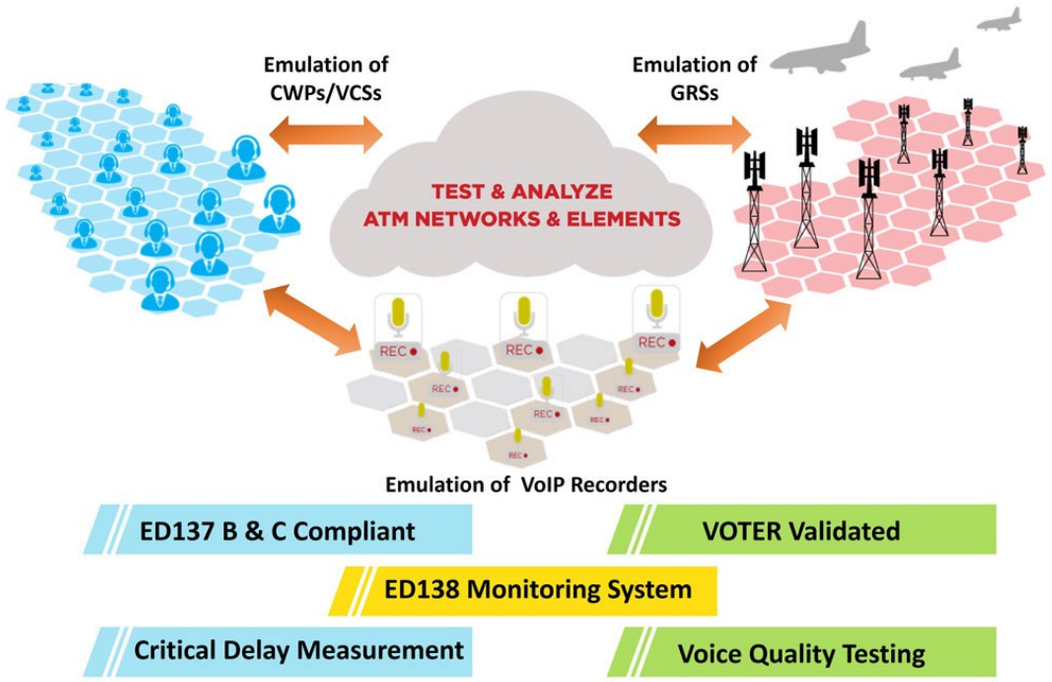
GL Communications Inc.

Test Solutions for Air Traffic Management
(Emulation & Surveillance)

December 2024



- **MAPS™ ED137 Radio/Controller Emulator (Air-to-Ground)**
- **MAPS™ ED137 Telephone Emulator (Ground-to-Ground)**
- **MAPS™ ED137 Recorder Emulator**
- **Critical Time Delay Measurement with Audio/Packet Analyzers**
  - **PacketExpert™** based modules - Packet Analyzer, Discrete Signal Logger (with Sensoray), and software based Event Data Logger
  - **VQuad™** based Audio Analyzer module is capable of delay measurement, generating event driven triggers
- **Air Traffic Network Surveillance**
  - **PacketScan™**
  - **NetSurveyorWeb™, NetSurveyorWeb™ Lite**
- **WAN Link Simulation**
- **MAPS™ CAS and ISDN**

For more information, refer to 5G Core (5GC) Network Test Solution webpage.

