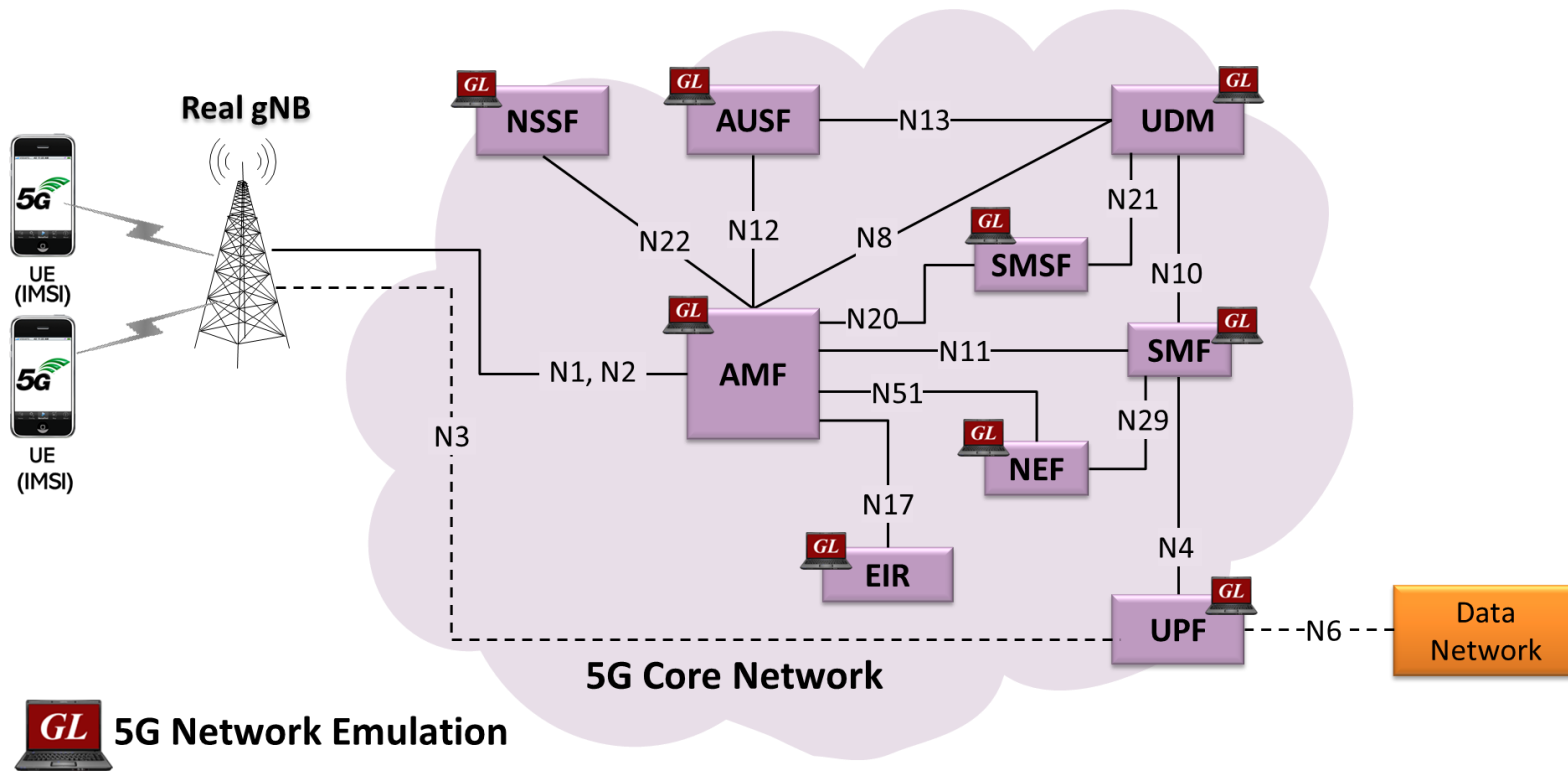

MAPS™ 5G N1N2 Interface Emulator

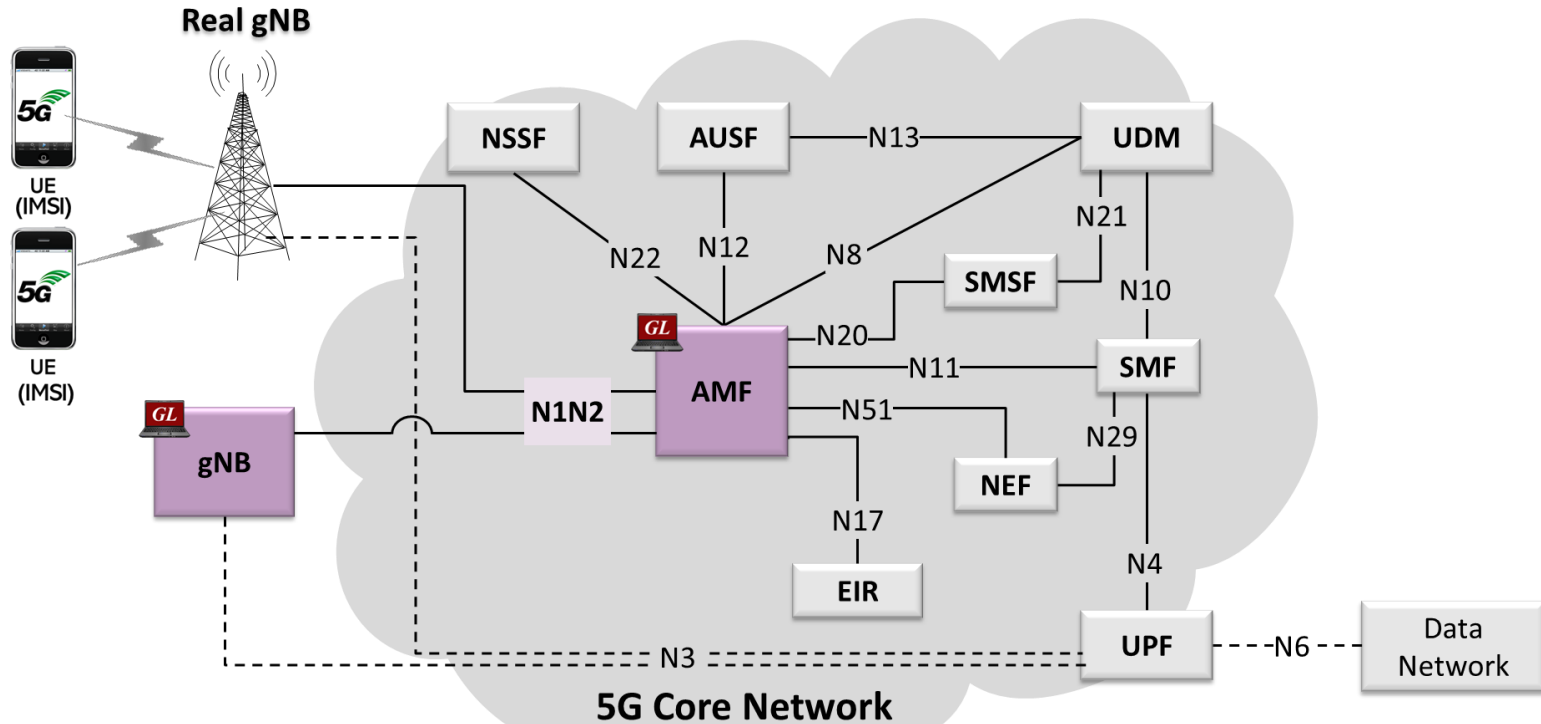


818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



MAPS™ 5G N1N2 Interface Network Architecture

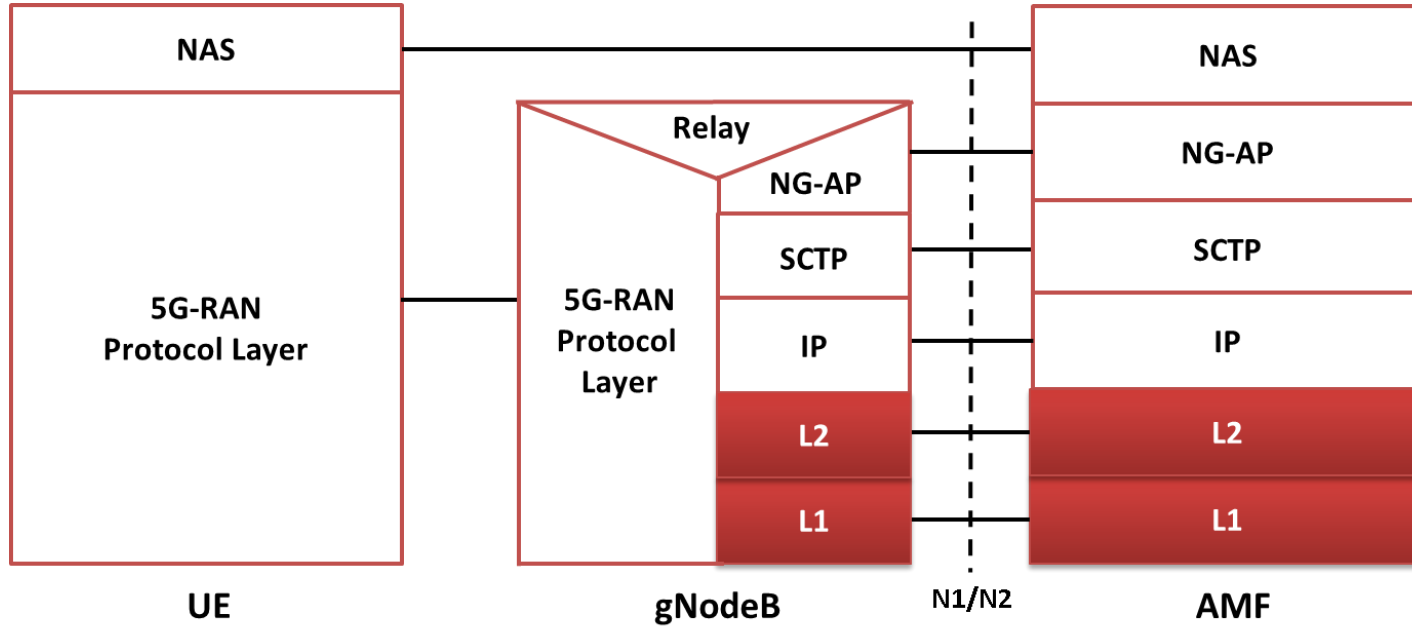


GL MAPS™ 5G N1N2
Interfaces Emulator

Features

- End-to-End 5G Network Emulation
- Emulate UE+gNodeB and AMF nodes
- Supports Control plane signaling and User plane traffic
- Generate and process NGAP/NAS (valid and invalid) messages
- Insertion of impairments to create invalid messages
- Supports 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
- Emulate Massive UEs (up to 64,000) with Voice Traffic
- Emulate User-plane GTP traffic at high line rates (up to 40 Gbps)
- Provides Call Statistics and Events Status

Protocol Stack Specification



Protocol Stack Specification (Contd.)

