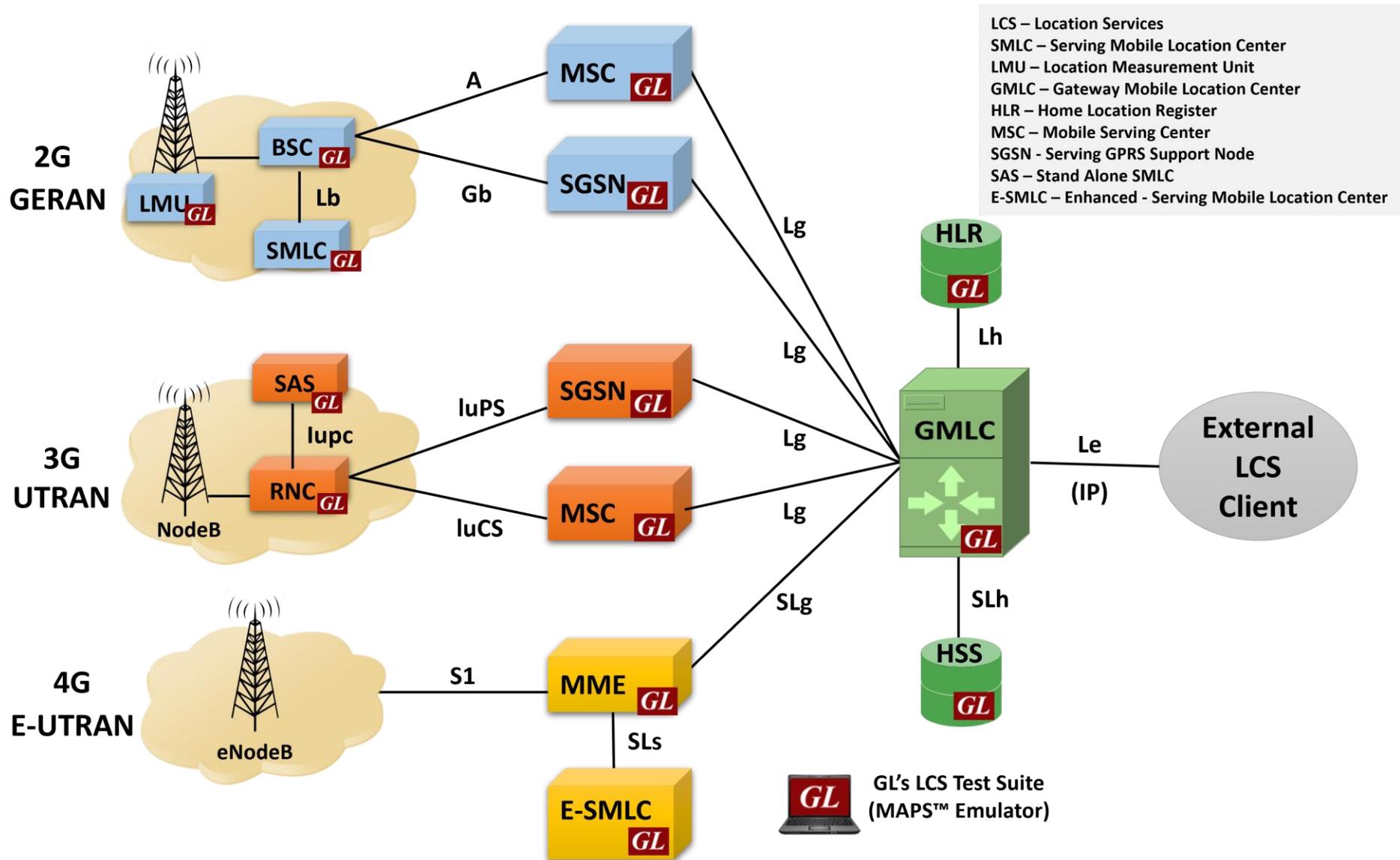

MAPS™ LTE SLs Emulator

Location Services Application Protocol (LCS-AP)