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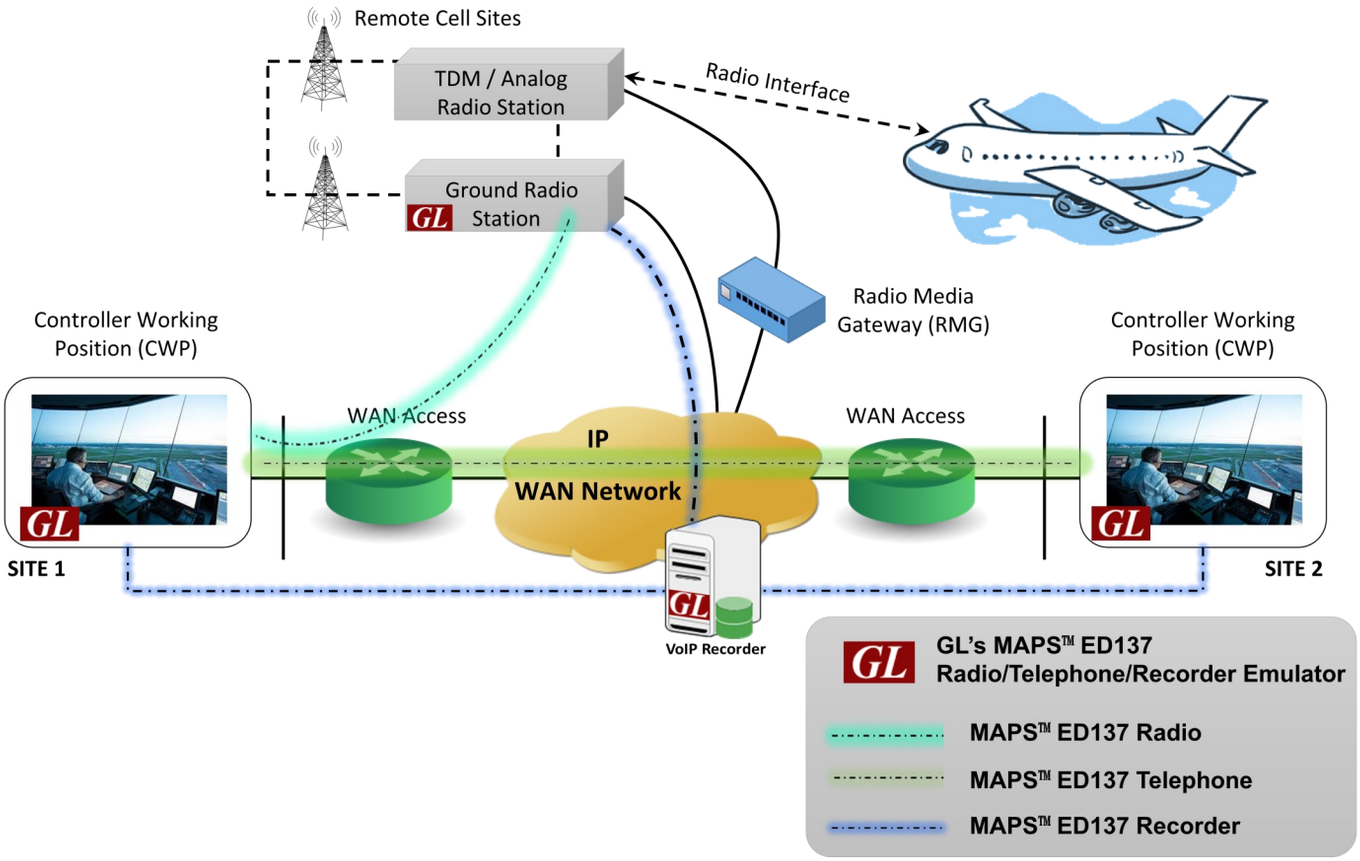
Table of Content

Simulation Test Tools for ATM per ED-137 Standards



Voice communications for Air Traffic Management (ATM), whether it is **Air-Ground (AG)** or **Ground-Ground (GG)** were predominantly over TDM based ATM networks. With the latest developments in EUROCAE (European Organization for Civil Aviation Equipment) ED137 inter-operability standard, it is now possible to implement VoIP technology for air traffic control communications.

GL uses a generic framework - **MAPS™ (Message Automation & Protocol Simulation)** to simulate protocols across different technologies like TDM, VoIP, 2G, 3G, 4G-LTE and 5G. Now, MAPS™ framework is used to simulate Radio, Telephone and Recorder interfaces as per EUROCAE's ED-137 standards.

MAPS™ ED-137 Radio simulates the functions of Controller Working Position (CWP) and Ground Radio Station (GRS) or Radio Media Gateway (RMG) entities. A single instance of MAPS™ ED-137 Radio can simulate hundreds of CWPs/ Radios with unique IP addresses. Similarly, **MAPS™ ED-137 Telephone** can simulate hundreds of Ground-to-Ground calls, supporting all Telephone call types and scenarios such as Call Hold, Call Transfer, Call Forward, Call Intrusion, Call Pick-Up, Conference Calls etc. **MAPS™ ED-137 Recorder** can emulate recorder interface at CWP, GRS, and Recorder Server. It can also store Call Record Details and record audio on the call. All our emulators support both B and C versions of ED-137 standards. Recently, we have enhanced all our emulators to support the latest version of standards - ED-137 Change1. Emulators are also validated against EUROCAE's VOTER tool.

For more information, refer to **Testing ED-137 and ED-138 Interoperability Standards for VoIP Air Traffic Control** webpage.