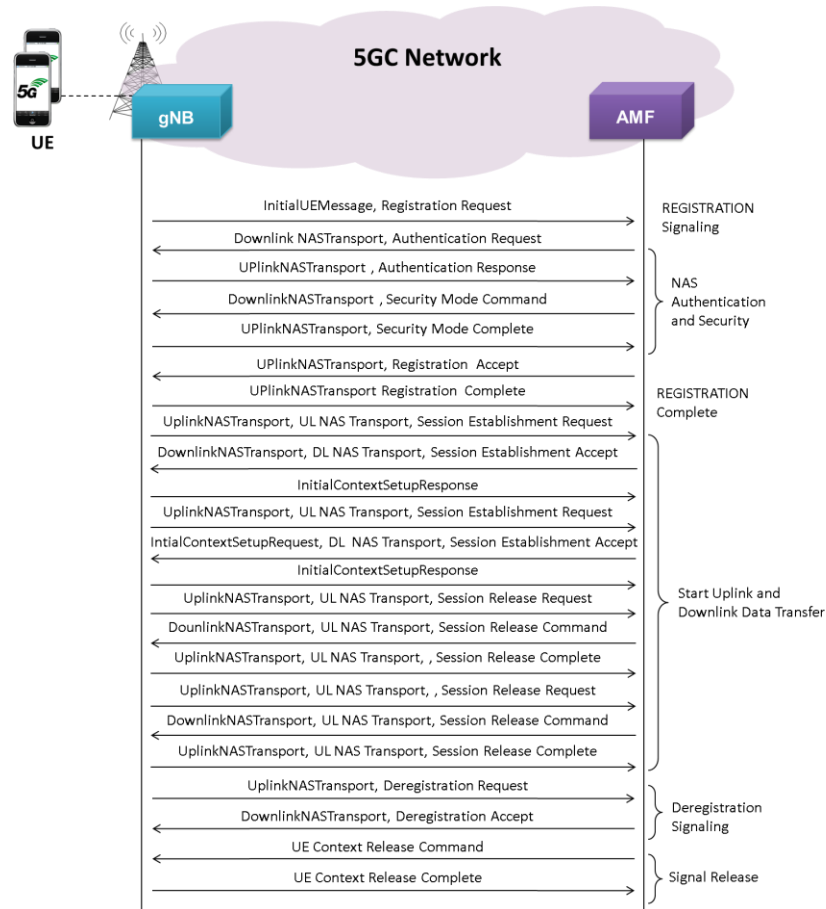
Supported Protocols	Standard / Specification Used
N1N2 Interface (gNB - AMF)	TS24.501
NG-AP	3GPP TS 38.413 V0.7.0 (2018-03)
SCTP	RFC 4960
Non-Access-Stratum (NAS)	3GPP TS 24.501 V1.0.0 (2018-3)
NR and NG-RAN	3GPP TS 28.300 V2.0.0 (2017-12)

- NG Application Protocol (NGAP): Application Layer Protocol between the gNodeB and the AMF
- SCTP for the control plane (SCTP): This protocol guarantees delivery of signaling messages between AMF and gNodeB (N1N2). SCTP is defined in RFC 2960

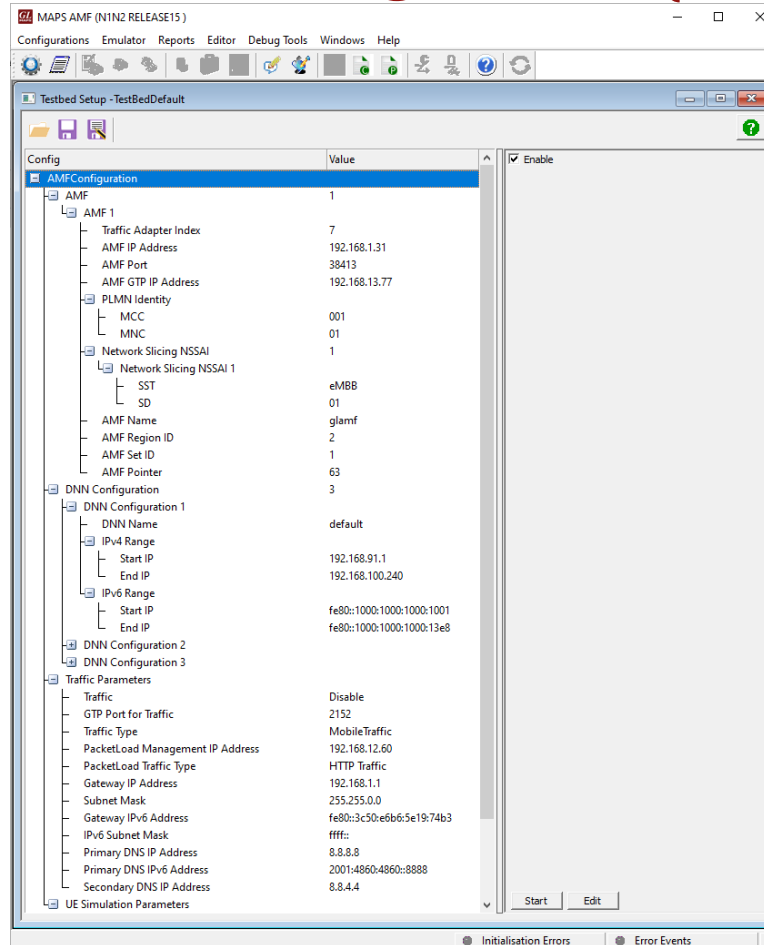
MAPS™ 5G Call Scenarios

- UE Registration Signaling
 - Initial UE Message
 - Downlink NAS Transport
 - Uplink NAS Transport
 - Registration Procedure
 - Authentication Procedure
 - Security Mode Procedure
 - PDN Connectivity Request
 - Initial Context Setup Procedure
- Session Establishment Procedure
 - Session Establishment Request
 - Session Establishment Accept
- Session Release Procedure
 - Session Release Request
 - Session Release Command
 - Session Release Complete
- Deregistration procedures
 - Deregistration Request
 - Deregistration Accept
- UE Context Release Procedure
 - UE Context Release Command
 - UE Context Release Complete

MAPS™ 5G N1N2 Call Scenario



Testbed Configuration (AMF)



Profile Configuration (AMF)

MAPS AMF (N1N2 RELEASE15)

