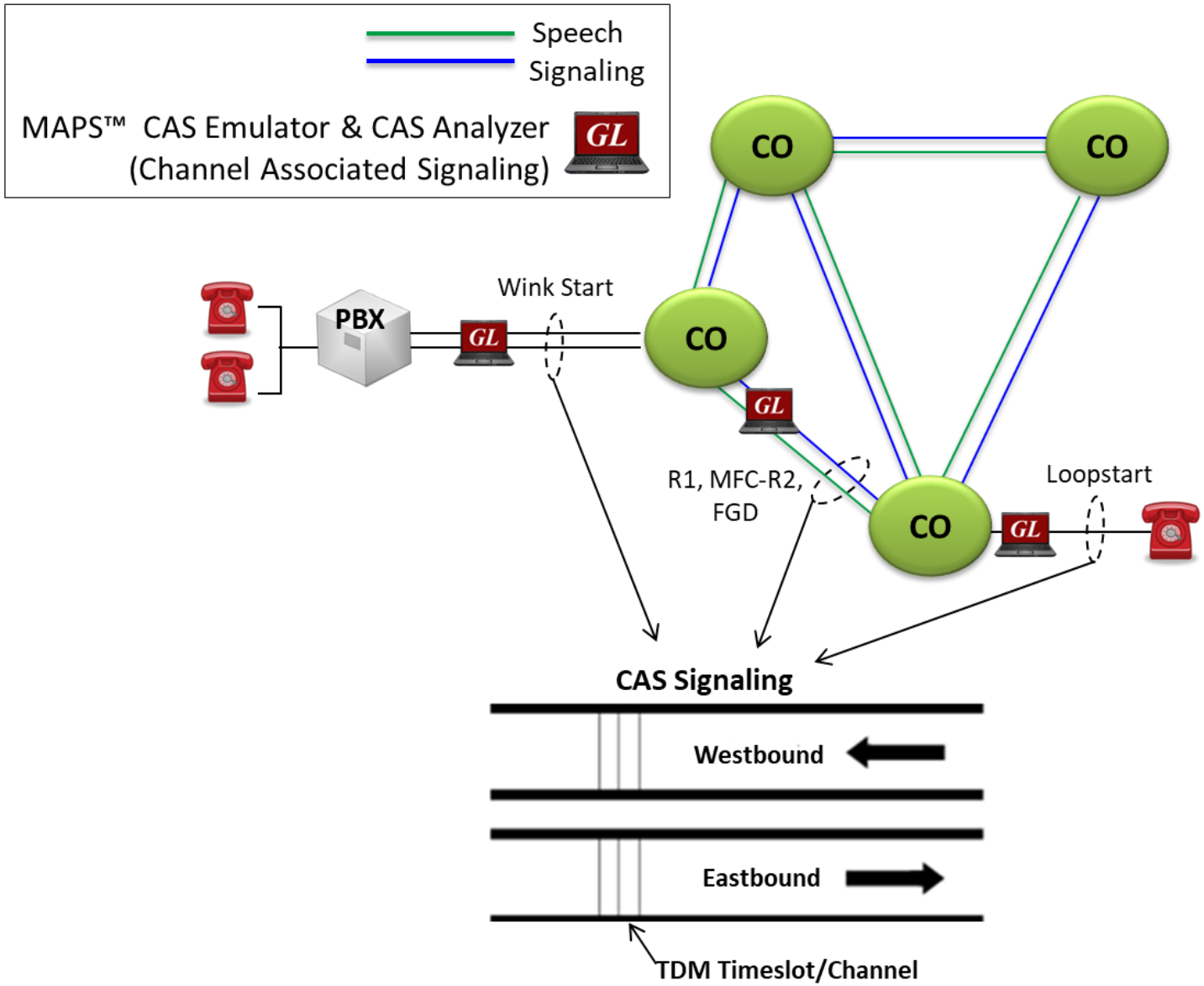
MAPS™ CAS Protocol Emulator

(Channel Association signaling (CAS) Emulation)

GL Communications Inc.
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: https://www.gl.com

MAPS™ CAS Emulator in Telephony Network



GL Communications

MAPS™ CAS Features

Call Scenarios

- Caller ID
- Two-way Calling
- Three-way Calling
- Three-way Calling with Calling Party Number Identification
- VMWI – Voice Mail with MWI (message waiting indicator) and SDT (stutter dial tone)
- Call Waiting – Detect tone, call id, flash to accept call

Reporting

- Central Database of events/results/errors
- Multi-User, Multi-Test, Multi-Reporting
- Executed test cases
- Successful test cases
- Failed test cases
- Failed reason
- Test results showing voice quality, failed call attempts, dropped calls
- PDF and CSV file formats

MAPS™ CAS Features (Contd.)

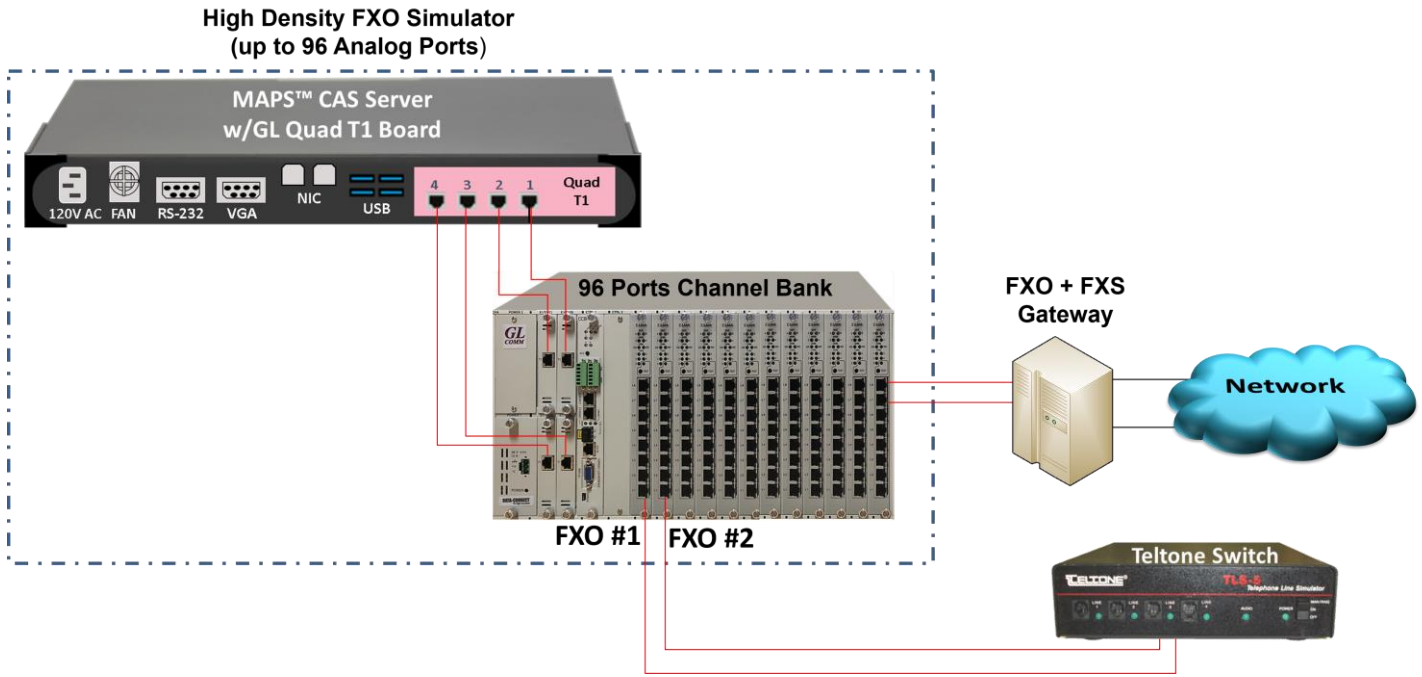
Functionalities

- Voice Prompt Confirmation (requires VQT)
- Voice Quality and Delay Measurements (requires VQT)
- Detect Caller ID, and VMWI
- Basic telephony functions - On-hook, Off-hook, Detect ringing signal, Dial, and 3-Way Call (using flash hook)
- Both analog and digital (T1) CAMA simulation is supported
- Dial Tone Delay, Post Pickup Delay, special dial tone, stutter dial tone, special information tone, call waiting, call in progress tone, reorder tone, busy tone, congestion tone, confirmation tone, howler tone, and ring-back tone
- Fax - Send /Receive fax image (TIFF format) file from/to the specified location
- Call Failure events
- Call Completion events
- Call Drop (sustain calls) events

MAPS™ CAS Solution

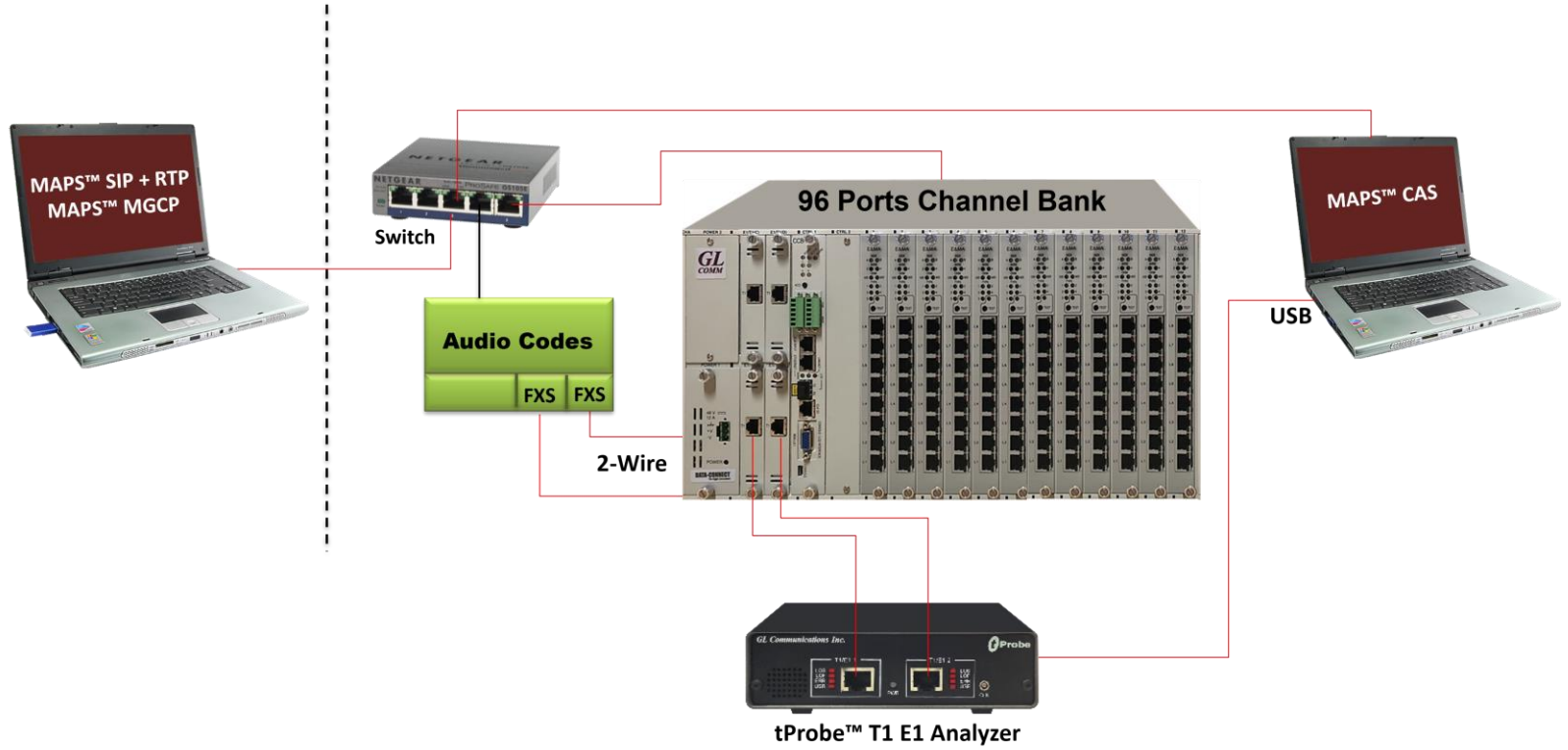
High Density FXO Simulation with MAPS™ CAS and Channel Bank

Features	High Density NB Solution MAPS™ CAS
Space Considerations	1U (MAPS™ CAS) 3U (Channel Bank)
Ports	Quad T1 (4 x T1) 96 Analog Channels
FXO Audio	NB Support
Operation	Fully Independent Ports with control b/w systems
Bulk Call	Yes – Supports



MAPS™ CAS Solution (Contd.)

End-to-End Hybrid Network Testing using High Density MAPS™ CAS and Channel Bank



Features	Hybrid Network Test Solution MAPS™ CAS
Space Considerations	1U (MAPS™ CAS) 1U (MAPS™ SIP/ MAPS™ MGCP) 1U (Audio Codes Media Gateway) 3U (Channel Bank)
Ports	Quad T1 (4 x T1) 96 Analog Channels
FXO Audio	NB Support
Operation	Fully Independent Ports with control b/w systems
Bulk Call	Yes – Supports

CAS Supported Protocols

- T1 Wink Start (R1 wink)
- T1 Loop Start and T1 Ground Start
- T1 Feature Group D (FGD)
- T1 Immediate Start
- FXO CAMA (Centralized Automated Message Accounting) simulation (analog two-wire and digital T1)
- E1 MFC-R2 (All variants, full / semi compelled) - Defined by the ITU Recommendations Q.421-Q.442 - uses multi-frequency compelled signaling protocol to exchange address information
- E1 European Digital CAS (EUC)
- E1 Digital E & M
- E1 International Wink Start
- E1 Sweden P7
- Any User-Defined CAS Protocol

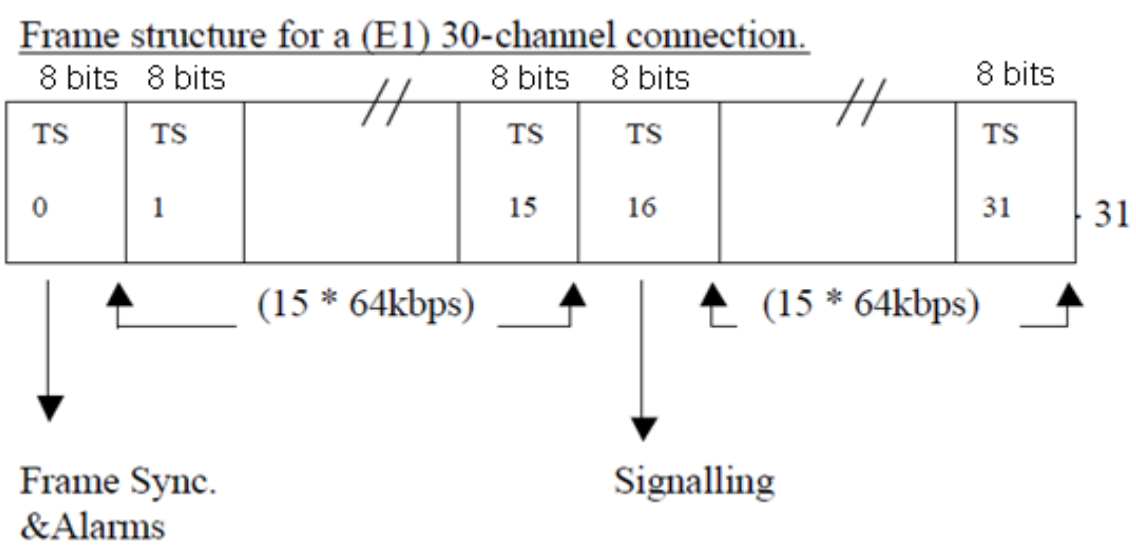
E1 MFC-R2 Call Simulation

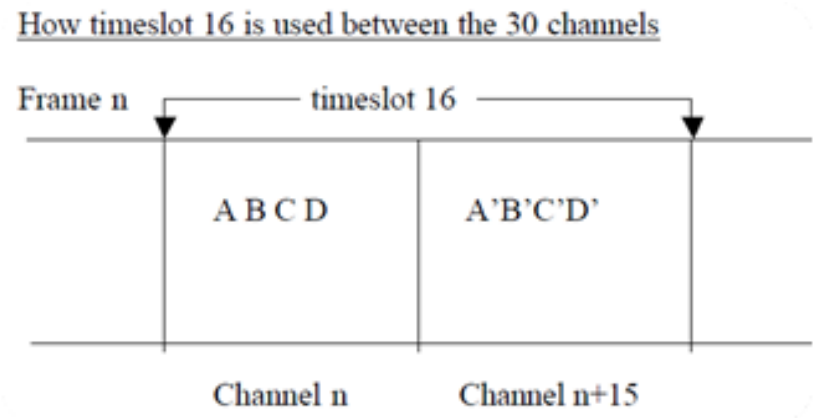
What is MFCR2 CAS?