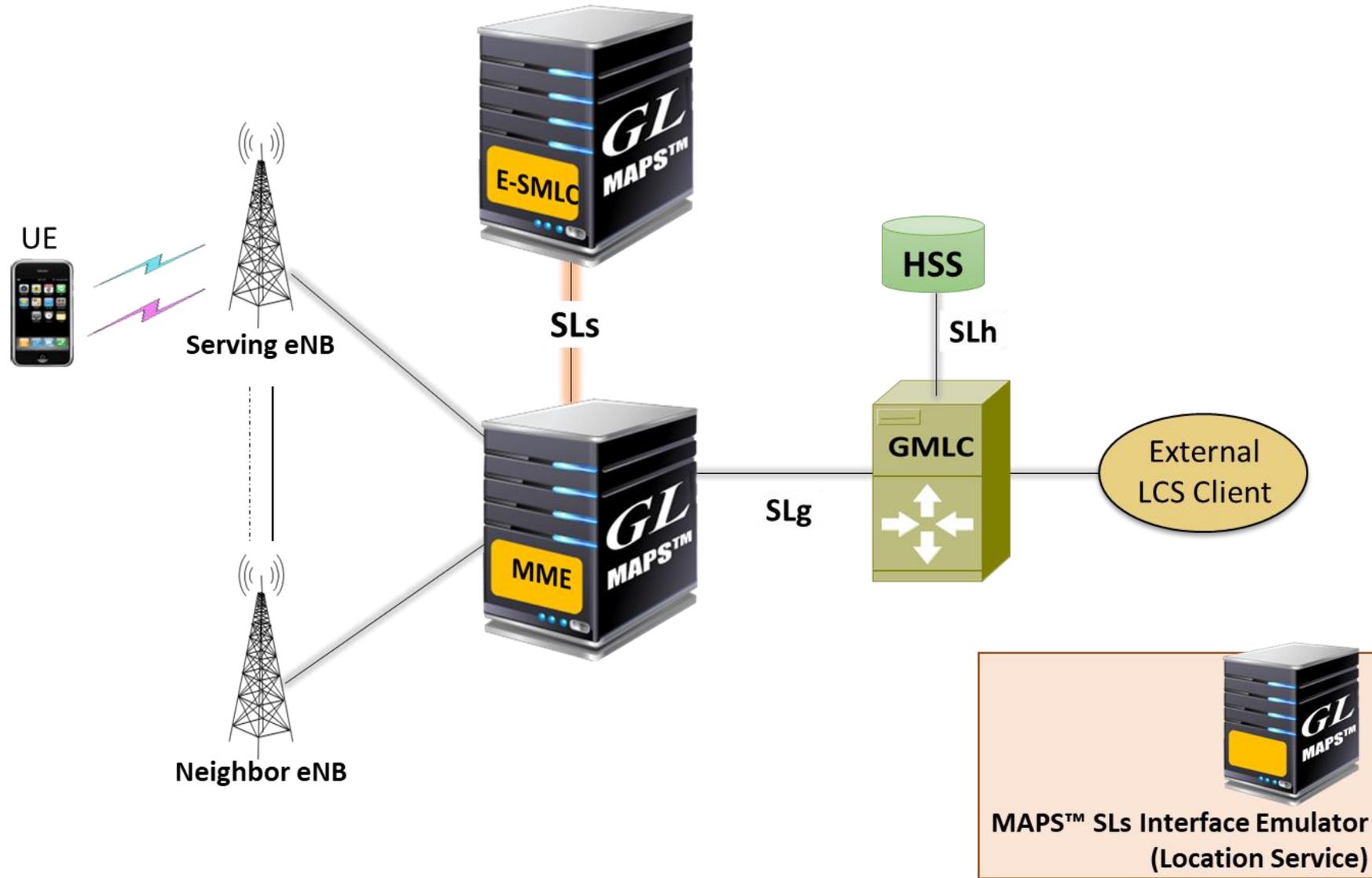


818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <http://www.gl.com>

LCS Architecture



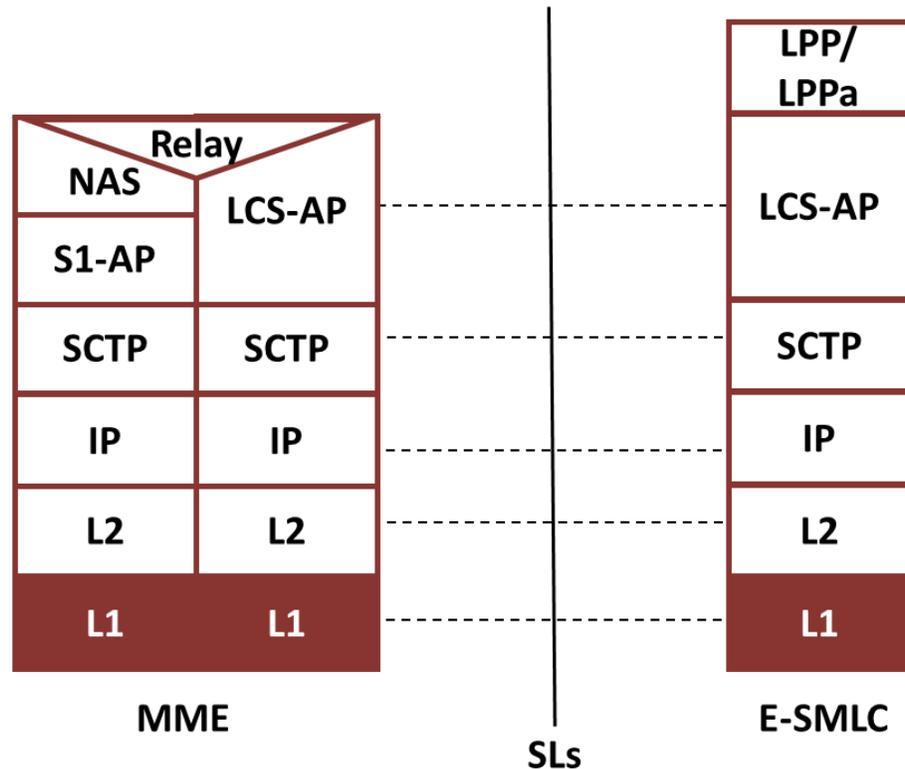
MAPS™ LTE SLs Interface



Main Features

- Useful tool to emulate Location services procedures over SLs interface
- Emulator can be configured as MME, E-SMLC nodes and study the call flow and exchange of signaling messages between any of these nodes
- User-friendly GUI for generating hundreds of UE signaling (Load Testing) over SCTP transport
- Ready scripts for LCS-AP procedures –
 - Location Service Request
 - Location Information Exchange
 - Connection Oriented Information Transfer
 - Connectionless Information Transfer
 - Location Abort procedure
 - Reset procedure
- Provides protocol trace with full message decoding of the LCS-AP messages

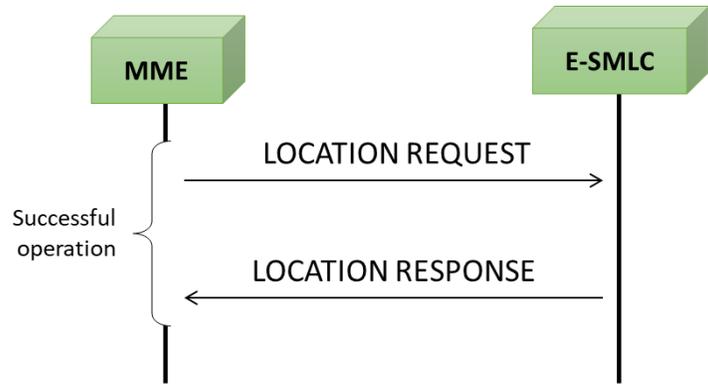
Protocol Stack and Standards



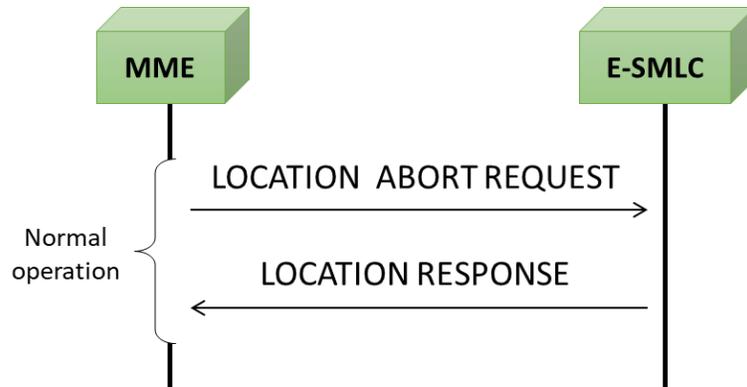
| Supported Protocols | Standard / Specification Used |
|---|----------------------------------|
| LPP | 3GPP TS 36.355- Release 14 |
| Location Services Application Part (LCS-AP) | 3GPP TS 29.171 V14.0.0 (2016-12) |
| Sctp | RFC 4960 |