Configurations Emulator Reports Editor Debug Tools Windows Help

Profile Editor -AMF_Profiles

#	Profiles (Edit-F2)	Config	Value	Enable
1	MSIN3012041631	MSIN3012041631		<input checked="" type="checkbox"/>
2	MSIN3012041632			<input type="checkbox"/>
3	MSIN3012041633			<input type="checkbox"/>
4	MSIN3012041634			<input type="checkbox"/>
5	MSIN3012041635			<input type="checkbox"/>
6	MSIN3012041636			<input type="checkbox"/>
7	MSIN3012041637			<input type="checkbox"/>
8	MSIN3012041638			<input type="checkbox"/>
9	MSIN3012041639			<input type="checkbox"/>
10	MSIN3012041640			<input type="checkbox"/>
11	MSIN3012041641			<input type="checkbox"/>
12	MSIN3012041642			<input type="checkbox"/>
13	MSIN3012041643			<input type="checkbox"/>
14	MSIN3012041644			<input type="checkbox"/>
15	MSIN3012041645			<input type="checkbox"/>
16	MSIN3012041646			<input type="checkbox"/>
17	MSIN3012041647			<input type="checkbox"/>
18	MSIN3012041648			<input type="checkbox"/>
19	MSIN3012041649			<input type="checkbox"/>
20	MSIN3012041650			<input type="checkbox"/>
21	MSIN3012041651			<input type="checkbox"/>
22	MSIN3012041652			<input type="checkbox"/>
23	MSIN3012041653			<input type="checkbox"/>
24	MSIN3012041654			<input type="checkbox"/>
25	MSIN3012041655			<input type="checkbox"/>
26	MSIN3012041656			<input type="checkbox"/>
27	MSIN3012041657			<input type="checkbox"/>
28	MSIN3012041658			<input type="checkbox"/>
29	MSIN3012041659			<input type="checkbox"/>
30	MSIN3012041660			<input type="checkbox"/>
31	MSIN3012041661			<input type="checkbox"/>
32	MSIN3012041662			<input type="checkbox"/>

Mobile Identity

- Type Of Identity: SUCI
- IMSI: 001013012041631
- SUCI
 - SUPI Format: IMSI
 - Protection Scheme Identifier: Null Scheme
 - Home Network Public Key Identifier: 0
- IMEI: 359877068325248
- IMEISV: 1234567890123001
- MSISDN: 3012041631

Authentication Parameters

- Authentication Type: 5G-AKA
- Authentication Algorithm Type: Milenage
- Key: 00112233445566778899aabb...
- Operator Variant Parameter Type: OPc
- OP: 01020304050607080910111...
- OPc: 01020304050607080910111...
- AMF: 8000
- SQN: 000000000079

Integrity and Encryption Algorithm Selection

- Integrity Algorithm Type: Integrity Algorithm 128 5G ...
- Encryption Algorithm Type: Encryption Algorithm 5G EA0
- NAS Key Set Identifier: 7
- Type Of Security Context Flag: Native Security Context

Required QoS

- Remote IP Address: 192.168.10.68
- Maximum Requested Bandwidth Uplink: 10000000
- Maximum Requested Bandwidth Downlink: 30000000
- FiveQ QoS Class Identifier: 9

Network Initiated Deregistration Parameters

- DeRegistration Cause: Implicitly de-registered
- Re registration Required: Required

UE Context

- PCSCF IP Address: 192.168.12.227
- PCSCF IPv6 Address: fe80:f81a:a8e6:8671:85ad
- IMS Voice Over PS Support: Supported
- DNN: internet

