MAPS[™] 5G N11 Interface Emulator



Overview

GL's MAPS[™] 5G System as a service-based architecture, includes a set of Network Functions (NFs) providing services as defined in 3GPP TS 23.501 (Release 17). The service-based interfaces use HTTP/2 protocol with JavaScript Object Notation (JSON) as the application layer serialization protocol.

GL's MAPS[™] emulate Session Management Function (SMF) within the 5G Core offering services to the Access and Mobility Management Function (AMF) via the Nsmf service-based N11 interface. The above network architecture represents the service-based interface, with focus on N11 between AMF and SMF. Here, any node SMF act as "NF Producer", where the specification is TS29.502 (Release 17).

The NF, SMF and AMF are the entities in 5G Core Network (5GC), which supports the following services via the Nsmf and Namf service-based N11 interface.

- Nsmf_PDUSession: Create SM Context, Update SM Context, Release SM Context, Notify SM Context Status and Retrieve SM Context operations
- Namf_Communication: N1N2 Message Transfer (UE Specific) operations based on N11 interface

Besides emulating network elements SMF and AMF functions, it also supports error tracking, regression testing, load testing. It can run pre-defined test scenarios against 5G interface test objects in a controlled and deterministic manner. Easy to use script syntax allows user to create conformance test cases based on their test plan.

MAPS[™] 5G N11 Interface Emulator supports powerful utilities such as Script Editor and Profile Editor which allows new scenarios to be created or existing scenarios to be modified using messages and parameters.

For more information, refer to <u>MAPS[™] 5G N11 Interface Emulator</u> webpage.



818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878, U.S.A (Web) <u>www.gl.com</u> - (V) +1-301-670-4784 (F) +1-301-670-9187 - (E-Mail) <u>info@gl.com</u>

Main Features

- Emulate SMF and AMF elements
- Supports Nsmf_PDUSession and 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
- Generate multiple subscribers using the CSV profiles
- Automation, Remote access, and Schedulers to run tests 24/7

Testbed Configuration

The testbed setup window allows user to setup the required test configurations in N11 interface. It includes a list of variables that are declared and assigned before starting the script. Testbed Setup defines the MAPS[™] parameters which communicates with the rest of the test network. End user configuration profile is used to configure MAPS[™] 5G N11 interface with the supported AMF and SMF parameters.



Figure: Testbed Setup

Pre-processing Tools

SCRIPT EDITOR - The script editor allows user to create/edit scripts and access protocol fields as variables for the message template parameters. The script uses pre-defined message templates, to perform send and receive actions.



Figure: Script Editor

PROFILE EDITOR - This feature allow loading profile to edit the values of variables using GUI, replacing the original value of variables in the message template. An XML file defines a set of multiple profiles with varying parameter values which allow user to configure call instances in call generation to receive calls. The **Profiles** include 5G parameters, that is required to configure the multiple UEs to emulate Signaling and Traffic.



Figure: Profile Editor

Call Generation and Reception

In call generation mode, MAPS[™] is configured for the outgoing messages, while in call receive mode, it is configured to respond to the incoming messages. Tests can be configured to run at once, multiple iterations, and continuously. Also, allow user to create multiple entries using quick configuration feature.

The editor allows to run the added scripts sequentially (order in which the scripts are added in the window) or randomly (any script from the list of added script as per the call flow requirements).

The test scripts are started manually at the call generation and at the call reception the script is automatically triggered by incoming messages.



