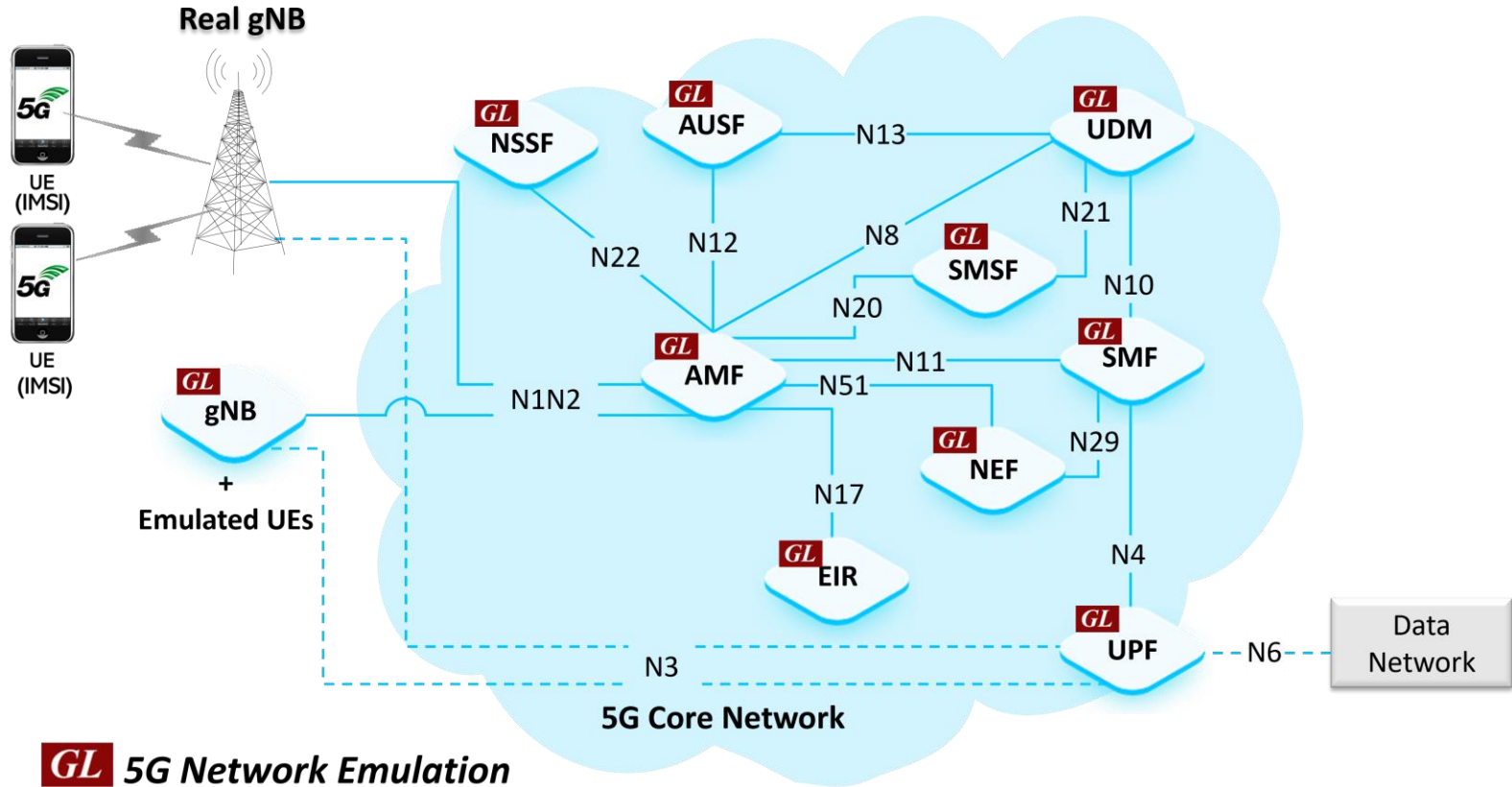

MAPS™ 5G N8 Interface Emulator



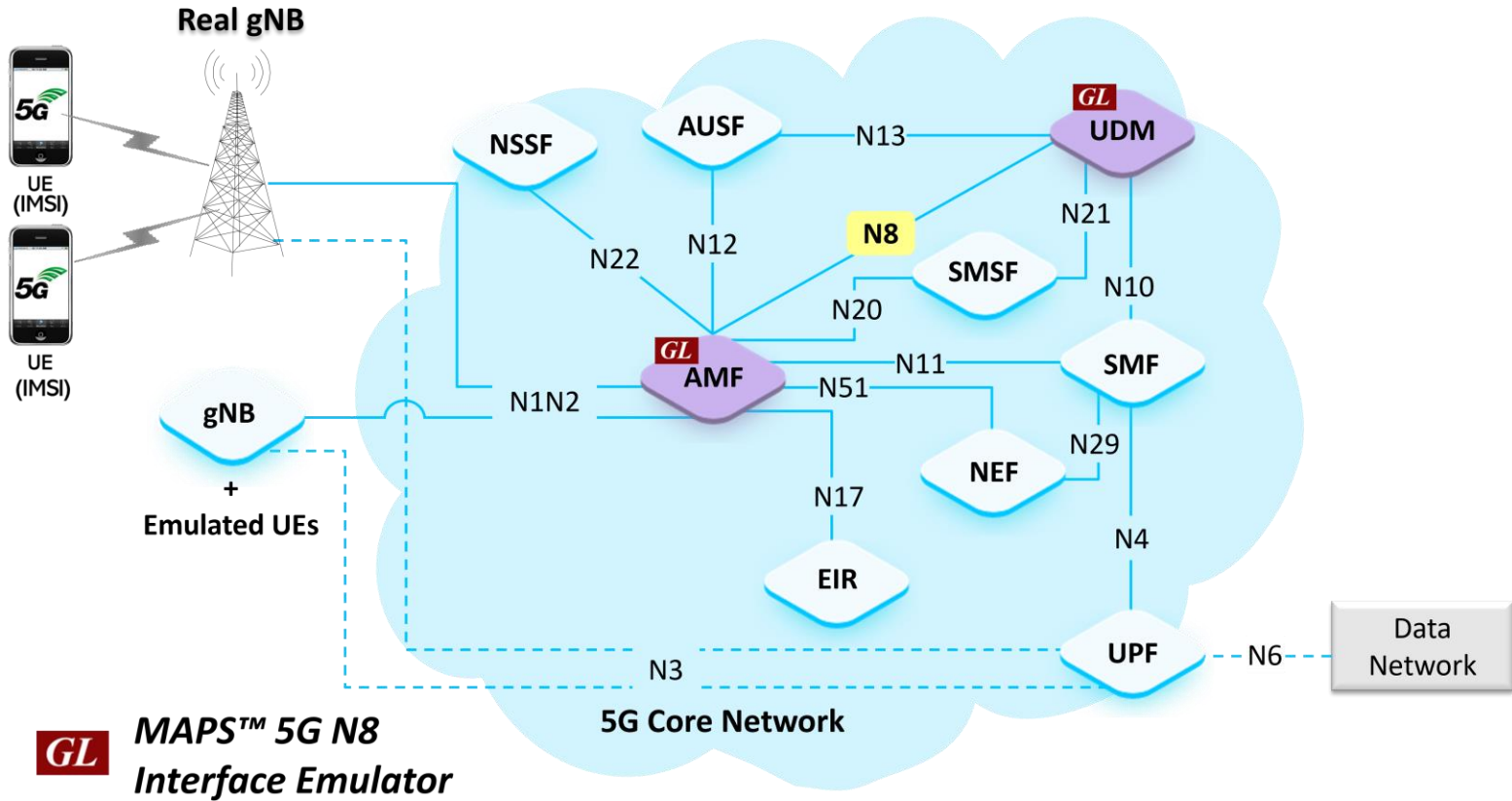
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

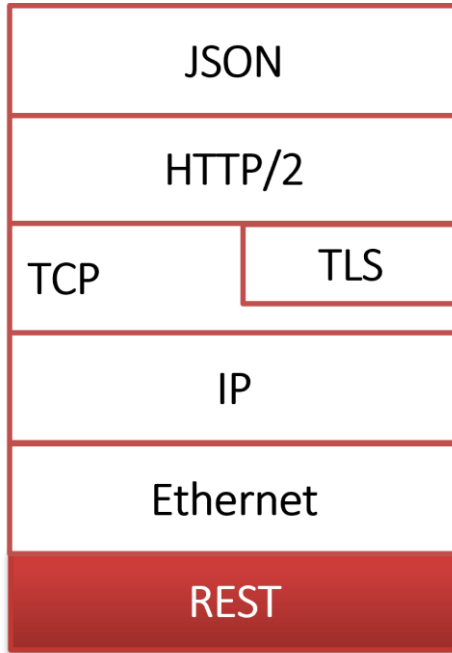
MAPS™ 5G N8 Interface



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

