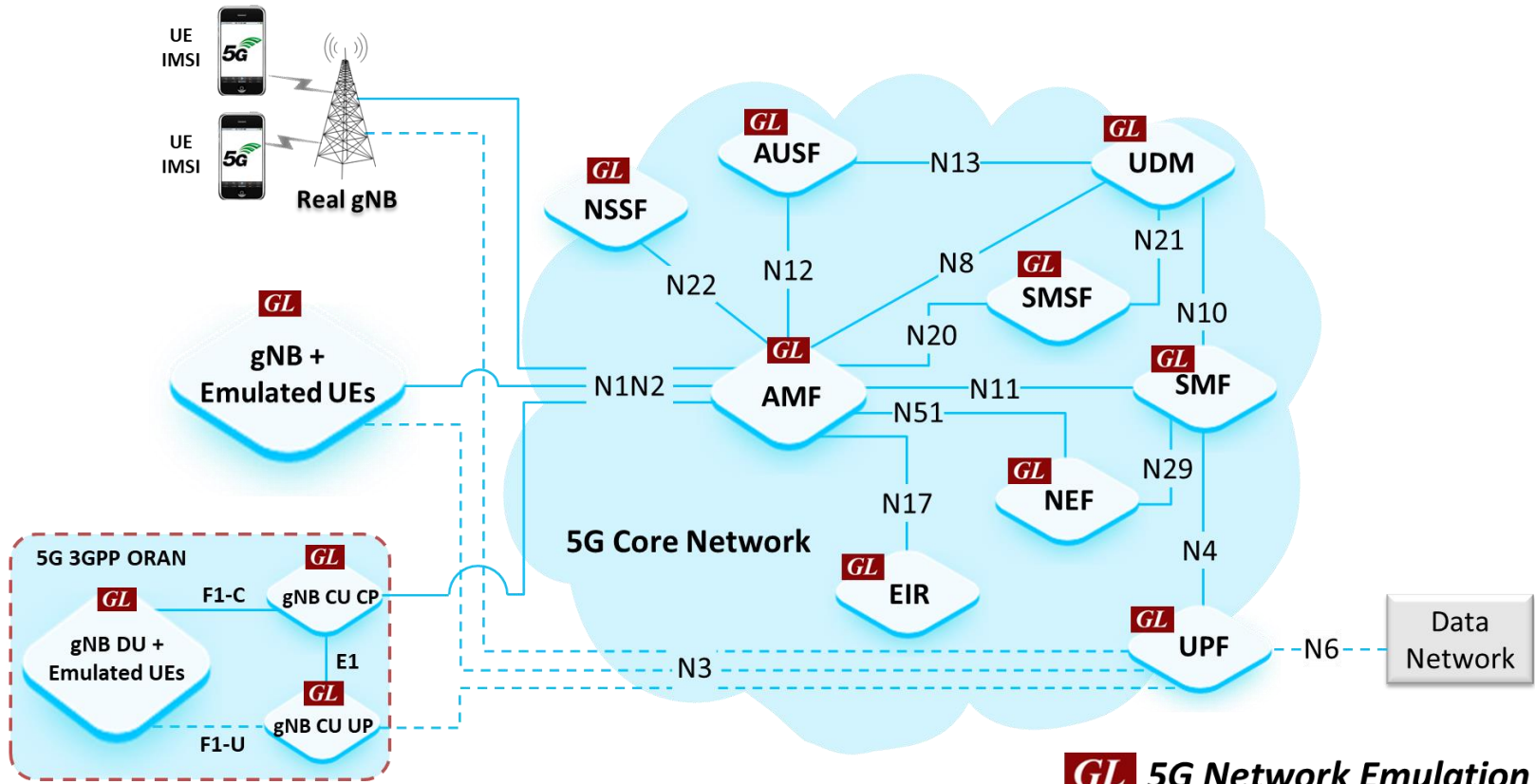

MAPS™ 5G N8 Interface Emulator



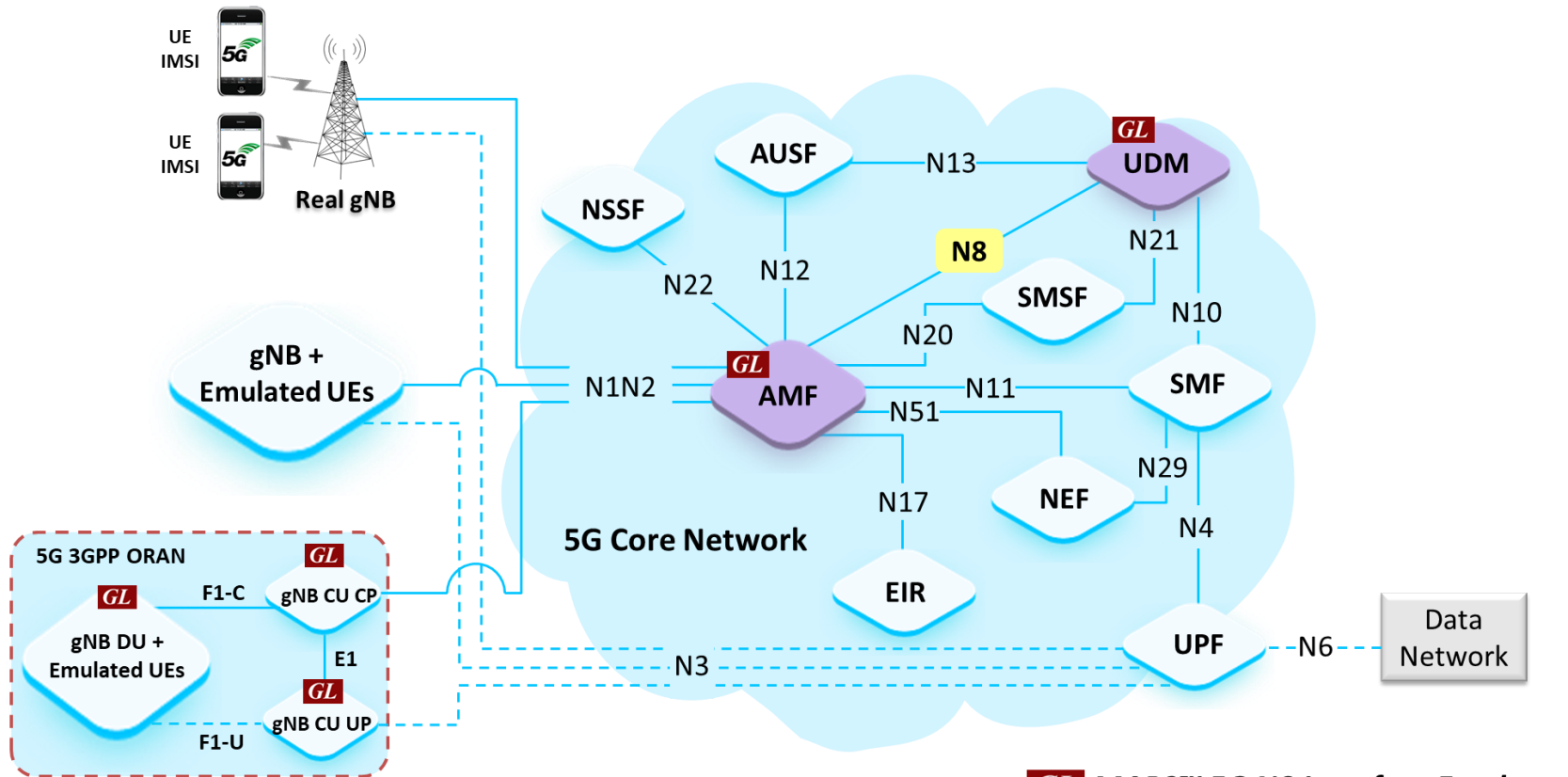
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N8 Interface

