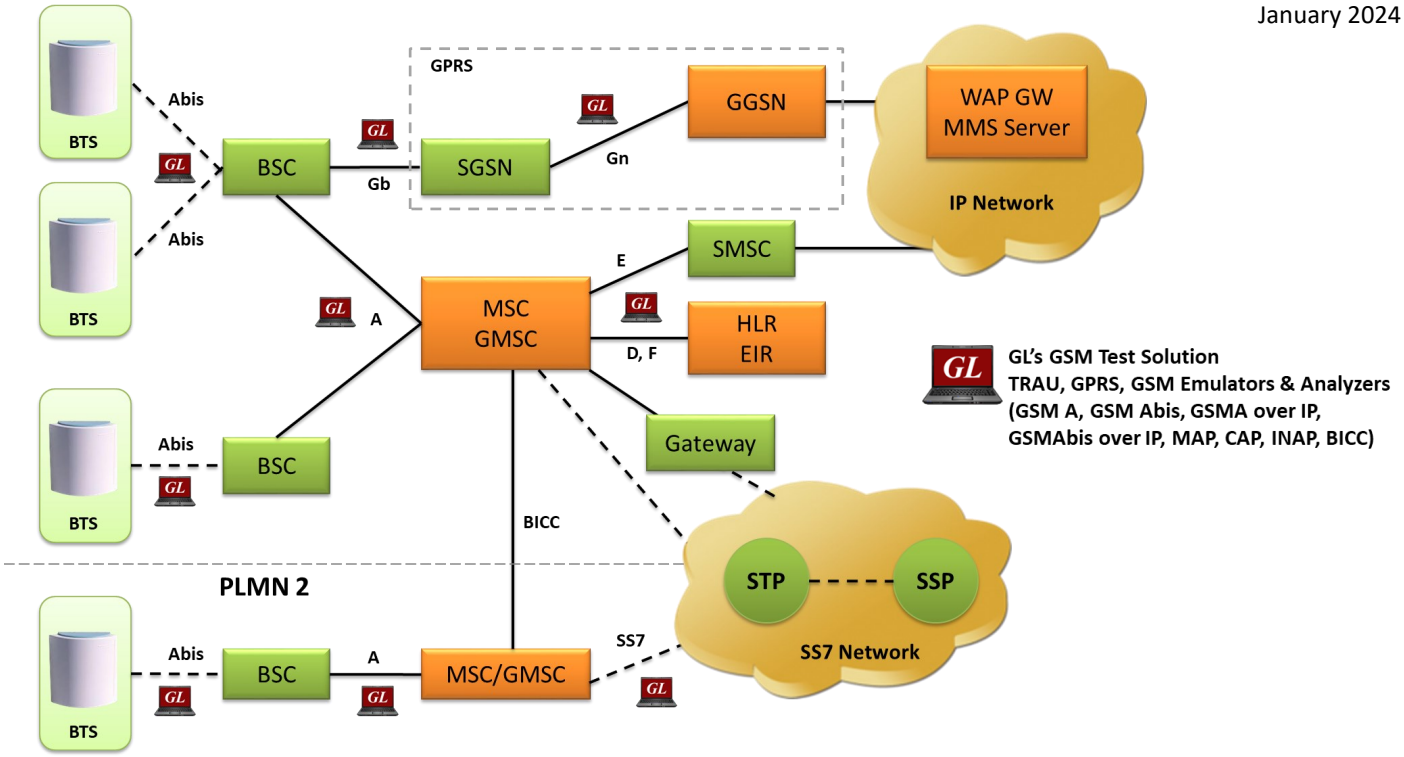
GL Communications Inc.

2G Networks Test Solutions
(GSM, GPRS)

January 2024



- **Complete 2G Communications Network Lab**
- **GSM GPRS Protocol Analysis (TDM, IP)**
- **GSM GPRS Protocol Emulation (TDM, IP)**
- **High Density RTP and Mobile Traffic Simulation**
- **End-to-End Voice and Data Quality Testing over 2G Networks**
- **GSM, GPRS Network Monitoring & Diagnosis Solution**

Visit GSM Protocol Test Solutions for more details.

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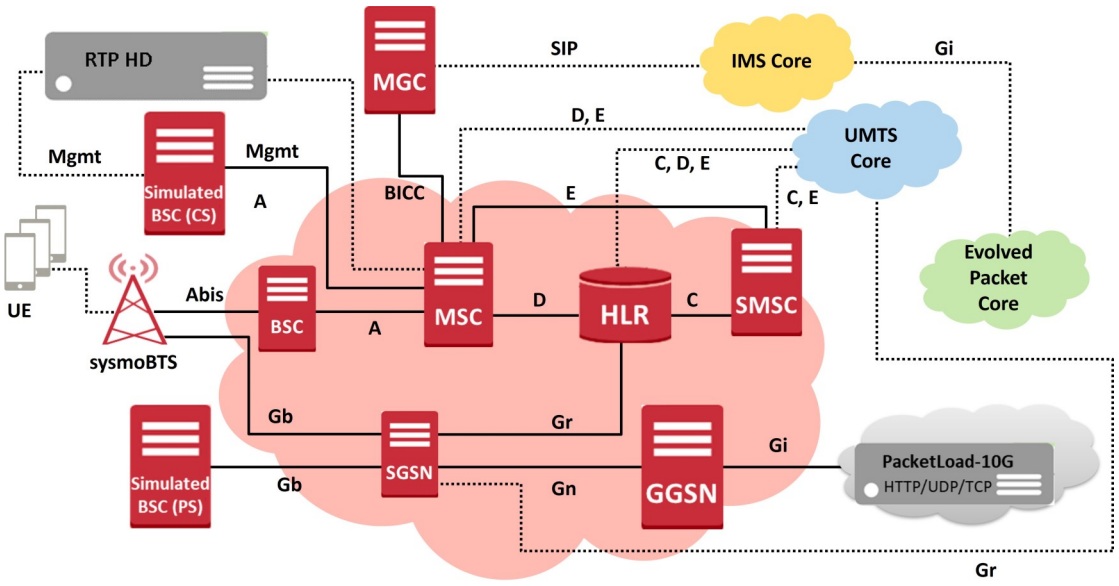
2G (GSM GPRS) Communications Network Lab