- Multi Frequency Compelled R2 Channel Associated Signaling
- Defined by the ITU Recommendations Q.421-Q.442 - uses multi-frequency compelled signaling protocol to exchange address information
- Used to convey information along a telephone trunk **between two switches** in order to establish a telephone call along that trunk
- Types of signals exchanged between two switches
  - Line Signals - Allows for the possible signaling states used to set up and clear down the call, and various other events
  - Inter Register signals – Allows selection signals and digits. The digits are used primarily to indicate the called number, but can also have other meanings

GL Communications

Line Signals





- Within E1 timeslot 16, each traffic channel is allocated 4 bits (ABCD) for signaling once every 16 frame multi frame. The 4 bits allows for 16 possible signaling states

Line Signals – MFCR2

- Although E1 Channel Associated Signaling (CAS) framing supports 4 signaling bits, only 2 of them (per direction) are used for R2 line signaling
- Billing pulses are also handled using these bits
- Af and Bf are the line signaling protocols in the forward direction
- Ab and Bb are the line signaling protocols backward direction

Signaling states of a typical call

State	Outbound AfBf	Direction	Inbound AbBb
Idle	10	← →	10
Seizure	00	→	01
Seizure Acknowledged	00	←	11
Ringing	00	←	11
Answer	00	←	01
Clear forward	10	→	11
Idle	10	←	10
Answer Conversation State	00	←	01
Billing pulses	00	←	11 or 00
Answer – Conversation state	00	←	01
Inbound side hangs up first: Clear back	00	←	11
Clear forward	10	→	11
Answer – Conversation state	00	←	01

GL Communications

Register Signals

- These are 2 out of 6 inband multitone signals sent in both directions to control the switching process
- For example, India uses 2 out of 5 frequencies resulting in a total of 10 different tones for forward and backward signals, respectively
- The below tables summarizes the meanings of each of the tones for forward signals. The meanings can however vary based on country specific implementation

Forward Group I		Forward Group II	
I-1	Digit 1	II-1	Subscriber without priority
I-2	Digit 2	II-2	Subscriber with priority
I-3	Digit 3	II-3	Maintenance equipment
I-4	Digit 4	II-4	Spare
I-5	Digit 5	II-5	Operator
I-6	Digit 6	II-6	Data transmission
I-7	Digit 7	II-7	Subscriber (International)
I-8	Digit 8	II-8	Data transmission
I-9	Digit 9	II-9	Subscriber with priority
I-10	Digit 0	II-10	Operator with forward transfer facility
I-11	-	II-11	Spare for national use
I-12	Request not accepted	II-12	Spare for national use
I-13	Satellite link not included	II-13	Spare for national use

Register Signals (Contd.)

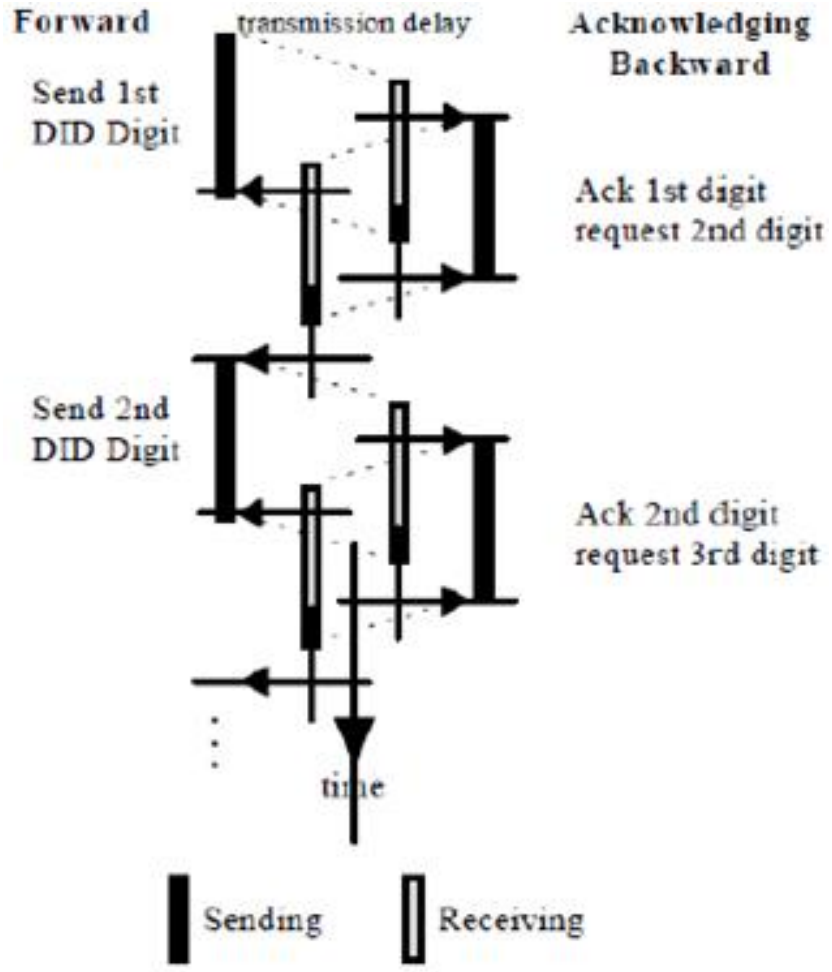
- The below tables summarizes the meanings of each of the tones for backward signals. The meanings can however vary based on country specific implementation

Backward Group A		Backward Group B	
A-1	Send next digit (N+1)	B-1	Spare for national use
A-2	Send last digit (N-1)	B-2	Send special information tone
A-3	Address completed, change to reception of Group B	B-3	Subscriber line busy
A-4	Congestion in National network	B-4	Congestion
A-5	Send calling party category	B-5	Unallocated number
A-6	Address complete, charge, setup speech conditions	B-6	Subscriber line free, charge
A-7	Send second to last digit (N-2)	B-7	Subscriber line free, no charge
A-8	Send third from last digit (N-3)	B-8	Subscriber line out of order
A-9	Spare for national use	B-9	Spare for national use
A-10	Spare for national use	B-10	Spare for national use
A-11	-	B-11	Spare for national use
A-12	-	B-12	Spare for national use
A-13	Send nature of circuit	B-13	Spare for national use
A-14	Request info on use of half echo suppression	B-14	Spare for national use
A-15	-	B-15	Spare for national use

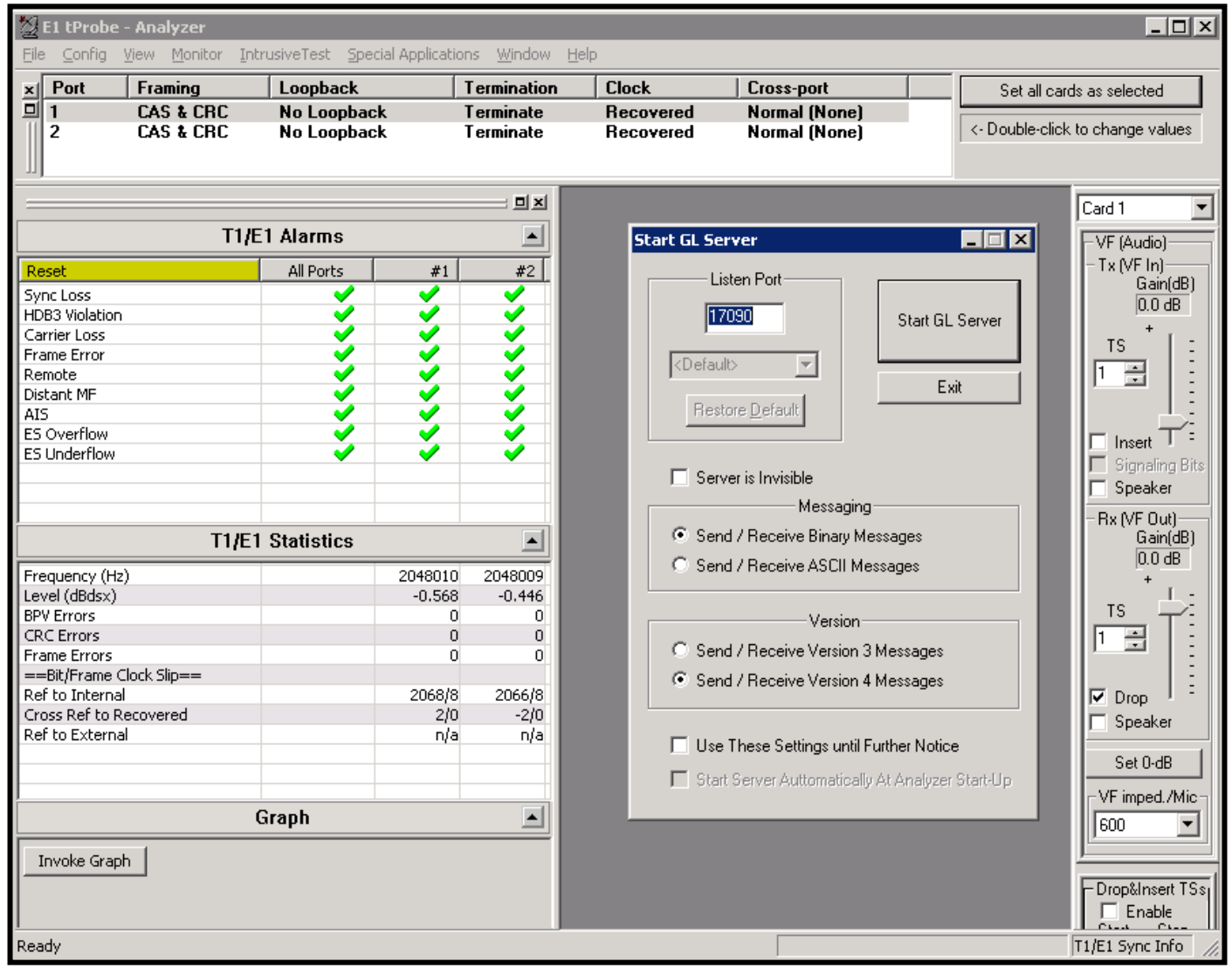
Compelled Signaling Operation

The inbound tones are exchanged between two switches in compelled way as shown

- On seizure of a link (or line), the outgoing R2 register automatically starts sending the first forward interregister signal
- As soon as the incoming R2 register recognizes this signal, it starts sending a backward interregister signal which has it's own meaning and at the same time serves as an acknowledgement signal
- As soon as the outgoing R2 register recognizes the acknowledging signal, it stops sending the forward interregister signal
- As soon as the incoming R2 register recognizes the cessation of the forward interregister signal, it stops sending the backward interregister signal
- As soon as the outgoing R2 register recognizes the cessation of the acknowledging backward interregister signal it may, if necessary, start sending the appropriate next forward interregister signal



E1 Analyzer


E1 tProbe - Analyzer
File Config View Monitor IntrusiveTest Special Applications Window Help
Port Framing Loopback Termination Clock Cross-port
1 CAS & CRC No Loopback Terminate Recovered Normal (None)
2 CAS & CRC No Loopback Terminate Recovered Normal (None)
Set all cards as selected
<- Double-click to change values
T1/E1 Alarms
Reset All Ports #1 #2
Sync Loss
HDB3 Violation
Carrier Loss
Frame Error
Remote
Distant MF
AIS
ES Overflow
ES Underflow
T1/E1 Statistics
Frequency (Hz) 2048010 2048009
Level (dBdsx) -0.568 -0.446
BPV Errors 0 0
CRC Errors 0 0
Frame Errors 0 0
==Bit/Frame Clock Slip==
Ref to Internal 2068/8 2066/8
Cross Ref to Recovered 2/0 -2/0
Ref to External n/a n/a
Graph
Invoke Graph
Start GL Server
Listen Port
17090
<Default>
Restore Default
Start GL Server
Exit
Server is Invisible
Messaging
Send / Receive Binary Messages
Send / Receive ASCII Messages
Version
Send / Receive Version 3 Messages
Send / Receive Version 4 Messages
Use These Settings until Further Notice
Start Server Automatically At Analyzer Start-Up
Card 1
VF (Audio)
Tx (VF In)
Gain(dB)
0.0 dB
TS
1
Insert
Signaling Bits
Speaker
Rx (VF Out)
Gain(dB)
0.0 dB
TS
1
Drop
Speaker
Set 0-dB
VF imped./Mic
600
Drop&Insert TSs
Enable
Ready
T1/E1 Sync Info

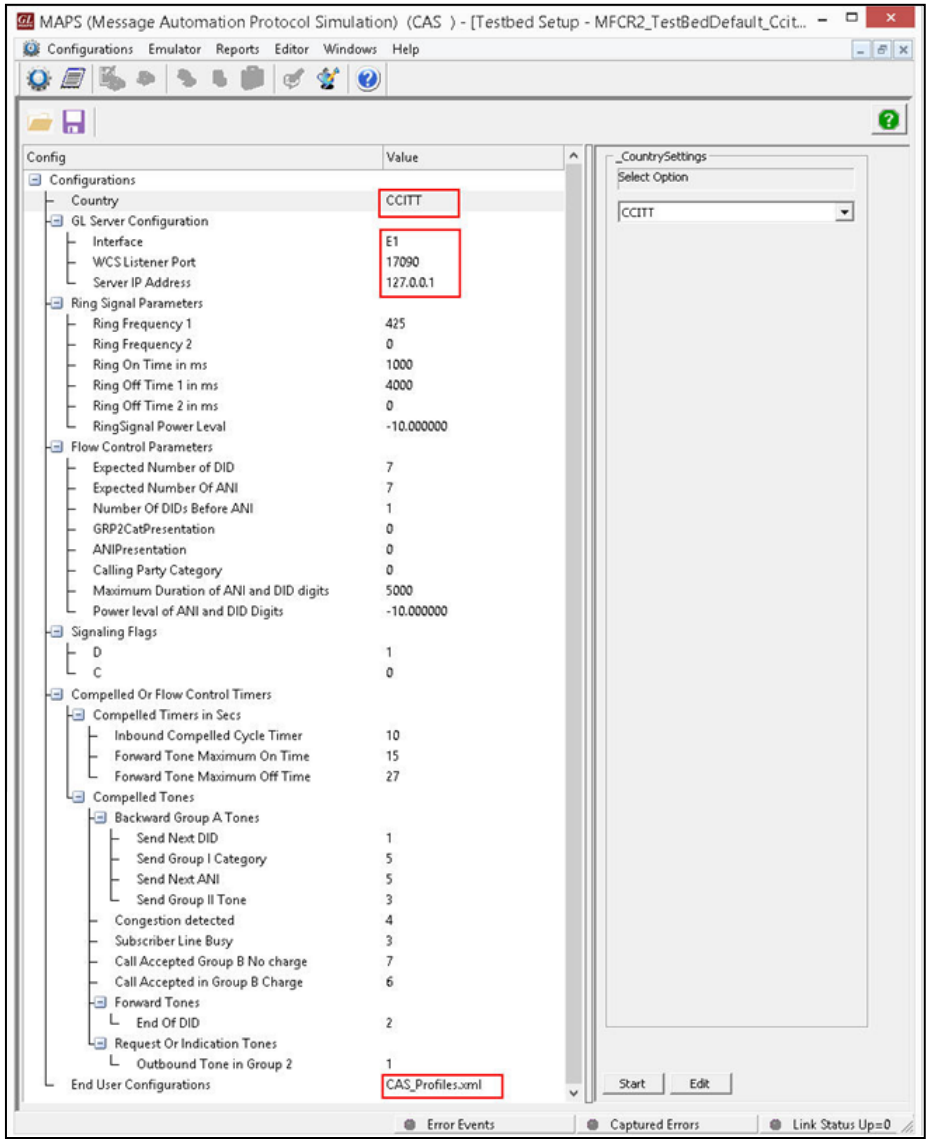
Test Bed Configuration

The test configuration window allows users to configure

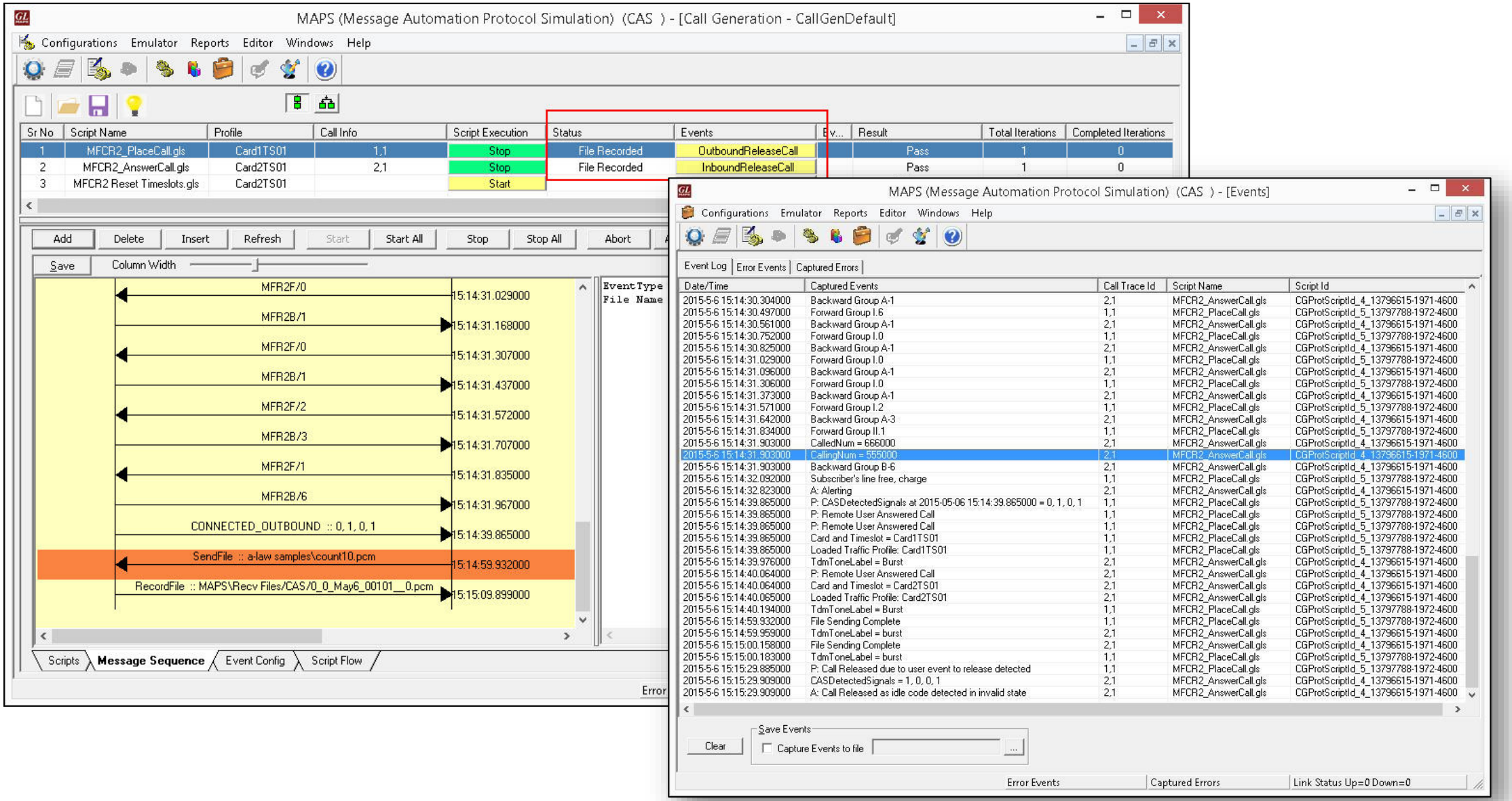
- various CAS signaling types including R1 digit parameters
- flow control parameters
- forward / backward tone parameters
- various other parameters to transmit and receive CAS inbound and outbound signals