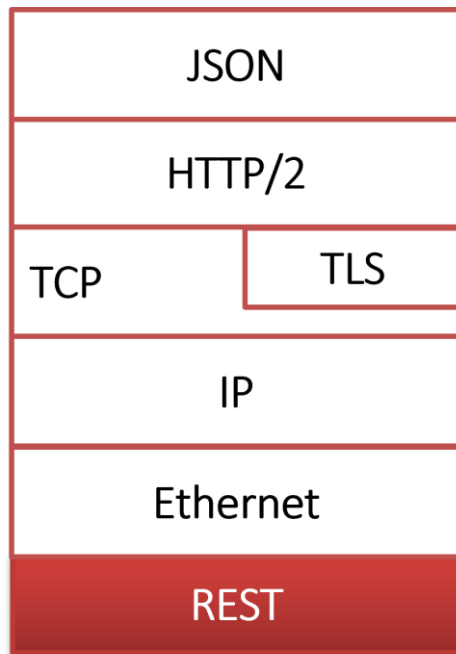


GL MAPS™ 5G N8 Interface Emulator

Main Features

- Emulate Access and Mobility Management Function (AMF) and Unified Data Management (UDM) elements
- 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 Editor and JSON messages
- Ready-to-use scripts for quick testing
- Provides Call Statistics and Events Status
- Emulate multiple subscribers using CSV Profiles
- Automation, Remote access, and Schedulers to run tests 24/7

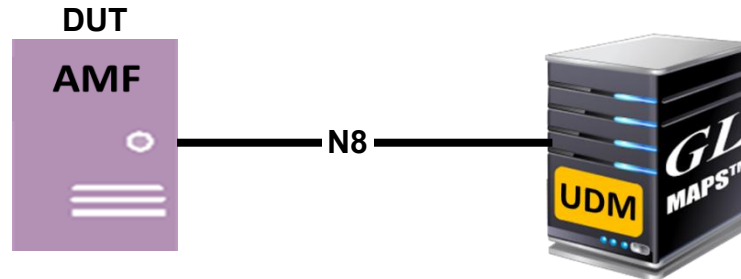
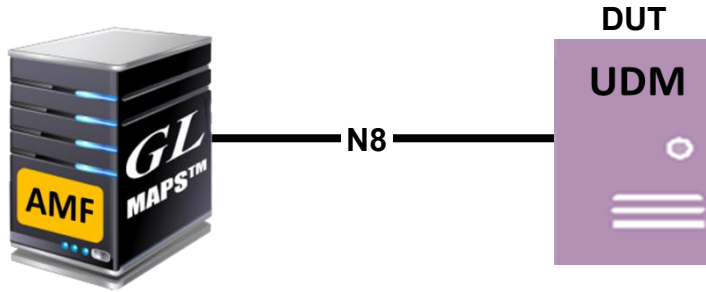
Protocol Stack Specification



Supported Protocols	Standard / Specification Used
N8 Interface	
N8 Interface (UDM - AMF)	TS29.503
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP HTTP / 2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

MAPS™ 5G N8 User Cases

- MAPS™ can emulate any one node (AMF/UDM) or both AMF and UDM nodes



Testbed Setup (AMF)

The screenshot displays the configuration interface for MAPS AMF (N8 RELEASE17). The window title is "MAPS AMF (N8 RELEASE17) - [Testbed Setup -TestBedDefault]". The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar with various icons. The main area is a configuration tree with columns for "Config", "Value", and "Enable".

Config	Value	Enable
AMF Configuration		<input checked="" type="checkbox"/>
AMF	1	
AMF 1		
AMF IP Address	192.168.12.170	
AMF Server Port	6666	
URI Scheme	HTTP	
Served GUAMI List	1	
Served GUAMI List 1		
GUAMI		
PLMN Identity		
MCC	001	
MNC	01	
AMF Region ID	2	
AMF Set ID	1	
AMF Pointer	63	
AMF Client Name	AMFClient1	
AMF API Versions		
AMF Communication Service	v1	
AMF Event Exposure Service	v1	
AMF Mobile Terminated Service	v1	
AMF Location Service	v1	
UDM	1	
UDM 1		
UDM IP Address	192.168.12.198	
UDM Server Port	6666	
UDM API Versions		
UE Authentication Service	v1	
Context Management Service	v1	
Subscriber Data Management Service	v2	
Event Exposure Service	v1	
Parameter Provision Service	v1	
NIDD Authorization Service	v2	
UE Simulation Parameters		
Type Of UE Simulation	Profiles	
End User Configuration	UE_Profiles_N8AMF.xml	
Auto Generated Users Info		
No Of Users To Be Simulated	100000	
Starting IMSI	001013012061631	
Starting MSIN	3012061631	
Starting IMEI	359877068345248	
Starting IMEISV	1234567890143001	
Auto Generated End User Configuration	AutoGenerated_UE_Profile_N8AMF.xml	

At the bottom right of the configuration tree, there are "Start" and "Edit" buttons. The status bar at the very bottom shows "Initialisation Errors" and "Error Events" with corresponding icons.

