ED137 VoIP Emulation and Analysis Tools for Air Traffic Management
GL Communications Inc. - Overview

- Located in the United States – Gaithersburg, Maryland
- Founded in 1986
- Engineering Consulting Services
- Test & Measurement Equipment
  - Wireless, VoIP, SONET-SDH, TDM
  - Visualization, Capture, Storage, Portability, Cost-Effectiveness
Today’s Agenda

❖ ED-137 Emulators
  • MAPSTM ED-137 Radio
  • MAPSTM ED-137 Telephone
  • MAPSTM ED-137 Recorder

❖ ED-138 Monitoring Solutions
  • PacketScan™
  • NetSurveyorWeb™

❖ Critical Delay Measurement in Air Traffic Management
GL’s Solution for Testing
Next Generation Air Traffic Management over IP
MAPSTM – Recorder, Radio, Controller Simulation
Basic Operations

Controller Working Position (CWP)

SITE 1
MAPS ED137 Radio (as CWP)

PTT ON
SQUELCH ON

Ground Radio Station

MAPS ED137 Radio (as GRS)

Controller Working Position (CWP)

SITE 1
MAPS ED137 Telephone (as CWP)

WAN Access

IP WAN Network

WAN Access

SITE 2
MAPS ED137 Telephone (as CWP)
MAPSTM - ED137 Telephone Emulator

- Light-weight - Software Only
- Easy-to-Use Graphical Interface
- MS Windows (7 & above) based systems
- CLI/API access for seamless integration with 3rd party test tools
- Incredibly Flexible Architecture for custom testing scenarios
MAPSTM - ED137 Telephone Emulator Highlights

- Emulates ED-137/2B Telephone interface at CWP endpoints
- Simulates multiple CWPs from single instance of MAPSTM.
- Each simulated CWP can have unique IP address.
- Supports Call Hold and Call Transfer
- Supports User authentication with Proxy and Registrar servers

- Allows call rejection through use of SIP response codes (4xx, 5xx, 6xx)
- Supported Codecs – G711 A-law, U-Law and G729
- Traffic Actions – send and record to file, send and detect digits/tones, Talk using microphone and play to speaker.
- Load generation or background traffic generation using Bulk Call Generation.
Call Types:

- Instantaneous Access Call
- Priority DA/IDA Call
- Routine Tactical DA/IDA Call
- Routine Strategic DA/IDA Call
- Routine General Purpose DA/IDA Call
- Position Monitoring (A/G and G/G) Call
- Position Monitoring (A/G only) Call
- Position Monitoring (G/G only) Call
Call Types:

- Displays easy to understand Call Flow Graphs of SIP message exchanges with timestamp.
- Displays Call Type, Call Setup time and SIP message contents (SIP headers and SDP attributes)
- Provides call statistics, Event logs, Captured errors and Error events.
MAPSTM - ED137 Radio Emulator

- Light-weight - Software Only
- Easy-to-Use Graphical Interface
- MS Windows (7 & above) based systems
- CLI/API access for seamless integration with 3rd party test tools
- Incredibly Flexible Architecture for custom testing scenarios
MAPSTM - ED137 Radio Emulator Features

- Emulates both **ED-137/1B** and **ED-137/1C** Radio interface at CWP or GRS
- Simulates multiple CWPs and Radios in single instance of MAPSTM using unique IP address.
- Portable, easy to configure and use during in-the-field installation, testing and commissioning.

- Supports all Radio Call Types, PTT Types, SIP Headers and all mandatory/optional SDP attributes.
- Supports **WG67 Key-In Event** package.
- Supports simulation of Radio Remote Control Equipment (RRCE) and handles Radio Remote Control commands.
MAPSTM - ED137 Radio Emulator Features

• **Multiple Radio Simulation** within a single instance of MAPSTM ED-137 Radio

• **IP Address Spoofing** simulates multiple CWPs/Radios each using a unique IP address

• **Linked Session Management** provides higher service availability and handles redundant connections to Radio

• Supports below new user-events on an established call
  - **Re-Invite**: Sends Re-INVITE to update a SIP session
  - **Receive Traffic**: To record voice to file or detect digits and tones on the call

• Handling PTT Priorities at Radio
Each profile represents a Radio and it will have its own parameters like Radio emulation type, frequency-Id etc.

- Supports feature specific RTP header extension types Climax Time Delay, Signal Quality Index, Radio Remote Control and Dynamic Delay Compensation.

- Codecs – G711A, G711U and G729

- Apply DSCP (Differentiated Service Code Point) values to signalling and media.

- Traffic actions – send and record to file, send and detect digits/tones, Talk using microphone and play to speaker.

