



mobileum

Action driven by intelligence

Emergency Communication Systems and Protocols Testing Services

Technical Proposal

Prepared for



National Single Emergency Call Service 112, Moldova

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Revision History

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1 Executive Summary

Mobileum is happy to assist National Single Emergency Call Service 112, Moldova (hereafter referred to as Service 112) with end-to-end testing capability across its network, helping to improve the network KPIs and offer enhanced services to its subscribers. We are pleased to present this technical proposal from our broad and versatile Testing Portfolio in response to Service 112's requirements.

The modernization of emergency communication networks through SIP-based interconnections and next-generation Service 112 necessitates continuous assurance of service availability, accuracy, and performance. Reliable routing of emergency calls, precise delivery of caller location information, and consistent accessibility across mobile and fixed networks are fundamental to effective emergency response operations. In addition, the expanding scope of emergency services including voice, data, SMS, public warning systems, and automotive eCall requires systematic validation across multiple access technologies and network environments. A centralized, subscription-based testing and monitoring service provides the required visibility, control, and reporting to support operational readiness, regulatory adherence, and sustained confidence in public safety communications.

Mobileum proposes to support Service 112 with its best-in-class GlobalRoamer® platform, a cloud-based, end-to-end active testing solution designed to ensure the availability, reliability, and compliance of emergency communications. The solution enables automated validation of emergency voice calls, SMS, public warning notifications, and eCall/NG-eCall services across 2G, 3G, LTE, VoLTE, IMS, and 5G networks. By generating real mobile traffic through SIM virtualization and a global SIM pool, GlobalRoamer® validates accurate call routing, location handling, and service performance from an end-user perspective. Real-time reporting, alarms, and detailed QoS/QoE metrics provide continuous service visibility and rapid issue detection. This subscription-based approach ensures operational readiness, regulatory compliance, and sustained confidence in Service 112 emergency communications.

We are firmly committed to earning Service 112's trust and respect as its preferred System provider and building a successful, mutually beneficial relationship to contribute positively to Service 112's testing requirements.

1.1 Mobileum's Offering to Service 112

Mobileum's proposed solution is based on its automated, active monitoring platform, GlobalRoamer®. The GlobalRoamer® platform is the industry's most advanced end-to-end active testing platform. It's hardware-based, and software-integrated solutions help operators assess and monitor the performance of network services and components by running real end-to-end tests and monitoring across various interfaces. Detailed explanations of system capabilities and components offered are provided in Chapter 2.

Product Offering	Offer Type	Included in the offer	Description
GlobalRoamer®	Flat rate Subscription Package	Included	Mobileum has offered the GlobalRoamer® platform subscription. The subscription supports automated testing of 112 voice calls, SMS to 112, public warning, and eCall/NG-eCall services, including the 1000 annual test-unit volume.



Table: Our Offer to Service 112

Please note that any requirements from Service 112 that are not covered in this Mobileum Technical Proposal or our Statement of Compliance (SOC) answers are outside the scope of the project and would necessitate a Change Request from Service 112 to include them as part of the offered scope and shall always be subject to a mutual agreement between the parties. For all requirements where we have responded as “Roadmap” in the SOC, it indicates that this is not a commitment to Service 112 or an obligation on the part of Mobileum. All Roadmap features are for indicative purposes only and are subject to change by Mobileum at our sole discretion, including but not limited to its availability to Service 112. Furthermore, those items marked as “Roadmap” will be delivered in line with Mobileum timelines and will not form part of the acceptance criteria unless there is a specific and separate milestone for them, explicitly agreed upon by Mobileum.

1.2 Mobileum Portfolio

Mobileum is the globally acknowledged leader in Testing and Monitoring, Network, and Roaming intelligence, Security, Fraud, and Risk services, and has been supplying industry-leading solutions in Testing and Monitoring intelligence to **over 1,000 global CSPs**. Our rich and exhaustive suite of Testing and Monitoring is used in more than **213 countries globally where 9 in 10 telecom operators use Mobileum testing solutions including all major telecom operators in the world**. Our solutions operate at the heart of several centralized, hub-based service ecosystems. We have been the preferred partner for our customers as they have navigated complex evolutions in the **technology, business and regulatory landscape** that have shaped the communication services business over the past decade and more.

Mobileum is offering active end-to-end domestic and roaming testing solutions to its customers which will assist them to improve network security and service quality for mobile networks. The offered Testing and Monitoring Solution is capable of performing various tests such as Voice, Messaging, Data, VoLTE and IoT on all technologies i.e., GSM, UMTS, LTE, NBIoT, 5G NSA and 5G SA. The offered Solution is compatible with various deployment models such as BareMetal, Virtualized and Cloud. The Solution will provide information from various levels i.e., from high level to root cause analysis and equip the operator to focus only on the action plan.

Mobileum’s Testing solution is a market-leading and award-winning product suite that has been certified by various standardization bodies, serving as proof of their extremely high-quality product, namely – **DIN EN ISO 9001:2015 Certificate**, **BABT** (British Approval Board for Telecommunications) for SITE System and **Eco Vadis**.



Figure: Mobileum Memberships and Certifications

SITE Test System have the following certificates and product conformities:

- FCC, CE Marking, ETL, Directives 2002/95/EC and 2002/96/EC
- Change Management with OTRS
- Environmental protection like green procurement and recycling
- Ethics like Sarbanes Oxley and "Code of Business Conduct and Ethics"

Mobileum enhanced E2E active testing platform offers capabilities to provide users with all the tools necessary for a complete Network lifecycle addressing multiple uses across all layers of the Network.

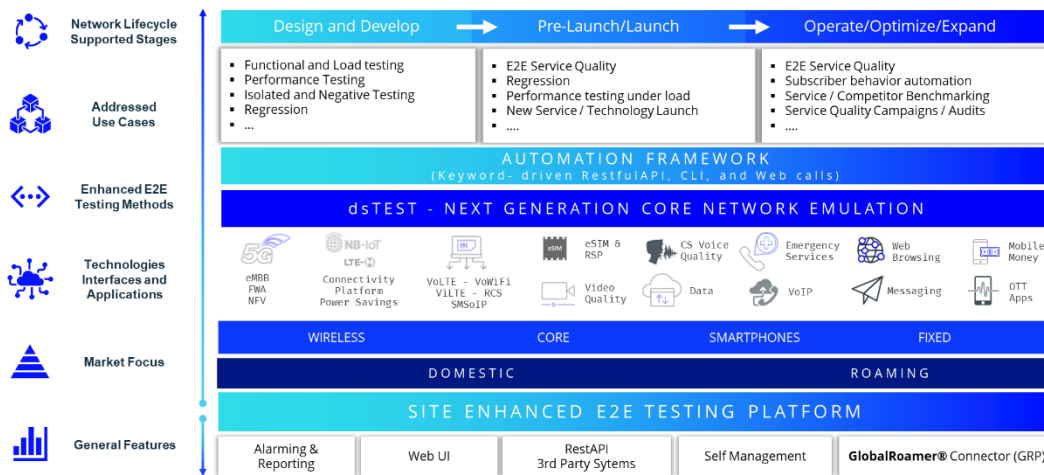


Figure: Mobileum SITE End-to-End Active Testing Platform



GLOBAL ROAMER		
End-to-End Roaming Quality of Service Testing WebUI with SIM multiplexing Technology		
TEST · MONITOR · TROUBLESHOOT · BENCHMARK		
Use the extensive GlobalRoamer platform covering 98% of all countries		
Virtualize any SIM card to any location in the world		
Generate real mobile traffic		
Measure real user experience and network performance		
Monitor GSMA defined KPI's		
Access to the GlobalRoamer platform	User-friendly WebUI Full test library	GlobalRoamer coverage and technologies
Active E2E testing platform	Schedule tests with predetermined KPI's	213 countries
SIM pool to terminate and originate test calls	Scheduler, reporting and trace analysis view	854 networks
Ad-hoc and fully flexible		600+ SIM cards 2G/3G, LTE, VoLTE, IoT, eCall
MONITORING		
END-TO-END TESTING	STEERING OF ROAMING	INTERNATIONAL INTERCONNECTION
End-to-end customer experience testing in specific locations	Monitor Outbound SoR daily or with monthly audits	Verify the quality of your international carriers
Verify Network Performance and Quality of Service	Benefit from OTA based SoR	Identify fraud cases like CLI spoofing and Call Stretching/Voice Playback
Check SS7 Connectivity to ensure outbound partners coverage	Perform Anti-Steering of Roaming Testing	Ensure that SLA's with your international carriers are fulfilled
LATEST FEATURES		
IOT EXPERIENCE	SIM POOL TRAFFIC PACKAGES	
Testing global IoT Connectivity	Use SIM Pools for generating charged calls	
Supports 2G, 3G, LTE, NB-IoT & LTE-M	Local Voice calls, SMS and Data Download	
IoT Specific reports and dashboards	International Voice calls, SMS (P2P and A2P)	
Service Monitoring		

Figure: Mobileum GlobalRoamer® End-to End Active Testing Platform

1.3 Unique Value Proposition and Benefits with Mobileum

Mobileum’s portfolio of products and services has put us in an exemplary position in delivering value to Service 112. Mobileum is confident of delivering an unmatched value proposition through the proposed solution offering, the key elements of which are briefly enumerated below.



- Mobileum offers industry most comprehensive solution to assure E2E availability and quality across all product/services over all the network technologies ranging from 5G Non-standalone (NSA) and standalone (SA) to 3G/4G, Fixed wireless, OTT, VOIP and IOT network proactively and in fully automated way.
- Mobileum offer Domestic, Roaming, Interconnect Active Testing, and monitoring solution that can be leveraged for Benchmarking against competition.
- Rich Reporting capabilities with Dashboards tailored for multiple audience including Management, Engineering, Operation and Marketing.
- Mobileum solution supports 5G NSA/ SA and LTE using various frequency bands to generate an extensive set of standard and additional 5G service KPIs, such as 5G radio, band, and bandwidth, network type, and restrict DCNR.
- The solution ensures accurate location handling, correct call routing, and uninterrupted accessibility to emergency services, minimizing avoidable delays and safeguarding public safety while protecting the operator's brand and trust.
- By enabling remote testing through TAC and CID emulation, the solution significantly reduces operational expenses associated with site visits while ensuring compliance with emergency and eCall regulations, mitigating the risk of penalties and legal exposure.
- The solution delivers consolidated performance insights, real-time alarms, and diagnostic metrics to proactively identify and resolve time-sensitive issues, ensuring readiness for emergency services and eCall systems with consistent quality assurance.
- Mobileum GlobalRoamer® solution help its customers to get insights into roaming quality for any operator across the world
- Mobileum GlobalRoamer® solution provides advantage to its customers to create an efficient and cost-effective strategy by leveraging GlobalRoamer®'s worldwide footprint
- Mobileum GlobalRoamer® solution helps its customers to compare MNO results per country or per roaming partner, against reference values. "Average" and "Best-in-Class"
- Mobileum GlobalRoamer® solution helps to benchmark routes and make pro-active decisions to balance quality and cost
- Mobileum GlobalRoamer® solution offers comprehensive troubleshooting capabilities with real time alarming upon service interruption or KPI degradation.
- Mobileum GlobalRoamer® is capable of performing the IREG testing for all technologies. We also have Outbound IREG testing in 213 countries to overcome resource constraints on roaming partner side
- Mobileum GlobalRoamer® supports end state tests in various modes such as IDLE, ATTACHED, ACTIVATED, IMS REGISTERED. This allows execution of multiple test cases sequentially using same resources within the same test job which significantly reduces time of test execution.
- Mobileum GlobalRoamer® solution ensures roaming revenue by monitoring service availability and performance with easy-to use dashboards
- Mobileum recognizes the importance of fast time-to-market, and we pride ourselves in accommodating our customer needs by collaboratively designing and managing a plan that helps to deploy our integrated solution platform quickly and efficiently.
- GlobalRoamer® solution can help Customer to verify the inbound market share given by their roaming partners with its inbound market share testing under Steering of roaming test scenario. This test will help Customer to have the actual percentage of the inbound market share and approach their roaming partners for appropriate solutions if any discrepancy is discovered. Let's assume Service 112's roaming partner potentially can give them 3.5 million minutes, but what Service 112 gets is only 1 million minutes. But Service 112 have neither information about the 3.5 million nor how much their competitors gets. To know your Inbound Roaming Market Share is key to define your Roaming strategies and Mobileum can tell you that.

Below is snapshot of some of the salient features of the Mobileum's GlobalRoamer® testing module.

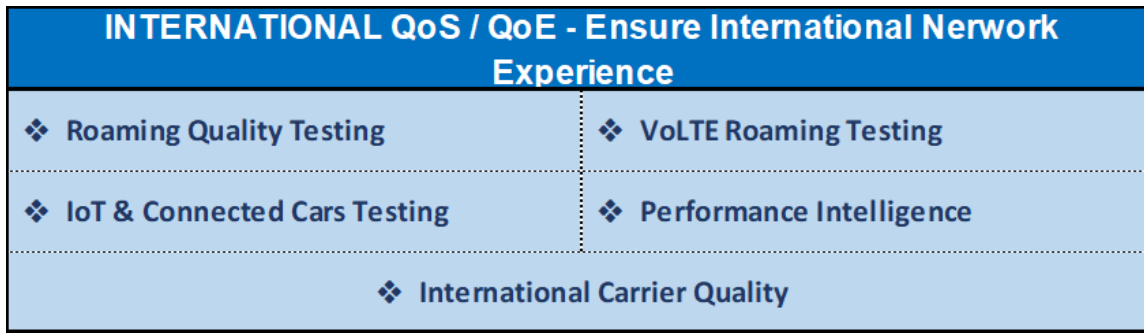


Figure: Salient Features

1.4 Key Contacts

Key Mobileum contacts for this proposal are listed below. Any queries regarding the contents of this proposal may be directed in the first instance to them.

Contact Type	Name and Designation	Contact Details
Commercial Contact	Zdravko Stambolov Key Account Manager	E-mail : Zdravko.Stambolov@mobileum.com Mobile: +35 9896 664881
	Victor Sirbu Technical Account Manager	E-mail : Victor.Sirbu@mobileum.com Mobile: +37 379 006477
General Manager	David Rottelman General Manager	E-mail : David.Rottelman@mobileum.com Mobile: +972 544 463899
Global Executives	Miguel Carames Chief Product Officer	E-mail : Miguel.Carames@mobileum.com Mobile: +19252062557
	Raja Hussain Chief Revenue Officer	Email: Raja.Hussain@mobileum.com Mobile: +65 9655 1168

Table: Key Contacts

2 General Overview of GlobalRoamer® System

Mobileum GlobalRoamer® System comprises of both Hardware and Software and is a globally installed testing system with a worldwide-footprint of testing probes, entirely managed, maintained and owned by Mobileum. It is the world's largest cloud setup for international QoS/QoE.

