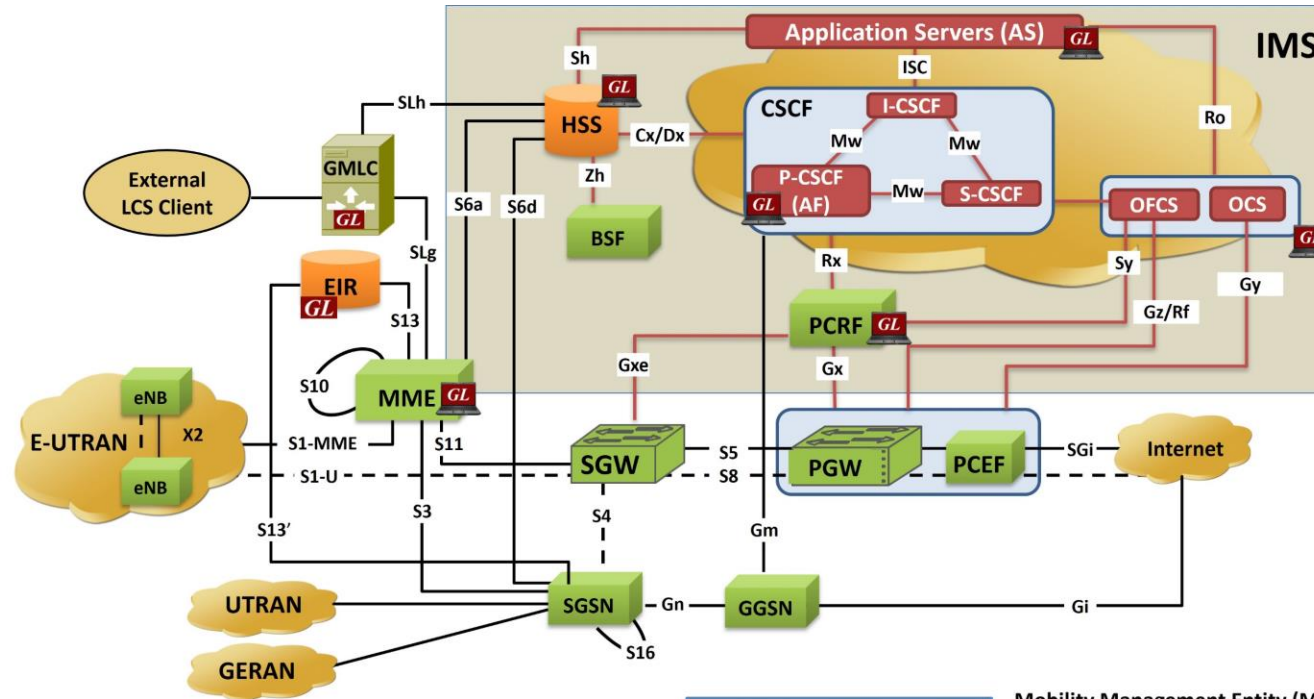

MAPS™ Diameter Interface Emulator

S6a, S6d, S13, S13', Cx/Dx, Gx, Gy, Rf, Ro, Rx, Sh, SLg, SLh, and Zh Interfaces Emulation

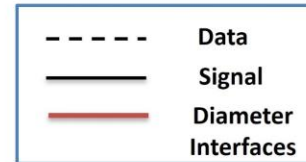


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Architecture



MAPS™ Diameter Emulator
(S6a, S13, S13', CxDx, Gx, Gy, Rf, Ro, Rx, Sh, SLg, SLh, and Zh)



- Mobility Management Entity (MME)
- Home Subscriber Server (HSS)
- Equipment Identity Register (EIR)
- Application Function (AF)
- Test Application Server (AS)
- Policy and Charging Rules Function (PCRF)
- Policy and Charging Enforcement Function (PCEF)
- Packet Data Network Gateway (PDN GW)
- Signaling Gateway (SGW)
- Gateway Mobile Location Center (GMLC)
- Online Charging System (OCS)
- Offline Charging System (OFCS)
- Home Subscriber Server (HSS)
- Bootstrapping Server Functionality (BSF)
- Serving GPRS Support Node (SGSN)
- Gateway GPRS Support Node (GGSN)
- Call Session Control Function (CSCF)
- Interrogating-Call Session Control Function (I-CSCF)
- Proxy-Call Session Control Function (P-CSCF)
- Serving-Call Session Control Function (P-CSCF)

Key Features

- Supports emulation of real-time LTE network using “MAPS 4G Wireless Lab Suite”
- Allows users to configure MAPS™ Diameter emulator as MME, HSS, PCRF, PCEF, CSCF, SGSN, PDN GW, EIR, AF, BSF, and AS entities to emulate a variety of interfaces such as S6a, S6d, S13, S13', Cx/Dx, Gx, Gy, Rf, Ro, Rx, Sh, SLg, SLh, and Zh
- Supports emulation of Location Services (LCS) based SLh and SLg interfaces between the GMLC <-> HSS and GMLC <-> MME entities
- User-friendly GUI for generating hundreds of UE Signaling (Load Testing) over SCTP/TCP Layers
- Support for TCP/TLS for secured information transfer
- Ready scripts for procedures over interfaces such as –
 - Location Management, Subscriber Data Handling, Authentication, Fault Recovery, and Notification procedures over S6a interface
 - AA-Request/Answer, Abort-Session-Request/Answer, and Session-Termination- Request/Answer procedure over Rx interface
 - CC-Request/Answer, Re-Auth-Request/Answer Over Gx Interface
- Impairments can be applied to messages to emulate error conditions
- Supports customization of call flows and message templates using Script editor and Message editor

Protocol Stack

Diameter	
SCTP	TLS
	TCP
IP	
MAC	
Diameter Protocol	

Supported Protocols	Standard / Specification Used
Diameter	IETF RFC 3588 S6a, S6d, S13 - 3GPP TS 29.272 V10.3.0 Rx - 3GPP TS 29214-b10 Cx/Dx - 3GPP TS 29.228 & TS29.229 Gx - 3GPP TS 29.212 & TS 23.203 Sh - 3GPP TS 29.328 & TS 29.329 Gy/Ro (DCCA)- 3GPP TS 32.225, 3GPP TS 32.299 and IETFRFC 4006 SLg - 3GPP TS 29.172 SLh - 3GPP TS 29.173 Zh - 3GPP TS 29.109
SCTP	RFC 4960
TCP	RFC793
TLS	RFC 5246

Elements and Interfaces of the Core Network

Interface	Elements	Purpose	Spec
S6a	MME and HSS	This enables the transfer of subscriber related data between the MME and the HS.	3GPP TS 29.272
Rx/Gx	AF and PCRF	Allows for dynamic QoS and charging-related service information to be exchanged between the PCRF and the AF. This information is used by the PCRF for the control of service data flows and IP bearer resources.	3GPP TS 23.203 & TS 29.214 V. B1.0
Gy/Ro	OCS and CTF	The PCEF node in LTE network, and CSCF node in IMS network perform the role of a Charging Trigger Function (CTF) entity to issue charging events to an Online Charging System (OCS).	3GPP TS 32.225, 3GPP TS 32.299 and IETF RFC 4006
SLg	GMLC and MME	SLg interface acts between GMLC (Gateway Mobile Location) and MME (Mobile Management Entity) to perform a Location Request.	3GPP TS 29.172
SLh	GMLC and HSS	SLh interface is used to obtain exact positioning request through GMCL (Gateway Mobile Location center) and HSS (Home Subscriber Server).	3GPP TS 29.173

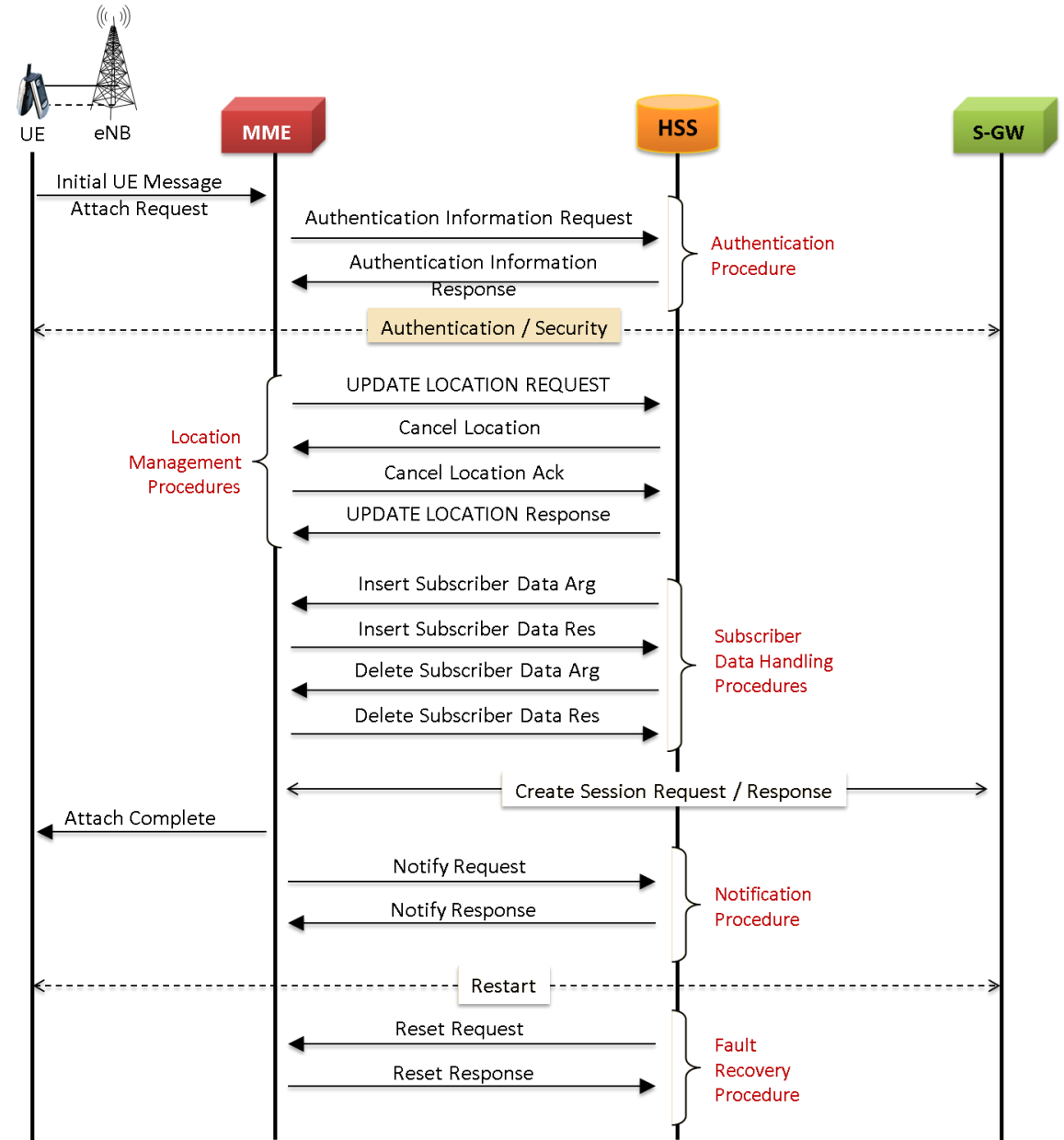
Elements and Interfaces of the Core Network (Contd.)

