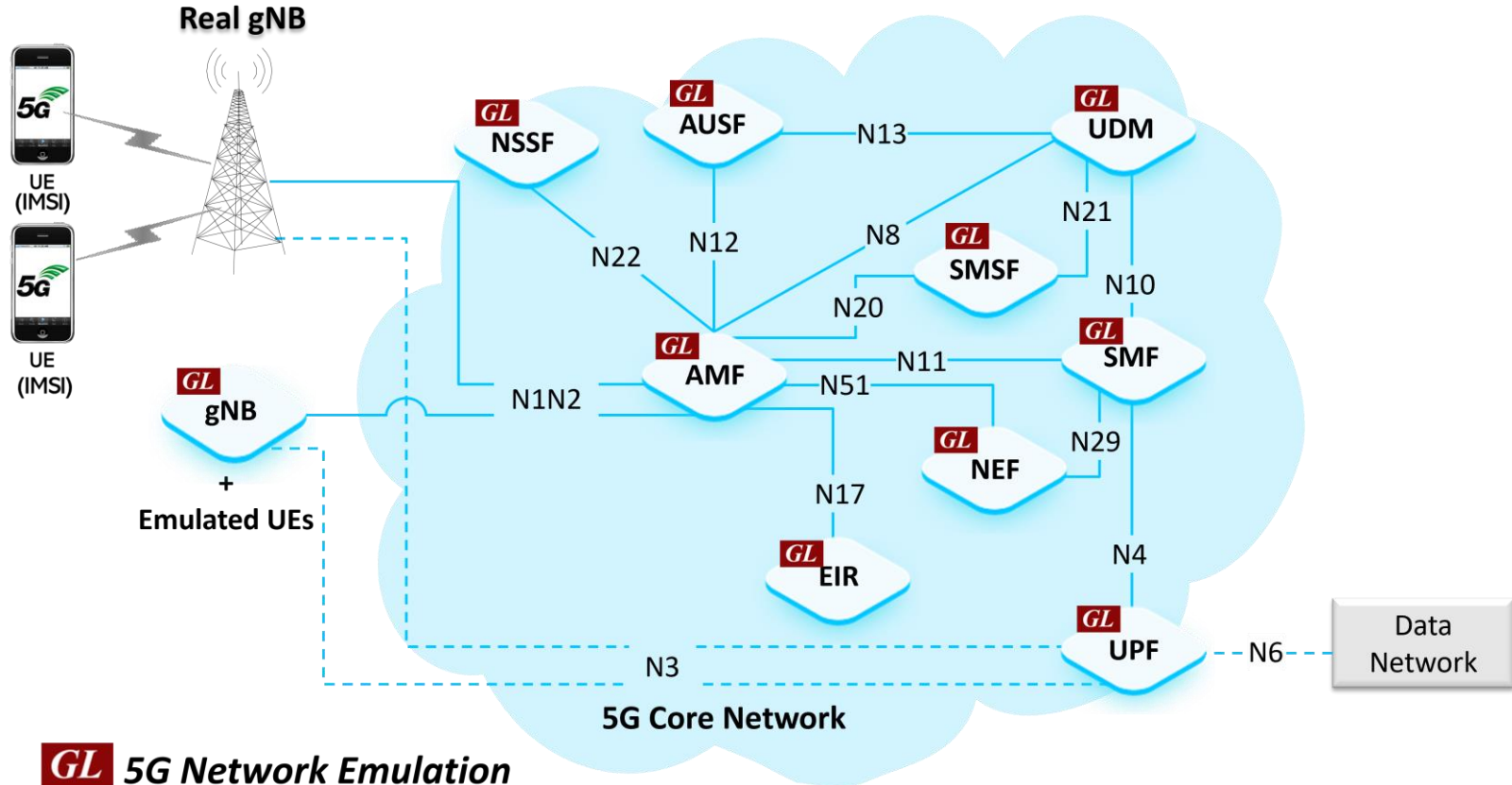

MAPS™ 5G N11 Interface Emulator



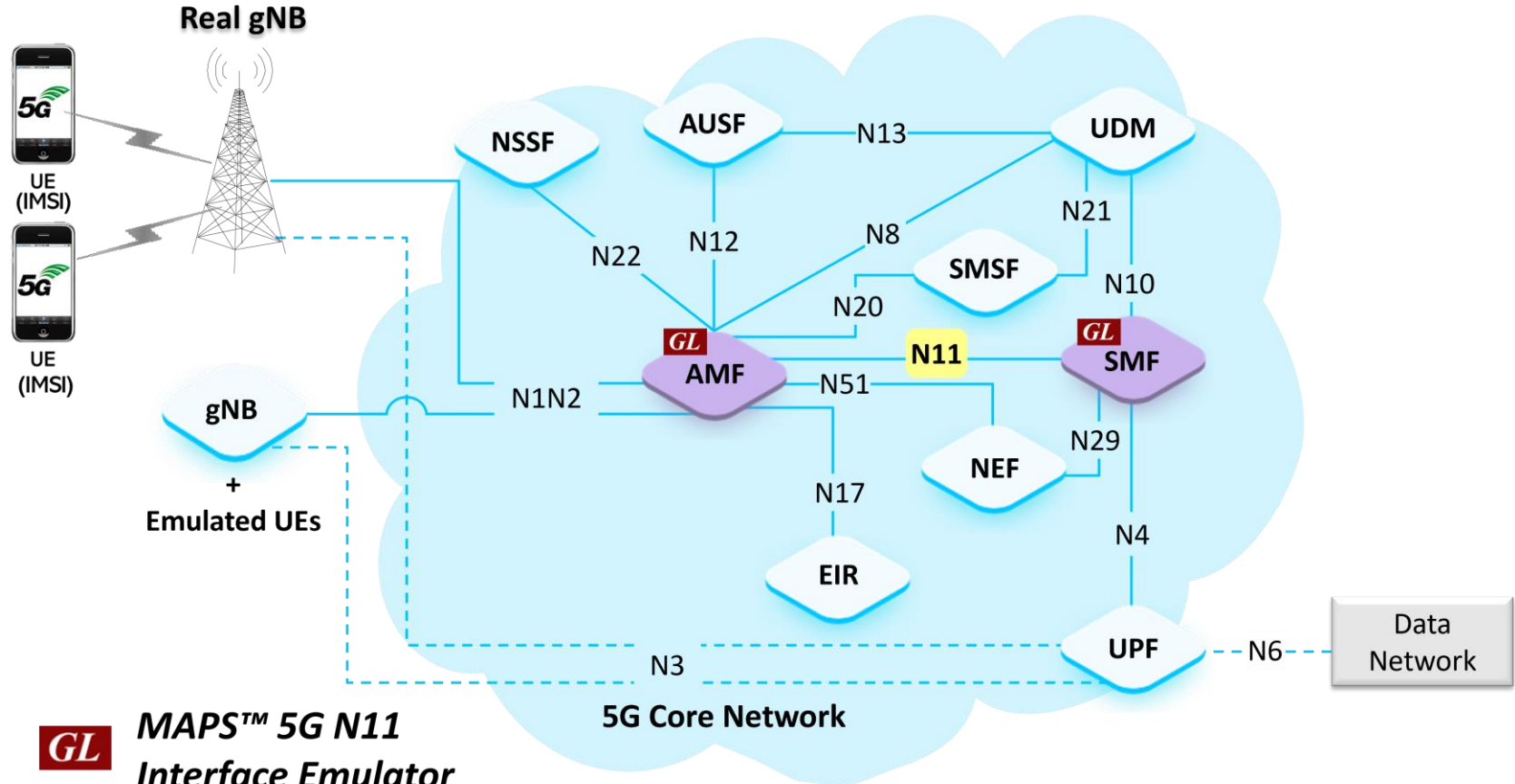
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

