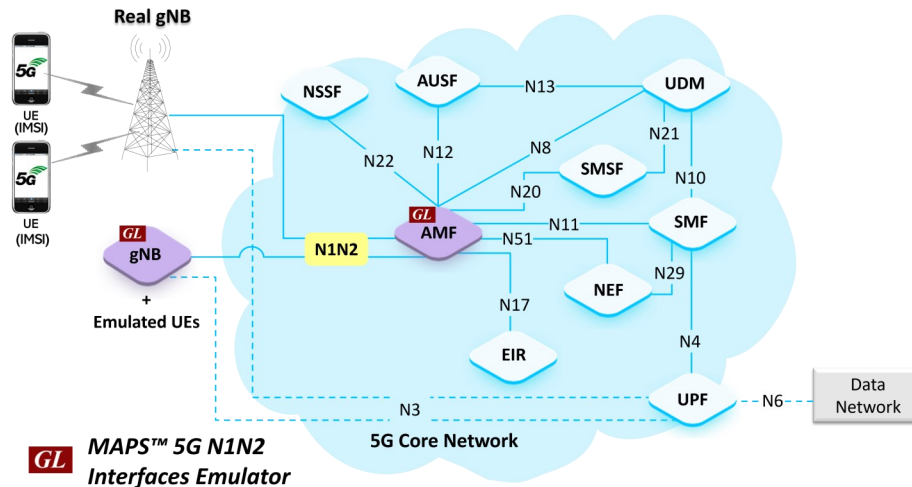


MAPS™ 5G N1N2 (NGAP) Emulator



Overview

GL's **Message Automation & Protocol Simulation (MAPS™)** is enhanced to test 5G N1N2 interface that can emulate gNodeB (gNB), and AMF (Access and Mobility Management Function) according to 3GPP standards.

It supports Non-Access-Stratum (NAS) signaling on N1N2 interface between UE and AMF. It also supports NGAP to emulate signaling services between NG-RAN and AMF.

MAPS™ N1N2 Interface emulator supported procedures include - NG Reset, NG Setup, Initial Context Setup, UE Context Release, Registration, De-registration, Primary authentication and key agreement procedure, Security mode control, Identification and PDU session management and SMS over NAS. The application gives the users an unlimited ability to edit NGAP/NAS message and call scenarios (message sequences).

In addition to control plane emulation the application supports generation and verification of traffic, including VoNR (Voice) calls with SIP signaling and RTP Traffic generation. It also emulates mobile traffic such as HTTP, FTP, Video by playing back real capture stateful over established TCP connection with additional licenses - Mobile Traffic Core – GTP (ETH101) and Mobile Traffic Core – Gateway (ETH102).

GL MAPS™ is not only used for protocol validation but also for performance and capacity by emulating tens of thousands of 5G subscribers.

MAPS™ 5G NGAP emulator supports utilities like Message Editor, Script Editor, and Profile Editor which allows new scenarios to be created or modified using 5G NGAP/N1N2 messages and parameters.

For more information, please refer to [MAPS™ 5G N1N2 Interface Emulator](#) webpage.

Main Features

- MAPS™ 5G N1N2 interface emulates gNodeB and AMF
- Application supports 5G Control Plane and User Plane
- Supported traffic types includes mobile data traffic such as HTTP and VoNR
- Generates and processes NGAP/NAS (valid and invalid) messages
- Includes gateway functionality to forward mobile traffic over GTP to and from external IP network
- Customization of call flow and message templates using Script and Message Editor
- Ready-to-use scripts for quick testing
- Supports scripted call generation and automated call reception
- Provides detailed Statistics and Events Status
- Emulates tens of thousands of 5G subscribers
- Supports Command Line Interface (CLI) via Python APIs.
- Automation, Remote access, and Schedulers to run tests 24/7



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Testbed Configuration

The testbed setup window allows users to setup the required test environment with SCTP configuration in N1N2 interface. SCTP configuration parameters consist of Source/Destination IP addresses, and Port numbers to configure MAPS™ to emulate gNodeB and AMF entities in N1N2 interface. MAPS™ can then generate and receive NGAP/NAS messages to/from valid IP address in the 5G network. End user configuration profile is used to configure MAPS™ 5G N1N2 with supported gNodeB and AMF parameters.

The screenshot shows the configuration window for MAPS gNB (N1N2 RELEASE17) in the Testbed Setup - TestBedDefault mode. The window is divided into several sections:

- Config Table:** A table listing configuration parameters and their values.