Interface	Elements	Purpose	Spec
CxDx	HSS and SCSCF	The Cx and Dx interfaces are the reference points for interactions between Home Subscriber Server (HSS) and Interrogating Call Session Control Function (I-CSCF) or Serving Call Session Control Function (S-CSCF).	3GPP TS 29.228 & TS29.229
S13/S13'	EIR and MME EIR and SGSN	The S13 and S13' interfaces is used for Mobile Equipment Identity Check Procedure is used between the MME and the EIR to check the Mobile Equipment's identity status.	3GPP TS 29.272 V10.3.0
Sh	HSS and AS	The Sh interface uses the method of communication between the AS (Application Server) function and the HSS (Home Subscriber Server).	3GGP TS 29.328 & TS 29.329
Zh	BSF and HSS	The Zh interface uses the Multimedia-Auth-Request method to communicate between BSF and HSS	3GPP TS 29.109

S6a Interface Signaling Procedure

MAPS™ Diameter at the MME end initiates the following S6a interface procedures:

- initiates the Authentication procedure by sending Authentication-Information-Request message
- initiates the Update Location procedure by sending Update-Location-Request message
- initiates the Purge UE procedure by sending Purge-UE-Request message



S6a Interface Call Generation and Reception

Call Generation at MME Node

MAPS MME (Diameter S6A) - [Call Generation - Default]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	MME_SessionControl.gls	MMEProfile0001	IMSI_001013012041631	Start	Purge-UE-Successful	None		Pass		
2	MME_SessionControl.gls	MMEProfile0002		Start		None		Unknown		
3	MME_SessionControl.gls	MMEProfile0003		Start		None		Unknown		
4	MME_SessionControl.gls	MMEProfile0004		Start		None		Unknown		
5	MME_SessionControl.gls	MMEProfile0005		Start		None		Unknown		
6	MME_SessionControl.gls	MMEProfile0006		Start		None		Unknown		
7	MME_SessionControl.gls	MMEProfile0007		Start		None		Unknown		

Add Delete Insert Refresh Start Start All Stop Stop All Abort Abort All

Save Column Width Show Latest

MME HSS

```

===== Diameter Layer =====
0000 Version = 00000001
0001 Length = 312 (x000)
Command Flags
0004 Request (R) = 1.....
0004 Proxiable (P) = .1.....
0004 Error (E) = ..0.....
0004 Potentially Retransmitted Message (T) = ..0.....
0005 Command Code = x00013E A
0008 Application Identifiers = x01000023
000C Hop By Hop Identifier = 1532358839
0010 End To End Identifier = 3941912165
Session-Id
AVP Code = x00000107
AVP Flags
Vendor Specific Bit (V) = 0.....
Mandatory Bit (M) = .1.....
Encryption For End To End Security (P) = ..0.....
Reserved (r) = ..000000
AVP Length = 64 (x0000)
AVP Data = MME@g1.co
Vendor-Specific-Application-Id
AVP Code = x00000104
AVP Flags
Vendor Specific Bit (V) = 0.....
Mandatory Bit (M) = .1.....
Encryption For End To End Security (P) = ..0.....
Reserved (r) = 000000
    
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors

Call Reception at HSS Node

MAPS HSS (Diameter S6A) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1000	Stop	Common Application Found	Request_Device...		Pass
2	HSS_SessionControl.gls	HSSProfile0001	IMSI_001013012041631	Completed	Purge-UE-Successful	None		Pass

Stop Stop All Abort Abort All Show Records Select Active Call Auto Trash Trash

Save Column Width Show Latest

MME HSS

```

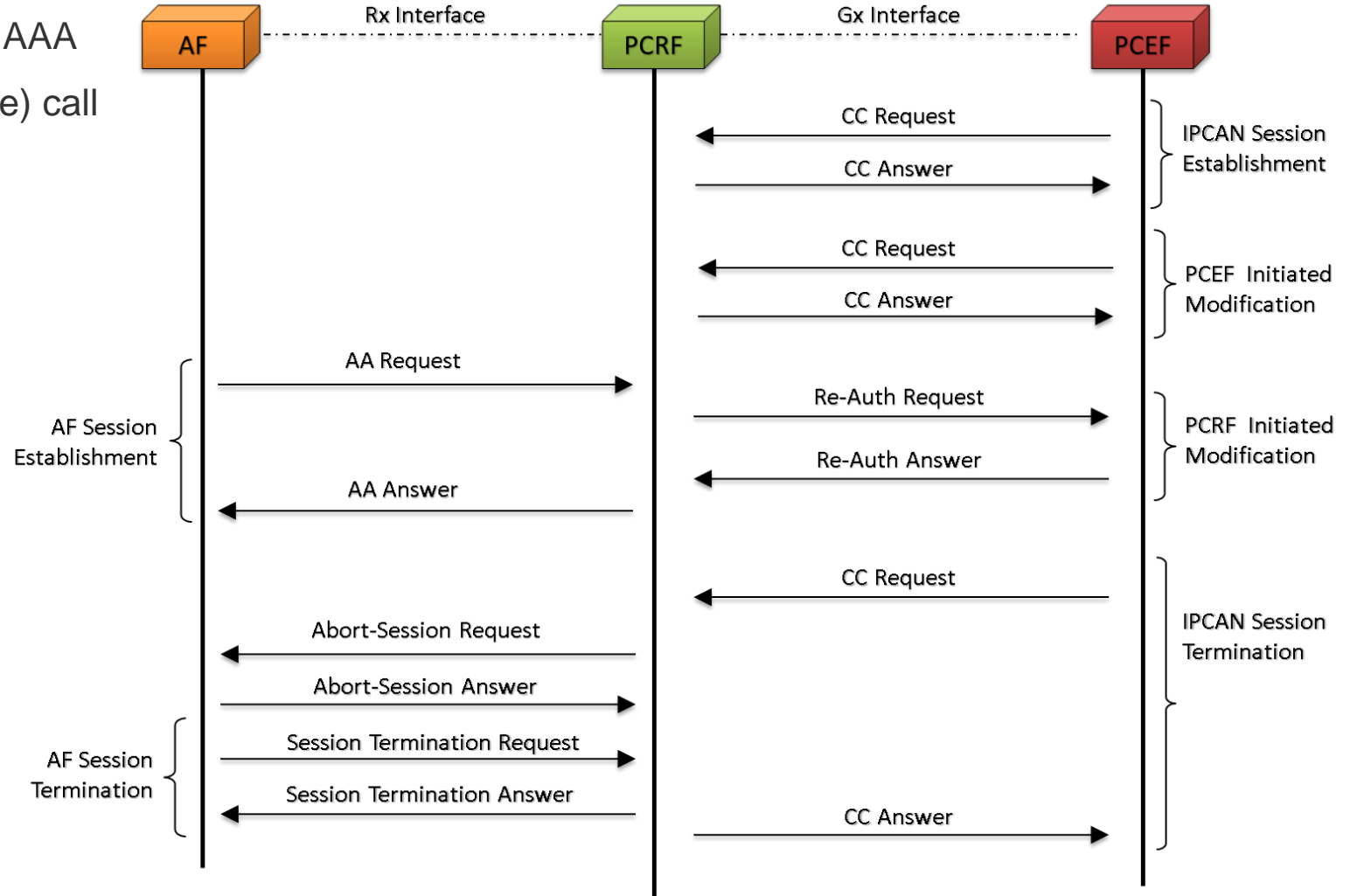
===== Diameter Layer =====
0000 Version = 00000001 Diameter Version 1
0001 Length = 312 (x000138)
Command Flags
0004 Request (R) = 1..... Message is Request
0004 Proxiable (P) = .1..... Message Proxied, Relayed or Redir
0004 Error (E) = ..0..... Message Doesn't Contain Protocol
0004 Potentially Retransmitted Message (T) = ..0..... Cleared
0005 Command Code = x00013E Authentication-Information Request
0008 Application Identifiers = x01000023 Application-ID of the S6a/S6d in
000C Hop By Hop Identifier = 1532358839 (x5B55F0B7)
0010 End To End Identifier = 3941912165 (xEAF4CE65)
Session-Id
AVP Code = x00000107 Session-Id
AVP Flags
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = ..0..... Not Needed
Reserved (r) = ..000000
AVP Length = 64 (x000040)
AVP Data = MME@g1.com;5006764164;2;GL-MAPS-3-24035193
Vendor-Specific-Application-Id
AVP Code = x00000104 Vendor-Specific-Application-Id
AVP Flags
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = ..0..... Not Needed
Reserved (r) = ..000000
AVP Length = 32 (x000020)
AVP Data =
Vendor-Id =
005C AVP Code = x0000010A Vendor-Id
0060 Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
0060 Mandatory Bit (M) = .1..... Support Of AVP Required
    
