5G Network Performance Monitoring in 5G TOURS & 5G HEART Horizon projects: Results and Lessons learned

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ACTA LTD
Advanced Communications Testing Applications

ACTA Overview

Basic Information – Products & Markets

- ACTA Ltd was founded in October 2002 in Athens, Greece. http://www.acta.com.gr
- It is a provider of Monitoring and Test/Measurement solutions, mainly focused on Telecoms, IT, Electronics and EMF & EMC technologies.
- It is active in the area of SE Europe, mostly focused on Greece, Cyprus and the Balkans.
- ACTA has ISO 9001 Quality Certificate for Sales and Technical Support.

Telecommunications	Network Solutions	Lab Equipment	Electromagnetic Fields
• Lab & Manufacturing Test	• Network Monitoring	• Electronics	• High Frequency Fields
• Network Test & Certification	• Operations Support Systems	• Electromagnetic Compatibility	• Low Frequency Fields
• Assurance, Analytics & Performance Management	• Synchronization	• Magnetometers	• Radiation Monitoring
• Networ Planning & Optimisation		• Laser Measurements	• Interference & Directional Analyzers – Spectrum Monitoring

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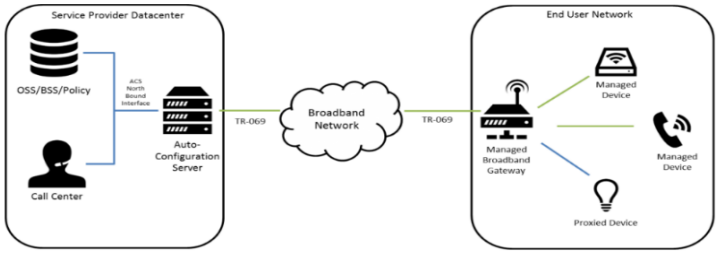
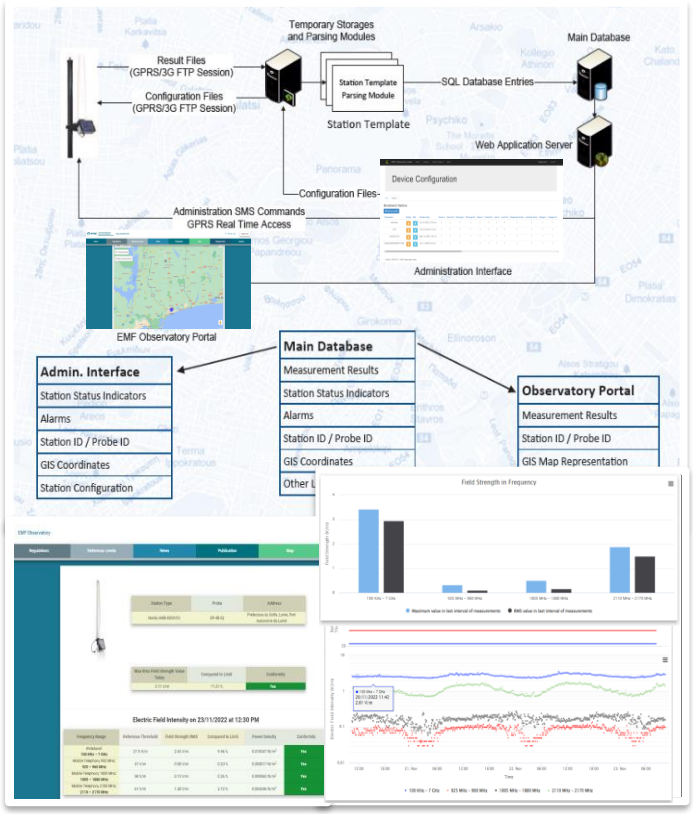
ACTA Overview

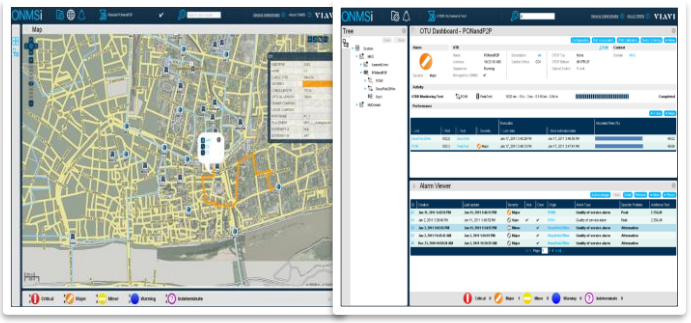
Key Competences

- ACTA Ltd has deployed TR-069 based "**zero-touch provisioning**" xDSL CPE management platforms, in three Greek Telecom Operators. The platform is a comprehensive zero-touch open end-to-end IoT Device-Edge-Cloud resource management system, which enables zero-touch service automation.





- **EMF Observatory Admin** is a Web platform which provides a rich set of tools to manage, organize and configure EMF stations (e.g., NARDA) in an effective, efficient and extremely simple way. It allows complete inventory management, configuration and firmware upgrade of single or multiple units, alarm indications and complete access to measurements and results. The solution currently deployed https://paratiritirioemf.eeae.gr, covers over 550 stations across the country. Other installations are http://www.monitor-emf.ro and https://emf.arcep.tg/



- ACTA Ltd provides equipment and services for **Optical Networks System Verification,** Turn up and Installation as well as Troubleshooting and Monitoring, based on Viavi ONMSi OTU 8000 and MTS 8100 series OTDR modules.