Config	Value
gNB	
gNBConfiguration	1
gNBConfiguration 1	
Traffic Adapter Index	2
gNB IP Address	192.168.13.12
gNB GTP IP Address	192.168.13.13
GTP Port For Traffic	2152
SCTP Mode	Client
Global RAN Node Type	globalgNB-ID
gNB ID	10000001
Ng ENB Configuration	Macro gNB Id
Macro gNB Id	12345
Short Macro gNB Id	12345
Long Macro gNB Id	12345
N3IWF Name	GLWifi
RAN Node Name	gnb000000001
Paging DRX	v128
Cell Identity	000000001
Supported TA List	1
Destination Parameters	
Select AMF Pool	1
AMF Pool Configurations	
AMF Pool	1
AMF Pool 1	
AMF	1
AMF 1	
AMF IP Address	192.168.13.61
AMF Port	38412
gNB Port	38412
Traffic Parameters	
Traffic	Disable
MobilePCore Traffic	
Packet Load Traffic Configuration	
External GateWay Configuration For PacketGen	
GTP Gateway for SIP or RTP Generation Over IP	
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	UE_Profiles.xml
CSV FileName	C:\Program Files\GL Communications I...
Auto Generated Users Info	
- Enable:** A checkbox labeled "Enable" which is checked.
- Buttons:** "Start" and "Edit" buttons are located at the bottom right of the table.
- Status Bar:** At the bottom of the window, there are three indicators: "Initialisation Errors", "Error Events", and "Captu".

Pre-processing Tools

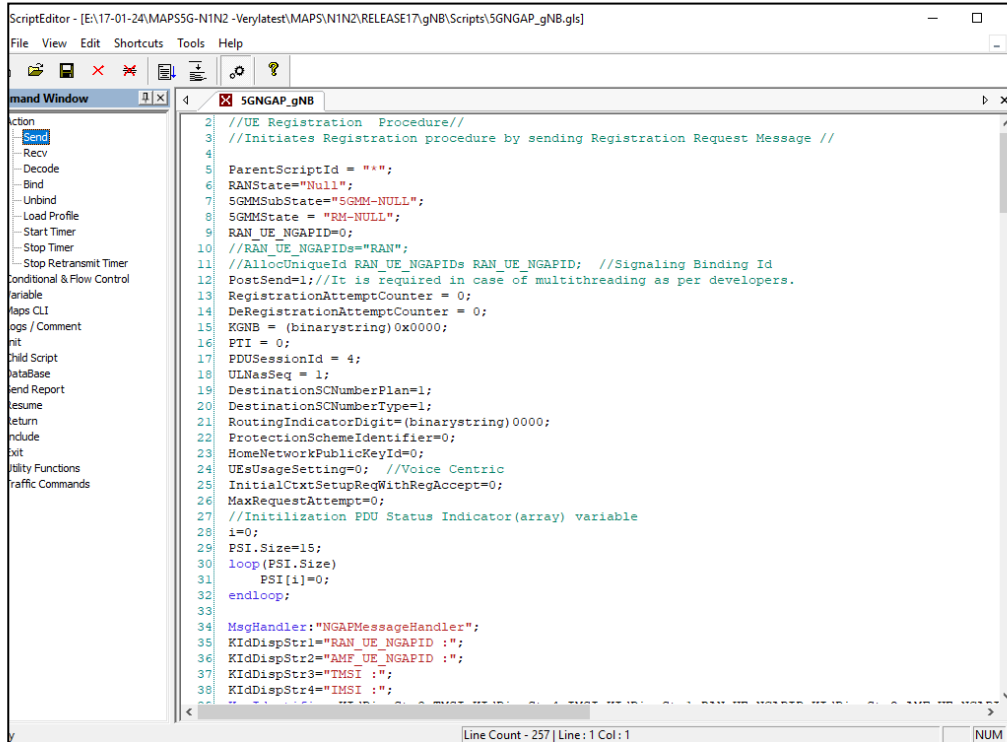
PROFILE EDITOR - This feature allows loading profile to edit the values of variables using GUI, replacing the original value of variables in the message template. An XML file defines a set of multiple profiles with varying parameter values which allows users to configure call instances in call generation to receive calls. The UE_Profiles includes 5G parameters, that is required to configure multiple UEs to emulate Signaling, Traffic, VoLTE calls. User can configure Mobile Traffic parameters, allowing emulation of offline HTTP Traffic using Mobile IP Core TCP Client Server connections.