Figure: Call Generation

	Z 3.00-015
🦻 Configurations Emulator Reports Editor Debug Tools Windows Help	- & ×
Q = S > > S = C C C C C C C C C	
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 Unk	nown
2 Nam[_Session_Control.gls SUPTorGPS1:jimsi-001013012041631., DNN:jinternet Completed SM Context Released None P	188
<	>
Stop Stop All Abort Abort All 🔽 Show Records 🗆 Select Active Call 🗆 Auto Trash	
Save Column Width — I Show Latest	
AMF SMF Find	
POST /nsmi-pdusession/v1/sm-contexts 16:10:50 55 757000	
201 :path : /nsaf-pdusession/vl/sa-contexts	
16:18:59:699000 16:18:59.699000 16:10:00 19:20:06:12:19:20:06:00 19:20:00 19:20:06:00 19:20:20:00 19:20:000 19:20:000 19:20:000 19:20:0000000000000000000	
POST /nami-comm/v1/ue-contexts/msi-001013012041631_2/n1-n2-messages 16:18:59.791000 accept : application/jscn,	
application/vnd.sypp.ngap, application/vnd.sypp.ngap,	
16:18:59:825000 content-type : multipart/related; boundary="8F8924ead	d23cl4b
POST /nsmi-pdusession/v1/sm-contexts/msi-001013012041631_2/modify 16:18:59.930000 contexts-length : 642	
201	
10:18:39.446000 Content-Type: application/json	
PUST /nsmr-pdusession/v1/sm-contexts/msr-UUIUI3UI2U41b31_2/release 16:19:52.771000	
204 "anType": "3GPP_ACCESS",	
""""""""""""""""""""""""""""""""""""""	
"nlsmHsg": (
"contentid": "bgnas-sa"	
Scripts A Message Sequence / Event Config A Script Flow /	
Initialisation Errors Error Events Captured Errors	Link Sta

Figure: Call Reception

Nsmf_PDUSession Service

Create SM Context Service Operation

MAPS[™] for 5G N11 interface emulate services between AMF and SMF network functions.

The **Create SM Context Service Operation** is used to create an individual SM context for a given PDU session, in the SMF, or in the V-SMF for HR roaming scenarios.

In this procedure, AMF creates an SM context using the HTTP POST method as shown below.



- AMF sends a POST request to the resource representing the SM contexts collection resource of the SMF
- On Success, "201 Created" shall be returned
- The SMF rejects the request if the UE is outside of the LADN service area
- On Failure or Redirection during a UE requested PDU Session Establishment, one of the HTTP status code is returned

Update SM Context Service Operation

The Update SM Context service operation is used to update an individual SM context and/or provide N1 or N2 SM information received from the UE or the AN, for a given PDU session, towards the SMF, or the V-SMF for HR roaming scenarios.

The NF Service Consumer (AMF) updates an individual SM context and/or provide N1 or N2 SM information to the SMF using the HTTP POST method as shown below.



- AMF sends a POST request to the resource representing the individual SM context resource in the SMF
- On Success, "204 No Content" or "200 OK" is returned
- The SMF may indicate to the NF Service Consumer that it shall release EBI(s) that were assigned to the PDU session by including the releaseEbiList IE, for example when a QoS flow is released
- On Failure, one of the HTTP status code is returned

Nsmf_PDUSession Service (Contd.)

Release SM Context Service Operation:

The Release SM Context service operation is used to release the SM Context of a given PDU session, in the SMF, or in the V-SMF for HR roaming scenarios.

AMF releases the SM Context of a given PDU session using the HTTP "release" custom operation as shown below.



- AMF sends a POST request to the resource representing the individual SM context to be deleted
- On Success, the SMF returns a "204 No Content" response with an empty payload body in the POST response
- If the POST request contains a vsmfReleaseOnly indication, the V-SMF release its SM context and corresponding PDU session resource locally, i.e. without signaling towards the H-SMF
- On Failure, one of the HTTP status code is returned

Notify SM Context Status Service Operation

The Notify SM Context Status service operation is used by the SMF to notify the NF Service Consumer about the status of an SM context related to a PDU session in the SMF, or the V-SMF for HR roaming scenarios.

The SMF notifies the AMF using the HTTP POST method as shown below.



- The SMF sends a POST request to the SM Context Status callback reference provided by the NF Service Consumer during the subscription to this notification
- If the notification is triggered by PDU session handover, the notification payload contains the Cause IE with the value "PDU_SESSION_HANDED_OVER"
- On Success, "204 No Content" is returned
- On Failure or Redirection, one of the HTTP status code is returned

Nsmf_PDUSession Service (Contd.)

Retrieve SM Context Service Operation

The Retrieve SM Context service operation is used to retrieve an individual SM context, for a given PDU session, from the SMF, or from the V-SMF for HR roaming scenarios.