Available Test Bed Profiles are

- MFCR2_TestBedDefault_Ccitt.xml
- MFCR2_TestBedDefault_China.xml
- MFCR2_TestBedDefault_India.xml
- MFCR2_TestBedDefault_Mexico.xml
- MFCR2_TestBedDefault_SaudiArabia.xml
- MFCR2_TestBedDefault_Sunrise.xml



MFCR2 Call Simulation using MAPS™ CAS

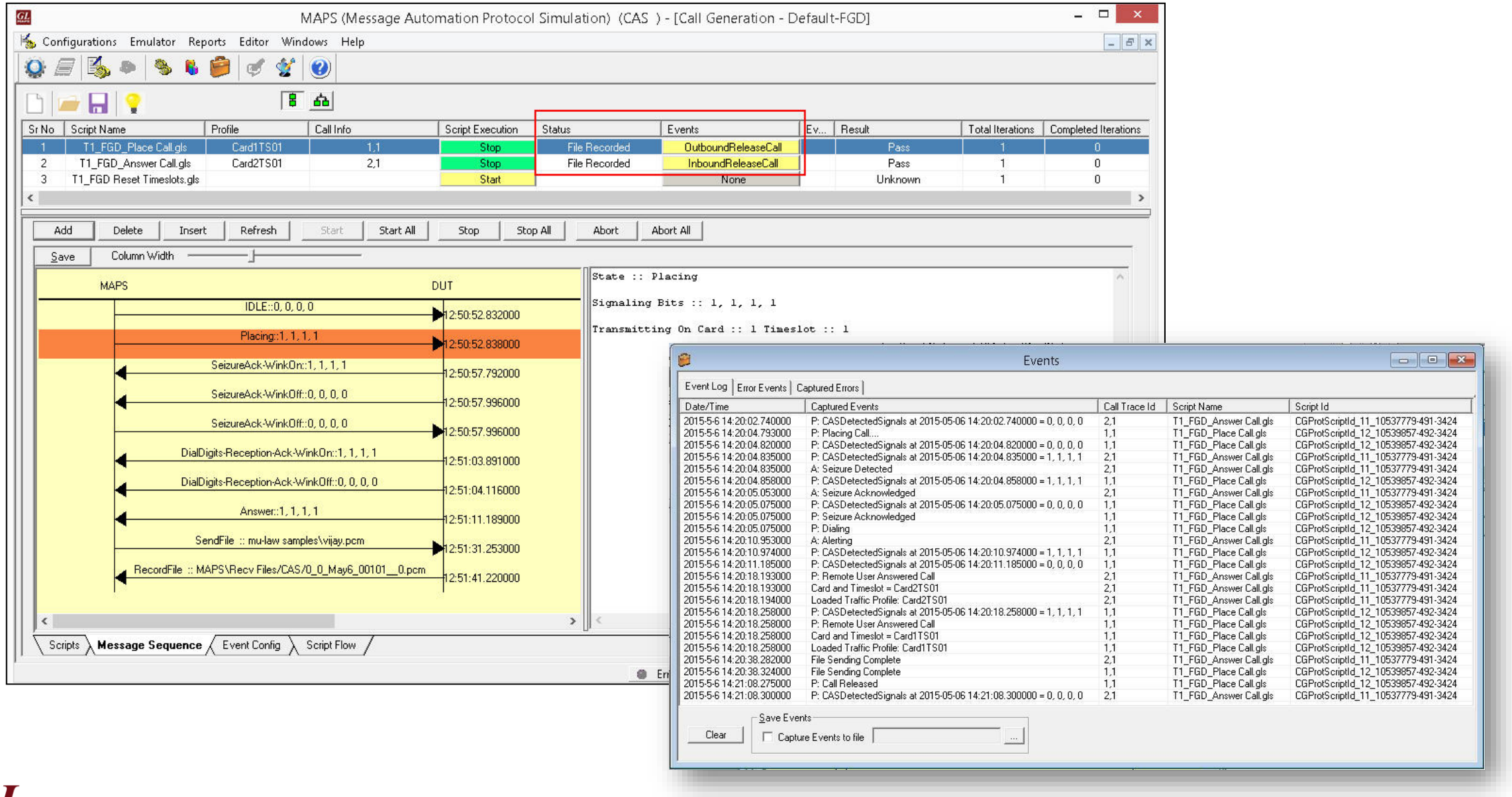


FGD Call Simulation

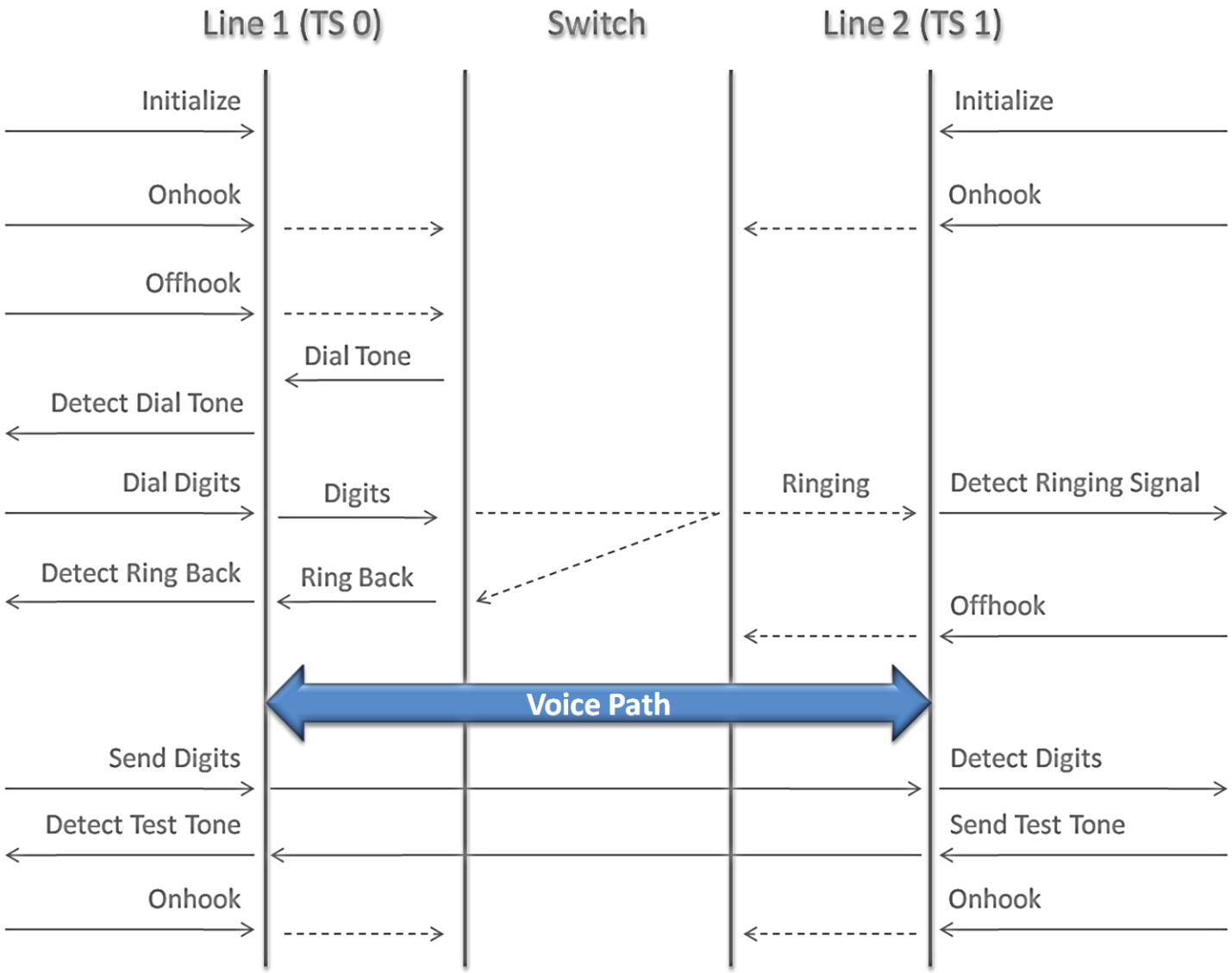
State	Outbound AfBf	Direction	Inbound AbBb
Idle	0 0	<---------->	0 0
Seizure	1 1	---------->	
Seizure acknowledged		<----------	1 1 – 0 0 (Wink)
The outbound side starts to send the address information using MF tones. Feature group D can transfer more than one digit field to speed up long distance calls. Every field starts with a KP tone (start of pulsing) and ends with ST tone (end of pulsing). After each digits field the inbound side acknowledges the reception with a signaling bit wink.			
Register signaling first field digit spill	MF tones Start KP	---------->	
	Called Number	---------->	
	MF tones End ST	---------->	
	MF tones Start KP	---------->	
	Calling Number	---------->	
	MF tones End ST	---------->	
Acknowledgment of Digits Reception		<----------	1 1 – 0 0 (Wink)
Once all the address information has been transferred, the inbound side accepts the call by sending the off-hook signaling code or rejects the call sending Idle signaling code If the call is rejected, the outbound side switches back to signaling AB = 00 (idle), clearing the line.			
Clear forward	0 0	<---------->	0 0
If the call is accepted, the inbound side answers the call by flipping both backward bits to 1.			
Answer		<----------	1 1
Call Active - Conversation State			
Clear	0 0	<---------->	0 0
Idle	0 0	<---------->	0 0

GL Communications

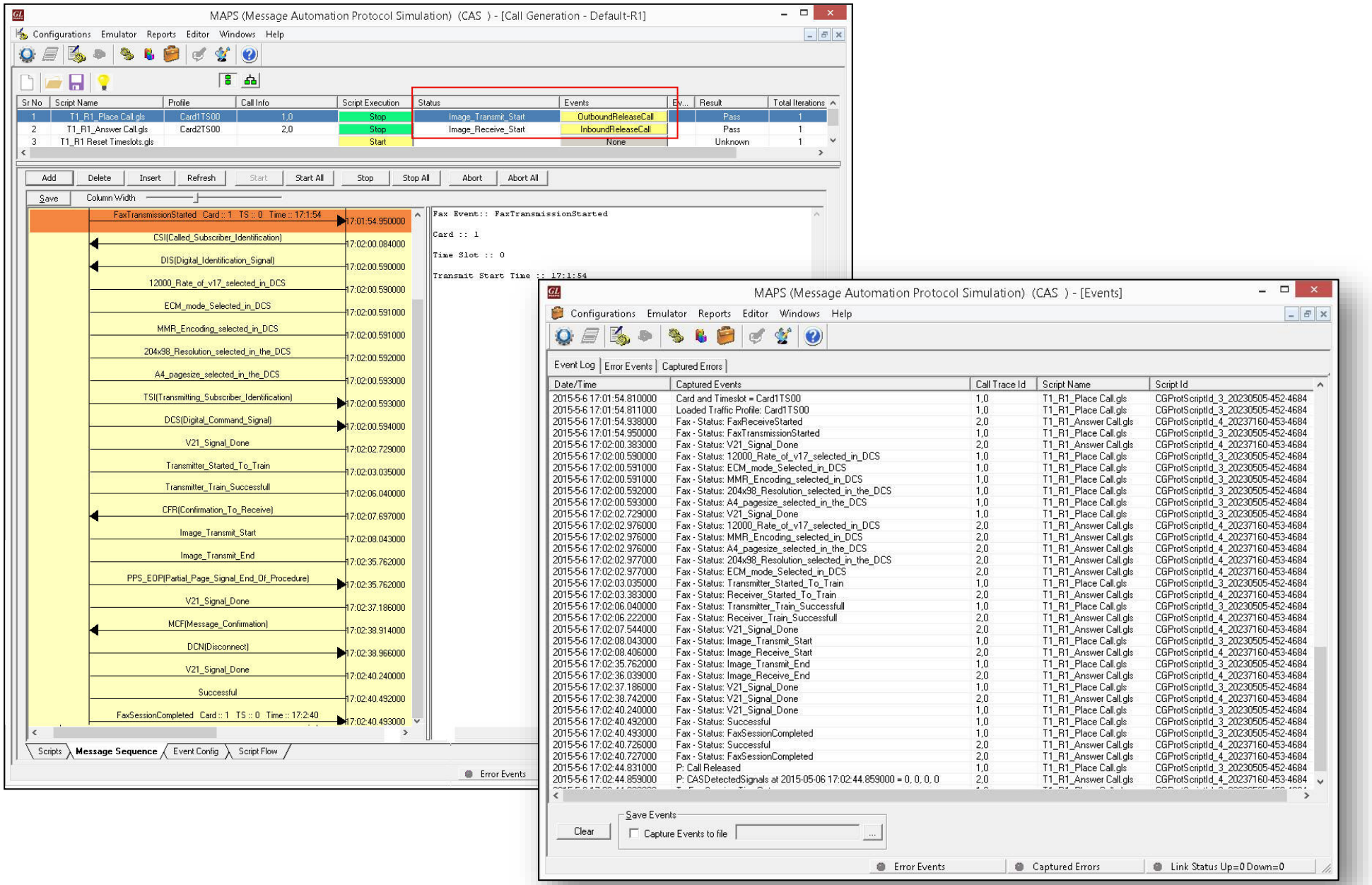
FGD Call Simulation using MAPS™ CAS



T1 Wink Start (R1 wink) Call Simulation



R1 Wink Call Simulation using MAPS™ CAS



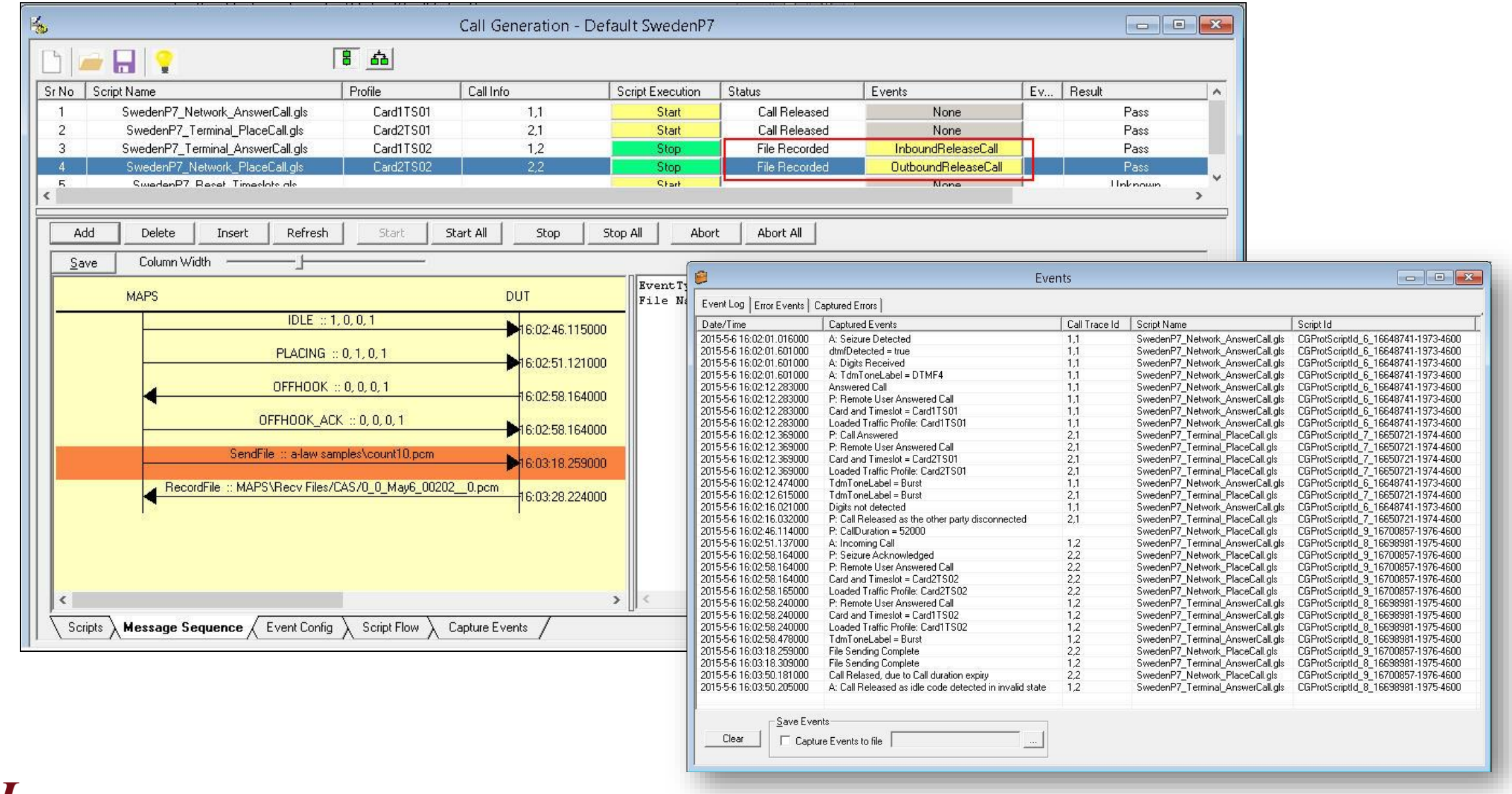
European Sweden P7 Call Simulation

CAS Signaling PABX (tProbe™) to Multiplexer (Subscriber)

