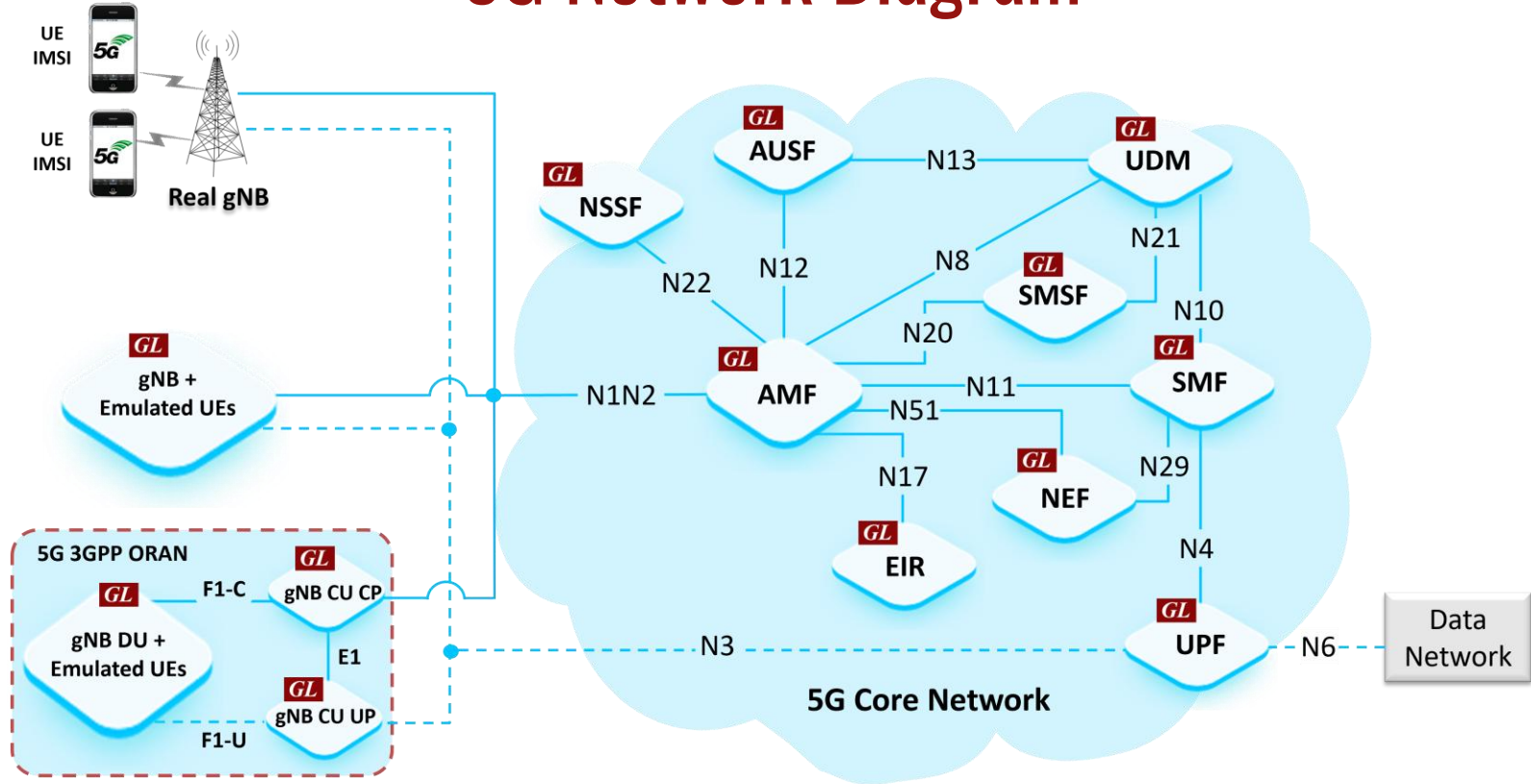

MAPS™ 5G F1AP Interface Emulator



