IoT measurements for industrial and outdoor environments

PPDRONE

Cloud-based private 4G/5G for Industrial and outdoor environments

- Company facts
  - Startup established in 2014
  - Located in Ljubljana, Slovenia
  - 100% IPR ownership
  - First employees Q4 2017
  - Trusted R&I partner in EU H2020
- Core Expertise: development, deployment and operation of telco grade Quality Assurance (QA) and Critical Communications Systems (CCS)
- Main technologies verticals
  - QA | Quality assurance of mobile, fixed and cloud systems | ***www.qmon.eu***
  - CCS | Solutions for 5G/IoT-based critical communications | ***5gsafety.net***

Internet INSTITUTE

How we started with 5G | R&I

5G PPP
The 5G Infrastructure Public Private Partnership

MATILDA
matilda-5g.eu

5GLOGINNOV
5g-loginnov.eu

5GASP
5gasp.eu

5G INDUCE
5g-induce.eu

5GINFIRE
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5G IANA
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This projects received funding from the European Union's Horizon 2020 research and innovation programme grant agreements No. 761898, 732497, 957400, 957403, 101016448, 101016608, 101016941 and 101016427.

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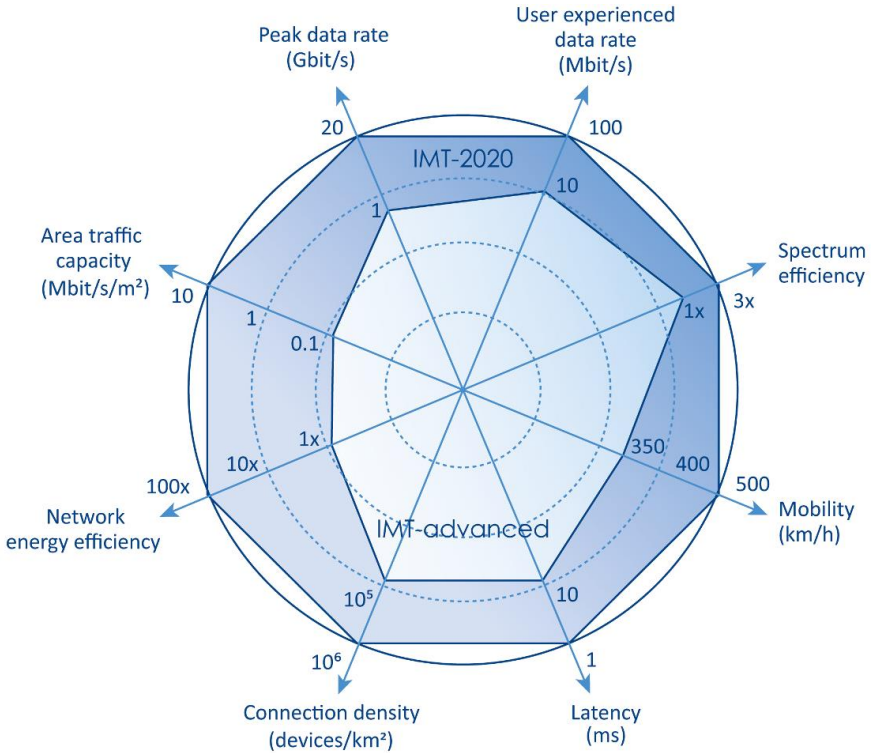
Introduction – role of 5G

- 5G opportunities
  - Industry (e.g., Industry 4.0, IoT)
    - private 5G networks
  - Consumer market (e.g., mobile gaming, fixed wireless access, new immersive user experience)
- 5G technology benefits
  - eMBB: > 10 Gbps
  - uRLLC: 99,99 % reliability, below 1 ms latency
  - mMTC: 1 million (IoT) devices per km^2
  - MEC: Mobile Edge Computing
  - NFV: Network Function Virtualization
  - MANO: Management and Orchestration