Signal or state	**ASB 501** **a | b | c | d**	**Multiplexer** **a | b | c | d**
Idle	1 0 0 1	1 0 0 1
Seizure (Ringing)	1 0 0 1 Line 0 1 0 1 Signal ---------->	1 0 0 1
Answer (Off Hook)	Line 0 1 0 1 Signal <----------	1 0 0 1 0 0 0 1
Stop ringing	0 1 0 1 Line 0 0 0 1 Signal ---------->	0 0 0 1
Register recall	Line 0 0 0 1 Signal <----------	0 0 0 1 1 0 0 1 0 0 0 1
Clear backward	tone 1 0 0 1 Signal >>>>>>>	X 0 0 1
On Hook (clear forward)	Line 1 0 0 1 Signal <----------	0 0 0 1 1 0 0 1

GL Communications

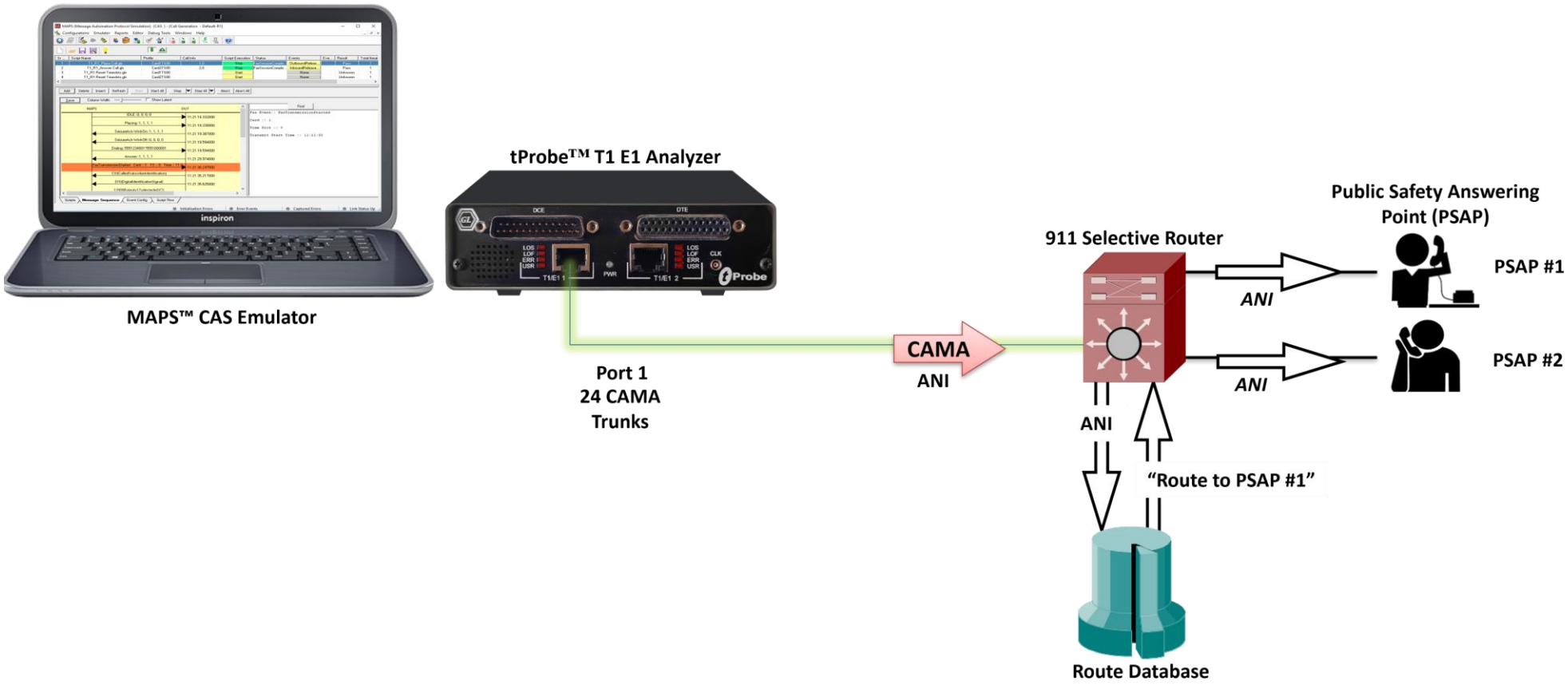
Sweden P7 Call Simulation using MAPS™ CAS



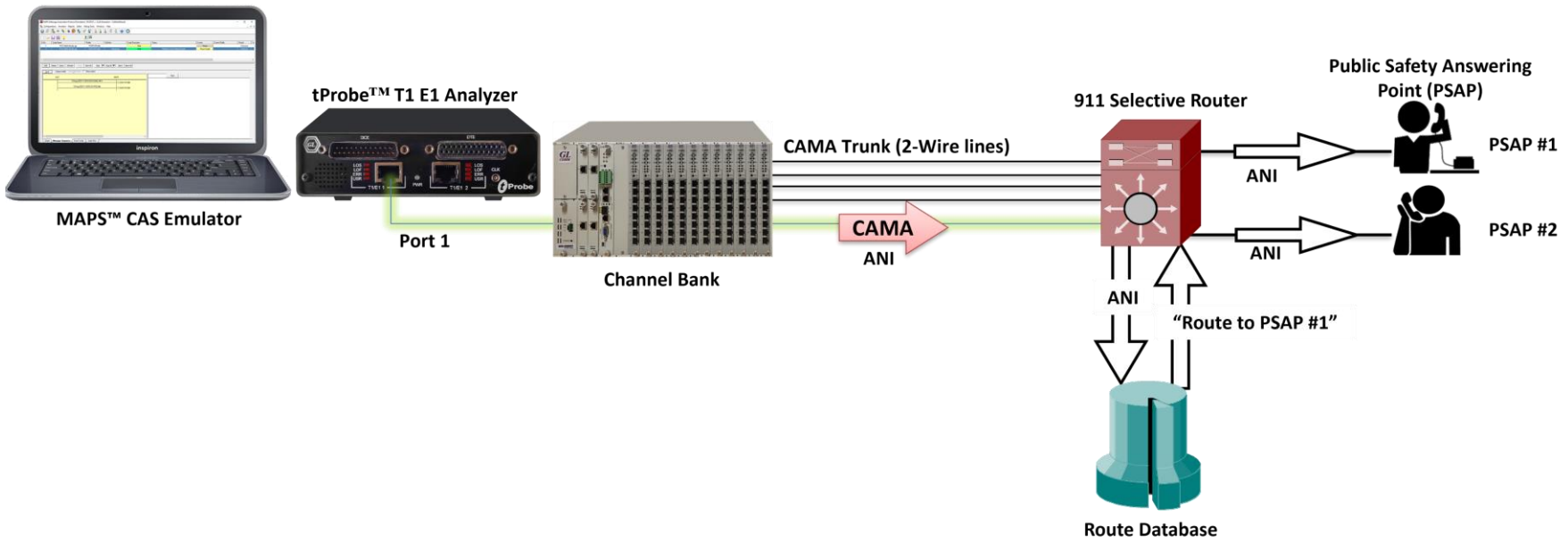
GL Communications

CAMA signaling Simulation for 911 Systems

Digital CAMA Simulation



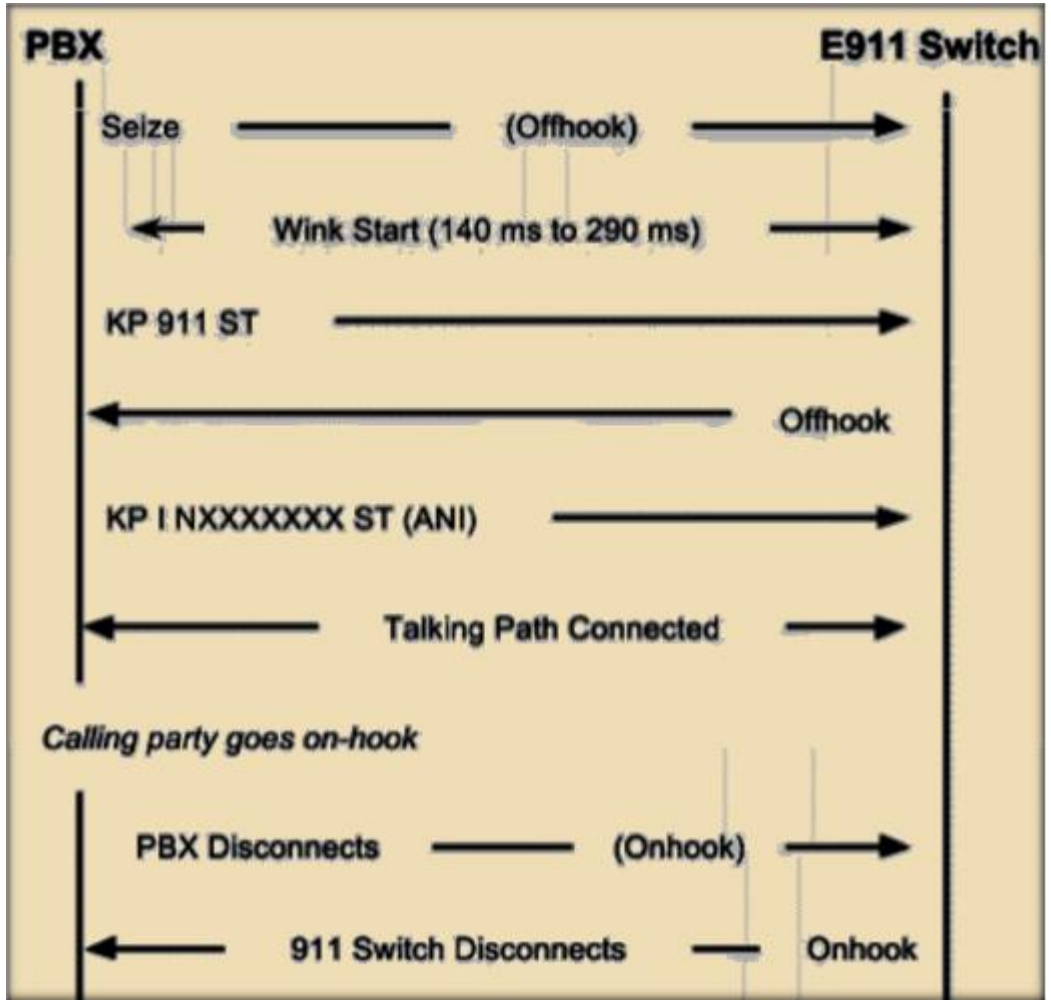
Analog CAMA Simulation via Channel Bank



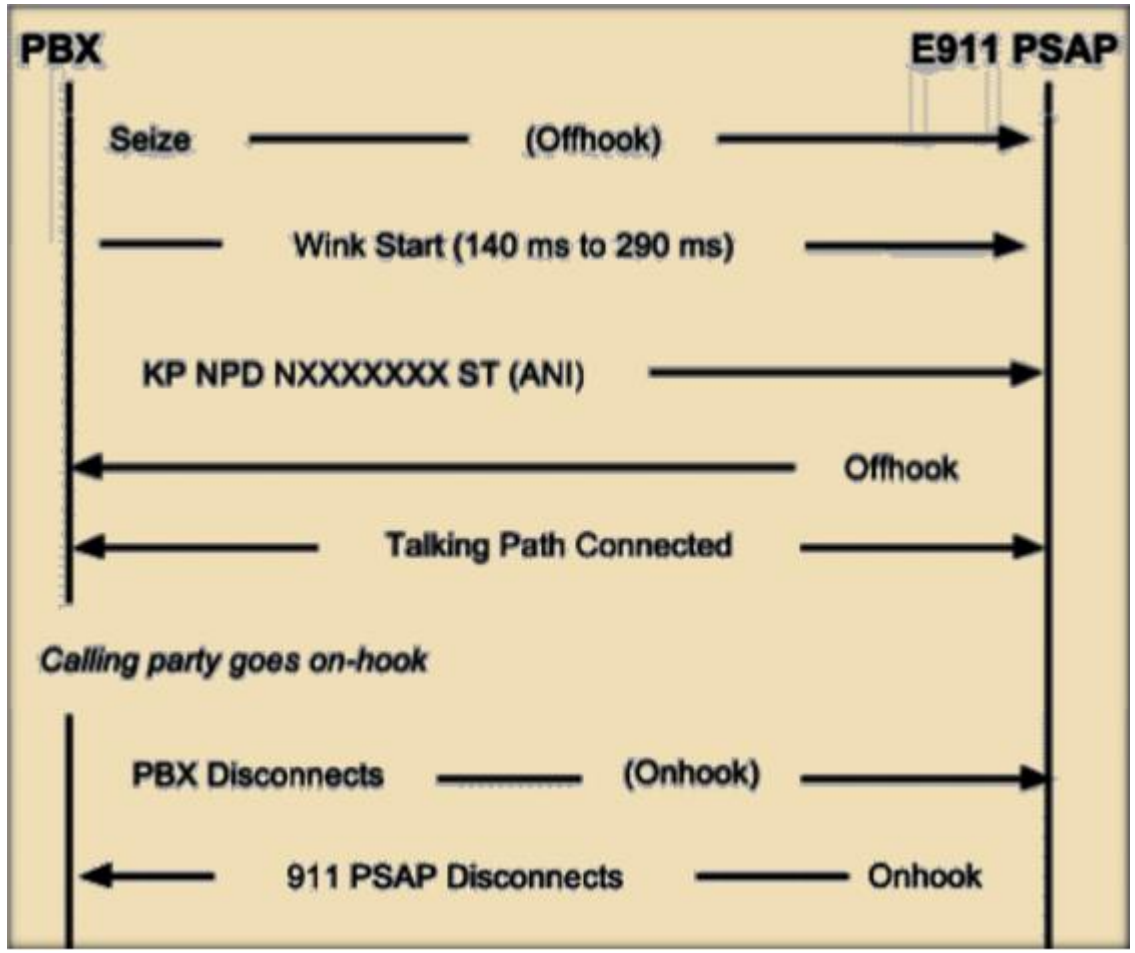
- MAPS™ CAS with Channel Bank can be used to simulate High density FXO supporting up to 96 Analog Channels
- For this simulation, MAPS™ CAS requires additional Channel Bank specially configured for CAMA. The tProbe™ T1 line is connected to Channel Bank with FXO cards for interfacing to 2-wire equipment (911 selective router)
- Single FXO board within the channel bank can convert one digital T1 line into 8 Analog lines