A footprint for roaming covering 98% of the globe

- 710+ networks
- 350+ locations
- 220+ countries
- 50+ fixed line networks
- **Central SIM Multiplexer** with a SIM Pool from 500+ MNOs



Figure: GlobalRoamer® Presence Across The World

The GlobalRoamer® testing and monitoring platform supports all the basic services such as Voice, SMS, Data and IoT testing and monitoring. The offered solution will enable Service 112 to perform Service Testing, Quality of Service (QoS), Quality of Experience (QoE), Tariff testing and roaming partnership by conducting related tests on various technologies such as 2G, 3G, 4G, 5G, IoT, VoLTE, VoWiFi and Emergency Services in the roaming scenarios.

Mobileum's GlobalRoamer® include an integrated Automation Framework, bolstered by GRP units for seamless testing automation. The latest upgrade of ICQT incorporates support for Voice over LTE (VoLTE) and SMS over IP (SMSoIP), enhancing testing capabilities. With enriched IMS parameters, GlobalRoamer® ensures comprehensive testing coverage for IMS deployments. Additionally, new test cases for Interactive Voice Response (IVR) and Domain Name System (DNS) further augment testing versatility. The VoLTE GRQ module introduces a new Macro Template and comprehensive reporting features, enhancing VoLTE testing efficiency. GlobalRoamer® stays updated with the latest IR25 version upgrades to maintain compatibility and performance. Moreover, Mobileum provides an important note to GRP customers regarding upcoming 2G/3G network closures, ensuring preparedness for network transitions. Overall, Mobileum's GlobalRoamer® offers a robust suite of features to meet the evolving needs of telecommunications testing and assurance.

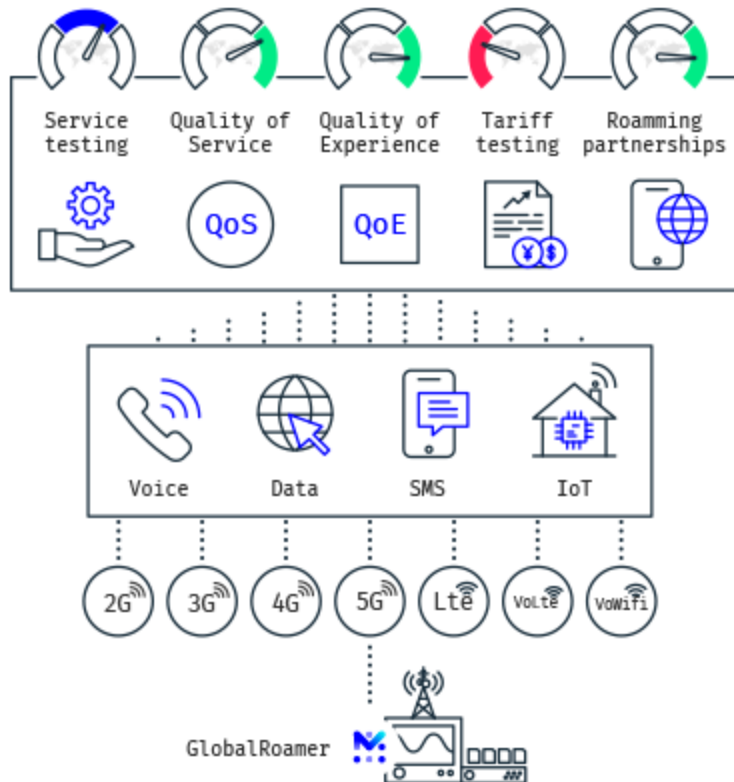


Figure: Roaming Quality Testing

This section details about the platforms and the features that are being proposed to Service 112.

2.1 Active Testing Solution Overview

GlobalRoamer®, the Mobileum Integrated Test Environment, is an internationally installed test system for 2G, 3G, LTE, VoLTE, IoT, 5G, and Emergency Services mobile services as well as for fixed network services. Real mobile traffic can be generated and tested anywhere, anytime, by virtualizing any SIM to any location in the globe, using our SIM card pool with about 550 SIM cards and over 400 MVNOs. By reaching thousands of VLRs around the world, Mobileum’s GlobalRoamer® solution enables CSPs to test international roaming agreements. CSPs are enabled to cross-check global partnerships, in addition to their customer’s roaming experience. The impact is widespread, benefiting not only the subscriber’s service experience but also the CSP, which can now speed up roaming agreements and troubleshoot any problem more quickly. Mobileum’s extensive amount of test cases allows Service 112 to measure and improve their user’s experience and network performance and identify service outages through real-time reporting and alarming. It is the most advanced automated active end-to-end testing and monitoring system available on the market. GlobalRoamer®’s unique features allows Service 112 to test and monitor the QoS QoE of the end user on roaming, enabling them to verify the end user experience being independent of any data from their roaming partners, perform various tests such as Roaming Testing, Global Roaming Quality Testing (GRQ), Steering of Roaming Testing (SoRT), IREG Testing, Roaming Performance Intelligence (RPI), International Interconnect Quality Testing, IoT Testing and Service Quality



Monitoring and get strategic insights into the roaming market and increase your roaming revenues, increase your direct roaming footprint full end-to-end setup, access all GlobalRoamer® performance data and re-evaluate your roaming strategy, guarantee roaming service through GlobalRoamer® IoT experience cloud,

Mobileum GlobalRoamer® helps you to Optimize your Roaming Business by its various customizable roaming services offerings. Some of the service offerings from GlobalRoamer® can be listed as below:

- **Roaming Footprint Roll Out Services**, under this offering the services are fully managed by Mobileum, and the reports are shared with the Customer. The offered use cases under this offering as mentioned below:
 - Roaming Implementation, (Full End-to-End Roaming Roll-Out including TADIG Testing)
 - IoT Agreement Negotiations
- **Post Launch Quality Testing**, under this offering the services are offered as SaaS to the Customer. The offered use cases under this offering as mentioned below:
 - Roaming Quality Assurance
 - Inbound Roaming Benchmarking
 - SLA Verification
- **Roaming Cost/ Revenue Optimization**, under this offering the services are offered as Managed Services by Mobileum, and the reports are shared with the Customer. The offered use cases under this offering as mentioned below:
 - Inbound Roaming Market Share
 - Roaming Performance Intelligence

With its sophisticated hardware and software components, GlobalRoamer® 's unique scalability, versatility and flexibility guarantee high investment security for your complete end-to-end active testing requirements. A high-level description of products and services of GlobalRoamer® solution is shared below.

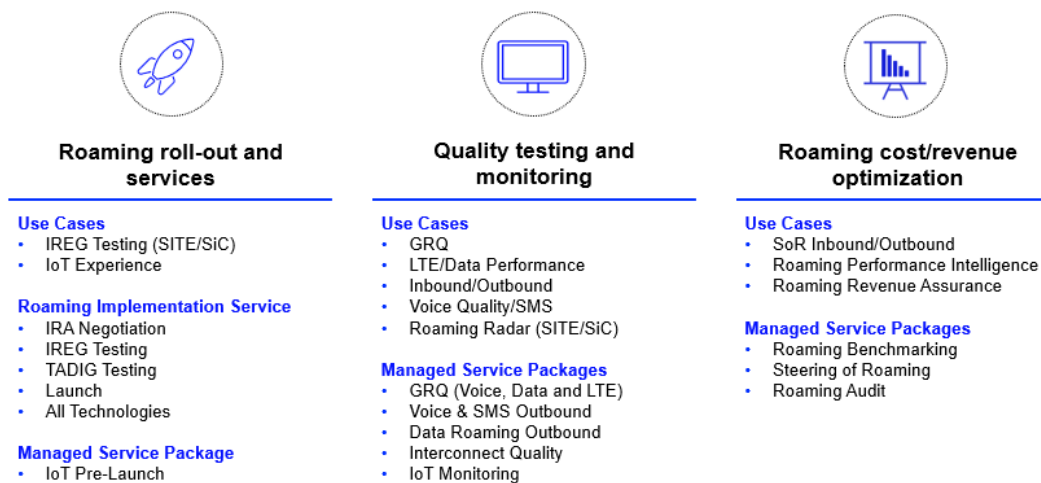


Figure: GlobalRoamer® Products and Services



GlobalRoamer® Functional Overview:

Mobileum offers a wide range of Products and Services like Roaming roll-out and Services, Quality Testing and Monitoring, Roaming Cost/ Revenue Optimization. The GlobalRoamer® testing and services has multiple offerings Roaming, Quality of Service Testing, International Carrier Testing, Steering of Roaming testing.

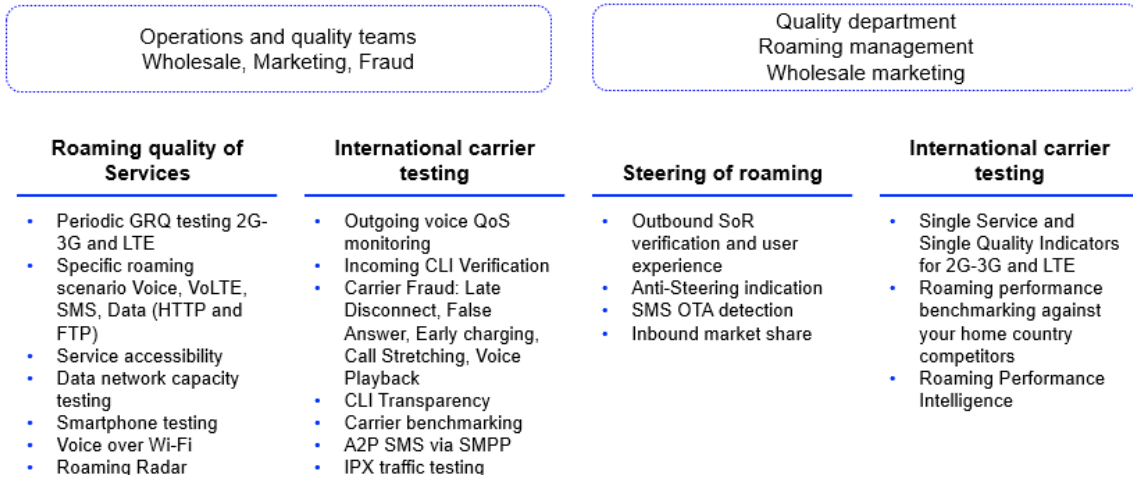


Figure: GlobalRoamer® Use Cases (Testing and Services)

With GlobalRoamer® extensive library Customer can access more than 387 standard test cases measuring over 5000 KPIs, over 1000 customer-specific measurements and tests. Mobileum GlobalRoamer® has its own setup of 89 fixed networks/lines in 48 Countries and 59 Locations, 549 SIM from 414 operators, 5G presence across 33 locations in 28 Countries with further expansion in roadmap and IoT presence across 81 Locations in 60 countries and 142 Mobile Networks with further expansion in roadmap.

The flexibility of test, scenarios, measurements and KPIs allows you to customize your system at any time to adopt to an ever-changing environment of new network Services and network technologies.

The GlobalRoamer® tests system combines radio, fixed-line, IP and core network testing- all in one test system!

You can use it for single-technology testing, as well as cross-technology testing using 2G, 3G, LTE, IoT and 5G networks

GlobalRoamer® Characteristics:

- Model real subscriber behavior: Continuous monitoring through scripts that simulate end-user behavior.
- Detailed measurement activity: Provides activity logs for deep test analysis.
- Modular structure: Guarantees maximum flexibility in Service, protocol and end-to-end active testing.

Supported Technologies:

GlobalRoamer® system is a ready to use solution as its Local Units are equipped with various wireless interfaces and are deployed across various locations globally. Depending on the model, the wireless interfaces support the following technologies:

- GSM, GPRS, EDGE, UMTS, HSDPA, HSDPA+, LTE and LTE- Advanced
- NB-IoT and LTE Cat M1. WLAN. 5G.

2.1.1 GlobalRoamer Architecture

GlobalRoamer®, the Mobileum Integrated Test Environment, is the industry’s most advanced active end-to-end test system available. It enables network operators and ISPs to perform preventive and permanent Roaming roll-out, Quality Testing and Monitoring, Roaming Cost/Revenue Optimization by facilitating, managing and operating their own testing infrastructure on the roaming business, when the end users are latched on the roaming partner network.

It comprises both hardware and software to emulate a large range of different test scenarios to get the full picture on your subscriber’s network experience.

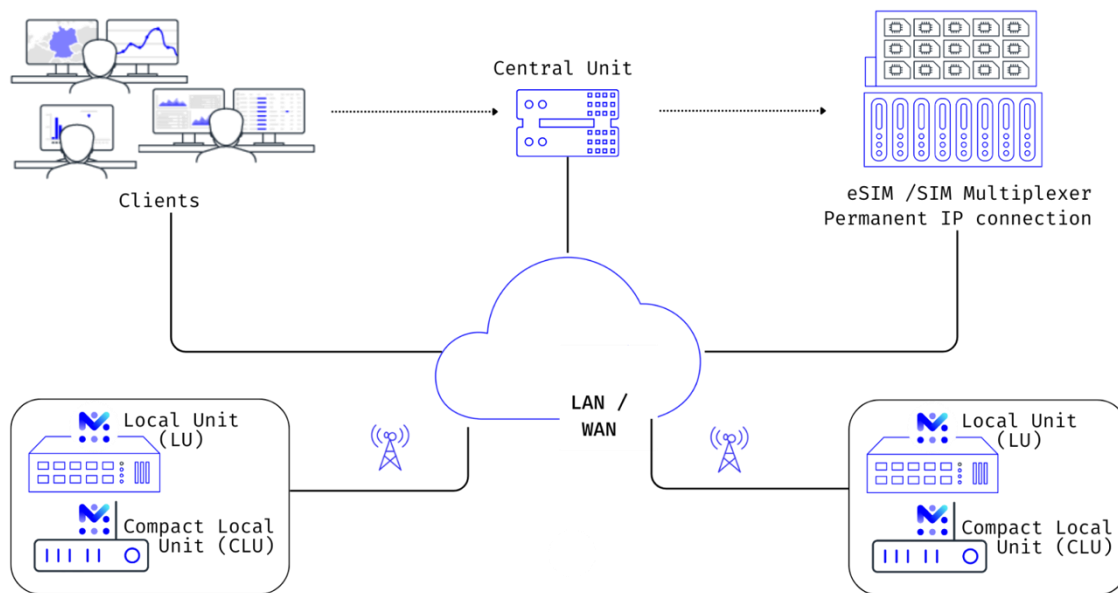


Figure: GlobalRoamer® Setup

The GlobalRoamer® test system easily integrates into any existing network infrastructures and is made of five essential architecture components:

Clients communicate with the system via a user-friendly and intuitive Graphical User Interface that can be accessed via a web browser. The user logs in and controls the whole process from testing to reporting. The Web UI is the primary user interface for daily test work: execution, reporting, alarming, configuration, etc. GlobalRoamer® RESTful API provides access to resources which can be used by external clients to interact with the system, e.g., for test case edition, parametrization, scheduling, getting the status of a running test case or even retrieving KPIs from executed tests or even receiving



alarms generated by GlobalRoamer® system. GlobalRoamer® also helps in diagnosing network problems, reporting and real-time alarming. The API templates can be exported as JSON. JSON can also be exported via API call or Web UI.