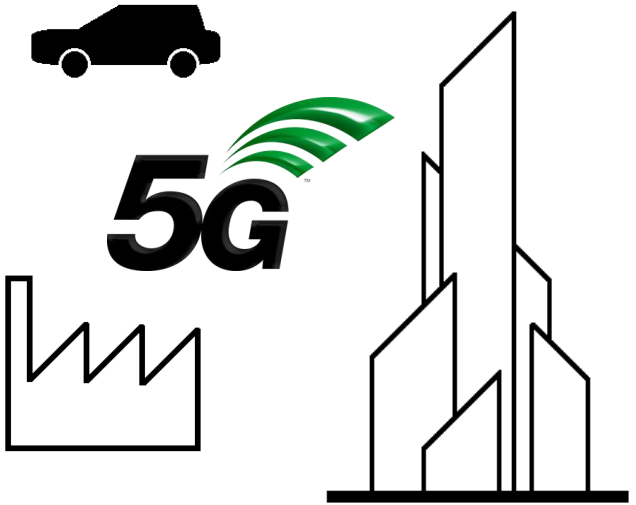


IMT-2020 = 5G
IMT-advanced = 4G

source: ETSI

Introduction – emergence of new services and apps

- 5G technology as an enabler
- 5G technology as an improvement comparing to other comm. technologies
- Some verticals with interest for 5G
  - Automotive (e.g., connected autonomous mobility and driving)
  - Public Protection and Disaster Relief (PPDR)
  - Smart cities
  - Industrial
    - improving safety of the personnel involved in industrial processes
    - improving robots' effectiveness
    - optimizing logistics processes and traffic flows
    - introducing mixed-reality assisted manufacturing, maintenance, etc.



Introduction – testing and optimizing

- Challenges testing and optimizing may help solve
  - 5G applications and services usually require very strict network conditions
  - The network should be available providing reliable service at any time
  - Balanced/optimal use of resources
- Based on the testing results, further steps are planned
  - Analyzing test results
  - Planning network and/or service optimization (re-configuration, topology, architecture, etc.)
- SLA (Service Level Agreement)
  - What it counts from the customer's point of view

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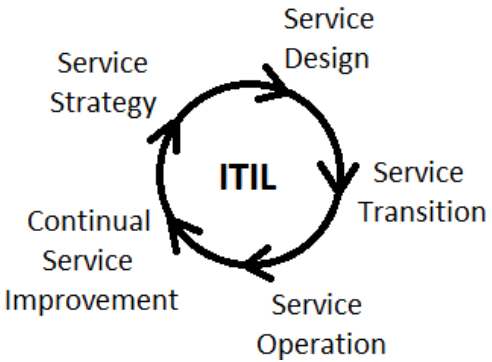
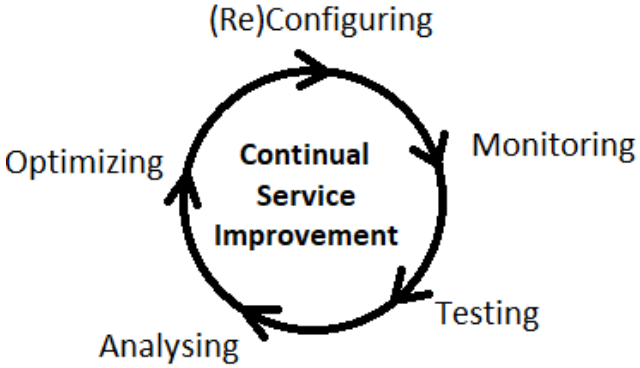
The need for testing and optimizing networks 1/4





- Testing plays crucial role since the very first stages of network integration
  - Lab testing
  - Deployment to the production
  - Production phase (Day-2 operation)

The need for testing and optimizing networks 2/4

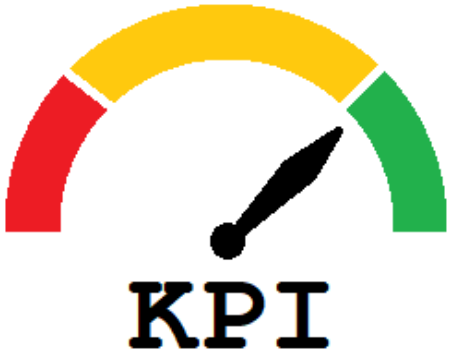
- Proactive testing and monitoring
  - Running live services (e.g., data download & upload) and observing effects in real time
  - Addressing relevant KPIs
- Proactive testing and monitoring as a first step in providing reliable network
  - Add testing and monitoring results to enrich data especially in production phase
  - Building a complete real-time picture of the network conditions
  - Detecting anomalies (ideally before customers do)
- Answers provided by proactive testing/monitoring
  - What are the performances the device/network is currently able to achieve
  - What is the effect to other devices in the network and to the network itself