CAS CAMA signaling Sequence

CAMA Type Trunk Connected to 911 Switch

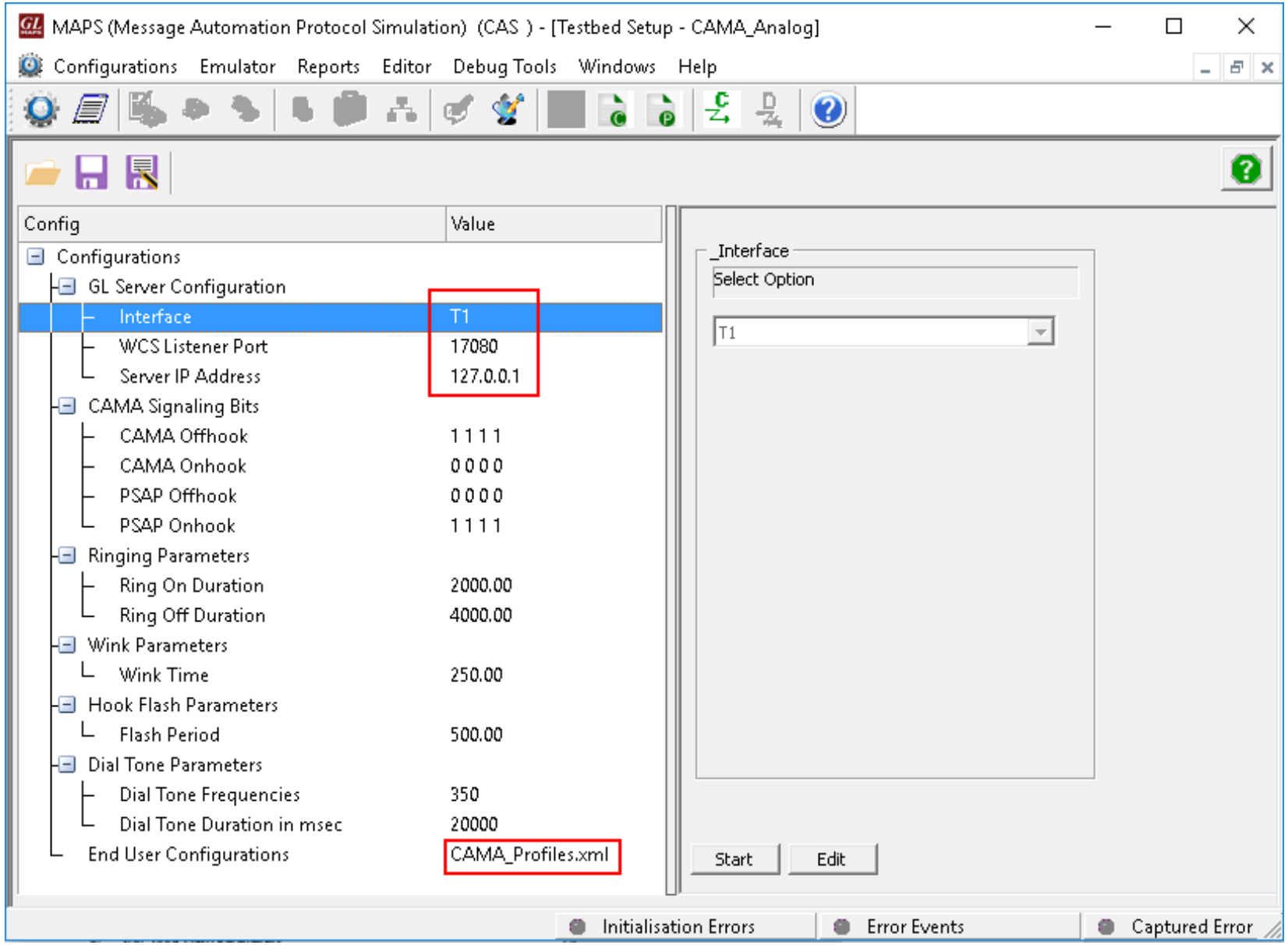


CAMA Type Trunk Connected to the PSAP

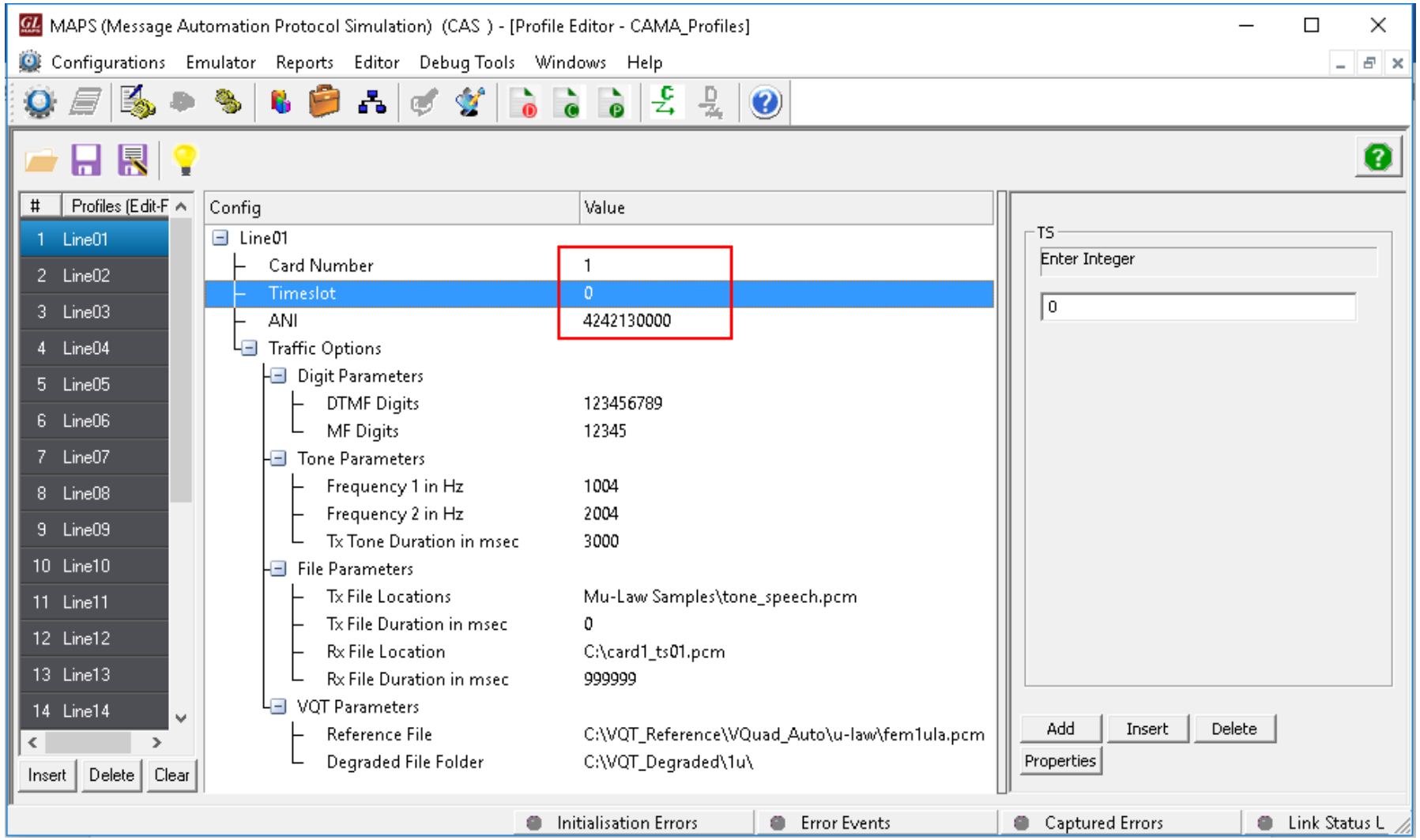


GL Communications

CAS CAMA Testbed Configuration

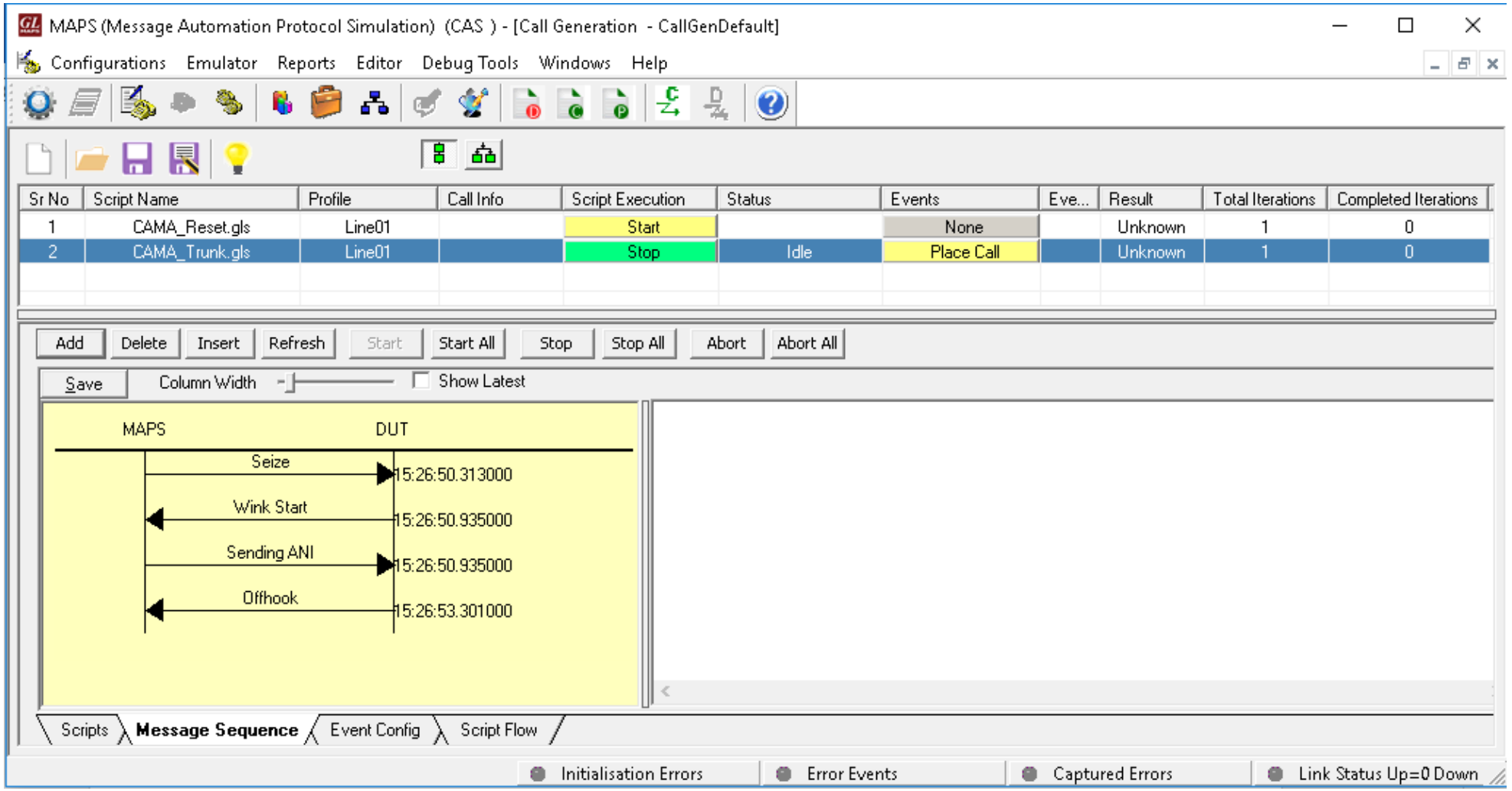


CAS CAMA Profile Configuration

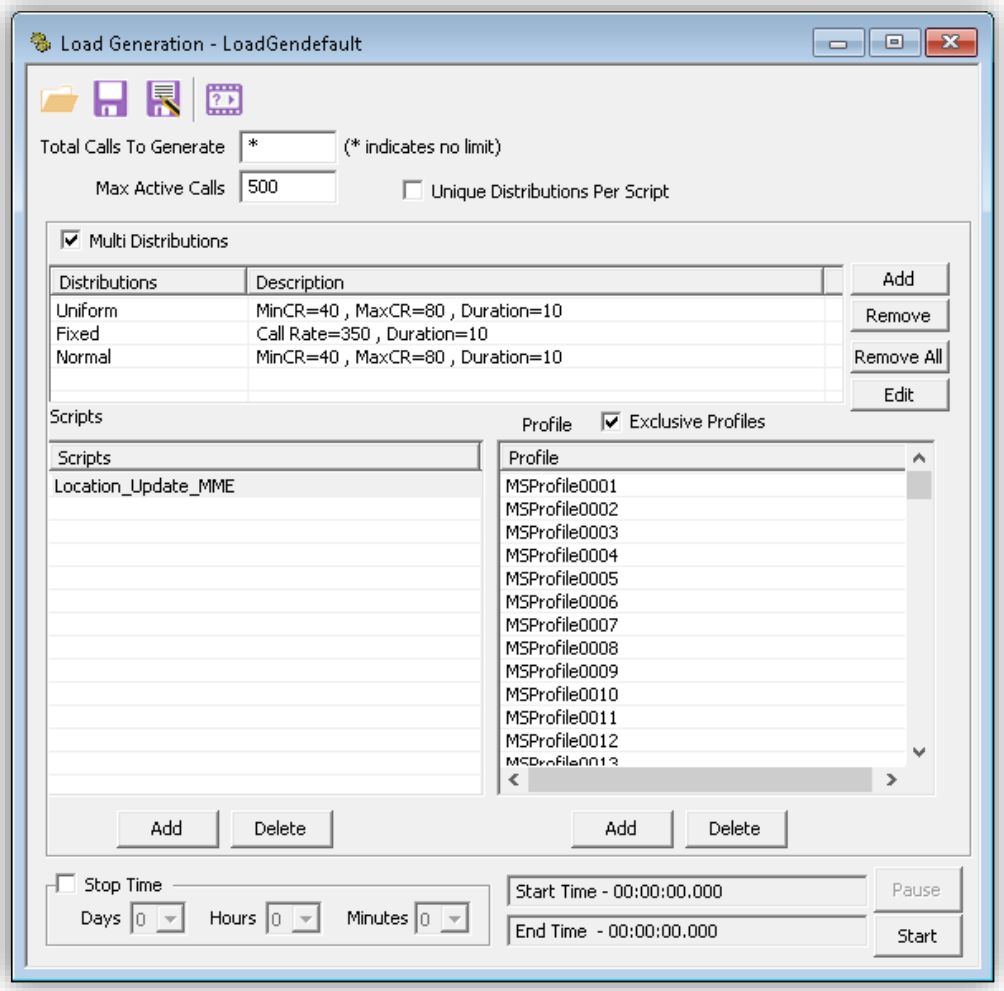


CAS CAMA Call Generation

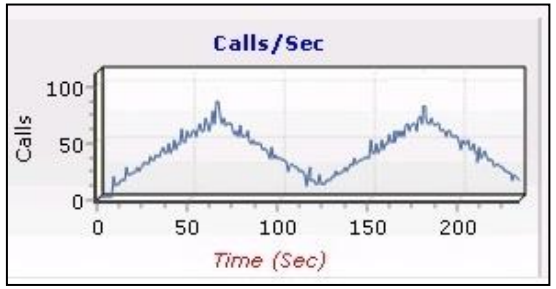
CAMA Simulation for Enhanced 9-1-1 Systems using MAPS™ CAS



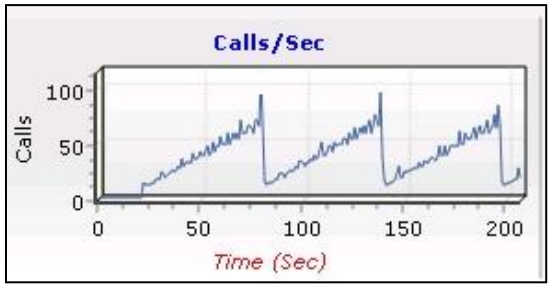
Load Generation



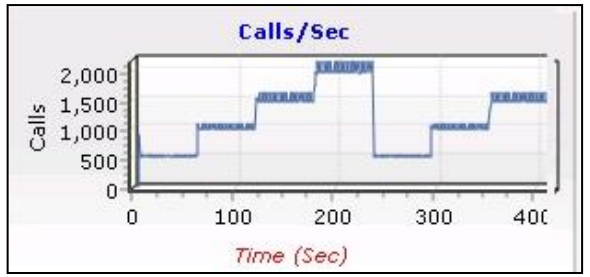
Saw-tooth Statistical Distribution



Ramp Statistical Distribution



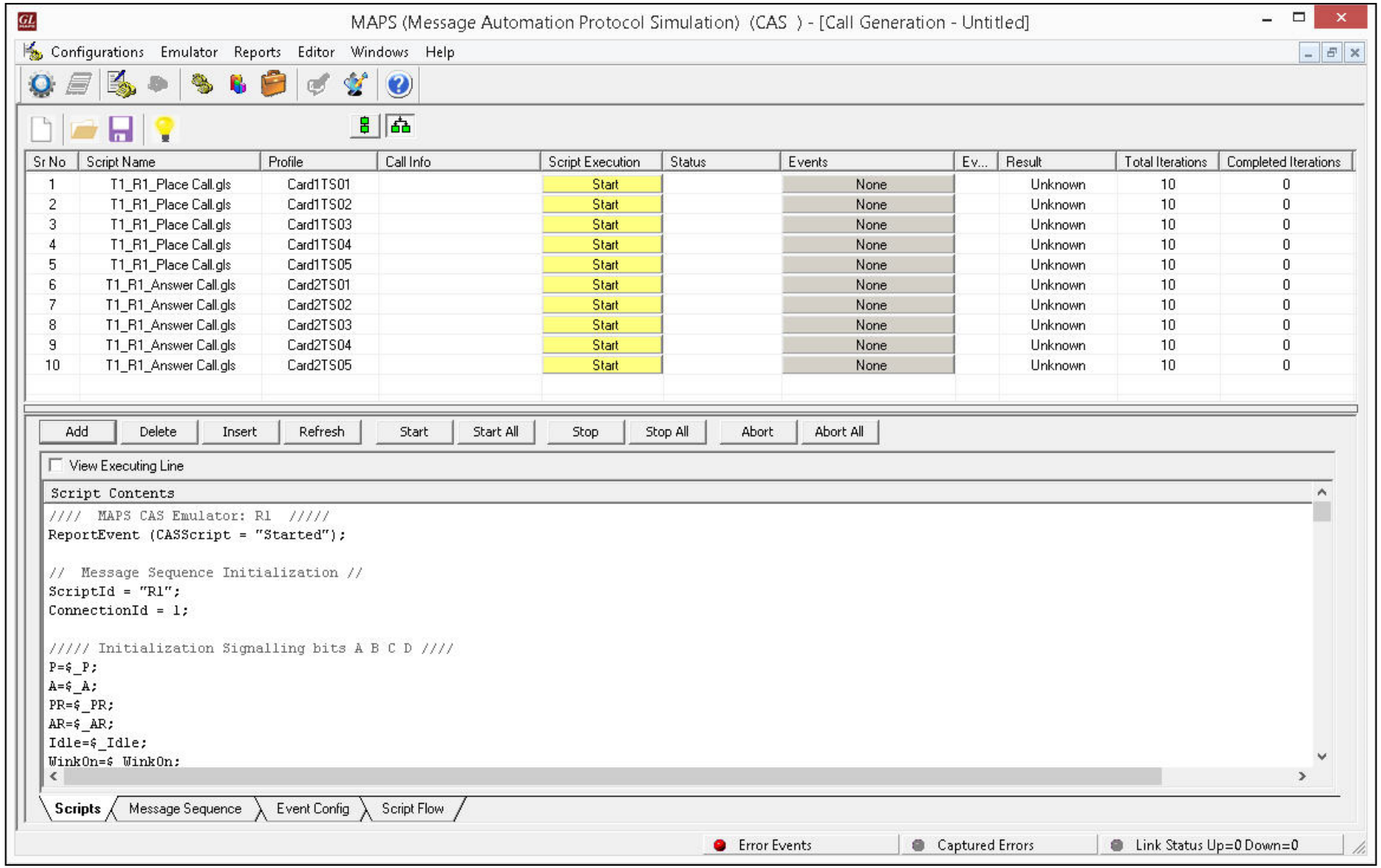
Step Statistical Distribution



- Stability/Stress and Performance testing using Load Generation
- Different types of Load patterns to distribute load
- User can load multiple patterns for selected script
- User configurable Test Duration, CPS, Maximum and Minimum Call Rate, etc.