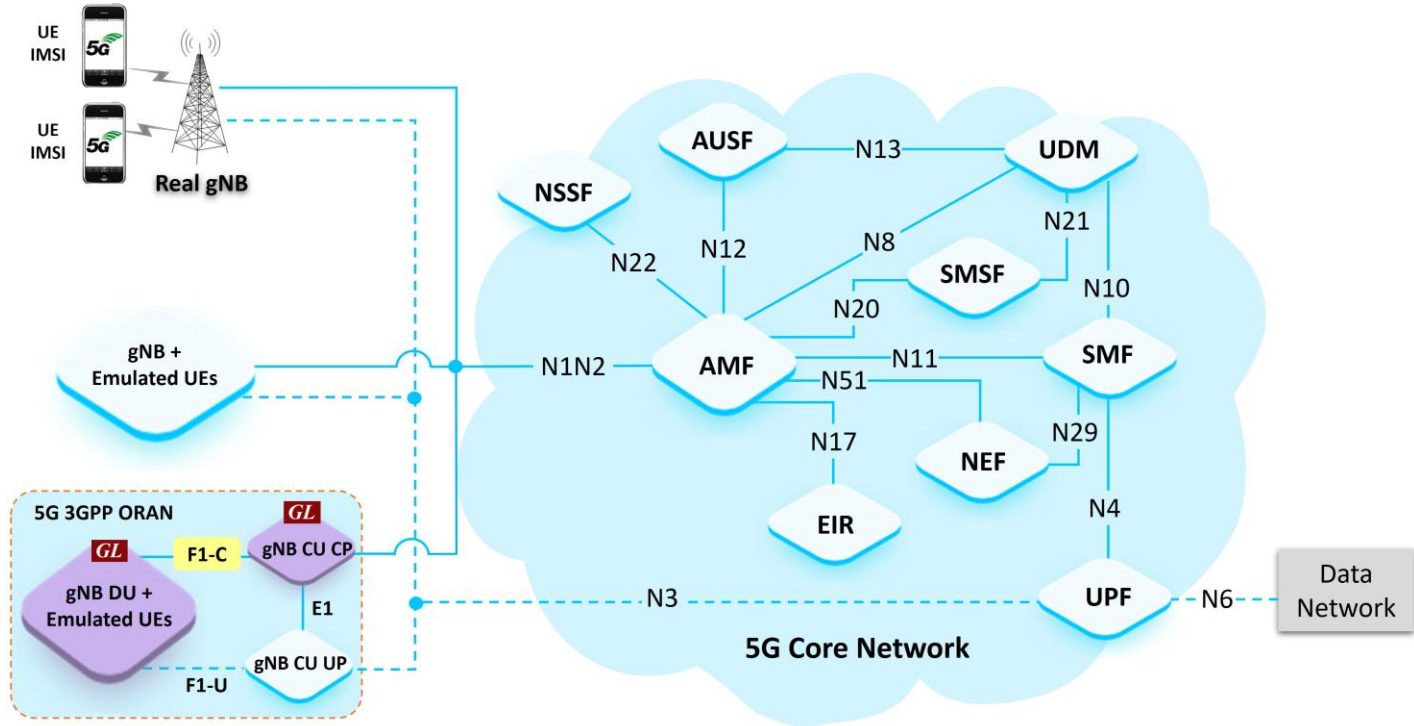
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