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status Up=1 Down

Rx/Gx Interface Signaling Procedure

- The MAPS™ Diameter emulate 3GPP AAA (Authentication Authorization Procedure) call control messages between the AF and PCRF nodes



Rx/Gx Interface Call Generation and Reception

Call Generation at AF Node

Call Reception at PCRF Node

MAPS AF (Diameter Rx) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	AF_SessionControl.gls	AFProfile0001	IMSI_001013012041631	Start	Session Terminated	None	Unknown	Pass	1	1
2	AF_SessionControl.gls	AFProfile0002		Start		None				
3	AF_SessionControl.gls	AFProfile0003		Start		None				
4	AF_SessionControl.gls	AFProfile0004		Start		None				

Add Delete Insert Refresh Start Start All Stop Stop All Abort Abort All

Save Column Width Show Latest

AF PCRF

AA-Request 12:52:17.536000

AA-Answer 12:52:17.796000

Session-Termination-Request 12:52:32.826000

Session-Termination-Answer 12:52:32.871000

```

0000 Version
0001 Length
0004 Command Flags
0004 Request (R)
0004 Proxiable (P)
0004 Error (E)
0004 Potentially Retransmitted Message (T)
0005 Command Code
0008 Application Identifiers
000C Hop By Hop Identifier
0010 End To End Identifier
Session-Id
AVP Code
AVP Flags
Vendor Specific Bit (V)
Mandatory Bit (M)
Encryption For End To End Security (P)
Reserved (r)
AVP Length
AVP Data
Padding Octet
Auth-Application-Id
AVP Code
Vendor Specific Bit (V)

```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors

MAPS PCRF (Diameter Rx) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1000	Stop	Common Application Found	Request_Device_...		Pass
2	PCRF_SessionControl.gls	PCRFProfile001	IMSI_001013012041631	Completed	Session Terminated	None		Pass

Stop Stop All Abort Abort All Show Records Select Active Call Auto Trash Trash

Save Column Width Show Latest

AF PCRF

AA-Request 12:52:17.745000

AA-Answer 12:52:17.785000

Session-Termination-Request 12:52:32.836000

Session-Termination-Answer 12:52:32.861000

```

===== Diameter Layer =====
0000 Version = 00000001 Diameter Version 1
0001 Length = 644 (x000284)
Command Flags =
0004 Request (R) = 1..... Message is Request
0004 Proxiable (P) = .0..... Message Locally Processed
0004 Error (E) = ..0..... Message Doesn't Contain
0004 Potentially Retransmitted Message (T) = ...0.... Cleared
0005 Command Code = x000109 AA-Request/Answer Command
0008 Application Identifiers = x01000014 Application-ID of the
000C Hop By Hop Identifier = 50108254 (x02FC975E)
0010 End To End Identifier = 3953330427 (xEBA308FB)
Session-Id =
AVP Code = x00000107 Session-Id
AVP Flags =
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = ..0..... Not Needed
Reserved (r) = ..00000
AVP Length = 63 (x00003F)
AVP Data = AF1.gls.com;5511740624;2;GL-MAPS-
Padding Octet = 00000000 (0)
Auth-Application-Id =
AVP Code = x00000102 Auth-Application-Id

```

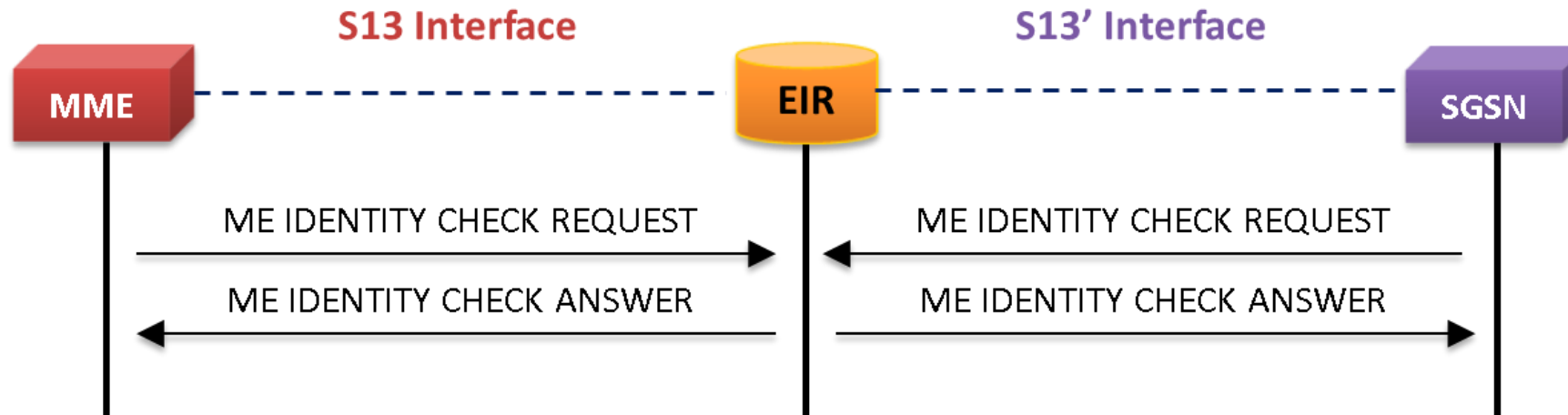
Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status Up=1

S13/S13' Interface Signaling Procedure

This procedure is mapped to the following commands in the Diameter application -

- ME-Identity-Check-Request (ECR) Command
- ME-Identity-Check-Answer (ECA) Command



S13/S13' Interface Call Generation and Reception

Call Generation at SGSN Node

The screenshot shows the MAPS SGSN interface for call generation. The main window displays a table with the following data:

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Itera...
1	ME-Identity-CheckProcedure.gls	SGSNProfile001	IMSI:.001013012041631.JMEI:.359877068325...	Start	ME-Identity-Check Successful:Whitelisted	None		Pass	1	1
2	ME-Identity-CheckProcedure.gls	SGSNProfile002		Start		None		Unknown	1	0

Below the table is a message sequence diagram showing the interaction between SGSN and EIR:

- SGSN sends ME-Identity-Check-Request to EIR at 12:57:44.237000.
- EIR responds with ME-Identity-Check-Answer to SGSN at 12:57:44.292000.

The right pane shows the Diameter Layer details for the received message:

```

===== Diameter Layer =====
0000 Version
0001 Length
Command Flags
0004 Request (R)
0004 Proxiable (P)
0004 Error (E)
0004 Potentially Retransmitted Message
0005 Command Code
0008 Application Identifiers
000C Hop By Hop Identifier
0010 End To End Identifier
Session-Id
AVP Code
AVP Flags
Vendor Specific Bit (V)
Mandatory Bit (M)
Encryption For End To End Security
Reserved (r)
AVP Length
AVP Data
Padding Octet
Padding Octet
    
```

Call Reception at PCRF Node

The screenshot shows the MAPS EIR interface for call reception. The main window displays a table with the following data:

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1000	Stop	Common Application Found	Request_Device_...		Pass
2	ME-Identity-CheckProced...	EIRProfile001	IMSI:.001013012041631.JM...	Completed	ME-Identity-Check Successful	None		Pass

Below the table is a message sequence diagram showing the interaction between SGSN and EIR:

- SGSN sends ME-Identity-Check-Request to EIR at 12:57:44.276000.
- EIR responds with ME-Identity-Check-Answer to SGSN at 12:57:44.283000.