Testbed Setup (UDM)

The screenshot displays the MAPS UDM (N8 RELEASE17) configuration interface. The window title is "MAPS UDM (N8 RELEASE17) - [Testbed Setup - TestBedDefault]". The menu bar includes "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". The toolbar contains various icons for file operations and system functions.

The main configuration area is divided into two columns: "Config" and "Value". The "UDM Configuration" tree is expanded, showing the following settings:

Config	Value
UDM	1
UDM 1	
UDM IP Address	192.168.12.198
UDM Port	6666
URI Scheme	HTTP
UDM API Versions	
UE Authentication Service	v1
Context Management Service	v1
Subscriber Data Management Service	v2
Event Exposure Service	v1
Parameter Provision Service	v1
NIDD Authorization Service	v2
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	UE_Profiles_N8UDM.xml
Auto Generated Users Info	
No Of Users To Be Simulated	100000
Starting IMSI	001013012061631
Starting MSIN	3012061631
Starting IMEI	359877068345248
Starting IMEISV	1234567890143001
Auto Generated End User Configuration	AutoGenerated_UE_Profile_N8UDM.xml

On the right side, there is an "Enable" checkbox which is checked. At the bottom right, there are "Start" and "Edit" buttons. The status bar at the bottom shows "Initialisation Errors" and "Error Events".

Profile Editor (AMF)

MAPS AMF (N8 RELEASE17) - [Profile Editor -UE_Profiles_N8AMF]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)
1	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

Config Value

- MSIN3012041631
 - Subscriber Info
 - IMEI: 359877068325248
 - SUPI: 001013012041631
 - MSIN: 3012041631
 - IMEISV: 1234567890123001
 - AMF Client Name: AMFClient1
 - PLMN ID
 - MCC: 001
 - MNC: 01
 - UECM Service Parameters
 - UECM Service Request: AMF Registration
 - Access Type: NON 3GPP ACCESS
 - RAT Type: NR
 - IMS VoPs: HOMOGENEOUS_SUPPORT
 - Dual Registration Flag: False
 - UE SRVCC Capability: False
 - SDM Service Parameters
 - SDM Service Request: Get SMS-Data
 - Multi DataSet Names: AM,SM,SMF_SEL
 - SDM Subscription
 - Immediate Report: False

Enable

Add Insert Delete

Properties

Initialisation Errors Error Events

Profile Editor (UDM)

The screenshot displays the MAPS UDM (N8 RELEASE17) Profile Editor interface. The window title is "MAPS UDM (N8 RELEASE17) - [Profile Editor -UE_Profiles_N8UDM]". The menu bar includes "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". The toolbar contains various icons for file operations and editing.

The main interface is divided into three main sections:

- Profiles (Edit-F2):** A list of profiles with columns for ID, Name, and Enable status. Profile 1, MSIN3012041631, is selected.
- Config:** A tree view showing the configuration for the selected profile. The tree structure is as follows:
 - MSIN3012041631
 - Subscriber Info
 - IMSI: 001013012041631
 - IMEI: 359877068325248
 - IMEISV: 1234567890123001
 - MSIN: 3012041631
 - HPLMN ID
 - MCC: 001
 - MNC: 01
 - NSSAI for HPLMN
 - Default Single NSSAI
 - Default Single NSSAI 1
 - SST: 1
 - SD: 01
 - Single NSSAIs
 - Single NSSAIs 1
 - SST: 2
 - SD: 01
 - Single NSSAIs 2
 - SST: 3
 - SD: 01
 - Supported Features: 0
 - Provisioning Time: 2022-08-01T10:35:1...
 - Additional Snsasai Data
 - Required Authent...: True
 - GPSSIs: 1
 - Internal GroupIds: 01030507-123-456-0...
 - VN GroupInfo
 - Shared VnGroup Datalds
 - Authentication Parameters
 - Authentication Type: 5G_AKA
 - Algorithm Type 5G AKA: Milenage
 - KEY: 00112233445566778...
 - Operator Variant Paramete...: OPc
- Value:** A column showing the values for the selected configuration items.
- Enable:** A column with a checked checkbox for the selected profile.

At the bottom of the interface, there are buttons for "Add", "Insert", and "Delete", and a "Properties" button. The status bar at the very bottom shows "Initialisation Errors", "Error Events", and "Captures".

Call Reception

GL MAPS UDM (N8 RELEASE17) - [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	UDM_HTTP2_Connection_Monitor.gls		UDM Server Clients : AMF	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nudm_UECM_Control.gls		SUPI : imsi-001013012041631	Completed	AMF Registration is updated	None		Pass

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

Save Column Width Show Latest Find

AMF UDM

PUT /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access 16:48:56.196000

201 16:48:56.198000

Status: 301
:method: PUT
:path: /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access
:scheme: http
:authority: 192.168.12.198:6667
content-type: application/json
accept: application/json, application/problem+json
content-length: 315

```
{
  "amfInstanceId": "837c17cc-0e7a-4ea5-a55a-7eb08331eb3d",
  "deregCallbackUri": "http://192.168.12.170:6666/nudm-uecm/v1/imsi-001013012041631/registra",
  "guam1": {
    "amfId": "2163",
    "plmnId": {
      "mcc": "001",
      "mnc": "01"
    }
  },
  "imsVoPs": "HOMOGENEOUS_SUPPORT",
  "initialRegistrationInd": true,
  "ratType": "NR"
}
```