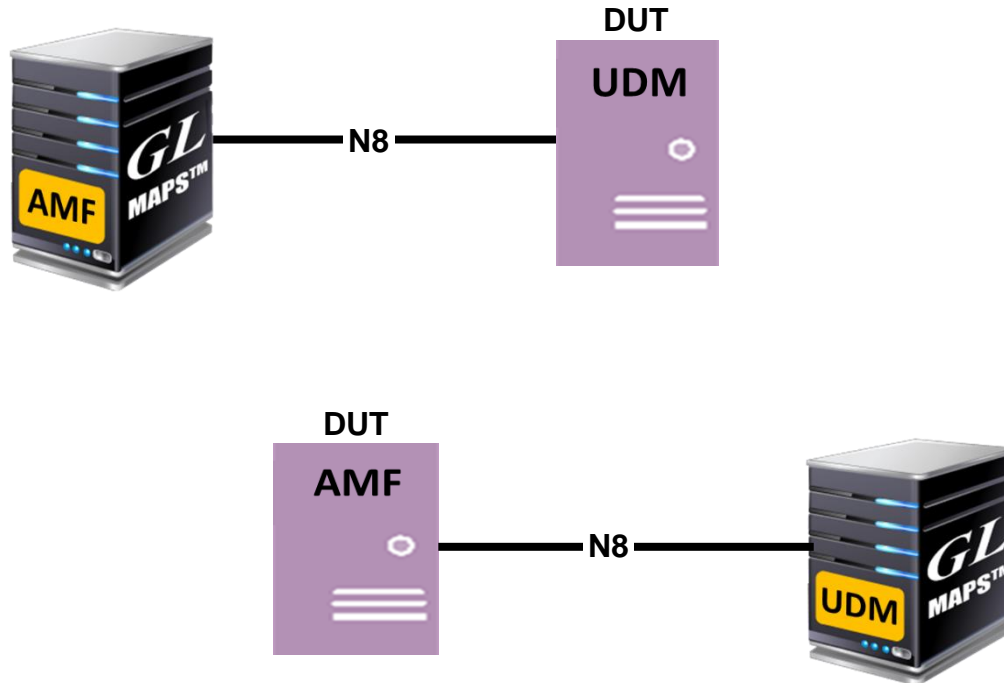
Protocol Stack Specification



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 "GL 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 tree view of configuration parameters, with a table showing the configuration name, its value, and an "Enable" checkbox.