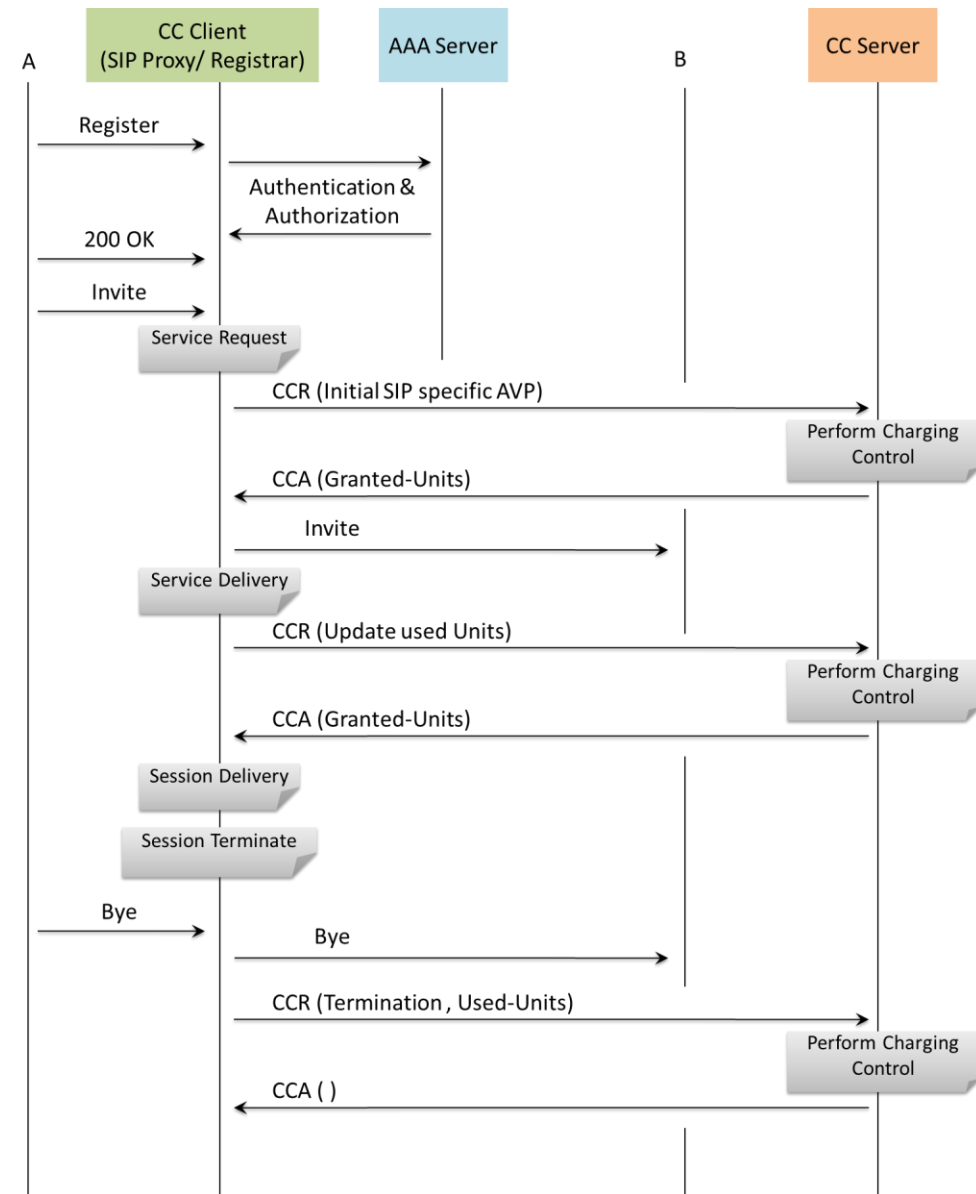
The right pane shows the Diameter Layer details for the received message:

```

===== Diameter Layer =====
0000 Version = 00000001 Diameter Version 1
0001 Length = 204 (x00011C)
Command Flags =
0004 Request (R) = 1..... Message is Request
0004 Proxiable (P) = .1..... Message Proxied, Relayed or Redirected
0004 Error (E) = ..0..... Message Doesn't Contain Protocol Error
0004 Potentially Retransmitted Message (I) = ..0..... Cleared
0005 Command Code = x000144 ME-Identity-Check Request/Answer
0008 Application Identifiers = x01000024 Application-ID of the S13/S13' interfa
000C Hop By Hop Identifier = 3839785280 (xE4DE7940)
0010 End To End Identifier = 1161853404 (x44A7E35C)
Session-Id
AVP Code = x00000107 Session-Id
AVP Flags
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = ..0..... Not Needed
Reserved (r) = ..000000
AVP Length = 66 (x000042)
AVP Data = SGSN1@gl.com;4064823282;2;GL-MAPS-2-2239147328-1
Padding Octet = 00000000 (0)
Padding Octet = 00000000 (0)
Vendor-Specific-Application-Id =
    
```

Gy Interface Signaling Procedures

- The PCEF node in LTE network, and CSCF node in IMS network perform the role of a Charging Trigger Function (CTF) entity to issue charging events to an Online Charging System (OCS)
- The charging events can be immediate (IEC), event-based (ECUR), or session-based (SCUR)



Gy Interface Call Generation and Reception

Call Generation at PDN GateWay Node

The screenshot shows the MAPS PDN GateWay interface for call generation. The top table lists three script executions:

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	PGW_SessionControl.gls	PGWProfile0001	IMSI_001013012041631	Start	Session-Terminated	None		Pass	1	1
2	PGW_SessionControl.gls	PGWProfile0002		Start		None		Unknown	1	0
3	PGW_SessionControl.gls	PGWProfile0003		Start		None		Unknown	1	0

The message sequence shows a series of Credit-Control-Request and Credit-Control-Answer messages between PGW and OCS nodes. The detailed log on the right shows the following Diameter Layer messages:

```

0000 Version = 00000001 Diameter Version 1
0001 Length = 476 (x0)
0004 Command Flags = 1.....
0004 Request (R) = .0.....
0004 Proxiable (P) = .0.....
0004 Error (E) = ..0....
0004 Potentially Retransmitted Message (T) = ..0....
0005 Command Code = x000110
0008 Application Identifiers = x00000004
000C Hop By Hop Identifier = 218604137
0010 End To End Identifier = 3908285937
Session-Id = x00000107
AVP Code = x00000107
AVP Flags = 0.....
Vendor Specific Bit (V) = 0.....
Mandatory Bit (M) = .0.....
Encryption For End To End Security (P) = ..0....
Reserved (r) = ..00000
AVP Length = 65 (x000041)
AVP Data = PGW1@gl
Padding Octet = 00000000 (0)
Origin-Host = x00000108
AVP Code = x00000108
AVP Flags = 0.....
Vendor Specific Bit (V) = 0.....
  
```

Call Reception at OCS Node

The screenshot shows the MAPS OCS interface for call reception. The top table lists two script executions:

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1000	Stop	Common Application Found	Request_Device...		Pass
2	OCS_SessionControl.gls	OCSProfile0001	001013012041631	Completed	Session Terminated	None		Pass

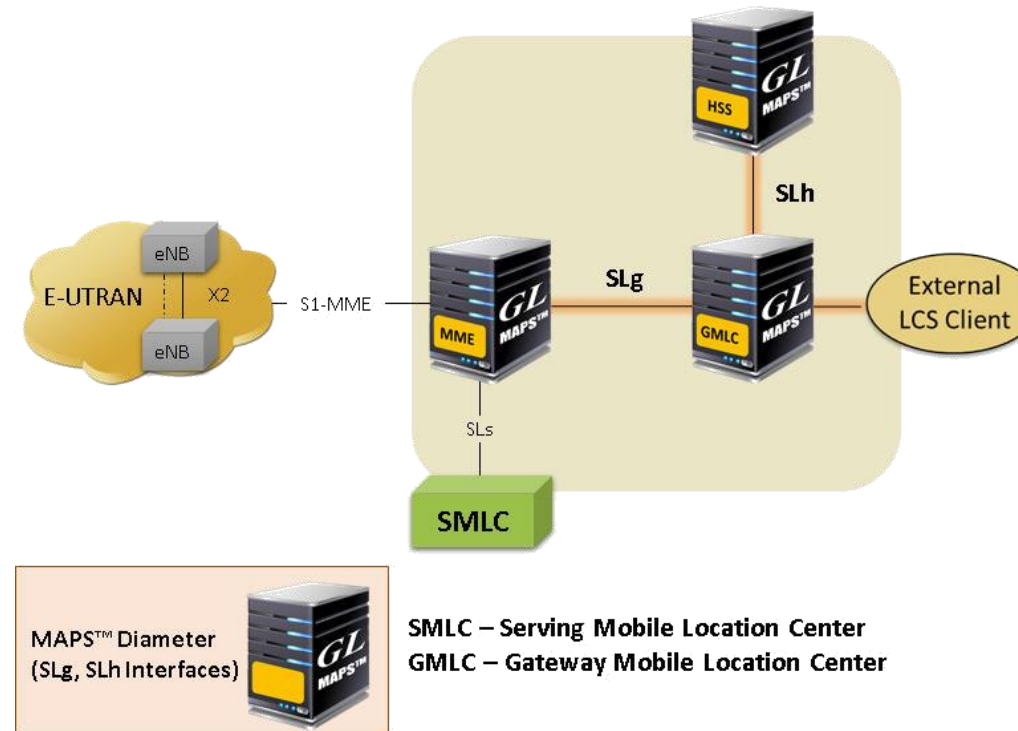
The message sequence shows a series of Credit-Control-Request and Credit-Control-Answer messages between PGW and OCS nodes. The detailed log on the right shows the following Diameter Layer messages:

```

0000 Version = 00000001 Diameter Version 1
0001 Length = 476 (x0001DC)
0004 Command Flags = 1..... Message is Request
0004 Request (R) = .0..... Message Locally Processed
0004 Proxiable (P) = .0..... Message Doesn't Contain Protocol Er
0004 Error (E) = ..0.... cleared
0004 Potentially Retransmitted Message (T) = ..0....
0005 Command Code = x000110 Credit-Control-Request/Answer Message
0008 Application Identifiers = x00000004 Application-ID of the Gy interface
000C Hop By Hop Identifier = 218604137 (x0D07A269)
0010 End To End Identifier = 3908285937 (x28F3B5F1)
Session-Id = x00000107
AVP Code = x00000107
AVP Flags = 0.....
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .0..... Support Of AVP Not Required
Encryption For End To End Security (P) = ..0.... Not Needed
Reserved (r) = ..00000
AVP Length = 65 (x000041)
AVP Data = PGW1@gl.com;5835844236;2;GL-MAPS-3-224630826
Padding Octet = 00000000 (0)
Padding Octet = 00000000 (0)
Padding Octet = 00000000 (0)
Origin-Host = x00000108
AVP Code = x00000108
AVP Flags = 0.....
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
  