GSM Core Network

GL offers an end-to-end 2G GSM GPRS Communications Network Lab (CNL) with all components within the wireless infrastructure to emulate both GERAN, and GSM Core, allowing complete testing of the GSM network. With these, one can emulate Voice, SMS calls in a lab environment, and study the network behaviour.

All functionalities conform to industry standards. The CNL provides reliable integrated solutions to vendors and service providers for simulation, monitoring, troubleshooting the 2G network.

MAPS™ GSM supports emulation of multiple UEs and various interfaces of GSM (A, Abis, C, D, E, BICC, Gb). MAPS™ Lb interface emulator supports Location Service Request procedure using BSSMAP-LE signalling protocol in GSM Location Service (LCS) architecture for simulating network elements over Lb interface (BSC and SMLC).

MAPS™ MAP IP signalling emulator is enhanced to emulate LCS procedures over Lg and Lh interfaces using MAP signalling protocol. MS initiated Location Report Procedure is supported over Lg Interface between GMLC and MSC and network initiated Location Retrieval Procedure is supported over Lh Interface between GMLC and HLR.

MAPS™ GPRS Gb supports simulation of Mobile traffic between BSS (Base Station Subsystem) and the SGSN (Serving GPRS Support Node) network elements. MAPS™ GPRS Gb also supports SGSN Pooling feature to test and verify redundancy, load balancing, and scalability of network.

Some of the real-time scenarios that can be realized with GL's 3G GSM GPRS Lab solution are listed below -

Voice, SMS (CS)

- Real-mobile <-> Real-mobile
- Simulated UE <->Real-mobile
- Simulated UE <->Simulated UE
- Real-mobile <-> Real-Mobile
- Bulk voice traffic simulation using MAPS™ RTP HD

Web Browsing

- Real-mobile
- Simulated UE
- Bulk mobile traffic simulation using PacketLoad™

Location Services

Inter-network Calls and Roaming Calls

- 2G user calling 3G user
- 3G user calling 2G user
- 2G user sending SMS to 3G user
- 3G user sending SMS to 2G user
- 2G user calling 3G roaming user
- 2G user calling 4G roaming user
- 3G user calling 2G roaming user
- 4G user calling 2G roaming user

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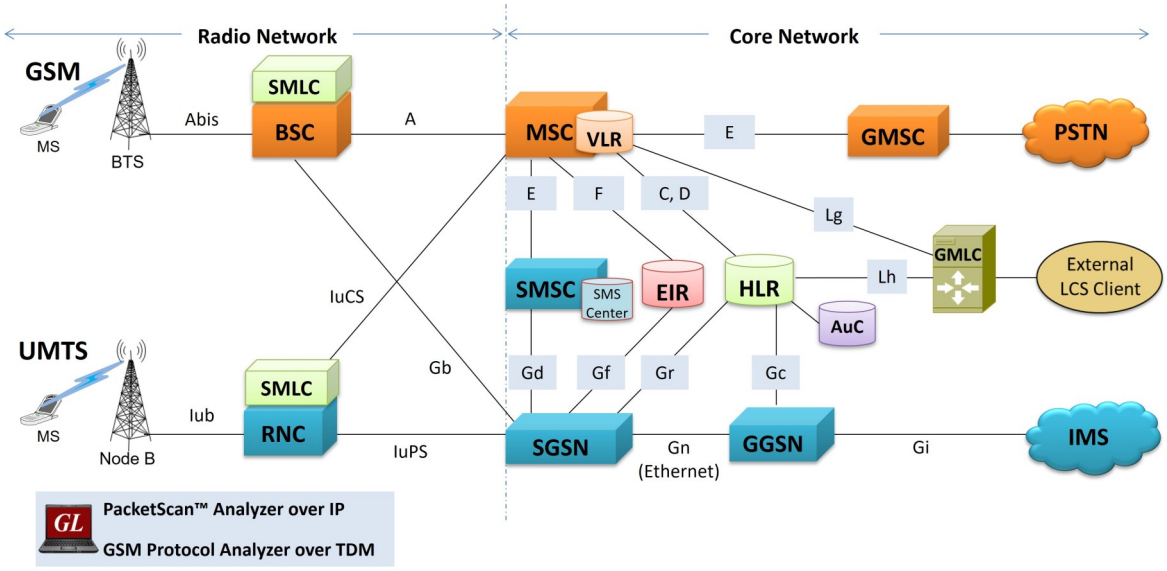
GSM - GPRS Network Monitoring (over IP/TDM)



PacketScan™ GSM an All-IP Network Monitoring software and Hardware based T1 E1 GSM Protocol Analyzer offers powerful features to capture and monitor live signaling and traffic over IP and TDM networks respectively.