Config	Value	Enable
AMF Configuration		<input checked="" type="checkbox"/>
AMF	1	<input checked="" type="checkbox"/>
AMF 1		<input checked="" type="checkbox"/>
AMF IP Address	192.168.12.170	<input checked="" type="checkbox"/>
AMF Server Port	6666	<input checked="" type="checkbox"/>
URI Scheme	HTTP	<input checked="" type="checkbox"/>
Served GUAMI List	1	<input checked="" type="checkbox"/>
Served GUAMI List 1		<input checked="" type="checkbox"/>
GUAMI		<input checked="" type="checkbox"/>
PLMN Identity		<input checked="" type="checkbox"/>
MCC	001	<input checked="" type="checkbox"/>
MNC	01	<input checked="" type="checkbox"/>
AMF Region ID	2	<input checked="" type="checkbox"/>
AMF Set ID	1	<input checked="" type="checkbox"/>
AMF Pointer	63	<input checked="" type="checkbox"/>
AMF Client Name	AMFClient1	<input checked="" type="checkbox"/>
AMF API Versions		<input checked="" type="checkbox"/>
UDM	1	<input checked="" type="checkbox"/>
UDM 1		<input checked="" type="checkbox"/>
UDM IP Address	192.168.12.198	<input checked="" type="checkbox"/>
UDM Server Port	6666	<input checked="" type="checkbox"/>
UDM API Versions		<input checked="" type="checkbox"/>
UE Authentication Service	v1	<input checked="" type="checkbox"/>
Context Management Service	v1	<input checked="" type="checkbox"/>
Subscriber Data Management Service	v2	<input checked="" type="checkbox"/>
Event Exposure Service	v1	<input checked="" type="checkbox"/>
Parameter Provision Service	v1	<input checked="" type="checkbox"/>
NIDD Authorization Service	v2	<input checked="" type="checkbox"/>
UE Simulation Parameters		<input checked="" type="checkbox"/>
Type Of UE Simulation	Profiles	<input checked="" type="checkbox"/>
End User Configuration	UE_Profiles.xml	<input checked="" type="checkbox"/>
Auto Generated Users Info		<input checked="" type="checkbox"/>

Buttons: Start, Edit

Status: Initialisation Errors, Ei

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 a tree view on the left and a details pane on the right. The tree view shows the following structure:

- UDM Configuration
 - UDM
 - 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.xml
 - Auto Generated Users Info

The details pane on the right shows the "Enable" checkbox checked. At the bottom of the details pane are "Start" and "Edit" buttons. The status bar at the bottom indicates "Initialisation Errors" and "Error".

Profile Editor (AMF)

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

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)
1	UEProfile0001
2	UEProfile0002
3	UEProfile0003
4	UEProfile0004
5	UEProfile0005
6	UEProfile0006
7	UEProfile0007
8	UEProfile0008
9	UEProfile0009
10	UEProfile0010
11	UEProfile0011
12	UEProfile0012
13	UEProfile0013
14	UEProfile0014
15	UEProfile0015
16	UEProfile0016

Config

Config	Value
UEProfile0001	
Subscriber Info	
PEI	359877068325248
SUPI	001013012041631
AMF Client Name	AMFClient1
PLMN ID	
MCC	001
MNC	01
UECM Service Parameters	
UECM Service Request	AMF Deregistration
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	Unsubscribe Notification
Multi DataSet Names	AM,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 -UE_Profiles]' application window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar with various icons. The main workspace is divided into three panes:

- Profiles (Edit-F2):** A list of 19 profiles, each with a unique MSIN number. 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
 - MSIN: 3012041631
 - HPLMN ID
 - MCC: 001
 - MNC: 01
 - NSSAI for HPLMN
 - Default Single NSSAI
 - Single NSSAIs
 - Supported Features: 0
 - Provisioning Time: 2022-08-01T10:35:15....
 - Additional Snsai Data
 - GPSIs: 1
 - Internal GroupIds: 01030507-123-456-0...
 - VN GroupInfo
 - SharedVnGrpDataIds JsonIssue AddInFut...
 - Authentication Parameters
 - Subscribed UE AMBR
 - RAT Restrictions: EUTRA
 - Forbidden Areas
 - Service Area Restriction
 - Core Network Type Restrictions: EPC
 - UPU Info
- Value:** A column showing the values for the selected configuration items.
- Enable:** A checkbox labeled 'Enable' which is checked.

At the bottom of the main workspace, there are buttons for 'Insert', 'Delete', and 'Clear'. Below the main workspace, there are three status indicators: 'Initialisation Errors', 'Error Events', and 'Capt'.

Call Generation

MAPS.AMF (N8 RELEASE17) - [Call Generation -Default]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Ev...	Result	Total It...	Completed Iterations
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI :_imsi-001013012041631	Start	AMF Registration is successful	None		Pass	1	1
2	Nudm_SDM_Control.gls	UEProfile0001		Start		None		Unknown	1	0

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

Save Column Width Show Latest

AMF UDM

PUT /nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access 15:49:58.586000

201 CREATED 15:49:58.979000

Find

```
PUT http://192.168.12.198:6666/nudm-uecm/v1/imsi-001013012041631/regist
content-type : application/json
accept : application/json,
application/problem+json

{
  "amfInstanceId": "f19d267b-dd40-4276-b396-92437d45c35e",
  "deregCallbackUri": "http://192.168.12.170:6666/nudm-uecm/v1/imsi-00101
  "guami": {
    "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

Call Reception

The screenshot displays the MAPS UDM (N8 RELEASE17) interface for Call Reception. The main window shows a table of call records and a detailed view of a message sequence between AMF and UDM.

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 : jmsi-001013012041631	Completed	AMF Registration is updated	None		Pass
3	Nudm_SDM_Control.gls		SUPI : jmsi-001013012041631	Completed	Successful Response Sent	None		Pass

Below the table, there are control buttons: Stop, Stop All, Abort, Abort All, Show Records (checked), Select Active Call, Auto Trash, and Trash.

The Message Sequence diagram shows a sequence between AMF and UDM. A PUT request is sent from AMF to UDM at 15:49:58.961000. The path is `/nudm-uecm/v1/jmsi-001013012041631/registrations/amf-3gpp-access`. A response with status 201 is received from UDM at 15:49:58.970000.

The detailed view on the right shows the following information:

```
Status: 3
:method : PUT
:path : /nudm-uecm/v1/jmsi-001013012041631/registrations/amf-3gpp-access
:scheme : http
:authority : 192.168.12.198:6666
content-type : application/json
accept : application/json,
application/problem+json
content-length : 317

{
  "amfInstanceId": "f19d267b-dd40-4276-b396-92437d45c35e",
  "deregCallbackUri": "http://192.168.12.170:6666/nudm-uecm/v1/jmsi-001013012041631/registrations/amf-3gpp-access"
}
```

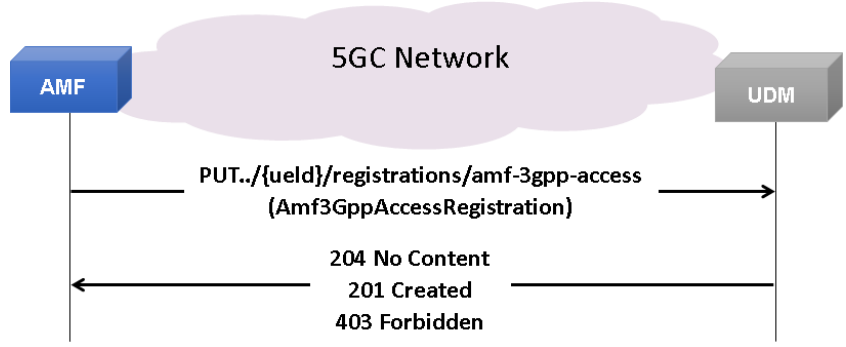
MAPS™5G N8 Interface Procedures

- 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

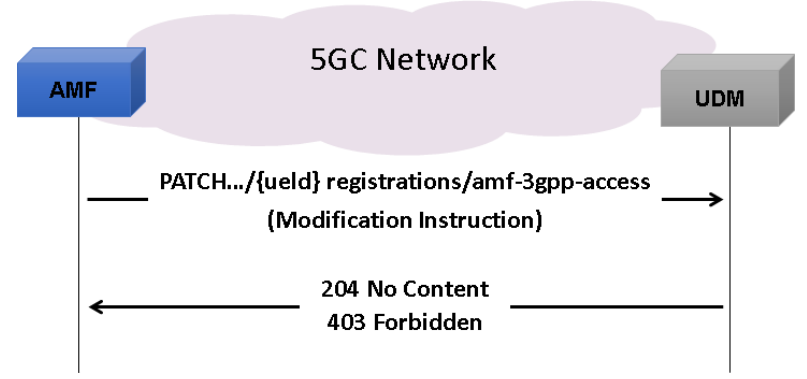
MAPS™ 5G N8 Interface Procedures

Nudm_UEContextManagement Service

AMF registration for 3GPP access



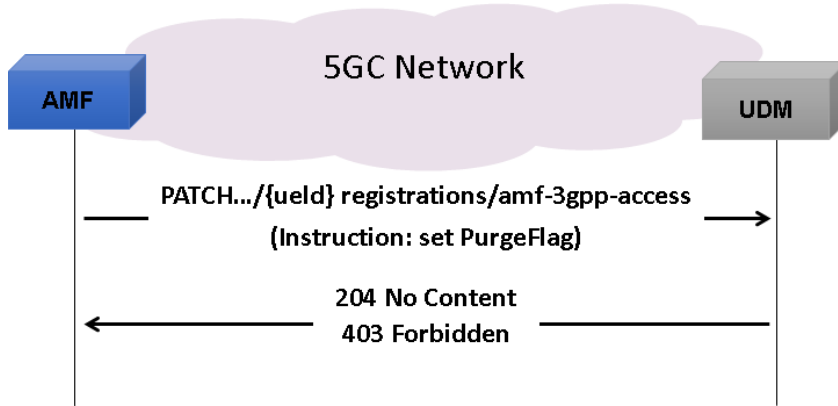
Update AMF Registration for 3GPP access