```

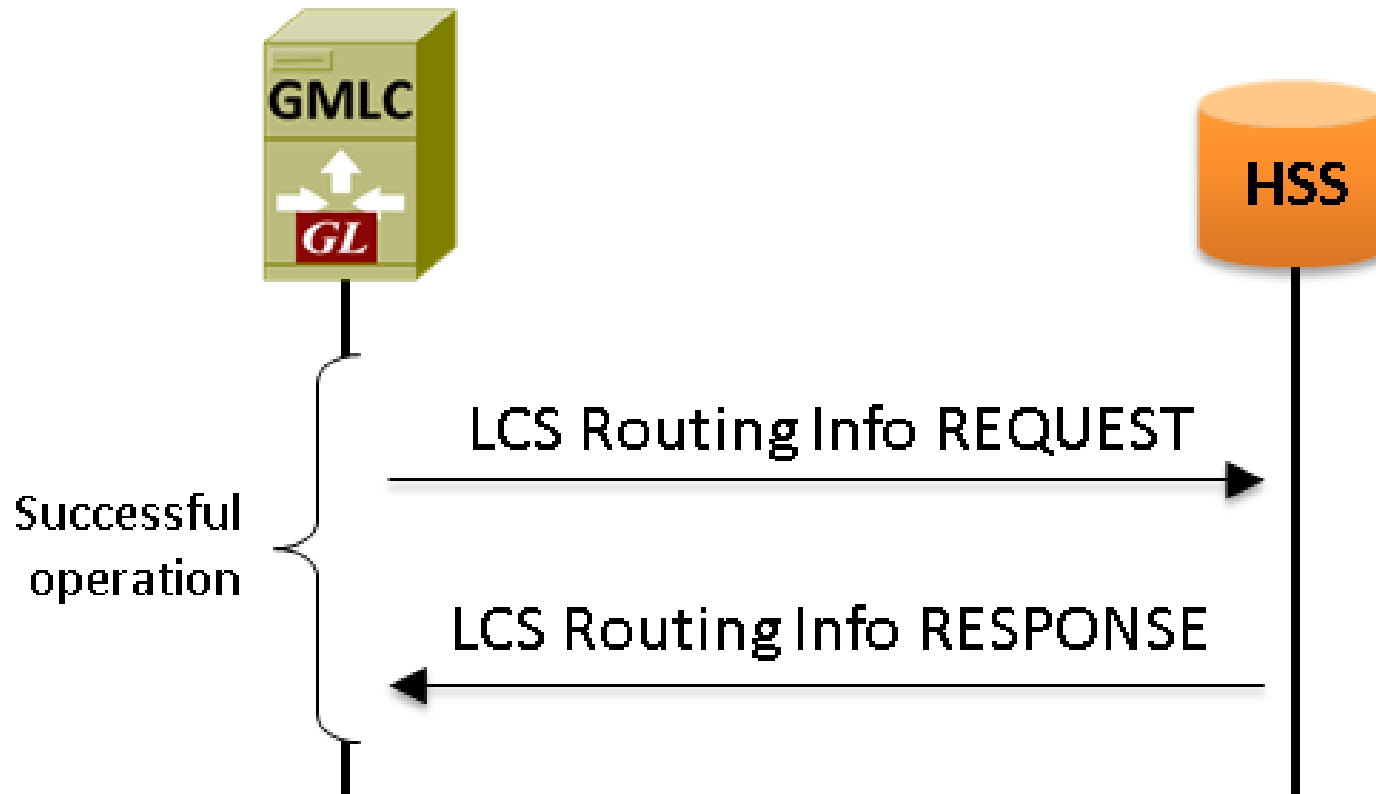
Location Services (LCS) Architecture

- SLh, SLg Interfaces
- MAPS™ Diameter supports Location Service (LCS) based SLh and SLg interfaces
- Between the GMLC <-> HSS is SLh interface and between GMLC <->MME is SLg interface



SLh Interface Signaling Procedure

- MAPS™ Diameter Emulator can be configured as GMLC (Gateway Mobile Location center), and HSS (Home Subscriber Server) in SLh interface
- Capable to connect the corresponding access network and the access network will provide the positioning of the UE



SLh Interface Call Generation and Reception

Call Generation at GMLC Node

MAPS GMLC (Diameter SLh) - [Call Generation - CallGenDefault]

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	SLh_Procedure_GMLC.gls	GMLCProfile0001	IMSI:.001013012041631	Start	Send-Routing-Info received	None		Pass	1	1
2	SLh_Procedure_GMLC.gls	GMLCProfile0002		Start		None		Unknown	1	0
3	SLh_Procedure_GMLC.gls	GMLCProfile0003		Start		None		Unknown	1	0
4	SLh_Procedure_GMLC.gls	GMLCProfile0004		Start		None		Unknown	1	0
5	SLh_Procedure_GMLC.gls	GMLCProfile0005		Start		None		Unknown	1	0
6	SLh_Procedure_GMLC.gls	GMLCProfile0006		Start		None		Unknown	1	0

Message Sequence Diagram: GMLC to HSS. LCS-Routing-Info-Request (15:05:03.953000) and LCS-Routing-Info-Answer (15:05:04.096000).

Call Reception at HSS Node

MAPS HSS (Diameter SLh) - [Call Reception]

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1000	Stop	Common Application Found	Request_Device...		Pass
2	SLh_Procedures_HSS.gls	HSSProfile0001	IMSI:.001013012041631	Completed	Location-Report-Answer Sent	None		Pass

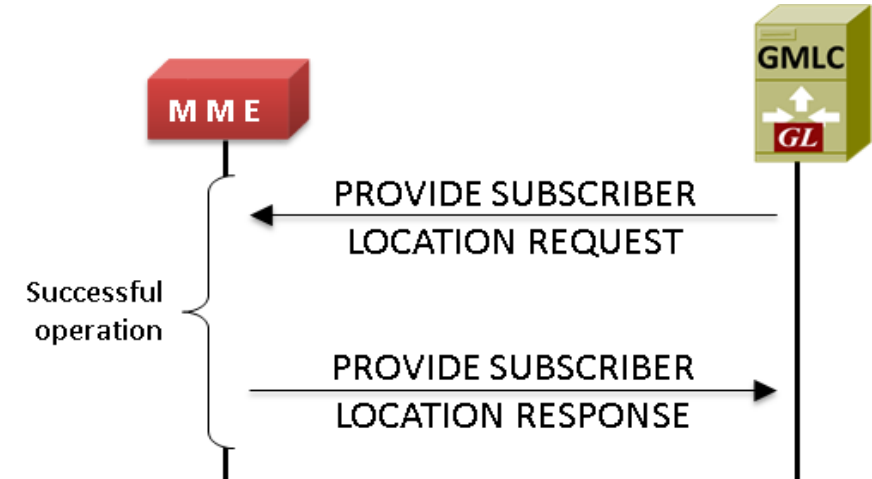
Message Sequence Diagram: GMLC to HSS. LCS-Routing-Info-Request (15:05:04.052000) and LCS-Routing-Info-Answer (15:05:04.087000).

```
=====  
Diameter Layer  
=====  
0000 Version = 00000001 Diameter Version 1  
0001 Length = 204 (x0000CC)  
Command Flags =  
0004 Request (R) = 1..... Message is Request  
0004 Proxiable (P) = .0..... Message Locally Processed  
0004 Error (E) = ..0..... Message Doesn't Contain Protocol E  
0004 Potentially Retransmitted Message (T) = ..1..... Possible Duplicate Due to Link Fai  
0005 Command Code = x80000E LCS-Routing-Info-Request/Answer  
0008 Application Identifiers = x0100004B Application-ID of the SLh interfa  
000C Hop By Hop Identifier = 3671355190 (xDAD46F36)  
0010 End To End Identifier = 2461976532 (x92BEC7D4)  
Session-Id =  
AVP Code = x00000107 Session-Id  
AVP Flags =  
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present  
Mandatory Bit (M) = .1..... Support Of AVP Required  
Encryption For End To End Security (P) = ..0..... Not Needed  
Reserved (z) = ..000000  
AVP Length = 66 (x000042)  
AVP Data = GMLC1@g1.com;4999792912;2;GL-MAPS-3-2246787  
Padding Octet = 00000000 (0)  
Origin-Host = 00000000 (0)  
AVP Code = x00000108 Origin-Host  
AVP Flags =  
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
```

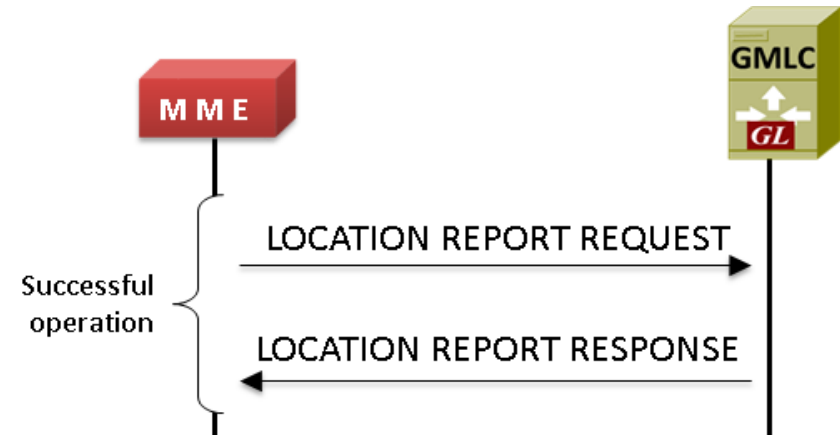
SLg Interface Signaling Procedure

- MAPS™ Diameter Emulator can be configured as GMLC (Gateway Mobile Location Center), and MME (Mobile Management Entity) in SLg interface
- Designed to estimate a location of the server and receive the exact location from the entity

Provide Subscriber Location Info (SLg)



Subscriber Location Report (SLg)



SLg Interface Call Generation and Reception

Call Generation at GMLC Node

The screenshot shows the MAPS GMLC (Diameter SLg) interface. The main window displays a table of call generation records:

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	SLg_Procedure_GMLC.gls	GMLCProfile0001	IMSI: 001013012041631	Start	Provide-Location-Answer received	None		Pass	1	1
2	SLg_Procedure_GMLC.gls	GMLCProfile0002		Start		None		Unknown	1	0
3	SLg_Procedure_GMLC.gls	GMLCProfile0003		Start		None				
4	SLg_Procedure_GMLC.gls	GMLCProfile0004		Start		None				

Below the table, a sequence diagram illustrates the interaction between GMLC and MME:

```

sequenceDiagram
    participant GMLC
    participant MME
    Note over GMLC, MME: Provide-Location-Request
    GMLC->>MME: Provide-Location-Request
    Note over MME: 15:35:56.997000
    MME-->>GMLC: Provide-Location-Answer
    Note over GMLC: 15:35:57.149000
    
```

The diagram shows a 'Provide-Location-Request' message from GMLC to MME at 15:35:56.997000, followed by a 'Provide-Location-Answer' message from MME to GMLC at 15:35:57.149000.