Main features

- Capture, decode, segregate, and perform various measurements across various interfaces of the GSM-GPRS networks
- Live monitoring of traffic statistics - digits, tones, voice, video, and T.38 fax over IPv4 and IPv6 (version 4 and version 6) networks
- Packet Data Analysis (PDA) monitor live TDM/IP networks with detailed summary and graphical display of every call
- Monitors QoS (quality of service) on voice and video calls
- Trace files for analysis can be loaded through simple command-line arguments

Following variants are available:

- T1 E1 Real-time and Offline GSM Analyzer permits continuous real-time monitoring of A (Interface b/w BSC and MSC), A-bis (Interface b/w BSC and BTS), Mobis (Motorola Proprietary Interface b/w BSC and BTS and also b/w BSC and PCU), Gs (Interface between SGSN and MSC), Ls / Lb / Lp Interface (Interface between MSC and SMLC), Up (Interface between UNC (UMA network controller) and MS
- As a Stand Alone Software for Real-Time and Offline Analysis (**PacketScan™**) offers powerful features to capture and monitor live signaling and traffic over IP (IPv4 & IPv6). The application can decode, segregate, and Troubleshoot network problems for all VOIP and wireless protocols, traffic types over IP network
- High-Density Packet Monitoring Tool (**PacketScan™ HD**): PacketScan™ HD is an high density multi-protocol VoIP monitoring, reporting and diagnostic network monitoring appliance. It can capture and process high volumes of communication protocols over IP and Wireless at 1GigE (PKV120) and 10GigE (PKV122) data rates
- As a Probe with Central Monitoring—**NetSurveyorWeb™** (PKV170): Multiple IP/TDM Protocol Analyzer probes can be deployed along with a centralized monitoring system. Protocol Analyzers can send Summary Fields, Frame Octets, and Call Detail Records to database along with Traffic Summary for the captured calls
- NetSurveyorWeb™ Lite (PKV169) is an integrated and a cost-effective web-based monitoring system that works with IP/TDM Protocol Analyzer probes as an addon tool

Supported Protocols

2G Interfaces

GSM Abis Interface
GSM A Interface
GPRS Gb Interface
MAP Interface
CAP Interface
BICC Interface
Gi Interface
C, D, E, F, H Interfaces

Location Services

Lb Interface
Lg and Lh Interfaces

Nodes

BTS
BSC
MSC/VLR
HLR
EIR
SMSC
SGSN
GMSC
gsmSCF, gsmSSF
SMLC
GMLC

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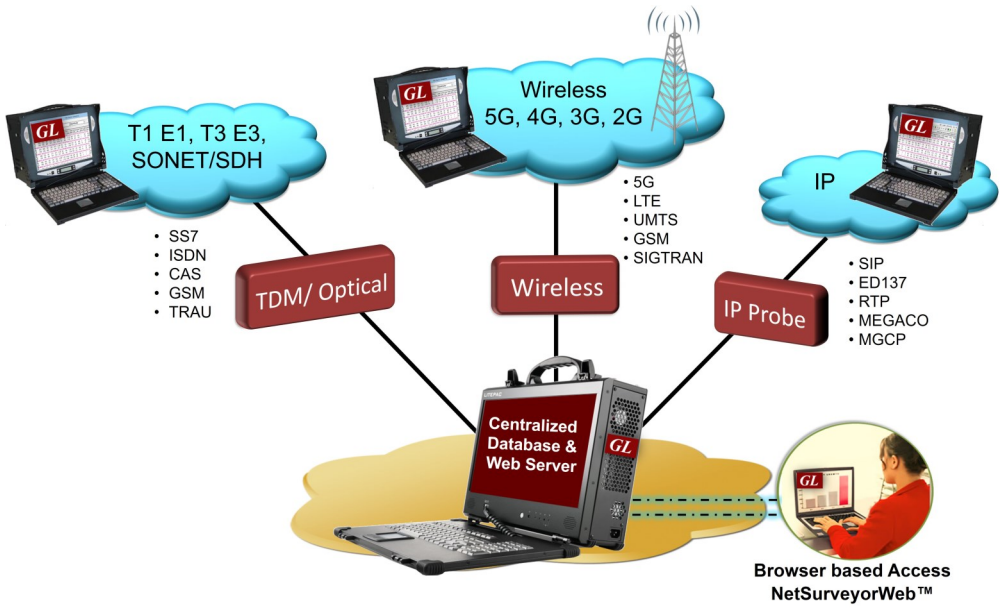
GPRS - GSM Network Monitoring & Diagnosis



NetSurveyorWeb™

GL's NetSurveyorWeb™ (PKV170) is a centralized web-based client that facilitates display of call data records and call summary using a web interface based on a scalable and flexible architecture. It is used in conjunction with GL's GSM Protocol Analyzer and GPRS Protocol Analyzer probes to non-intrusively monitor the entire network from a central remote testing location.

GL's GSM-GPRS Protocol Analyzer have unlimited ability to capture, decode, and measure KPIs. The analyzers support decoding all GSM-GPRS protocols, as listed in the table here. GL's GSM-GPRS protocol analysis probes feed data to centralized database (Oracle) in real-time for further analysis. The probes provide instant visibility into the performance with extensive KPIs, and also the operation of nodes in GSM networks.

NetSurveyorWeb™ Lite

NetSurveyorWeb™ Lite (PKV169) is an integrated and a cost-effective monitoring system that works at the probe-level as an addon tool with all real-time Protocol Analyzers. It is a web-based client that allows to view historical and real-time call data records. It enhances the capabilities of protocol analyzer to process large volumes of calls, filter for specific calls, build custom statistics and KPIs, automation and graphical features to analyze the call detail records (CDRs).