Call Emulation Procedures

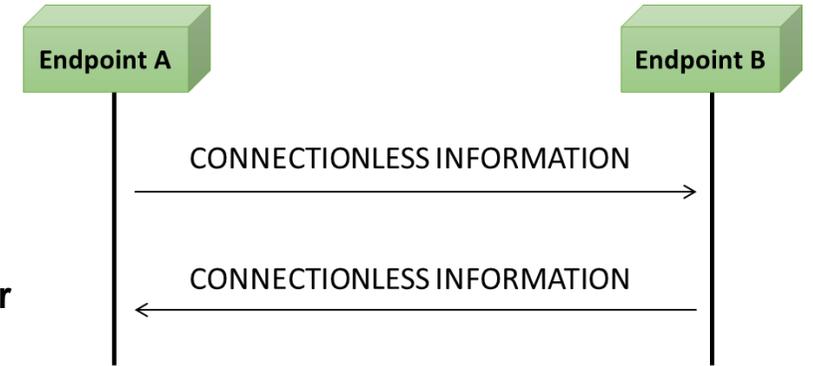
Location Service Request Procedure



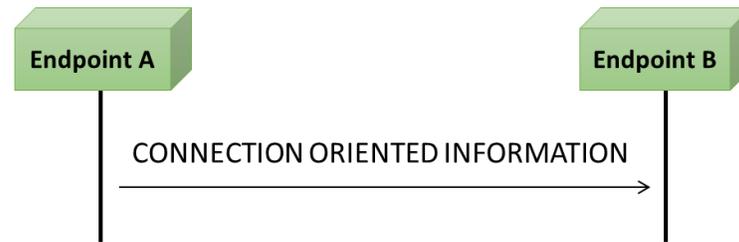
Location Abort



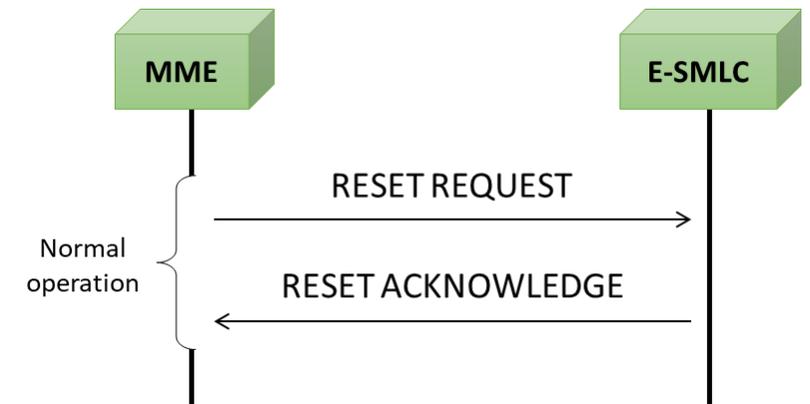
Connectionless Information Transfer



Connection Oriented Information Transfer



Reset Procedure



Testbed Configuration

The screenshot displays the MAPS (Message Automation Protocol Simulation) MME (LTE SLs 3GPP) configuration window. The window title is "MAPS (Message Automation Protocol Simulation) MME (LTE SLs 3GPP) - [Testbe...". The menu bar includes "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". The toolbar contains various icons for file operations and simulation control.

The main configuration area is divided into two panes. The left pane shows a tree view of the configuration structure:

| Config | Value |
|------------------------|-----------------|
| MMEConfiguration | |
| MME | 1 |
| MME1 | |
| MME IP Address | 192.168.1.26 |
| PLMN Id | |
| Mobile Country Code | 404 |
| Mobile Network Code | 10 |
| Macro eNBId | 0001 |
| Cell Id | 1 |
| Connected E SMLCs | |
| ESMLC | 1 |
| ESMLC 1 | |
| E SMLC IP Address | 192.168.1.26 |
| E SMLC Port | 9082 |
| E SMLC Id | 1 |
| MME Port | 9083 |
| MME SCTP Mode | Client |
| End User Configuration | UE_Profiles.xml |

The right pane shows the "MMEIPAddress" configuration field, which is currently set to "192.168.1.26". Below the field are "Start" and "Edit" buttons.

At the bottom of the window, there is a status bar with a "Initialisation Errors" indicator.

Profile Configuration

The screenshot displays the MAPS (Message Automation Protocol Simulation) E-SMLC (LTE SLs 3GPP) - [Profile Editor - UE_Profiles] window. The interface is divided into three main sections:

- Left Panel:** A list of profiles (UEProfile0001 to UEProfile0037) with a search bar and navigation buttons (Insert, Delete, Clear).
- Center Panel:** A configuration tree for the selected profile (UEProfile0100). The tree is expanded to show the following parameters and values:
 - Mobile Identity Parameters
 - IMEI: 359877068325347
 - IMSI: 311480012041730
 - Current Location
 - MCC: 311
 - MNC: 480
 - CellId: 1
 - ESMLCId: 1
 - LCS Parameters
 - LCS Coordinates Input Method: Profile
 - LCS Coordinates CSV File Name: Location_Coordinates.csv
 - Location Estimate Parameters
 - Type of Shape: Point with Uncertainty Circle
 - Degrees of Latitude: 56.00
 - Degrees of Longitude: 25.00
 - Uncertainty Semi Major in meters: 5.30
 - Uncertainty Semi Minor in meters: 10.90
 - Orientation of Major Axis: 80
 - Confidence: 4
 - Altitude in meters: 3600
 - Direction Of Altitude: Altitude Expresses Height
 - Uncertainty Altitude in meters: 8.40
 - Inner Radius: 64
 - Uncertainty Radius: 15
 - Offset Angle: 12
 - Included Angle: 8
 - Polygon Shape Parameters
 - Polygon 1
 - Degrees of Latitude: 40.00
 - Degrees of Longitude: 30.00
 - Polygon 2
 - Degrees of Latitude: 25.00
 - Degrees of Longitude: 88.00
 - Polygon 3
 - Degrees of Latitude: 32.00
 - Degrees of Longitude: -123.00
 - Polygon 4
 - Degrees of Latitude: 51.00
 - Degrees of Longitude: 53.00
 - Polygon 5
 - Degrees of Latitude: 70.00
 - Degrees of Longitude: 23.00
 - Positioning Data Parameters
 - Usage: Successful
 - Positioning Method: Timing Advance
 - Request Error response for Connection Info: Yes
 - Accuracy Fulfillment Indicator: Requested Accuracy Fulfilled
 - Payload Type for Connection Oriented Message: LPP
- Right Panel:** A detailed view of the selected profile (UEProfile0100). It shows the IMEI field with the value 359877068325347 and a text input field for the IMEI. Below the input field are buttons for Add, Insert, and Delete, and a Properties button.