Call Reception at MME Node

The screenshot shows the MAPS MME (Diameter SLg) interface. The main window displays a table of call reception records:

Sr No	Script Name	Profile	Call Info	Script Execut...	Status	Events	Events Profile	Results
1	Diameter_Base.gls		1	Stop	Common Application Found	Request_Device...		Pass
2	SLg_Procedures_MME.gls	MMEProfile0001	IMSI: 001013012041631	Completed	Provide-Location-Response sent	None		Pass

Below the table, a sequence diagram illustrates the interaction between GMLC and MME:

```

sequenceDiagram
    participant GMLC
    participant MME
    Note over GMLC, MME: Provide-Location-Request
    GMLC->>MME: Provide-Location-Request
    Note over MME: 15:35:57.119000
    MME-->>GMLC: Provide-Location-Answer
    Note over GMLC: 15:35:57.140000
    
```

The diagram shows a 'Provide-Location-Request' message from GMLC to MME at 15:35:57.119000, followed by a 'Provide-Location-Answer' message from MME to GMLC at 15:35:57.140000.

The interface also displays a detailed log of the Diameter message exchange:

```

===== Diameter Layer =====
0000 Version = 00000001 Diameter Version 1
0001 Length = 304 (x000130)
Command Flags =
0004 Request (R) = 1..... Message is Request
0004 Proxiable (P) = .0..... Message Locally Processed
0004 Error (E) = .0..... Message Doesn't Contain Protocol Er
0004 Potentially Retransmitted Message (T) = ...1.... Possible Duplicate Due to Link Fail
0005 Command Code = x80000C Provide-Location-Request/Answer
0008 Application Identifiers = x01000027 Application-ID of the SLg interfac
000C Hop By Hop Identifier = 3435285535 (x0CC24C1F)
0010 End To End Identifier = 4172751943 (xF8B72447)
Session-Id =
AVP Code =
AVP Flags =
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = .0..... Not Needed
Reserved (r) = ...00000
AVP Length = 66 (x000042)
AVP Data = GMLC18gl.com;3818059110;2;GL-MAPS-3-22486410
Padding Octet = 00000000 (0)
Padding Octet = 00000000 (0)
Auth-Session-State =
AVP Code = x00000115 Auth-Session-State
AVP Flags =
Vendor Specific Bit (V) = 0..... Vendor ID Field Not Present
Mandatory Bit (M) = .1..... Support Of AVP Required
Encryption For End To End Security (P) = .0..... Not Needed
Reserved (r) = ...00000
AVP Length = 12 (x00000C)
AVP Data =

```

Testbed Setup Configuration

The screenshot shows the MAPS MME (Diameter S6A) configuration window. The main window is titled "Testbed Setup - TestBedDefault" and contains a configuration tree on the left and a parameter list on the right. The configuration tree is expanded to show the following structure:

- Config
 - MME Interfaces
 - Transport Type: SCTP
 - Transport Mode: Client
 - Interface: 1
 - Interface 1
 - MME Parameters
 - MME IP Address: 192.168.12.195
 - MME Port: 3868
 - MME Host: MME@gl.com
 - MME Realm: gl.com
 - Destination Node Parameters
 - Destination Node: HSS
 - Destination IP Address: 192.168.12.219
 - Destination Port: 3868
 - Destination Host: HSS@gl.com
 - Destination Realm: gl.com
 - UE Simulation Configuration
 - Type Of UE Simulation: Profiles
 - Data Base Path: \\192.168.13.2\DataBase\450 ...
 - CSV FileName: C:\Program Files\GL Comm...
 - End User Configuration for Profile: MME_Profiles.xml

The right pane shows a table with the following data:

Config	Value	Enable
<input checked="" type="checkbox"/>		<input checked="" type="checkbox"/>

At the bottom of the right pane, there are "Start" and "Edit" buttons. The status bar at the bottom of the window shows "Initialisation Errors".

Profile Configuration

The screenshot displays the 'MAPS MME (Diameter S6A) - [Profile Editor -MME_Profiles]' application window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar with various icons. On the left, a list of profiles is shown, with 'MMEProfile0001' selected. The main area displays a tree view of configuration parameters for the selected profile, with a corresponding table of values. A right-hand pane shows the 'Enable' checkbox checked and buttons for 'Add', 'Insert', 'Delete', and 'Properties'. At the bottom, there are 'Insert', 'Delete', and 'Clear' buttons, and status indicators for 'Initialisation Errors' and 'Error Events'.

#	Profiles (Edit-F2)	Config	Value	Enable
1	MMEProfile0001	MMEProfile0001		<input checked="" type="checkbox"/>
2	MMEProfile0002			
3	MMEProfile0003			
4	MMEProfile0004			
5	MMEProfile0005			
6	MMEProfile0006			
7	MMEProfile0007			
8	MMEProfile0008			
9	MMEProfile0009			
10	MMEProfile0010			
11	MMEProfile0011			
12	MMEProfile0012			
13	MMEProfile0013			
14	MMEProfile0014			
15	MMEProfile0015			
16	MMEProfile0016			
17	MMEProfile0017			
18	MMEProfile0018			
19	MMEProfile0019			
20	MMEProfile0020			
21	MMEProfile0021			
22	MMEProfile0022			
23	MMEProfile0023			
24	MMEProfile0024			

Config	Value
MMEProfile0001	
Connection Identifier	1
Subscriber Info	
IMSI	001013012041631
MSISDN	3012041631
IMEI	359877068325248
User Id	4041098859
Authentication Parameters	
Requested Authentication Info	Both EUTRAN/UTRAN-...
Immediate response preferred for Do...	UTRAN-GERAN
Number Of Authentication Vectors	1
Authentication Vectors	
Authentication Algorithm Type	Milenage
RES Length	16 bytes
KEY	00112233445566778899...
Operator Variant Parameter Type	OPc
OP	01020304050607080910...
OPc	01020304050607080910...
SQN	000000000079
AMF	8000
Visited PLMN Ids	
MCC	001
MNC	01
EPS Location Information	
MCC	001
MNC	01
TAC	1000
E Utran Cell Id	122
RAT Type	EUTRAN
Software Version	001
Alert Reason	UE_PRESENT
UE SRVCC Capability	SUPPORTED

Incoming Call Handler Configuration

The screenshot displays the 'Incoming Call Handlers Configuration' window in the MAPS HSS (Diameter S6A) application. The window title is 'MAPS HSS (Diameter S6A) - [Incoming Call Handlers Configuration - default]'. The menu bar includes 'Configurations', 'Emulator', 'Reports', 'Editor', 'Debug Tools', 'Windows', and 'Help'. The toolbar contains various icons for file operations and system functions.

The main area is divided into three sections:

- Message Name / Script Name Table:** A table with two columns. The first column lists message names, and the second column lists the corresponding script names.
- Scripts List:** A list box showing the selected script, 'HSS_SessionControl.gls'. To the right of this list are radio buttons for 'Sequence' (selected) and 'Random'.
- Control Buttons:** 'Up' and 'Down' buttons are located to the right of the Scripts list. 'Add' and 'Delete' buttons are located below the Scripts list. At the bottom of the window, there are 'Add', 'Delete', 'Apply Scripts', and 'Clear Scripts' buttons.

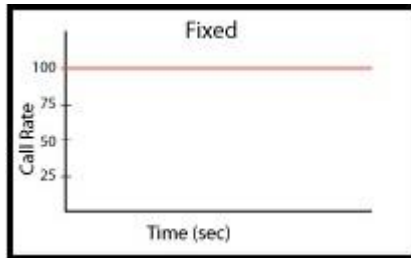
The status bar at the bottom right shows 'Initialisation Errors' and 'Error Events'.

Message Name	Script Name
Authentication-Information-Request	HSS_SessionControl.gls
Update-Location-Request	HSS_SessionControl.gls
Notify-Request	HSS_SessionControl.gls
Purge-UE-Request	HSS_SessionControl.gls
Capabilities-Exchange-Request	Diameter_Base.gls
Device-Watchdog-Request	Diameter_Base.gls
Disconnect-Peer-Request	Diameter_Base.gls
Reset-Request	RSA_Rx.gls
Accounting-Request	SplitAccounting.gls

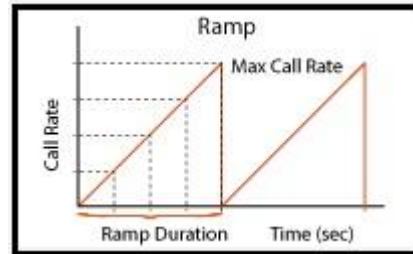
Load Generation

- 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.

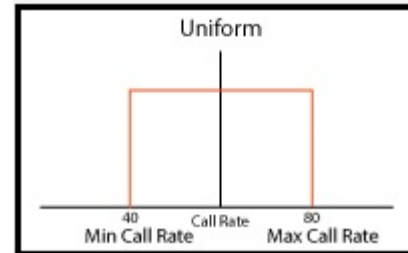
Fixed



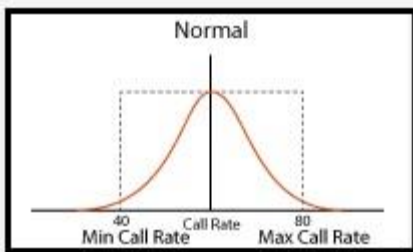
Ramp



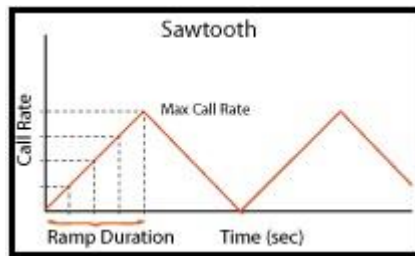
Uniform



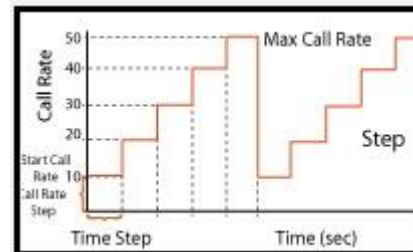
Normal



Saw-tooth



Step



The screenshot shows the 'Load Generation - LoadGendefault' software interface. It includes a title bar, a toolbar, and several configuration sections. The 'Total Calls To Generate' is set to '*' (no limit), and 'Max Active Calls' is set to 2000. The 'Unique Distributions Per Script' checkbox is checked. The 'Multi Distributions' section is checked, and a table lists three distributions: Uniform, Fixed, and Normal. The 'Scripts' section lists 'MME_SessionControl'. The 'Profile' section lists 14 profiles from MMEProfile0001 to MMEProfile0014. The 'Add' and 'Delete' buttons are visible. The 'Stop Time' section is unchecked, and the 'Start Time' and 'End Time' are both set to -00:00:00.000.