Supported Protocols

2G Interfaces
GSM Abis Interface
GSM A Interface
GPRS Gb Interface
MAP Interface
CAP Interface
BICC Interface
Gi Interface
C, D, E, F, H Interfaces

Location Services
Lb Interface
Lg and Lh Interfaces

Nodes
BTS
BSC
MSC/VLR
HLR
EIR
SMSC
SGSN
GMSC
gsmSCF, gsmSSF
SMLC
GMLC

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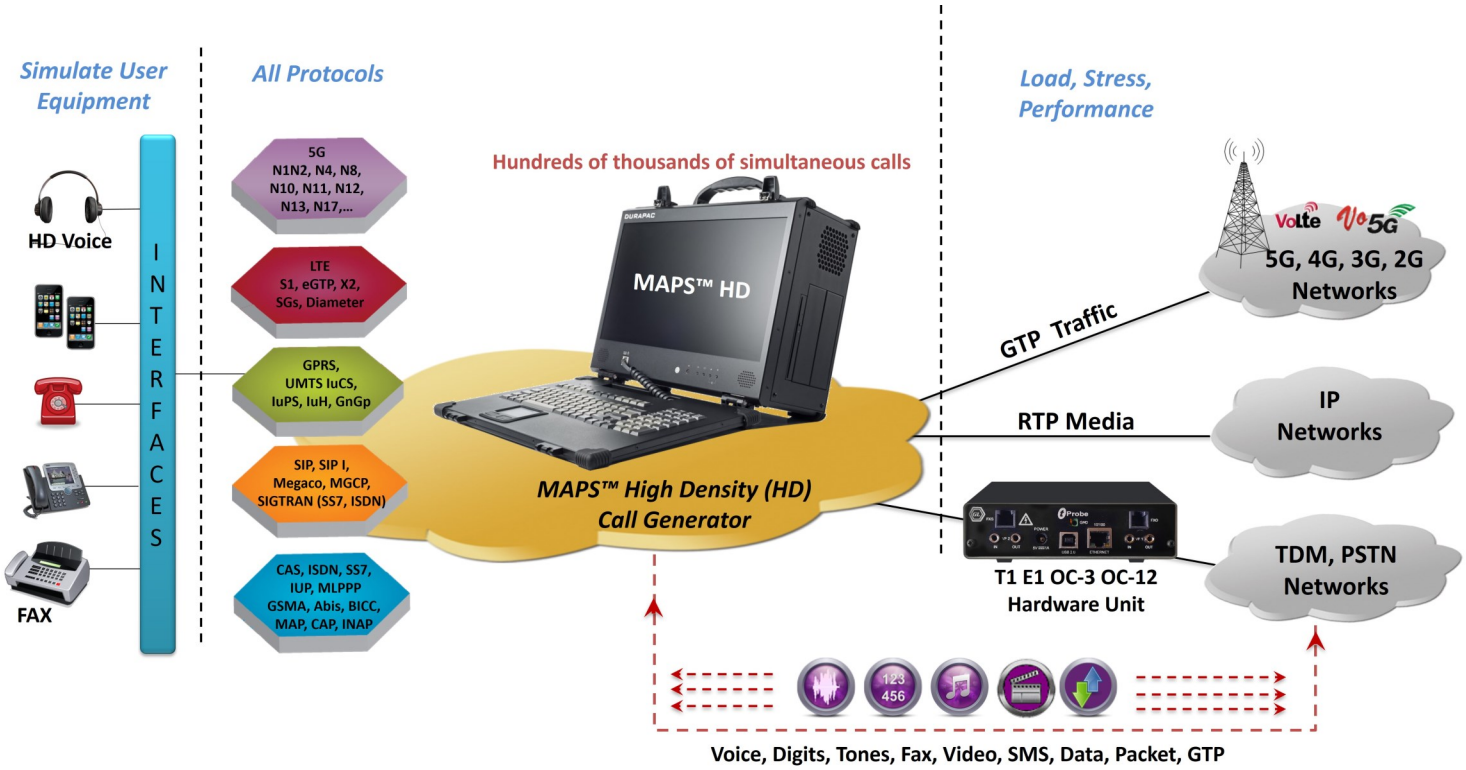
High Density RTP and Mobile Traffic Simulation



GL's MAPS™ HD is a High Density 1U network appliance that is capable of high call intensity (hundreds of calls/sec) and high volume of sustained calls (tens of thousands of simultaneous calls/1U platform) for a vast array of communication protocols covering IP and Wireless networks. MAPS™ HD network appliance is designed to easily achieve up to 20,000 endpoints per appliance (5000 per port). This requires GL's RTP HD traffic generation capability (PKS109) and specialized 1U rack system with integrated HD NIC (w/ 4x 1 GigE Or 2x 10 GigE).

Mobile Traffic Simulation -GPRS Gb:

- Generate and verify user mobile data (Email, Web-HTTP, and FTP), gateway traffic, and packet traffic over (GTPv1 and GTPv2) GPRS Gb network interface

RTP Traffic Simulation:

- Create, manage RTP sessions and generate and receive RTP traffic over the sessions with complete automation capability
- Simulation of RTP Traffic such as Voice, Digits, Tones, IVR and Impairments
- Automate the IVR testing process (call establishment and traffic generation / detection) process through scripts
- Supports all standard Voice Codecs

SMS Traffic Simulation

- Ability to push / pull Short Messages over the network as if sent by thousands of mobile phones (Short Message Mobile Originated (SMS-MO)). MAPS™ can also transmit a Short Message to a mobile phone (Short Message Mobile Terminated (SMS-MT))

