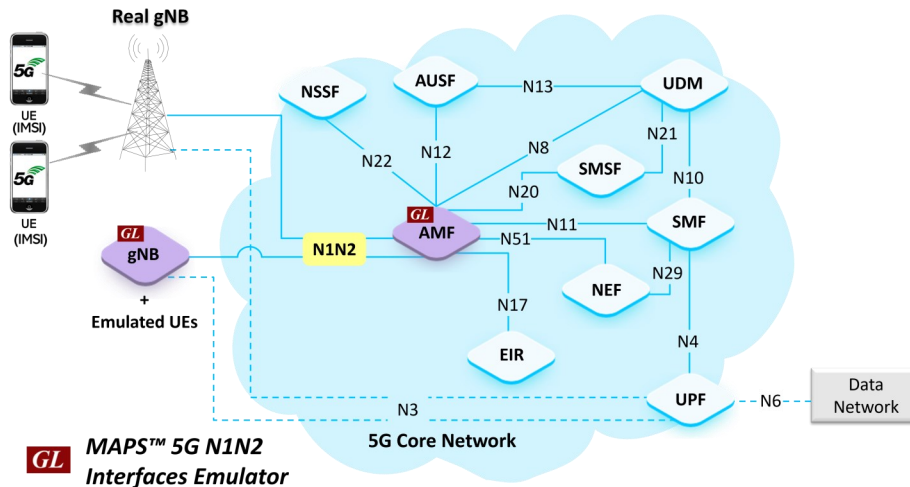


# MAPS™ 5G N1N2 (NGAP) Emulator



## 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 (Release 17).

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, 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