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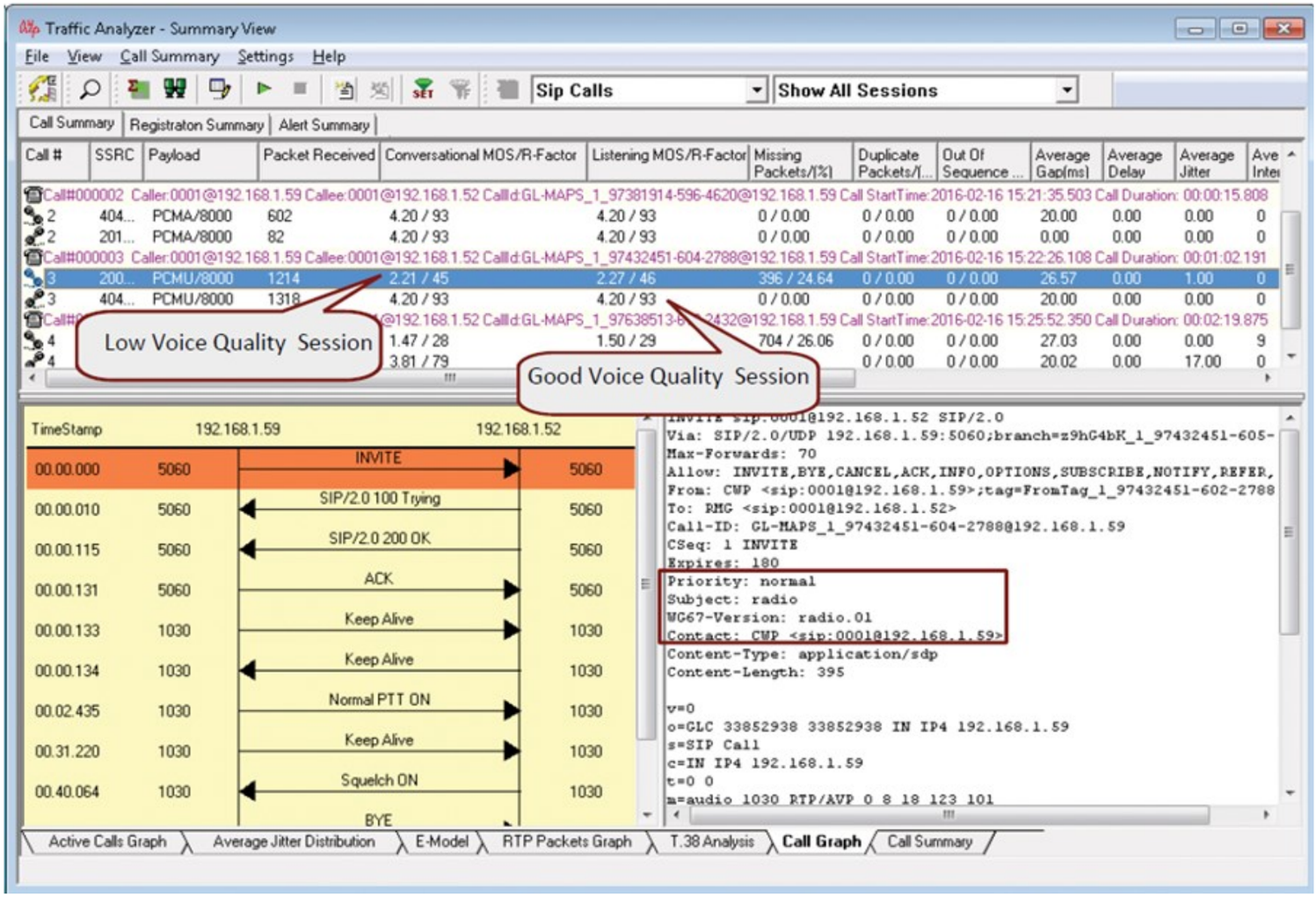
Monitoring Probes for VoIP ATM Network



Measuring delay, jitter, packet loss, and voice quality through ATM/IP networks is very important. GL offers powerful features within **PacketScan™** software to capture and monitor live signaling and traffi-c. PacketScan™ can capture, decode, segregate, monitor, and collect statistics on all Ground-to-Ground calls and Air-to-Ground calls as per EUROCAE ED-138 standards. The PacketScan™ is an essential tool for troubleshooting and passive monitoring.