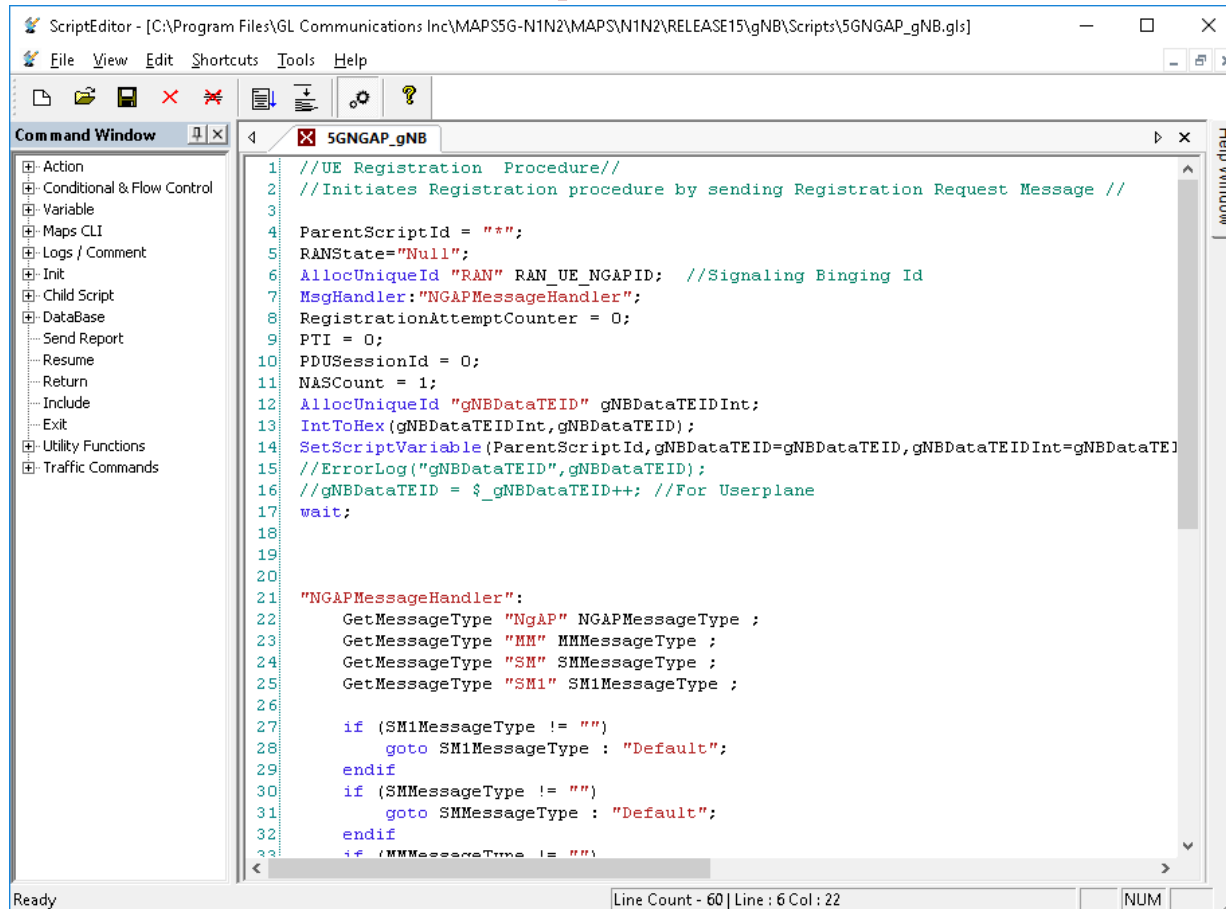
QoS Rule

- QoS Rule Identifier: 1
- Rule Operation Code: Create new QoS rule
- DQR: The QoS rule is default QoS...