Central Unit control and coordinate central processes and the whole system. The overall system is managed by a central server called the **Central Unit** which comprises the central processes used for the control and coordination of the complete platform as well as different **databases** which contain the system configuration, test definitions, measurement definitions, test details and user logins.

The Central Unit (CU) is the test control unit of GlobalRoamer® and some of its main components include:

- Operation & Maintenance (O&M) Manager
- Scheduler
- Resource Manager
- Test Execution Manager

The O&M Manager supports the administration and control of all GlobalRoamer® units from a centralized application. All Local Units can be managed remotely without manual on-site intervention. In case of failure, an alarm is generated by the O&M Manager. Optionally, these alarms can trigger actions such as sending an SNMP trap or executing a script to send e-mails or text messages.

GlobalRoamer Scheduler allows for test case planning by setting the periodicity of the desired test cases. To avoid resource conflicts, an intelligent Resource Manager controls access to interfaces and SIM cards, assuring smooth operation and maximum test parallelism. GlobalRoamer® Test Execution Manager controls test jobs and administers information stored in the Local Units.

SIM Multiplexer handles many SIMs and USIM cards to physically separate them from mobile Terminals. SIM cards are stored in the SIM Multiplexer (SIMMUX). A SIMMUX can have a maximum of 15 boards with each board able to accommodate 15 SIMs, resulting in a maximum capacity of 225 SIM Cards in one unit. More SIMMUXs can be configured depending upon the test requirements. Service 112 does not need to send the test SIMs to different locations. Using Central SIM Multiplexing, all the test SIMs will be physically stored in the SIM Multiplexer. Then at the time of the tests' execution, these SIMs are virtualized and are used to run any kind of voice, messaging, or data test on the available networks at that location – emulating a real subscriber at that location. The subscribers' information from a SIM card is read out by the system and transmitted via LAN/WAN network to any test location required. The latest version supports eSIM, which extends the SIM profile centralization with the possibility to directly download eSIMs from QR codes and no need to ship physical plastic SIM cards anymore.

Local Units contain test probes located at geographically different locations for test execution. The GlobalRoamer® setup has preinstalled Local Units (Radio Probes) at 344 Locations in 214 countries and various Network tests including 3G, 4G, 5G, fixed IP, core network tests or Smartphone testing, can be performed at those locations without your subscribers' SIM cards. Any SIM cards stored in a SIM Multiplexer can be virtually transmitted to any of the system's remote test stations (Local Units). The subscriber information of the virtually transmitted SIM card is then used by the system to perform the actual test.

Data Bases which contain the system configuration, test definitions, measurement definitions, test details.

With its leading-edge hardware and software components, GlobalRoamer®'s unique scalability, versatility and flexibility guarantee high investment security for your complete end-to-end active testing requirements

2.2 Features Description

The key features supported by the GlobalRoamer® platform can be listed down below.

2.2.1 Openness

The GlobalRoamer® Solution system comes as a standard preconfigured package for the testing and monitoring need in the roaming scenario. However, depending upon the customer's needs it can be customized to meet the specified requirements. Existing equipment is linked directly, controlled, and monitored via the GlobalRoamer® Web User Interface. GlobalRoamer® can also be easily integrated into existing test environments via the RESTful Application Programming Interface.

GlobalRoamer® RESTful API provides access to resources which can be used by external clients to interact with the system, e.g., for test case edition, parametrization, scheduling, getting the status of a running test case or even retrieving KPIs from executed tests or even receiving alarms generated by the GlobalRoamer® system.

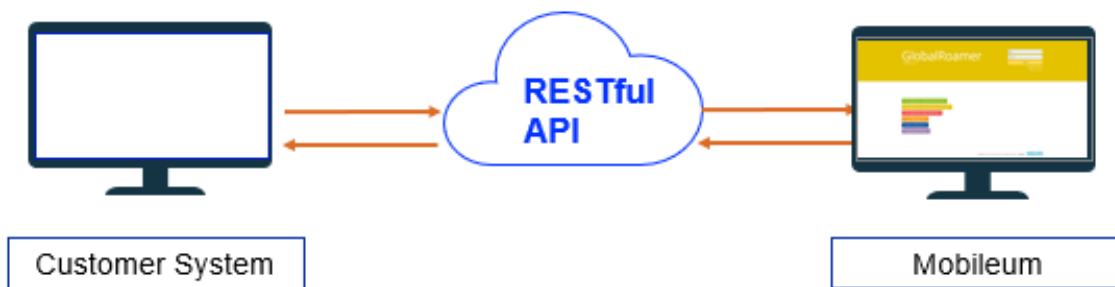


Figure: Customer Access to GlobalRoamer® through RESTful API

2.2.2 Attractive Web User Interface

GlobalRoamer® is accessible via the Web User Interface (UI) with identity access (user and password created within GlobalRoamer®) or via LDAP authentication.

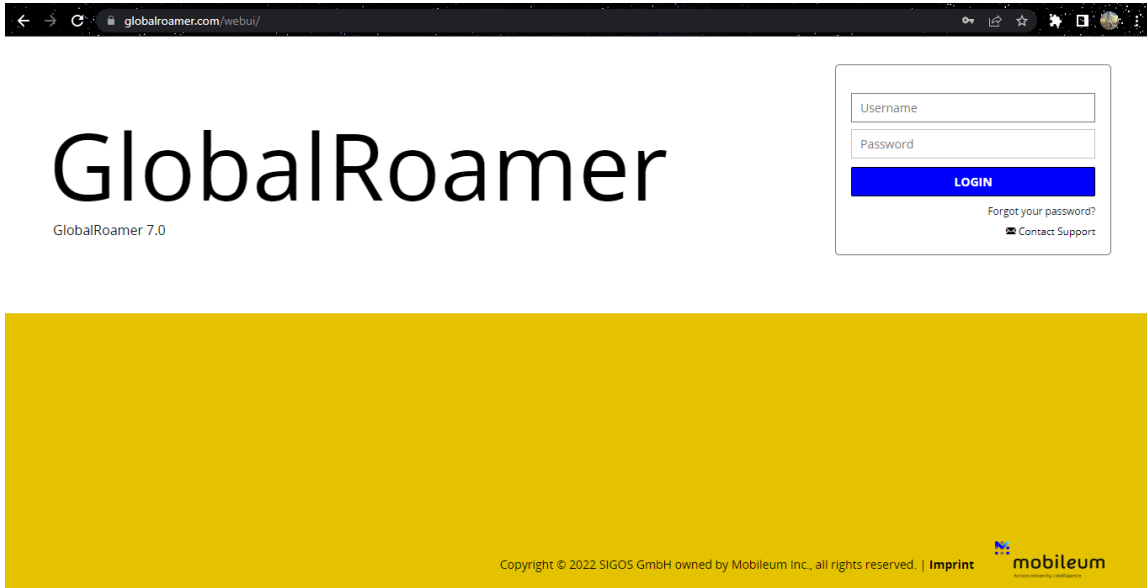


Figure: GlobalRoamer® Web UI login

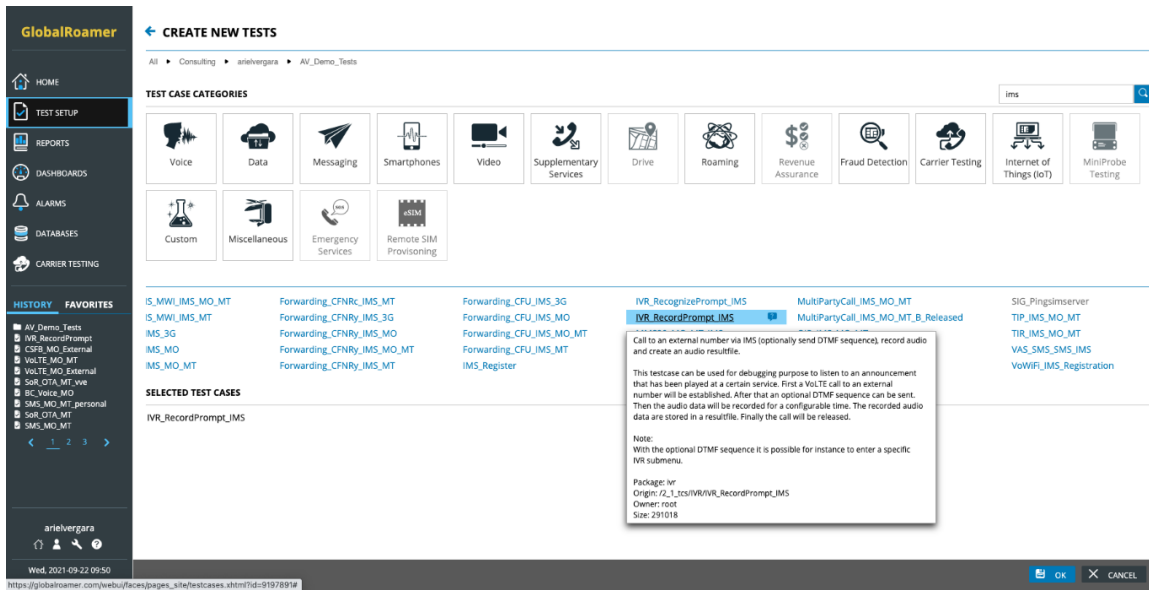


Figure: GlobalRoamer® Web UI

2.2.3 Easy Test Case Setup

GlobalRoamer® has a powerful web-based graphical user interface (WebUI) to enable the user to set-up desired tests quickly. Tests can run (repeatedly) in real-time. The user can view each test as it progresses and has immediate access to detailed trace information as soon as the test completes to troubleshoot rapidly. The macro template feature allows the users to quickly configure the visited side and home side for testing. Macro template also enable the IMS variables required for IMS Registration, VoLTE call and SMSoIP.

The test set up view allows the setup of various tests viz. Voice, SMS and Data testing. It currently shows all orders that have been executed. If an order includes multiple tests the number of pass, failure and inconclusive is shown.

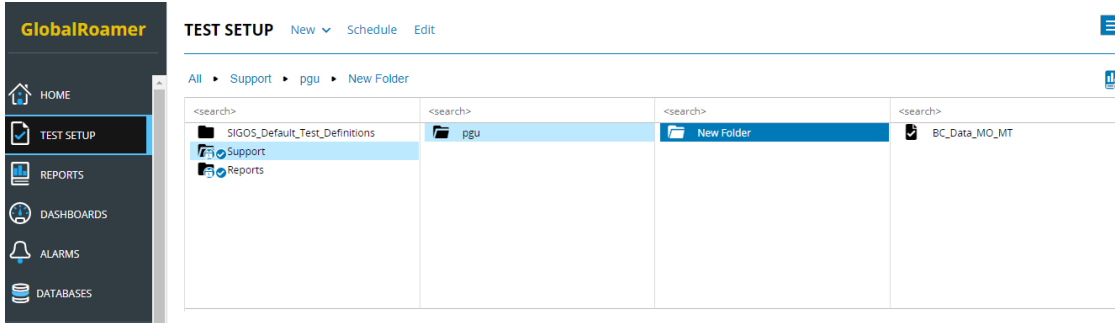


Figure: Test Case Setup

To execute a new test, the call type has to be selected first and then from the New menu the scheduling is selected.

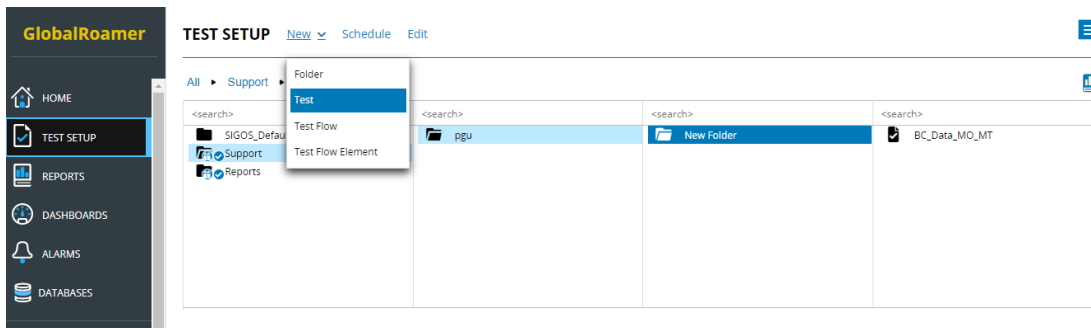


Figure: Test Case Setup_2

Ad-Hoc test are for one single run. The periodic testing allows to schedule the tests repetitively.



Figure: Ad-Hoc Voice test case Setup

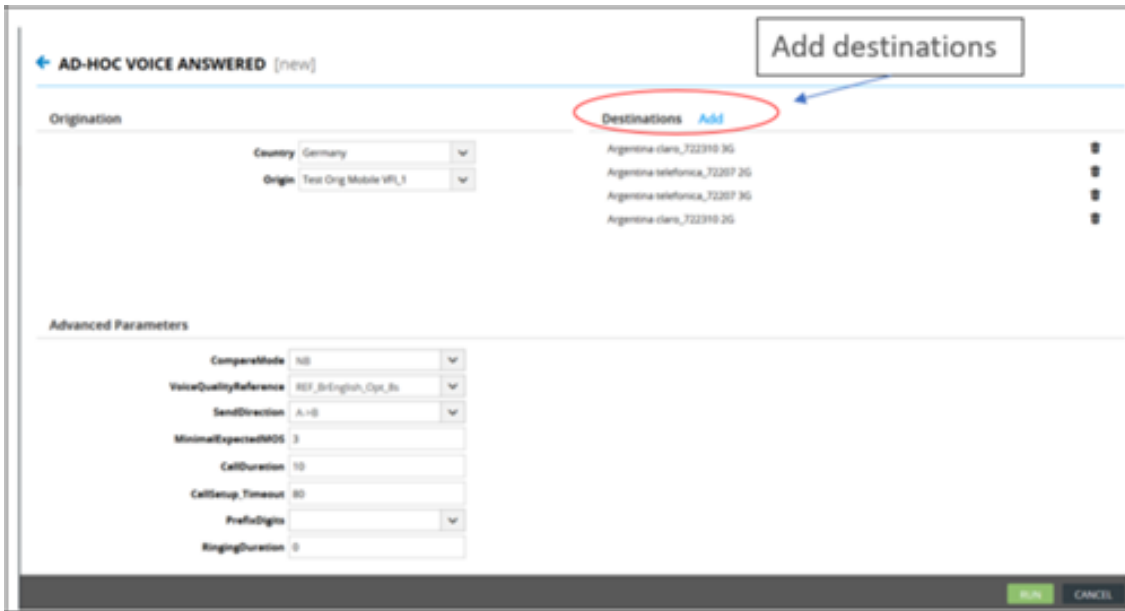


Figure: Ad-Hoc Voice test case Setup_2

2.2.4 Reporting

The GlobalRoamer® System provides reporting capability to view reports by service, roaming partner, country, etc. Because of the underlying service model technology, it is also possible to drill-down to identify specific service problems, view individual test results or even view detailed test trace information to help identify the root cause of a service problem.