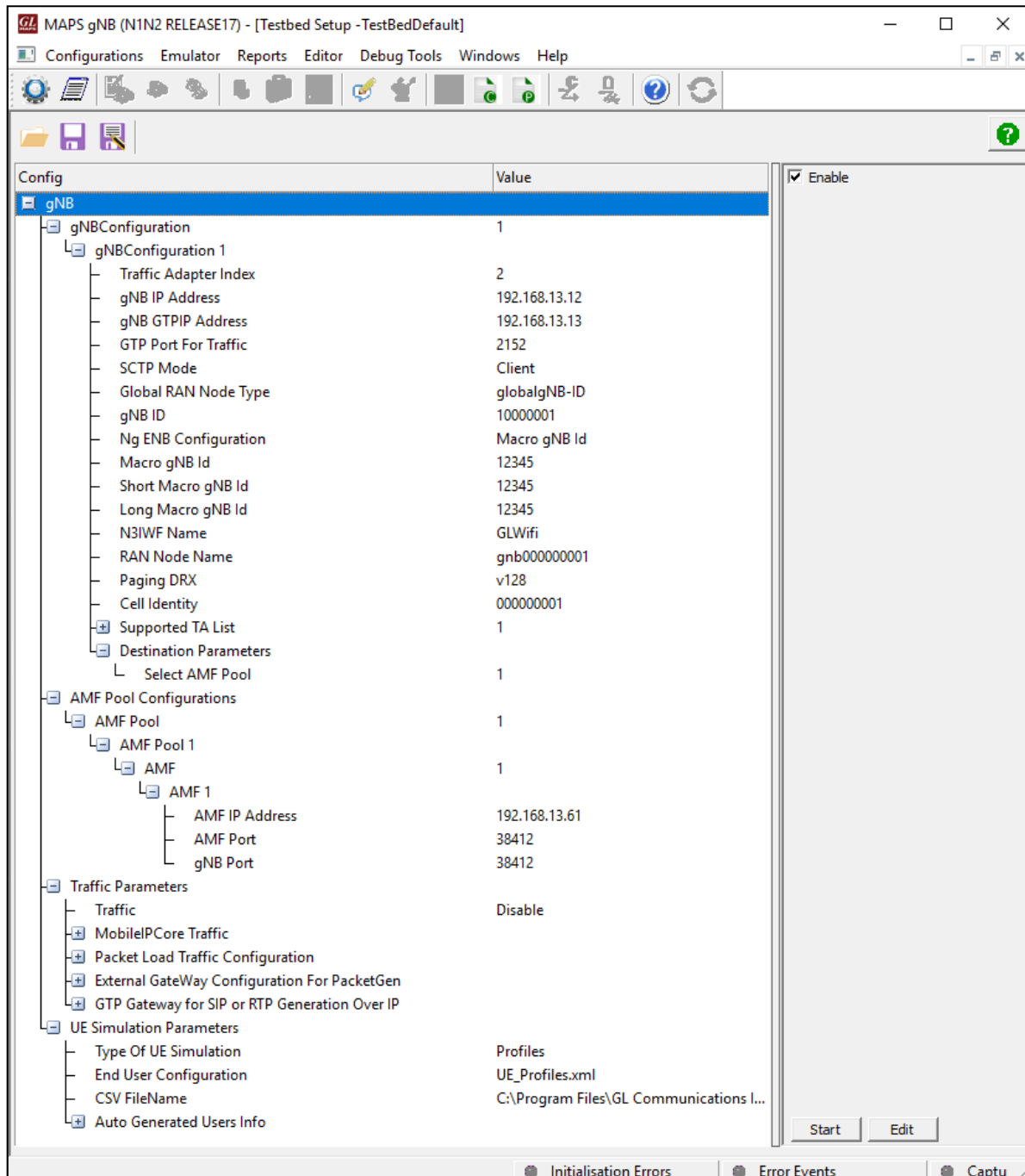
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