The need for testing and optimizing networks 3/4

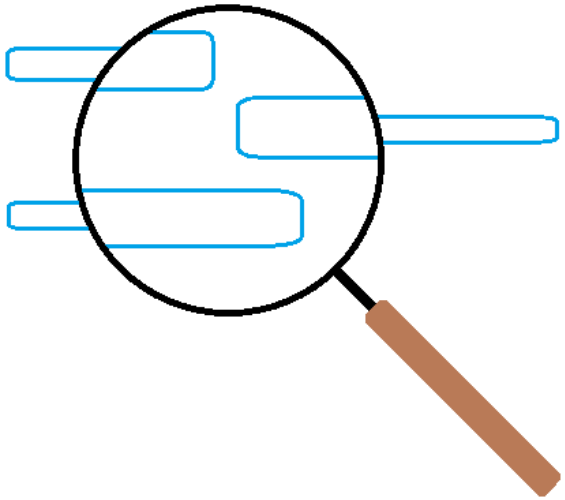
- Addressing complexity of 5G networks
  - Running tests within the network
    - Distributed network architecture
    - Physically distributed network components
- Optimizing network
  - Self-healing
  - Manual intervention
  - Optimizing network architecture and topology

The need for testing and optimizing networks 4/4

- Some common KPIs for 5G services
  - Service availability
  - Service reliability
  - Bandwidth
  - End-to-end latency
  - Response time
  - Error rate
  - QoS and QoE
  - Positioning quality (in case 5G is used for localization services)
- Some KPIs for 5G network
  - Service onboarding and deployment time
  - Time to scale service/component
  - Reconfiguration time
  - Area traffic capacity
  - Connection density



Methodology – key objectives



- Get relevant data
- Get data from most/all occasions customer can run into
  - Location
  - Moving speed
- Use of customer-like devices while testing customers point of view
- Be efficient
- Build a complete picture of the network/service status
  - Combine data from various sources (tests, monitoring, system data)
  - Use AI methods where appropriate

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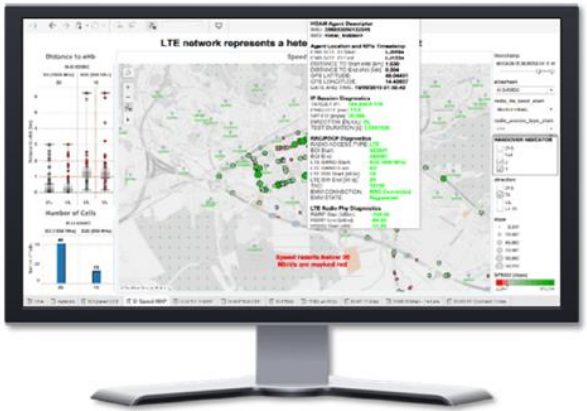
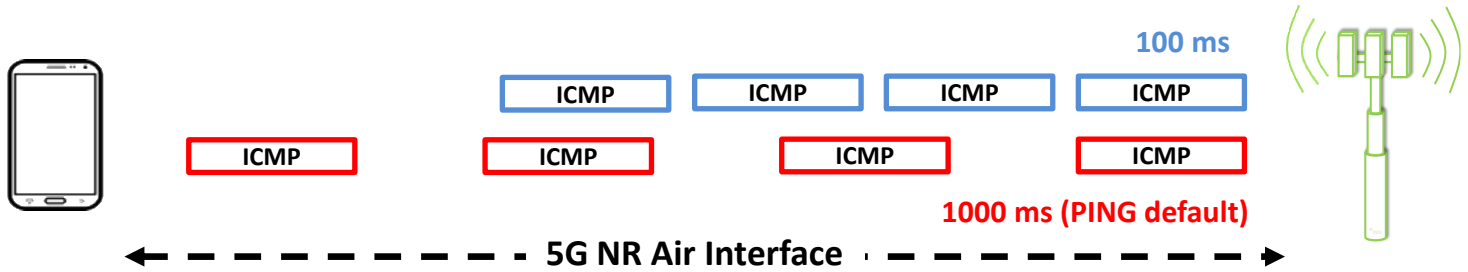
Methodology – test types