The landing page of the Testing application is the Report view. In this page the test results are presented with a set of essential KPIs. The test results can be displayed per test typology by using the dropdown menu. Once a test type is selected only the corresponding KPIs are displayed.

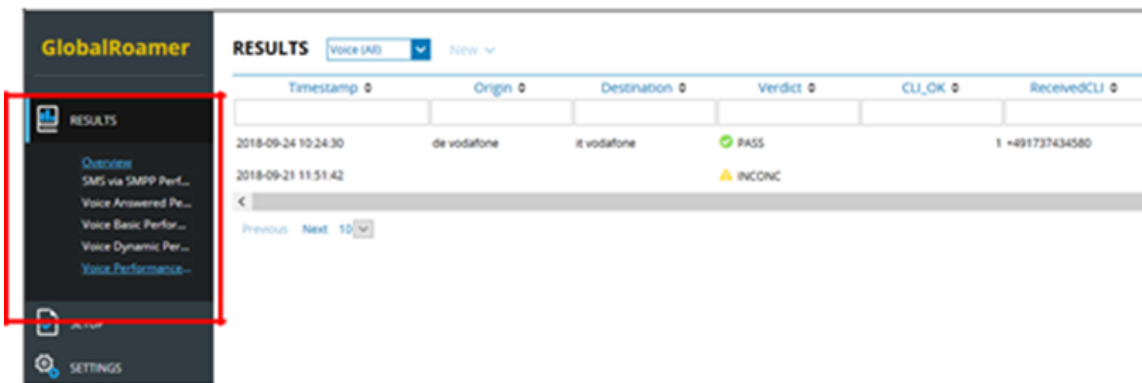


Figure: Report Extractions

All charts shall be configured individually via the GlobalRoamer® Reporting environment. Reports can be created for all KPIs and Measurements available in GlobalRoamer®. These reports can be based on standard KPIs, customized KPIs and KPIs according to ETSI specifications. The reports can be

illustrated in various formats like markers, bars, lines, or matrix to provide a user-friendly color-coded overview of vital services or specific KPIs.

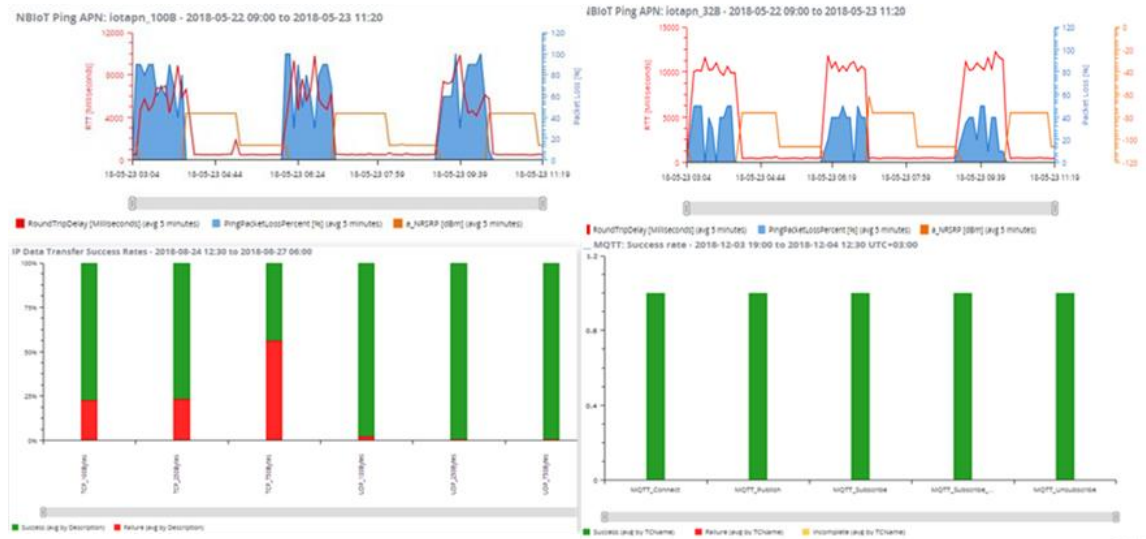


Figure: IoT Reporting Screenshots

The GSMA has developed a set of recommendations for testing and monitoring the Roaming Quality. The IR.81 covers all technologies available 2G/3G, LTE, VoLTE and IMS service suite. Below shared image shows the KPIs supported for IR.81 based tests:

All KPIs - 2019-11-01 00:00 to 2019-12-05 15:14 UTC+01:00

	ae du	at 3	at orange	au optus	bh batelco	avg
----- Service Access & Ping -----						
101_PS_location_update_success_ratio [Percent]	94.62	99.07	9.52	86.26	99.44	66.1
102_PS_location_update_delay [Seconds]	11.08	5.57	3.97	9.28	9.97	9.1
105_Default_EPS_bearer_context_activation_success_ratio [Percent]	99.05	100.0	99.41	99.56	100.0	99.66
106_Default_EPS_bearer_context_activation_time [Milliseconds]	35.25	23.39	64.26	84.32	30.29	46.36
107_DNS_host_name_resolution_success_ratio [Percent]	100.0	100.0	100.0	100.0	100.0	100.0
108_DNS_host_name_resolution_time [Milliseconds]	776.9	242.51	250.27	629.91	479.83	529.46
151_PING_packet_loss_ratio [Percent]	0.26	0.0	0.07	4.35	0.0	1.17
152_PING_round_trip_time [Milliseconds]	262.1	56.35	75.79	285.37	316.2	175.9
----- HTTP Performance -----						
141_HTTP_IP_service_access_success_ratio [Percentage]	100.0	100.0	100.0	99.18	100.0	99.76
142_HTTP_IP_service_setup_time [Milliseconds]	1777.13	1887.13	475.27	840.84	1787.88	1500.13
143_HTTP_session_success_ratio [Percentage]	100.0	100.0	100.0	99.18	100.0	99.76
144_HTTP_session_time [Milliseconds]	7419.64	40021.4	9081.91	10519.74	5792.41	11774.03
145_HTTP_mean_data_rate [Mbits/s]	0.66	4.66	1.1	6.81	0.44	2.59
146_HTTP_data_transfer_success_ratio [Percentage]	100.0	100.0	100.0	100.0	100.0	100.0
148_HTTP_download_data_capacity [Mbits/s]	--	8.86	--	--	--	8.86
----- FTP Performance -----						
131a_FTP_download_IP_service_access_success_ratio [Percentage]	100.0	100.0	100.0	93.94	100.0	98.66
132a_FTP_download_IP_service_setup_time [Seconds]	3.93	5.39	4.5	4.35	19.15	5.18
133a_FTP_download_session_success_ratio [Percentage]	100.0	100.0	100.0	93.94	100.0	98.66
134a_FTP_download_session_time [Seconds]	5.2	35.25	4.95	15.11	20.11	28.64
135a_FTP_download_mean_data_rate [Mbits/s]	1.12	3.17	3.09	14.92	0.85	5.57
136a_FTP_download_data_transfer_success_ratio [Percentage]	100.0	100.0	100.0	100.0	100.0	100.0

Figure: IR.81 Report

Mobileum’s Reporting Engine provides several options for visualizing VoLTE KPIs that cover service availability (success rates), call establishment durations, and voice quality measurements. All test VoLTE cases provide a set of KPIs, which include:



- IMS Registration Duration
- PCSCF discovery/used address
- No. of Registration Requests
- QCI (default and dedicated bearers)
- SIP KPIs: Invite duration, Trying to Ring duration, end-to-end session establishment duration, session duration
- RTP KPIs: Jitter (Avg., Max), Data Rate, Packet Loss, no. of packets dropped
- Voice Quality (POLQA)
- Offered/used codecs
- L3 KPIs: EPS bearer activation duration, QCI (default, dedicated bearer), AMBR for used APN, GBR/MBR (default, dedicated bearer)

Voice over LTE (VoLTE) Service Overview

Automated Scheduled Testing

		17:59	23:59	05:59	11:59	17:59		
VoLTE PDP Context Activation Duration [Seconds]	*****	0.33	0.26	0.33	0.29	0.26	0.27	
VoLTE IMS Registration Duration [Seconds]	*****	0.98	2.3	2.5	0.83	2.2	0.98	
VoLTE SIP Trying to Ringing Duration [Seconds]	*****	1.85					1.62	
VoLTE SIP Deregistration Duration [Seconds]	*****	0.45	0.45	0.45	0.45	0.45	0.46	
VoLTE SIP Availability [Percent]	*****	100.0	100.0	100.0	100.0	100.0	100.0	
VoLTE to VoLTE Voice Quality [MOS]	*****	4.26	4.29	4.32	4.31	4.31	4.32	
UMTS to VoLTE Voice Quality [MOS]	*****	4.23	4.26	4.28	4.26	4.28	4.23	
VoLTE to UMTS Voice Quality [MOS]	*****	4.11	4.27	4.23	4.25	4.28	4.2	4.15

Precise troubleshooting and diagnosis

Values exceed the threshold of 1 second

Figure: Automated Testing Report

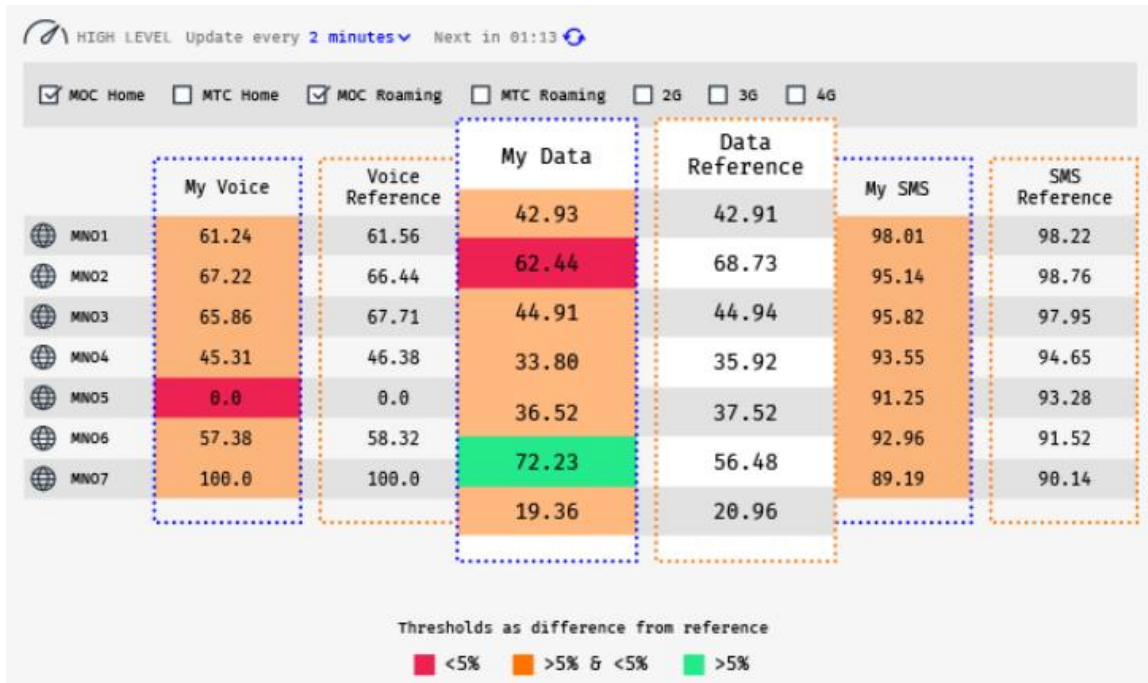


Figure: Benchmarking KPI Report

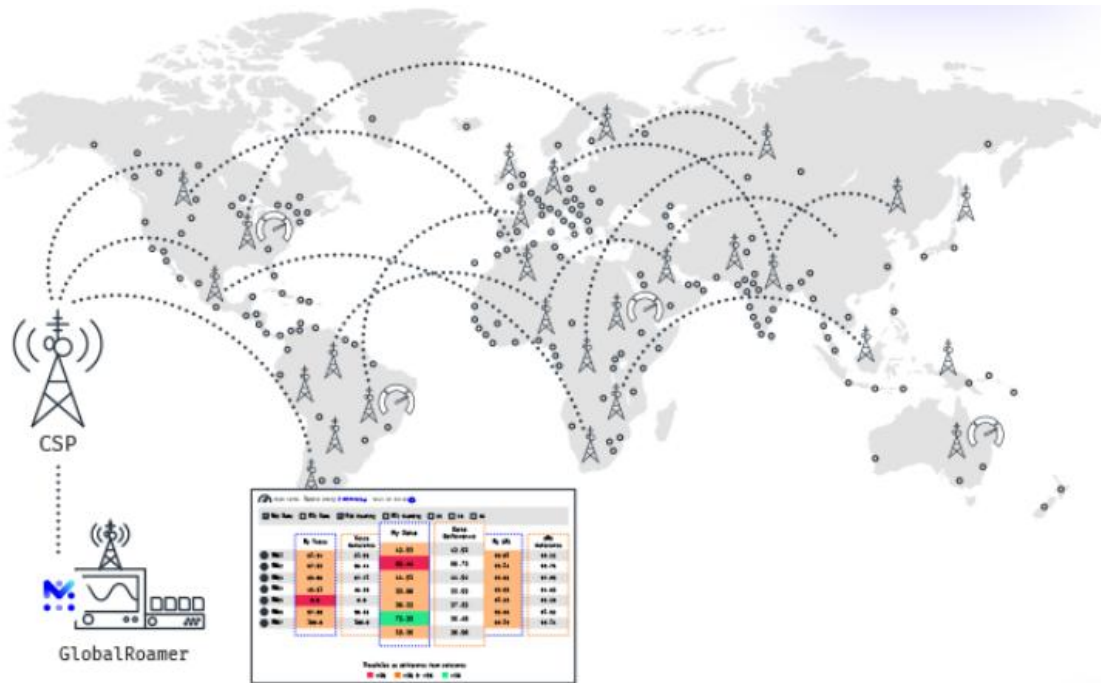


Figure: Benchmarking KPIs of MNOs Across the World

The GlobalRoamer® system support the export of JSON via file via API call or Web UI. Users can export test configurations as JSON files, which simplifies creating API calls from existing test definitions. JSON Export is available with two methods: API call and as a Web UI context menu selection.

POST: <https://HOST/siteapi/expdrt-testcase>

Request:

```
{
  "path" : "/Test
  Folder/SIG_Write_Measurements_P
  ASS"
}
```

Figure: JSON Export image

Reports can now be saved as PDF which makes it easy to share the reports among or other organizations.