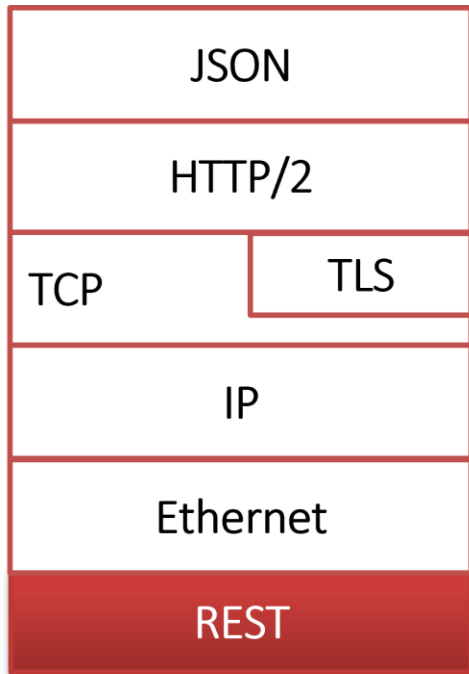
MAPS™ 5G N11 Interface



Main Features

- Emulate Session Management Function (SMF) and Access and Mobility Management Function (AMF) elements
- Supported Procedures are-
 - Nsmf_PDUSession Services
 - Namf_Communication Services
- Services use REST APIs based on HTTP and JSON data format
- Supports Command Line Interface (CLI) through a client-server model, enabling users to control all features via Python APIs
- Supports TLS and TCP transports
- Supports scripted call generation and automated call reception
- Supports customization of call flow and message templates using Script and JSON messages
- Ready-to-use scripts for quick testing
- Provides Call Statistics and Events Status
- Automation, Remote access, and Schedulers to run tests 24/7