TDM Traffic Simulation

- Simulation of TDM Traffic such as digits, voice file, single tone, dual tones, Dynamic VF
- Simulation of TDM Fax Traffic
- TRAU GSM traffic over GSM Abis interface
- Create, monitor, and terminate TRAU GSM traffic sessions

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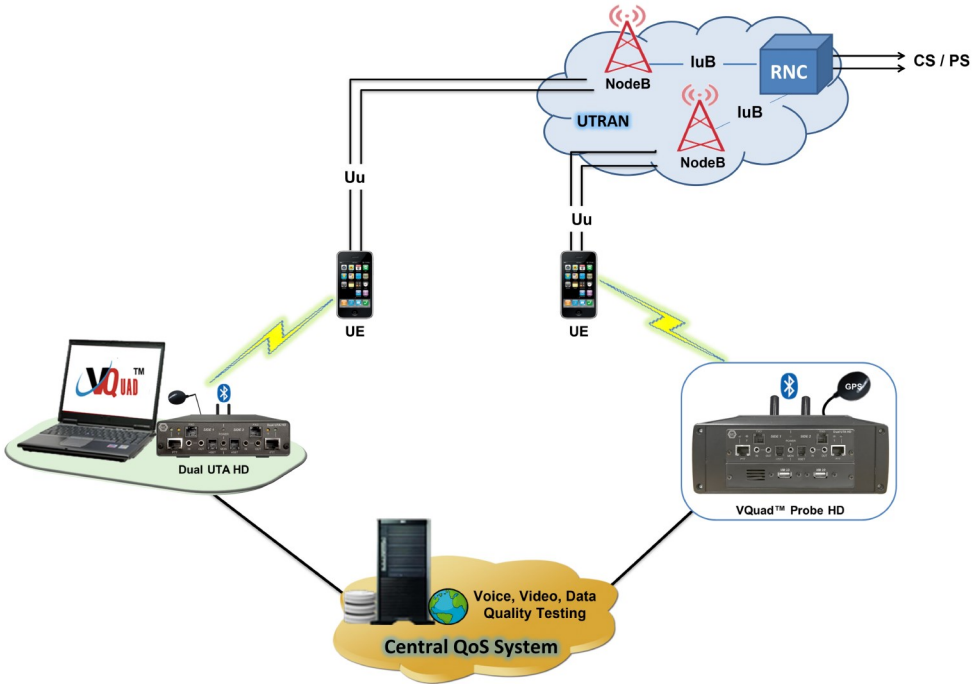
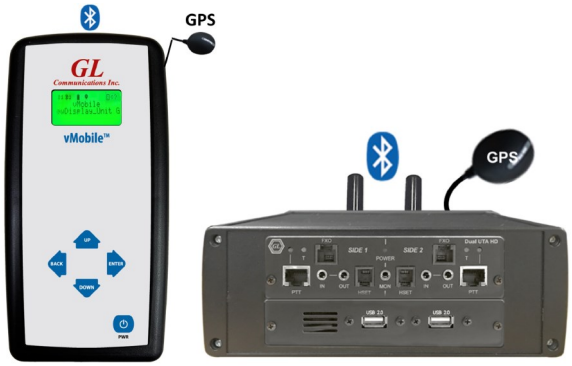
End-to-End 2G GSM GPRS Network Testing



2G GSM GPRS QoS Test Suite
Voice, Video, & Data Quality Testing



vMobile™ and VQuad™ Probe HD

Dual UTA HD unit

VQuad™ Probe HD is a self-contained unit used to objectively evaluate Signal Strength, Voice, Video, & Data Quality on Cellular networks (5G, 4G VoLTE, 3G, 2G), Land Mobile Radios, and Wired networks.

It includes VQuad™ software, Dual Universal Telephone Adapter (Dual UTA HD), and PC in a portable platform. VQuad™ Probe HD can connect to practically any end-point, wired or wireless devices, independent of underlying network type. Voice Quality testing supported using either Bluetooth® or wired headset connection methods.

Various associated analytical applications (Voice Quality, Video Quality, Data tests, Echo and Delay tests, Fax tests, Voice Band Analysis) work with the base VQuad™ software to provide "end-to-end assessment" of the network performance.

GL's Voice Quality Testing (VQT) supports automated voice quality between using - POLQA (ITU-P.863) and PESQ (ITU-P.862). The POLQA algorithm is specifically used for testing Wideband VoLTE networks.

GL's VQuad™ NetTest solution supports egress/ingress Data analysis along with Voice/Video Quality Testing and GPS.

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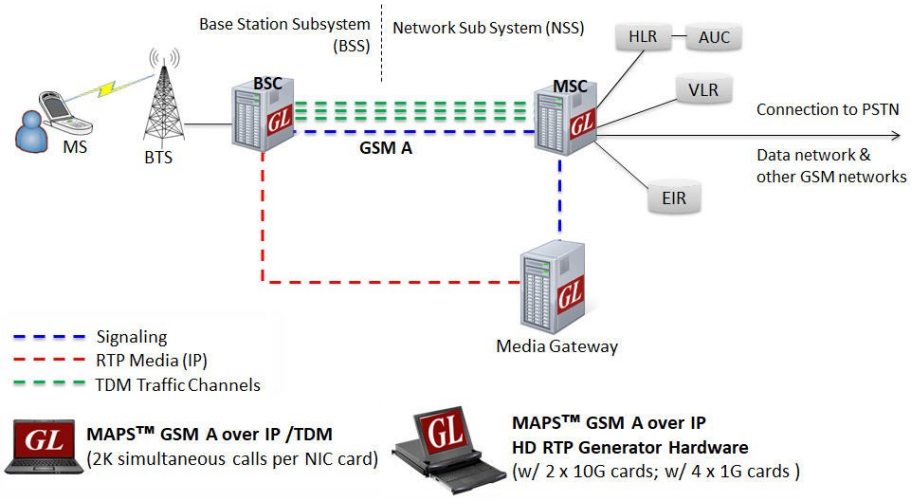
GSM Protocol Emulation