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ACTA Network Monitoring

The Viavi MTS-5800 probe

The Viavi SFP network probe

The Virtual CPE/ Software Probe hardware

Probes – KPIs - Protocols

ACTA is member of two R&D EU projects (H2020 Horizon). The projects implement 5G network solutions for a variety of Verticals as customers.

- 5G HEART - https://5gheart.org/
- 5G TOURS - https://5gtours.eu/

Type	Probe type	Direction	KPI L2/L3	KPI L4
SAT - RFC2544 - Y.1564	MTS 5800	Bidirectional		Service Activation Testing
			Throughput	peak throughput
			Latency	Latency
			packet loss	packet loss
				Availability
PM - TWAMP - RFC5357	SFP & Virtual	Bidirectional		
			Latency	
			packet loss	
			Delay variation (jitter)	
WireSpeed - RFC6349 (TrueSpeed)	MTS 5800 & Virtual	Bidirectional		peak throughput (TCP)

- ACTA is using TWAMP (RFC 5357) for Performance Measurements running between SFPs and virtual probes, that define network segments under observation, at specific locations in OTE Labs and the trials locations. These provide L3 KPIs such as Latency, Jitter and Packet Loss. 5G BBUs are acting also as TWAMP reflectors. The use of the improved TWAMP protocol provides better accuracy than ICMP (Ping).
- The Viavi MTS-5800 network tester installed at OTE Labs is used for Service Activation Testing, as well as throughput testing with TrueSpeed (RFC 6349).
- Fusion TrueSpeed VNF - Throughput testing as a virtual network function based on RFC 6349.

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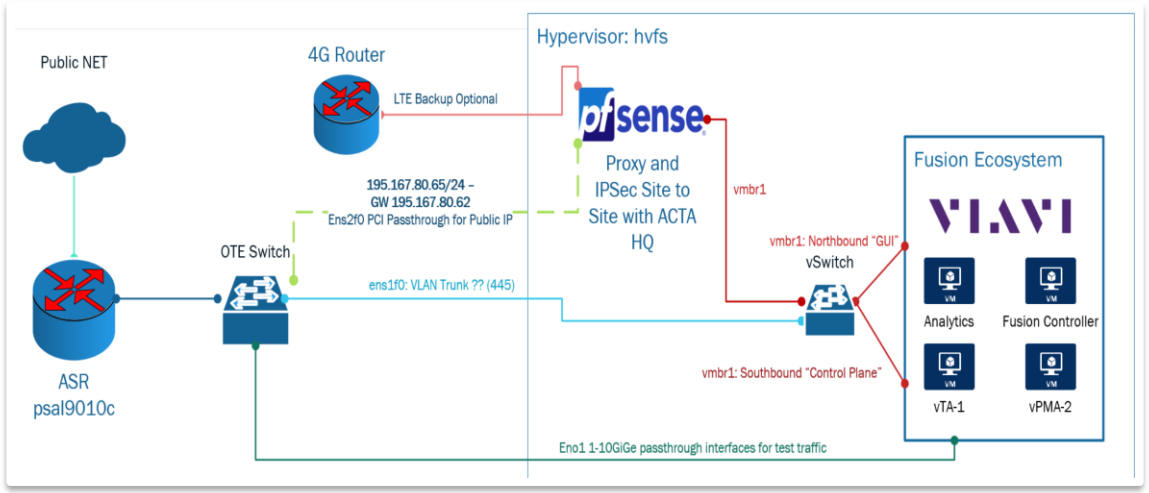
ACTA Network Monitoring

KMVaP - KPI Measurement and Validation Platform



ACTA's KMVaP ecosystem at OTE Labs

- The core part of the KMVaP cental management system is based on Viavi's Network Integrated Test, Real-time analytics and Optimization (NITRO) platform. This is augmented by Open-Source components and ACTA developed software in order to become a complete KPI validation system.
- All the components of the KMVaP platform are Virtual Machines using a VM Hypervisor.
- A KAFKA interface is enabled in the KMVaP management Platform that is delivering the measurements in real-time to the KAFKA topic defined in the KAFKA server.
- The collection of data is an automated process running 24x7, with 1min monitoring granularity and up to 10 ms sampling granularity.