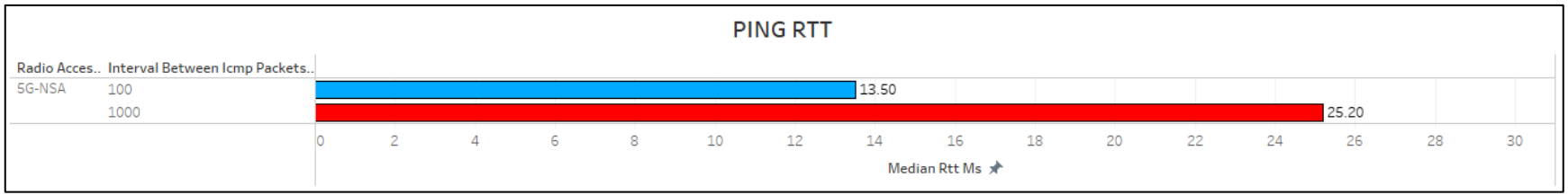
- Continuous testing/monitoring
  - Regularly running tests on pre-defined locations
  - Testing schedule
- On-demand testing
  - Testing on special purpose, e.g.,
    - Double-checking anomaly detected during the continuous testing
  - May include testing on unusual locations
    - Use of special equipment, e.g., drones
- Drive tests
  - Testing on a larger geographical area



Methodology – why does it matter?

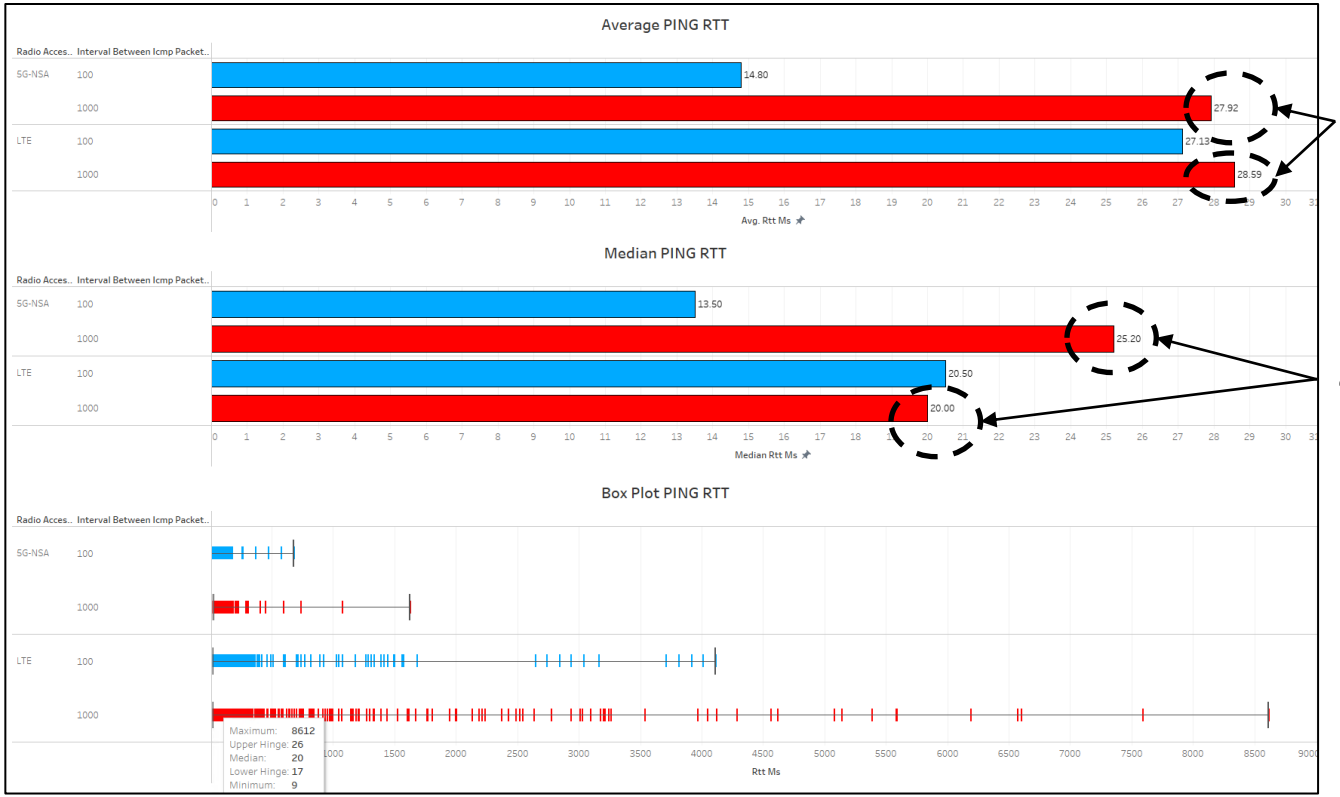
- RTT Example – interval between sent test packets can affect observed RTT