5G Network Test Solution

MAPS™ 5G F1AP Interface Network Architecture

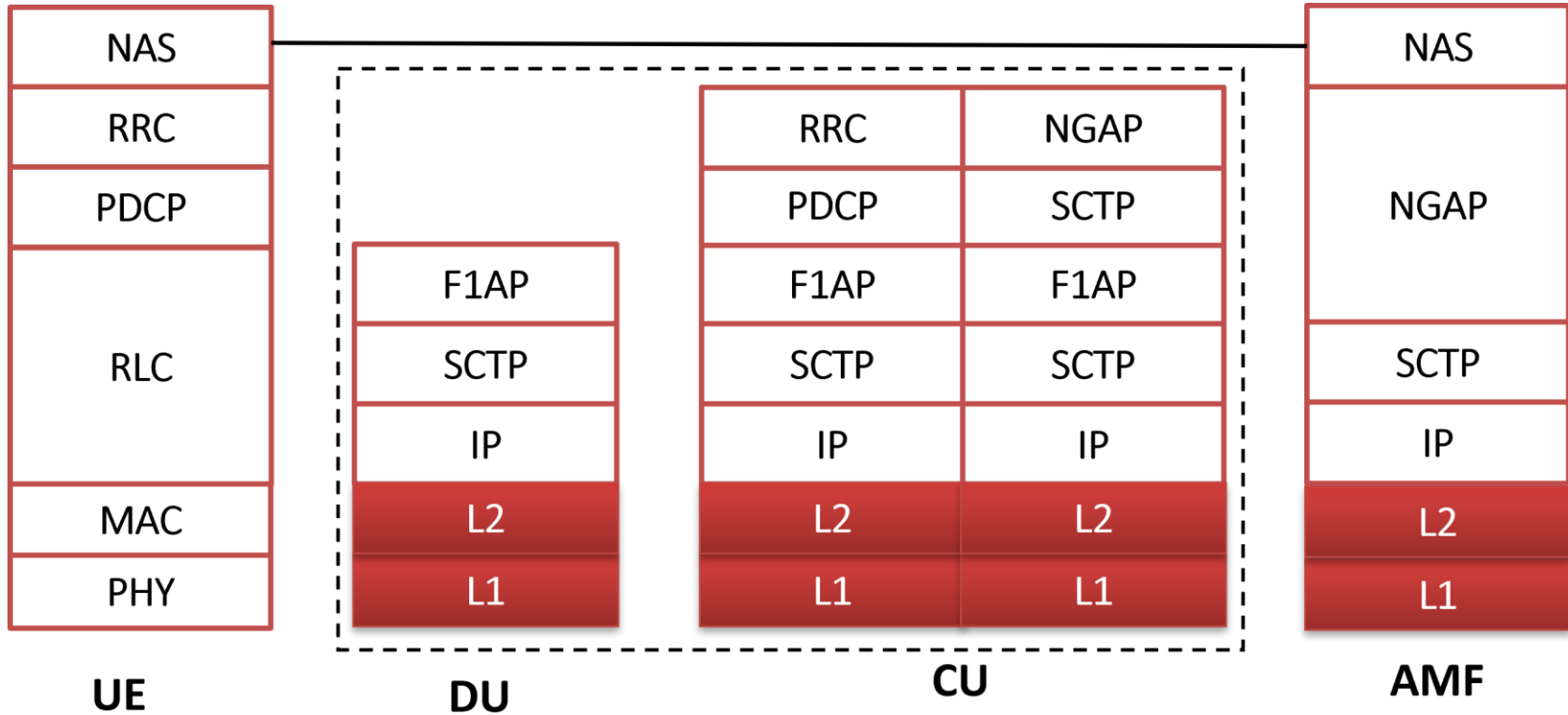


GL MAPS™ 5G F1AP Interface Emulator

Features

- MAPS™ 5G ORAN F1AP interface emulates gNB Central Unit (CU) and Distributed Unit (DU)
- Supports 5G F1-C (Control Plane) and F1-U (User Plane) procedures
- Generates and processes valid and invalid F1AP messages for protocol compliance testing
- Supports GTP-U traffic tunneling for end-to-end user-plane emulation
- Provides fault insertion and impairment simulation for robustness and negative testing
- Ready-to-use scripts for quick and repeatable F1 interface testing
- Customizable call flow and message templates using Script, Message, and Profile Editors
- Supports automated call generation, reception, and scheduling for 24/7 remote testing
- Performs performance, load, functional, and regression testing of CU and DU nodes
- Supports SCTP over IP transport layer testing with configurable association parameters
- Simulates large-scale midhaul environments for interoperability, training, and R&D testing

Protocol Stack Specification



Protocol Stack Specification (Contd.)

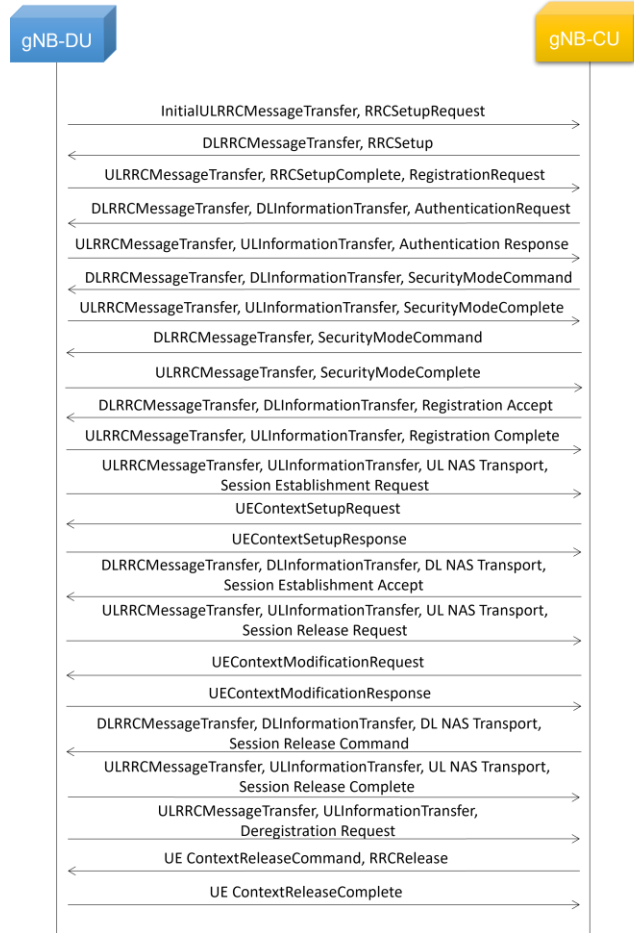
Supported Protocols	Standard / Specification Used
F1 Interface (gNB-CU – gNB-DU)	TS38.473
SCTP	RFC 4960
Non-Access-Stratum (NAS)	3GPP TS 24.501
NR and NG-RAN	3GPP TS 38.300 V17

- F1 Application Protocol (F1AP): Application Layer Protocol between the gNB DU and the gNB CU
- SCTP for the control plane (SCTP): This protocol guarantees delivery of signaling messages between gNB DU and gNB CU (F1AP). SCTP is defined in RFC 4960