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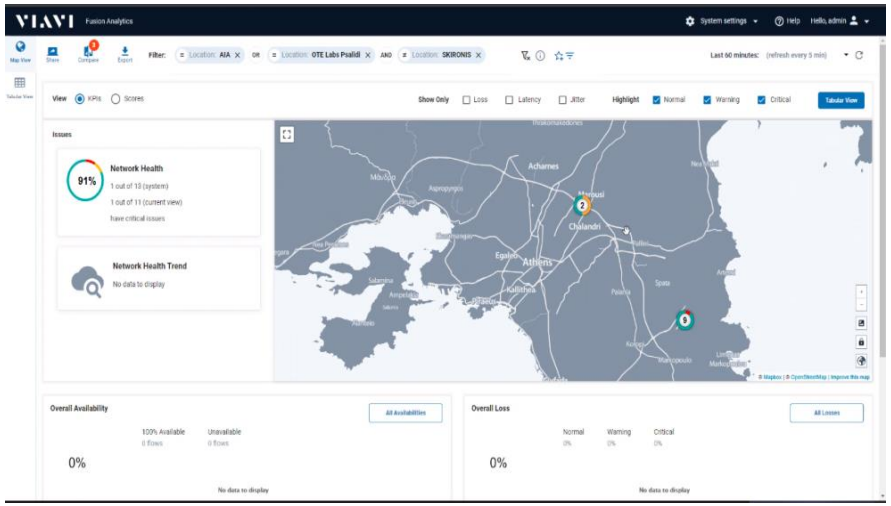
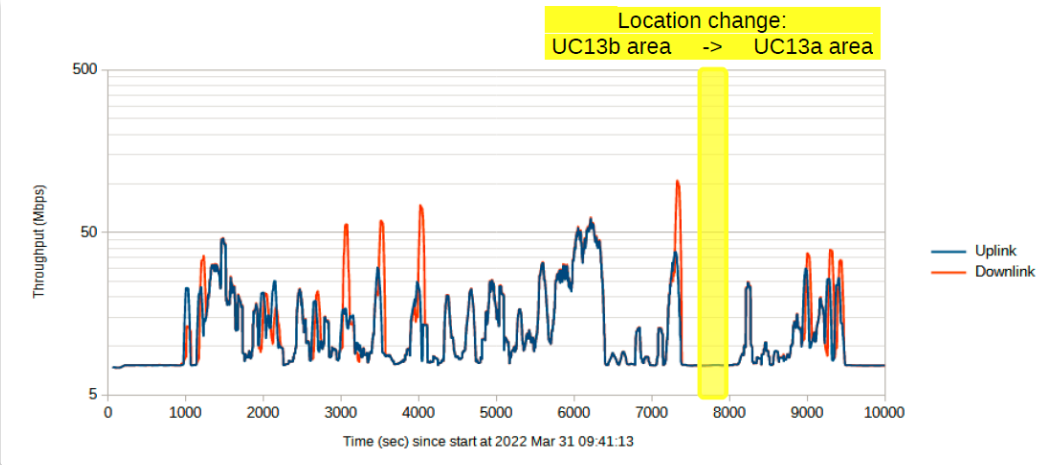
ACTA in 5G TOURS

Real Time Measurements



- **5G TOURS Touristic City** Greek pilot applications that are tested in Athens International Airport include:
  - Smart Parking Service Offering
  - Ground based “Follow-me Cars” Remote Monitoring and Guidance
  - AR/VR multimedia Services while on the move
  - Emergency Analytics and Decision Making e.g. Airport evacuation
- Typical KMVaP views are shown in the images, that allow the operator to monitor in real time the progression of the selected KPIs* along the selected flows (network segments).



* **ACTA KPI Management & Validation Ecosystem - Application in 5G TOURS:** https://youtu.be/vuGtfQNsdn4

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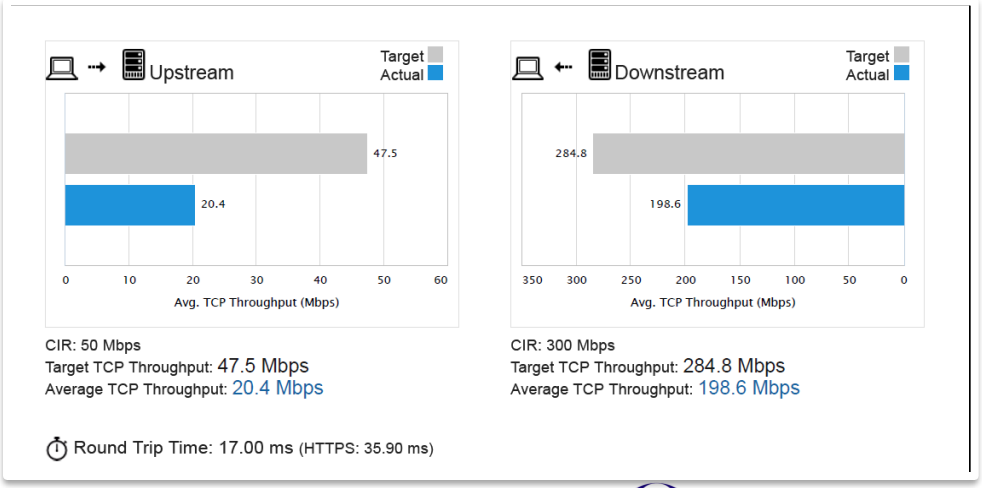
Field Tests – Latency, Jitter, Packet Loss, Throughput

- Average latency figures stay around 20-25 ms, with the RAN part contributing almost 1 ms, which in effect means that radio conditions can vary and affect KPIs.
- Jitter remains on average very low, in the order of 4 ms, where the contribution of the RAN part is infinitesimally small.
- For the E2E path, the packet loss remains constantly very close to 0%.
- L4 peak TCP throughput, measured through VIAVI speed tests, (Wirespeed - RFC6349), average values of 200 Mbps downstream and 20 Mbps upstream reflect the particularities of the network (50 MHz bandwidth).