Results captured at commercial 5G mobile operator in Slovenia. More than 20K samples were taken in the duration of one month.

Analytics – why does it matter?



Results presented as Average RTT:
5G is better than 4G. Looks OK!

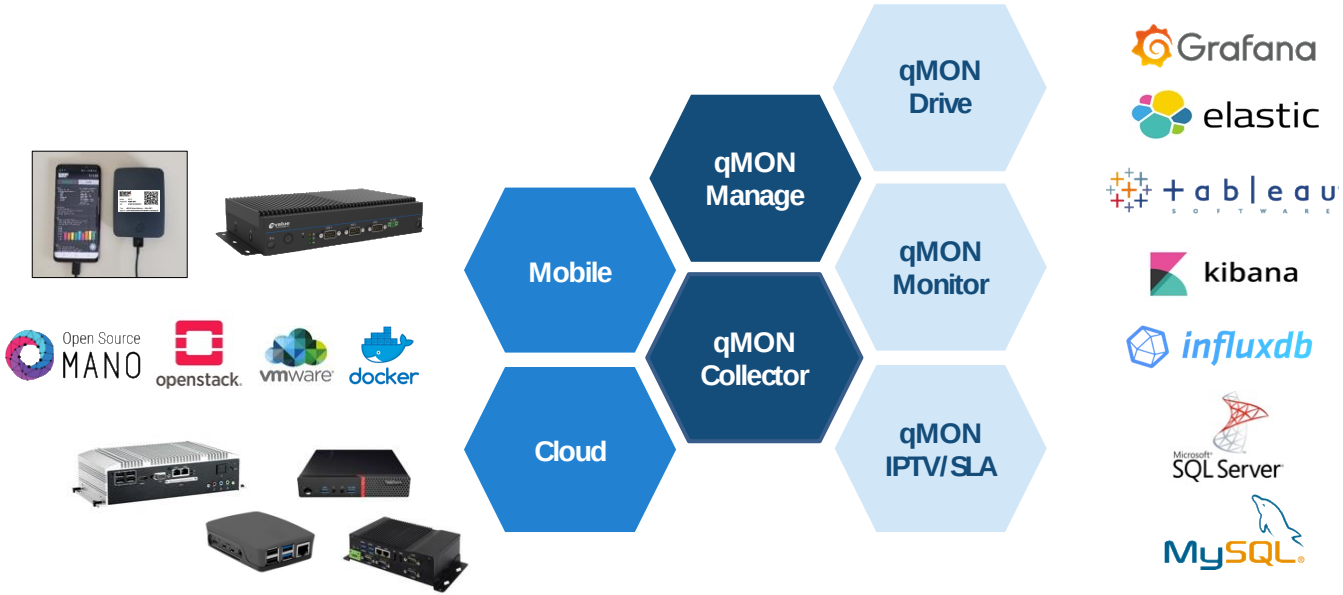
Results presented as Median RTT:
4G is better than 5G? Misconfigured 5G NSA on the eNb/gNb?