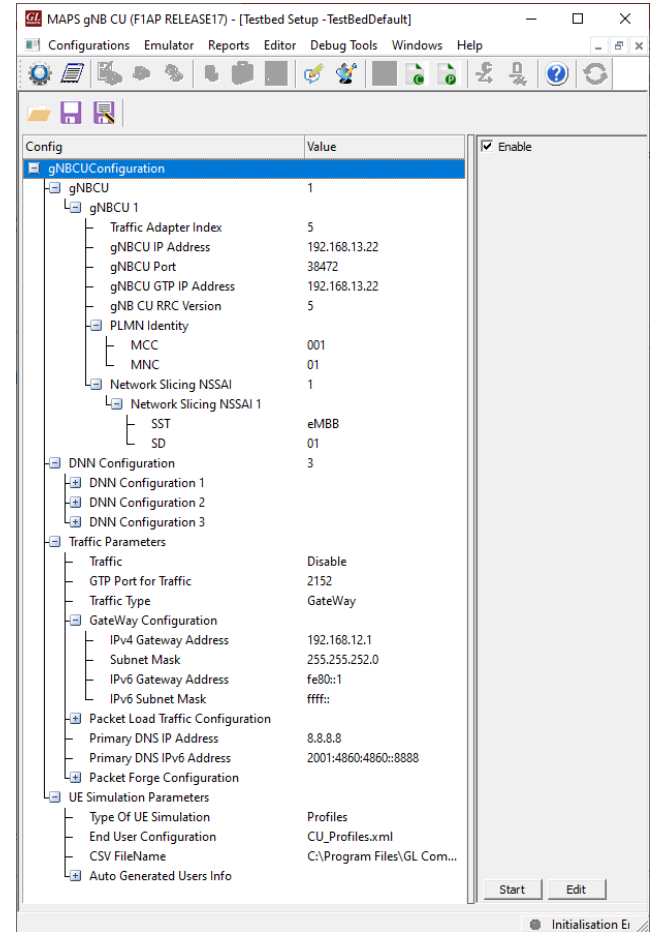
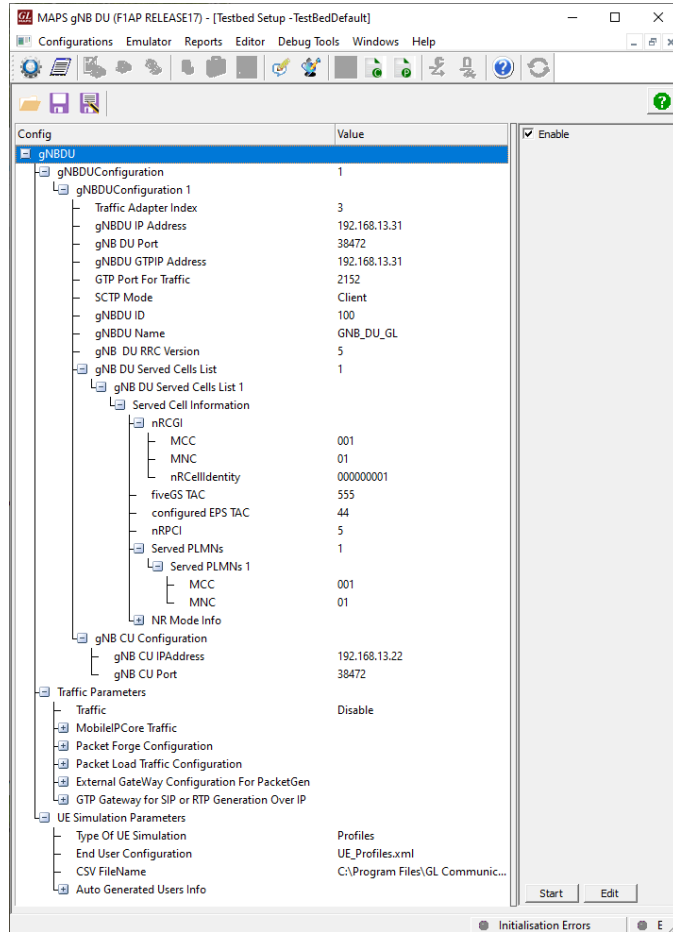
MAPS™ 5G Call Scenarios

- UE Registration Signaling
 - InitialULRRRCMessageTransfer
 - DLRRRCMessageTransfer
 - ULRRRCMessageTransfer
 - Registration Procedure
 - Authentication Procedure
 - Security Mode 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 Procedure
 - UE Context Setup Procedure
 - UE Context Modification Procedure
 - UE Context Release Procedure

MAPS™ 5G F1AP Call Scenario



Testbed Configuration (gNB DU and gNB CU)



Profile Configuration (gNB DU)

MAPS gNB DU (F1AP RELEASE17) - [Profile Editor -UE_Profiles]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)	Config	Value	Enable
1	MSIN3012041631	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			
28	MSIN3012041658			

Config

Config	Value
Registration Parameters	
Registration Type	Initial Registration
SMS Over NAS Transport Requested	Not Supported
Follow On Request	Follow On Request Pendi...
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
C RNTI	1631
GMM Capability	
S1 Mode	Not Supported
HO Attach	Not Supported
LPP Capability	LPP in N1 Mode not sup...
Requested NSSAI	
RNSSAI	1
RNSSAI 1	
Requesting NSSAI SST	eMBB
Requesting NSSAI SD	1
Include UEContextRequest IE	True
RRC Establish Cause	MO Signaling
nRCGI	
MCC	001
MNC	01
Cell Identity	000000001
Tracking Area Information	
TAC	37
Authentication Parameters	
Authentication Type	5G-AKA
Authentication Algorithm Type	Milenage
Key	00112233445566778899aa...