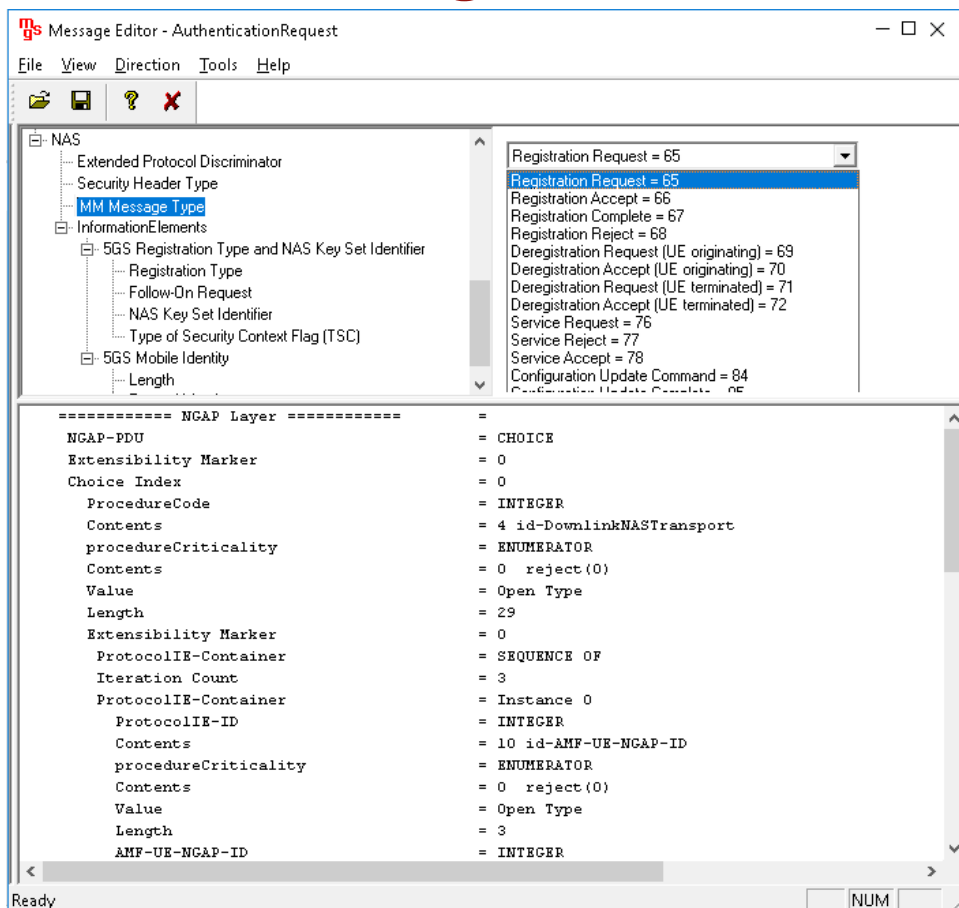
Add Insert Delete Properties

Initialisation Errors Error Events Captured Errors

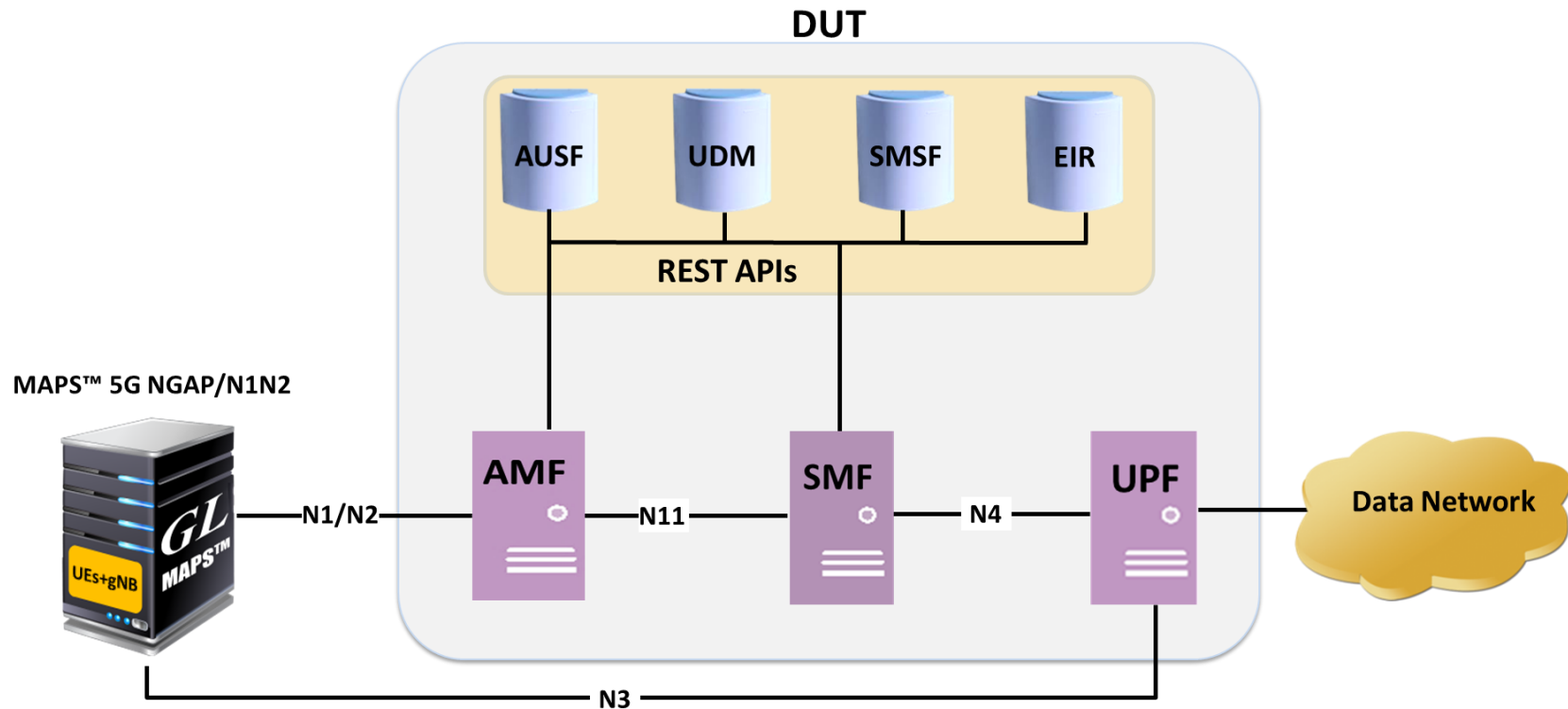
Script Editor



Message Editor

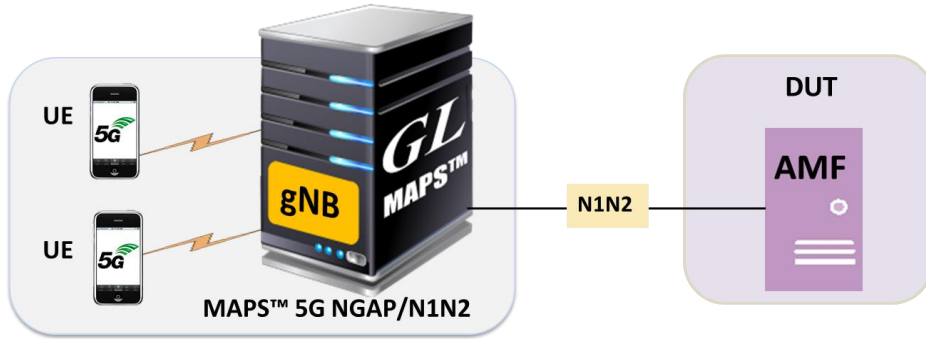


MAPS™ gNB Emulator testing 5G Core Network

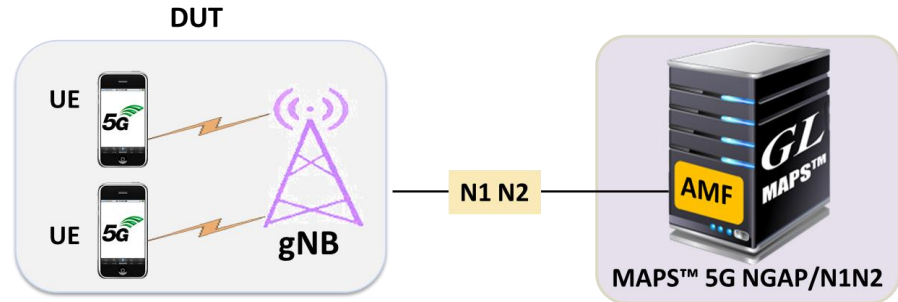


MAPS™ 5G N1N2 Use Cases

MAPS™ N1N2 configured as AMF to test gNB (DUT)