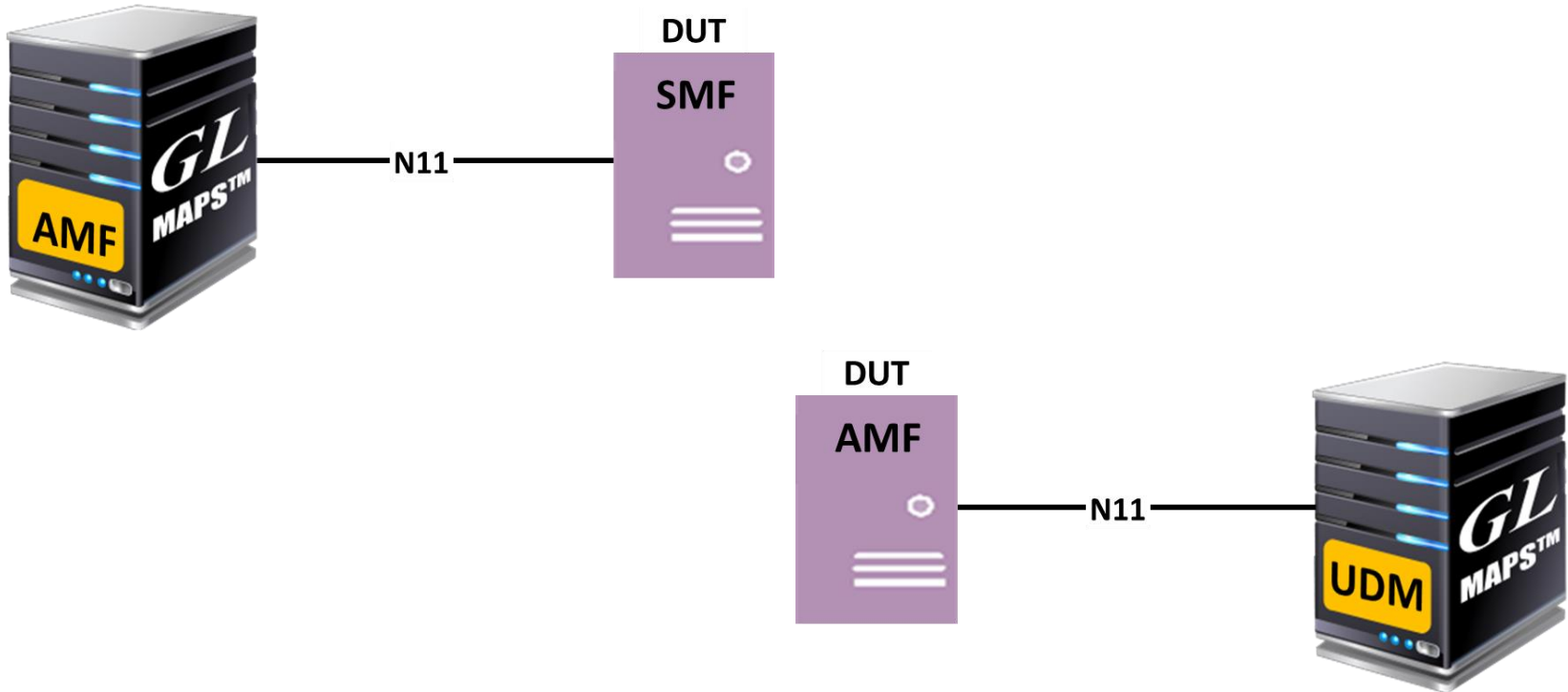
Protocol Stack Specification



Supported Protocols	Standard / Specification Used
N11 Interface (SMF - AMF)	TS29.502 (Release 17)
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP / 2 (Hypertext Transfer Protocol)	3GPP TR 21.905 (Release 17) IETF RFC 7540 IETF RFC 7232 IETF RFC 7234
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

MAPS™5G N11 User Cases

- MAPS™ can emulate any one node (AMF/SMF) or both AMF and SMF nodes



Testbed Setup (AMF)

GL MAPS AMF (N11 RELEASE17) - [Testbed Setup - TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config Value

☒ Enable

AMF Configurations

- AMF
 - AMF 1
 - AMF IP Address: 192.168.12.170
 - AMF Server Port: 6666
 - AMF Client Name: Client1
 - URI Scheme: HTTP
 - Traffic Adapter Index: 0
 - GTP Tunnel IP Address: 192.168.12.170
 - AMF API Versions
 - AMF Communication Service: v1
 - SMF Configurations
 - SMF
 - SMF 1
 - SMF IP Address: 192.168.12.198
 - SMF Server Port: 6666
 - SMF API Version: v1
- Traffic Parameters
 - Traffic: Disable
 - Traffic Type: MobileTraffic
- UE Simulation Parameters
 - Type Of UE Simulation: Profiles
 - End User Configuration: AMF_Profiles.xml
 - Auto Generated Users Info

Start Edit

Initialisation Errors

Testbed Setup (SMF)

GL MAPS SMF (N11 RELEASE17) - [Testbed Setup - TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config

Config	Value	Enable
SMF Configurations		☒
SMF	1	
SMF 1		
SMF IP Address	192.168.12.198	
SMF Server Port	6666	
URI Scheme	HTTP	
SMF API Version	v1	
Traffic Adapter Index	1	
GTP Tunnel IP Address	192.168.12.198	
AMF Configurations		
AMF	1	
AMF 1		
AMF IP Address	192.168.12.170	
AMF Server Port	6666	
AMF API Versions		
AMF Communication Service	v1	
DNN Configuration	3	
Traffic Parameters		
Traffic	Enable	
Traffic Type	GateWay	
Gateway IP Address	192.168.12.1	
Subnet Mask	255.255.252.0	
Primary DNS IP Address	192.168.1.3	
Secondary DNS IP Address	8.8.8.8	
UE Simulation Parameters		
Type Of UE Simulation	Profiles	
End User Configuration	SMF_Profiles.xml	
Auto Generated Users Info		

Start Edit

Initialisation Errors E

Profile Editor (AMF)

MAPS AMF (N11 RELEASE17) - [Profile Editor -AMF_Profiles]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)
1	MSIN3012041631
2	MSIN3012041632
3	MSIN3012041633
4	MSIN3012041634
5	MSIN3012041635
6	MSIN3012041636
7	MSIN3012041637
8	MSIN3012041638
9	MSIN3012041639
10	MSIN3012041640
11	MSIN3012041641
12	MSIN3012041642
13	MSIN3012041643
14	MSIN3012041644
15	MSIN3012041645
16	MSIN3012041646
17	MSIN3012041647
18	MSIN3012041648
19	MSIN3012041649
20	MSIN3012041650
21	MSIN3012041651
22	MSIN3012041652
23	MSIN3012041653
24	MSIN3012041654
25	MSIN3012041655

Config

Config	Value	Enable
MSIN3012041631		☒
Mobile Identity		
SUPI	001013012041631	
PEI	359877068325248	
MSIN	3012041631	
AMF Client Selection	Client1	
Serving Network		
MCC	001	
MNC	01	
SM Parameters		
PDU SessionId	1	
PDU Session Type	IPV4	
SSC Mode	SSC Mode 1	
DNN Name	internet	
Integrity Protection Maximum Data Rate		
UP Integrity Protection for UL	64 kbps	
UP Integrity Protection for DL	64 kbps	
Requested NSSAI		
SST	eMBB	
SD	01	
Traffic Parameters		
Mobile Traffic Parameters		
Udp Src Port	2152	
Udp Dst Port	2152	
HTTP Server IP Address	192.168.14.70	
TCP port for HTTP	80	
Transmission Type	Once	
Start File Count	1	
Traffic File Name	www.etsi.org	
File Count For Concurrent Or Sequential	3	
File Playback Count	1	
OS Socket	Disable	
TxFile For Once Transmission From List	1	

Insert Delete Clear

Initialisation Errors Error Events Cap

Profile Editor (SMF)

MAPS SMF (N11 RELEASE17) - [Profile Editor -SMF_Profiles]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)
1	MSIN3012041631
2	MSIN3012041632
3	MSIN3012041633
4	MSIN3012041634
5	MSIN3012041635
6	MSIN3012041636
7	MSIN3012041637
8	MSIN3012041638
9	MSIN3012041639
10	MSIN3012041640
11	MSIN3012041641
12	MSIN3012041642
13	MSIN3012041643
14	MSIN3012041644
15	MSIN3012041645
16	MSIN3012041646
17	MSIN3012041647
18	MSIN3012041648
19	MSIN3012041649
20	MSIN3012041650
21	MSIN3012041651
22	MSIN3012041652
23	MSIN3012041653
24	MSIN3012041654
25	MSIN3012041655
26	MSIN3012041656
27	MSIN3012041657