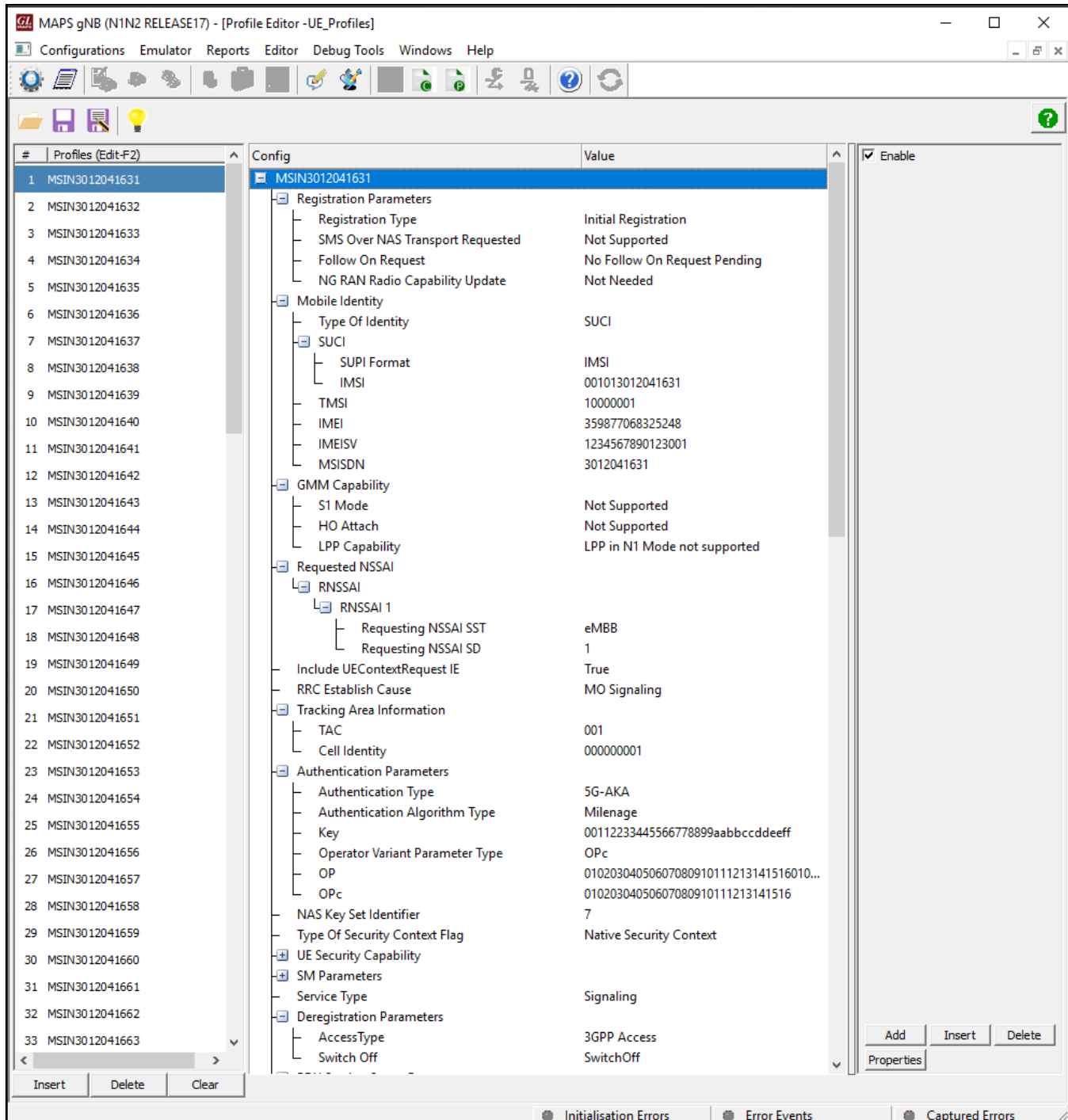
## Testbed Configuration