Tools

- Several commercial test tools exists on the market today
- Key requirements
  - Distributed architecture (e.g., autonomous agents/probes)
  - End-to-end test, realistic load generation, zero-loss data
  - 5G and Cloud architecture (VNF, MANO)
  - Analytics, reporting and visualization capabilities
  - Mobile network testing (e.g., RSSI, RSRP, RSRQ, SINR, Carrier Aggregation, Cell ID, etc.)
  - Network and service testing (e.g., DNS, ping, FTP, web browsing, multicast, Voice, etc.)
  - Supporting several technologies (e.g., 5G SA/NSA, LTE, HSPA, GPRS, EDGE, FE, GE, 10GE)
  - Over-the-Air (OTA) updates
  - Industrial and outdoor environment conditions support (temp. range -40°C to +60°C; IP67)

Tools – our approach

- We have developed our own testing tool – qMON
  - System based on a modular architecture



Tools – qMON

- qMON at a glance
  - Unified mobile, fixed and cloud (FMC) system operations
  - 5G and Cloud/VNF ready (MANO)
  - Distributed autonomous agents and system operation with zero data loss
  - Feature-rich and multi-layer with support of 100+ KPIs
  - True end-to-end automated measurements and realistic load generation
  - GIS and operator-based KPI data enrichment
- Supported use cases
  - End-to-end QoS and QoE monitoring of network and services in live environments
  - Continuous service and SLS/SLA monitoring in real-time
  - Drive and benchmark testing
  - Coverage and performance assessment
  - Live network and service troubleshooting
  - Network and services trending
  - Device and system performance predictions under realistic load conditions

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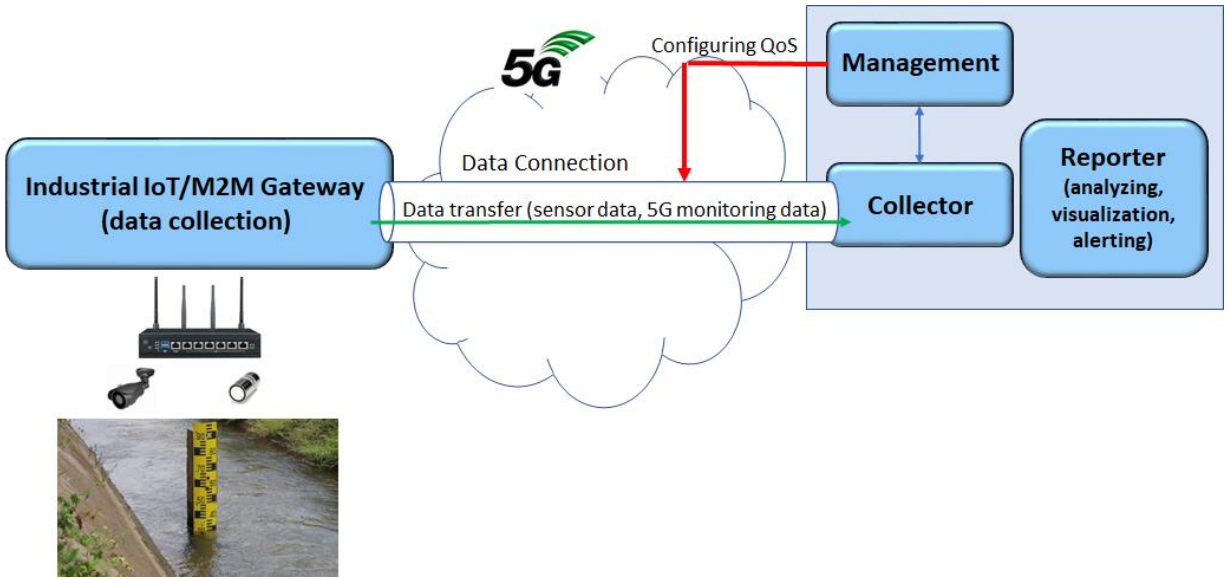
Use cases – EVOLVED-5G

- Industrial-grade 5G connectivity for the Factory of the Future IoT devices
  - IoT data collection via QoS guaranteed 5G connection