Incoming Call Handler Configuration

Incoming Call Handlers Configuration - default

| Message Name | Script Name |
|----------------------------|--------------------------------------|
| Location Request | Location_Request_E-SMLC.gls |
| Reset Request | Reset_E-SMLC.gls |
| Location Abort Request | LocationAbort_E-SMLC.gls |
| Connectionless Information | ConnectionLessInformation_E-SMLC.gls |

Scripts

- ConnectionLessInformation_E-...

Sequence
 Random

Up
Down

Add Delete

Add Delete Clear Scripts

Call Generation

Active Calls Call Status Call Events

Loading Scripts
and
Profiles

| Sr No | Script Name | Profile | Call Info | Script Execution | Status | Events | E... | Result | Total ... | Compl... |
|-------|--------------------------|---------------|--------------------|------------------|---------------------------------------|----------------------------------|------|---------|-----------|----------|
| 1 | Location_Request_MME.gls | UEProfile0001 | 0x0311480012041631 | Start | Successful Location Response Received | None | | Pass | 1 | 1 |
| 2 | Location_Request_MME.gls | UEProfile0002 | 0x0311480012041632 | Stop | SLs Location Request Initiated | Send_SLs_ConnectionOriented_M... | | Unknown | 1 | 0 |
| 3 | Location_Request_MME.gls | UEProfile0003 | | Start | | None | | Unknown | 1 | 0 |
| 4 | Location_Request_MME.gls | UEProfile0004 | | Start | | None | | Unknown | 1 | 0 |
| 5 | Location_Request_MME.gls | UEProfile0005 | | Start | | None | | Unknown | 1 | 0 |

Message Sequence Diagram:

```

sequenceDiagram
    participant MME
    participant E_SMLC
    MME->>E_SMLC: Location Request 12:55:17.550000
    E_SMLC->>MME: Connection Oriented Information 12:55:19.831000
    E_SMLC->>MME: Location Response 12:55:22.639000
    
```


Decoded Message:

```

===== LCSAP Layer =====
LCSAP-PDU = CHOICE
Extensibility Marker = 0
Choice Index = 0
ProcedureCode = INTEGER
Contents = 0 id-Location-Service-Reques
Criticality = ENUMERATOR
Contents = 0 reject(0)
Value = Open Type
Length = 67
Extensibility Marker = 0
Preamble = 0
ProtocolIE-Container = SEQUENCE OF
Iteration Count = 9
ProtocolIE-Container = Instance 0
ProtocolIE-ID = INTEGER
Contents = 2 id-Correlation-ID
Criticality = ENUMERATOR
Contents = 0 reject(0)
Value = Open Type
Length = 4
    
```

Message Sequence

Decode Message

Call Reception

The screenshot displays the MAPS (Message Automation Protocol Simulation) E-SMLC (LTE SLs 3GPP) - [Call Reception] window. The window title bar includes the GL logo and the text "MAPS (Message Automation Protocol Simulation) E-SMLC (LTE SLs 3GPP) - [Call Reception]". The menu bar contains "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". The toolbar includes various icons for file operations and simulation control.

The main area is divided into three sections:

- Call Results Table:** A table with columns: No, Script Name, Profile, Call Info, Script Execution, Status, Events, and Results. The Results column is highlighted with a red box and labeled "Call Results".

| No | Script Name | Profile | Call Info | Script Execution | Status | Events | Results |
|----|-----------------------------|---------------|--------------------|------------------|-----------------------------------|-------------------------------------|---------|
| 1 | Location_Request_E-SMLC.gls | UEProfile0001 | 0x0311480012041631 | Completed | Successful Location Response sent | None | Pass |
| 2 | Location_Request_E-SMLC.gls | UEProfile0002 | 0x0311480012041632 | Completed | Successful Location Response sent | None | Pass |
| 3 | Location_Request_E-SMLC.gls | UEProfile0003 | 0x0311480012041633 | Stop | | Send_SLs_ConnectionOriented_Message | Unknown |
- Message Sequence Diagram:** A diagram showing the interaction between MME and E-SMLC. It includes a "Location Request" message from MME to E-SMLC at 12:56:55.608000, a "Connection Oriented Information" message from MME to E-SMLC at 12:56:57.378000, and a "Location Response" message from E-SMLC to MME at 12:57:00.629000. This section is labeled "Message Sequence".
- Decoded Message:** A detailed view of the message structure, showing the LCSAP Layer and its contents. The message is identified as "LCSAP-PDU" and contains a "Choice Index" of 0, a "ProcedureCode" of INTEGER, and a "Contents" field with a value of "0 reject (0)". This section is labeled "Decode Message".

The bottom status bar shows "Initialisation Errors", "Error Events", "Captured Errors", and "Link Status Up=1 Down=0".