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.



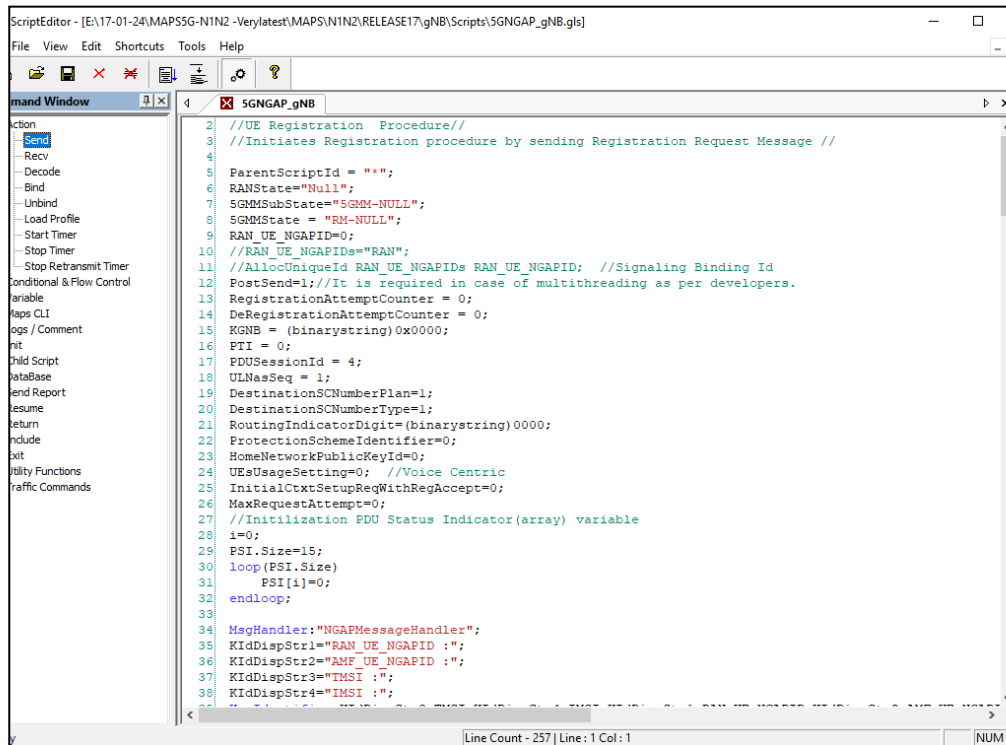
## Pre-processing Tools

**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.

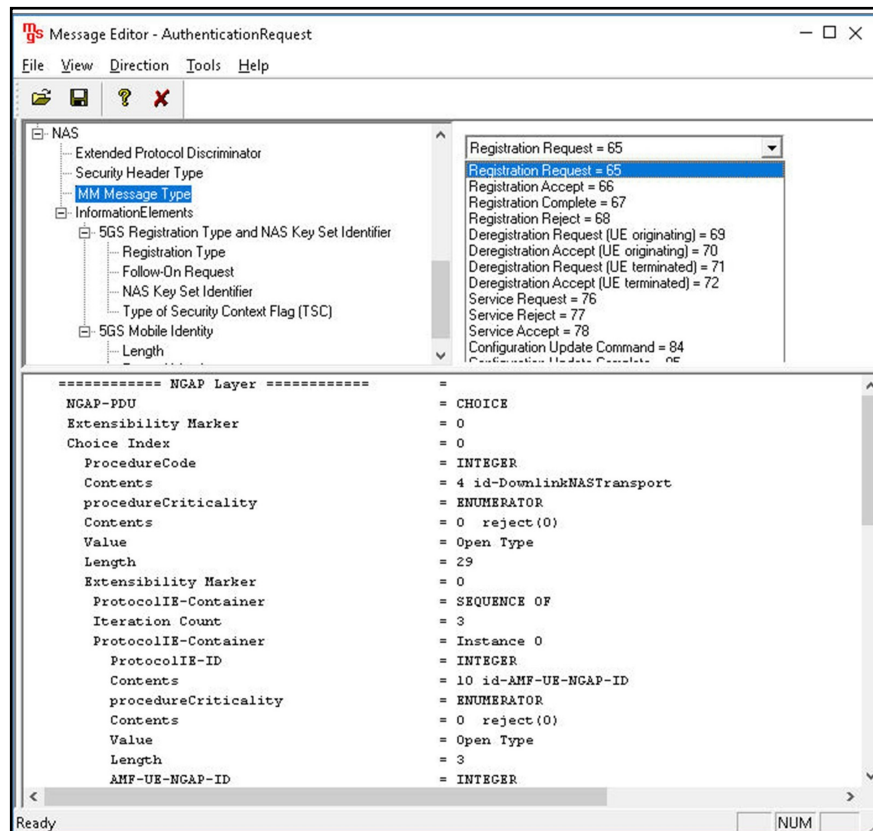


## Pre-processing Tools (Contd.)

**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.

The screenshot displays the MAPS gNB (N1N2 RELEASE17) - [Call Generation - default] interface. The top section shows a table of test scripts with columns: Sr No, Script Name, Profile, Call Info, Script Execution, Status, Events, Result, Total Iterations, and Completed Iterations. Below the table are buttons for Add, Delete, Insert, Refresh, Start, Start All, Stop, Stop All, Abort, and Abort All. The main area is divided into two panes. The left pane shows a message sequence diagram for gNB 0 and AMF 0, with messages like InitialUEMessage, Registration Request, DownlinkNASTransport, Authentication Request, etc. The right pane shows a detailed view of the NGAP layer messages, including NGAP-PDU, InitiatingMessage, ProcedureCode, and various fields like ProtocolIE-Container, ProtocolIE-ID, and Value.

