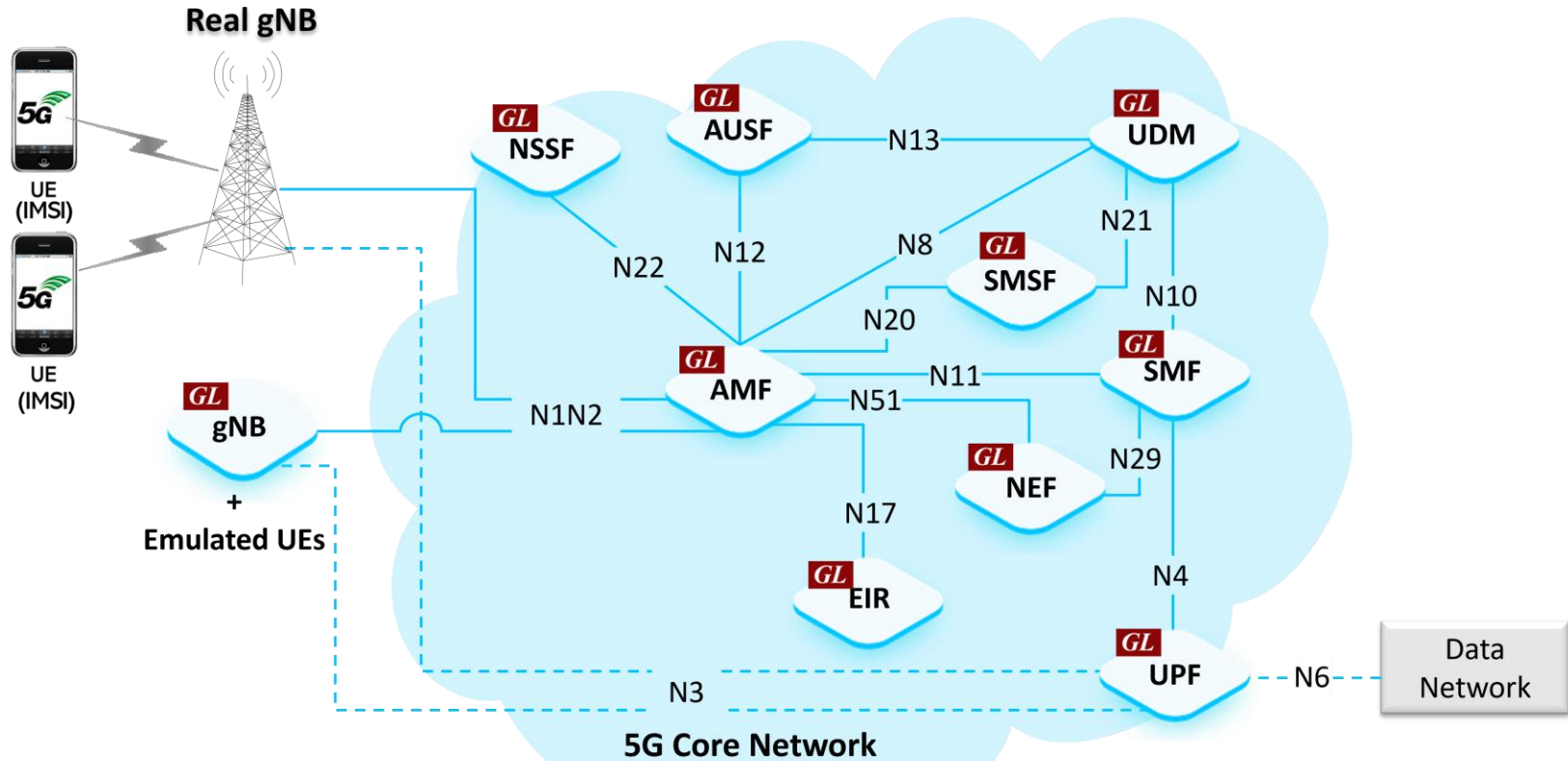

MAPS™ 5G N10 Interface Emulator



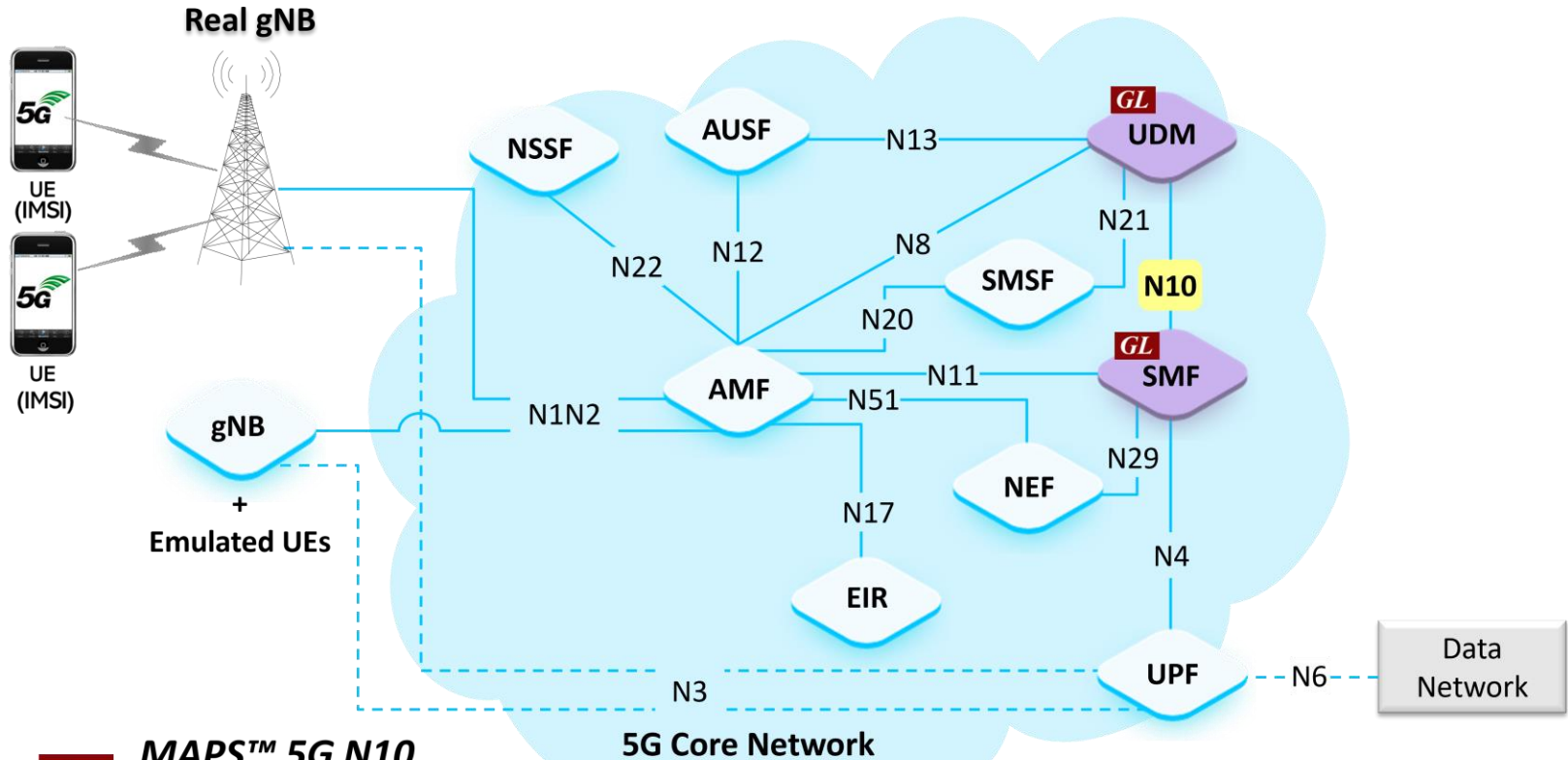
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N10 Interface

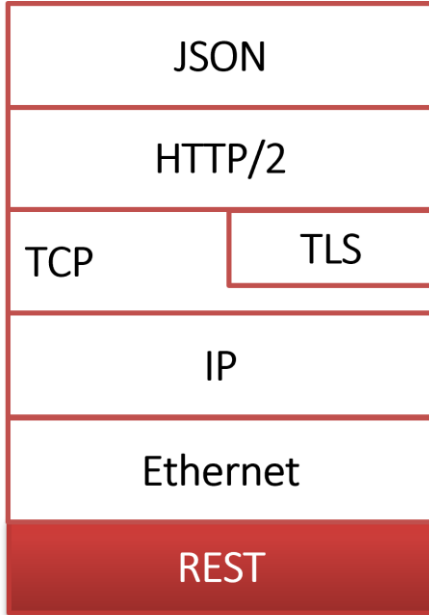


MAPS™ 5G N10
Interface Emulator

Main Features

- Emulate Unified Data Management (UDM) and Session Management Function (SMF) elements
- Supported Procedures are-
 - Nudm_SubscriberDataManagement Services
 - Nudm_UEContextManagement Services
- 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 and JSON Messages
- Ready-to-use scripts for quick testing
- Provides Call Statistics and Events Status
- Generate multiple subscriber using CSV profiles
- Automation, Remote access, and Schedulers to run tests 24/7