Scripts Message Sequence Event Config Script Flow

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

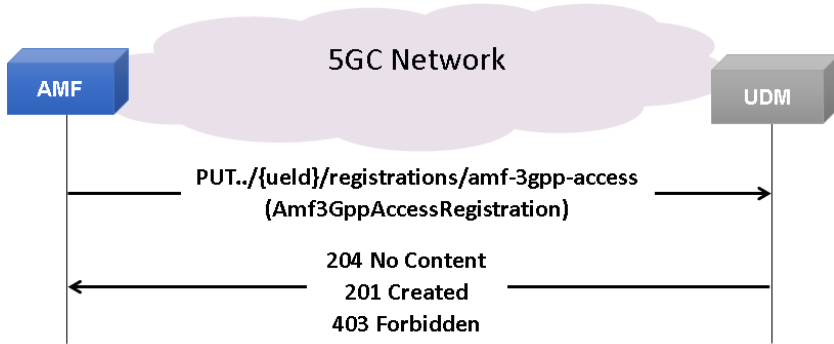
MAPS™5G N8 Interface Procedures

- Nudm_UEContextManagement Service
 - AMF registration for 3GPP access
 - Update AMF registration for 3GPP access
 - AMF deregistration for 3GPP access
 - UDM Initiated NF(AMF) Deregistration for 3GPP access
 - AMF registration for Non 3GPP access
 - Update AMF registration for Non 3GPP access
 - AMF deregistration for Non 3GPP access
 - UDM Initiated NF(AMF) Deregistration for NON 3GPP Access
 - UDM initiated P-CSCF-Restoration
- Nudm_SubscriberDataManagement Service
 - Slice Selection Subscription Data Retrieval
 - Access and Mobility Subscription Data Retrieval
 - SMF Selection Subscription Data Retrieval
 - SMS Subscription Data Retrieval
 - Retrieval Of Multiple Data Sets
 - UE Context in SMF Data Retrieval
 - UE Context In SMSF Data Retrieval
 - LCS Mobile Originated Data Retrieval
 - Subscription to notifications of data change
 - Modification of a subscription to notifications of data change
 - Unsubscribe to notifications of data change

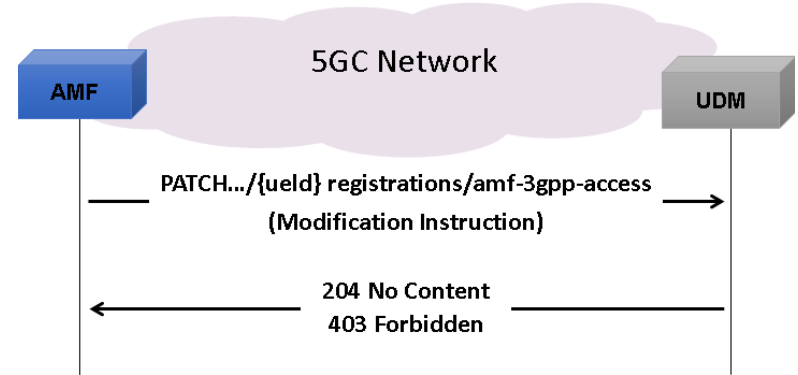
MAPS™ 5G N8 Interface Procedures

Nudm_UEContextManagement Service

AMF registration for 3GPP access



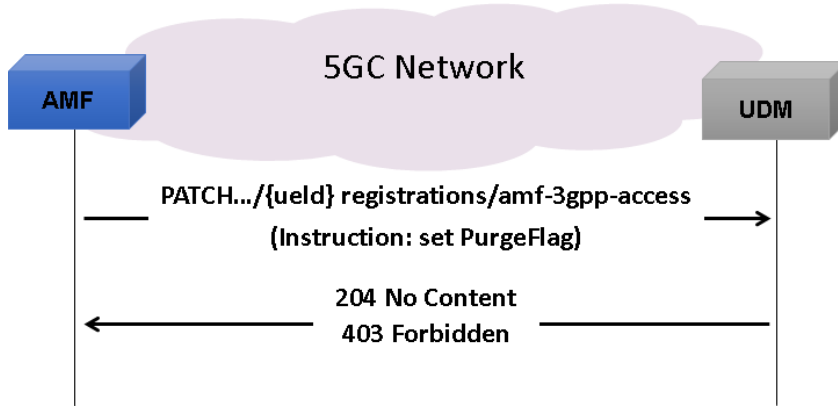
Update AMF Registration for 3GPP access



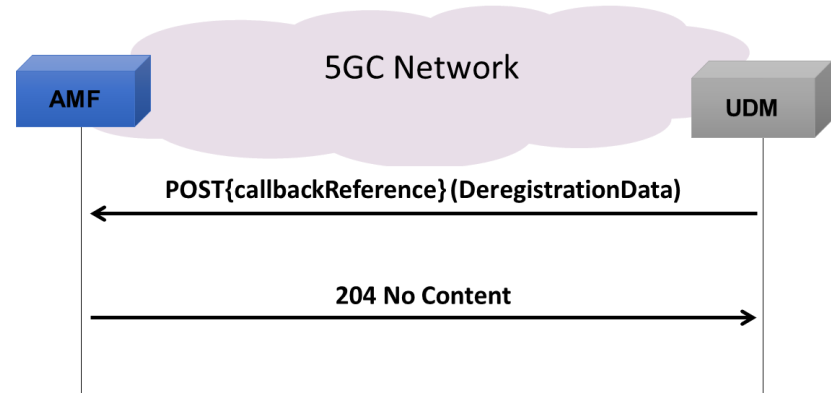
5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

AMF de-registration for 3GPP access



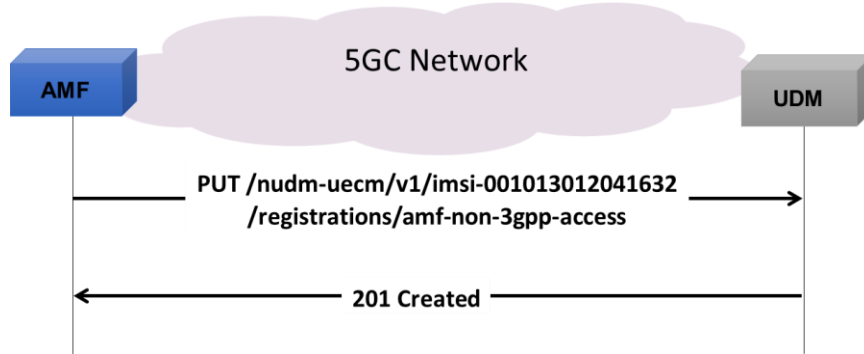
UDM Initiated NF(AMF) Deregistration for 3GPP access