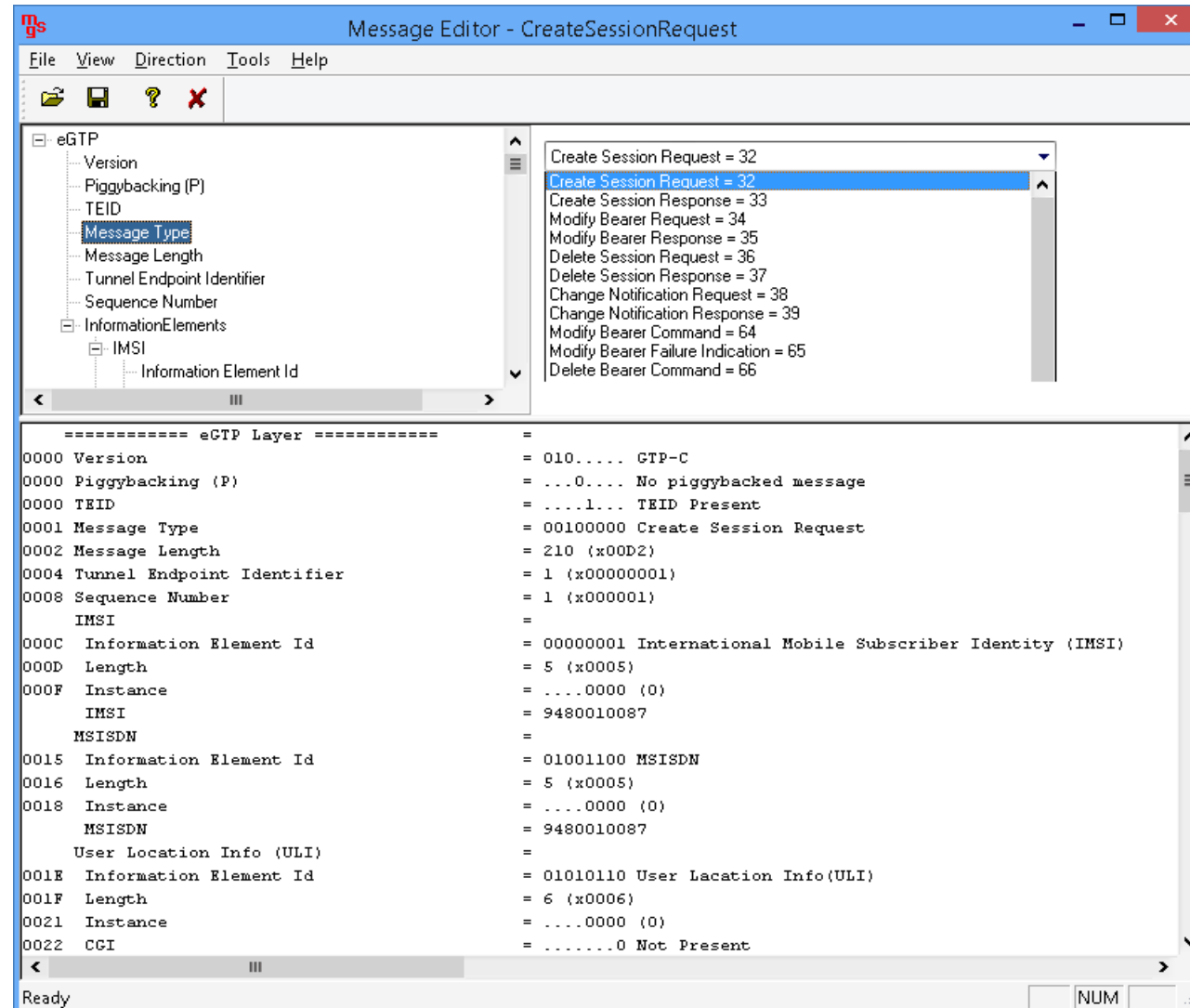
Distributions	Description
Uniform	MinCR=40 , MaxCR=80 , Duration=10
Fixed	Call Rate=100 , Duration=10
Normal	MinCR=40 , MaxCR=80 , Duration=10

Scripts	Profile
MME_SessionControl	MMEProfile0001
	MMEProfile0002
	MMEProfile0003
	MMEProfile0004
	MMEProfile0005
	MMEProfile0006
	MMEProfile0007
	MMEProfile0008
	MMEProfile0009
	MMEProfile0010
	MMEProfile0011
	MMEProfile0012
	MMEProfile0013
	MMEProfile0014

Customizations - Call Flow (Scripts)

```
ScriptEditor - [C:\Program Files\GL Communications Inc\MAPS-Diameter\MAPS\Diameter\S6A\MME\Scripts\MME_SessionControl.gls]
File View Edit Shortcuts Tools Help
Command Window
MME_SessionControl
1 //*****Initializing Parameters *****
2 LogActiveCallInfoTimeOut = (60000+_ResponseTimeOut);
3 starttimer LogActiveCallInfoTimer LogActiveCallInfoTimeOut msec;
4 S6AMMEScriptId = "S6A_MME";
5 State="Null";
6 //ReportEvent(DiameterSession="Diameter Session Started");
7 ReportEvent(Script = "Running");
8 // _EnableCLI=1;
9 //*****Handling Received Messages *****
10
11 if (MessageType=="Cancel-Location-Request")
12     IsReception=1;
13     StartChildScript (S6AMMEScriptId,"","S6a_MME.gls","",IsReception=IsRecept
14 else
15     IsGeneration=1;
16     InterfaceId=(ConnectionIdentifier-1);
17     starttimer UserEventTimer 1 msec;
18 endif
19
20 wait;
21
22 "UserEventTimerExpiry":
23     StartChildScript (S6AMMEScriptId,"","S6a_MME.gls",LoadedProfileName,IsGer
24     if (MessageType=="Cancel-Location-Request")
25         StartChildScript (S6AMMEScriptId,"","S6a_MME.gls",LoadedProfileName,
26     endif
27     if(_AuthenticationProcedures==1)
28         (S6AMMEScriptId)goto "DiameterAuthenticateUser";
29     elseif(_UpdateLocationProcedures==1)
30         (S6AMMEScriptId) goto "DiameterUpdateLocation";
31     elseif(_PurgingProcedure==1)
32         (S6AMMEScriptId) goto "DiameterPurgeUERRequest";
33     endif
34     resume;
35
36
Line Count - 420 | Line : 1 Col : 1
```


Customizations - Protocol Messages

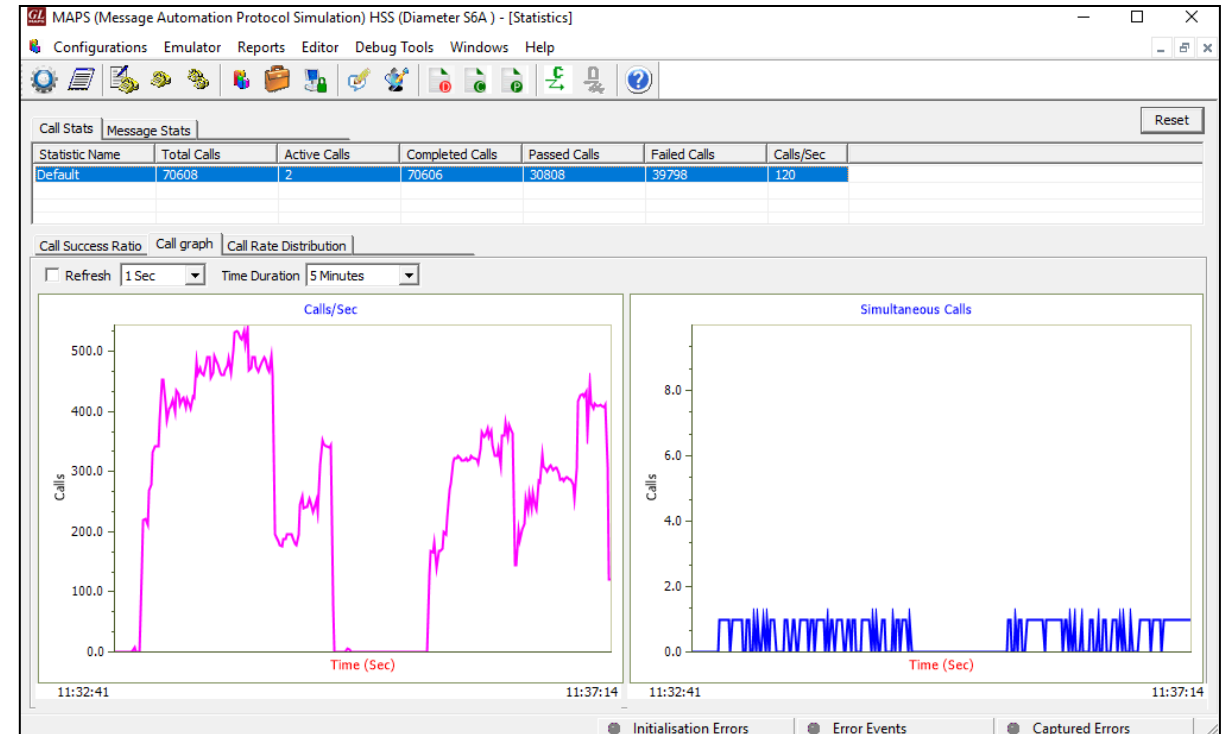
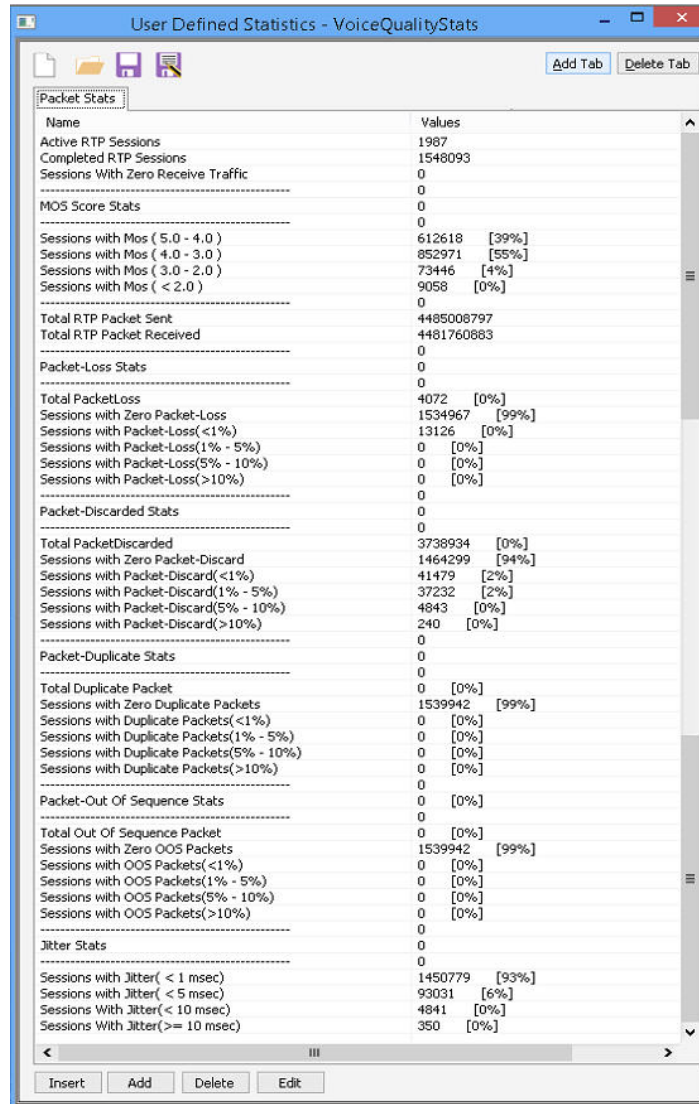