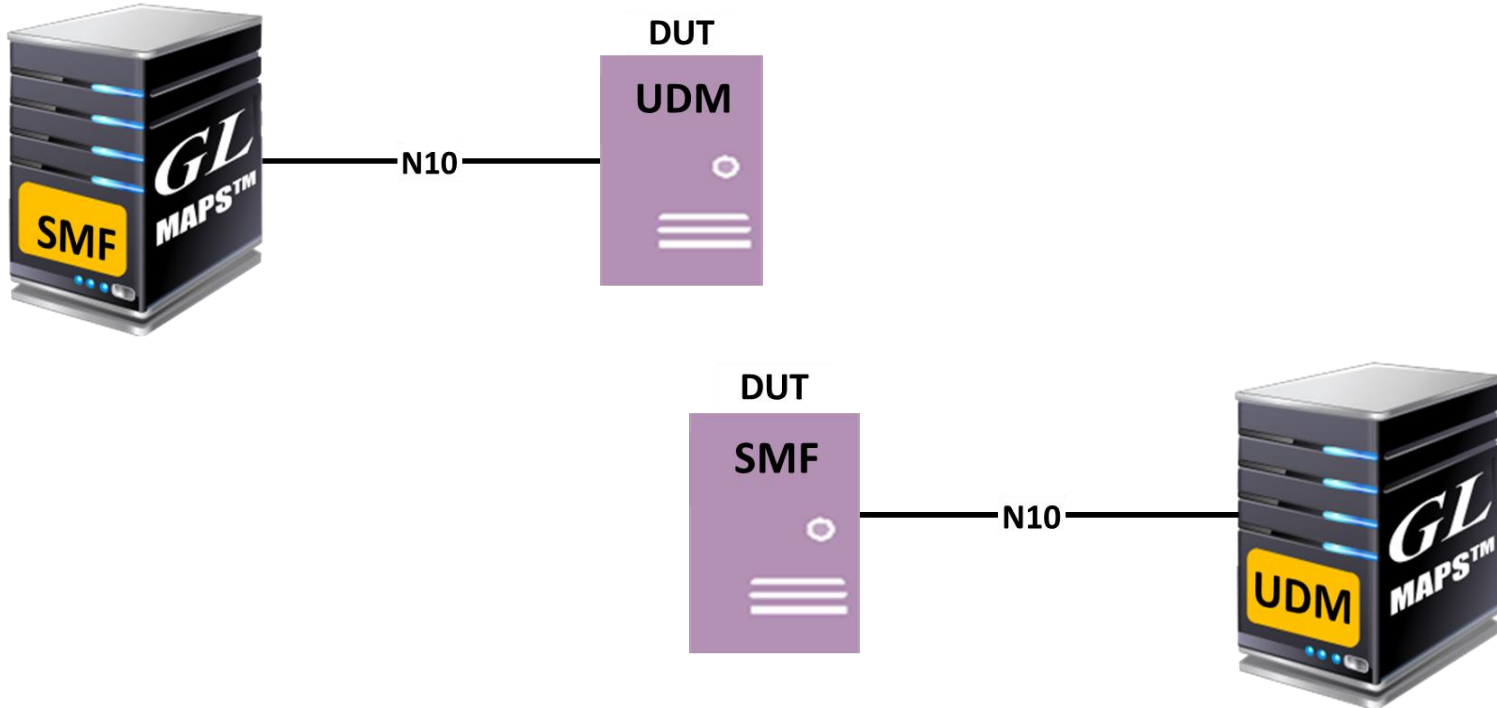
Protocol Stack Specification



Supported Protocols	Standard / Specification Used
N10 Interface	
N10 Interface (UDM - SMF)	TS29.503 Release 15
JavaScript Object Notation (JSON)	IETF RFC 8259
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 N10 User Cases

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



Testbed Setup (SMF)

The screenshot shows the MAPS SMF (N10 RELEASE17) configuration window. The window title is "MAPS SMF (N10 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 area is divided into a "Config" pane on the left and a "Value" pane on the right. The "Config" pane shows a tree view of configuration items, and the "Value" pane shows the corresponding values. A "Enable" checkbox is checked on the right side of the "Value" pane. At the bottom of the "Value" pane, there are "Start" and "Edit" buttons.