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	5GNGAP_UESessionControl.gls	MSIN3012041631	TMSI_0x699A5B8E,MSI_001013012041631	Start	UE CONTEXT RELEASED	None	Pass	1	1
2	5GNGAP_UESessionControl.gls	MSIN3012041632		Start		None	Unknown	1	0

Buttons: Add, Delete, Insert, Refresh, Start, Start All, Stop, Stop All, Abort, Abort All

gNB 0 AMF 0

InitialUEMessage, Registration Request 16:39:15.435000

DownlinkNASTransport, Authentication Request 16:39:16.241000

UplinkNASTransport, Authentication Response 16:39:16.244000

DownlinkNASTransport, Security Mode Command 16:39:16.342000

UplinkNASTransport, Security Mode Complete 16:39:16.343000

InitialContextSetupRequest, Registration Accept 16:39:16.456000

InitialContextSetupResponse 16:39:16.457000

UplinkNASTransport, Registration Complete 16:39:16.458000

UplinkNASTransport, UL NAS Transport, Session Establishment Request 16:39:16.493000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept 16:39:16.542000

PDUSessionResourceSetupResponse 16:39:16.546000

UplinkNASTransport, UL NAS Transport, Session Establishment Request 16:39:16.550000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept 16:39:16.646000

PDUSessionResourceSetupResponse 16:39:16.648000

UplinkNASTransport, UL NAS Transport, Session Release Request 16:39:24.386000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command 16:39:24.454000

PDUSessionResourceReleaseResponse 16:39:24.456000

UplinkNASTransport, UL NAS Transport, Session Release Complete 16:39:24.457000

UplinkNASTransport, UL NAS Transport, Session Release Request 16:39:24.459000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command 16:39:24.553000

PDUSessionResourceReleaseResponse 16:39:24.553000

Find

NGAP Layer

NGAP-PDU = InitiatingMessage

InitiatingMessage =

ProcedureCode = 15 id-InitialUEMes

procedureCriticality = 0 reject (0)

Value =

InitialUEMessage =

ProtocolIE-Container = 6 Items

Item = 0

ProtocolIE-Field =

ProtocolIE-ID = 85 id-RAN-UE-NGAP-

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 = x7E004171000D01001

Item = 2

ProtocolIE-Field =

ProtocolIE-ID = 121 id-UserLocatic

procedureCriticality = 0 reject (0)

Value =

UserLocationInformation =

userLocationInformationNR =

nR-CGI =

pLMNIdentity =

0042 MCC = 001

0043 MNC = 01

nRCellIdentity = 0000000000

tAI =

pLMNIdentity =

004A MCC = 001

004B MNC = 01

tAC = x000001

Item = 3

ProtocolIE-Field =

ProtocolIE-ID = 90 id-RRCEstablish

procedureCriticality = 0 reject (0)