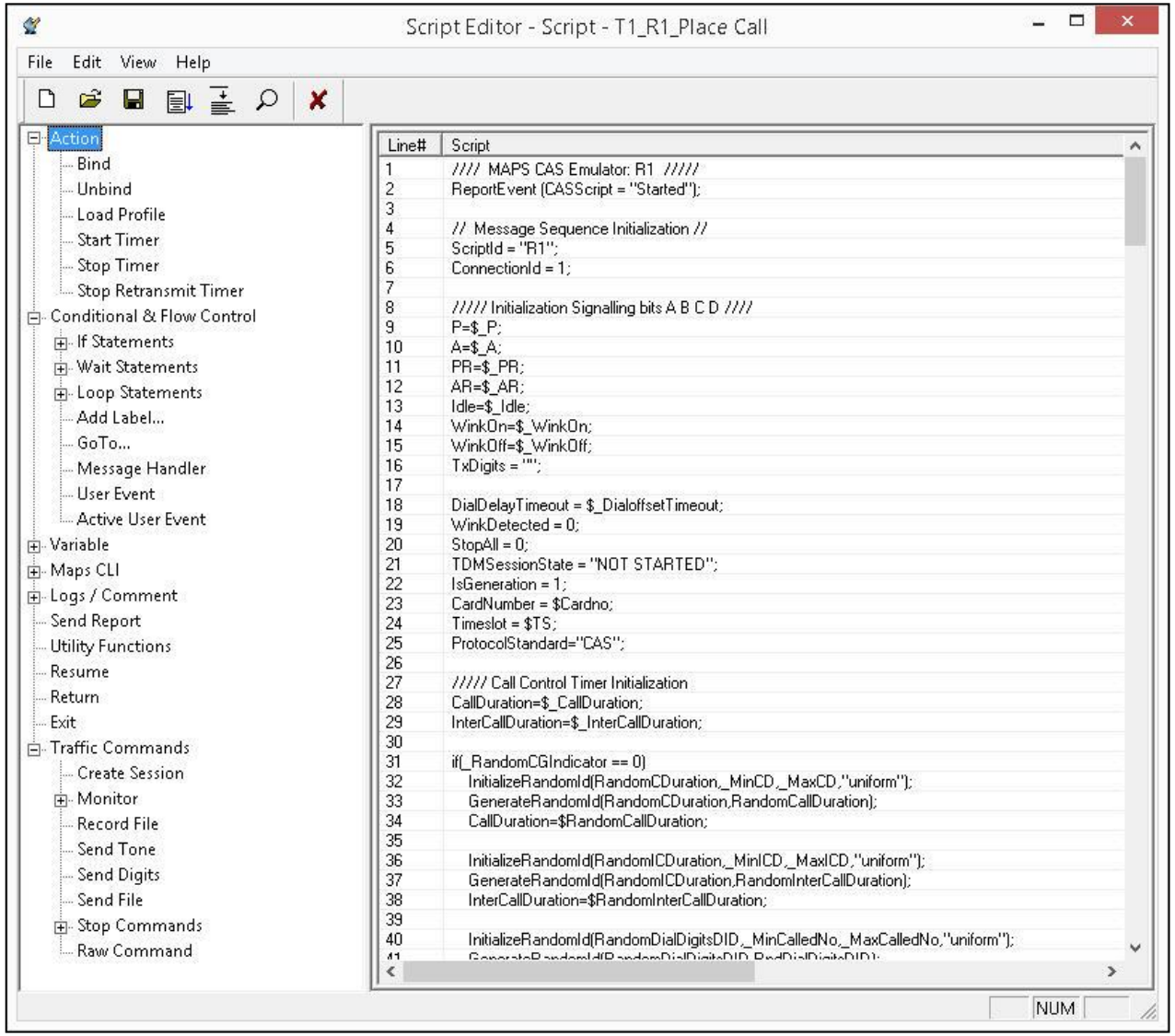
GL Communications

Bulk Call Generation



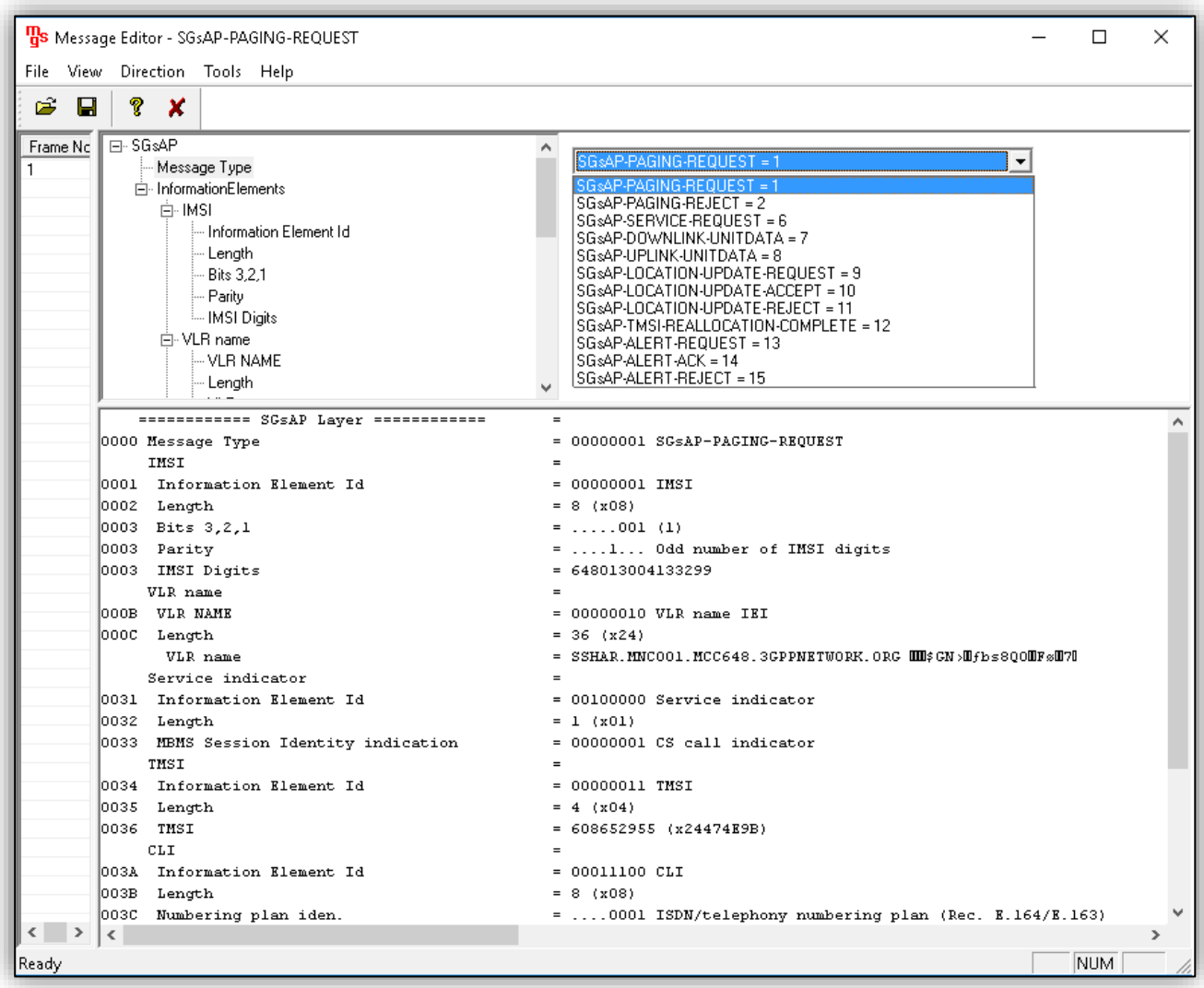
Customizations - Call Flow (Scripts)

- Scripts are written in our proprietary *.gls scripting language. They represent generic state machines intended provide protocol/signaling logic for a call and establish bearer traffic
- Each instance of a script corresponds to a single transaction/call, i.e., if you place 500 calls in parallel you will actually have 500 script instances running at once. If you place 500 calls in series the same script will execute and terminate 500 times
- It is possible to create your own scripts, but almost never necessary! We attempt to provide all necessary scripts out of the box



Customizations - Protocol Messages

- When the script actually sends a message it does so by loading a hdl file template from disk
- These message templates provide the actual structure of the message, the script simply populates it with values contained in its variables
- These messages are customizable by the user, header fields can be altered and removed. Binary-based messages are edited in our provided message editor



Customizations - Statistics and Reports

MOS, R-Factor

Packet Loss

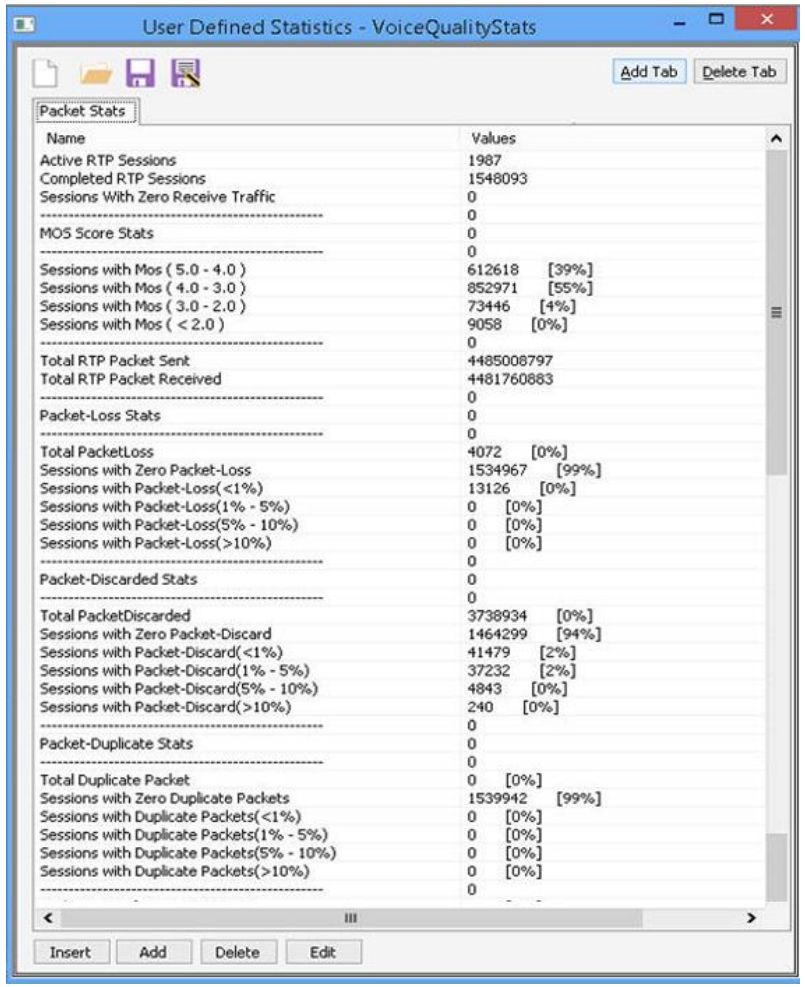
Packets Discarded

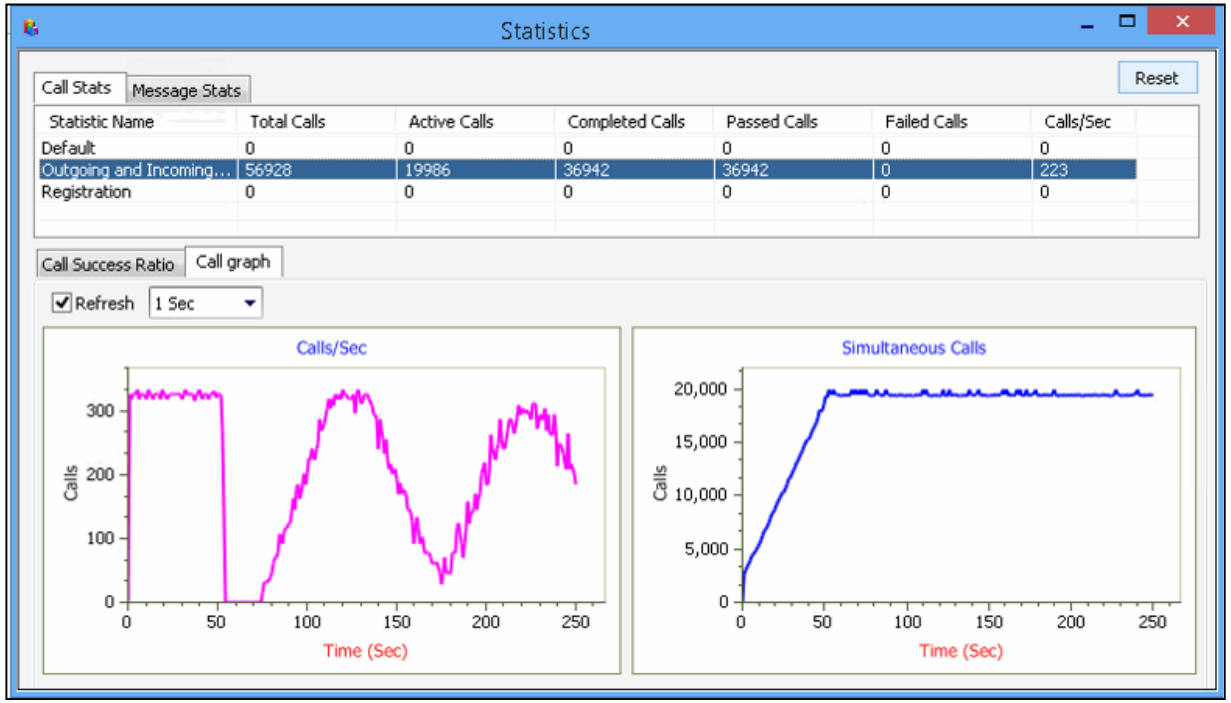
Duplicate Packets

Out-Of-Sequence

Packets

Jitter Statistics





Call Stats provide a running tabular log of system level stats, tracked stats include - Total Calls, Active Calls, Completed Calls, Passed Calls, Failed Calls, Instantaneous Calls/Sec