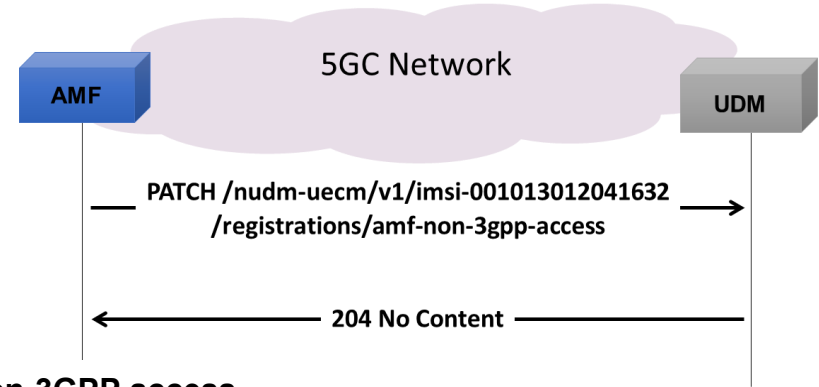
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

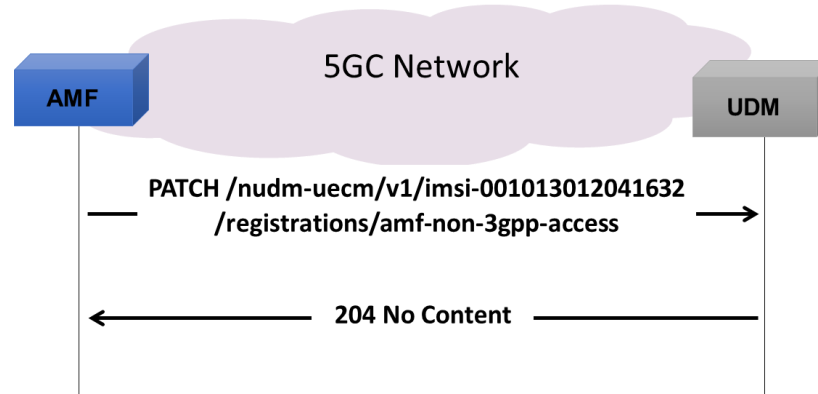
AMF Non-3GPP Access Registration



Update AMF Registration for Non-3GPP access



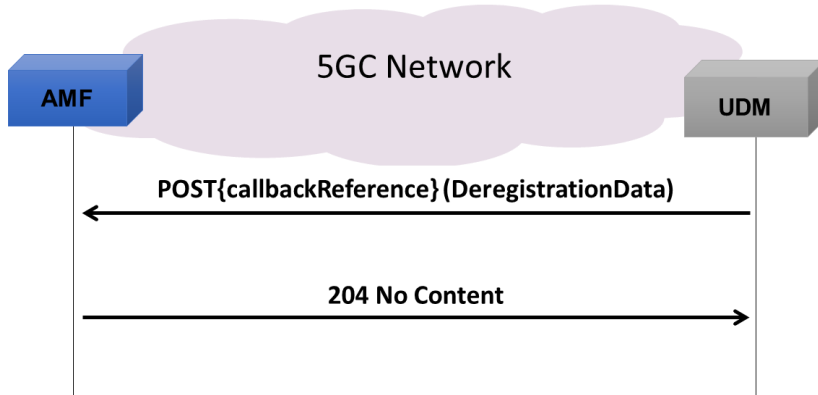
AMF De-registration for Non-3GPP access



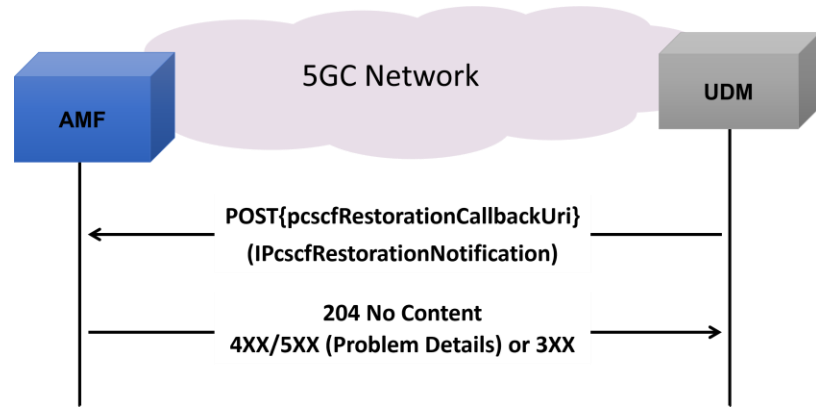
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

UDM Initiated NF(AMF) Deregistration for Non-3GPP Access



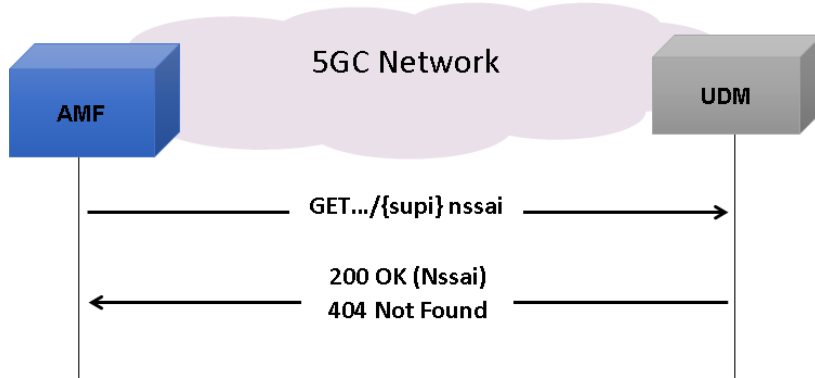
UDM initiated P-CSCF-Restoration



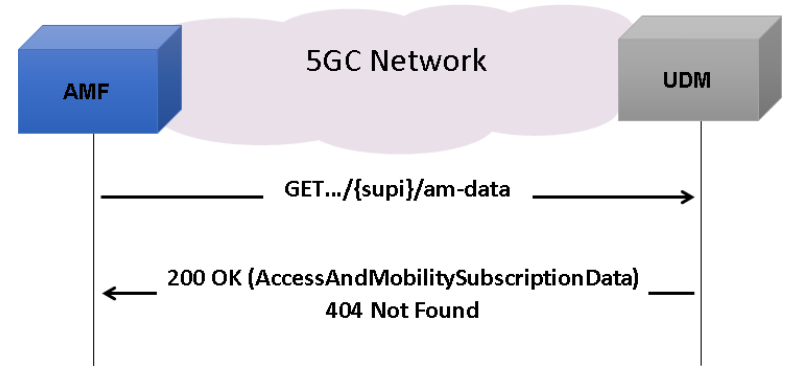
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