- All traffic supported – Digits, Tones, Voice, Video, Fax
- Live monitoring of IPv4 and IPv6 networks, including the ability to play and recorded voice files
- Decodes signaling, traffic and extended RTP headers as per ED-137
- Measures Voice Quality statistics such as MOS/R-Factor, Packet Loss, Jitter, Delay, and many more for each call
- Permits analysis of adherence to protocol standards for the system under test or observation
- Provides graphical representation of signaling analysis including protocol ladder diagrams

For more information, refer to **PacketScan™ - All-IP Analyzer** webpage

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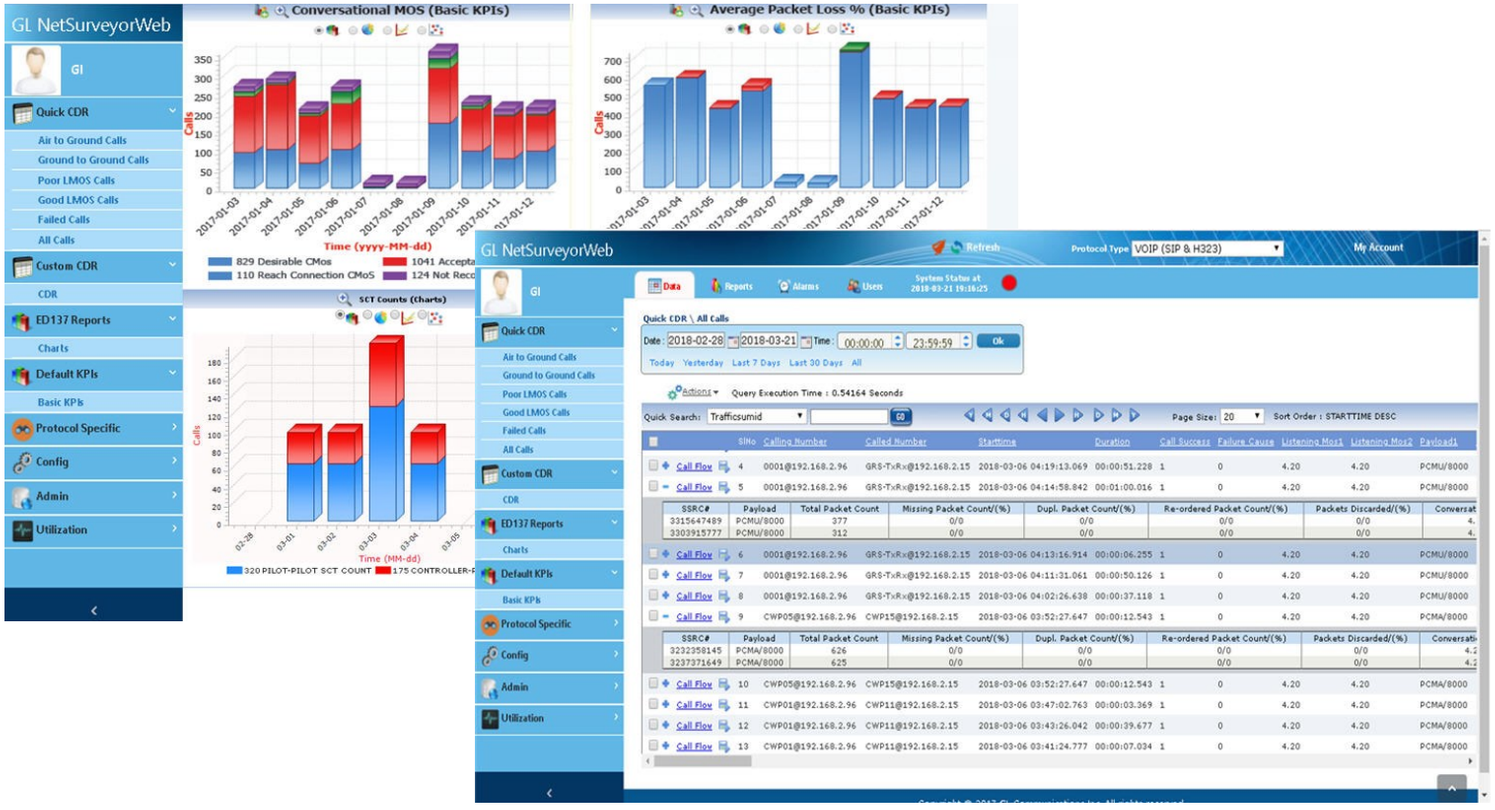
Air Traffic Control Monitoring Solutions

Multiple PacketScan™ probes can be deployed at remote locations to non-intrusively monitor VoIP ATM network. GL's **NetSurveyorWeb™** is a web-based network surveillance system that works with PacketScan™ probes for controlling, collecting, and analyzing call data records. It provides a centralized web-based dashboard to users. NetSurveyorWeb™ is based on a scalable and flexible architecture and is widely used to non-intrusively monitor from one or many testing locations.