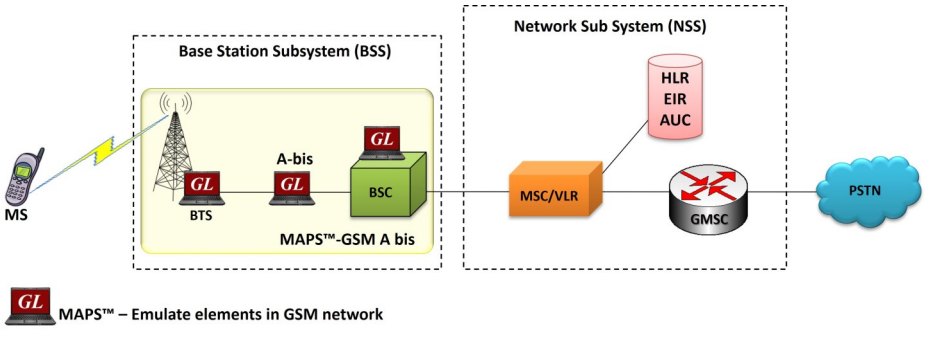
MAPS™ GSM A Emulator (over TDM, IP)



GL's MAPS™ GSM A Emulator over IP and MAPS™ GSM A Emulator over TDM are used to emulate BSSMAP and DTAP messages over GSM A Interface and signaling specification as defined by 3GPP standards. The tester supports testing network elements MSC and BSC for error tracking, regression testing, conformance testing, load testing/call generation and generation of high volumes of GSM traffic. It is able to run pre-defined test scenarios against GSM A interface test objects in a controlled & deterministic manner. The tester supports traffic such as sending/ receiving of voice files, DTMF digits and tone over IP and TDM respectively.

- Emulate BSC or MSC nodes
- Complete GSM A signaling simulation over IP along with RTP traffic
- Supports transmission and detection of RTP traffic – Auto digits, voice file, single /dual tones, Fax, IVR, and User defined traffic
- Access to all BSSMAP and DTAP message parameters like TMSI, IMSI, CIC, MCC, LAC, and more
- User controlled access to optional parameters such as timers

MAPS™ GSM Abis Emulator (over TDM, IP)



MAPS™ GSM Abis can emulate BTSM messages and signaling over GSM Abis interface as per 3GPP standards. The tester supports testing network elements BTS and BSC for error tracking, regression testing, conformance testing, load testing/call generation, and generation of high volumes of GSM Abis traffic. It is able to run pre-defined test scenarios against GSM Abis interface test objects in a controlled and deterministic manner. The tester supports TRAU/RTP traffic such as sending receiving of voice files, DTMF digits and tone over IP and TDM respectively

- Emulate BTS or BSC nodes
- Complete GSM Abis signaling simulation over IP along with traffic
- Supports TRAU traffic simulation - Transmit TRAU DTMF Digits (Send TRAU File, Send TRAU Tones), Receive Actions (Monitor TRAU Digits, Rx TRAU File, Monitor TRAU Tones), and Stop Traffic Actions
- Supports all Call Control, Mobility Management, and Radio Resource messages and procedures
- Access to all BTSM Message Parameters like TMSI, IMSI, Request Reference, and others

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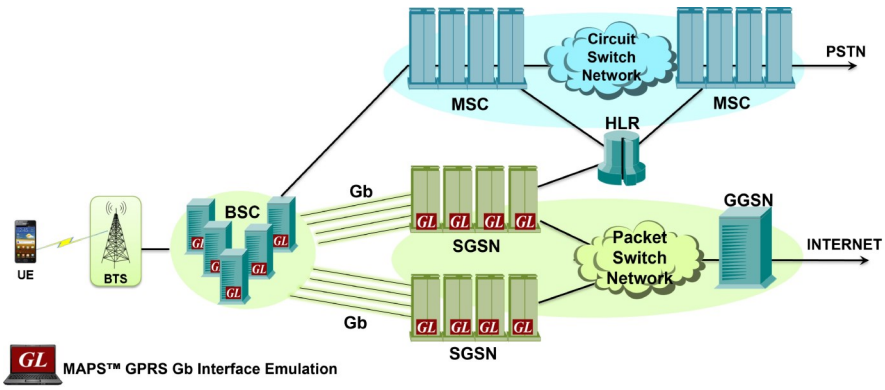
GSM Protocol Emulation

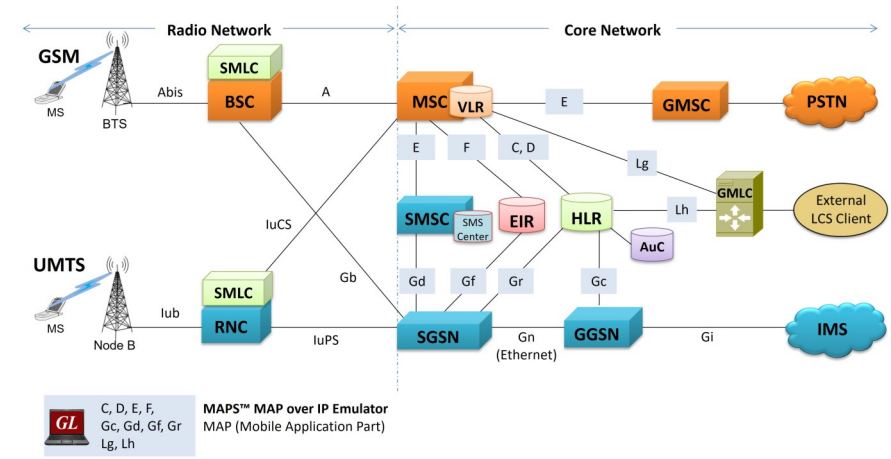
MAPS™ GPRS Gb Interface Emulation over (IP)