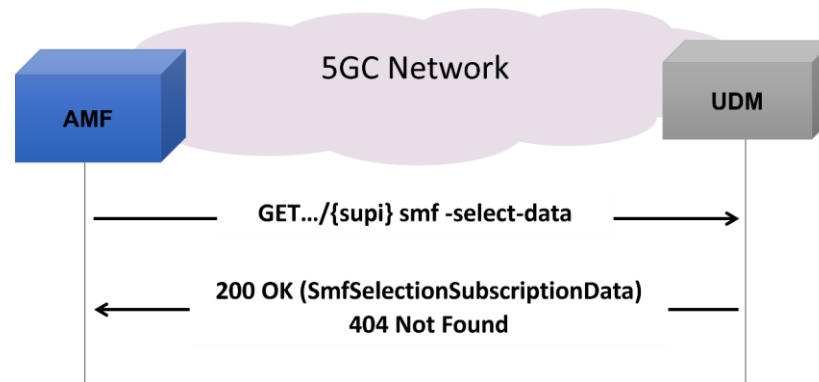
Slice Selection Subscription Data Retrieval



Access and Mobility Subscription Data Retrieval



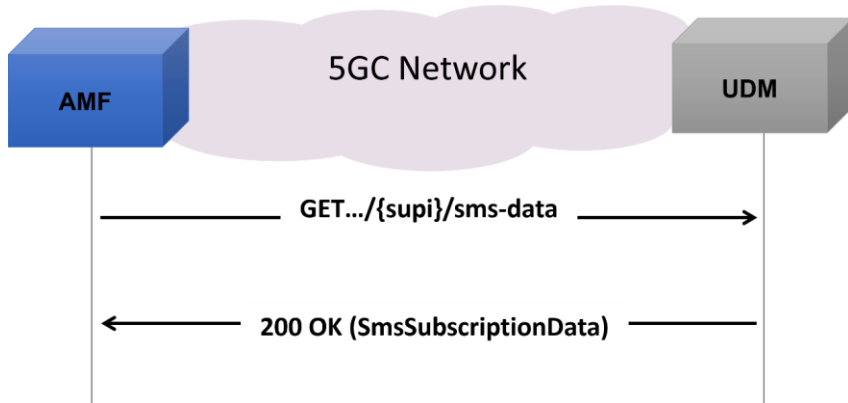
SMF Selection Subscription Data Retrieval



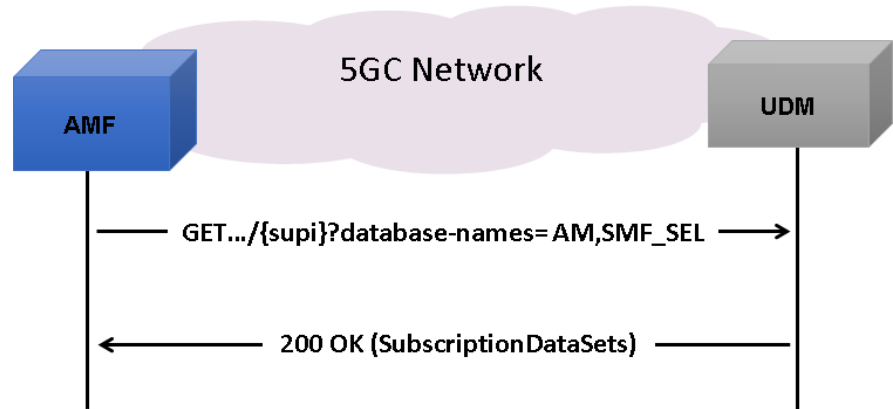
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

SMS Subscription Data Retrieval



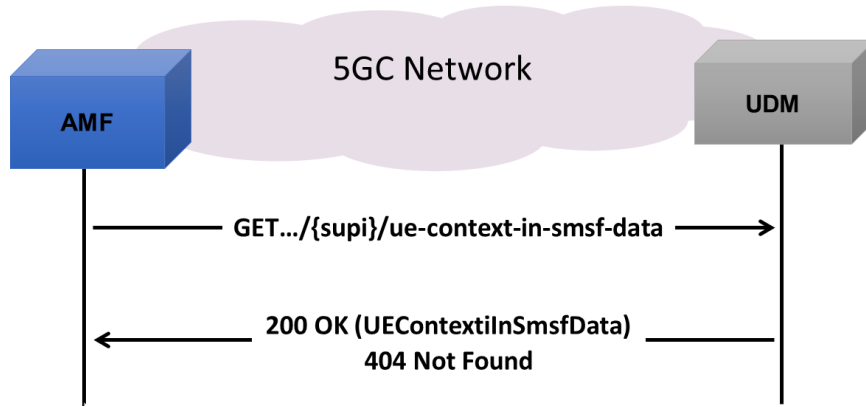
Retrieval of Multiple Data Sets



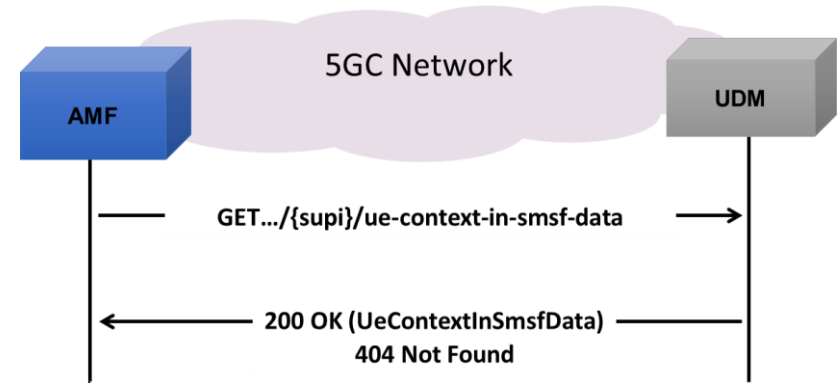
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