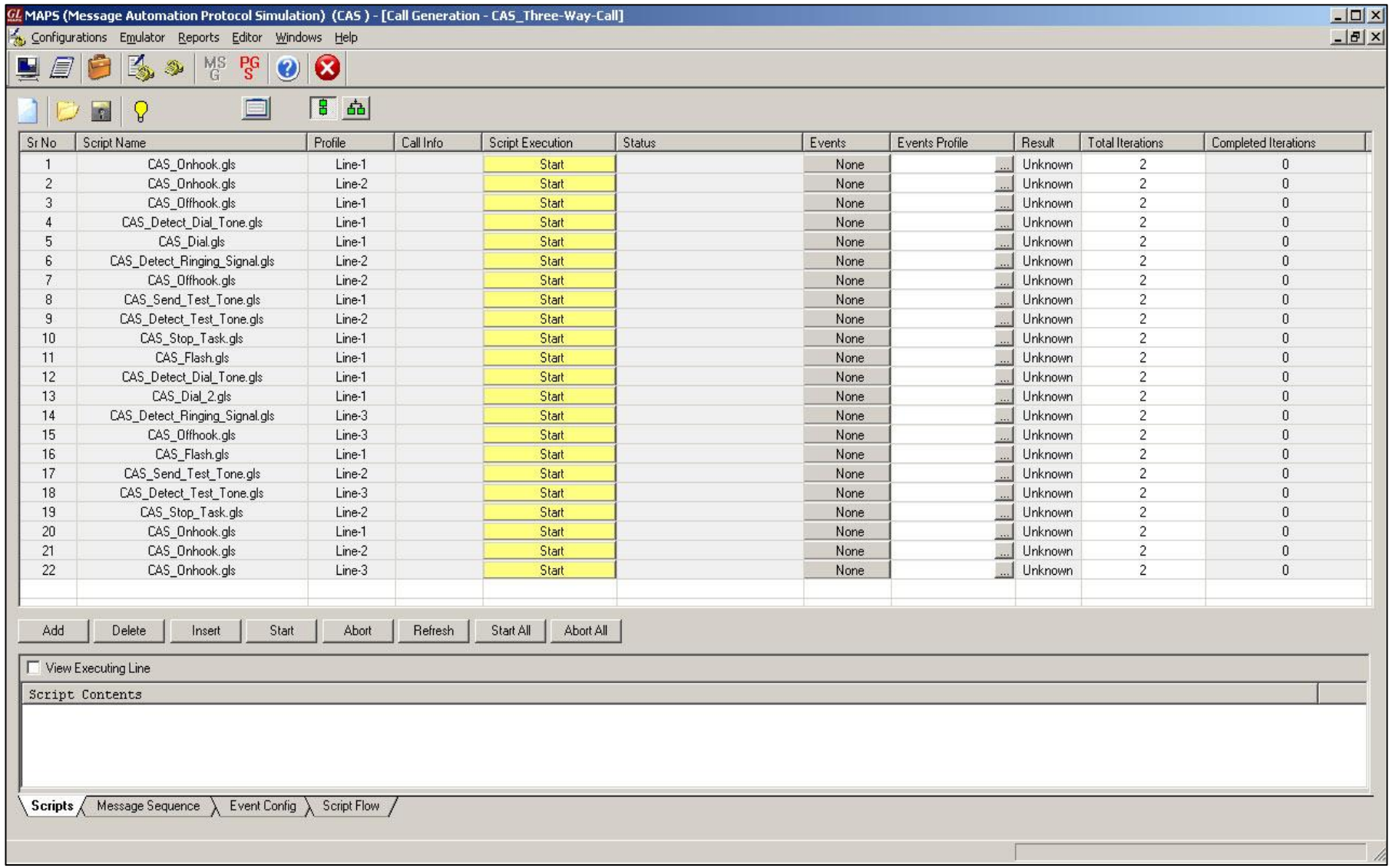
GL Communications

Sample Call Scenarios

3 Way Call

GL Communications

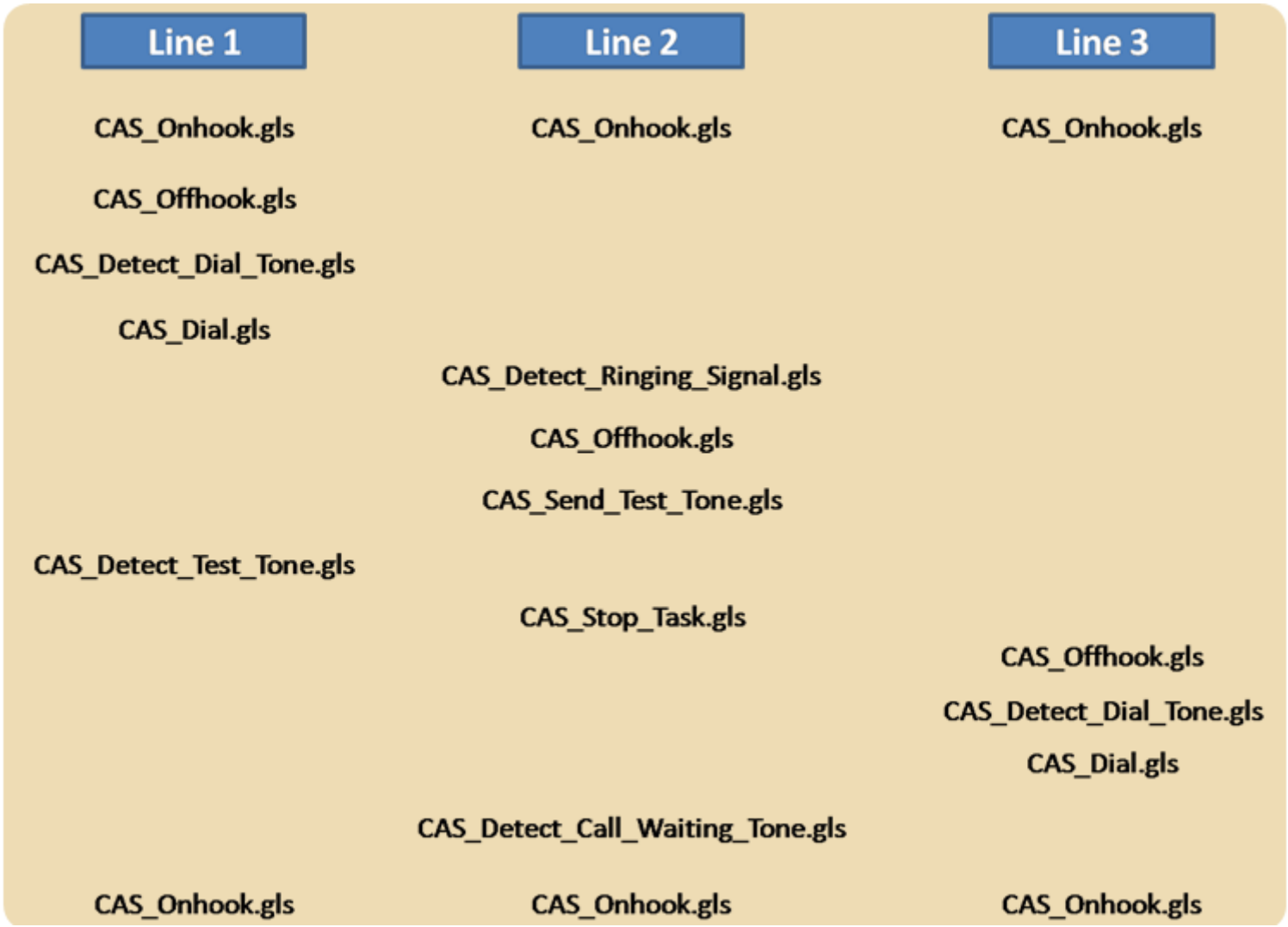
Sample Call Scenarios – 3 Way Call Simulation



Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	CAS_Onhook.gls	Line-1		Start		None		Unknown	2	0
2	CAS_Onhook.gls	Line-2		Start		None		Unknown	2	0
3	CAS_Offhook.gls	Line-1		Start		None		Unknown	2	0
4	CAS_Detect_Dial_Tone.gls	Line-1		Start		None		Unknown	2	0
5	CAS_Dial.gls	Line-1		Start		None		Unknown	2	0
6	CAS_Detect_Ringing_Signal.gls	Line-2		Start		None		Unknown	2	0
7	CAS_Offhook.gls	Line-2		Start		None		Unknown	2	0
8	CAS_Send_Test_Tone.gls	Line-1		Start		None		Unknown	2	0
9	CAS_Detect_Test_Tone.gls	Line-2		Start		None		Unknown	2	0
10	CAS_Stop_Task.gls	Line-1		Start		None		Unknown	2	0
11	CAS_Flash.gls	Line-1		Start		None		Unknown	2	0
12	CAS_Detect_Dial_Tone.gls	Line-1		Start		None		Unknown	2	0
13	CAS_Dial_2.gls	Line-1		Start		None		Unknown	2	0
14	CAS_Detect_Ringing_Signal.gls	Line-3		Start		None		Unknown	2	0
15	CAS_Offhook.gls	Line-3		Start		None		Unknown	2	0
16	CAS_Flash.gls	Line-1		Start		None		Unknown	2	0
17	CAS_Send_Test_Tone.gls	Line-2		Start		None		Unknown	2	0
18	CAS_Detect_Test_Tone.gls	Line-3		Start		None		Unknown	2	0
19	CAS_Stop_Task.gls	Line-2		Start		None		Unknown	2	0
20	CAS_Onhook.gls	Line-1		Start		None		Unknown	2	0
21	CAS_Onhook.gls	Line-2		Start		None		Unknown	2	0
22	CAS_Onhook.gls	Line-3		Start		None		Unknown	2	0

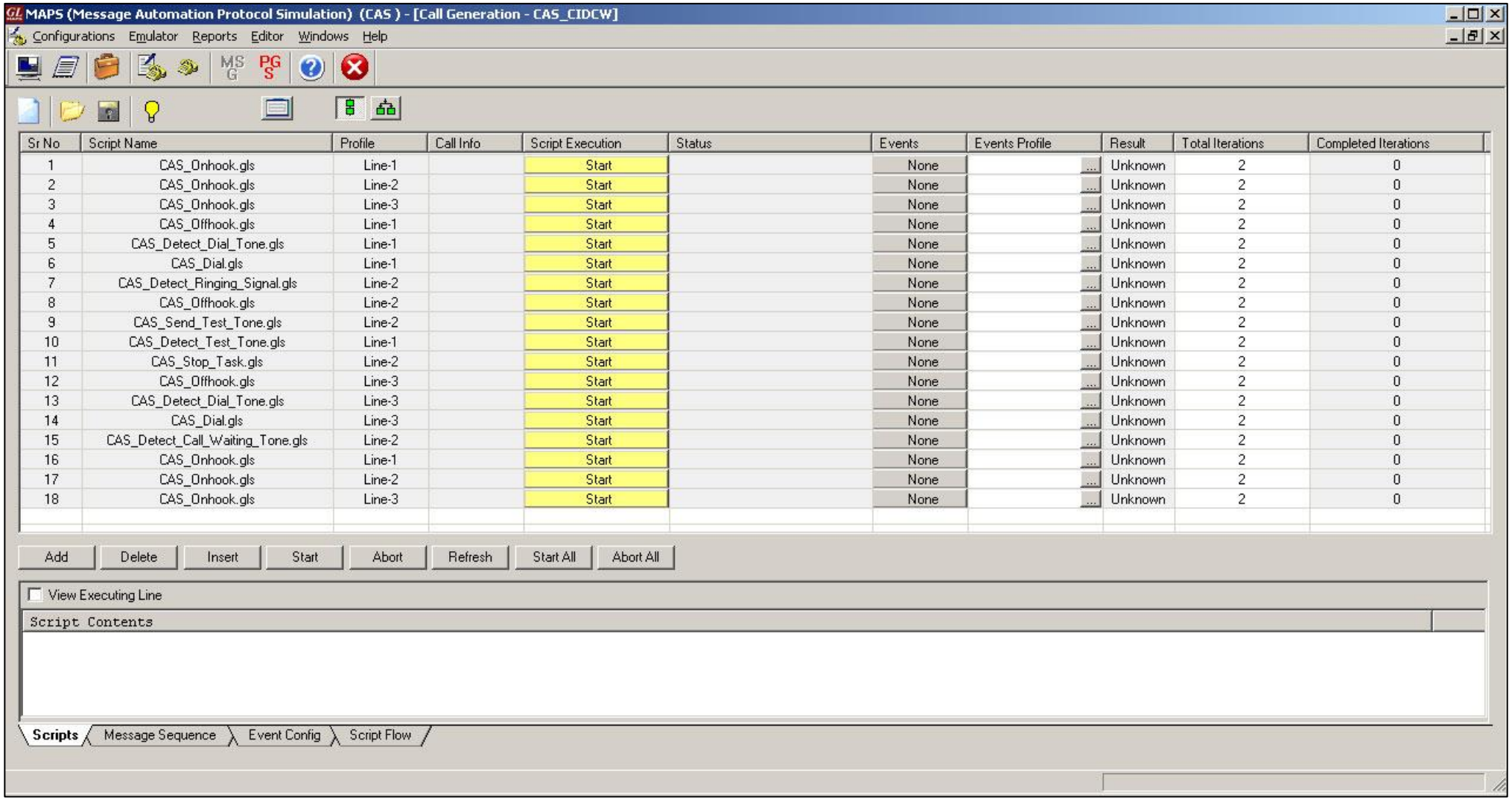
GL Communications

Sample Call Scenarios - Caller ID with Call Waiting (CIDCW)

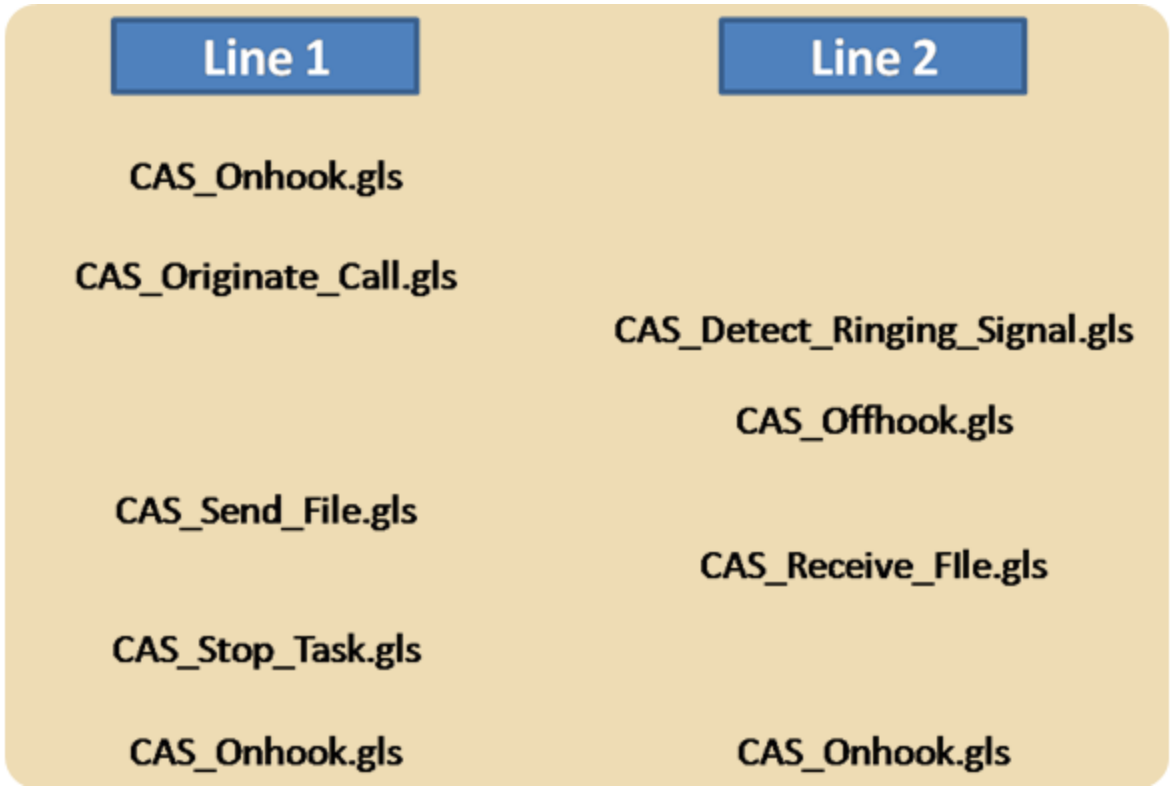


GL Communications

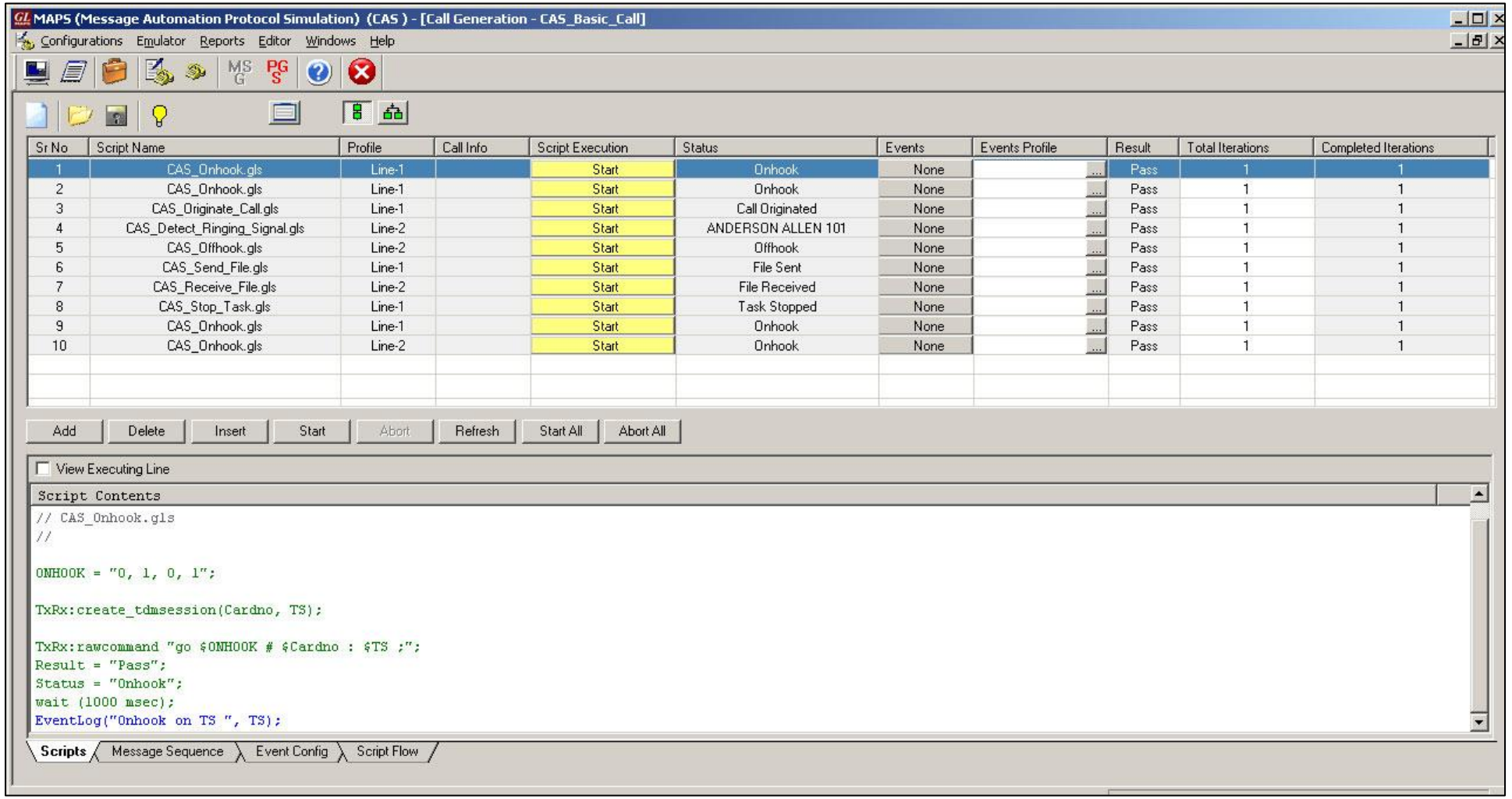
Sample Call Scenarios - Caller ID with Call Waiting (CIDCW) Simulation