Config

Config	Value
MSIN3012041631	
Subsriber Info	
IMSI	001013012041631
MSIN	3012041631
HPLMN ID	
HPLMN ID 1	
MCC	001
MNC	01
QoS Rule	
QoS Rule Identifier	1
Rule Operation Code	Create new QoS rule
DQR	The QoS rule is not default Q...
Number of Packet filters	1
Packets Filter Direction	Bidirectional
Packets Filter Id	15
QoS Rule Precedence	255
Segregation	Not Requested
Trace Data	
Expected UE Behaviour List	
Supported Features	0
SessionManagementSubscriptionData	
Traffic Parameters	
Mobile Traffic Parameters	
Udp Src Port	2152
Udp Dst Port	2152
HTTP Server IP Address	192.168.14.70
TCP port for HTTP	80
Transmission Type	Once
Start File Count	1
Traffic File Name	www.etsi.org
File Count For Concurrent Or Sequential	1
File Playback Count	1
OS Socket	Disable
TxFile For Once Transmission From List	4

Enable

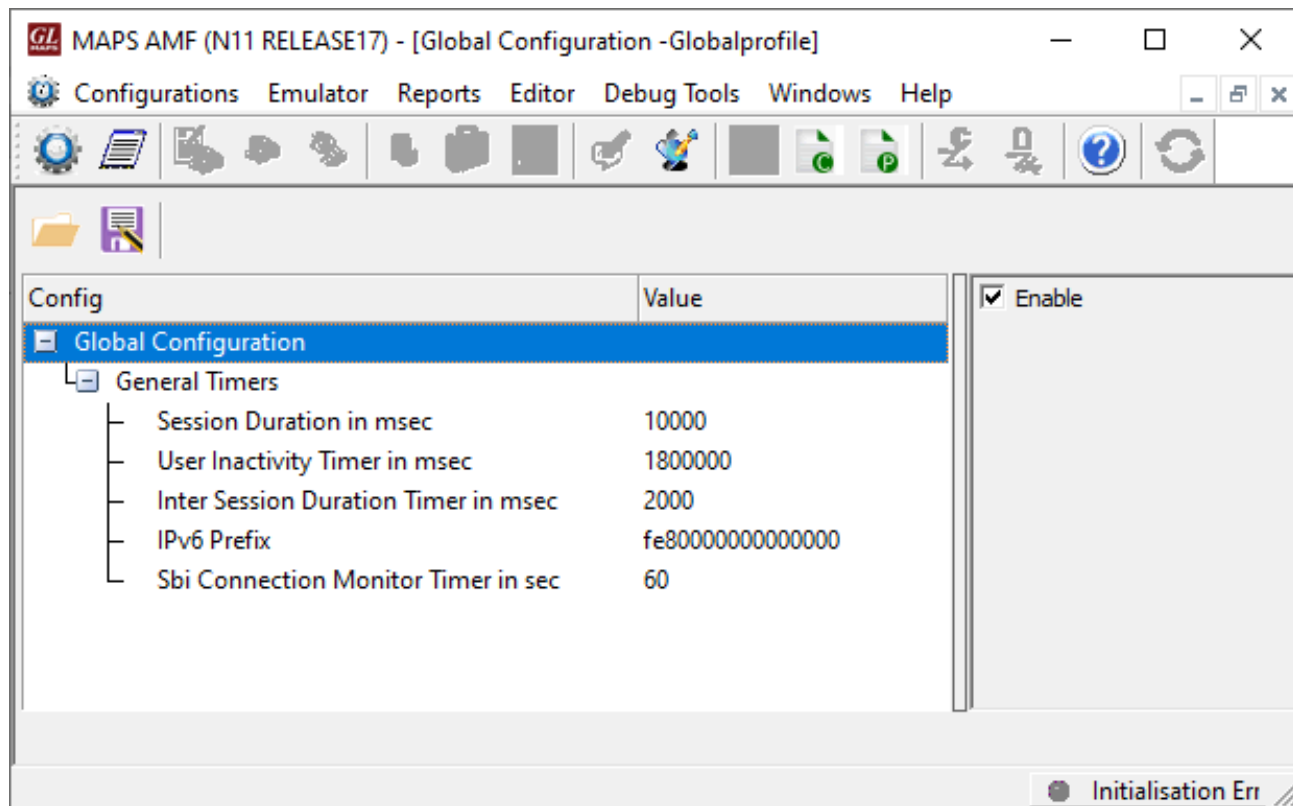
Add Insert Delete

Properties

Insert Delete Clear

Initialisation Errors Error Events Captured Em

Global Configuration



Call Generation

MAPS AMF (N11 RELEASE17) - [Call Generation -CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Itera
1	Namf_Session_Control.gls	MSIN3012041631	imsi-001013012041631	Start	SM Context Released	None	Pass	1	1
2	Namf_Session_Control.gls	MSIN3012041632		Start		None	Unknown	1	0

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

Save Column Width Show Latest

AMF SMF

POST /nsmf-pdusession/v1/sm-contexts 16:18:59.008000

201 CREATED 16:18:59.707000

POST /namf-comm/v1/ue-contexts/imsi-001013012041631_2/n1-n2-messages 16:18:59.818000

200 16:18:59.818000

POST /nsmf-pdusession/v1/sm-contexts/imsi-001013012041631_2/modify 16:18:59.916000

201 CREATED 16:18:59.951000

POST /nsmf-pdusession/v1/sm-contexts/imsi-001013012041631_2/release 16:19:52.760000

204 NO-CONTENT 16:19:52.793000

Find

POST http://192.168.12.198:6666/nsmf-pdusession/v1/sm-contexts
accept : application/json,
application/vnd.3gpp.ngap,
application/problem+json
content-type : multipart/related; boundary=8F8924ea47d23c14b86

--8F8924ea47d23c14b86
Content-Type: application/json

{
 "anType": "3GPP_ACCESS",
 "dnn": "internet",
 "gpsi": "msisdn-3012041631",
 "n1SmMsg": {
 "contentId": "5gmas-sm"
 },
 "pduSessionId": 1,
 "pei": "imei-359877068325248",
 "ratType": "NR",