UE Context in SMF Data Retrieval



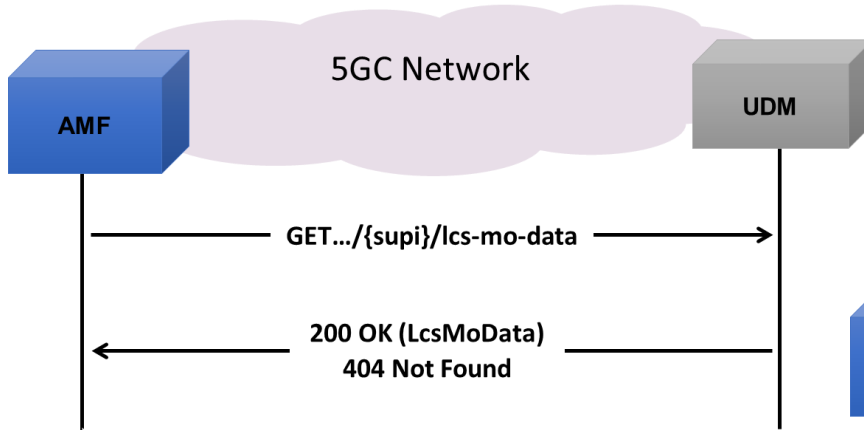
UE Context In SMSF Data Retrieval



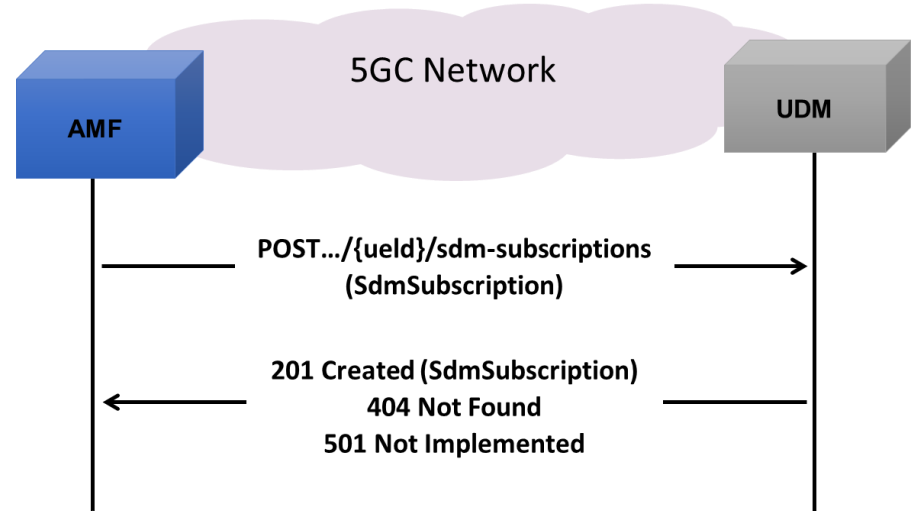
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

LCS Mobile Originated Data Retrieval



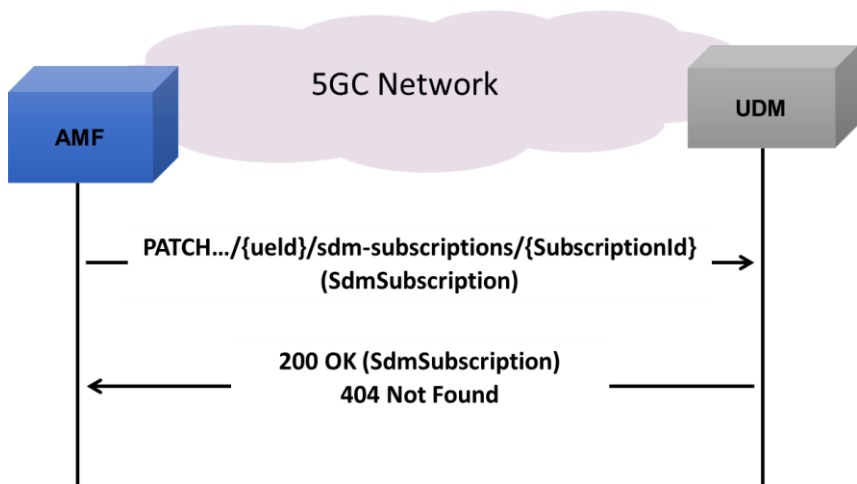
Subscription to notifications of data change



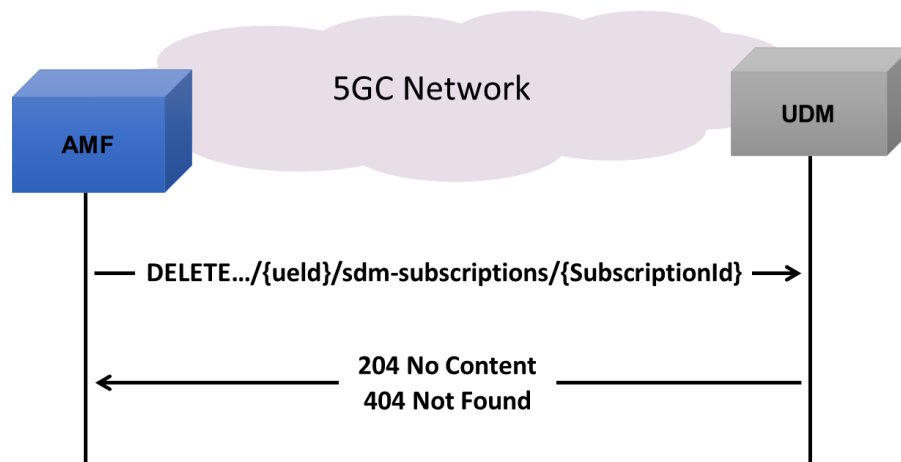
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