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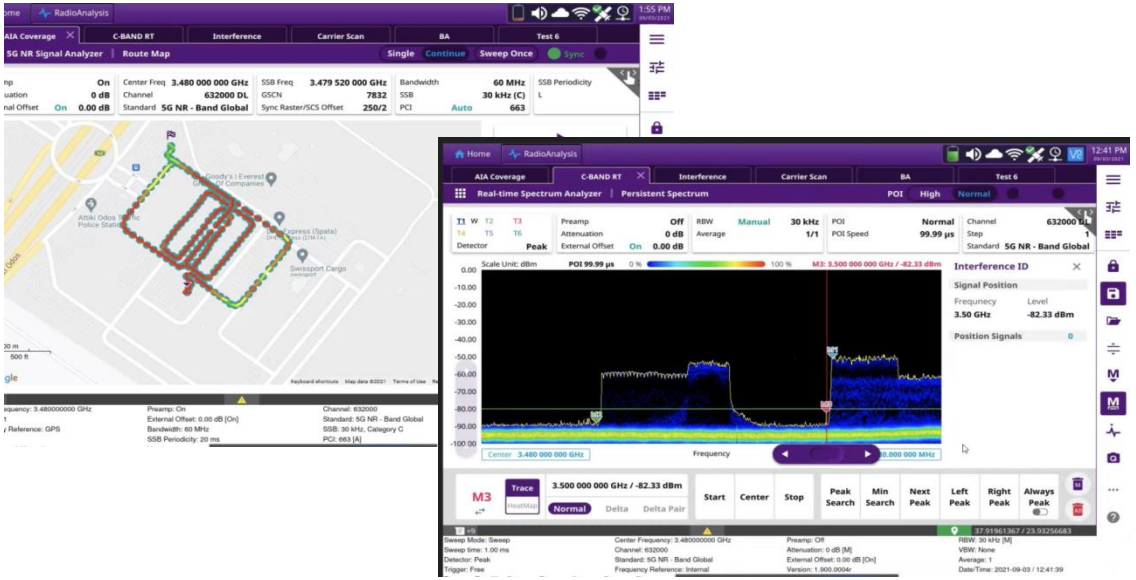
ACTA in 5G TOURS

Field Tests – RF Measurements

- ACTA provided RF measurement equipment Viavi ONA 800A, which was used together with NOKIA to optimize the network and resolve coverage and interference issues on the field.
- Measurements were taken in April, September and December 2021, following reconfigurations of the network.
- The results were:
  - ✓ the elimination of a timing error,
  - ✓ and the reduction of the available 5G spectrum from 100 MHz to 50 MHz within the 3450-3500 MHz band (to avoid interference from commercial 5G networks in the area)



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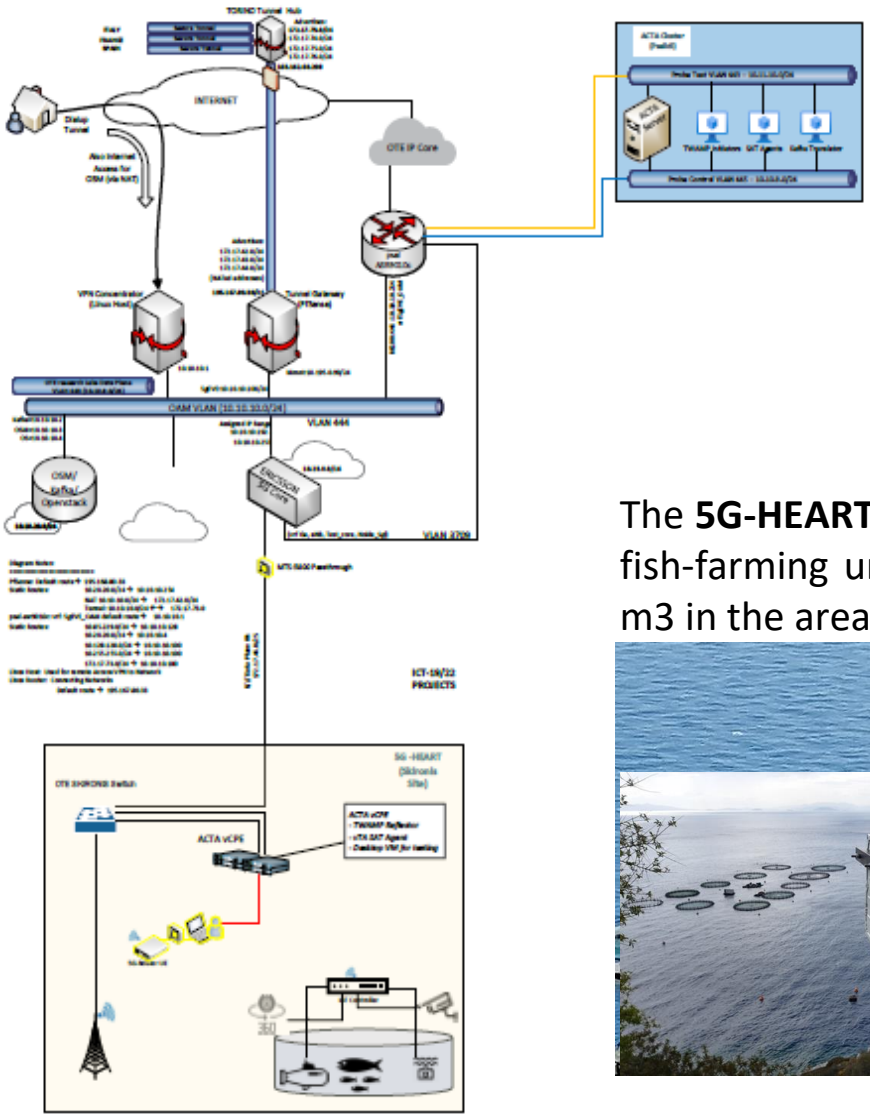
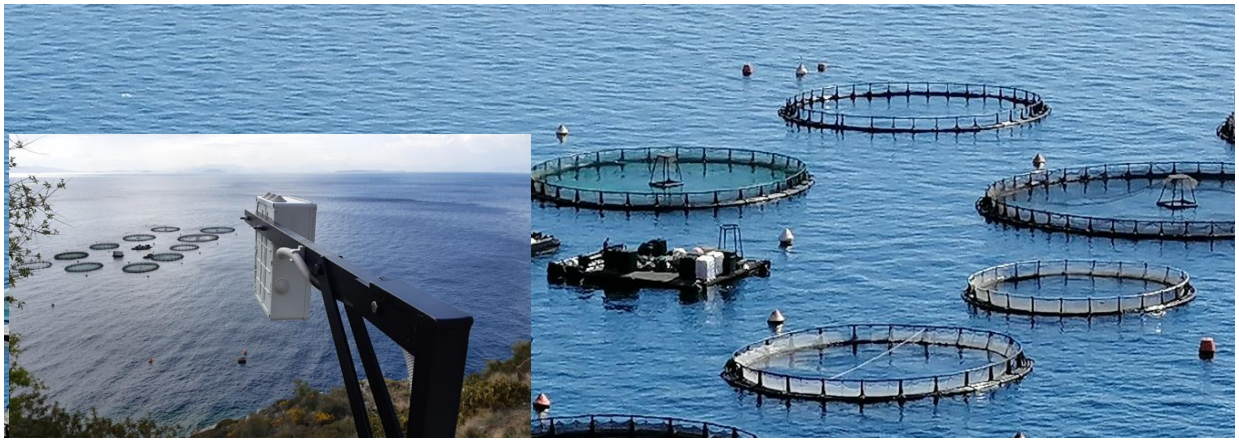
ACTA in 5G HEART