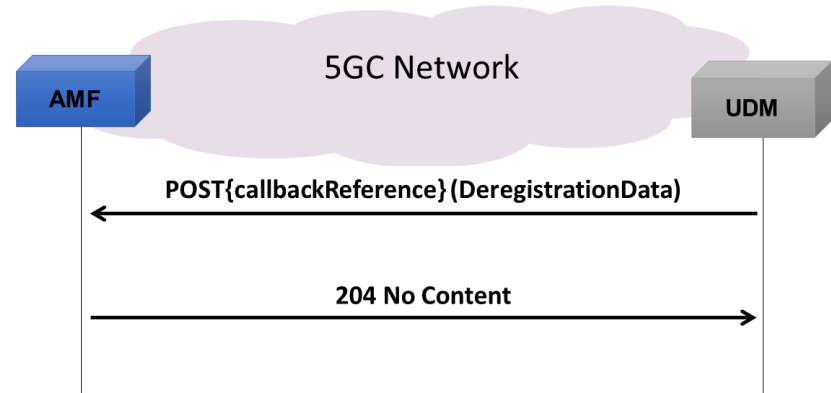
5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

AMF de-registration for 3GPP access



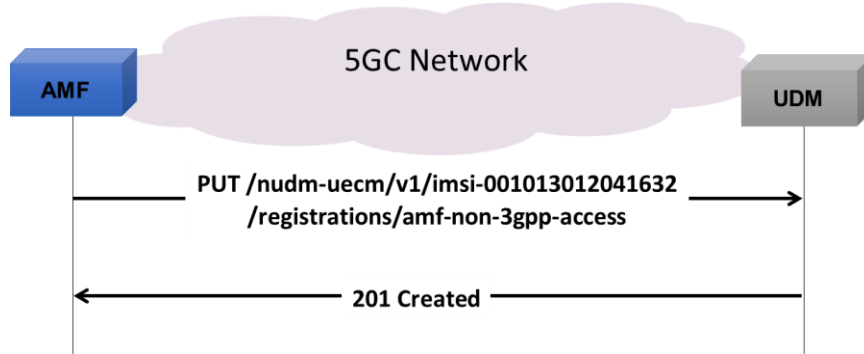
UDM Initiated NF(AMF) Deregistration for 3GPP access



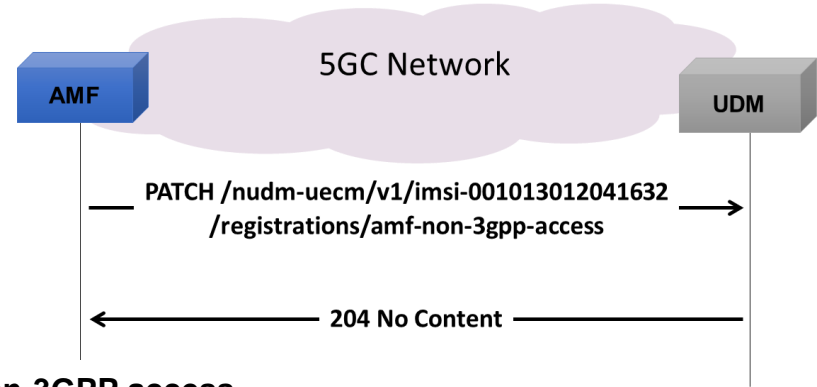
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

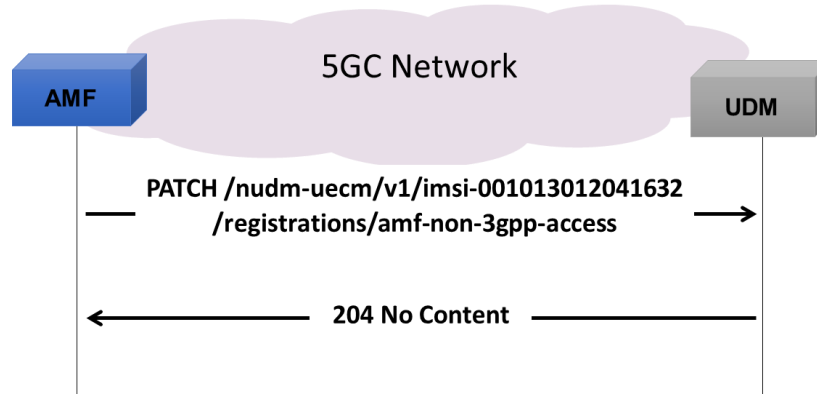
AMF Non-3GPP Access Registration



Update AMF Registration for Non-3GPP access



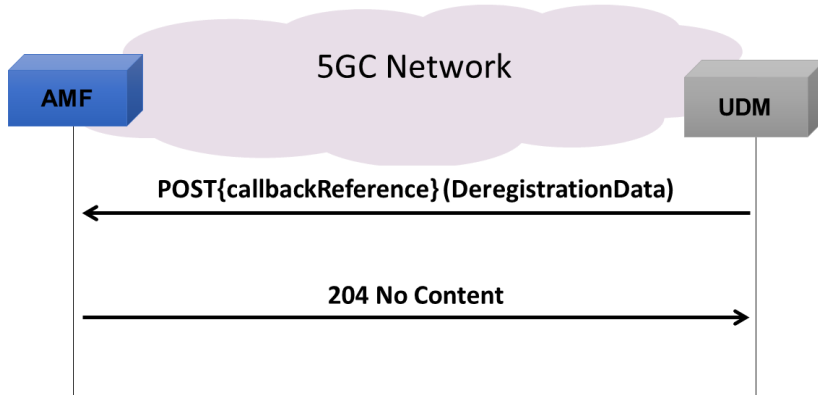
AMF De-registration for Non-3GPP access



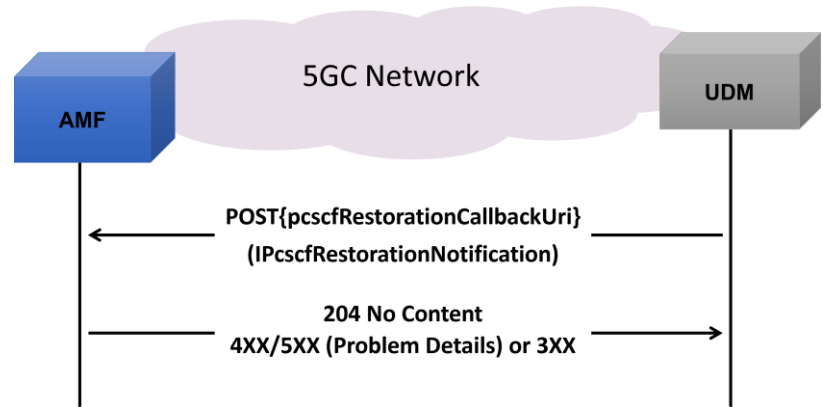
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_UEContextManagement Service

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



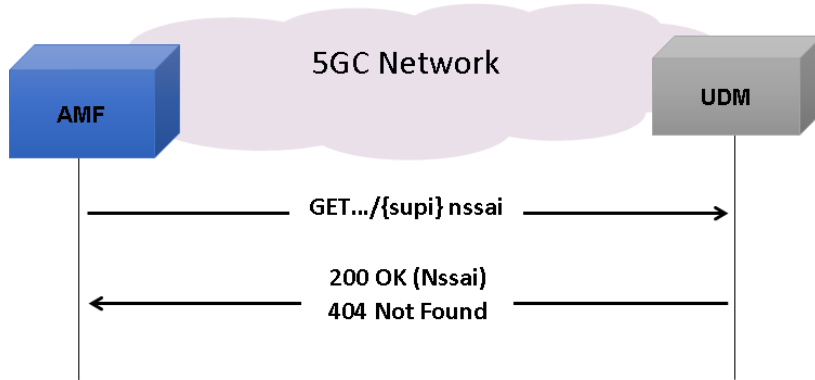
UDM initiated P-CSCF-Restoration