Message Sequence

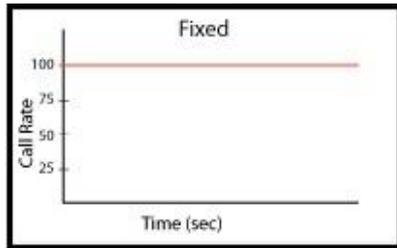
Call Results

Decode Message

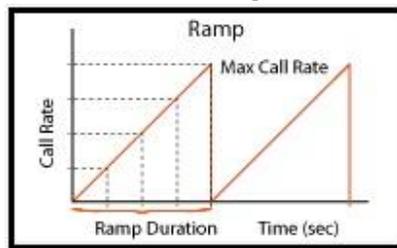
Load Generation

- 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.

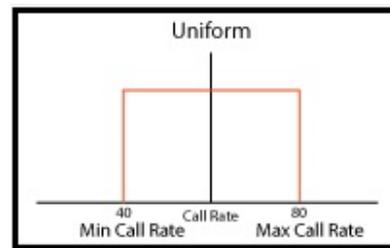
Fixed



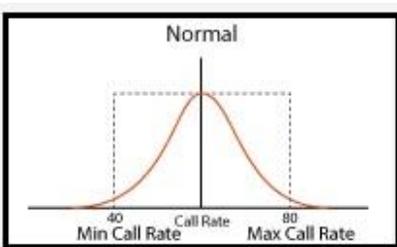
Ramp



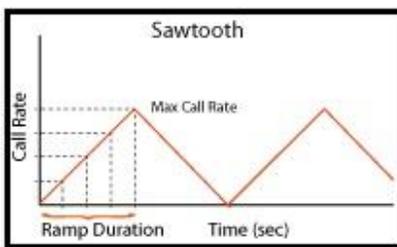
Uniform



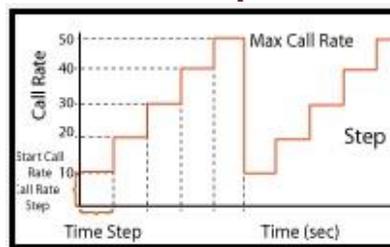
Normal



Saw-tooth



Step



The screenshot shows the MAPS configuration window for MME (LTE SLs 3GP...). The window has a menu bar with 'Configurations', 'Emulator', 'Reports', 'Editor', 'Debug Tools', 'Windows', and 'Help'. Below the menu bar is a toolbar with various icons. The main area contains several configuration options:

- Total Calls To Generate: * (* indicates no limit)
- Max Active Calls: 0
- Unique Distributions Per Script
- Multi Distributions

| Distributions | Description |
|---------------|---------------------------------|
| Uniform | MinCR=40, MaxCR=80, Duration=10 |
| Fixed | Call Rate=200, Duration=10 |
| Normal | MinCR=40, MaxCR=80, Duration=10 |

Scripts: Location_Request_MME

Profile: Exclusive Profiles

| Profile |
|---------------|
| UEProfile0001 |
| UEProfile0002 |
| UEProfile0003 |
| UEProfile0004 |
| UEProfile0005 |
| UEProfile0006 |
| UEProfile0007 |
| UEProfile0008 |
| UEProfile0009 |
| UEProfile0010 |

Buttons: Add, Delete, Add, Delete

Stop Time

Days: 0, Hours: 0, Minutes: 0

Start Time: 00:00:00.000, End Time: 00:00:00.000

Buttons: Pause, Start

Buttons: Initialisation Errors, Error Ev...

Bulk Call Generation

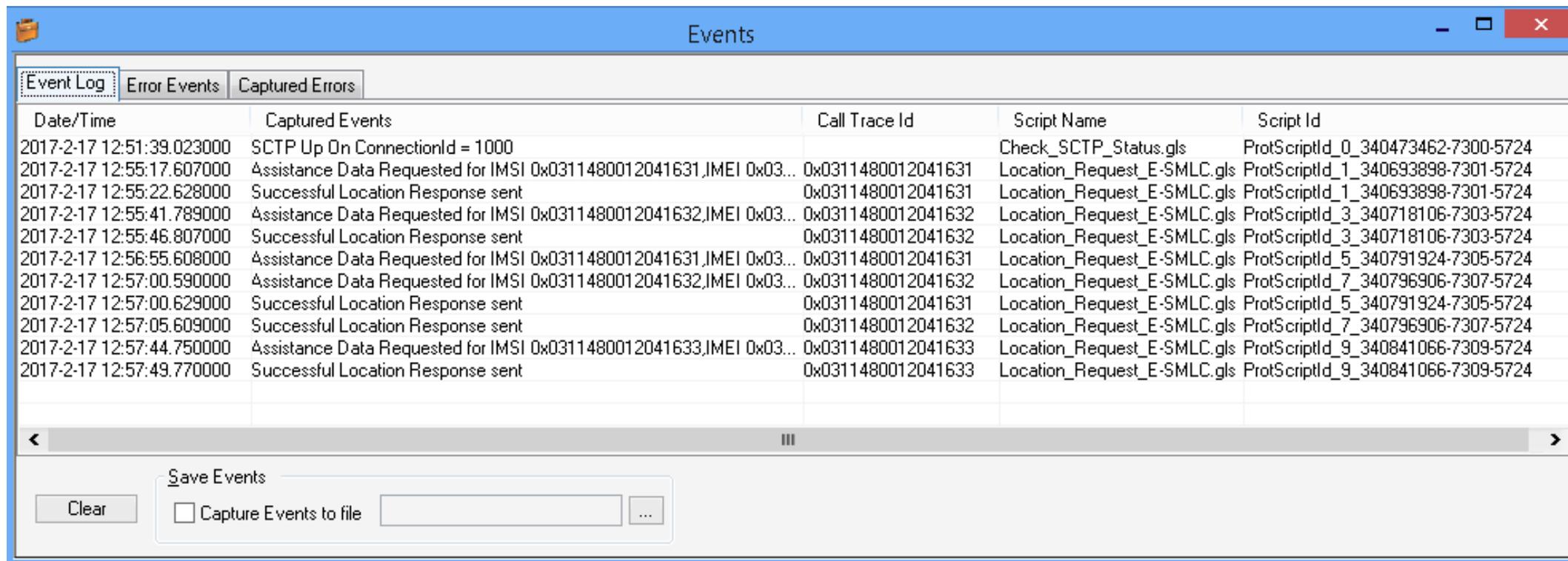
| Sr No | Script Name | Profile | Call Info | Script Execution | Status | Events | E... | Result | Total Iterations | Completed Iterations |
|-------|--------------------------|---------------|-----------|------------------|--------|--------|------|---------|------------------|----------------------|
| 1 | Location_Request_MME.gls | UEProfile0001 | | Start | | None | | Unknown | 10 | 0 |
| 2 | Location_Request_MME.gls | UEProfile0002 | | Start | | None | | Unknown | 10 | 0 |
| 3 | Location_Request_MME.gls | UEProfile0003 | | Start | | None | | Unknown | 10 | 0 |
| 4 | Location_Request_MME.gls | UEProfile0004 | | Start | | None | | Unknown | 10 | 0 |
| 5 | Location_Request_MME.gls | UEProfile0005 | | Start | | None | | Unknown | 10 | 0 |
| 6 | Location_Request_MME.gls | UEProfile0006 | | Start | | None | | Unknown | 10 | 0 |
| 7 | Location_Request_MME.gls | UEProfile0007 | | Start | | None | | Unknown | 10 | 0 |
| 8 | Location_Request_MME.gls | UEProfile0008 | | Start | | None | | Unknown | 10 | 0 |
| 9 | Location_Request_MME.gls | UEProfile0009 | | Start | | None | | Unknown | 10 | 0 |
| 10 | Location_Request_MME.gls | UEProfile0010 | | Start | | None | | Unknown | 10 | 0 |

```
KeyIdentifier:IMSI;
starttimer InterCallDurationTimer 10 msec;

wait;

"InterCallDurationTimerExpiry":
  if (ProfileLoaded != 1)
    ErrorLog ("No Subscriber Profile Selected");
    exit;
  endif
  IsGeneration=1;
```