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status L

Call Reception

GL MAPS SMF (N11 RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	SMF_HTTP2_Connection_Monitor.gls		SMF Server Clients : AMF,	Stop		Connect Server	Unknown
2	Nsmf_Session_Control.gls		SUPIorGPSI :imsi-001013012041631,, DNN :internet	Completed	SM Context Released	None	Pass

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

Save Column Width ☐ Show Latest

AMF SMF

POST /nsmf-pdusession/v1/sm-contexts 16:18:59.567000

201 16:18:59.699000

POST /namf-comm/v1/ue-contexts/imsi-001013012041631_2/n1-n2-messages 16:18:59.791000

200 OK 16:18:59.825000

POST /nsmf-pdusession/v1/sm-contexts/imsi-001013012041631_2/modify 16:18:59.930000

201 16:18:59.946000

POST /nsmf-pdusession/v1/sm-contexts/imsi-001013012041631_2/release 16:19:52.771000

204 16:19:52.783000

Status: 1

method : POST

path : /nsmf-pdusession/v1/sm-contexts

scheme : http

authority : 192.168.12.198:6666

accept : application/json,

application/vnd.3gpp.ngap,

application/problem+json

content-type : multipart/related; boundary="8F8924ea47d23c14b"

mime-version : 1.0

content-length : 642

--"8F8924ea47d23c14b86"