The screenshot shows the 'Message Editor - CreateSessionRequest' window. The left pane displays a tree view of the eGTP message structure, with 'Message Type' selected. The right pane shows a list of message types, with 'Create Session Request = 32' selected. The main area displays a hex dump of the message structure.

```
===== eGTP Layer =====  
0000 Version = 010..... GTP-C  
0000 Piggybacking (P) = ...0.... No piggybacked message  
0000 TEID = ....1... TEID Present  
0001 Message Type = 00100000 Create Session Request  
0002 Message Length = 210 (x00D2)  
0004 Tunnel Endpoint Identifier = 1 (x00000001)  
0008 Sequence Number = 1 (x000001)  
IMSI  
000C Information Element Id = 00000001 International Mobile Subscriber Identity (IMSI)  
000D Length = 5 (x0005)  
000F Instance = ....0000 (0)  
IMSI = 9480010087  
MSISDN  
0015 Information Element Id = 01001100 MSISDN  
0016 Length = 5 (x0005)  
0018 Instance = ....0000 (0)  
MSISDN = 9480010087  
User Location Info (ULI)  
001E Information Element Id = 01010110 User Location Info (ULI)  
001F Length = 6 (x0006)  
0021 Instance = ....0000 (0)  
0022 CGI = .....0 Not Present
```

Customizations - Statistics and Reports

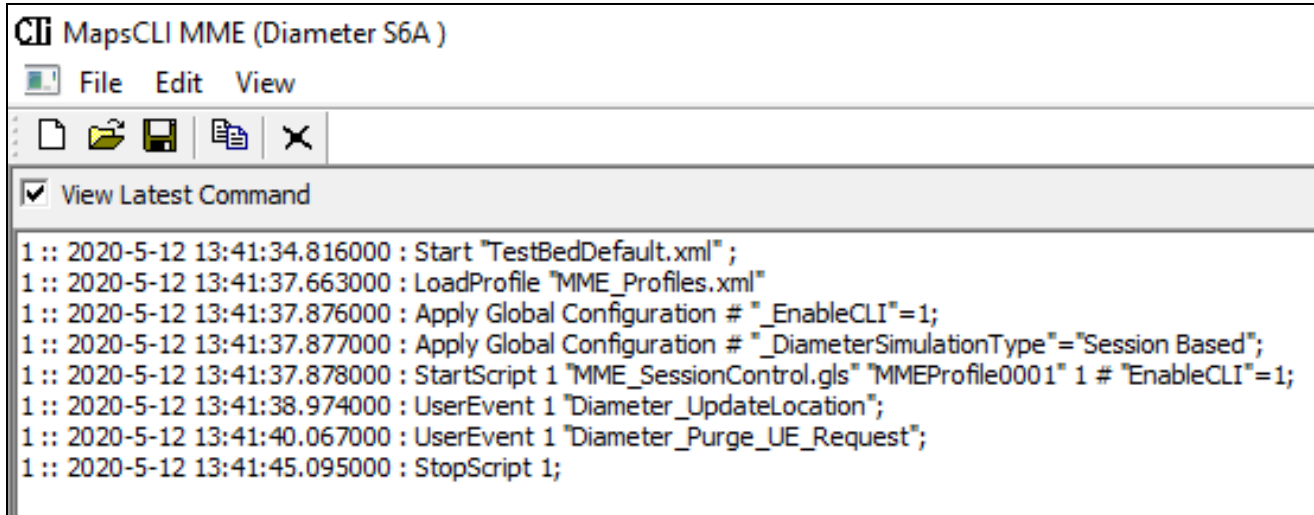
- MOS, R-Factor
- Packet Loss
- Packets Discarded
- Duplicate Packets
- Out-Of-Sequence Packets
- Jitter Statistics



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

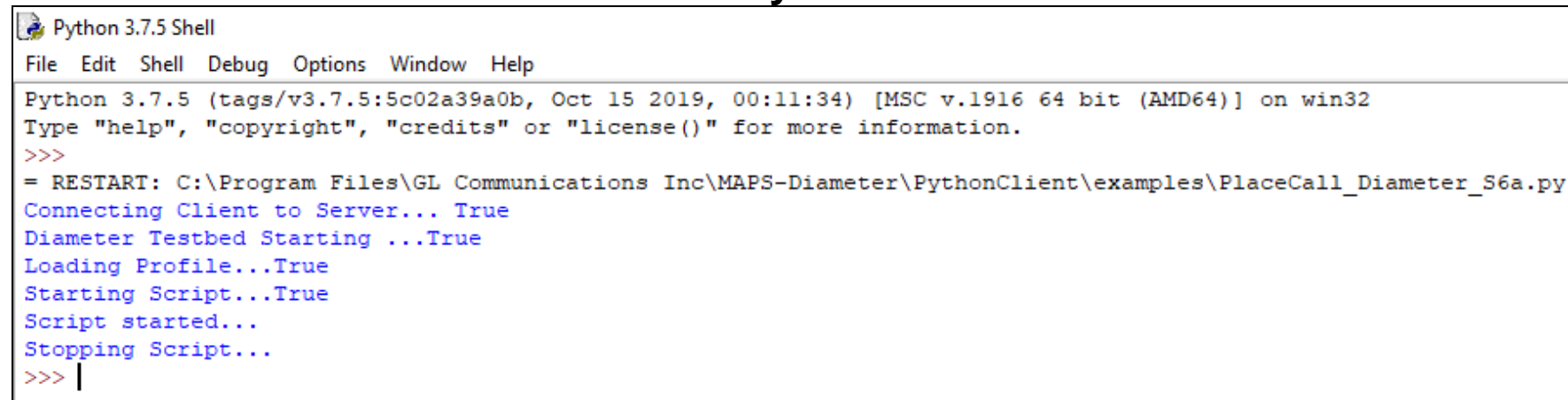
Command Line Interface

MAPS™ CLI Server



```
1 :: 2020-5-12 13:41:34.816000 : Start "TestBedDefault.xml" ;
1 :: 2020-5-12 13:41:37.663000 : LoadProfile "MME_Profiles.xml"
1 :: 2020-5-12 13:41:37.876000 : Apply Global Configuration # "_EnableCLI"=1;
1 :: 2020-5-12 13:41:37.877000 : Apply Global Configuration # "_DiameterSimulationType"="Session Based";
1 :: 2020-5-12 13:41:37.878000 : StartScript 1 "MME_SessionControl.gls" "MMEProfile0001" 1 # "EnableCLI"=1;
1 :: 2020-5-12 13:41:38.974000 : UserEvent 1 "Diameter_UpdateLocation";
1 :: 2020-5-12 13:41:40.067000 : UserEvent 1 "Diameter_Purge_UE_Request";
1 :: 2020-5-12 13:41:45.095000 : StopScript 1;
```

Python Client



```
Python 3.7.5 (tags/v3.7.5:5c02a39a0b, Oct 15 2019, 00:11:34) [MSC v.1916 64 bit (AMD64)] on win32
Type "help", "copyright", "credits" or "license()" for more information.
>>>
= RESTART: C:\Program Files\GL Communications Inc\MAPS-Diameter\PythonClient\examples\PlaceCall_Diameter_S6a.py
Connecting Client to Server... True
Diameter Testbed Starting ...True
Loading Profile...True
Starting Script...True
Script started...
Stopping Script...
>>> |
```

Thank you