GL also offers **NetSurveyorWeb™ Lite** as a simple all-in-one integrated monitoring PC containing a web server, database, and protocol analyzer probe. This system comes with all applications built-in so that users can immediately start monitoring the ATM networks.



Both applications provide a convenient display of call data records by connecting to **PacketScan™ probes**.

- Provides database query methods in order to query captured results, and gather status, statistics, and events
- Results are displayed both in tabular and graphical formats for both current and historical records
- Provides protocol signaling, traffic, and call detail records
- Perform filter and/or search for specific information
- Generate reports, alarms and E-mail notifications

For more information, refer to [Network Surveillance System (NetSurveyorWeb™)] webpage

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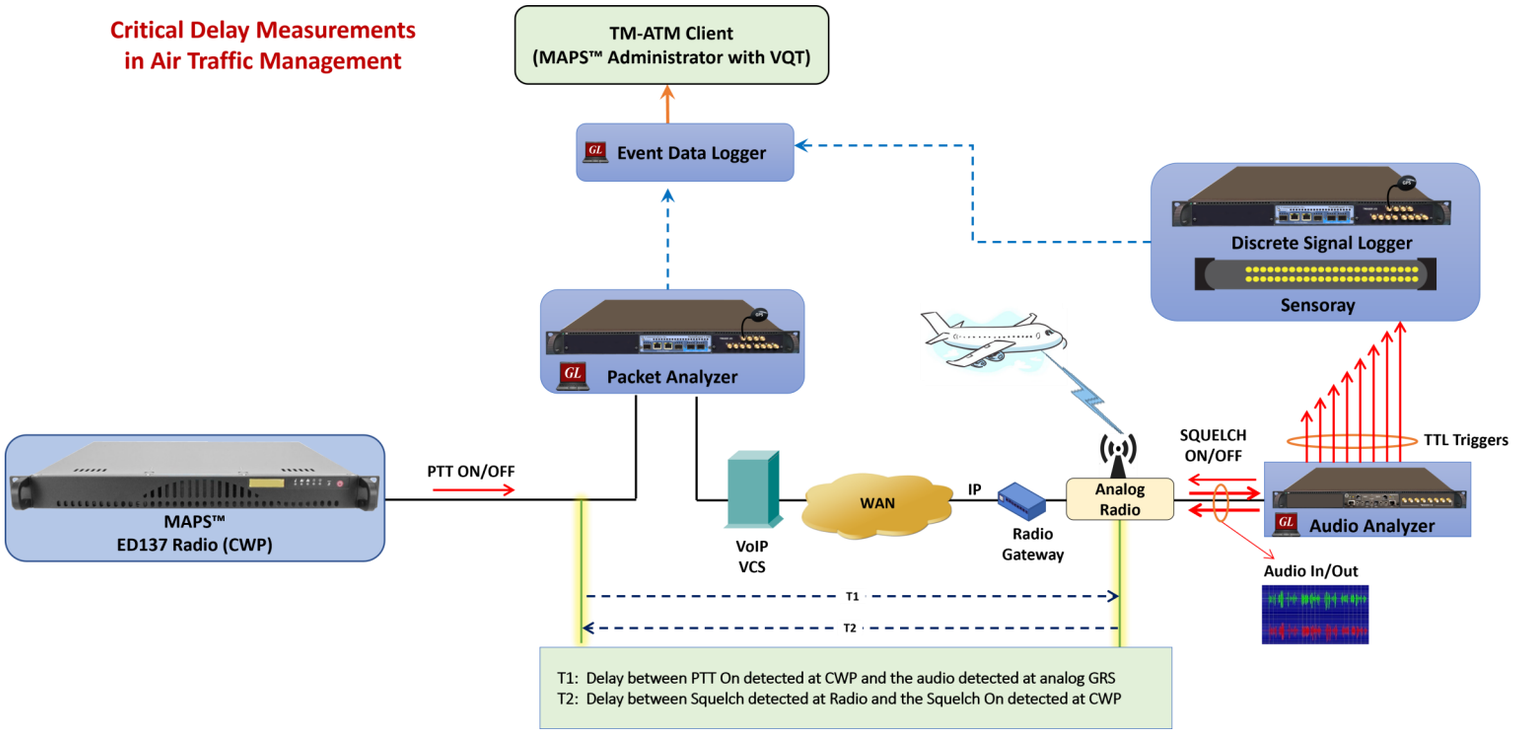
Timing Measurements in Air Traffic Management (TM-ATM)