Value =

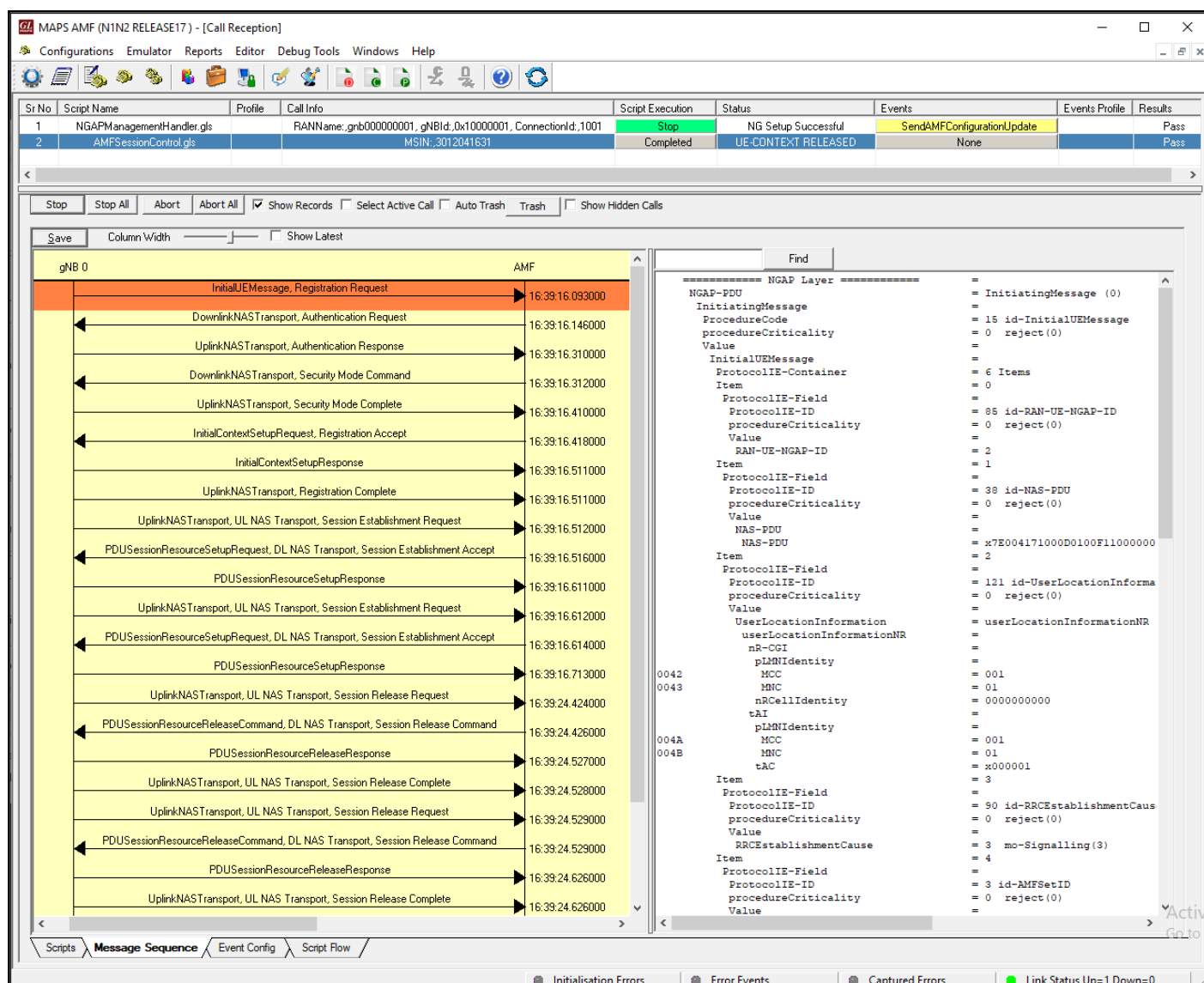
RRCEstablishmentCause = 3 mo-Signalling (S