The screenshot shows the Profile Editor interface for UE_Profiles. The main window is titled "MAPS gNB (N1N2 RELEASE17) - [Profile Editor - UE_Profiles]". The interface is divided into several sections:

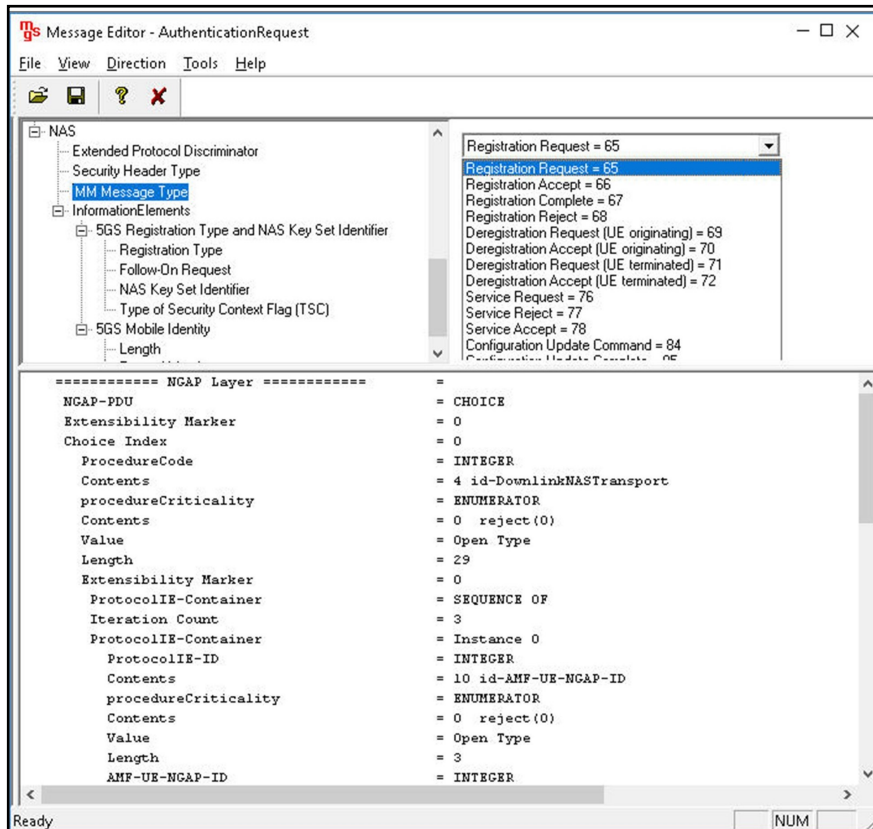
- Profiles List (Left):** A list of profiles with IDs ranging from MSIN3012041631 to MSIN3012041663.
- Config Tree (Center):** A hierarchical tree view for the selected profile (MSIN3012041631). The tree includes:
 - Registration Parameters:** Registration Type (Initial Registration), SMS Over NAS Transport Requested (Not Supported), Follow On Request (No Follow On Request Pending), NG RAN Radio Capability Update (Not Needed).
 - Mobile Identity:** Type Of Identity (SUCI), SUCI (SUPI Format: IMSI, IMSI: 001013012041631, TMSI: 10000001, IMEI: 359877068325248, IMEISV: 1234567890123001, MSISDN: 3012041631).
 - GMM Capability:** S1 Mode (Not Supported), HO Attach (Not Supported), LPP Capability (LPP in N1 Mode not supported).
 - Requested NSSAI:** RNSSAI (RNSSAI 1: Requesting NSSAI SST: eMBB, Requesting NSSAI SD: 1), Include UEContextRequest IE (True), RRC Establish Cause (MO Signaling).
 - Tracking Area Information:** TAC (001), Cell Identity (00000001).
 - Authentication Parameters:** Authentication Type (5G-AKA), Authentication Algorithm Type (Milenage), Key (00112233445566778899aabbccddeeff), Operator Variant Parameter Type (OPc), OP (01020304050607080910111213141516010...), OPc (01020304050607080910111213141516), NAS Key Set Identifier (7), Type Of Security Context Flag (Native Security Context).
 - SM Parameters:** Service Type (Signaling).
 - Deregistration Parameters:** AccessType (3GPP Access), Switch Off (SwitchOff).
- Enable/Action (Right):** An "Enable" checkbox is checked. Below it are buttons for "Add", "Insert", and "Delete".
- Bottom Bar:** Includes "Insert", "Delete", and "Clear" buttons, and a status bar with "Initialisation Errors", "Error Events", and "Captured Errors" indicators.

Pre-processing Tools (Contd.)

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.



MESSAGE EDITOR - The message editor allows user to build a template for each protocol message type. The value for each field may be changed in the message template prior to testing. The protocol fields comprise of mandatory and optional parameters.



Call Generation and Call 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 once, multiple iterations and continuously. Also, allows users 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 call generation, and at the call reception, the script is automatically triggered by incoming messages.