GL 's **Timing Measurements in Air Traffic Management (TM-ATM)** test suite accurately emulates endpoints in ATM networks and providescritical timing measurements for various types of delay occurrences in signaling and voice transmission. It includes all necessary hardware deployed across the ATM network and software to identify, capture, timestamp, and correlate events at Analog, TDM, and IP interfaces. This TM-ATM solution is based on GL's **Message Automation and Protocol Simulation (MAPS™)** software program. MAPS™can emulate a wide range of telecom protocols including ED-137 Radio, Telephone, and Recorder. The MAPS™ program runs on Windows® operating system and uses the PC's network interface card to send and receive traffic.

The TM-ATM server components can be broadly categorized into two sets:

- **Packet based** – Packet Analyzer, Discrete Signal Logger, and Software based Event Data Logger
- **Analog/4-Wire** - Audio Analyzer

A brief description of GL Tools used and their functionalities for Timing Measurement:

Audio Analyzer - The Audio Analyzer is a 4-Wire audio device which includes 2 audio channels and 8 TTL triggers. It can connect to a CWP and simulate a controller by activating PTT and transmitting audio. It supports PTT interfaces to connect to CWP Dual Jack Module and other 4-wire interfaces. The analyzer can generate TTL for different actions (PTT ON, PTT OFF, Send Audio, Detect Audio).

Discrete Signal Logger - Continuously monitors the TTL inputs to Sensoray and the TTL output from the Audio Analyzer at regular intervals. The Sensoray can also generate analog control signals (PTT/Squelch etc.) that can be controlled from the Discrete Signal Logger. Each time itreceives a trigger pulse, it promptly generates a TELNET packet containing all the necessary information, including the corresponding channel number. The filtering module efficiently filters and timestamps these relevant TELNET packets before forwarding the Discrete Events to the Event Data Logger.

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Timing Measurements in Air Traffic Management (TM-ATM)

Packet Analyzer - Functions as a highly precise Ethernet tap, filtering packets of interest from a bidirectional Ethernet link without disturbing the traffic. The filtered packets are timestamped using highly precise stratum clock (Timed Events) and forwarded to Event Data Logger for. It also generates output TTL signal pulses for every filter match, which can be processed using an external device like Oscilloscope.

Event Data Logger - Receives the Discrete event packets forwarded from Discrete Signal Logger and the Timed event packets from Packet Analyzer systems throughout the network. It decodes the packet to extract information such as Device number, Filter number, Clock Sourceetc. and updates both type of Events to the MAPS™ Administrator's for every filter match, which can be processed using an external device like Oscilloscope.

MAPS™ Administrator - A control/logging client application, which uses TCP/IP to send commands to and receive notifications from all the above-mentioned server tools. MAPS™ Administrator will calculate the time difference between posted events, i.e., Discrete Events (from Discrete Signal Logger) and Timed Events (from Packet Analyzer) and reports precise measured delay at different points in the network. MAPS™ Admin is script based and API driven products that can be reused for various purposes during test cycles.

For more information, refer to **Critical Delay Measurements in Air Traffic Management** webpage