MAPS™ is designed to emulate GPRS Gb interface messages and signaling specification as defined by 3GPP standards. MAPS™ GPRS Gb currently supports Gb interface between the BSS (Base Station Subsystem) and the SGSN (Serving GPRS Support Node) over IP transmission protocol. Emulation over Frame Relay transmission protocol will be supported in future. Besides testing network elements (SGSN and BSS), the tester also involves error tracking, regression testing, and load testing/call generation. MAPS™ GPRS Gb interface Emulator supports various procedures including Network Service Control, Identity Check, Combined GPRS / IMSI Attach, and Routing Area Update.

- Complete analysis and simulation capability
- Functional testing, Regression testing and Conformance testing of network elements
- QoS requests for greater or lesser bandwidth
- GSM GPRS lab setup can be used in educational institutions for training purposes

MAPS™ MAP Emulator (over TDM, IP)



GL's MAPS™ MAP supports emulation of all the GSM MAP interfaces. MAPS™ MAP currently supports various procedures emulating MSC (VLR), HLR, EIR, and SMSC entities over H, C, D, E, F interfaces in TDM and IP networks. Supported procedures include Location Update, Retrieve Roaming Number, Remote User Status, Check IMEI Service, and others. It also supports send/receive SMS (Short Message Service) over the signaling channel.

- Performance testing, Load Testing, Function al testing, Regression testing and Conformance testing of network elements
- Inter-operability testing of networks
- Wrap-around testing (WAT)
- Real-time applications of location-based services such as up-to-date information for vehicle tracking, stolen assets tracking, temperature, traffic services, emergency services, etc.

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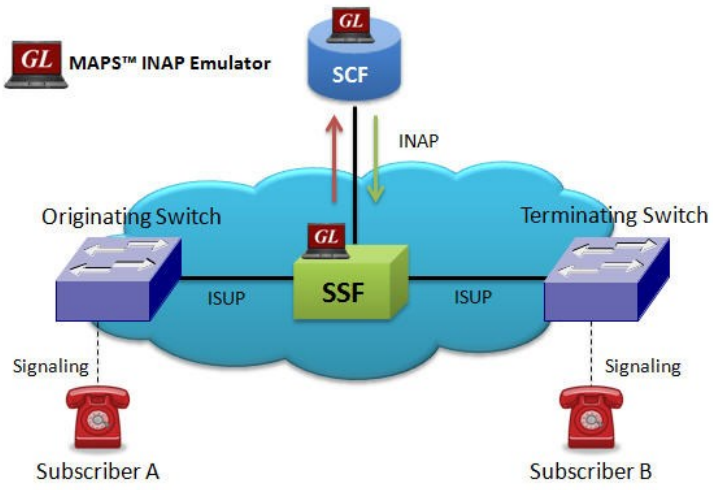
GSM Protocol Emulation

MAPS™ INAP Emulation (over TDM, IP)

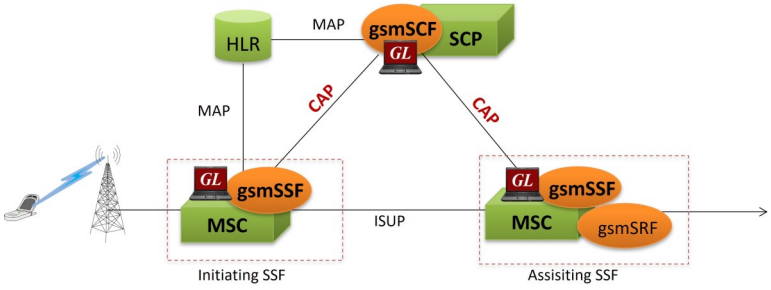


GL's MAPS™ INAP tester supports testing network elements gsmSCF (Service Control Function) and gsmSSF (Service Switching Function). MAPS™ INAP functionality covers the ITU and ANSI variants of SS7 implementing M3UA, M2PA, M2UA, MTP3 and ISUP protocols over TDM and IP transport protocols. INAP can be transported using 'traditional' SS7 protocols carried by Message Transfer Protocol (MTP) in TDM (T1 and E1) or over IP using SIGTRAN.

MAPS™ INAP scripts are suitable for testing objects reliably and accurately validated for compliance with ANSI, and ITU-T specifications

- Unlimited ability to edit INAP messages and to create IN service scenarios (message sequences)
- Able to run pre-defined test scenarios against INAP test objects in a controlled and deterministic manner
- Provides fault insertion, and erroneous call flows testing capability

MAPS™ CAP Emulator (over TDM, IP)



MAPS™ CAP Emulator Over TDM and ATM Networks

CAP -> CAMEL Application Part
CAMEL -> Customized Applications for Mobile networks Enhanced Logic
gsmSCF -> GSM Service Control Function
gsmSRF -> GSM Specialized Resource Function
gsmSSF -> GSM Service Switching Function

GL's MAPS™ CAP Emulator can emulate CAP (CAMEL Application Part) supplementary services such as unified messaging, prepaid, and toll-free (Freephone). CAP information flow is defined between functional entities such as SCF and SSF distributed across network executing services. MAPS™ CAP functionality covers the ITU and ANSI variants of M3UA, M2PA, MTP3 and ISUP protocols over TDM and IP. CAP can be transported using 'traditional' protocols carried by Message Transfer Protocol (MTP) in TDM (T1 and E1) or over IP using SIGTRAN.