Measurements Network – OTE Labs & Skironis Aquaculture



The **5G-HEART Aquaculture** Greek pilot use case is in the Skironis fish-farming unit, on floating facilities of fifty thousand (50.000) m3 in the area of Megara Bay, near Athens.



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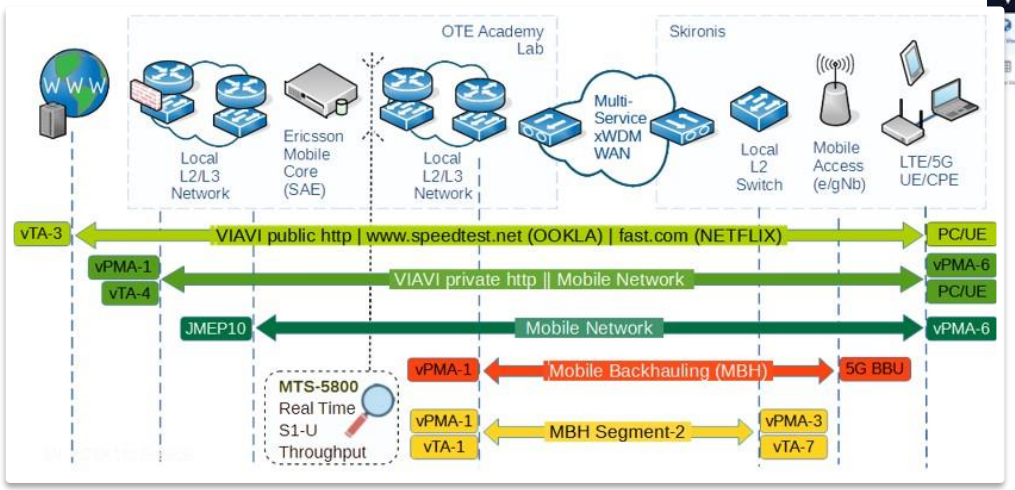
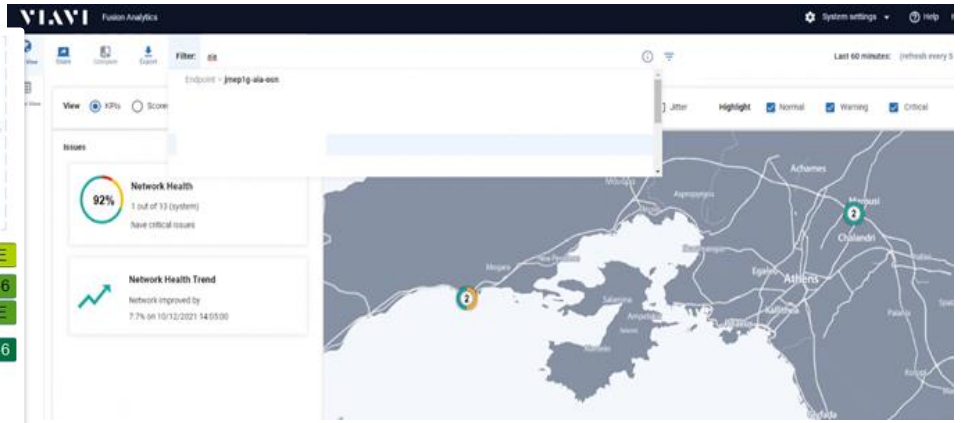
Site Installations – Probes & KMVaP views

- ACTA has installed network monitoring probes. Positioning of the probes in various parts of the network, allows for measuring the 5G network performance KPIs end-to-end as well as in segments of the network (Radio vs. Core, Physical vs. Service Layer, E2E vs. Segments of interest to the Operator).
- A Robustel 5G router/probe was installed in the SKIRONIS premises, to allow for 24/7 measurements remote collection.
- Additional Robustel routers that were used for communication of the surveillance cameras to the network, were also used as measurements end-points (UEs) for the specific scenaria.