Content-Type: application/json

```
{
  "anType": "3GPP_ACCESS",
  "dnn": "internet",
  "gpsi": "msisdn-3012041631",
  "n1SmMsg": {
    "contentId": "5gmas-sm"
  }
}
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Sta

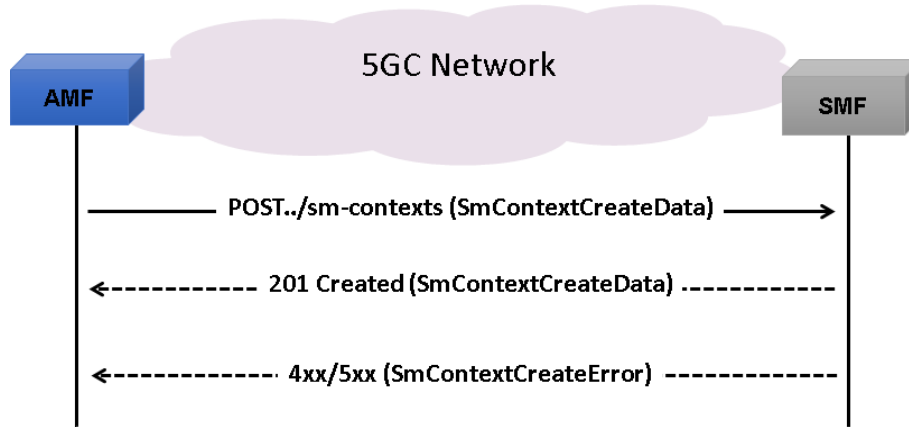
MAPS™5G N11 Interface Procedures

- Nsmf_PDUSession Services
 - Create SM Context Service Operation
 - Update SM Context Service Operation
 - Release SM Context Service Operation
 - Notify SM Context Status Service Operation
 - Retrieve SM Context Service Operation
- Nudm_UEContextManagement Service
 - Network triggered Service Request
 - PDU Session establishment
 - PDU Session modification
 - PDU Session release
 - Session continuity, service continuity and UP path management
 - Inter NG-RAN node N2 based handover
 - SMS over NAS procedures
 - UE assisted and UE based positioning procedure
 - Network assisted positioning procedure
 - UE configuration update procedure for transparent UE policy delivery

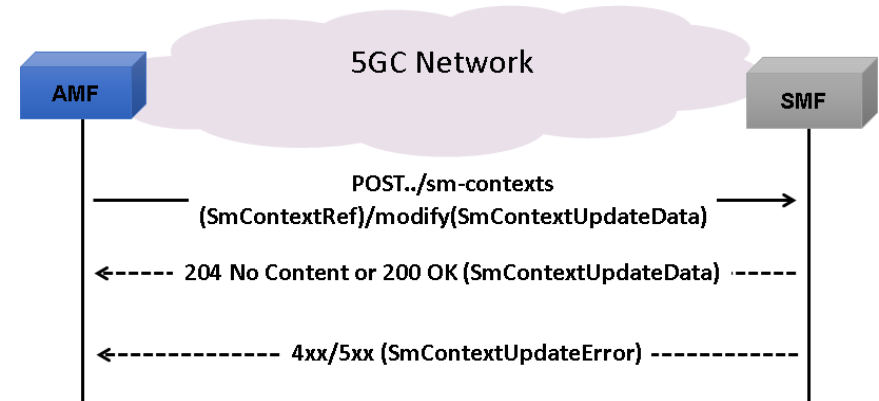
MAPS™ 5G N11 Interface Procedures

Nsmf_PDUSession Service

Create SM Context Service Operation



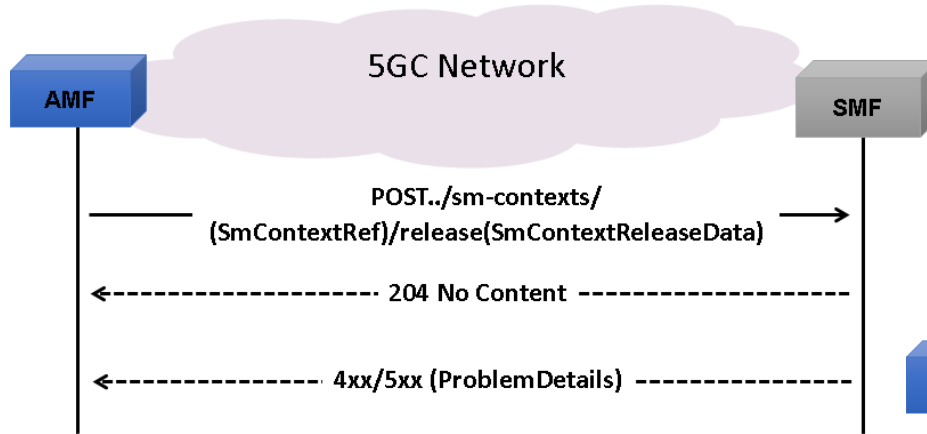
Update SM Context Service Operation



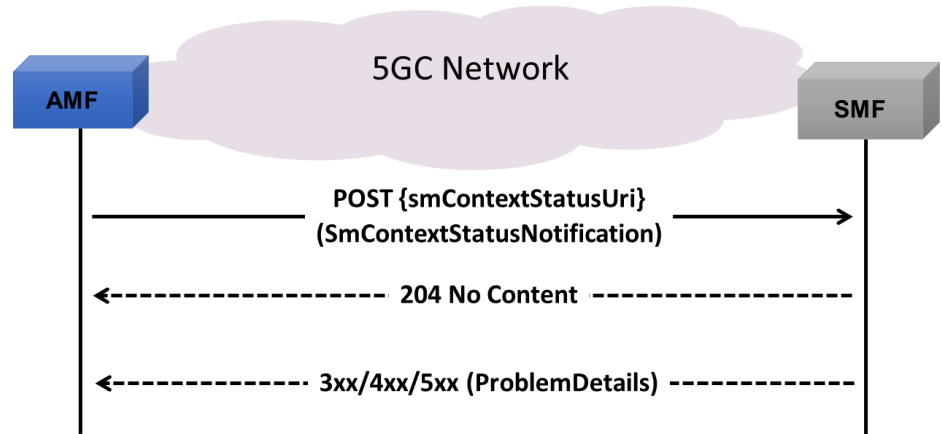
MAPS™ 5G N11 Interface Procedures

Nsmf_PDUSession Service (*Contd.*)

Release SM Context Service Operation



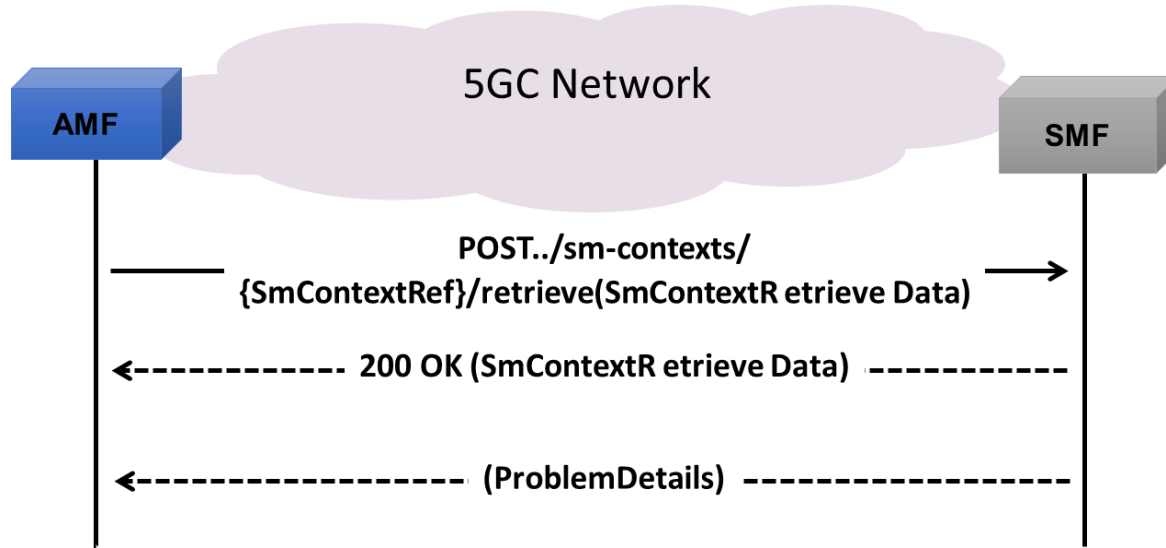
Notify SM Context Status Service Operation



MAPS™ 5G N11 Interface Procedures

Nsmf_PDUSession Service (*Contd.*)

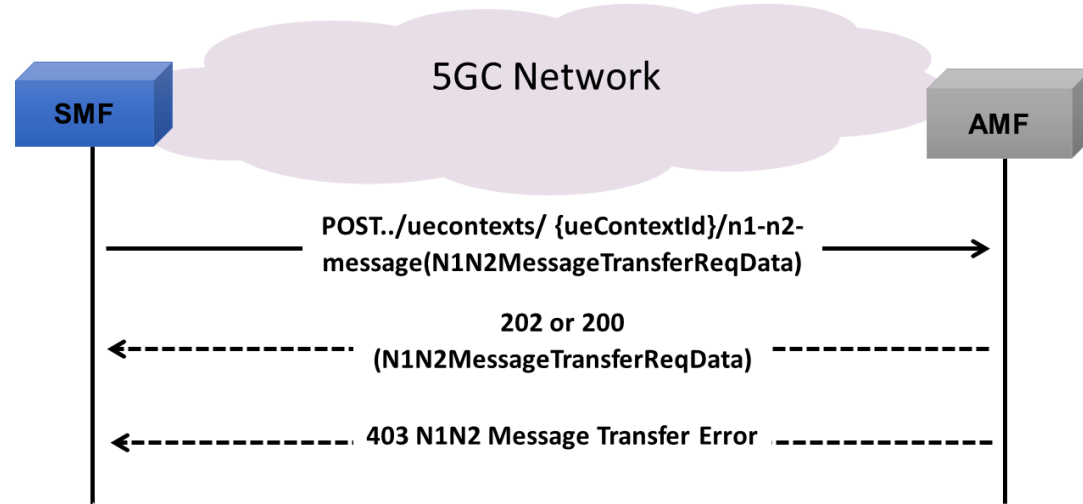
Retrieve SM Context Service Operation



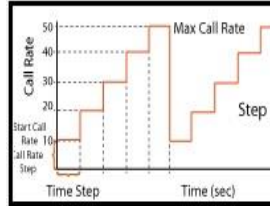
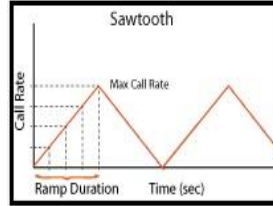
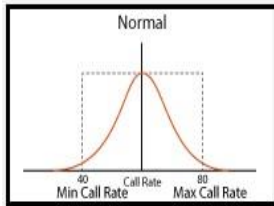
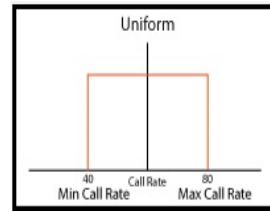
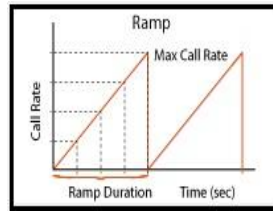
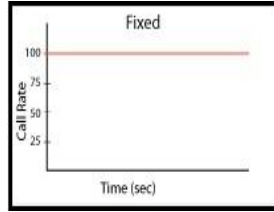
MAPS™ 5G N11 Interface Procedures

Namf_Communication Service

- Network triggered Service Request
- PDU Session establishment
- PDU Session modification
- PDU Session release
- Session continuity, service continuity and UP path management
- Inter NG-RAN node N2 based handover
- SMS over NAS procedures
- UE assisted and UE based positioning procedure
- Network assisted positioning procedure
- UE configuration update procedure for transparent UE policy delivery



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.

GL MAPS AMF (N11 RELEASE17) - [Load Generation - LoadGendefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Total Calls To Generate * (* indicates no limit)

Max Active Calls 1000 ☐ Unique Distributions Per Script

☒ Multi Distributions Iteration * (* indicates no limit)

Distributions	Description	Add	Remove	Remove All	Edit
Uniform	MinCR=40, MaxCR=80, Duration=10.00				
Fixed	Call Rate=100, Duration=10.00				
Normal	MinCR=40, MaxCR=80, Duration=10.00				

Scripts

Scripts	Profile
Namf_Session_Control	MSIN3012041631
	MSIN3012041632
	MSIN3012041633
	MSIN3012041634
	MSIN3012041635
	MSIN3012041636
	MSIN3012041637

☐ Stop Time

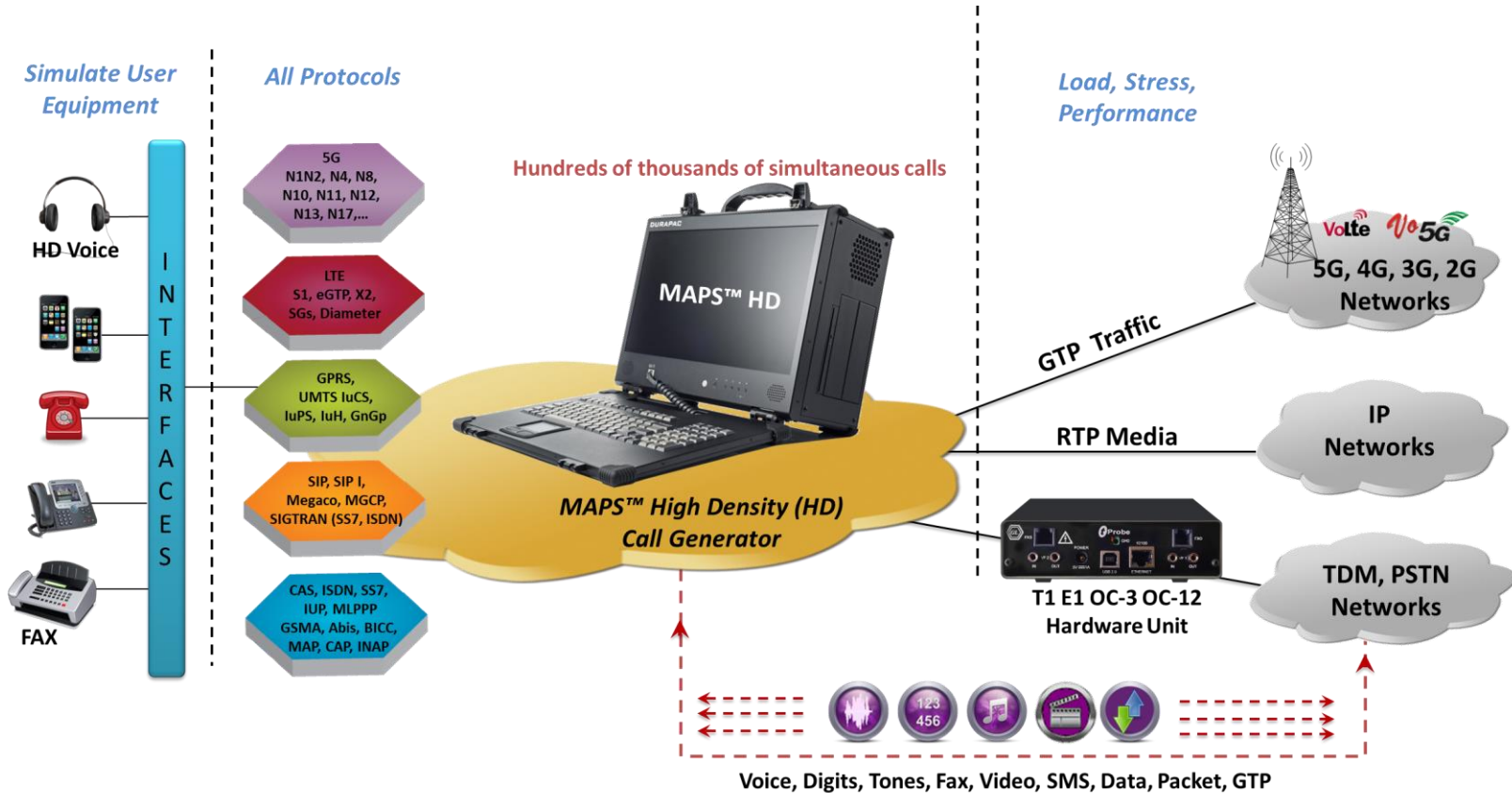
Days 0 Hours 0 Minutes 0

Start Time - 00:00:00.000

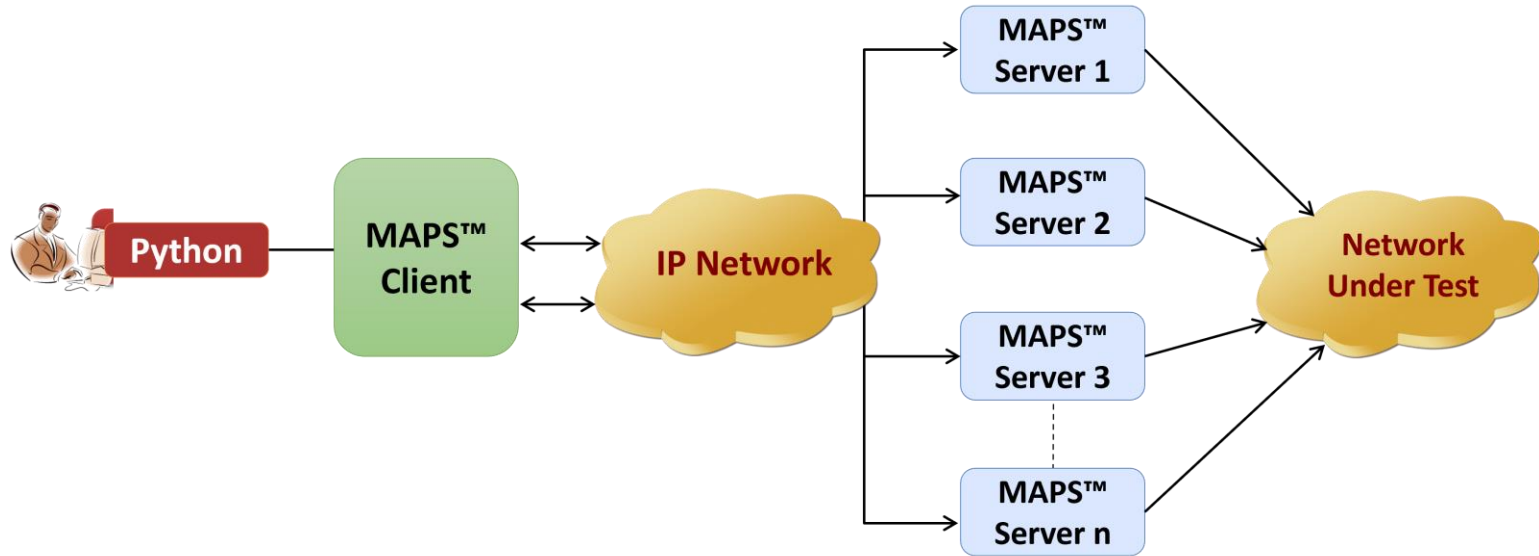
End Time - 00:00:00.000

Initialisation Err

Traffic Emulation



MAPS™ API Architecture



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

Python Client and MAPS™ CLI Server