Events Log



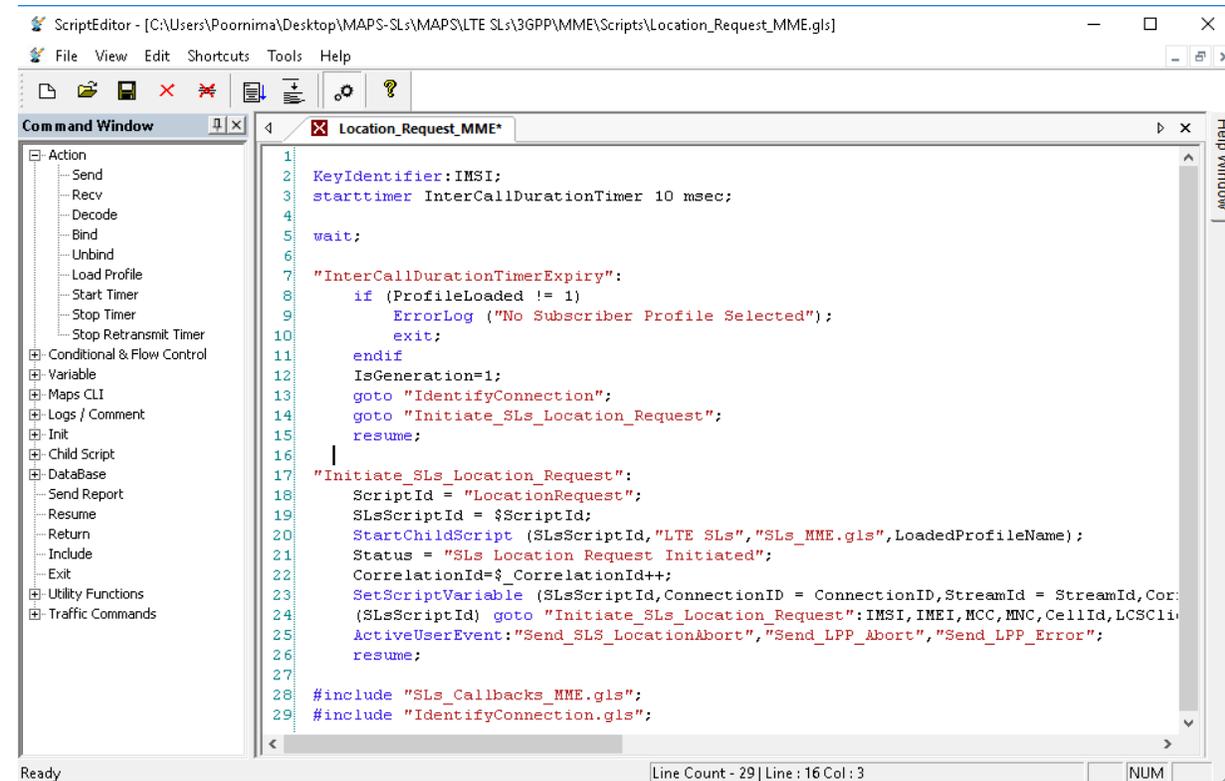
| Date/Time | Captured Events | Call Trace Id | Script Name | Script Id |
|---------------------------|--|--------------------|-----------------------------|------------------------------------|
| 2017-2-17 12:51:39.023000 | SCTP Up On ConnectionId = 1000 | | Check_SCTP_Status.gls | ProtScriptId_0_340473462-7300-5724 |
| 2017-2-17 12:55:17.607000 | Assistance Data Requested for IMSI 0x0311480012041631,IMEI 0x03... | 0x0311480012041631 | Location_Request_E-SMLC.gls | ProtScriptId_1_340693898-7301-5724 |
| 2017-2-17 12:55:22.628000 | Successful Location Response sent | 0x0311480012041631 | Location_Request_E-SMLC.gls | ProtScriptId_1_340693898-7301-5724 |
| 2017-2-17 12:55:41.789000 | Assistance Data Requested for IMSI 0x0311480012041632,IMEI 0x03... | 0x0311480012041632 | Location_Request_E-SMLC.gls | ProtScriptId_3_340718106-7303-5724 |
| 2017-2-17 12:55:46.807000 | Successful Location Response sent | 0x0311480012041632 | Location_Request_E-SMLC.gls | ProtScriptId_3_340718106-7303-5724 |
| 2017-2-17 12:56:55.608000 | Assistance Data Requested for IMSI 0x0311480012041631,IMEI 0x03... | 0x0311480012041631 | Location_Request_E-SMLC.gls | ProtScriptId_5_340791924-7305-5724 |
| 2017-2-17 12:57:00.590000 | Assistance Data Requested for IMSI 0x0311480012041632,IMEI 0x03... | 0x0311480012041632 | Location_Request_E-SMLC.gls | ProtScriptId_7_340796906-7307-5724 |
| 2017-2-17 12:57:00.629000 | Successful Location Response sent | 0x0311480012041631 | Location_Request_E-SMLC.gls | ProtScriptId_5_340791924-7305-5724 |
| 2017-2-17 12:57:05.609000 | Successful Location Response sent | 0x0311480012041632 | Location_Request_E-SMLC.gls | ProtScriptId_7_340796906-7307-5724 |
| 2017-2-17 12:57:44.750000 | Assistance Data Requested for IMSI 0x0311480012041633,IMEI 0x03... | 0x0311480012041633 | Location_Request_E-SMLC.gls | ProtScriptId_9_340841066-7309-5724 |
| 2017-2-17 12:57:49.770000 | Successful Location Response sent | 0x0311480012041633 | Location_Request_E-SMLC.gls | ProtScriptId_9_340841066-7309-5724 |