AMF retrieves an SM context using the HTTP POST method (retrieve custom operation) as shown below.



- AMF sends a POST request to the resource representing the individual SM context to be retrieved
- On Success, "200 OK" is returned
- If the target MME capabilities were provided in the request parameters, and if the target MME supports the non-IP PDN type, the SMF is returned
- On Failure, one of the HTTP status code is returned



Namf_Communication Service

The SMF uses N1N2 Message Transfer service operation to transfer N1 and/or N2 information to the UE through the AMF by following the below procedures:

- 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



- The SMSF sends a POST request to transfer N1 and N2 information which include a N1N2MessageTransfer Notification URI to AMF in the request message
- On **Success**, 200 OK response is received. The AMF shall set the cause IE in the N1N2MessageTransferRspData as "N1_N2_TRANSFER_INITIATED"
- On **Failure**, the appropriate HTTP status code indicating the error shall be returned and appropriate additional error information should be returned in the POST response body



Command Line Interface (CLI)

The MAPS[™] 5G N11 (AMF) can be configured as a CLI server application for remote control via command-line clients, including Python. These clients can execute various functions remotely, such as initiating the testbed setup, loading scripts, profiles, and applying user events like call generation, termination, and traffic control. Users can generate and receive calls using commands.

🌛 Python 3.7.5 Shell				<u> </u>	8 3		\times
<u>F</u> ile <u>E</u> dit She <u>l</u> l <u>D</u> ebug <u>C</u>	<u>)</u> ptions <u>W</u> indow <u>H</u> elp						
Python 3.7.5 (tags/v: (AMD64)] on win32	3.7.5:5c02a39a0b,	Oct 15 2019,	00:11:34)	[MSC v.19	916 €	54 bi	t ^
Type "help", "copyri	ght", "credits" o	r "license()"	for more	informatio	on.		
>>>		-					
= RESTART: C:\Progra	m Files\GL Commun	ications Inc\	MAPS5G-N11	(MAPSCLI)	Pytho	onCII	en
t\examples\AMF\N11_P	laceCall.py						
N11 Server Connection	n True						
N11 Testbed Starting	True						
N11 Profile Loading.	True						
Waiting for AMF - SM	F Connectivity	55 A. C. TARY, M. C.					
N11 Namf_Session_Co	ntrol.gls Script	Started					
ProfileLoadStatus ==	Profile loaded						
Starting N11 script	True	1010014		100237-01		11.11	
Create SM Context Re ontext	quest Initiation	N11_sm	ContextRel	easeType=	Rele	aseS	MC
N11 user event= Crea	teSMContextReques	t					
UserEventStatus= App	lied						
CallInitiatedStateSt	atus = Initiated	l					
CallInitiatedState=	0						
responseStatus 1 =	- SM Context Create	d					
responseStatus 2 = 1	N1 N2 TRANSFER Re	snonse Sent					
responseStatus 3 =	Session Establish	Accent					
responseStatus 4 =	UndateSMContextRe	quest Sent					
responseStatus 5 =	SM Context Undate	d					
N11 DeleggeSMContext	status= Annliad						
True							
CreateSMcontext Deen	ongo Statug	M Context Del	besee				
MADS N11 MegCount: 7	onde sededas s	I CONCEAC REL	casca				
MAPS WII MSGCourt.							
Time Stemp	Pouto	Maggagga					
11.12.50 747	Kouce	204					
11.12.30. (T)	N11 Maggara Flow	407	*				
Time Stown	NII Message riow	Moggogg					
Nagaoga dagada	ROUCE	nessage					
11.12.57 700		DOGT /	mf nduge	i	aart		
11:12:57.709	->	P051 - / ns	mr-pausess	10n/ V1/ Sm-	-cont	exts	
11:12:27.709 ->	PUSI - /nsmi-	pausession/vl	/sm-contex	CS			
Message decode							
11:12:58.034	<-	201					