Insert Delete Clear

Add Insert Delete Properties

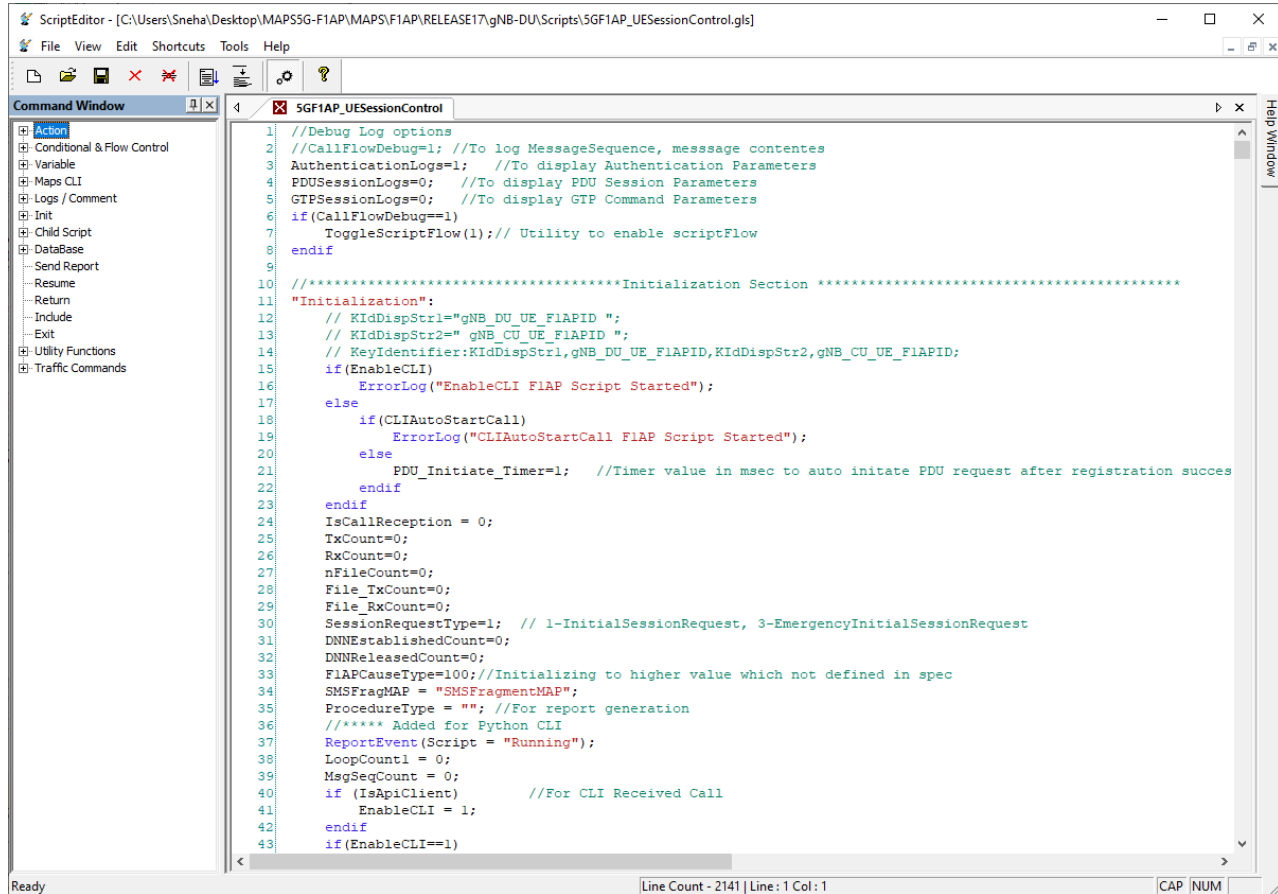
Initialisation Errors Error Events Cap

Profile Configuration (gNB CU)

The screenshot displays the MAPS gNB CU (FIAP RELEASE17) - [Profile Editor - CU_Profiles] window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar. On the left, a list of profiles is shown, with 'MSIN3012041631' selected. The main area displays the configuration for this profile, organized into a tree structure. The 'Config' column lists the configuration items, and the 'Value' column shows their corresponding values. An 'Enable' checkbox is present for each item. At the bottom, there are buttons for 'Insert', 'Delete', and 'Clear', and a status bar with 'Initialisation Errors', 'Error Events', and 'Capture' indicators.

#	Profiles (Edit-F2)	Config	Value	Enable
1	MSIN3012041631	MSIN3012041631		☒
2	MSIN3012041632	Mobile Identity		☒
3	MSIN3012041633	Type Of Identity	SUCI	☒
4	MSIN3012041634	IMSI	001013012041631	☒
5	MSIN3012041635	SUCI		☒
6	MSIN3012041636	SUPI Format	IMSI	☒
7	MSIN3012041637	Protection Scheme Identifier	Null Scheme	☒
8	MSIN3012041638	Home Network Public Key Identifier	0	☒
9	MSIN3012041639	IMEI	359877068325248	☒
10	MSIN3012041640	IMEISV	1234567890123001	☒
11	MSIN3012041641	MSISDN	3012041631	☒
12	MSIN3012041642	GUAMI		☒
13	MSIN3012041643	MCC	001	☒
14	MSIN3012041644	MNC	01	☒
15	MSIN3012041645	AMF Region ID	2	☒
16	MSIN3012041646	AMF Set Id	1	☒
17	MSIN3012041647	AMF Pointer	63	☒
18	MSIN3012041648	Authentication Parameters		☒
19	MSIN3012041649	Authentication Type	5G-AKA	☒
20	MSIN3012041650	Authentication Algorithm Type	Milenage	☒
21	MSIN3012041651	Key	00112233445566778899aab...	☒
22	MSIN3012041652	Operator Variant Parameter Type	OPc	☒
23	MSIN3012041653	OP	010203040506070809101112...	☒
24	MSIN3012041654	OPc	010203040506070809101112...	☒
25	MSIN3012041655	AMF	8000	☒
26	MSIN3012041656	SQN	000000000079	☒
27	MSIN3012041657	Integrity and Encryption Algorithm Selection		☒
28	MSIN3012041658	Integrity Algorithm Type	Integrity Algorithm 128 5G I...	☒
		Encryption Algorithm Type	Encryption Algorithm 128 5G...	☒
		NAS Key Set Identifier	7	☒
		Type Of Security Context Flag	Native Security Context	☒
		Tracking Area Information		☒
		TAC	37	☒
		Required QoS		☒
		Remote IP Address	192.168.10.68	☒
		Maximum Requested Badwidth Uplink	30000000	☒
		Maximum Requested Bandwidth Downlink	20000000	☒

Script Editor



Message Editor

Message Editor - AuthenticationRequest

File View Direction Tools Help

Frame No 1

NAS

- Extended Protocol Discriminator
- Security Header Type
- MM Message Type
- InformationElements
 - 5GS Registration Type and NAS Key Set Identifier
 - Registration Type
 - Follow-On Request
 - NAS Key Set Identifier
 - Type of Security Context Flag (TSC)
 - 5GS Mobile Identity