Config	Value
SMF Configuration	
SMF	1
SMF 1	
SMF IP Address	192.168.12.170
SMF Server Port	6666
URI Scheme	HTTP
SMF Client Name	Client1
UDM	1
UDM 1	
UDM IP Address	192.168.12.198
UDM 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.xml
Auto Generated Users Info	
No Of Users To Be Simulated	4000
Starting IMSI	001013012041631
MSIN	3012041631
Auto Generated End User Configuration	AutoGeneratedUser_Profile.xml

Testbed Setup (UDM)

The screenshot shows the MAPS UDM (N10 RELEASE17) configuration window. The title bar reads "MAPS UDM (N10 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 area is divided into a tree view on the left and a table on the right. The tree view shows a hierarchy starting with "UDM Configurations", followed by "UDM", "UDM 1", and "UDM API Versions". The table on the right lists the values for these configurations. A "Start" button and an "Edit" button are located at the bottom right of the table. The status bar at the bottom shows "Initialisation Errors" and "Error Events".

Config	Value
UDM Configurations	
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.xml
Auto Generated Users Info	
No Of Users To Be Simulated	4000
Starting IMSI	001013012041631
Auto Generated End User Configuration	AutoGeneratedUser_Profile.xml

Profile Editor (SMF)

MAPS SMF (N10 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 Value

UEProfile0001

- Subscriber Info
 - SUPI 001013012041631
- SMF Client Selection Client1
- PLMN ID
 - MCC 001
 - MNC 01
- UECM Service Parameters
 - UECM Service Request SMF Registration
 - PDU SessionId 1
- SDM Service Parameters
 - SDM Service Request Get SM-Data
 - Dnn Internet
 - Subscription Expires 2022-08-02T025:09:13.445Z
 - Immediate Report False
- SessionManagementSubscriptionData
 - SessionManagementSubscriptionData 1
 - Single Nssai 1
 - Single Nssai 1
 - SST 1
 - SD 01

Enable

Add Insert Delete

Properties

Insert Delete Clear

Initialisation Errors Error Events C

Profile Editor (UDM)

MAPS UDM (N10 RELEASE17) - [Profile Editor -UE_Profiles]

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
18	MSIN3012041648
19	MSIN3012041649
20	MSIN3012041650
21	MSIN3012041651
22	MSIN3012041652

Config

MSIN3012041631

- Subscriber Info
 - IMSI 001013012041631
 - IMEI 359877068325248
 - 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 1
 - SD 02
 - Supported Features 0
 - Provisioning Time 2022-08-01T10:35:15.330Z
 - Additional Snsai Data
 - Additional Snsai Properties
 - Required Authentication Au... True
- GPSIs 1
 - GPSIs 1 msisdn-3012041631
- Internal GroupIds 01030507-123-456-01020...
- Authentication Parameters
 - Authentication Type 5G_AKA
 - Algorithm Type 5G AKA Milenage
 - KEY 00112233445566778899a...

Enable

Add Insert Delete

Properties

Initialisation Errors Error Events Capture

Call Generation

GL MAPS SMF (N10 RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total It...	Completed Iterations
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI : :imsi-001013012041631	Start	SMF Registration is successful	None	Pass	1	1
2	Nudm_SDM_Control.gls	UEProfile0001	SUPI : :imsi-001013012041631	Start	UE's SM Data Received	None	Pass	1	1

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

Save Column Width Show Latest

SMF UDM

GET /nudm-sdm/v2/imsi-001013012041631/sm-data?dnn=internet 12:36:33.716000

200 OK 12:36:34.111000

Find

GET http://192.168.12.198:6666/nudm-sdm/v2/imsi-001013012041631/sm-data?dnn=internet
accept : application/json,
application/problem+json

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status I

Call Reception

GL MAPS UDM (N10 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 : ,SMF,	Stop	Monitoring HTTP2 Connection Status	None		Unknown
2	Nudm_UECM_Control.gls		SUPI : ,imsi-001013012041631	Completed	SMF Registration is updated	None		Pass
3	Nudm_SDM_Control.gls		SUPI : ,imsi-001013012041631	Completed	Successful Response Sent	None		Pass