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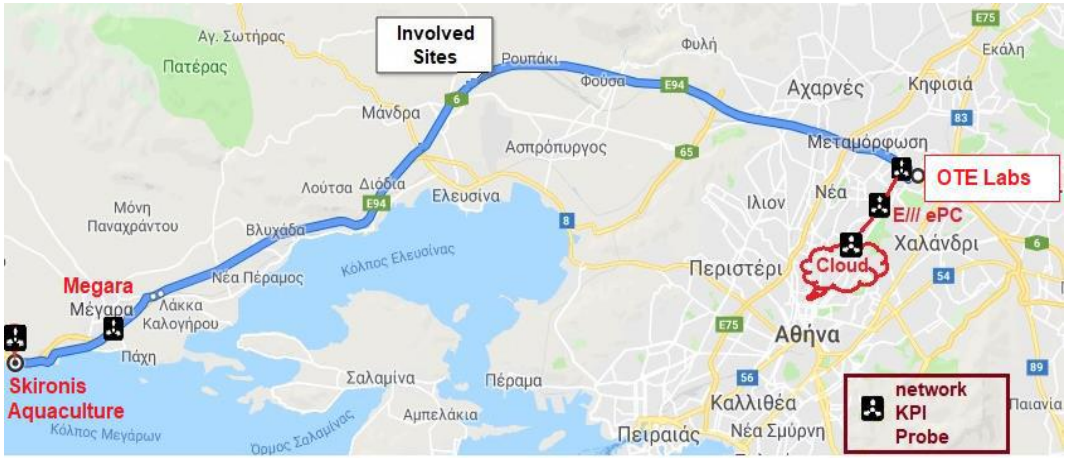
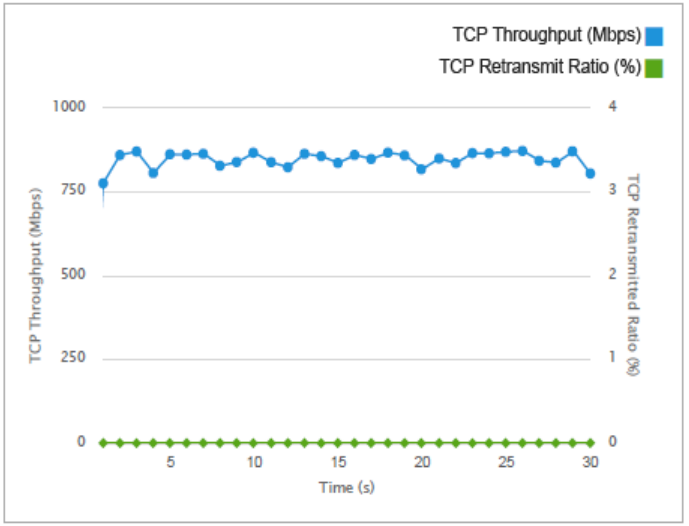
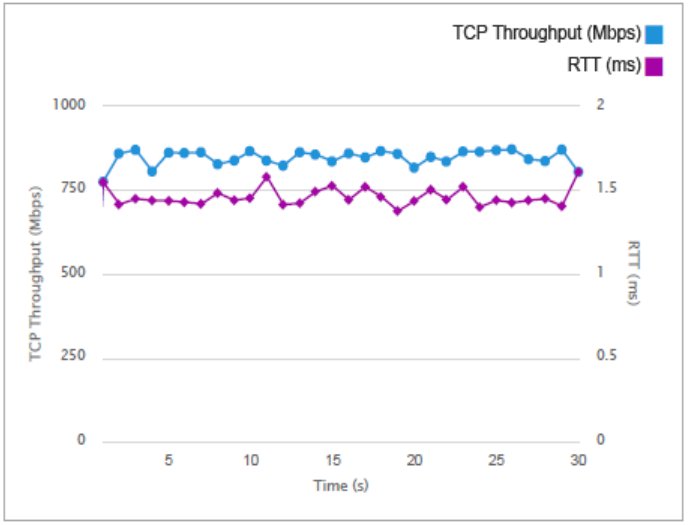
Transport Network Measurements – L4 KPIs

The probes measuring the backhaul traffic between SKIRONIS and OTE Labs can provide Throughput and the Loss Rate for the transport network between SKIRONIS OSN and OTE Labs OSN (1Gbps optical backhaul network).

- ✓ 949 Mbps throughput (out of 1 Gbps capacity)
- ✓ 0% packet loss
- ✓ 1,34 ms RTT