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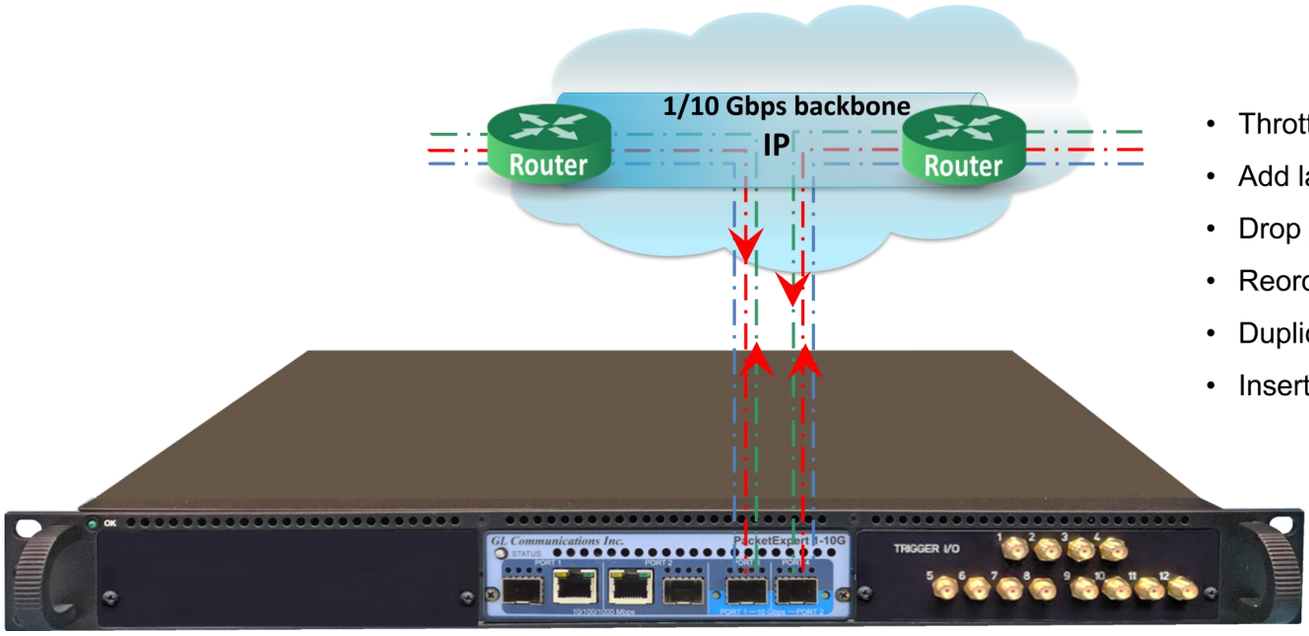
Wide Area Network (WAN) Simulation



- Throttle bandwidth
- Add latency
- Drop packets
- Reorder packets
- Duplicate packets
- Insert packet errors

GL can simulate real world WAN impairments in order to safely test applications in the lab.

GL's WAN link emulators support both electrical (RJ-45) and optical (single mode and multi-mode) interfaces, with capacity ranging from 10Kbps to 10Gbps.

Simulates impairments such as bandwidth throttling, latency, packet loss, packet reordering, packet duplication and byte errors

- Provides a visual display of the current traffic conditions including throughput graphs and link statistics
- Acts as a transparent bi-directional Ethernet link
- Automate stream impairments using pre-defined CSV file
- Allows bandwidth control from 10 Kbps to 10 Gbps to emulate various WAN link speeds