Use cases – EVOLVED-5G

- The use case scenario
  - IoT GW installed in the field/factory with non-5G enabled sensors connected to it
  - IoT GW provides 5G connectivity for data delivery to the database/collector
  - The requirement is to provide industrial grade 5G connectivity with assured QoS as defined by the SLA
- The solution
  - monitoring capabilities integrated on both sides to regularly run end-to-end tests
    - IoT GW: agent
    - Core network: collector, manager, reporter
  - Analyzing & optimizing
    - Network slice re-configuration in case of SLA not passing detected

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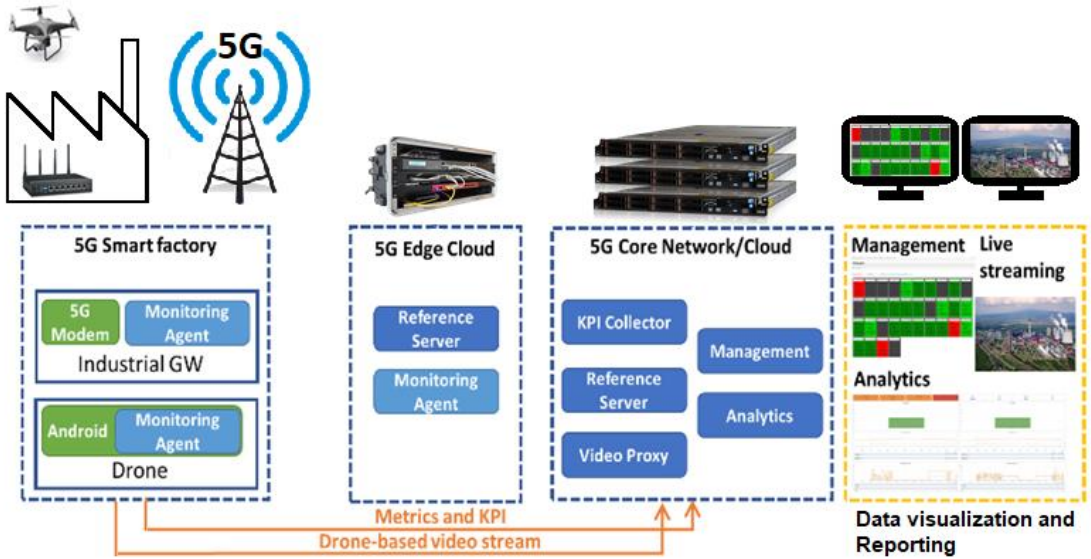
Use cases – 5G-INDUCE

- 5G Network performance and radio coverage monitoring for Industry 4.0, enhanced by drone



Use cases – 5G-INDUCE

- Monitoring 5G network performance and radio coverage
  - Smart-factory plant
  - Assuring high availability of critical communications needed for the main process to run (e.g., automated fork-lift operations)
  - Assuring high availability of services needed for the main process to run (e.g., video-based remote-control operation)
  - Drone assistance to provide height-related performance & coverage data
- Supporting automatic optimization of 5G network quality of service (QoS)
  - Utilizing collected monitoring data
- Optimizing 5G network coverage
  - Obstacles and/or interference sources in industrial environments,
  - Providing regular and/or on-demand drone-assisted measurements with detailed analytics