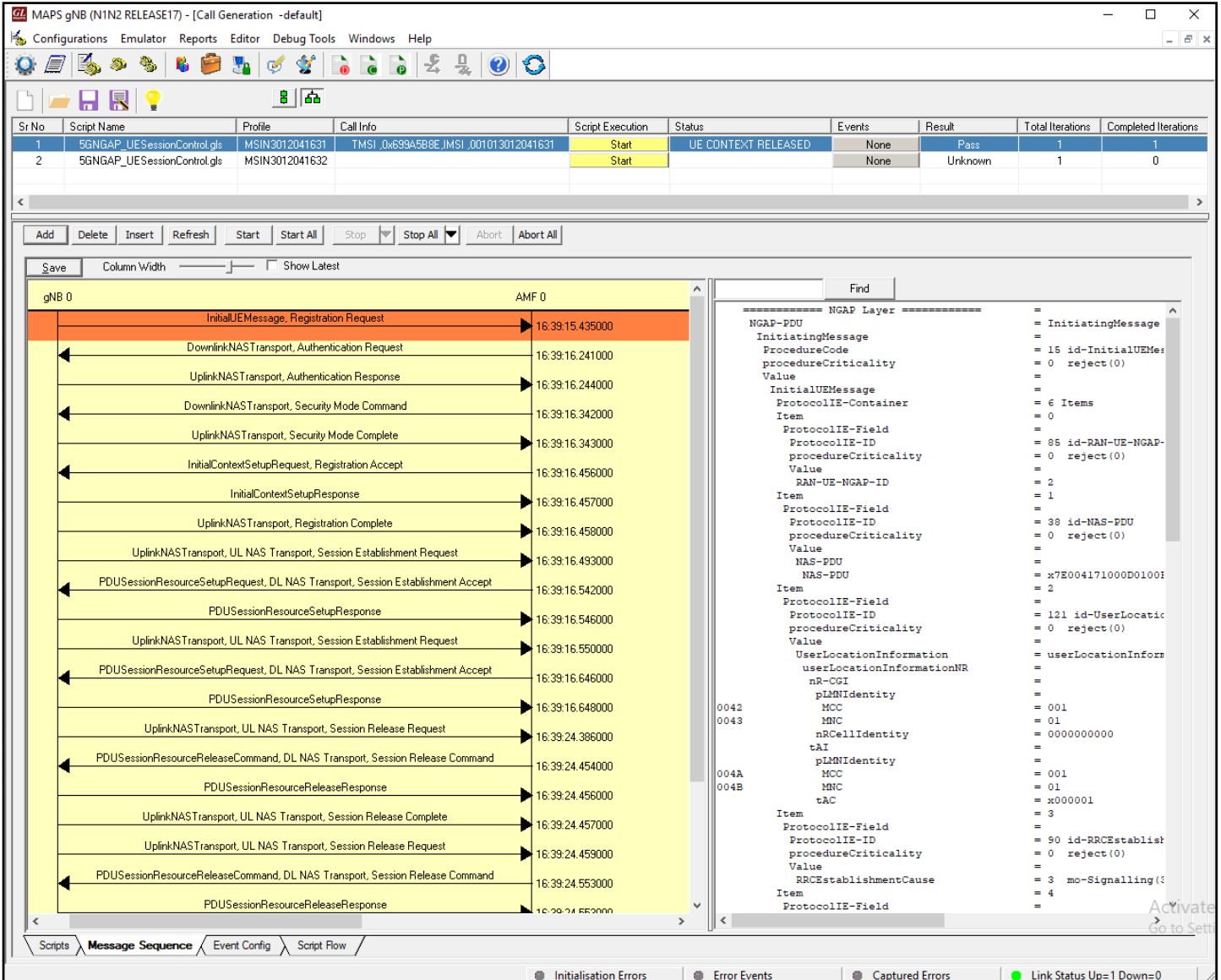


Figure: Call Generation

Call Generation and Call Reception (Contd.)

The screenshot displays the MAPS AMF (N1N2 RELEASE17) - [Call Reception] interface. The top menu bar includes Configurations, Emulator, Reports, Editor, Debug Tools, Windows, and Help. Below the menu is a toolbar with various icons. A table at the top shows script execution details:

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	NGAPManagementHandler.gls		RANName: gnb000000001, gNBId: 0x10000001, ConnectionId: 1001	Stop	NG Setup Successful	SendAMFConfigurationUpdate		Pass
2	AMFSessionControl.gls		MSIN: 3012041631	Completed	UE-CONTEXT RELEASED	None		Pass

Below the table are control buttons: Stop, Stop All, Abort, Abort All, Show Records, Select Active Call, Auto Trash, Trash, Show Hidden Calls. The main area is split into two panes:

- Left Pane (Message Sequence):** Shows a sequence of messages between gNB 0 and AMF. The messages include:
 - InitialUEMessage, Registration Request (16:39:16.093000)
 - DownlinkNASTransport, Authentication Request (16:39:16.146000)
 - UplinkNASTransport, Authentication Response (16:39:16.310000)
 - DownlinkNASTransport, Security Mode Command (16:39:16.312000)
 - UplinkNASTransport, Security Mode Complete (16:39:16.410000)
 - InitialContextSetupRequest, Registration Accept (16:39:16.418000)
 - InitialContextSetupResponse (16:39:16.511000)
 - UplinkNASTransport, Registration Complete (16:39:16.511000)
 - UplinkNASTransport, UL NAS Transport, Session Establishment Request (16:39:16.512000)
 - PDU Session Resource Setup Request, DL NAS Transport, Session Establishment Accept (16:39:16.516000)
 - PDU Session Resource Setup Response (16:39:16.611000)
 - UplinkNASTransport, UL NAS Transport, Session Establishment Request (16:39:16.612000)
 - PDU Session Resource Setup Request, DL NAS Transport, Session Establishment Accept (16:39:16.614000)
 - PDU Session Resource Setup Response (16:39:16.713000)
 - UplinkNASTransport, UL NAS Transport, Session Release Request (16:39:24.424000)
 - PDU Session Resource Release Command, DL NAS Transport, Session Release Command (16:39:24.426000)
 - PDU Session Resource Release Response (16:39:24.527000)
 - UplinkNASTransport, UL NAS Transport, Session Release Complete (16:39:24.528000)
 - UplinkNASTransport, UL NAS Transport, Session Release Request (16:39:24.529000)
 - PDU Session Resource Release Command, DL NAS Transport, Session Release Command (16:39:24.529000)
 - PDU Session Resource Release Response (16:39:24.626000)
 - UplinkNASTransport, UL NAS Transport, Session Release Complete (16:39:24.626000)
- Right Pane (Find):** Shows a detailed protocol stack analysis for the selected message. The stack includes:
 - NGAP-PDU
 - InitiatingMessage (0)
 - ProcedureCode = 15 id-InitialUEMessage
 - procedureCriticality = 0 reject(0)
 - Value
 - InitialUEMessage
 - ProtocolIE-Container = 6 Items
 - Item
 - ProtocolIE-Field
 - ProtocolIE-ID = 85 id-RAN-UE-NGAP-ID
 - procedureCriticality = 0 reject(0)
 - Value
 - RAN-UE-NGAP-ID = 2
 - Item = 1
 - ProtocolIE-Field
 - ProtocolIE-ID = 38 id-NAS-PDU
 - procedureCriticality = 0 reject(0)
 - Value
 - NAS-PDU
 - NAS-PDU = x7E004171000D0100F11000000
 - Item = 2
 - ProtocolIE-Field
 - ProtocolIE-ID = 121 id-UserLocationInforma
 - procedureCriticality = 0 reject(0)
 - Value
 - UserLocationInformation
 - userLocationInformationNR
 - nR-CGI
 - PLMNIIdentity
 - MCC = 001
 - MNC = 01
 - nRCellIdentity = 0000000000
 - tAI
 - PLMNIIdentity
 - MCC = 001
 - MNC = 01
 - tAC = x000001
 - Item = 3
 - ProtocolIE-Field
 - ProtocolIE-ID = 90 id-RRCEstablishmentCaus
 - procedureCriticality = 0 reject(0)
 - Value
 - RRCEstablishmentCause = 3 mo-Signalling(3)
 - Item = 4
 - ProtocolIE-Field
 - ProtocolIE-ID = 3 id-AMFSetID
 - procedureCriticality = 0 reject(0)
 - Value

At the bottom, there are tabs for Scripts, Message Sequence, Event Config, and Script Flow. A status bar at the very bottom shows: Initialisation Errors, Error Events, Captured Errors, and Link Status Up=1 Down=0.

Figure: Call Reception

Emulation of 5G N1N2 Signaling Procedure

The below 5G N1N2 signaling procedure indicates the messages flow between gNodeB (gNB) and AMF, which are emulated using MAPS™ application.