- Impairments (Packet Loss, Packet Effects and Latency) can be applied to RTP traffic
MAPS™ - ED137 Radio Emulator – Call Reception

- Supports Call pre-emption, PTT priority handling, permitted users list.
- Apply events like PTT, Squelch, PTT Summation, PTT Mute, SCT and more on the call.
- Displays Call graph and message decodes for each call.
- Load generation or background traffic generation can be done using Bulk Call generation feature.
- Supports automation of Call and Traffic generation.
- Detects Pilot-Pilot and Controller-Pilot induced SCT (Synchronous Transmissions).
• Displays easy to understand Call Flow Graph of SIP message sequences and message contents.
• Call graphs also notify all the events (PTT on/off, Squelch on/off, PTT Mute, Summation, etc.) on the call with timestamp.
Multiple Controller and Radio Simulation

MAPS ED137 Radio (CWP)

Profiles

001@192.168.1.1
002@192.168.1.1
003@192.168.1.1
010@192.168.1.1

Radio – Idle
Radio – TxRx
Radio – Rx Only
Coupling

MAPS™ ED137 Radio (GRS)

Profiles

GRS_001
(Transceiver, FID: 125.000)
001@192.168.1.10

(Receiver, FID: 125.025)
002@192.168.1.11

GRS_010
(Transmitter, FID: 125.050)
010@192.168.1.20

GL Communications Inc.
ED137C Features in MAPS™ - ED137 Radio Emulator

- Radio Receiver Multicast Operation
- SELCAL (Selective Calling) Tone Transmission
- Simulation of Non-VoIP source PTT keying
- WG67 KEY-IN event package now includes frequency id (fid) of Radio
- Option to retain active sessions at GRS when frequency (fid) changes
- Added Test PTT
- PTT-id 63 is reserved for SELCAL tone transmission and PTT-ids 60, 61 and 62 are reserved for PTT keying from non-VoIP source
- Radio version updated to “radio.02” in WG67-Version SIP header
MAPSTM - ED137 Recorder Emulator

- Light-weight - Software Only
- Easy-to-Use Graphical Interface
- MS Windows (7 & above) based systems
- CLI/API access for seamless integration with 3rd party test tools
- Incredibly Flexible Architecture for custom testing scenarios
MAPS™ - ED137 Recorder

Air-to Ground Calls
Ground-to Ground Calls
Recorder Interface Calls

Controller A
VoIP VCS
Recorder

SIP, RTP
RSTP, RTP

PTT
Squelch

PTT
Squelch

Commercial
VHF
118-136 MHz

Military
UHF
225-400 MHz

Ground Radio Station
VoIP VCS
Controller B

GL Communications Inc.
MAPSTM - ED137 Recorder Emulator Highlights

• Emulates ED-137/4B Recorder interface at CWP, GRS and Recorder endpoints
• Simulates Recorder interface on multiple CWPs and Radios from single instance of MAPS
• Simulates Recorder interface for both Air-to-Ground and Ground-to-Ground calls
• Supported codecs include G711 A-law, U-law and G729

GL Communications Inc.
MAPSTM - ED137 Recorder Emulator Highlights

- Simulates recording interface at CWP, VCS, GRS and Recorder end points
- Supports all three media transport methods: Embedded Binary Data, RTP over TCP and RTP over UDP
- Custom Call Record Data properties and operations can be added
- Provides Call Graph and message decodes.
- Recorder node records the voice on sessions to audio files and saves Call Record Data to CSV files
MAPSTM - ED137 Recorder Emulator Highlights

• Scripts to automate PTT and Squelch operations on recording sessions

• Scripts/sessions can be run repeatedly for defined number of iterations with results of the test.

• Multiple scripts can be run simultaneously or sequentially or randomly.

• Scheduler helps to run a set of scripts (test cases) at different intervals as defined by user.

• Hundreds of recording sessions can be made to Recorder to verify performance and load testing.
A typical ED137 Recorder Call between CWP-to-Recorder and GRS-to-Recorder simulation using MAPSTM at one or both of the peer-end as shown.

Complete call flow graph and message decodes are displayed for each call.

The PTT, and Squelch (Record) events are also updated to the call graph indicating the time at which the event occurred.
• Typical G-G call scenario that can be simulated using MAPSTM at one or both the peer ends.