Item = 4

ProtocolIE-Field =

Figure: Call Generation

## Call Generation and Call Reception (Contd.)



### 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.

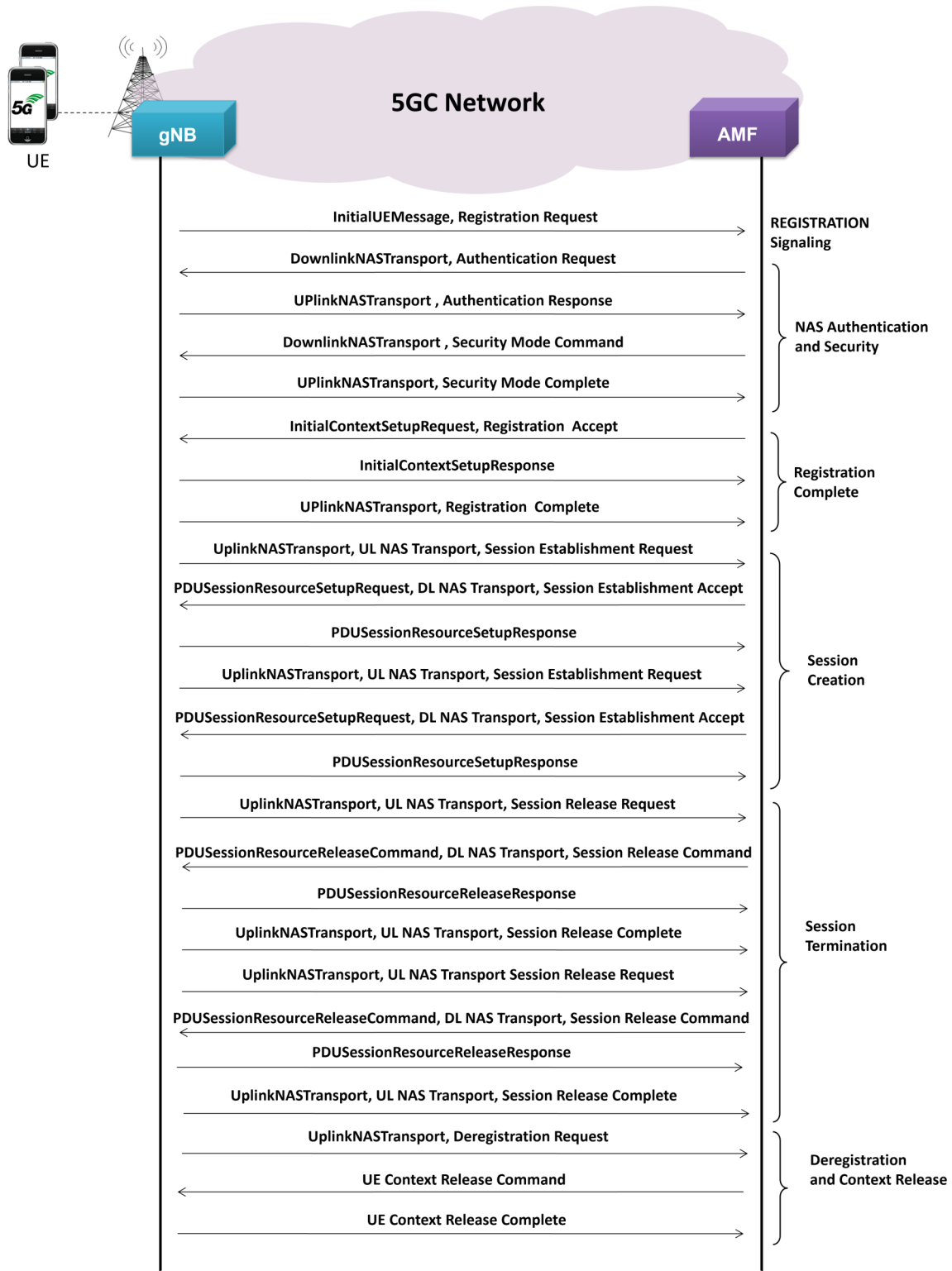
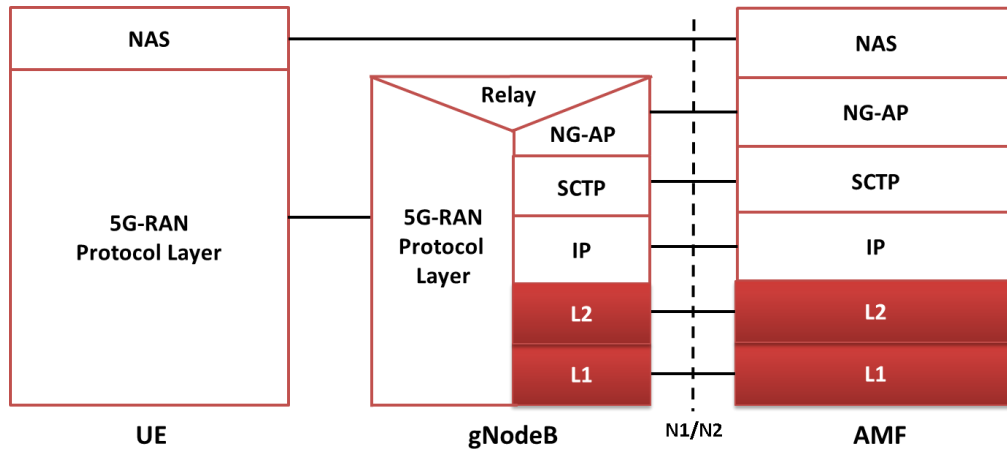