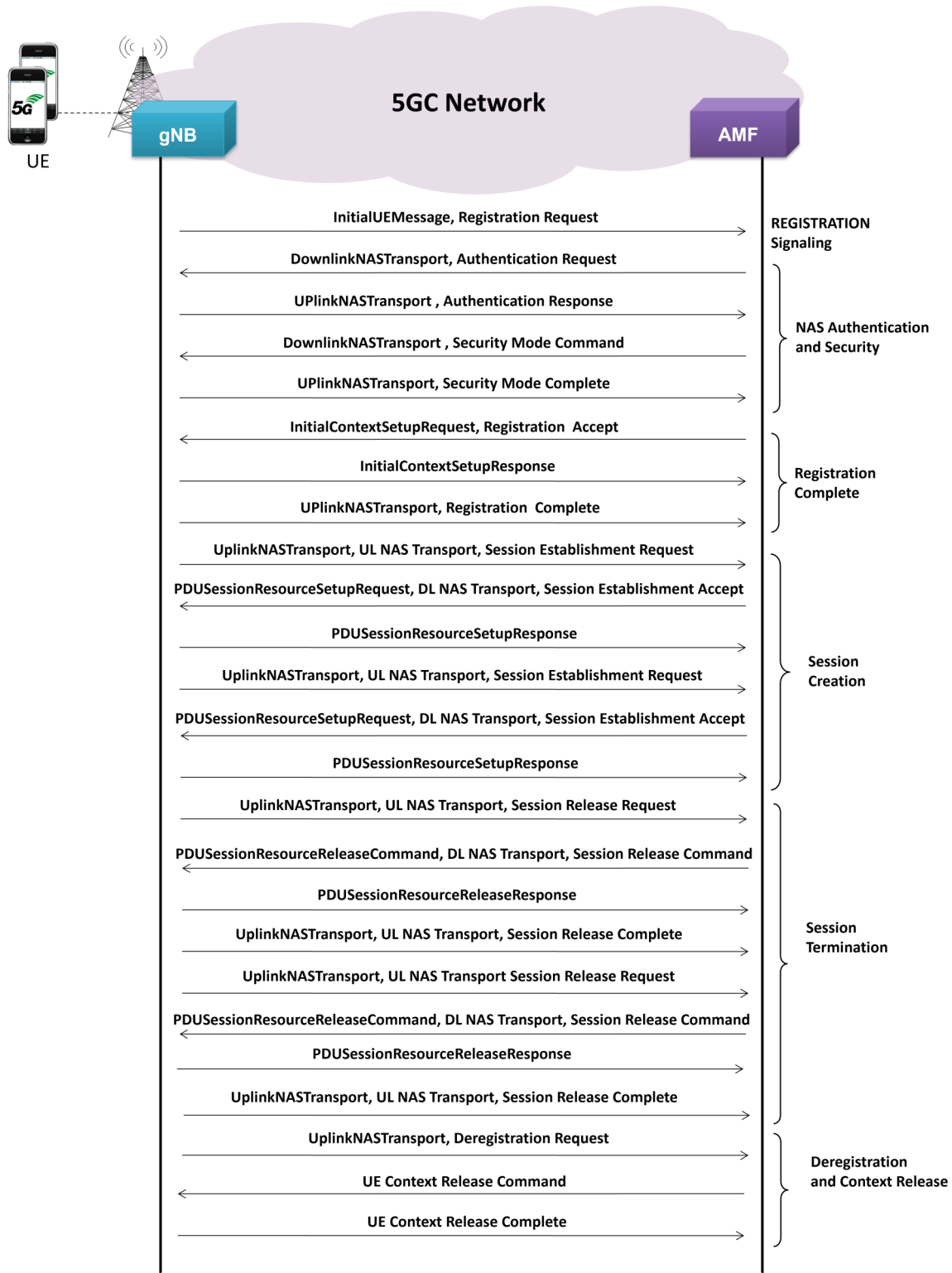
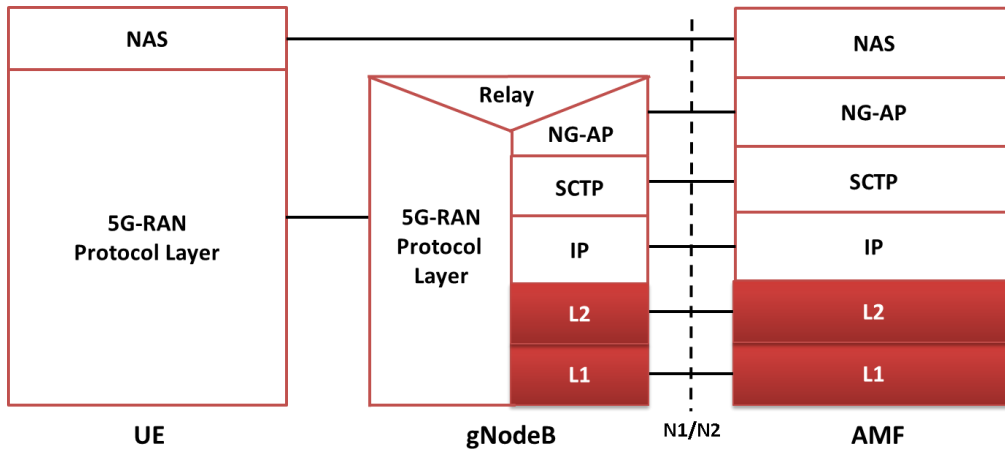


Figure: 5G N1N2 Signaling Procedure

Supported Protocols and Specifications



Supported Protocols	Standard / Specification
N1N2 Interface (gNB - AMF)	TS24.501
System Architecture for the 5G	3GPP TS 23.501
Non-Access-Stratum (NAS)	3GPP TS 24.501
NG Application Protocol (NGAP)	3GPP TS 38.413
SCTP	RFC 4960
GPRS Tunneling Protocol for User Plane (GTP-U)	3GPP TS 29.281

Command Line Interface (CLI)

MAPS™ can be configured as server-side application, to enable remote controlling of the application through multiple command-line based clients. Supported clients include Python.