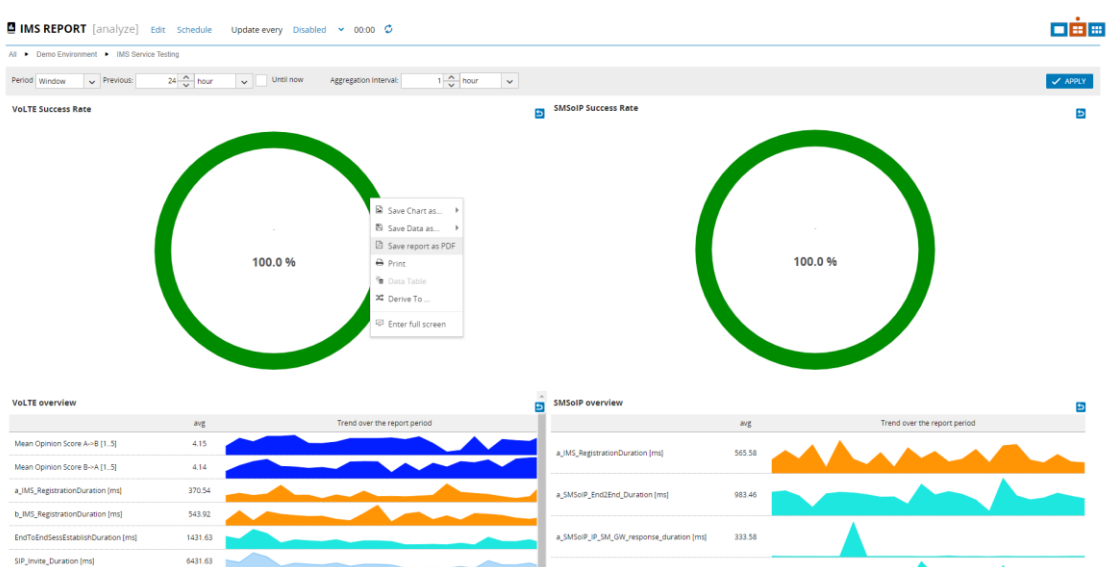




Figure: Save report in PDF

2.2.5 Alarming

With the Alarming module, users defining the individual threshold settings and severity points, real-time alerts can be easily configured to predefined recipients. GlobalRoamer® service alarm supervision is based on KPIs. Different alarm levels can be specified in the reports and the alarms can be defined and triggered by different service alarm features e.g., aggregation and threshold. This service provides real-time alarms if values exceed or fall below a given threshold. When an alarm is generated or cleared, individual notifications can be forwarded to the desired destination via SNMP, e-mail, or SMS.

The system shall allow the assignment of different alarm levels. Those are:

- Warning
- Minor
- Major
- Critical

The system shall support alarm forwarding/notification based on SNMP traps, SMS and E-mails, including individual alarm definition description.

The alarm level shall be adjustable to individual threshold level settings.

The alarm level activation shall be adjustable on user level to allow a condition to be fulfilled before an alarm will be generated

The alarm function shall support variable threshold conditions:

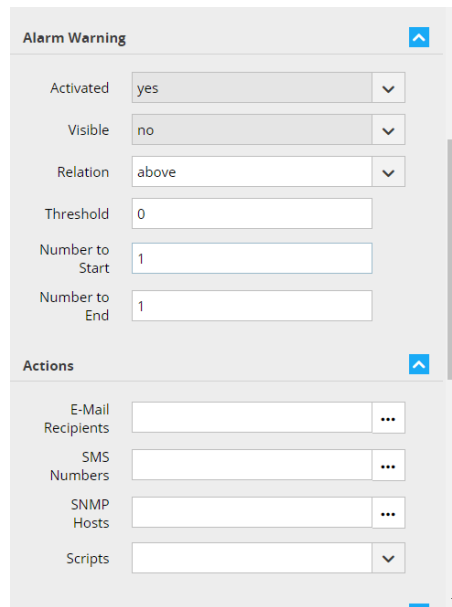
- Above
- Above – or – equal
- Below
- Below – or – equal
- Equal
- Not equal

The alarm should allow the activation and deactivation on user level

The alarm activation shall be supported by status changes of the underlying KPI level, or the alarm condition will be fulfilled

The supervision of non-aggregated KPI thresholds should be supported by the alarm function

The alarm function shall support a graphical alarm report view showing the KPI (incl. Alarm threshold) history. The export and distribution of this report shall be supported.



The screenshot shows the 'Alarm Warning' configuration window. It includes the following fields and options:

- Activated:** yes (dropdown)
- Visible:** no (dropdown)
- Relation:** above (dropdown)
- Threshold:** 0 (text input)
- Number to Start:** 1 (text input)
- Number to End:** 1 (text input)
- Actions:**
 - E-Mail Recipients:** (text input with dropdown arrow)
 - SMS Numbers:** (text input with dropdown arrow)
 - SNMP Hosts:** (text input with dropdown arrow)
 - Scripts:** (dropdown menu)

Figure: GlobalRoamer® Alarm Setup

Notifications for all the above alarming conditions can be generated using the GlobalRoamer® Alarming module. All the notifications are sent as email to any desired email destination address which can be changed easily.

2.2.6 Dashboard

GlobalRoamer® Dashboard is a simple yet powerful and intelligent tool for assessing and organizing all data. It provides a comfortable and simplified overview of reports by illustrating the most important KPIs briefly. Its user-friendly and flexible design makes it an essential tool for data analysis at different organizational levels e.g., Management, Engineering, etc. Multiple status overviews and reports can be displayed, filtered, updated and individually configured at once. Thanks to GlobalRoamer® Dashboard's customizable configuration, filtering KPIs and storing them individually is only a few clicks away.

The Dashboard offers 24/7 service monitoring via an easy-to-use graphical user interface

Benefits:

- No GlobalRoamer® System experience is needed
- Highly flexible and customizable navigation
- Firewall friendly HTTP Web protocol
- Navigation tree feature including drop down functions
- Customizable service filters via navigation tree or selection lists
- All known reporting functions are available and are fully integrated
- Report time window can be changed for all reports at once
- Can be adapted to the customer's corporate identity (logo, colours, titles)
- Drill down and chart analysis is fully supported
- Table and MSC trace viewer are fully integrated
- Provision to create, view, forward reports via email and reports can be exported to an external FTP server via FTP/SFTP
- The user shall be able to save / backup report definitions as well as import them

- The system shall support user friendly drag and drop functionality for reports, report definitions
- The reporting system shall support different graphical chart types

Some examples of network performance dashboards as shown below:



Figure: Dashboard of IoT

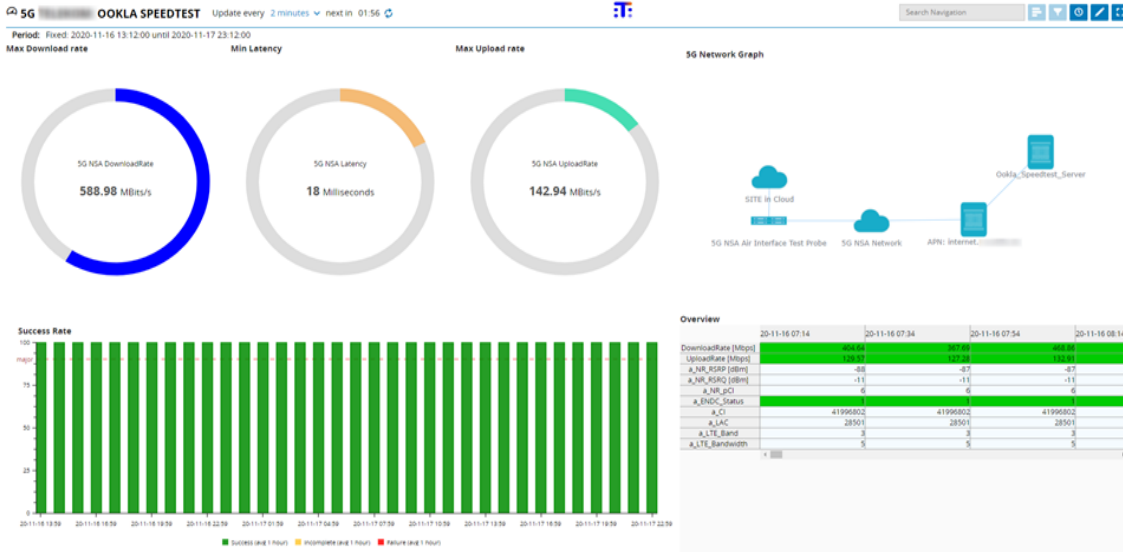


Figure: 5G Dashboard for (Ookla) SpeedTest



Figure: Various Types of Dashboards and Service Alarms with Real Time Monitoring

GlobalRoamer® as the backbone of powerful KPIs

Mobileum’s Roaming Performance Intelligence tool allows customers to look beyond their test results and compare with other peer averages available on GlobalRoamer® . The results are presented via web-based dashboards with benchmarking charts, including the last 7 days trend. They enable clients to distinguish between general poor performance and solvable issues. We offer unique benchmarking information for Operational and Roaming Management teams.

RPI is a unique reporting tool that can be used to compare the MNO results per county, or per roaming partner, against a reference value, where both “Average” and “Best-in-Class” values are presented. Our dashboards give key insights into roaming quality across all mobile operators worldwide to compare your customer’s experience against our data. This unique benchmarking information on current partners and ‘forbidden’ roaming partners allow you unique insights to re-evaluate your roaming strategy

2.2.7 Use Cases

GlobalRoamer® is having multiple use cases which are tested and used in live network. Some prominent use cases are described as below:

2.2.7.1 Emergency Services Testing

Emergencies are unpredictable, but access to emergency services must always be guaranteed. The correct routing of calls and precise location information can mean the difference between life and death. Sadly, delays caused by misrouted calls or location errors have proven fatal in cases that could have been prevented. Moreover, failure to comply with national and international emergency

communication regulations can result in penalties, legal actions, and reputational damage for telecom operators. Mobileum’s Emergency Services Testing Suite is a field-proven solution validated in both the US and EU to test and continuously monitor national emergency numbers and eCall functionality. Designed for compatibility with 2G, 3G, and VoLTE networks, and with 5G support on the roadmap, it ensures uninterrupted, resilient communication with Public Safety Answering Points (PSAPs), enabling fast and accurate emergency response that saves lives.

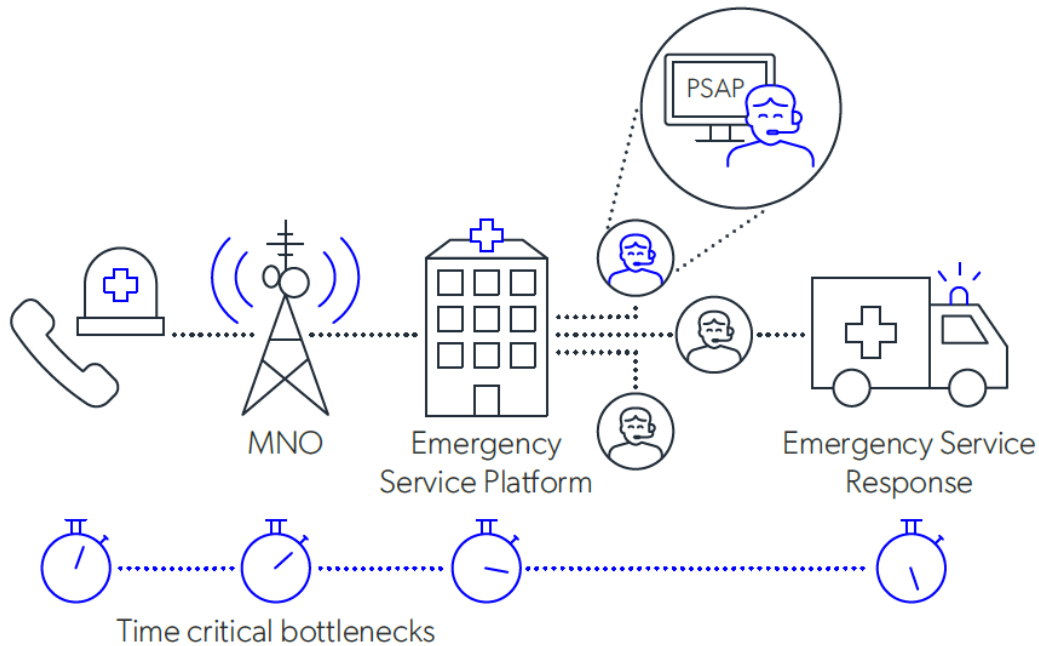


Figure: Emergency Services Testing

2.2.7.1.1 VoLTE and Legacy Network Emergency Call Testing

Mobileum’s Emergency Call Testing solution verifies the end-to-end availability and performance of emergency services across 2G, 3G, and VoLTE interfaces. As operators decommission legacy networks and accelerate VoLTE roaming, maintaining emergency call functionality becomes even more critical.

Our approach includes:

- Establishing a test call to emergency numbers.
- Playing a pre-recorded message to PSAPs, identifying it as a test.
- Verifying call routing, signaling paths, and timing accuracy.

This ensures that emergency communications meet performance standards even while subscribers roam abroad.

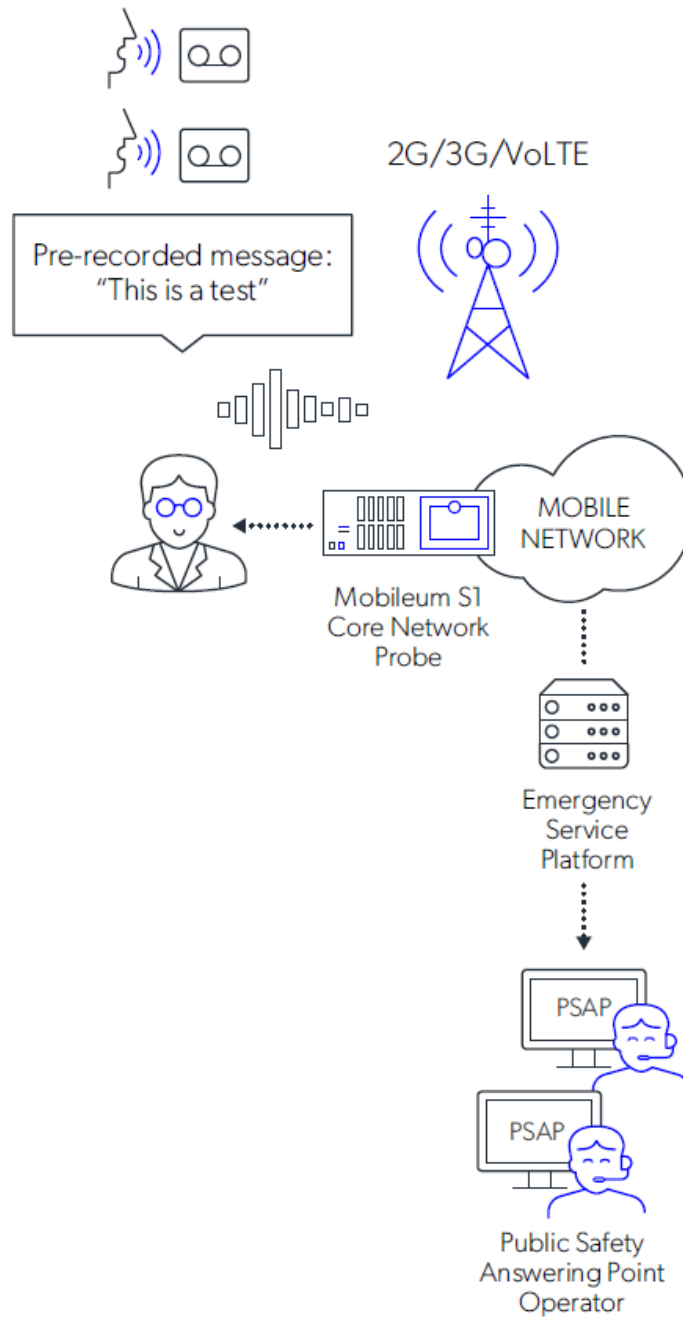


Figure: VoLTE and Legacy Network Emergency Call Testing

2.2.7.1.2 Enhanced Emergency Localization Testing

To meet regulatory mandates, operators must periodically verify the location accuracy of emergency calls. Traditional methods involve costly field visits and manual validation. Mobileum’s Interactive VoLTE Emergency Testing dramatically reduces operational overhead by enabling location emulation from a centralized lab. Users simply configure TAC, Cell ID, and coordinates via the S1 Core Network

probe, which simulates location data and establishes a voice channel with the PSAP validating correct location transmission in real time.