Figure: 5G N1N2 Signaling Procedure

## Supported Protocols and Specifications



Supported Protocols	Standard / Specification
N1N2 Interface (gNB - AMF)	TS24.501 (Release 17)
System Architecture for the 5G	3GPP TS 23.501 (Release 17)
Non-Access-Stratum (NAS)	3GPP TS 24.501 (Release 17)
NG Application Protocol (NGAP)	3GPP TS 38.413 (Release 17)
SCTP	RFC 4960
GPRS Tunneling Protocol for User Plane (GTP-U)	3GPP TS 29.281 (Release 17)



## 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-N1N2\MAPSCLI\PythonClient\examples\gNB\N1N2_PlaceCall_Default.py
N1N2 Server Connection... True
N1N2 Testbed Starting ... 0
True
N1N2 Profile Loading... True
Check NGAP Link Status... True
N1N2 Call Initiated... True
Call Status... RN-REGISTER-INITIATED
Call Status... REGISTRATION-COMPLETED

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

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

De-register Initiated... True
Total Signalling Messages: 25
N1N2 Call's LastMSGRCv....
Time Stamp      Route      Message
12:11:23.444    <-      UEContextReleaseCommand, , ,

***** N1N2 Call Message Flow *****
CLI(gNB) <--> DUT(AMF)

Time Stamp      Route      Message
12:11:10.624    ->      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
12:11:11.903    <-      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    <-      PDUSessionResourceSetupRequest, DL NAS Transport, , Session Establishment Accept
12:11:12.324    ->      PDU Session Resource Setup Response
12:11:12.464    ->      UplinkNASTransport, UL NAS Transport, Session Establishment Request
12:11:12.639    <-      PDUSessionResourceSetupRequest, DL NAS Transport, , Session Establishment Accept
12:11:12.707    ->      PDU Session Resource Setup Response
12:11:12.859    <-      UplinkNASTransport, Session Release Request
12:11:12.946    <-      PDUSessionResourceReleaseCommand, DL NAS Transport, , Session Release Command
12:11:12.958    ->      PDU Session Resource Release Response
12:11:12.969    ->      UplinkNASTransport, UL NAS Transport, Session Release Complete
12:11:12.983    ->      UplinkNASTransport, UL NAS Transport, Session Release Request
12:11:12.945    <-      PDUSessionResourceReleaseCommand, DL NAS Transport, , Session Release Command
12:11:12.955    ->      PDU Session Resource Release Response
12:11:12.962    ->      UplinkNASTransport, UL NAS Transport, Session Release Complete
12:11:12.983    ->      UplinkNASTransport, Deregistration Request
12:11:12.944    <-      UEContextReleaseCommand, , ,
12:11:12.953    ->      UEContextReleaseComplete
N1N2 Script Stopping... True
N1N2 Server Disconnecting... True
>>>
===== RESTART: C:\Program Files\GL Communications Inc\MAPS5G-N1N2\MAPSCLI\PythonClient\examples\gNB\N1N2_PlaceCall_Default.py =====
Ln: 111 Col: 4
```

Figure: Sample Python Client

```
CLI MapsCLI gNB (N1N2 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 "SIGMAP_L3SessionControl.gls" "MSIN3012041631" 1 # "MSIN"="(binarystring)3012041631," "IMSI"="(binarystring)3001013012041631,"
1: 2024-2-19 12:20:01.201000 : UserEvent 1 "TransportUp";
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 12:20:26.763000 : 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
<a href="#">PKS500</a>	MAPS™ 5G N1N2 Interface Emulator
<a href="#">ETH101</a>	Mobile Traffic Core - GTP
<a href="#">ETH102</a>	Mobile Traffic Core - Gateway

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

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

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



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