```
Python 3.7.5 Shell
File Edit Shell Debug Options Window Help
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\MAPS5G-N11\MAPSCLI\PythonClie
t\examples\AMF\N11_PlaceCall.py
N11 Server Connection... True
N11 Testbed Starting ... True
N11 Profile Loading... True
Waiting for AMF - SMF Connectivity
N11 Namf_Session_Control.gls Script Started...
ProfileLoadStatus == Profile loaded
Starting N11 script True
Create SM Context Request Initiation ... N11_smContextReleaseType= ReleaseSMC
ontext
N11_user_event= CreateSMContextRequest
UserEventStatus= Applied
CallInitiatedStateStatus = Initiated
CallInitiatedState= 0
responseStatus_1 = SM Context Created
responseStatus_2 = N1_N2_TRANSFER_Response_Sent
responseStatus_3 = Session Establish Accept
responseStatus_4 = UpdateSMContextRequest Sent
responseStatus_5 = SM Context Updated
N11_ReleaseSMContext_status= Applied
True
CreateSMContext Response Status... SM Context Released
MAPS N11 MsgCount: 7
MAPS LastMSGRev.....
Time Stamp Route Message
11:12:58.747 <- 204
*****MAPS N11 Message Flow *****
Time Stamp Route Message
Message decode...
11:12:57.709 -> POST - /nsmf-pdusessio
11:12:57.709 -> POST - /nsmf-pdusession/v1/sm-contexts
Message decode...
11:12:58.034 <- 201
```