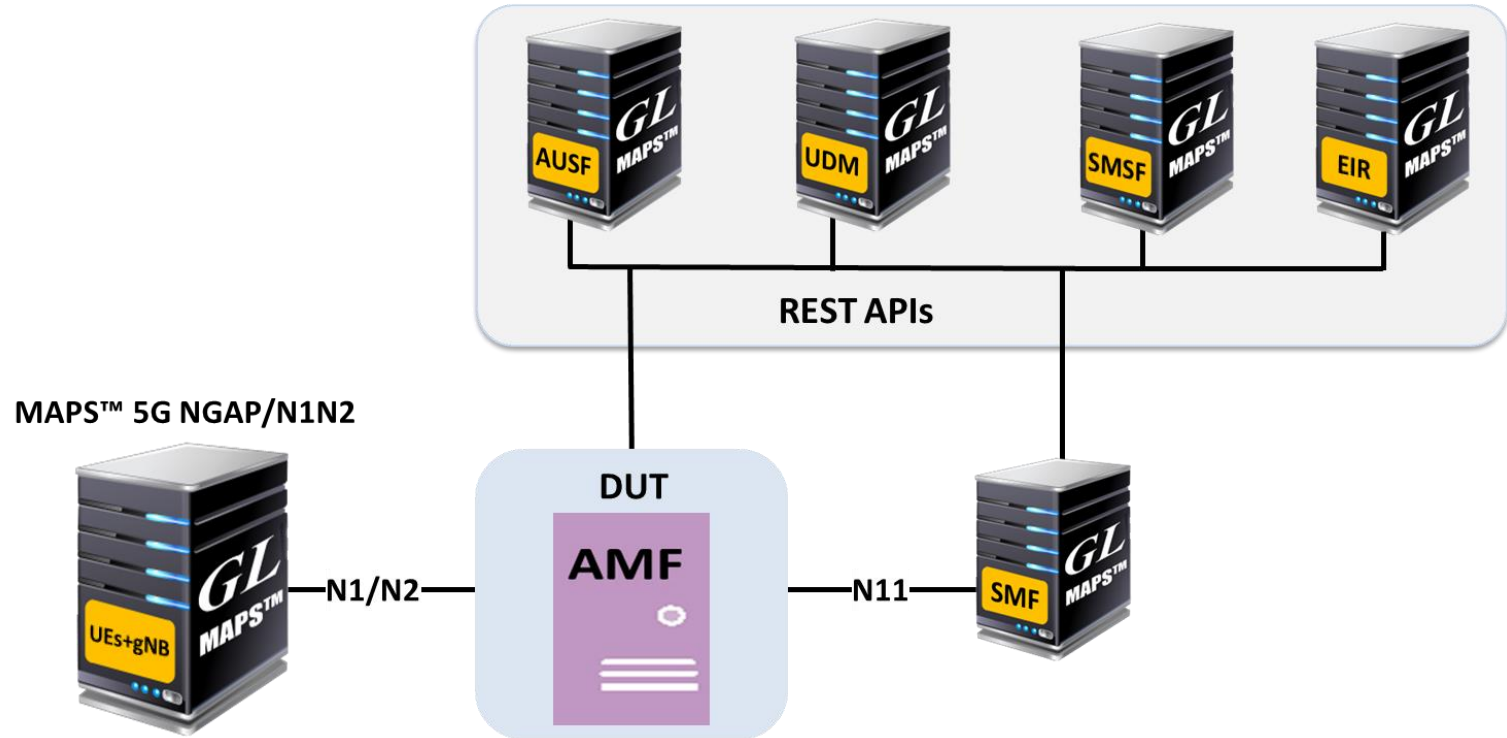


MAPS™ N1N2 configured as gNB to test AMF (DUT)



MAPS™ 5G N1N2 Use Cases (Contd.)

Wrap Around Testing of AMF



MAPS™ 5G N1N2 Interface – Call Generation

MAPS gNB (N1N2 RELEASE15) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	5GNGAP_UESessionControl.gls	MSIN3012041631	TMSI: 0x6528BCC1JMSI: 001013012041631	Start	UE CONTEXT RELEASED	None		Pass	1	1
2	5GNGAP_UESessionControl.gls			Start		None		Unknown	1	0
3	5GNGAP_UESessionControl.gls			Start		None		Unknown	1	0

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

Save Column Width Show Latest

gNB 0 AMF 0

InitialUEMessage, Registration Request 15:22:04.468000

DownlinkNASTransport, Authentication Request 15:22:04.550000

UplinkNASTransport, Authentication Response 15:22:04.551000

DownlinkNASTransport, Security Mode Command 15:22:04.632000

UplinkNASTransport, Security Mode Complete 15:22:04.636000

InitialContextSetupRequest, Registration Accept 15:22:04.720000

InitialContextSetupResponse 15:22:04.725000

UplinkNASTransport, Registration Complete 15:22:04.729000

UplinkNASTransport, UL NAS Transport, Session Establishment Request 15:22:04.770000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept 15:22:04.853000

PDUSessionResourceSetupResponse 15:22:04.857000

UplinkNASTransport, UL NAS Transport, Session Establishment Request 15:22:04.860000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept 15:22:04.951000

PDUSessionResourceSetupResponse 15:22:04.954000

UplinkNASTransport, UL NAS Transport, Session Release Request 15:23:04.368000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command 15:23:05.053000

PDUSessionResourceReleaseResponse 15:23:05.054000

UplinkNASTransport, UL NAS Transport, Session Release Complete 15:23:05.054000

UplinkNASTransport, UL NAS Transport, Session Release Request 15:23:05.055000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command 15:23:05.133000

PDUSessionResourceReleaseResponse 15:23:05.135000

UplinkNASTransport, UL NAS Transport, Session Release Complete

Find

NGAP Layer

NGAP-PDU = CHOICE

Extensibility Marker = 0

Choice Index = 0

InitiatingMessage = SEQUENCE

ProcedureCode = INTEGER

Contents = 16 id=InitialUEMessage

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 93

InitialUEMessage = SEQUENCE

Extensibility Marker = 0

ProtocolIE-Container = SEQUENCE OF

Iteration Count = 6

ProtocolIE-Container = Instance 0

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

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

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 3

RAN-UE-NGAP-ID = INTEGER

Length Determinant = 2

Contents = 10001

ProtocolIE-Container = Instance 1

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

Contents = 38 id=NAS-PDU

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 44

NAS-PDU = OCTET STRING

NAS-PDU = x7E004171000D0100F110000000003214061

ProtocolIE-Container = Instance 2

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

Contents = 121 id=UserLocationInformation

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 15

UserLocationInformation = CHOICE

Choice Index = 1

UserLocationInformationNR = SEQUENCE

Extensibility Marker = 0

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status Up=1 Down=0

MAPS™ 5G N1N2 Interface – Call Reception

MAPS AMF (N1N2 RELEASE15) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Results
1	NGAPManagementHandler.gls		RANName: gnb0000000001, gNB...	Completed	NG Setup Successful	None		Pass
2	AMFSessionControl.gls		MSIN_3012041631	Completed	UE CONTEXT RELEASED	None		Pass