Sample Call Scenarios - Playback Record



Sample Call Scenarios - Playback Record Simulation

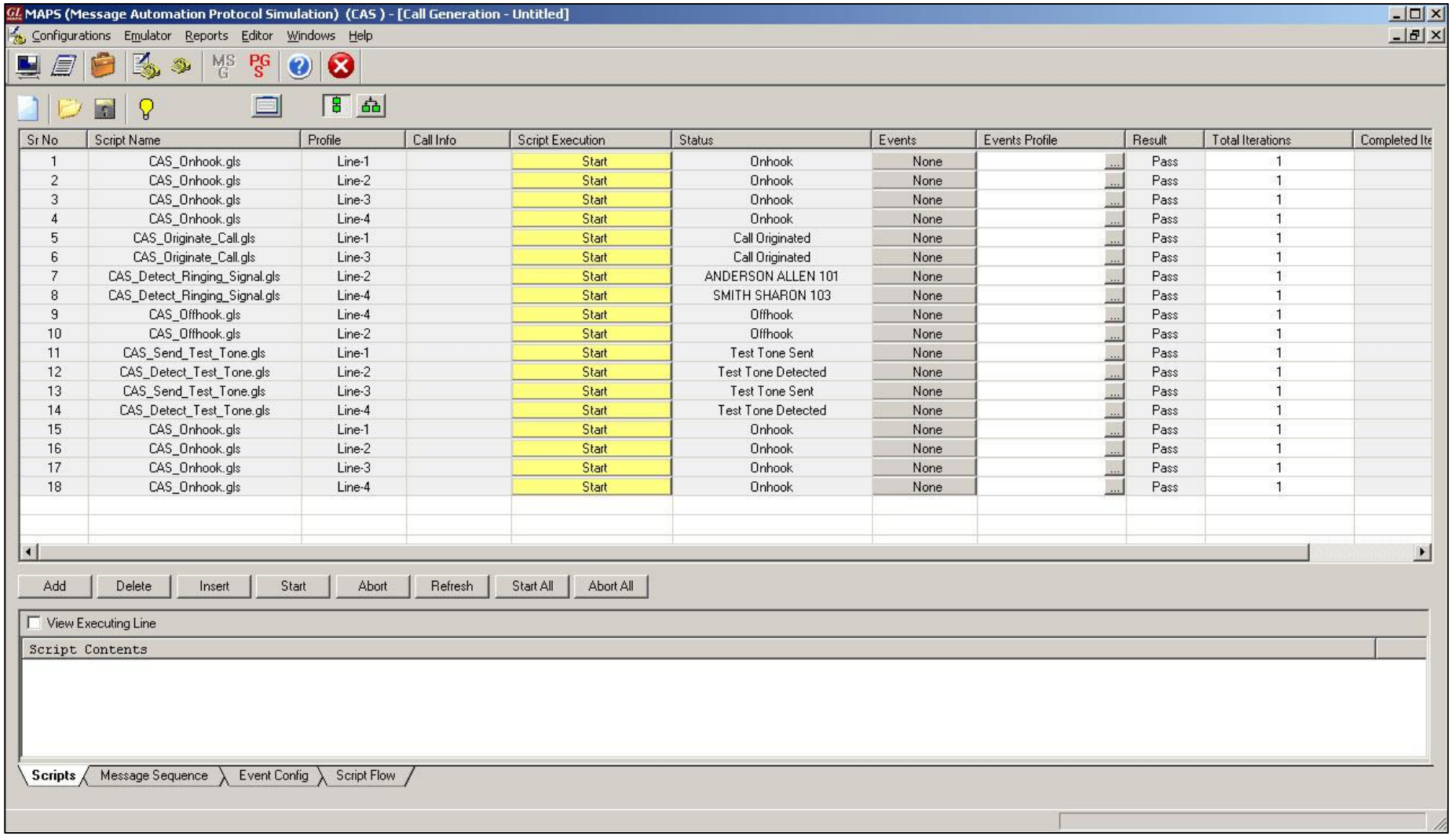


Sample Call Scenarios - Simultaneous Calls

Line 1	Line 2	Line 3	Line 4
CAS_Onhook.gls	CAS_Onhook.gls	CAS_Onhook.gls	CAS_Onhook.gls
CAS_Originate_Call.gls		CAS_Originate_Call.gls	
	CAS_Detect_Ringing_Signal.gls		CAS_Detect_Ringing_Signal.gls
	CAS_Offhook.gls		CAS_Offhook.gls
CAS_Send_Test_Tone.gls			
	CAS_Detect_Test_Tone.gls		
		CAS_Send_Test_Tone.gls	
			CAS_Detect_Test_Tone.gls
CAS_Onhook.gls	CAS_Onhook.gls	CAS_Onhook.gls	CAS_Onhook.gls

GL Communications

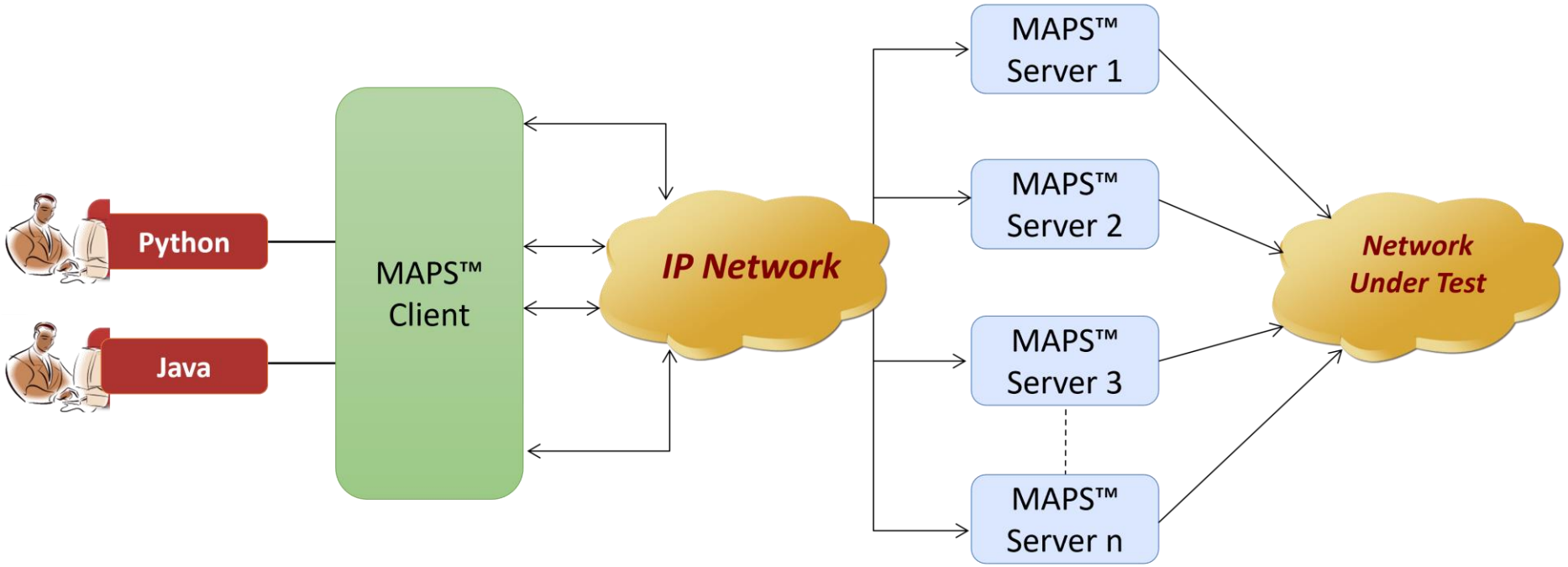
Sample Call Scenarios - Simultaneous Calls Simulation



Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Ite
1	CAS_Onhook.gls	Line-1		Start	Onhook	None		Pass	1	
2	CAS_Onhook.gls	Line-2		Start	Onhook	None		Pass	1	
3	CAS_Onhook.gls	Line-3		Start	Onhook	None		Pass	1	
4	CAS_Onhook.gls	Line-4		Start	Onhook	None		Pass	1	
5	CAS_Originate_Call.gls	Line-1		Start	Call Originated	None		Pass	1	
6	CAS_Originate_Call.gls	Line-3		Start	Call Originated	None		Pass	1	
7	CAS_Detect_Ringing_Signal.gls	Line-2		Start	ANDERSON ALLEN 101	None		Pass	1	
8	CAS_Detect_Ringing_Signal.gls	Line-4		Start	SMITH SHARON 103	None		Pass	1	
9	CAS_Offhook.gls	Line-4		Start	Offhook	None		Pass	1	
10	CAS_Offhook.gls	Line-2		Start	Offhook	None		Pass	1	
11	CAS_Send_Test_Tone.gls	Line-1		Start	Test Tone Sent	None		Pass	1	
12	CAS_Detect_Test_Tone.gls	Line-2		Start	Test Tone Detected	None		Pass	1	
13	CAS_Send_Test_Tone.gls	Line-3		Start	Test Tone Sent	None		Pass	1	
14	CAS_Detect_Test_Tone.gls	Line-4		Start	Test Tone Detected	None		Pass	1	
15	CAS_Onhook.gls	Line-1		Start	Onhook	None		Pass	1	
16	CAS_Onhook.gls	Line-2		Start	Onhook	None		Pass	1	
17	CAS_Onhook.gls	Line-3		Start	Onhook	None		Pass	1	
18	CAS_Onhook.gls	Line-4		Start	Onhook	None		Pass	1	

GL Communications

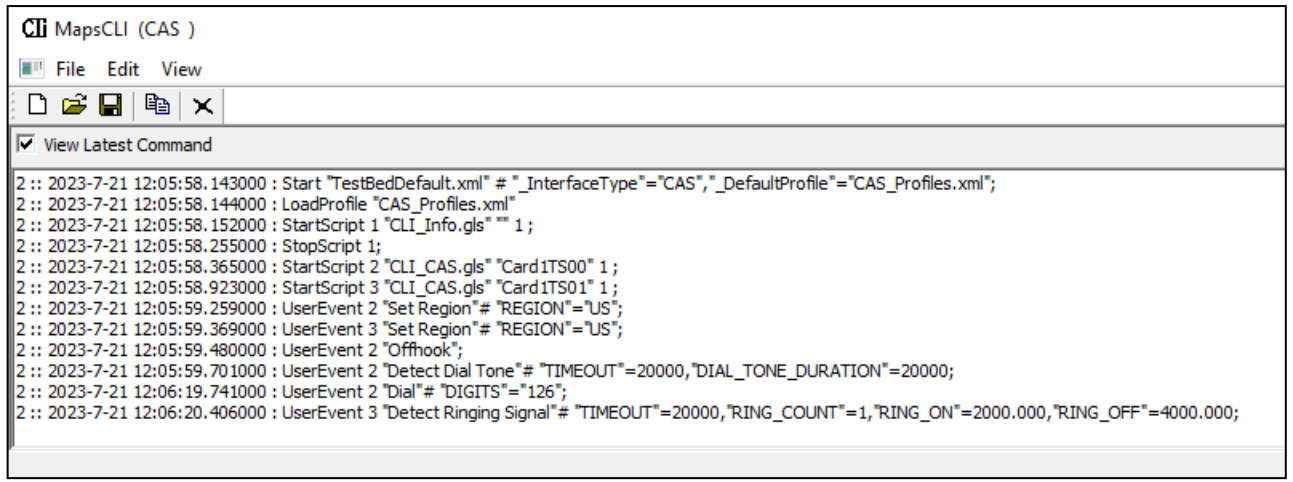
MAPS™ API Architecture



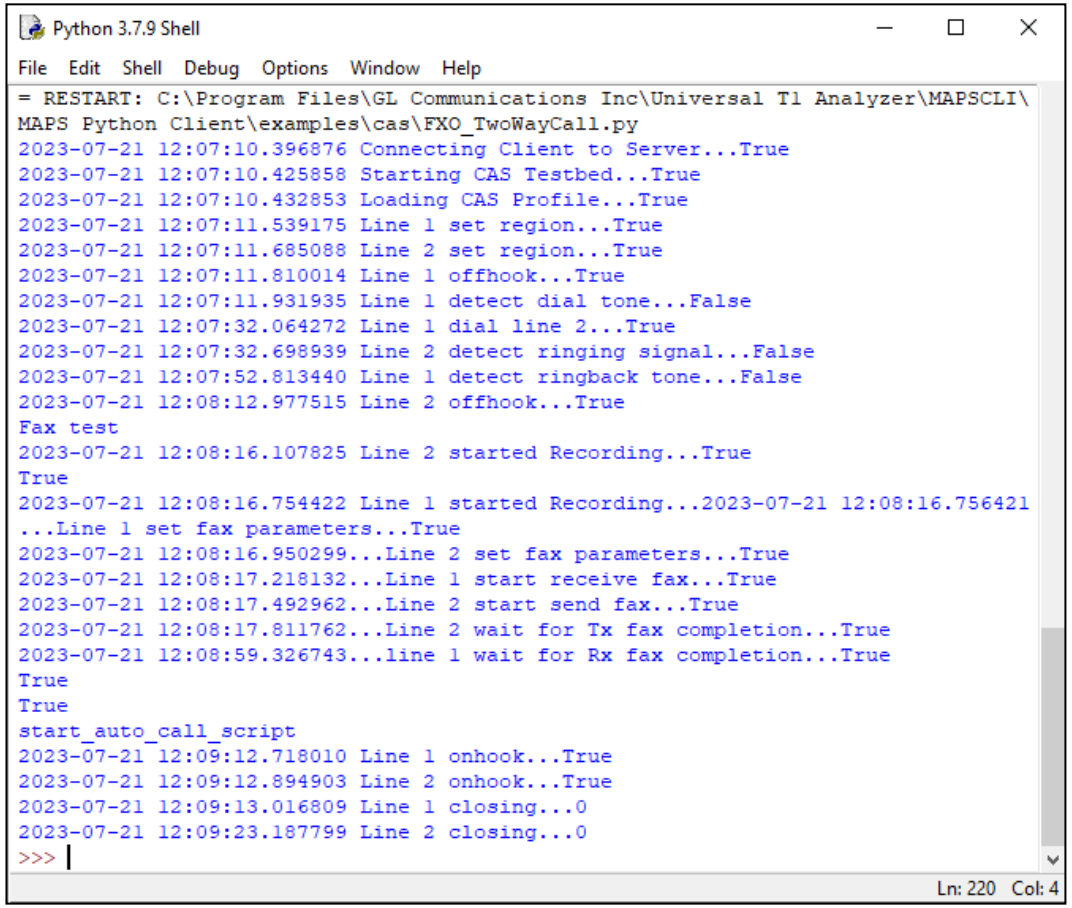
- API wraps our proprietary scripting language in standard languages familiar to the user:
  - Python
  - Java
- Clients and Servers support a “Many-to-Many” relationship, making it very easy for users to develop complex test cases involving multiple signaling protocols

CLI Support

MAPS™ CLI Server



Sample Python Client Script



GL Communications

Thank you