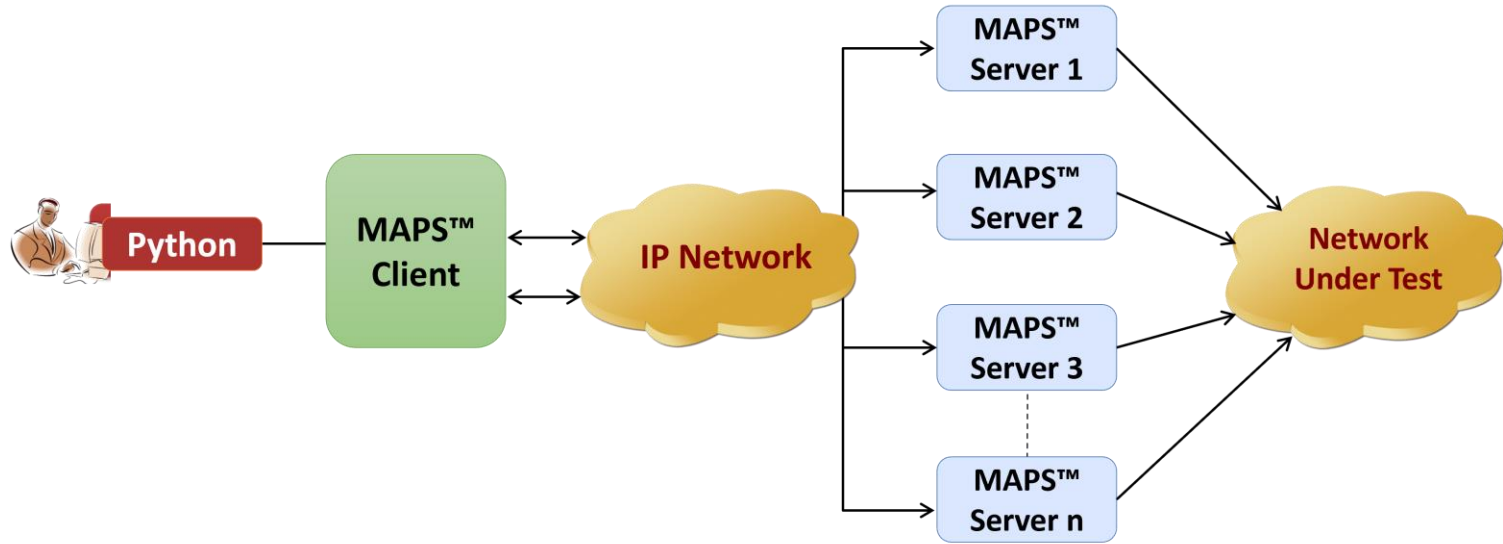
Modification of a subscription to notifications of data change



Unsubscribe to notifications of data change



MAPS™ API Architecture



- API wraps our proprietary scripting language in standard languages familiar to the user:
 - Python
- Clients and Servers support a “Many-to-Many” relationship, making it very easy for users to develop complex test cases involving multiple signaling protocols

CLI/API Support

Python Client

```
*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-N8\MAPSCLI\PythonClient
\examples\AMF\N8_AMF_PlaceCall.py
N8 CLI Server Connection... True
N8 Testbed Starting ... True
N8 Profile Loading... True
N8 Nudm_UECM_Control.gls Script Started... True
Call Initiation Status ... AMF_Registration : True
Call Response Status... Request Sent
ConfirmationResponse = AMF Registration is successful
MAPS N8 MsgCount: 2
MAPS LastMSGRCv.....
Time Stamp          Route          Message
11:06:41.546        <-            201
*****MAPS N8 Message Flow *****
Time Stamp          Route          Message
Message decode...
11:06:41.202        ->            PUT - /nudm-u
/registrations/amf-3gpp-access
11:06:41.202        ->            PUT - /nudm-uecm/v1/imsi-0010
mf-3gpp-access
{"amfInstanceId":"540563c3-fbf7-4e09-8827-a895aab6fbb
://192.168.12.170:6666/nudm-uecm/v1/imsi-001013012041
access/notification","guami":{"amfId":"2163","plmnId"
"imsVoPs":["HOMOGENEOUS_SUPPORT"],"initialRegistrationI
Message decode...
11:06:41.546        <-            201
11:06:41.546        <-            201
{"amfInstanceId":"540563c3-fbf7-4e09-8827-a895aab6fbb
://192.168.12.170:6666/nudm-uecm/v1/imsi-001013012041
access/notification","guami":{"amfId":"2163","plmnId"
"imsVoPs":["HOMOGENEOUS_SUPPORT"],"initialRegistrationI
Stopping Script... True
Stopping N8 TestBed...
```

MAPS™ CLI Server

```
CLI MapsCLI AMF (N8 RELEASE17)
File Edit View
View Latest Command
11: 2024-1-30 11:06:34.746000 : Start "TestBedDefault.xml" # "_AMF[0].UDMIPAddress"="192.168.12.198", "_TypeOfUESimulation"="XML", "_DefaultProfile"="UE_Profiles.xml";
11: 2024-1-30 11:06:38.031000 : LoadProfile "UE_Profiles.xml"
11: 2024-1-30 11:06:40.331000 : StartScript 1 "Nudm_UECM_Control.gls" "UEProfile0001" 1 # "IMSI"="( binarystring )001013012041631,"AccessType"="3GPP_ACCESS","EnableCLI"=1;
11: 2024-1-30 11:06:40.662000 : UserEvent 1 "Nudm_AMF_3GPP_Access_Registration";
11: 2024-1-30 11:06:41.309000 : UserEvent 1 "GetCallStatus";
11: 2024-1-30 11:06:42.616000 : UserEvent 1 "GetMessageCount";
11: 2024-1-30 11:06:42.736000 : UserEvent 1 "GetLastReceivedMessage";
11: 2024-1-30 11:06:42.841000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
11: 2024-1-30 11:06:42.946000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
11: 2024-1-30 11:06:43.066000 : StopScript 1;
11: 2024-1-30 11:06:43.171000 : Stop TestBedSetup;
ServerLog:errCode = 0,errString = connection has been gracefully closed for ClientId=1
NUM
```

Thank you