2.2.7.1.3 Automotive Emergency Communications (eCall) Testing

The eCall initiative, originally launched in the EU, mandates that vehicles automatically contact emergency services in the event of a serious accident. These systems transmit critical vehicle and location data, followed by live voice communication with the occupants.

Mobileum’s eCall Testing Solution replicates in-vehicle system behavior to validate:

- Proper routing to test and live emergency numbers.
- Push-mode transmission of the Minimum Set of Data (MSD).
- Voice channel establishment and audio validation from the PSAP.

This dedicated wireless module ensures automotive OEMs and operators are eCall-compliant and ready to save lives.

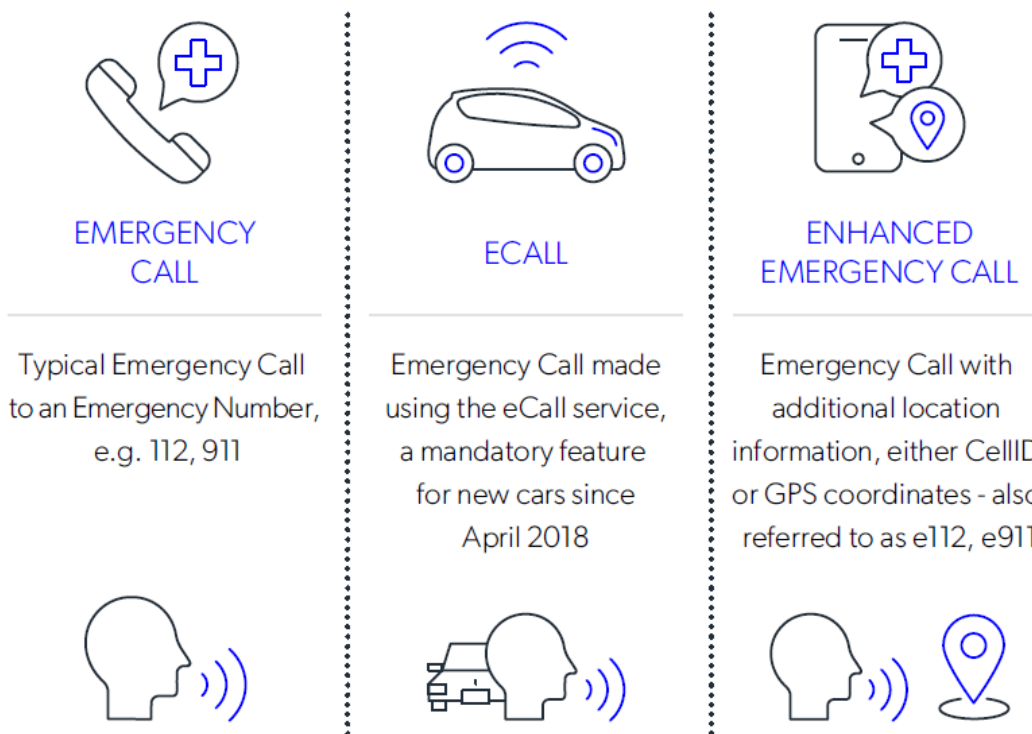


Figure: Automotive Emergency Communication Testing

2.2.7.1.4 Public Warning Systems Testing

Public Warning Systems are based on the Cell Broadcast Service (CBS), a 3GPP-standardized solution that allows the broadcast of general messages to devices within a certain region, and are

used for emergency alerts and public warning messages. In many countries, the services are typically regulated by telecommunications regulators, e.g., FCC and CE. The correct transmission of the CBS messages and their validation based on specific words or partial strings is essential for the efficacy of public warning systems.

Mobileum’s PWS Testing is a holistic testing solution for all mission-critical services and:

- is available for S1 interfaces
- verifies and periodically monitors the correct transmission of CBS messages
- validates CBS Messages based on specific words or partial strings
- can be integrated to our Automation Framework to trigger CBS messages

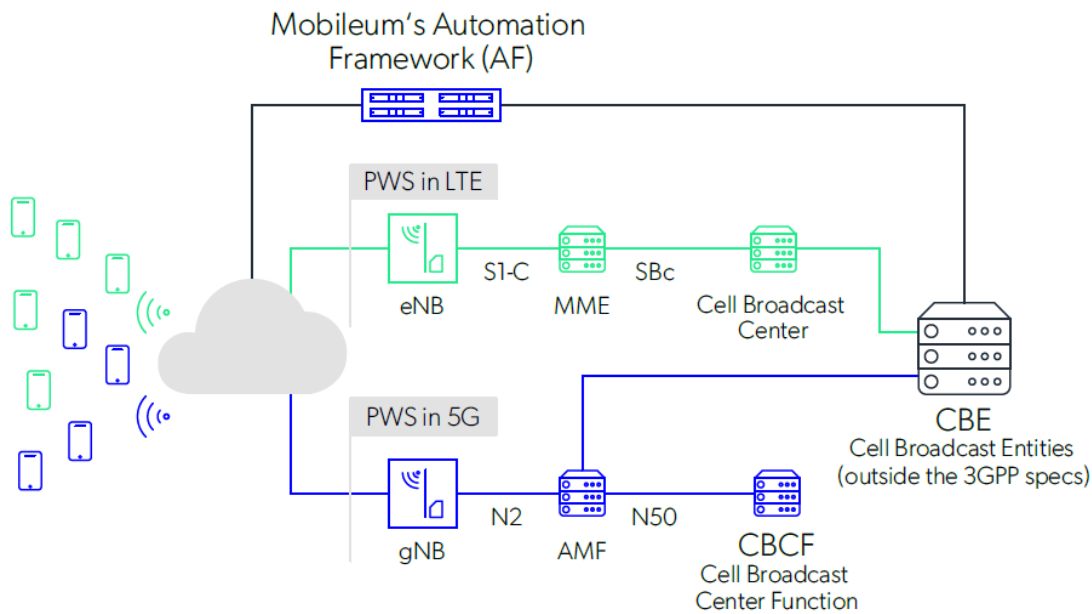


Figure: Public Warning Systems Testing

2.3 Customer Reference

Following is Mobileum’s Testing environment including the “Global Roamer platform” worldwide footprint:



Inco GmbH	BRA-Bello Horizonte	Eircom Limited	KDDI Japan	Orange France	TCAM NIC-Managua	Verizon Wireless
3 Austria	BRA-Brasilia	Enreach NL	KM-Basseterre	Orange Jordan	TCAM SLV-El Salvador	VGB-Road Town
3 UK	BSNL India	Entel PCS	Korek Telecom Company	Orange Morocco	TCA-Providenciales	Viaero Wireless
42com	BT UK	Epic Communications Limited	KPN Netherland	Orange Poland	Telavox AB	Videotron
A1 Bulgaria	Cable & Wireless Panama	Ericsson Japan	LBN-Beirut	Orange Spain	Tel2	Viva Kuwait
A1 Hrvatska	Cable & Wireless WI - Jamaica	Etisalat Afghanistan	LIG Uplus Korea	Packet One Networks	Telecom Egypt	Vodafone Congo
ADM-Oranjestad	CAN-Saskatchewan	Etisalat Egypt	LIE-Vaduz	PAN-Islamabad	Telecom Italia Sparkle	Vodafone South Africa
Aeris UK	CHE-Zurich	Etisalat Sri Lanka	LUX-Luxembourg	Pakistan Mobile Communication	Telecom Liechtenstein	Vodafone Australia
Afghan Wireless	China Mobile International	Etisalat UAE	LVA-Riga	PAN-Panama	Telecom PT	Vodafone CZ Republic
AFG-Kabul	China Unicom	Faroese Telecom	Lycatelcom	PCCW HongKong	Telecom26	Vodafone Egypt
Airtel Group	CISCO Systems	Fastweb	manx Telecom	PER-Lima	Telefonica Germany	Vodafone Essar India
Airtel Sri Lanka	Claro Argentina	FIN-Helsinki	MAR-Casablanca	Personal Telecom Argentina	Telefonica Spain	Vodafone Fiji
AIS Thailand	Claro Brazil	Finnet-(DNA) Finland	MAR-Telecom	Post Luxembourg	Telmach Hrvatska	Vodafone GMBH
ALB-Telecom	Claro Chile	FLO Live	MasMovile (Voigo) - Spain	PRI-San Juan	Telenor	Vodafone Group
Altice Dominicana	Claro Guatemala	GAMMA UK	Mass Response Service	Proximus Belgium	Telenor Connexion	Vodafone Ireland
America Movil Peru	CLK Networks	GEO-Tbilisi	MCO-Monaco	PSE-Ramallah	Telenor Pakistan	Vodafone Italy
Andorra Telecom	COL-Bogota	GIB-Gibraltar	MDA-Chisinau	PT Huawei Services	Rakuten	Vodafone New Zealand
ARE-Dubai	Colombia Movil Spain	GlobalTelecom	MDV-Male	RJIO India	Rogers	Vodafone Qatar
Asiacell Iraq	Comfone Switzerland	Globe Telecom Philippines	MEQ	ROU-Bucharest	Telia Company	Vodafone Romania
Aspider Netherland	CONECCL Ecuador	Globetouch Cloud	MEX- Mexico	RUS-Moscow	Telkomsel Indonesia	Vodafone Spain
AT & T Wireless USA	COSMOTE	GO plc	MNE-Montenegro	SaskTel	Telna USA	Vodafone Spain
ates Telefon Australia	CRE-San Jose	GRC-Athens	MNE-Podgorica	Setar-Aruba	TELUS Canada	Vodafone Turkey
AUT-Vienna	Croatian Telecom	GT FIGO	Mobile Vikings	Sierra Wireless	TIGO Guatemala	Vodafone UK
Axiata Celcom Malaysia	Cubic Telecom	GTM-Guatemala	Mobily Saudi Arabia	Symmetric Telecom	TIM BRASIL	Vodafone Ziggo
Axiata (XL Indonesia)	CW DMA-Roseau	H3G Ireland	Mobitel Georgia	Singtel Singapore	TIM Sparkle Italy	Vanage
Azercell-Azerbaijan	CW PAN-Rio Mato	Herrigs Services Limited	Mobitel Sri Lanka	Sky Telecoms Services	TNS USA	Wataniya Telecom Maldives
Azerfon Azerbaijan	CW VCT-Kingstown	HUE	MSDOnline	SoftBank Mobile	Top Connect OU	Wind (Globe Alive) Canada
Bakcell Azerbaijan	Cyta Mobile Cyprus	HUN-Budapest	Ncell	Spark Telecom New Zealand	Transatel FR	Wind Italy
Base Belgium	CZE-Praga	Hutchison Lanka	Nedjaa Algeria	Sprint US	True Move	Wireless Logic Ltd
Base Belgium	DEU-Berlin	Hutchison Whampoa	NOVA Iceland	STC Bahrain	Truphone	WDM
Base Belgium	Deutsche Telekom	Ice Communication	NPL-Katmandu	STC Saudi Arabia	TSIT Trinidad & Tobago	TTO-Port Spain
Base Belgium	Dialog Srilanka	IND-Bangalore	OMN-Mascate	STP-Sao Tome	TT-Port Spain	UAB TELE2
Base Belgium	ialog Srilanka	IND-Delhi	Ooredoo Maldives	Sunrise Switzerland	Ummiah Mobile Company	Ummiah Mobile Company
Batelco Bahrain	Djizey Algeria	INDOSAT Indonesia	Ooredoo Group	Sunrise Switzerland	Unitel Mongolia	Unitel Mongolia
BEL-Brussels	DMK-Copenhagen	INTELIQUENT, Inc.	Ooredoo Kuwait	SVK-Bratislava	UNW Brunet	Ziggo Netherlands
Belgacom	DOM-Santo Domingo	ITA-Milan	Ooredoo Palestine	Swisscom Switzerland	URU-Montevideo	ZMB-Lusaka
Bell Canada	DTAC Thailand	ITA-Milan	Ooredoo Tunisia	Syniverse USA	USA ATN	Zong Pakistan
BGD-Dhaka	DTAG Germany	IUSACELL	Ooredoo Oman	T-Mobile USA	USA IOWA	ZWE-Harare
Bosnia & Herzegovina Telecom	Eastlink	JAM-Jamaica	Optimus Portugal	T-Mobile Netherlands	USA-LOS ANGELES	
BHR-Manama	ECU-Quito	JOR-Amman	Optus Australia	Taiwan Mobile	USA-Miami	
Bitel Lithuania	EE UK	KAZ-Astana	Orange Belgium	Tata Communications	USA-Pennsylvania	
BLK-Minsk	EGY-Egypt			TCAM CRI-San Jose	USA-WASHINGTON	
BLZ-Belmopan					USA-WYOMING	
Bouygues Telecom					VEN-Caracas	
					VEON_VimpelCom	

Figure: Global Reference list

3 Testing Logical Architecture

This section elaborates on testing logical architecture.

3.1 GlobalRoamer® Deployment Architecture

The GlobalRoamer® testing platform is fully owned and managed by Mobileum, connectivity to the customer is provided over the internet via IPsec tunnel. The testing team shall be provided with access to the central server with valid credentials over secure channel. The GlobalRoamer® platform architecture comprises mainly of five essential components: Client, Central Unit, SIMMUX/eSIMMUX, Local Units and Database. The essential components are explained under [section 2.1.1](#). Service 112 has the option to choose the solution with the ready to use SIMMUX which is already deployed by Mobileum in Germany. Mobileum already has a large footprint of LU spread over all the key location worldwide which are capable of performing tests on multiple technologies such as GSM, UMTS, LTE, IoT and 5G NR. Service 112 can choose to subscribe to the services as per their requirement and convenience that best fits your business needs, budget, and resources. Due to its ready to use service the return-on-investment period is very short as it eliminates the additional time required for physical deployment of the solution. The Customer will receive the login credentials to the GlobalRoamer® platform which can be accessed through a web page over the internet Service 112 can log in and perform the desired test and monitor the network performance of their network and their roaming partner nationally or internationally. Being a separate entity, GlobalRoamer® gives Service 112 the freedom to perform the tests and monitor the KPI independently and not to rely on their roaming partners for any Logs or data.