MAPS™ CAP scripts, suitable for testing objects reliably and accurately validated for compliance with ANSI and ITU specifications. It is suitable for controlling telecommunication services such as Camel Voice Call Service – which includes Prepaid Call, Toll-free call (free phone), Low Balance Call Services (release on low balance, play announcement on low balance), Camel GPRS Service, Camel SMS Service, and Camel Initiate Call Attempt (ICA) Service.

- Test response of network against protocol message modification, or corruption
- Test Service Usage Charging for Voice, Data, SMS, etc
- Cost-of-call verification through balance check

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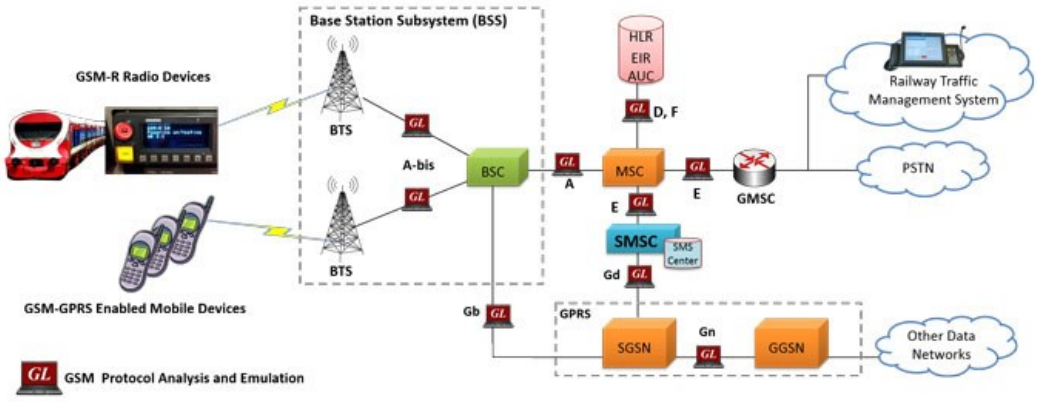
GSM TRAU Protocol Analyzer

GSM-R (GSM Railway) Protocol Analyzer

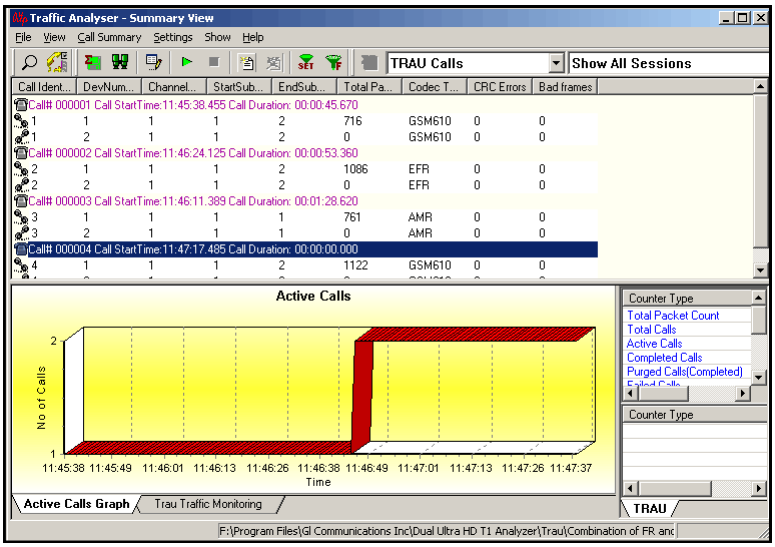


GSM-R (GSM Railway) is a proven mobile communications standard of ERTMS (European Rail Traffic Management System), the European standard for railway operations.

It is used to carry railway-specific voice and data services. It is an extension of the standard GSM signaling protocol and uses frequencies specifically reserved for railway operations.

- Decoding of many RR layer non-transparent messages such as "System Information", "Measurement Result", "Immediate Assignment" etc.
- Decoding of GSM-R as per EIRENE specification (H 22 T 0001 2) and ETSI TS 102 610 standards to verify and monitor GSM-R Network
- Complete end-to-end surveillance of the GSM-R Network
- Surveillance of specific tracks and high-speed lines
- Roll-out, and verification railway specific applications

TRAU Packets Analyzer (over TDM)



- Analyze TRAU frames at the Abis interface (b/w BSC and BTS)
- TRAU streams may be captured on the selected timeslots (contiguous or non-contiguous), sub-channels or full bandwidth 32 or 24 channels
- Capture and decode TRAU frames such as FR (Full Rate GSM 6.10), HR (Half Rate), EFR (Enhanced Full Rate), AMR (Adaptive Multi Rate), AMR-WB, O&M and Data
- Extracts speech data from TRAU frames, play the speech data on PC soundcard, or record voice to a file, after decompressing TRAU speech data to 16-bit linear PCM
- Multiple streams of TRAU traffic on various T1 or E1 channels can be simultaneously decoded
- Offline TRAU Analysis support - Trace files for analysis can be loaded offline through GUI or simple command-line arguments

TRAU Packet Data Analysis

- TRAU Packet Data Analysis (PDA) displays call information in tabular and graphical formats
- Provides Active Call graphs to view active calls over the duration of the capture
- Supports TRAU Traffic Monitoring to identify the frames and classify traffic

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