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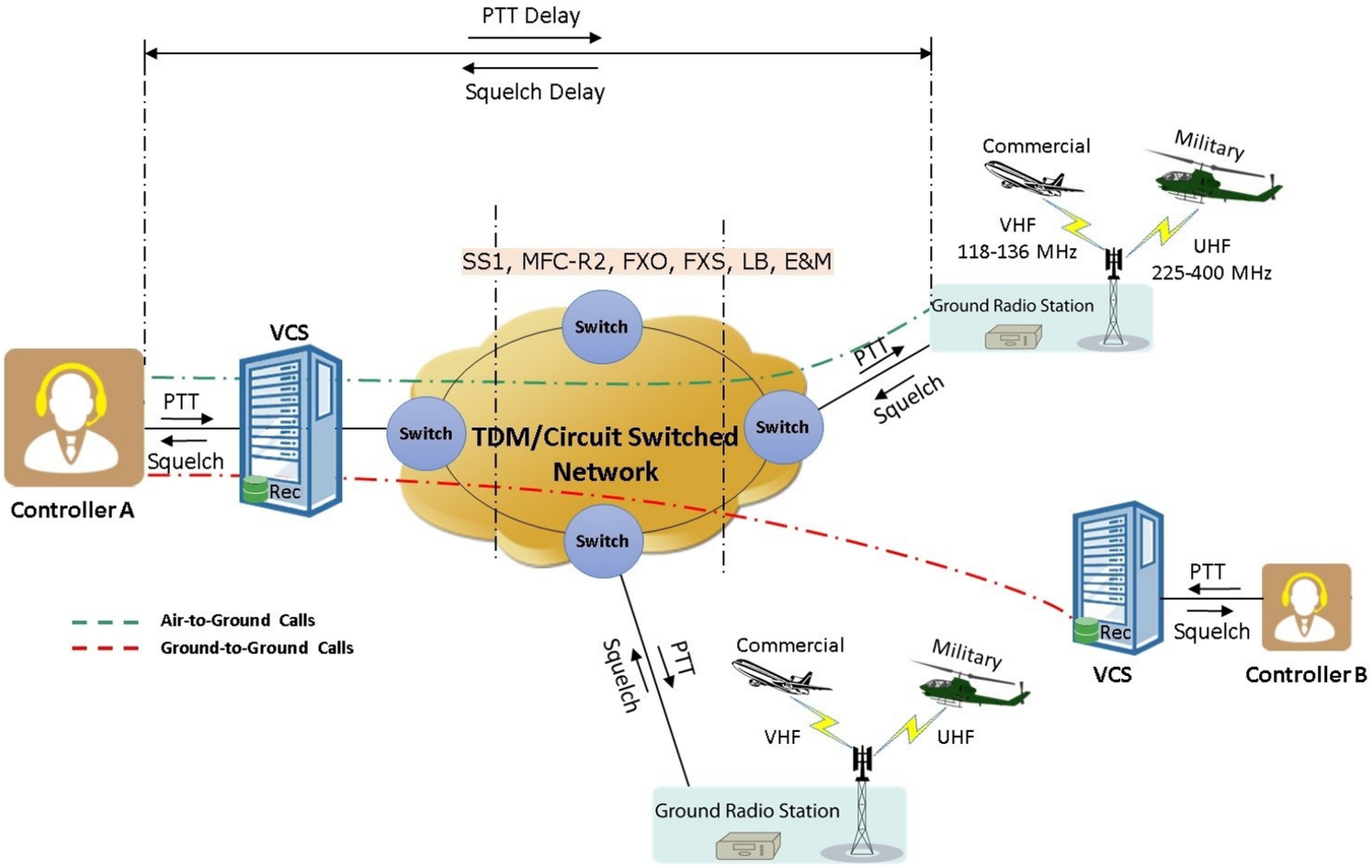
Test Solutions for Legacy TDM ATM Network



TDM Record and Playback Applications

GL's Synchronous Trunk Record/Playback (or STRP) application offers both Record and Playback features on T1 E1. For large capacity, GL's **Octal T1 E1** boards can record and playback on up to 192 T1 channels and 256 E1 channels per board. More scalability can be achieved with multiple boards. This application is most valuable for critical data analysis in defense and research activities.

The application permits the user to synchronously record any type of traffic (voice, digits, and tones) on multiple complete T1 or E1 lines (trunks) with accurate timestamp. It also allows to playback some or all of the recorded data to recreate the live transmission exactly as it occurred. Refer to **Synchronous Record-Playback for Mission Critical Data** webpage for complete information on STRP application.

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Test Solutions for Legacy TDM ATM Network

Protocol Emulators and Analyzers

GL's **MAPS™ ISDN** is an advanced protocol simulator/tester for ISDN simulation over TDM (T1 E1) and generates high volumes of ISDN traffic. The tester can emulate ISDN signaling as defined by ITU-T, 5ESS, 4ESS, BELL, DMS-100, DMS-250, and QSIG ECMA standards. Refer to **MAPS™ ISDN Protocol Emulator** webpage for complete information on MAPS™ ISDN.

GL's **MAPS™ CAS** is used to perform testing using CAS signaling and transmission and detection of TDM traffic over T1/E1 using scripts, and offers a complete solution for testing, troubleshooting, and maintenance of devices and networks implementing CAS. Typical CAS signaling methods are: Loop Start, R1, E1 MFC-R2, E1 Digital E & M, SS5, Sweden P7, FGD, CAMA, and other variants of these methods. Refer to **MAPS™ CAS Protocol Emulator** webpage for complete information on MAPS™ CAS.

GL's **SS1 Analyzer** detects and analyzes tone sequences that make up SS1 dial digits. Sequences of pulse and guard tones are detected, decoded, and assembled into their corresponding dial digits. The tone sequences are also verified for compliance against a "specification" parameter file which can correspond to published standards or user criteria. The **SS1 Emulator (Dialer)** application provides the ability to setup and dial tone sequences that make up SS1 dial digits. The applications' interface includes options to setup Dial Code, and control Mask (pulse) and Space (guard) frequencies and duration, Initial, Nominal, and Final Durations, Timeout definitions, Transmit Channel, and other similar parameters related to the dial code.

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