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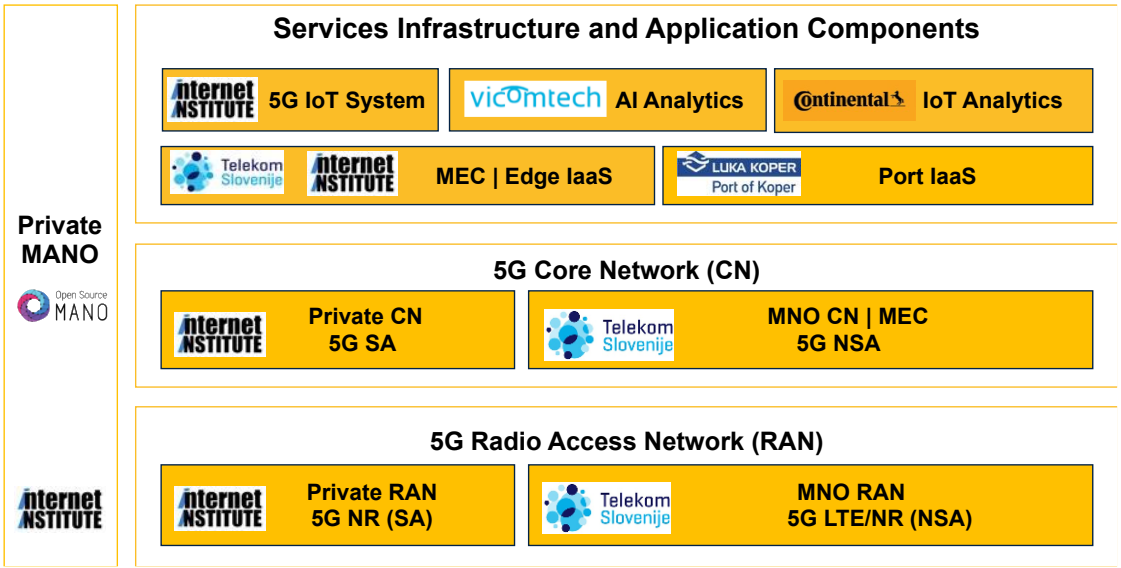
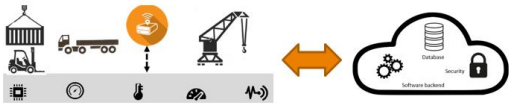
Use cases – 5G-LOGINNOV

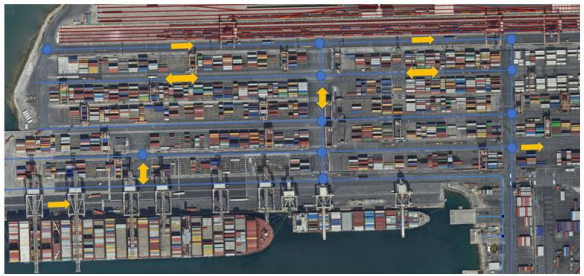
- 5G for logistics and security processes in a sea-port
  - Exploitation of applications and services based on 5G-assured Industry 4.0 scenarios

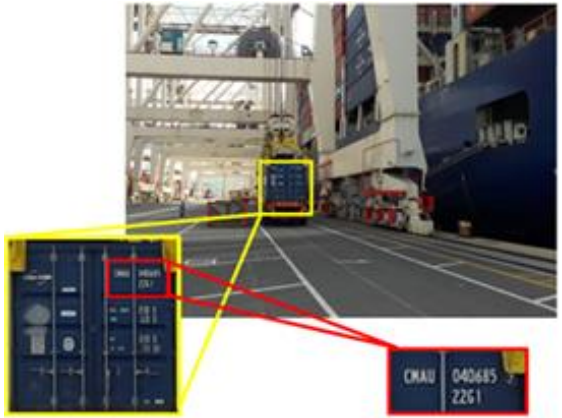


Use cases – 5G-LOGINNOV

- Maintaining 5G network to provide various services and applications
  - Automation control of the container management (AI analytics)
  - Remote automation (IoT analytics)
  - Mission-critical port security services (video surveillance, CCTV applications)







Use cases – 5G-LOGINNOV

- Providing continuous, on-demand and drive tests for several network and service KPIs
  - Service onboarding and deployment time, time to scale service/component, reconfiguration time, area traffic capacity, connection density
  - Service availability, service reliability, bandwidth, end-to-end latency

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Conclusions

- Providing reliable and high-quality communications
  - Knowing the network/service condition at any time
  - Maintaining SLA
    - Predict troubles before customers do
    - 5G is designed to support industrial and critical services, but this means responsibility as well
- Testing
  - Plays crucial role since the very first stages of network integration until production phase
  - A first step into providing reliable network and services
- Optimizing
  - Enabling continual improvements of network/service based on test results analysis

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Co-funded by the European Union under grant agreements No. 101016608 (EVOLVED-5G), 101016941 (5G-INDUCE) and 957400 (5G-LOGINNOV).