Save Events

Capture Events to file

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 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.



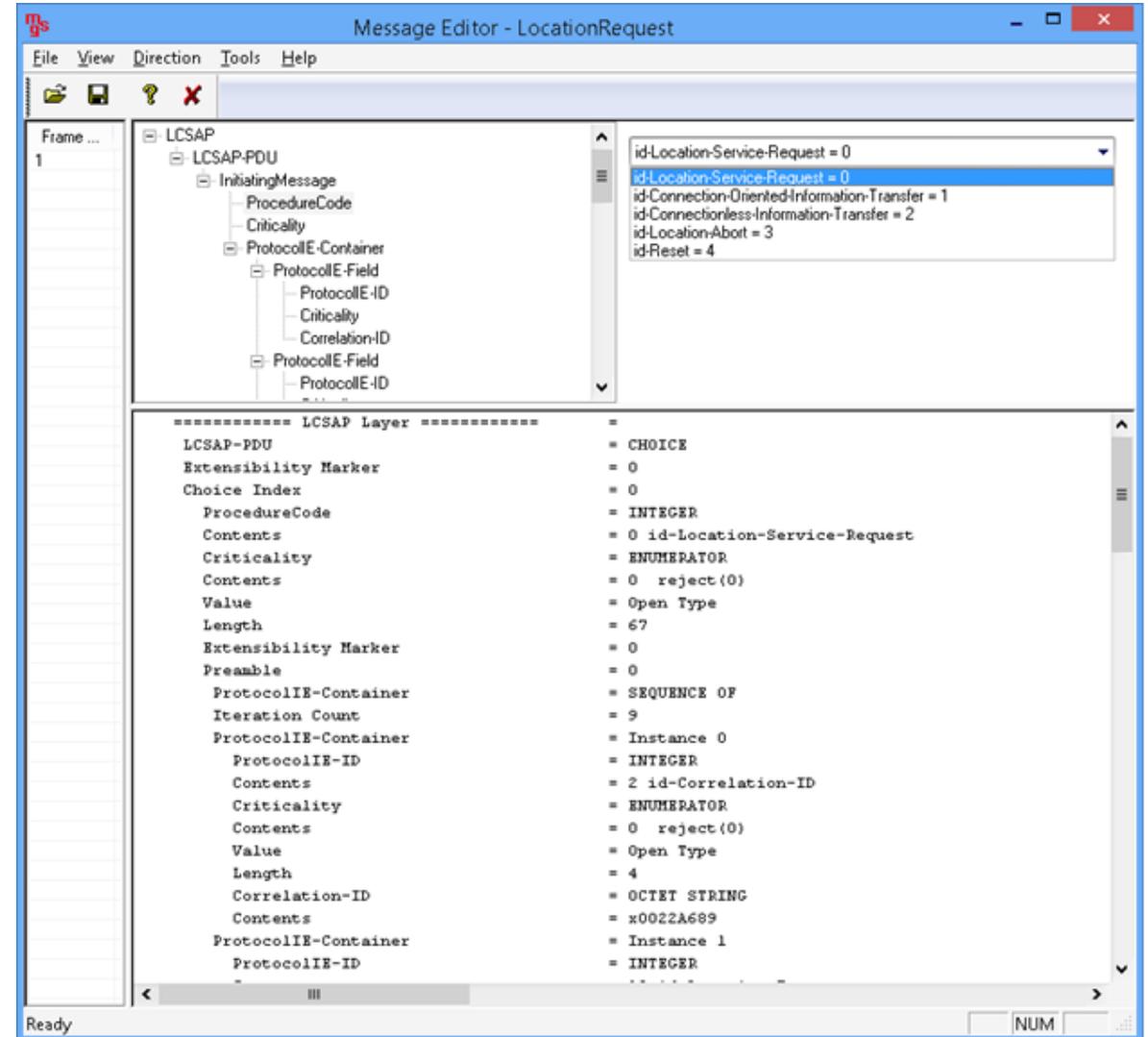
```
ScriptEditor - [C:\Users\Poornima\Desktop\MAPS-SL\MAPS\LTE SLs\3GPP\MME\Scripts\Location_Request_MME.gls]
File View Edit Shortcuts Tools Help
Command Window
Action
  Send
  Recv
  Decode
  Bind
  Unbind
  Load Profile
  Start Timer
  Stop Timer
  Stop Retransmit Timer
  Conditional & Flow Control
  Variable
  Maps CLI
  Logs / Comment
  Init
  Child Script
  DataBase
  Send Report
  Resume
  Return
  Include
  Exit
  Utility Functions
  Traffic Commands
Location_Request_MME*
1
2 KeyIdentifier:IMSI;
3 starttimer InterCallDurationTimer 10 msec;
4
5 wait;
6
7 "InterCallDurationTimerExpiry":
8   if (ProfileLoaded != 1)
9     ErrorLog ("No Subscriber Profile Selected");
10    exit;
11  endif
12  IsGeneration=1;
13  goto "IdentifyConnection";
14  goto "Initiate_SLs_Location_Request";
15  resume;
16
17 "Initiate_SLs_Location_Request":
18  ScriptId = "LocationRequest";
19  SLsScriptId = $ScriptId;
20  StartChildScript (SLsScriptId,"LTE SLs","SLs_MME.gls",LoadedProfileName);
21  Status = "SLs Location Request Initiated";
22  CorrelationId=$CorrelationId++;
23  SetScriptVariable (SLsScriptId,ConnectionID = ConnectionID,StreamId = StreamId,Cor:
24  (SLsScriptId) goto "Initiate_SLs_Location_Request":IMSI,IMEI,MCC,MNC,CallId,LCSCli:
25  ActiveUserEvent:"Send_SLs_LocationAbort","Send_LPP_Abort","Send_LPP_Error";
26  resume;
27
28 #include "SLs_Callbacks_MME.gls";
29 #include "IdentifyConnection.gls";
Ready Line Count - 29 | Line : 16 Col : 3 NUM
```