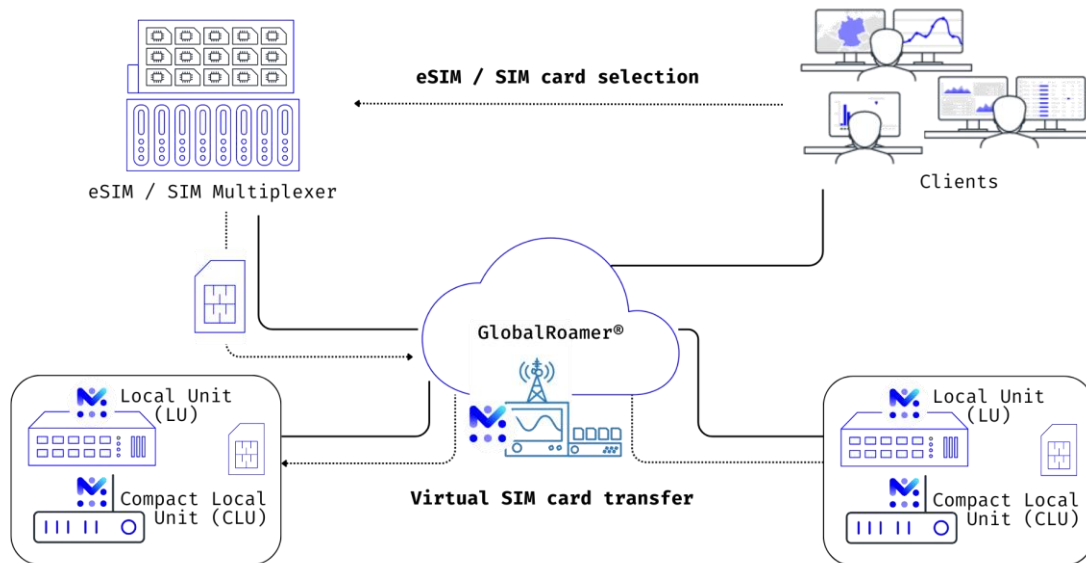


Figure: Deployment Architecture when SIMMUX is Deployed at Customer's Premises

With Mobileum testing accessibility is made simple. Once the SIM cards or eSIMs are received by Mobileum, Service 112 account will be activated within one business day and tests can start. Service 112 will receive the first results and reports within 48 hours.

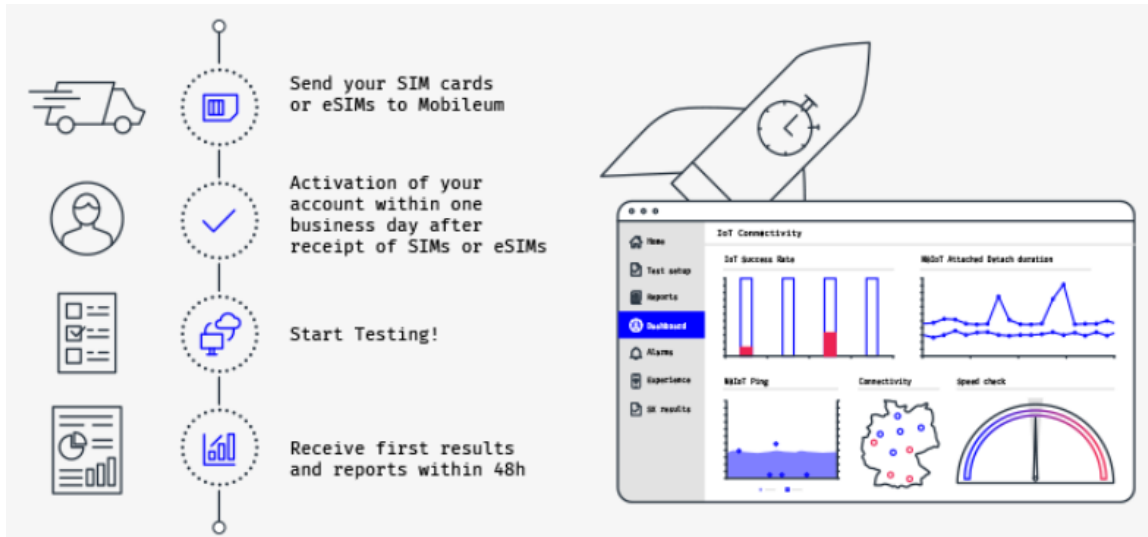


Figure: GlobalRoamer® Service Activation

Customer-oriented scope of service

Roaming Performance Intelligence is a solution available to Mobileum customers, who can have access to all performance data through a single subscription valid for 12 months. Customers can use their GlobalRoamer® account to execute their own tests to generate comparable data. The KPI reference values for each network are provided for the last 7 days and a minimum of 28 samples are available. This value corresponds to an average of 4 tests per day, a reasonable minimum sample to have relevant data. The KPIs are mostly oriented to the roaming experience and focused on calls originated and terminated in roaming.

Mobile network operators (MNOs) can choose from a wide range of aggregated data, which they will retrieve for comparison against their current performance results. MNOs using the service can simply pick their current results from the “My Data” tab, and immediately start getting performance benchmark metrics against the reference data generated by every GlobalRoamer® user executing tests in any given mobile network.

3.2 Testing Capabilities of the Solution

For the detailed information on the supported test cases by the offered solution kindly refer to the document named “A02_Service112_Mobileum_RFT-Annex_1b_GlobalRoamer_Testcases_v8.0.1.pdf” attached along with other documents.



4 Support and Maintenance

Mobileum provides maintenance and support services to the Licensed Software, under an annual Support and Maintenance Agreement that starts at the end of the Software’s warranty period which corresponds to the 3rd Level Support and is provided by a centralized support team with advanced training in all Mobileum products. This team is at the disposal of our customers to assist in solving any problem related to Mobileum software code. The support shall be provided in English.

If required, additional services can be added for providing 2nd Level Operation Support & Maintenance which addresses the day-to-day local system monitoring with its surrounding environment, making sure that each connecting system provides the data it is supposed to at the correct time and correct format, performing housekeeping and backup operations among other operational tasks. The local 1st level support corresponds to the first support line that is typically provided by the local operator helpdesk team and is not provided by Mobileum.

The following summarizes the levels of support and how Mobileum addresses those levels

- 1st Level Operational Helpdesk – Part of Managed Services
- 2nd Level Operational Support – Part of Managed Services
- 3rd Level Product Support – This is included as part of the support & maintenance agreement

The Support and Maintenance Agreement does not cover on-GlobalRoamer® intervention, unless requested by Mobileum, optimization or assisted operation services, and user training or support. Corrections will be carried out depending on the level of severity of the defects, as defined in the following standard table (the defect is classified with the agreement of the customer):

SLA	Definition	Example
Critical	Faults through which the equipment does not work anymore.	- Complete failure of the CU hardware - Central GlobalRoamer® software component crashed, and cannot be restarted (scheduler, resource manager)
Major	Problems that partly interfere with the principal function of the equipment.	- Failure of an LU - Failure of a SIM Multiplexer - A test application does not work properly on all locations with any parameter settings
Minor	Problems that do not interfere with the principal function of the equipment.	- Documentation problems - Failure of a test interface/test probe - A test application does not work properly under certain conditions (locations, times, parameterization, etc.)
Question	Queries regarding system functionality and usage as well as proposals to improve the system.	

Figure: Severity Levels

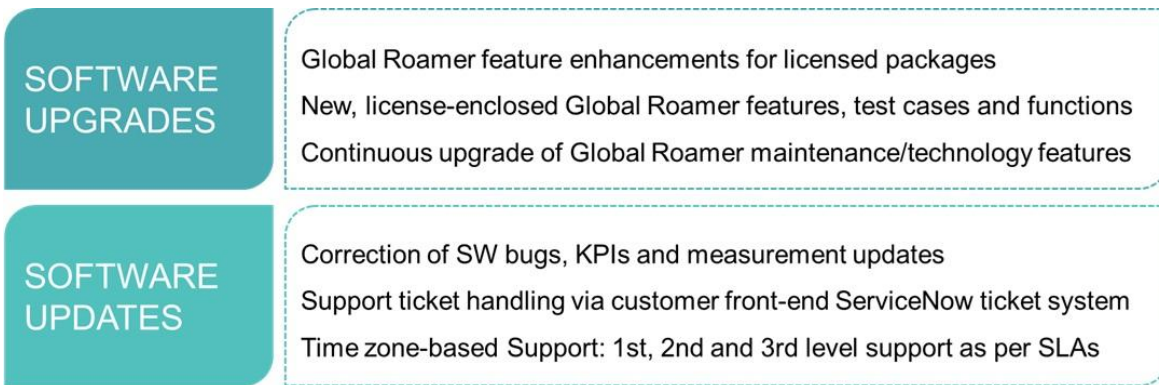


Figure: Support and maintenance services type

4.1 Approach

Mobileum’s GlobalRoamer® platform is a ready to use testing solution setup offered to Service 112. The offered solution will enhance the testing and monitoring capabilities of Service 112 in roaming environment and assist them to meet their desired requirements. Service 112 can choose from the various service packages and the test packages the as per their requirement and based on that Mobileum can suggest the best package or subscription to meet your testing requirements. The GlobalRoamer® Solution can be offered as SaaS or Manages Services or as a Consulting Services all depending upon the requirements of Service 112. Login credentials shall be shared with Service 112 when GlobalRoamer® is opted as SaaS or consulting service and successful subscription of the service has been done. With the login credentials the users can login and perform the tests.



5 About Mobileum

Over the last 26 years, Mobileum is proud to have over 1000+ mobile networks as customers in over 180+ countries. Our products are supported by a robust intellectual property portfolio of over 300+ issued patents, many of which power foundational technologies in mobile communications. Our customer base represents over 80% of the total number of mobile operator licenses issued in the world, and we are aggressively working towards increasing that organically and inorganically through acquisitions. This vast customer base, spread across diverse geographies, cultures and economies, gives Mobileum a cutting edge since these global requirements make our products extremely feature-rich compared to the competition.

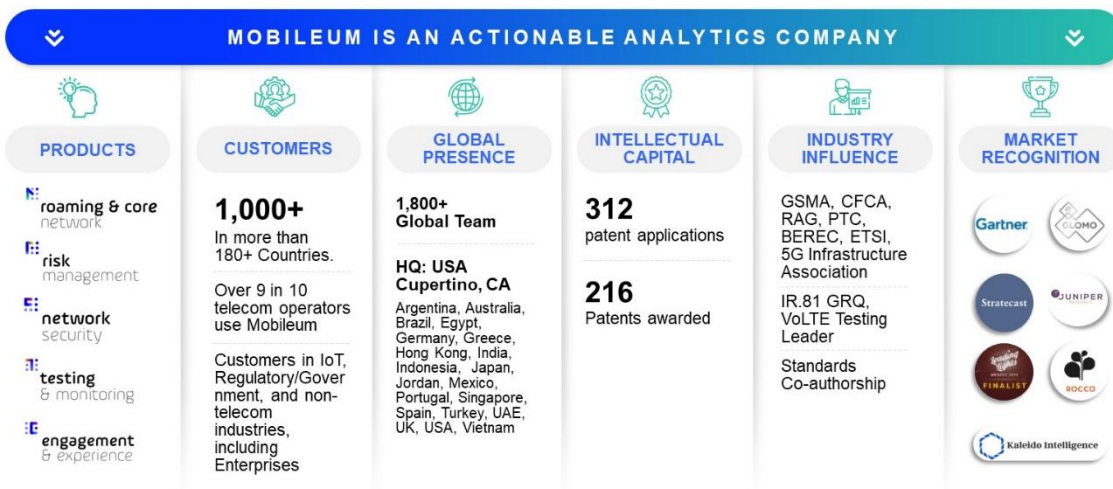


Figure: About Mobileum

Headquartered in Silicon Valley, U.S.A., Mobileum has global offices in Mexico, Argentina, Brazil, Chile, Belgium, Germany, Ireland, Portugal, Romania, Spain, UK, Egypt, Jordan, UAE, China, India, Indonesia, Japan, Malaysia, and Singapore. For more details, refer <https://www.mobileum.com/contact-us>

5.1 Our Story – Growth Through Innovation

Mobileum has grown through innovation in telecoms. We were founded in 2001 as Roamware, where our original insight was that Mobile Operators could manage roaming traffic intelligently to grow their revenue quickly and manage costs efficiently to expand margins and profitability. This innovation in steering allowed us to quickly become a market leader. We built mutually beneficial and lasting relationships with our customers, and we continued to invest in our technology and our people.

We recognized the critical value of analytics early and invested in the capability to combine our domain expertise in the network and BSS with advanced analytics and big data, and this combination is the basis of our unique Active Intelligence platform. Today we leverage this platform to rapidly deliver revenue-impacting solutions in focused areas of roaming, fraud and security and customer engagement. We work in partnership with CSPs of all kinds to use these solutions and accelerate their digital transformation programs.



Mobileum has acquired many companies in adjacent business areas and this consolidation helped us to serve our customers better by pre-integrating products and technologies. The following paragraphs detail the companies and their business.

Mobileum acquired Evolved Intelligence, a UK-based company, in October 2018. This transaction enhanced our signaling security portfolio. The new converged signaling firewall supports SS7, Diameter, GTP, 5G SBI, and SIP protocols. After acquisition, a voice firewall to detect and prevent voice-based spam/scam and a SMS firewall to detect and prevent A2P bypass and malicious SMS was developed. Mobileum has been able to significantly grow the business since its acquisition.

In August 2019, Mobileum acquired WeDo Technologies (“WeDo”). WeDo was a leader in risk and business management solutions for communication service providers (CSPs) globally, helping them to drive revenues, mitigate risk, and prevent fraud on their networks. WeDo’s rich and expansive portfolio of products and solutions is backed by advanced analytical insights, consulting, and professional and managed services. Mobileum used its presence and knowledge of networks to bring real-time revenue assurance and fraud management solutions to the market - a significant leap in a world that was used to offline CDR processing. The business has significantly increased because of connecting risk management with real time prevention using firewall.

Riding on the success of acquiring and integrating two companies, Mobileum acquired SIGOS, its competitor for global roaming testing, in July 2020. With global operations in Silicon Valley, Belgium, Germany, and Singapore, SIGOS’s Global Roamer and SITE products enabled active end-to-end roaming and domestic testing. These tests helped CSPs to improve their service quality, perform continuous reliability tests, improve network security, and roaming & interconnect revenue assurance. The combination of the two companies created significant value for our customers who were able to now run additional tests for 5G, CloT, and trigger them based on network events. Mobileum also gained many IoT customers as the product portfolio enhanced.