Clients can remotely perform all functions such as start testbed setup, load scripts, and profiles, apply user events such as send digits/file/tones, detect digits/file/tones, dial, originate call, terminate call, start and stop traffic. Users can also generate and receive calls through commands. This client application is distributed along with MAPS™ Server application.

```

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-NIN2\MAPSCLI\PythonClient\example\gNB\NIN2_PlaceCall_Default.py
NIN2 Server Connection... True
NIN2 Testbed Starting ... 0
True
NIN2 Profile Loading... True
Check NGAP Link Status... True
NIN2 Call Initiated... True
Call Status... RM-REGISTER-INITIATED
Call Status... REGISTRATION-COMPLETED

FDU Session Initiate for Dnn ims ... True
FDU Session Established

FDU Session Initiate for Dnn internet ... True
FDU Session Established

De-register Initiated... True
Total Signalling Messages: 25
NIN2 Call's LastMSGRCv....
Time Stamp Route Message
12:11:23.444 <- UEContextReleaseCommand, , ,
***** NIN2 Call Message Flow *****
CLI(gNB) <-> DUT(AMF)
Time Stamp Route Message
12:11:10.424 -> InitialUEMessage, Registration Request
12:11:11.537 <- DownlinkNASTransport, Authentication Request, ,
12:11:11.552 -> UplinkNASTransport, Authentication Response
12:11:11.637 <- DownlinkNASTransport, Security Mode Command, ,
12:11:11.650 -> UplinkNASTransport, Security Mode Complete
12:11:12.903 <- InitialContextSetupRequest, Registration Accept, ,
12:11:11.929 -> InitialContextSetupResponse
12:11:11.937 -> UplinkNASTransport, Registration Complete
12:11:12.046 -> UplinkNASTransport, UL NAS Transport, Session Establishment Request
12:11:12.244 <- FDUSessionResourceSetupRequest, DL NAS Transport, , Session Establishment Accept
12:11:12.324 -> FDU Session Resource Setup Response
12:11:12.464 -> UplinkNASTransport, UL NAS Transport, Session Establishment Request
12:11:12.639 <- FDUSessionResourceSetupRequest, DL NAS Transport, , Session Establishment Accept
12:11:12.707 -> FDU Session Resource Setup Response
12:11:12.858 -> UplinkNASTransport, UL NAS Transport, Session Release Request
12:11:12.046 <- FDUSessionResourceReleaseCommand, DL NAS Transport, , Session Release Command
12:11:12.058 -> FDU Session Resource Release Response
12:11:12.069 -> UplinkNASTransport, UL NAS Transport, Session Release Complete
12:11:12.083 -> UplinkNASTransport, UL NAS Transport, Session Release Request
12:11:12.245 <- FDUSessionResourceReleaseCommand, DL NAS Transport, , Session Release Command
12:11:12.255 -> FDU Session Resource Release Response
12:11:12.262 -> UplinkNASTransport, UL NAS Transport, Session Release Complete
12:11:12.283 -> UplinkNASTransport, Deregistration Request
12:11:12.444 <- UEContextReleaseCommand, , ,
12:11:12.453 -> UEContextReleaseComplete
NIN2 Script Stopping... True
NIN2 Server Disconnecting... True
>>>
===== RESTART: C:\Program Files\GL Communications Inc\MAPS5
G-NIN2\MAPSCLI\PythonClient\example\gNB\NIN2_PlaceCall_Default.py =====
Ln: 111 Col: 4