Registration Request = 65
 Registration Accept = 66
 Registration Complete = 67
 Registration Reject = 68
 Deregistration Request (UE originating) = 69
 Deregistration Accept (UE originating) = 70
 Deregistration Request (UE terminated) = 71
 Deregistration Accept (UE terminated) = 72
 Service Request = 76
 Service Reject = 77
 Service Accept = 78

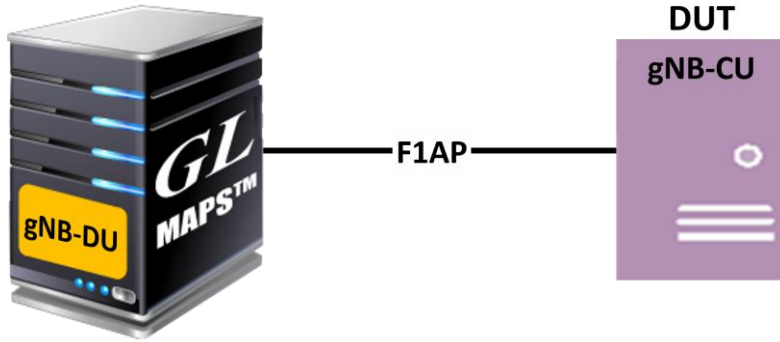
===== FLAP Layer =====

0000	FLAP-PDU	= CHOICE
0000	Choice Index	= 0
0000	InitiatingMessage	= SEQUENCE
0001	ProcedureCode	= INTEGER
0001	Contents	= 12 id-DLRRMessageTransfer
0002	Criticality	= ENUMERATOR
0002	Contents	= 1 ignore(1)
0003	Length	= 41
0004	Value	= Open Type
0004	DLRRMessageTransferIEs	= SEQUENCE
0004	Extensibility Marker	= 0
0004	ProtocolIE-Container	= SEQUENCE OF
0005	Iteration Count	= 4
0007	ProtocolIE-Container	= Item 0
0007	ProtocolIE-Field	= SEQUENCE
0007	ProtocolIE-ID	= INTEGER
0007	Contents	= 40 id-gNB-CU-UE-FLAP-ID
0009	Criticality	= ENUMERATOR
0009	Contents	= 0 reject(0)
000A	Length	= 2
000B	Value	= Open Type
000B	gNB-CU-UE-FLAP-ID	= INTEGER
000B	Length Determinant	= 1
000C	Contents	= 0
000D	ProtocolIE-Container	= Item 1

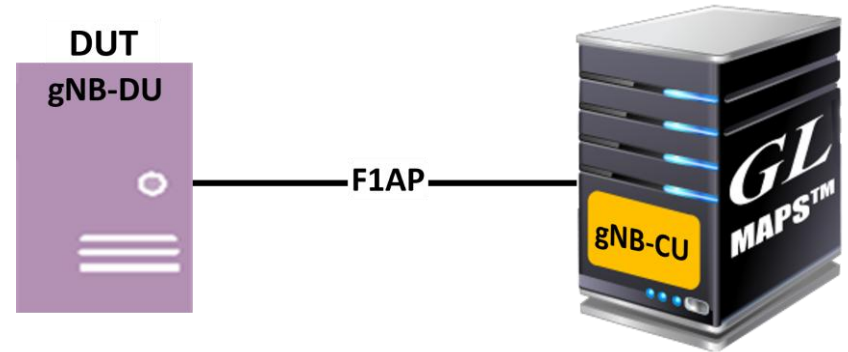
Ready CAP NUM

MAPS™ 5G F1AP Use Cases

MAPS™ F1AP configured as gNB DU to test gNB CU (DUT)



MAPS™ F1AP configured as gNB CU to test gNB DU (DUT)



MAPS™ 5G F1AP Interface – Call Generation

MAPS gNB DU (F1AP RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events...	Result	Total Iterations	Completed Iterations
1	5GFIAP_UESessionControl.gls	MSIN3012041631	TMSI: 0x5F5A80CB IMSI: 001013012041631	Start	RM-Deregistered	None		Pass	1	1
2	5GFIAP_UESessionControl.gls	MSIN3012041632		Start		None		Unknown	1	0
3	5GFIAP_UESessionControl.gls	MSIN3012041633		Start		None		Unknown	1	0
4	5GFIAP_UESessionControl.gls	MSIN3012041634		Start		None		Unknown	1	0

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

Save Column Width Show Latest

gNB-DU-0 gNCU

InitialULRRMessageTransfer, RRCSetupRequest 11:30:05.221000

DLRRMessageTransfer, RRCSetup 11:30:05.408000

ULRRMessageTransfer, RRCSetupComplete, Registration Request 11:30:05.410000

DLRRMessageTransfer, DLInformationTransfer, Authentication Request 11:30:05.605000

ULRRMessageTransfer, DLInformationTransfer, Authentication Response 11:30:05.608000

DLRRMessageTransfer, DLInformationTransfer, Security Mode Command 11:30:05.807000

ULRRMessageTransfer, DLInformationTransfer, Security Mode Complete 11:30:05.809000

DLRRMessageTransfer, SecurityModeCommand 11:30:06.008000

ULRRMessageTransfer, SecurityModeComplete 11:30:06.009000

DLRRMessageTransfer, DLInformationTransfer, Registration Accept 11:30:06.209000

ULRRMessageTransfer, ULInformationTransfer, Registration Complete 11:30:06.211000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Establishment Request 11:30:06.239000