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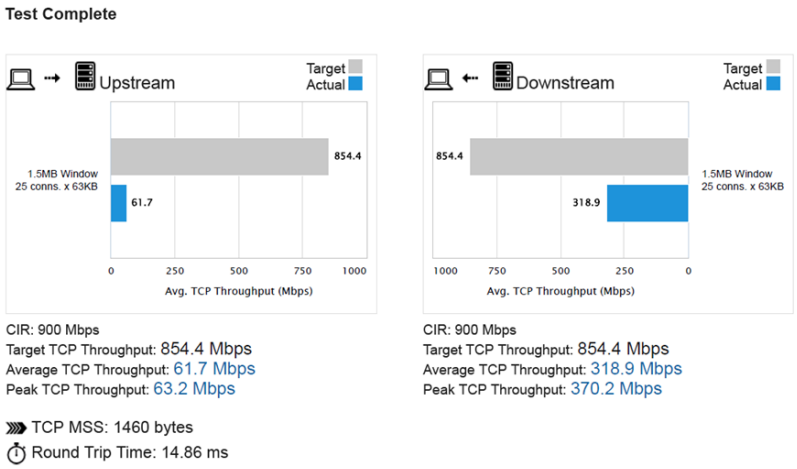
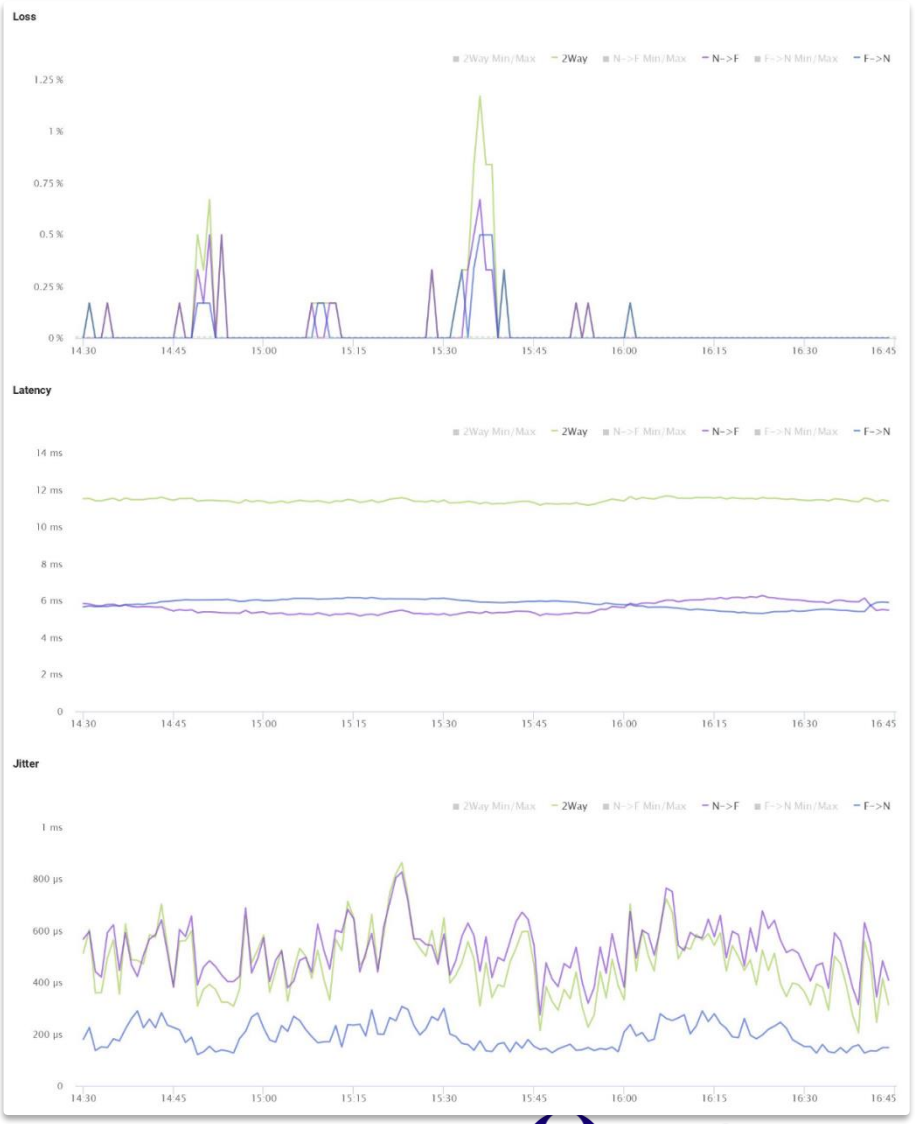
End-to-end Network Measurements – L3/4 KPIs

- ✓The delay, jitter and loss parameters of the e2e network (TWAMP (RFC 5357) – L3 KPIs) have been measured during multiple trials, as shown in the side figure:
  - 11-15 ms delay
  - 0,5 - 2,5 ms jitter
  - 0% Frame loss
- ✓In terms of L4 TCP throughput capability of the e2e network, test traffic Service Activation Testing SAT (RFC 6349) has resulted to (figure below):
  - 160 - 320 Mbps downlink throughput
  - 60 Mbps uplink throughput