```

Figure: Sample Python Client

```

CLI MapsCLI gNB (NIN2 RELEASE17)
File Edit View
View Latest Command
1: 2024-2-19 12:19:37.252000 : Start "TestBedDefault.xml" = "gNB[0].gNBIPAddress[0]"="192.168.12.28","_TypeOfUESimulation"="XML";
1: 2024-2-19 12:19:51.469000 : LoadProfile "UE_Profiles.xml"
1: 2024-2-19 12:19:59.012000 : StartScript "1\NGAP_L1ESessionControl.gls" "MSIN3012041631" 1 "MSIN"="(binarystring)3012041631," "IMSI"="(binarystring)001013012041631,";
1: 2024-2-19 12:20:01.201000 : UserEvent 1 "IsTransportUp";
1: 2024-2-19 12:20:03.600000 : UserEvent 1 "StartRegistration";
1: 2024-2-19 12:20:05.250000 : UserEvent 1 "SessionEstablish";
1: 2024-2-19 12:20:05.580000 : UserEvent 1 "SessionEstablish";
1: 2024-2-19 12:20:15.852000 : UserEvent 1 "DeRegister";
1: 2024-2-19 12:20:26.344000 : UserEvent 1 "GetMessageCount";
1: 2024-2-19 12:20:26.349000 : UserEvent 1 "GetLastReceivedMessage";
1: 2024-2-19 12:20:26.454000 : UserEvent 1 "GetMessageCount";
1: 2024-2-19 12:20:26.574000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
1: 2024-2-19 12:20:26.679000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
1: 2024-2-19 12:20:26.783000 : UserEvent 1 "GetMessageInfo" # "Index"=2;
1: 2024-2-19 12:20:26.888000 : UserEvent 1 "GetMessageInfo" # "Index"=3;
1: 2024-2-19 12:20:27.008000 : UserEvent 1 "GetMessageInfo" # "Index"=4;
1: 2024-2-19 12:20:27.113000 : UserEvent 1 "GetMessageInfo" # "Index"=5;
1: 2024-2-19 12:20:27.218000 : UserEvent 1 "GetMessageInfo" # "Index"=6;
1: 2024-2-19 12:20:27.338000 : UserEvent 1 "GetMessageInfo" # "Index"=7;
1: 2024-2-19 12:20:27.443000 : UserEvent 1 "GetMessageInfo" # "Index"=8;
1: 2024-2-19 12:20:27.548000 : UserEvent 1 "GetMessageInfo" # "Index"=9;
1: 2024-2-19 12:20:27.653000 : UserEvent 1 "GetMessageInfo" # "Index"=10;
1: 2024-2-19 12:20:27.773000 : UserEvent 1 "GetMessageInfo" # "Index"=11;
1: 2024-2-19 12:20:27.878000 : UserEvent 1 "GetMessageInfo" # "Index"=12;
1: 2024-2-19 12:20:28.103000 : UserEvent 1 "GetMessageInfo" # "Index"=13;
1: 2024-2-19 12:20:28.208000 : UserEvent 1 "GetMessageInfo" # "Index"=14;
1: 2024-2-19 12:20:28.313000 : UserEvent 1 "GetMessageInfo" # "Index"=15;
1: 2024-2-19 12:20:28.418000 : UserEvent 1 "GetMessageInfo" # "Index"=16;
1: 2024-2-19 12:20:28.538000 : UserEvent 1 "GetMessageInfo" # "Index"=17;
1: 2024-2-19 12:20:28.643000 : UserEvent 1 "GetMessageInfo" # "Index"=18;
1: 2024-2-19 12:20:28.748000 : UserEvent 1 "GetMessageInfo" # "Index"=19;
1: 2024-2-19 12:20:28.873000 : UserEvent 1 "GetMessageInfo" # "Index"=20;
1: 2024-2-19 12:20:29.078000 : UserEvent 1 "GetMessageInfo" # "Index"=21;
1: 2024-2-19 12:20:29.198000 : UserEvent 1 "GetMessageInfo" # "Index"=22;
1: 2024-2-19 12:20:29.303000 : UserEvent 1 "GetMessageInfo" # "Index"=23;
1: 2024-2-19 12:20:29.408000 : UserEvent 1 "GetMessageInfo" # "Index"=24;
1: 2024-2-19 12:20:30.728000 : StopScript 1;
ServerLog:errCode = 0,errString = connection has been gracefully closed for ClientId = 1
NUM

```

Figure: MAPS™ CLI Server

Buyer's Guide

Item No	Product Description
PKS500	MAPS™ 5G N1N2 Interface Emulator
ETH101	Mobile Traffic Core - GTP
ETH102	Mobile Traffic Core - Gateway

Item No	Related Software
PKS305	MAPS™ 5G Multi-Interface Emulation
PKS501	MAPS™ 5G N4 Interface Emulator
PKS502	MAPS™ 5G N17 Interface Emulator
PKS503	MAPS™ 5G N8 Interface Emulator (Requires PKS502)
PKS504	MAPS™ 5G N10 Interface Emulator (Requires PKS502)
PKS505	MAPS™ 5G N11 Interface Emulator (Requires PKS502)
PKS506	MAPS™ 5G N12 Interface Emulator (Requires PKS502)
PKS507	MAPS™ 5G N13 Interface Emulator (Requires PKS502)
PKS508	MAPS™ 5G N20 Interface Emulator (Requires PKS502)
PKS509	MAPS™ 5G N21 Interface Emulator (Requires PKS502)
PKS510	MAPS™ 5G N22 Interface Emulator (Requires PKS502)
PKS511	MAPS™ 5G N29 and N51 Interface Emulator (Requires PKS502)
PKS170	CLI Support for MAPS™

For complete list of MAPS™ products, please refer to [Message Automation & Protocol Simulation \(MAPS™\)](#) webpage.



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