UEContextSetupRequest 11:30:06.410000

UEContextSetupResponse 11:30:06.413000

DLRRMessageTransfer, DLInformationTransfer, DL NAS Transport, Session Establishment Accept 11:30:06.612000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Release Request 11:30:13.794000

UEContextModificationRequest 11:30:13.945000

UEContextModificationResponse 11:30:13.947000

DLRRMessageTransfer, DLInformationTransfer, DL NAS Transport, Session Release Command 11:30:14.146000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Release Complete 11:30:14.147000

ULRRMessageTransfer, ULInformationTransfer, Deregistration Request 11:30:14.150000

UEContextReleaseCommand, RRCRelease 11:30:14.346000

UEContextReleaseComplete 11:30:14.347000

Find

FIAP Layer

0000 FIAP-PDU = CHOICE

0000 Choice Index = 0

0000 InitiatingMessage = SEQUENCE

0001 ProcedureCode = INTEGER

0001 Contents = 11 id-InitialULRARC

0002 Criticality = ENUMERATOR

0002 Contents = 1 ignore(1)

0003 Length = 425

0005 Value = Open Type

0005 InitialULRRMessageTransferIEs = SEQUENCE

0005 Extensibility Marker = 0

0005 ProtocolIE-Container = SEQUENCE OF

0006 Iteration Count = 5

0008 ProtocolIE-Container = Item 0

0008 ProtocolIE-Field = SEQUENCE

0008 ProtocolIE-ID = INTEGER

0008 Contents = 41 id-gNB-DU-UE-F1

000A Criticality = ENUMERATOR

000A Contents = 0 reject(0)

000B Length = 2

000C Value = Open Type

000C gNB-DU-UE-F1AP-ID = INTEGER

000C Length Determinant = 1

000D Contents = 2

000E ProtocolIE-Container = Item 1

000E ProtocolIE-Field = SEQUENCE

000E ProtocolIE-ID = INTEGER

000E Contents = 111 id-NRCCI

0010 Criticality = ENUMERATOR

0010 Contents = 0 reject(0)

0011 Length = 9

0012 Value = Open Type

0012 NRCCI = SEQUENCE

0012 Extensibility Marker = 0

0012 Preamble = 0

0013 pLMI-Identity = OCTET STRING

0013 MCC = 001

0014 MNC = 01

0016 nRCellIdentity = BITSTRING

0000 nRCellIdentity =0000 00000000

001B ProtocolIE-Container = Item 2

001B ProtocolIE-Field = SEQUENCE

001B ProtocolIE-ID = INTEGER

001B Contents = 95 id-C-RNTI

001D Criticality = ENUMERATOR

001D Contents = 0 reject(0)

001E Length = 3

001F Value = Open Type

001F C-RNTI = INTEGER

001F Extensibility Marker = 0

Scripts Message Sequence Event Config Script Flow Capture Events

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

MAPS™ 5G F1AP Interface – Call Reception

MAPS gNB CU (F1AP RELEASE17) - [Call Reception]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	F1APManagementHandler.gls		gNB-DU-100, gNB-DU-TransactionId:1, ConnectionId:1002	Stop	F1 Setup Successful	SendF1Reset	Pass
2	gNB-CU-SessionControl.gls		MSIN: 3012041631	Completed	DE-REGISTRATION ACCEPTED	None	Pass

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

Save Column Width Show Latest

gNB-DU gNB-CU-0

InitialULRRMessageTransfer, RRCSetupRequest 11:30:05.309000

DLRRMessageTransfer, RRCSetup 11:30:05.314000

ULRRMessageTransfer, RRCSetupComplete, Registration Request 11:30:05.506000

DLRRMessageTransfer, DLInformationTransfer, Authentication Request 11:30:05.510000

ULRRMessageTransfer, DLInformationTransfer, Authentication Response 11:30:05.707000

DLRRMessageTransfer, DLInformationTransfer, Security Mode Command 11:30:05.709000

ULRRMessageTransfer, ULInformationTransfer, Security Mode Complete 11:30:05.907000

DLRRMessageTransfer, SecurityModeCommand 11:30:05.910000

ULRRMessageTransfer, SecurityModeComplete 11:30:06.108000

DLRRMessageTransfer, DLInformationTransfer, Registration Accept 11:30:06.110000

ULRRMessageTransfer, ULInformationTransfer, Registration Complete 11:30:06.310000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Establishment Request 11:30:06.311000

UEContextSetupRequest 11:30:06.314000

UEContextSetupResponse 11:30:06.508000

DLRRMessageTransfer, DLInformationTransfer, DL NAS Transport, Session Establishment Accept 11:30:06.510000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Release Request 11:30:13.845000

UEContextModificationRequest 11:30:13.847000

UEContextModificationResponse 11:30:14.045000

DLRRMessageTransfer, DLInformationTransfer, DL NAS Transport, Session Release Command 11:30:14.047000

ULRRMessageTransfer, ULInformationTransfer, UL NAS Transport, Session Release Complete 11:30:14.246000

ULRRMessageTransfer, ULInformationTransfer, Deregistration Request 11:30:14.247000