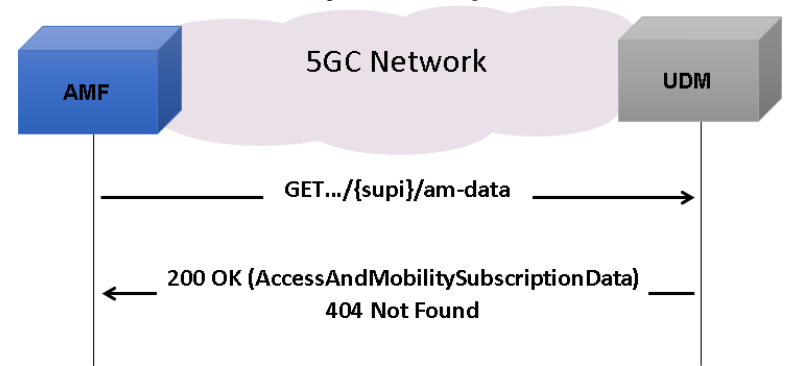
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

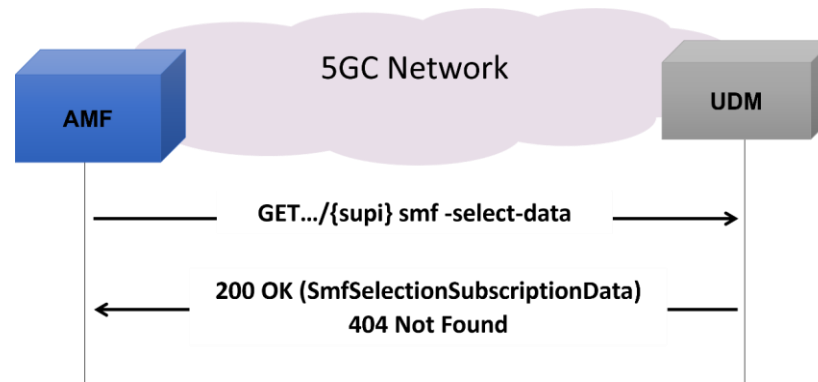
Slice Selection Subscription Data Retrieval



Access and Mobility Subscription Data Retrieval



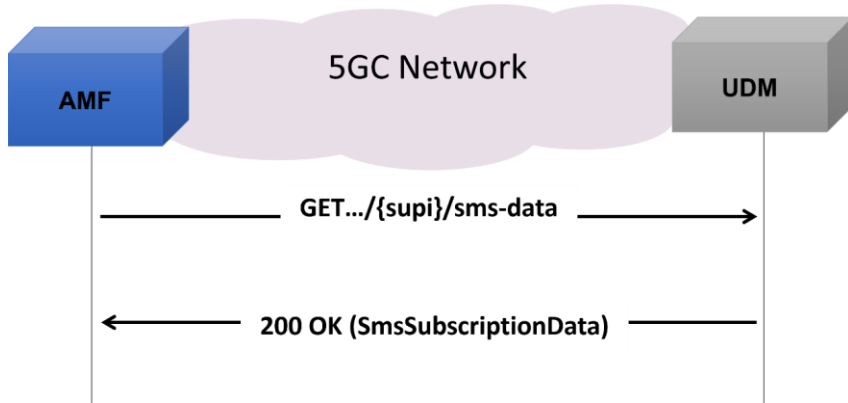
SMF Selection Subscription Data Retrieval



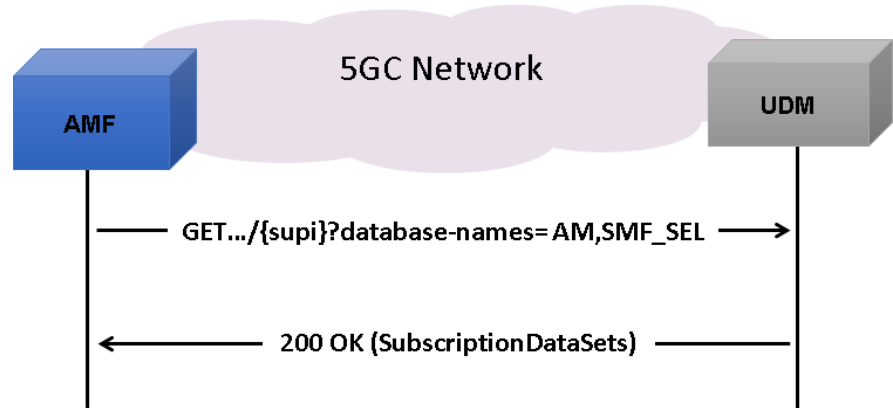
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

SMS Subscription Data Retrieval



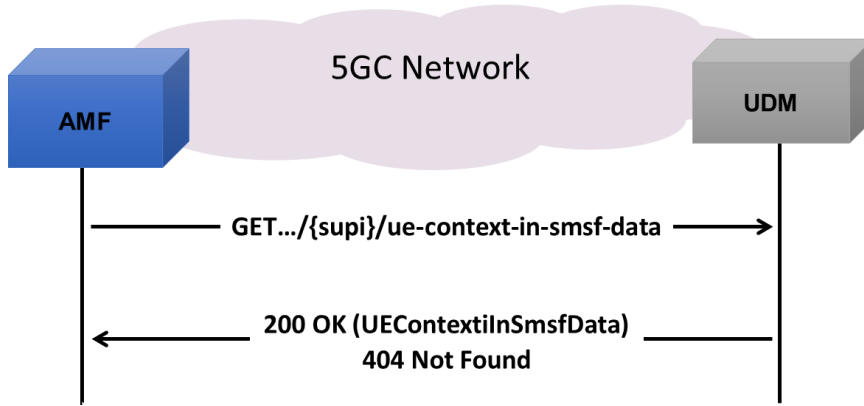
Retrieval of Multiple Data Sets



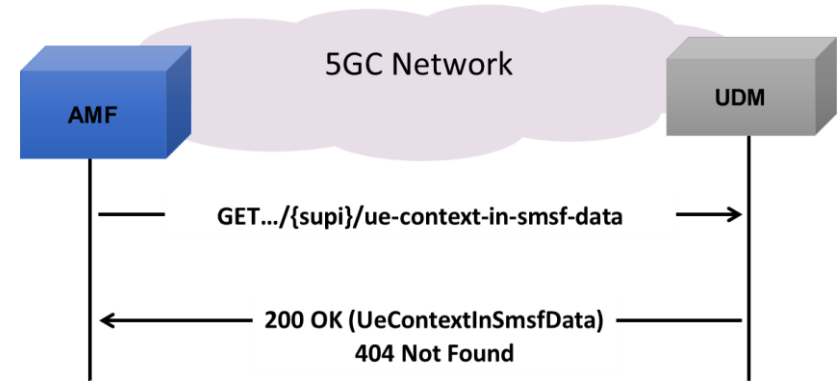
MAPS™5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

UE Context in SMF Data Retrieval



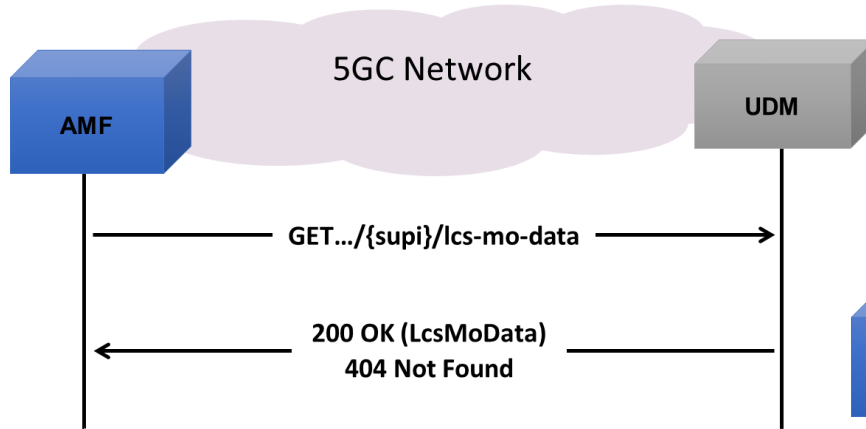
UE Context In SMSF Data Retrieval



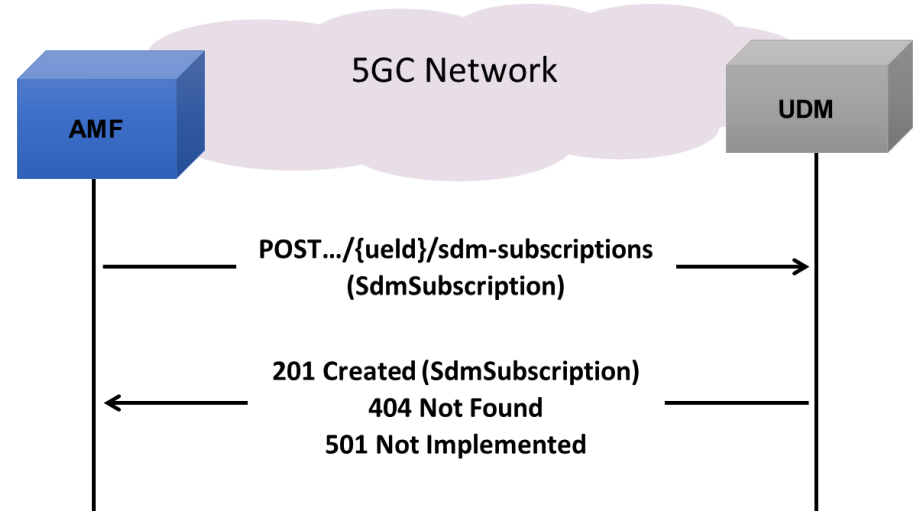