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

Save Column Width ☐ Show Latest

gNB 0 AMF

InitialUEMessage, Registration Request → 15:22:04.516000

DownlinkNASTransport, Authentication Request ← 15:22:04.519000

UplinkNASTransport, Authentication Response → 15:22:04.591000

DownlinkNASTransport, Security Mode Command ← 15:22:04.592000

UplinkNASTransport, Security Mode Complete → 15:22:04.671000

InitialContextSetupRequest, Registration Accept ← 15:22:04.673000

InitialContextSetupResponse → 15:22:04.772000

UplinkNASTransport, Registration Complete → 15:22:04.772000

UplinkNASTransport, UL NAS Transport, Session Establishment Request → 15:22:04.809000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept ← 15:22:04.812000

PDUSessionResourceSetupResponse → 15:22:04.911000

UplinkNASTransport, UL NAS Transport, Session Establishment Request → 15:22:04.912000

PDUSessionResourceSetupRequest, DL NAS Transport, Session Establishment Accept ← 15:22:04.915000

PDUSessionResourceSetupResponse → 15:22:04.993000

UplinkNASTransport, UL NAS Transport, Session Release Request → 15:23:05.013000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command ← 15:23:05.014000

PDUSessionResourceReleaseResponse → 15:23:05.092000

UplinkNASTransport, UL NAS Transport, Session Release Complete → 15:23:05.093000

UplinkNASTransport, UL NAS Transport, Session Release Request → 15:23:05.093000

PDUSessionResourceReleaseCommand, DL NAS Transport, Session Release Command ← 15:23:05.094000

PDUSessionResourceReleaseResponse → 15:23:05.172000

UplinkNASTransport, UL NAS Transport, Session Release Complete → 15:23:05.172000

Find

===== NGAP Layer =====

NGAP-PDU = CHOICE

Extensibility Marker = 0

Choice Index = 0

InitiatingMessage = SEQUENCE

ProcedureCode = INTEGER

Contents = 15 id-InitialUEMes

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 93

InitialUEMessage = SEQUENCE

Extensibility Marker = 0

ProtocolIE-Container = SEQUENCE OF

Iteration Count = 6

ProtocolIE-Container = Instance 0

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

Contents = 85 id-RAN-UE-NGAP-

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 9

RAN-UE-NGAP-ID = INTEGER

Length Determinant = 2

Contents = 10001

ProtocolIE-Container = Instance 1

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

Contents = 38 id-NAS-PDU

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 44

NAS-PDU = OCTET STRING

NAS-PDU = x7E004171000D0100F

ProtocolIE-Container = Instance 2

ProtocolIE-Field = SEQUENCE

ProtocolIE-ID = INTEGER

Contents = 121 id-UserLocatio

procedureCriticality = ENUMERATOR

Contents = 0 reject(0)

Value = Open Type

Length = 15

UserLocationInformation = CHOICE

Choice Index = 1

UserLocationInformationNR = SEQUENCE

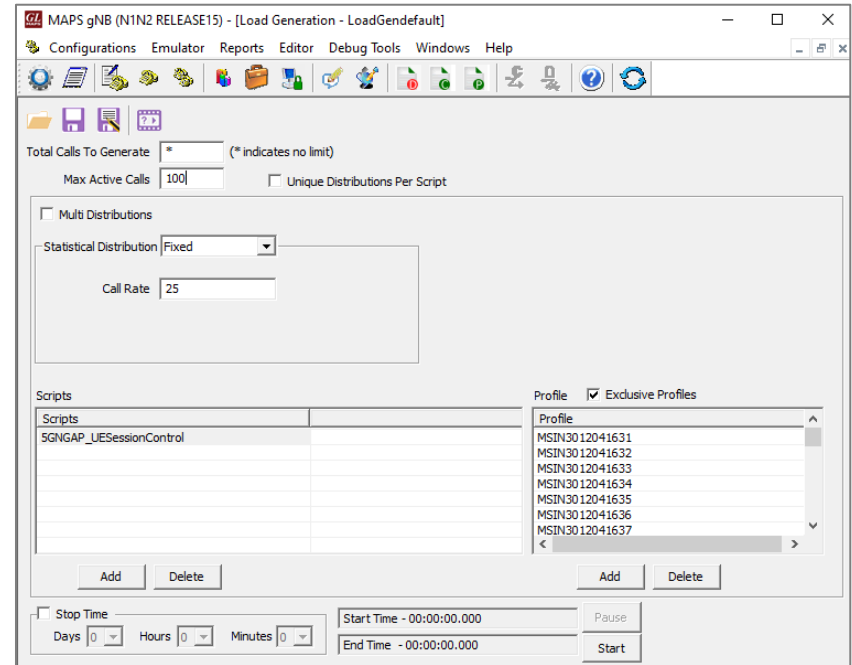
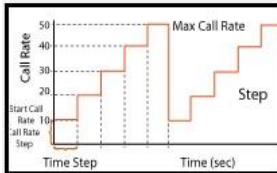
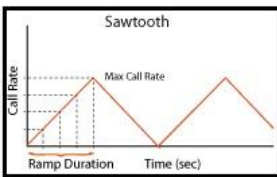
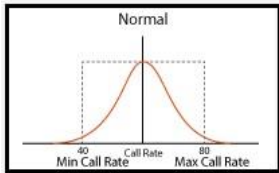
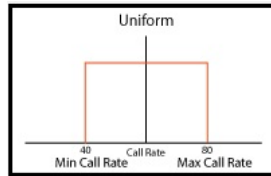
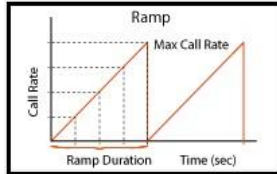
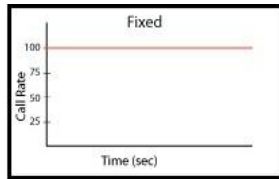
Extensibility Marker = 0

Scripts Message Sequence Event Config Script Flow

● Initialisation Errors ● Error Events ● Captured Errors ● Link Status Up=1 Down=0

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.



Thank you