```
CLI MapsCLI AMF (N11 RELEASE17)
File Edit View
View Latest Command
1 :: 2024-1-30 11:12:06.453000 : Start "TestBedDefault.xml" # "_TypeOfUESimulation"="XML","_DefaultProfile"="AMF_Profiles.xml";
1 :: 2024-1-30 11:12:09.832000 : LoadProfile "AMF_Profiles.xml"
1 :: 2024-1-30 11:12:54.935000 : StartScript 1 "Namf_Session_Control.gls" "MSIN3012041631" 1 # "IMSI"="( binarystring )001013012041631,"EnableCLI"=1;
1 :: 2024-1-30 11:12:57.669000 : UserEvent 1 "CreateSMContextRequest";
1 :: 2024-1-30 11:12:58.225000 : UserEvent 1 "ReleaseSMContext";
1 :: 2024-1-30 11:12:58.876000 : UserEvent 1 "GetCallStatus";
1 :: 2024-1-30 11:12:59.966000 : UserEvent 1 "GetMessageCount";
1 :: 2024-1-30 11:13:00.076000 : UserEvent 1 "GetLastReceivedMessage";
1 :: 2024-1-30 11:13:00.193000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
1 :: 2024-1-30 11:13:00.297000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
1 :: 2024-1-30 11:13:00.418000 : UserEvent 1 "GetMessageInfo" # "Index"=2;
1 :: 2024-1-30 11:13:00.629000 : UserEvent 1 "GetMessageInfo" # "Index"=3;
1 :: 2024-1-30 11:13:00.854000 : UserEvent 1 "GetMessageInfo" # "Index"=4;
1 :: 2024-1-30 11:13:00.959000 : UserEvent 1 "GetMessageInfo" # "Index"=5;
1 :: 2024-1-30 11:13:01.169000 : UserEvent 1 "GetMessageInfo" # "Index"=6;
1 :: 2024-1-30 11:13:01.394000 : StopScript 1;
```

Thank you