UEContextReleaseCommand, RRCRelease 11:30:14.250000

UEContextReleaseComplete 11:30:14.445000

Find

===== F1AP Layer =====

```

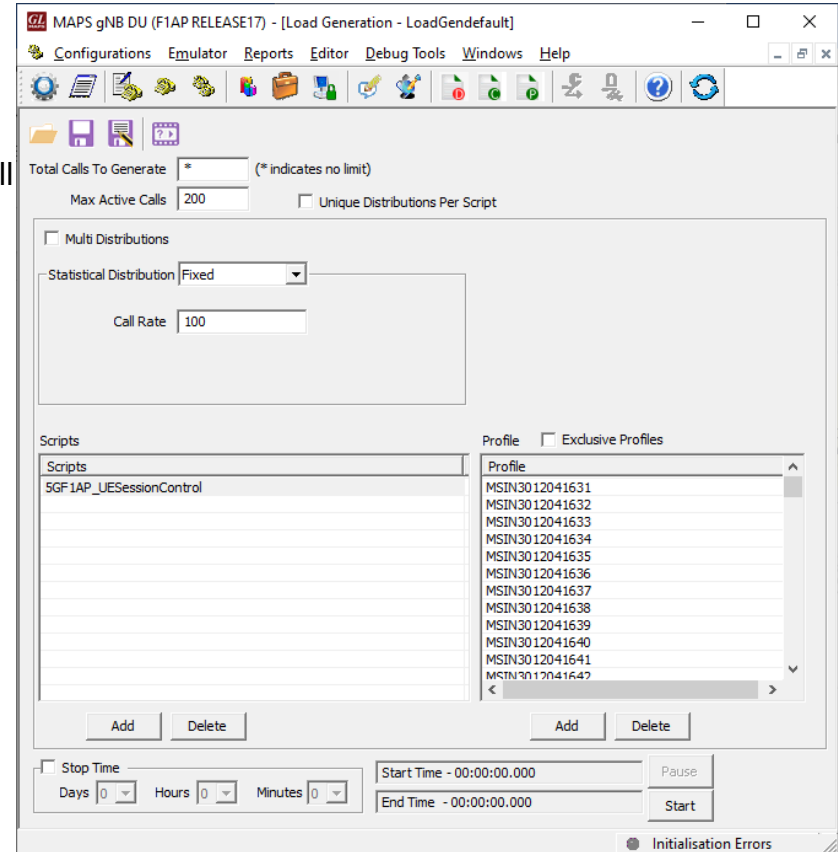
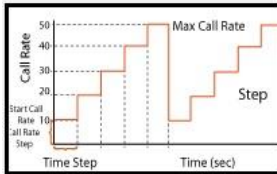
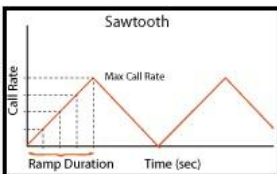
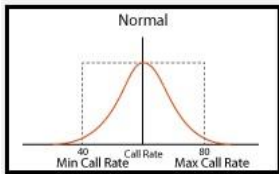
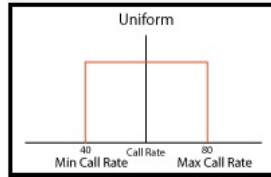
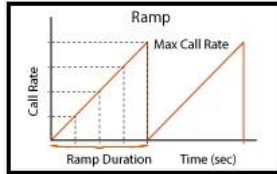
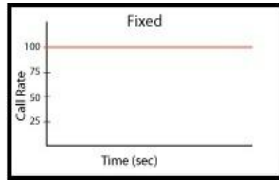
0000 F1AP-PDU = CHOICE
0000 Choice Index = 0
0000 InitiatingMessage = SEQUENCE
0001 ProcedureCode = INTEGER
0001 Contents = 11 id-InitialULRRCM
0002 Criticality = ENUMERATOR
0002 Contents = 1 ignore(1)
0003 Length = 425
0005 Value = Open Type
0005 InitialULRRMessageTransferIs = SEQUENCE
0005 Extensibility Marker = SEQUENCE OF
0006 Iteration Count = 5
0008 ProtocolIE-Container = Item 0
0008 ProtocolIE-Field = SEQUENCE
0009 ProtocolIE-ID = INTEGER
0009 Contents = 41 id-gNB-DU-UE-F1AP
000A Criticality = ENUMERATOR
000A Contents = 0 reject(0)
000B Length = 2
000C Value = Open Type
000C gNB-DU-UE-F1AP-ID = INTEGER
000C Length Determinant = 2
000D Contents = 2
000E ProtocolIE-Container = Item 1
000E ProtocolIE-Field = SEQUENCE
000E ProtocolIE-ID = INTEGER
000E Contents = 111 id-NRQCI
0010 Criticality = ENUMERATOR
0010 Contents = 0 reject(0)
0011 Length = 5
0012 Value = Open Type
0012 NRQCI = SEQUENCE
0012 Extensibility Marker = 0
0012 Preamble = OCTET STRING
0013 gNB-Identity = 001
0014 MNC = 01
0016 nRCellIdentity = BITSTRING
0016 nRCellIdentity = ...0000 00000000 0
001B ProtocolIE-Container = Item 2
001B ProtocolIE-Field = SEQUENCE
001B ProtocolIE-ID = INTEGER
001B Contents = 95 id-C-NTI
001D Criticality = ENUMERATOR
001D Contents = 0 reject(0)
001E Length = 3
001F Value = Open Type
001F C-NTI = INTEGER
001F Extensibility Marker = 0
0022 Contents = 50 id-DR-Container
    
```

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