Figure: Sample Python Client

CI MapsCLI AMF (N11 RELEASE17)	<u>(1917)</u>		×
Eile Edit View		-	. 8 ×
View Latest Command			
<pre>1 :: 2024-1-30 11:12:06.453000 : Start TrestBedDerault.xm" #rypeOrUESimulation"= XML", "_DefaultProhie"="AMF_Prohies.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" "M5IN3012041631" 1 # "IM5I"=(binarystring)0010130120- 1 :: 2024-1-30 11:12:58.25000 : UserEvent 1 "CreateSMContextRequest"; 1 :: 2024-1-30 11:12:58.876000 : UserEvent 1 "ReleaseSMContext"; 1 :: 2024-1-30 11:12:58.876000 : UserEvent 1 "GetCallStatus"; 1 :: 2024-1-30 11:12:59.966000 : UserEvent 1 "GetCallStatus"; 1 :: 2024-1-30 11:12:59.966000 : UserEvent 1 "GetCallStatus"; 1 :: 2024-1-30 11:13:00.076000 : UserEvent 1 "GetMessageCount"; 1 :: 2024-1-30 11:13:00.076000 : 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 11:13:00.84000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.84000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.84000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.84000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.950000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.950000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.950000 : UserEvent 1 "GetMessageInfo" # "Index"=3; 1 :: 2024-1-30 11:13:00.950000 : UserEvent 1 "GetMessageInfo" # "Index"=4; 1 :: 2024-1-30 11:13:00.950000 : UserEvent 1 "GetMessageInfo" # "Index"=5;</pre>	¥1631,"	'EnableCL	I"=1;
1 :: 2024-1-30 11:13:01.169000 : UserEvent 1 "GetMessageInfo"# "Index"=6; 1 :: 2024-1-30 11:13:01.394000 : StopScript 1;			~
		NUM	

Figure: MAPS[™] CLI Server





Supported Protocols	Standard/ Specification		
N11 Interface (SMF - AMF)	TS29.502 (Release 17)		
JavaScript Object Notation (JSON)	IETF RFC 8259		
	IETF RFC 7231		
	IETF RFC 7540/RFC 7541		
TLS	IETF RFC 8446		
ТСР	IETF RFC 793		
	IETF RFC 791 [5]		
1274	IETF RFC 2460 [6]		



Buyer's Guide

Item No	Product Description
<u>PKS505</u>	MAPS™ 5G N11 Interface Emulator
<u>PKS305</u>	MAPS™ 5G Multi-Interface Emulation
Item No	Related Software
<u>PKS500</u>	MAPS™ 5G N1/N2 Interface Emulator
<u>PKS501</u>	MAPS [™] 5G N4 Interface Emulator
<u>PKS502</u>	5G Service based Emulation (Prerequisite base license for all service based (Open API) interface emulations)
<u>PKS502</u>	MAPS [™] 5G N17 Interface Emulator
<u>PKS503</u>	MAPS™ 5G N8 Interface Emulator (Requires PKS502)
<u>PKS504</u>	MAPS™ 5G N10 Interface Emulator (Requires PKS502)
<u>PKS506</u>	MAPS [™] 5G N12 Interface Emulator (Requires PKS502)
<u>PKS507</u>	MAPS™ 5G N13 Interface Emulator (Requires PKS502)
<u>PKS508</u>	MAPS™ 5G N20 Interface Emulator (Requires PKS502)
<u>PKS509</u>	MAPS™ 5G N21 Interface Emulator (Requires PKS502)
<u>PKS510</u>	MAPS™ 5G N22 Interface Emulator (Requires PKS502)
<u>PKS511</u>	MAPS™ 5G N29 Interface Emulator (Requires PKS502)
<u>PKS511</u>	MAPS™ 5G N51 Interface Emulator (Requires PKS502)
<u>PKS170</u>	CLI Support for MAPS™

For complete list of MAPS[™] products, refer to <u>Message Automation & Protocol Simulation (MAPS[™])</u> webpage.

For more details on supported MAPS[™] 5G interfaces, refer to <u>5G Core (5GC) Network Test Solution</u> webpage.

GL Communications Inc.

818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878, U.S.A (Web) <u>www.gl.com</u> - (V) +1-301-670-4784 (F) +1-301-670-9187 - (E-Mail) <u>info@gl.com</u>