In June 2021, Mobileum acquired three more companies –

a) Developing Solutions, a network testing software provider that focused on core network testing for load and lab use cases covering 3G, 4G, 5G, and IMS. This acquisition complemented the SIGOS acquisition and also enabled Mobileum to expand its customer base to some of the largest core network equipment providers (NEPS).

b) In the same month, Mobileum also acquired Convene Networks, a technology provider of integrated core network solutions for 3G/4G/5G networks. This acquisition expanded our product portfolio with core network elements.

c) the third largest acquisition of the month was Niometrics, a provider of deep network analytics with high bandwidth DNA probes that monitor 10 Tbps data traffic at one of the largest network in the world. The acquisition expanded Mobileum’s actionable analytics platform with customer discovery, engagement, and experience capabilities, enabling Communications Service Providers (“CSPs”) to identify new revenue streams and to improve customer experience across the entire customer lifecycle.

Mobileum’s Active Intelligence Platform underpins all its solutions and services. Using Machine Learning and Artificial Intelligence the platform can deliver real-time traffic analytics and customer

analytics as well as apply business logic to inform traffic management decisions, assess risk, and protect the network.



Figure: Detailed portfolio of solutions on top of our Active Intelligence Platform

These real-time insights from the platform are fundamental to the way our software solutions help operators protect their revenues and profitably manage existing services as well as successfully plan and introduce new ones. All our insight-fueled solutions aim to improve network and customer performance while at the same time driving and protecting revenues and reducing or minimizing costs.

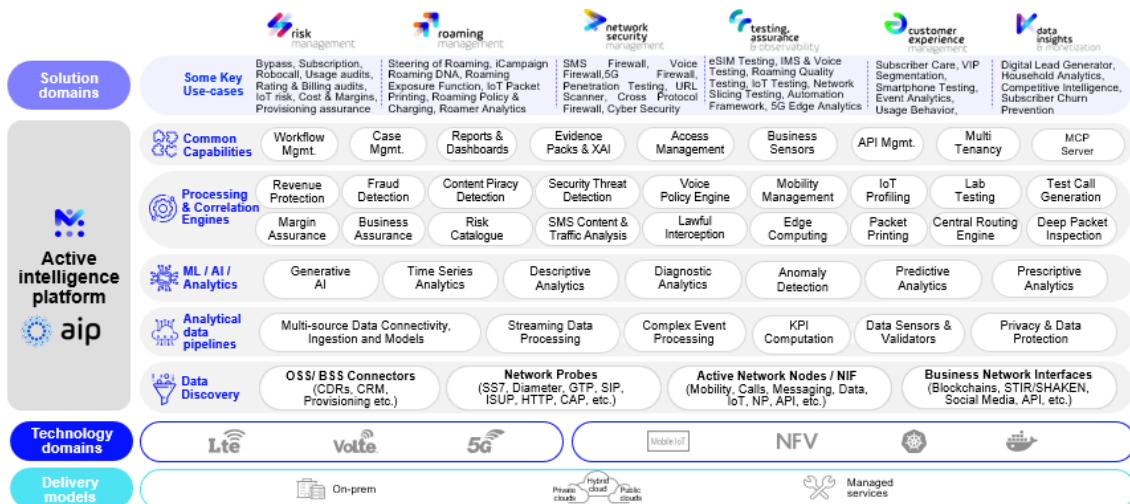


Figure: Solutions Built on Our Cloud-Native Active Intelligence™ Platform

5.2 Various Mobileum Portfolios for Diversified Customers

Mobileum is a leading provider of Telecom analytics solutions for roaming, core network, security, risk management, domestic and international connectivity testing, and customer intelligence. More than 1,000 customers rely on its Active Intelligence platform, which provides advanced analytics solutions,

allowing customers to connect deep network and operational intelligence with real-time actions that increase revenue, improve customer experience and reduce costs.

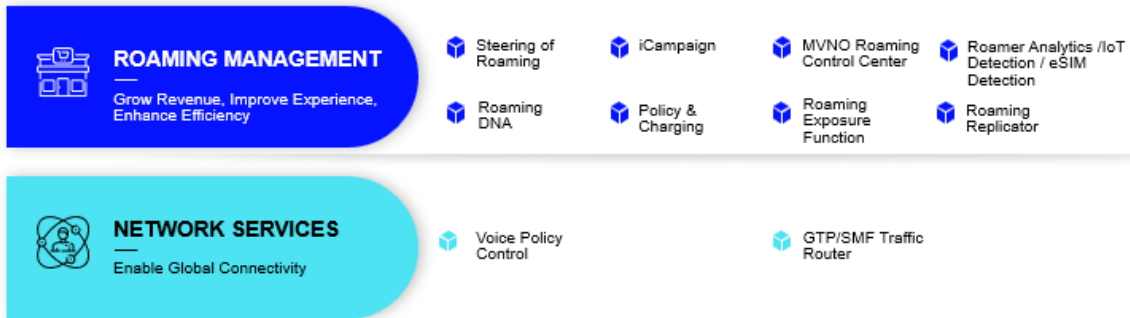


Figure: Roaming and Core Network

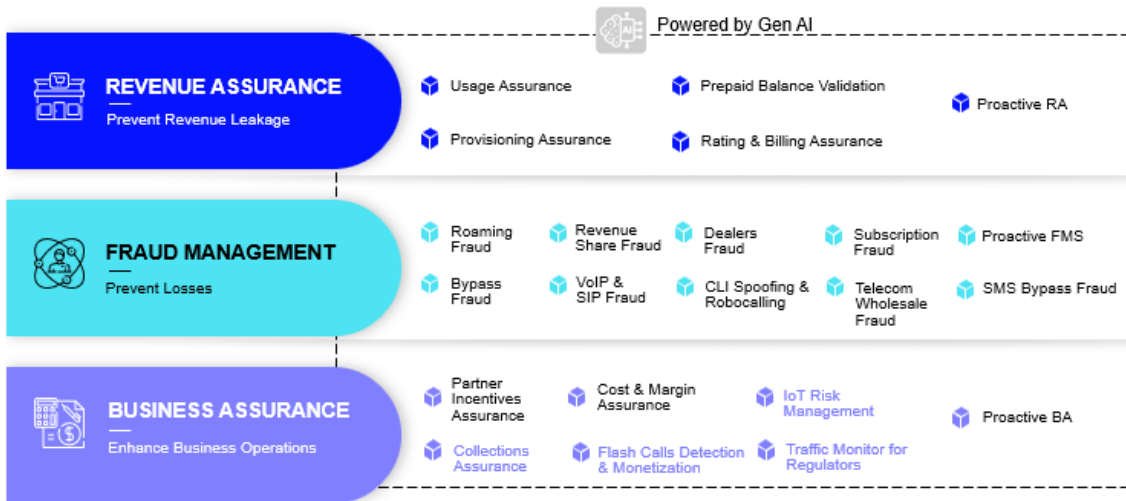


Figure: Fraud and RISK Portfolio

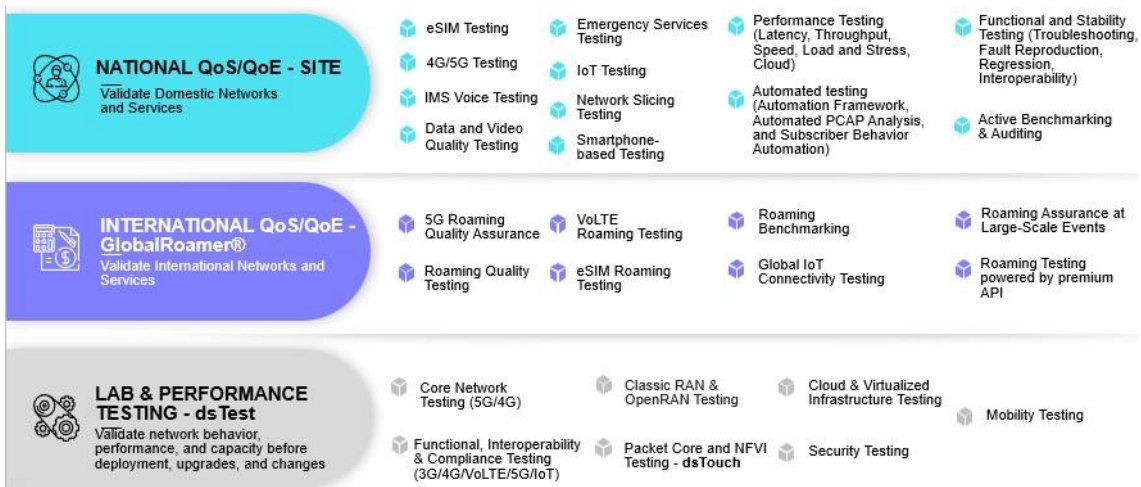


Figure - Testing and Monitoring Portfolio

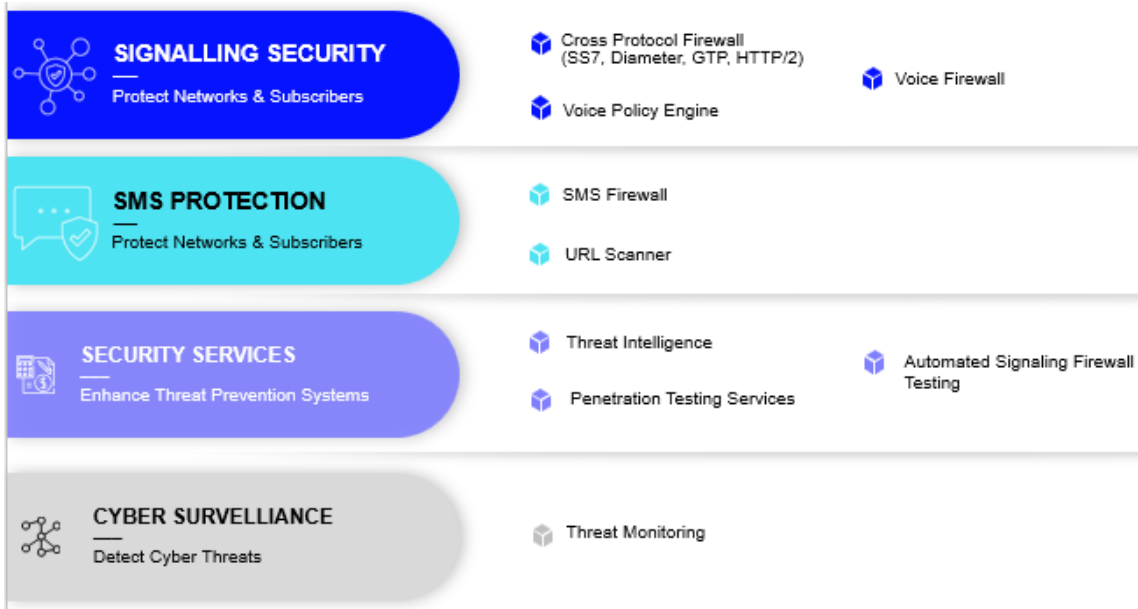


Figure: Network and Security Portfolio

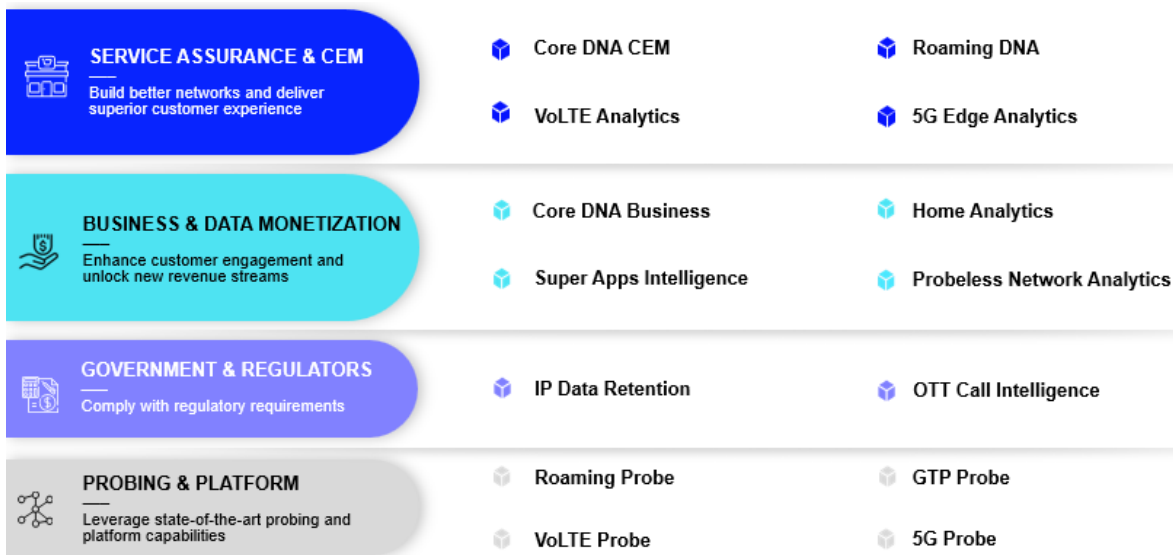


Figure: Engagement and Experience Portfolio

5.3 Global Customer Footprint

Mobileum’s customers include over 1000 plus mobile operator networks in more than 180 countries. Some of the major groups and standalone operators represented in Mobileum’s client base include –



Figure: Global Footprint

5.4 Recognitions

Mobileum is highly recognized by the market and by its customers.

<p>Leading Steering of Roaming Vendor MNO quote: "They are innovators and this is what MNO's need in this space"</p>	<p>#1 Tier-1 vendor for Network Security and Monetization solutions Tier-1 vendor for SMS Monetization solutions Tier-1 vendor for SMS Firewall solutions Leading provider for Flash Calling Monetization, Voice Firewall, AI application solutions</p>	<p>Stratecast Telecom Roaming Test and Security Global Price/Performance Value Leadership Financial Assurance for the Overall Revenue Assurance Market Leadership Top Ten to Watch</p>
<p>Leader in Innovation MNO quotes: "They are the ones to follow, passionate about our industry's future", "There is no one who doubts they are innovative and often find unique solutions through their research"</p>	<p>JUNIPER Best Steering of Roaming Solution (Gold Winner 2025) Messaging Fraud Mitigation Innovation (Gold Winner, 2025)</p>	<p>Kaleido #1 Champion Vendor for Roaming Analytics, Fraud Management, Roaming Testing, Signaling Security & Firewall Kaleido Champion Vendor for Steering of Roaming</p>
<p>Global Financial Assurance Leader Analyst quote: "a consistently strong performer in the fraud, revenue and business assurance market"</p>	<p>THE FAST MODE Winner Network Testing and Assurance Leader innovation category The Fast Mode 100 solution providers 2025</p>	<p>Most Innovative Test & Measurement product Finalist GSMA MWC GLOMO Award Finalist</p>

Figure: Recognition



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