Customizations - Protocol Messages

When the script actually sends a message it does so by loading a text file template from disk (“LocationRequest.hdl” in the right hand screenshot).

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. Text-based protocol messages can be edited in any text editor. Binary-based messages must be edited in our provided message editor.



Customizations - Statistics and Reports

MOS, R-Factor

Packet Loss

Packets

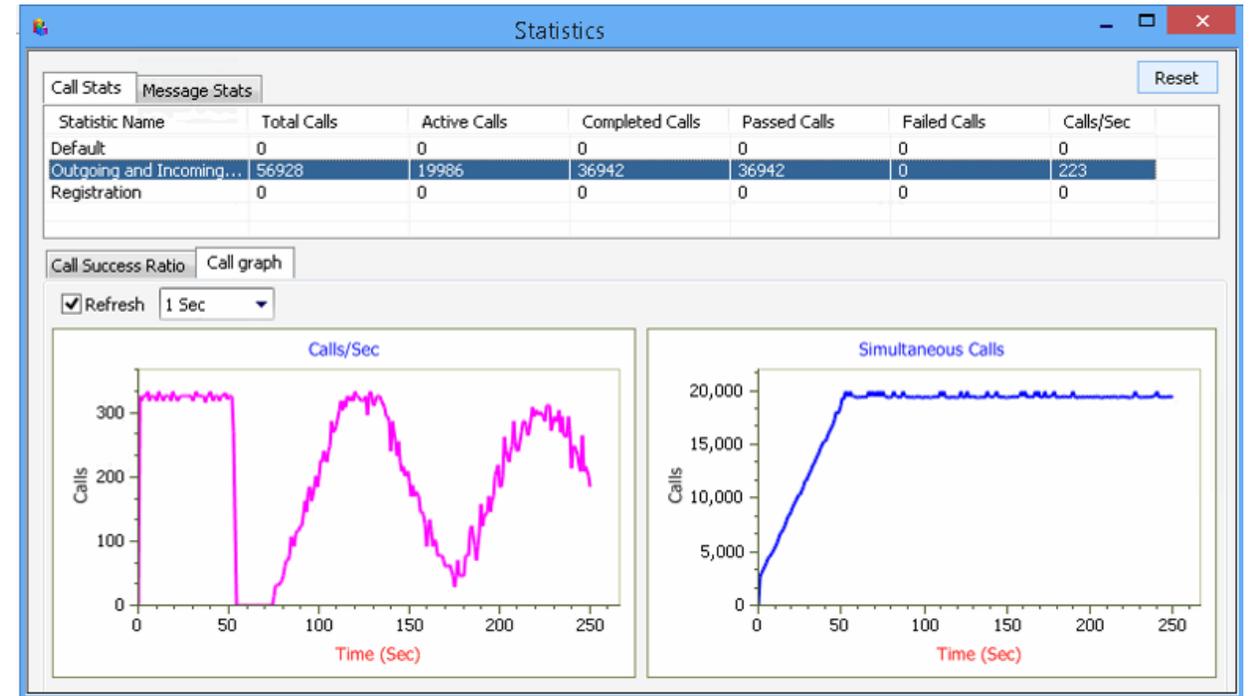
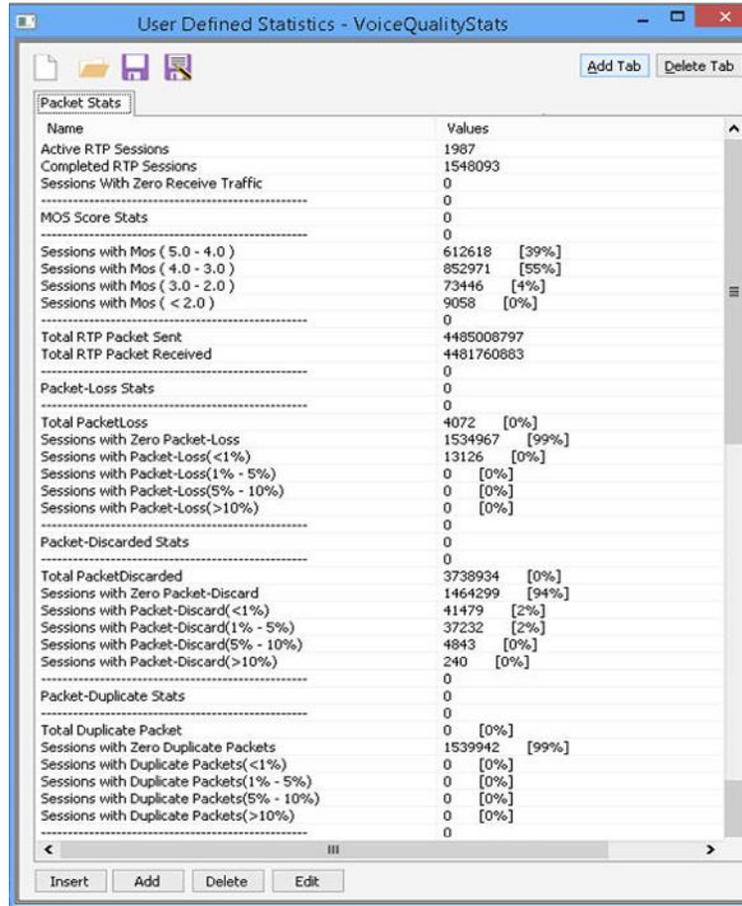
Discarded

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.

Thank you