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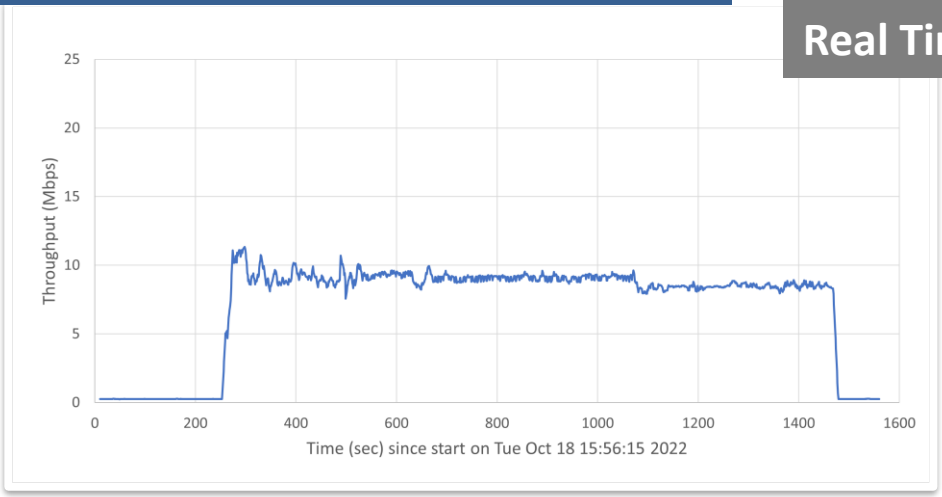
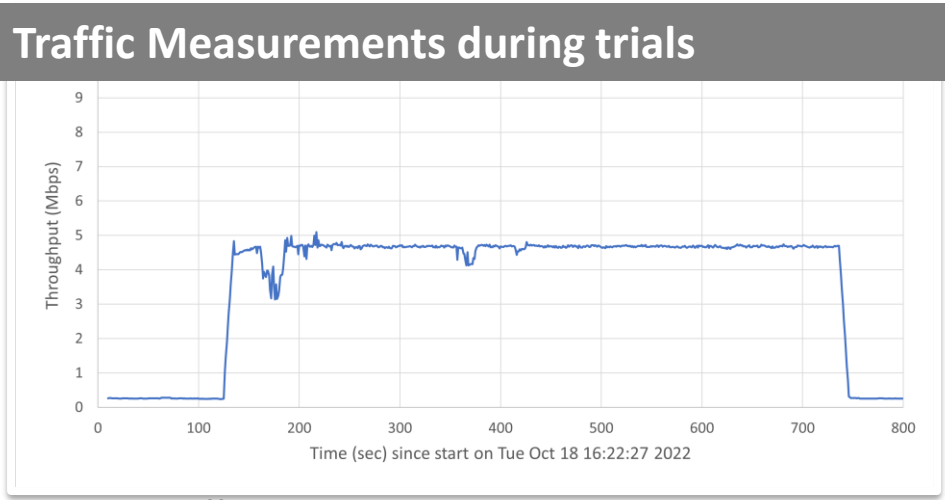
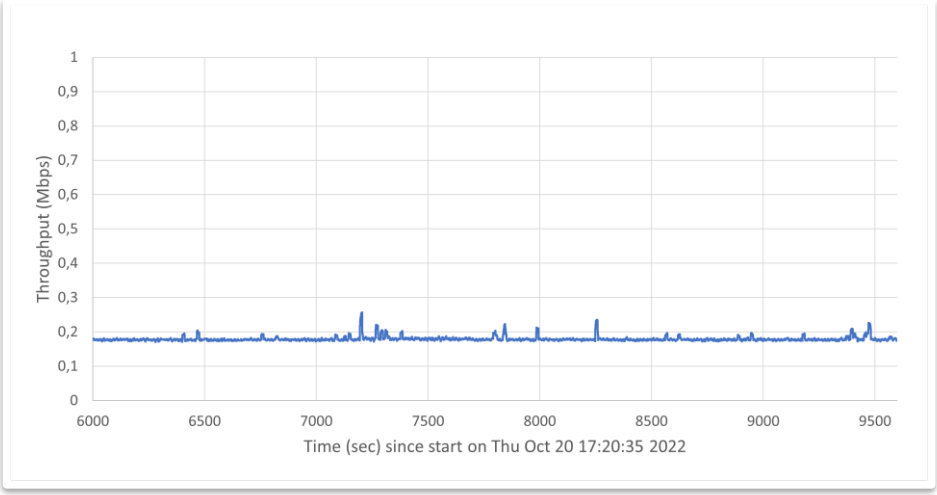
Real Time Traffic Measurements during trials



- Throughput measurements – underwater camera at Skironis site - around 5 Mbps



- Traffic measurements during actual streaming for both high-res and low-res surveillance cameras- around 10 Mbps



- Traffic measurements during actual sensors communication - around 0,2 Mbps

- Traffic measurements during actual streaming for drone camera - around 15 Mbps

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ACTA results overview

Lessons Learned

- ✓ The 5G network implementations for both projects offered lab and real-life setups for trials and performance monitoring. ACTA collaborated throughout the duration of the projects with all technical partners (OTE, NOKIA, Ericcson) to establish, verify and operate a complete real-time measurements environment for all network segments (transport, radio, etc).
- ✓ The available 50 MHz bandwidth in the field, configured on purpose to avoid interference with commercial 5G networks, limited the maximum uplink throughput capacity to approx. 300 Mbps, whereas in ideal lab conditions it approached 0,8 -1 Gbps.
- ✓ Specific and varying radio conditions prevailing on location, have affected loss, latency and jitter and as a result availability/reliability metrics. Overall, the networks were robust and could satisfactorily handle the traffic provided.
- ✓ In most use cases, latency for the e2e network remained well below 15 ms which is a very satisfactory result, even though it may fall short of some ambitious purely URLLC cases. Still, this is a network engineering issue that goes beyond the specific trial networks.
- ✓ Real time traffic especially created by video streaming applications, varied from 5 to 120 Mbps, while the upload throughput capacity of the networks varied from 20 to 60 Mbps.
- ✓ The transport parts of the networks (provided by OTE) exhibited remarkable stability and performance consistency throughout the trials.
- ✓ The complete measurements files could be correlated and further analyzed in relation to application-level measurements using the 5G EVE KAFKA communication. This resulted in innovations related to real-time analysis and decision making (i.e., deployment of resources, or establish a new VNF).

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Thank you
Q & A

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