• In this GG call scenario, recording is initiated immediately after call establishment unlike in AG call where the Key/Squelch commands are issued from CWP/GRS to initiate recording.
MAPSTM - MAPSTM ED137 Recorder acting as CWP/GRS and testing Recorder

- MAPSTM ED137 acting as Controller Working Position (CWP) and/or Ground Recorder Station (GRS) generates Air-to-Ground recording sessions towards Recorder (DUT – Device Under Test).
MAPS™ - MAPS™ ED137 Recorder acting as CWPs and testing Recorder

- MAPS™ ED137 acting as Controller Working Position (CWP) generates Ground-to-Ground recording sessions towards Recorder (DUT).
MAPSTM - MAPSTM ED137 Recorder testing Recorder interface of CWP/VCS

- MAPSTM ED137 can be configured to act as recorder to receive recording sessions from Controller Working Position (CWP) or Voice Communication Systems (VCS), thus testing the recorder interface of CWP/VCS.
MAPSTM - MAPSTM ED137 Recorder testing Recorder interface of GRS

- MAPSTM ED137 can be configured to act as recorder to receive recording sessions from Ground Recorder Station (GRS), thus testing the recorder interface of GRS.
Air Traffic Control Monitoring Solutions
A-G and G-G Call Monitoring Tools - PacketScan™ & NetSurveyorWeb™

• Lightweight - Software Only

• Easy-to-Use Graphical Interface (Technician and Engineer Friendly)

• MS Windows (7 & above) based systems

• Used to evaluate overall network health or to solve deep protocol or traffic issue

• Real-time and/or post processing
PacketScan™ Software – Protocol Decode

- Offers powerful features to capture and monitor Air-to-Ground, and Ground-to-Ground calls
- Permits analysis of adherence to protocol standards for the system under test or observation
- Displays Frame Summary, Detail, and Hex Views
- Capture calls in real-time for infinite time
- Decodes SIP, RTP and all RTP header extension fields as per ED-137/1B
- Capture and View Filters to analyze only traffic of interest.
- Reads and writes Wireshark trace formats also.
PacketScan™ Software – Traffic Analyzer

- Organizes captured frames into logically calls and/or sessions.
- ED-138 Statistics (MOS/R-Factor, Packet Loss, Delay and Jitter)
- Provides both aggregated and per call statistics.
- Provides graphical analysis of calls like Call Ladder Diagrams, MOS and Jitter variation graphs.
- Record and Playback audio on the call
- Listen in Real-time, View Spectrum Analysis & Oscilloscope of Voice
- Detects inband/outband Digits and Tones.
- Triggers and Actions feature can filter on “Calls of Interest”.

GL Communications Inc.
• Web-based network surveillance system for air traffic monitoring
• Works with multiple PacketScan™ Probes to non-intrusively monitor at remote locations
• Scalable and Flexible Architecture
• Real-time and/or historical analysis
• Multi-user support, and user-friendly interface
• Filter and Search Options. Provides quick database query methods
• Results are displayed both in tabular and graphical formats
• Provides protocol signaling, traffic, and call detail records (CDRs)
• Generates Reports and Alarms.
NetSurveyorWeb™ – Triggers and Actions

• Triggers:
  ➢ Threshold exceeded
  ➢ Call of Interest changes state
  ➢ Time of Day met

• Actions:
  ➢ E-mail
  ➢ Log Event
  ➢ Visual and Audible Alarms
Air Traffic Control
GL’s Critical Time Delay Measurements
Critical Time Delay Measurements - Overview

Controller 1  Legacy VCS  VoIP Gateway  VoIP VCS  Controller 2

$\tau_0$ $\tau_1$ $\tau_2$ $\tau_3$ $\tau_4$

Ground Radio Station

VoIP Backbone
Critical Time Delay Measurements - Overview

Diagram showing the flow of data from Controller 1 through VoIP Gateway, Legacy VCS, and VoIP VCS to Controller 2, with timelines marked as $t_0, t_1, t_2, t_3, t_4, t_5$. The system includes Audio Analyzers, Packet Analyzers, Packetizers, and an Event Data Analyzer.
Audio Analyzer - Overview

- Emulate Controller (PTT and Audio); Generates TTL triggers based on PTT On, PTT Off, Audio Start and Audio Detect (on or off)
- Inject and record analog signals at the CWP, Radio and VoIP gateway interfaces.
- Perform Voice quality analysis as per ITU-T standards (PESQ, POLQA)
- Automation with other GL test solutions and CLI/API access for seamless integration with 3rd party test tools
Packet Analyzer - Overview

- Filter packets of interest only and store or trigger timed event.
- Capture simultaneously on multiple ports with 40 byte filter depth per port. Define what byte(s) of interest to be hardware-level filtered.
- Packet filtering can be based on all Layer 2 (Ethernet), Layer 3 (IP), and Layer 4 (UDP/TCP) Headers
- Capable of generating packet and TTL triggers (1 Microsecond pulse) for each real-time packet that satisfies filter criteria
- Automation with other GL test solutions and CLI/API access for seamless integration with 3rd party test tools
Packet Analyzer – Capturing Traffic of Interest

GL Communications Inc.

Traffic of Interest

Filtering

Ethernet, IP, UDP, and TCP Filters

Drop Port (Electrical)

Port #1 Forwarding

Span Ports (Electrical/Optical)

Network A

GL Communications Inc.

Packet Analyzer

Network B
Thank You
Any Questions?