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

LCS Mobile Originated Data Retrieval



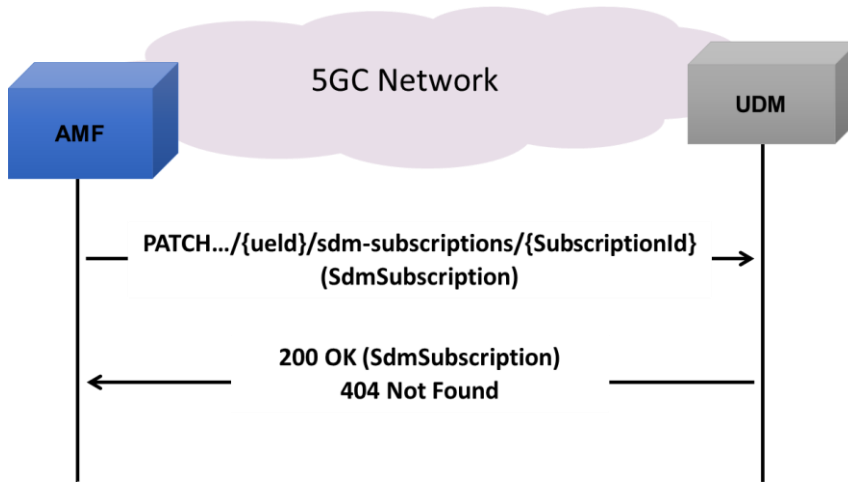
Subscription to notifications of data change



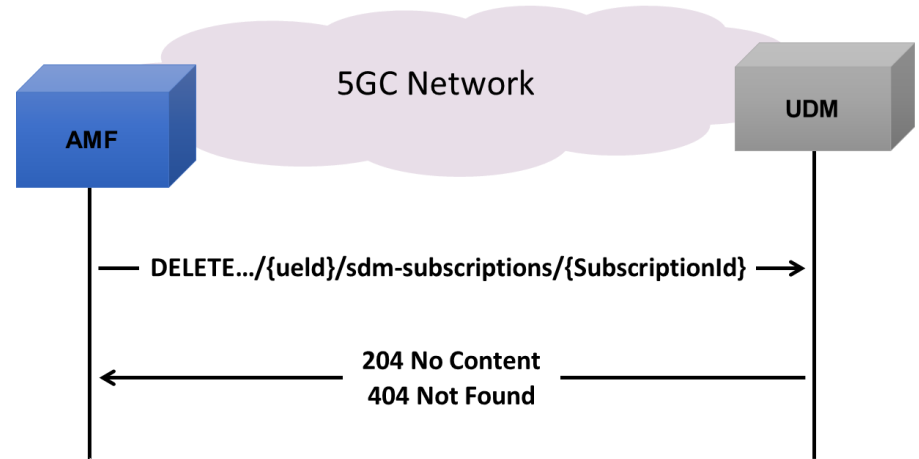
MAPS™ 5G N8 Interface Procedures (Contd.)

Nudm_SubscriberDataManagement Service

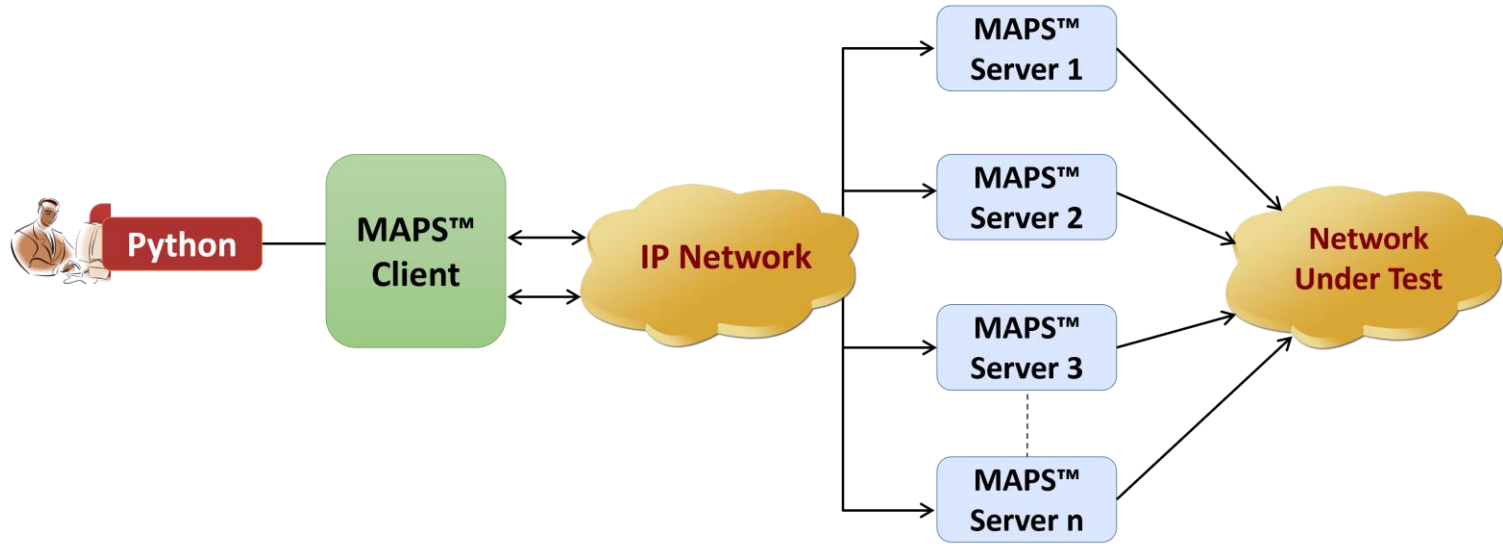
Modification of a subscription to notifications of data change



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-001013012041
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
1 :: 2024-1-30 11:06:34.746000 : Start "TestBedDefault.xml" # "_AMF[0].UDMIPAddress"="192.168.12.198", "_TypeOfUESimulation"="XML", "_DefaultProfile"="UE_Profiles.xml";
1 :: 2024-1-30 11:06:38.031000 : LoadProfile "UE_Profiles.xml"
1 :: 2024-1-30 11:06:40.331000 : StartScript 1 "Nudm_UECM_Control.gls" "UEProfile0001" 1 # "IMSI"="( binarystring )001013012041631,"AccessType"="3GPP_ACCESS","EnableCLI"=1;
1 :: 2024-1-30 11:06:40.662000 : UserEvent 1 "Nudm_AMF_3GPP_Access_Registration";
1 :: 2024-1-30 11:06:41.309000 : UserEvent 1 "GetCallStatus";
1 :: 2024-1-30 11:06:42.616000 : UserEvent 1 "GetMessageCount";
1 :: 2024-1-30 11:06:42.736000 : UserEvent 1 "GetLastReceivedMessage";
1 :: 2024-1-30 11:06:42.841000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
1 :: 2024-1-30 11:06:42.946000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
1 :: 2024-1-30 11:06:43.066000 : StopScript 1;
1 :: 2024-1-30 11:06:43.171000 : Stop TestBedSetup;
ServerLog:errCode = 0,errString = connection has been gracefully closed for ClientId=1
NUM
```


Thank you