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

Save Column Width Show Latest

SMF UDM

GET /nudm-sdm/v2/imsi-001013012041631/smf-data 12:36:34.092000

200 12:36:34.104000

Find

```
Status: 0
:method : GET
:path : /nudm-sdm/v2/imsi-001013012041631/smf-data?dnn=internet
:scheme : http
:authority : 192.168.12.198:6666
:accept : application/json,
application/problem+json
```

Scripts **Message Sequence** Event Config Script Flow

● Initialisation Errors ● Error Events ● Captured Errors ● Link Status L

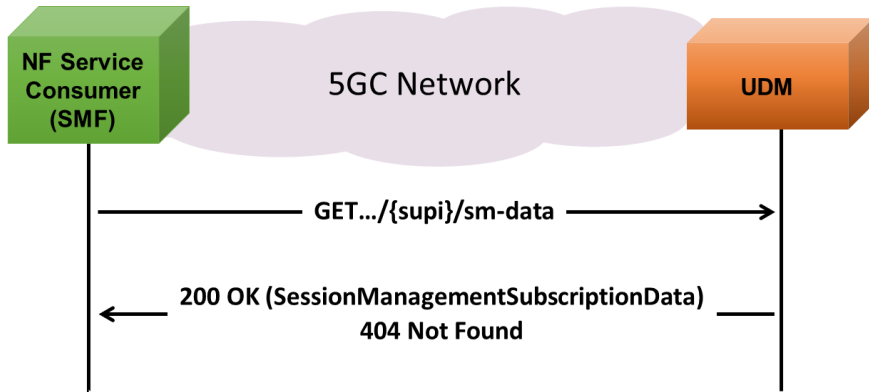
MAPS™ 5G N10 Interface Procedures

- Nudm_SubscriberDataManagement Services:
 - Session Management Subscription Data Retrieval
 - Subscription to Notifications of Data Change
 - Modification of a subscription to notifications of data change
 - Unsubscribe to notifications of data change
- Nudm_UEContextManagement Services:
 - SMF registration
 - SMF deregistration
 - SMF Deregistration Notification
 - UDM Initiated P-CSCF-Restoration Notification

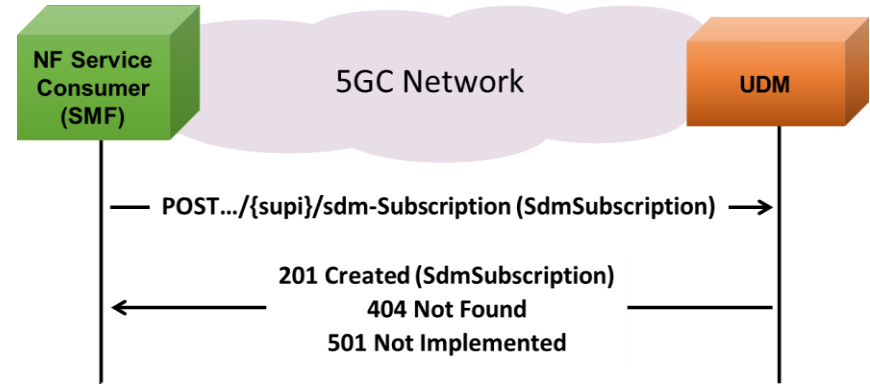
MAPS™ 5G N10 Interface Procedures

Nudm_SubscriberDataManagement Service

Session Management Subscription Data Retrieval



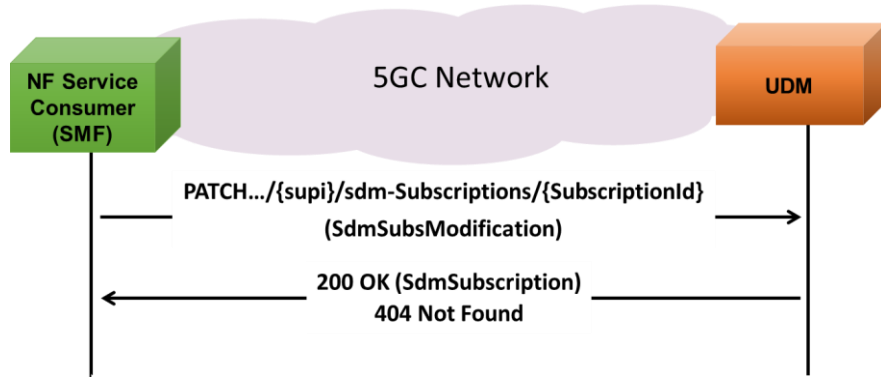
Subscription to notifications of data change



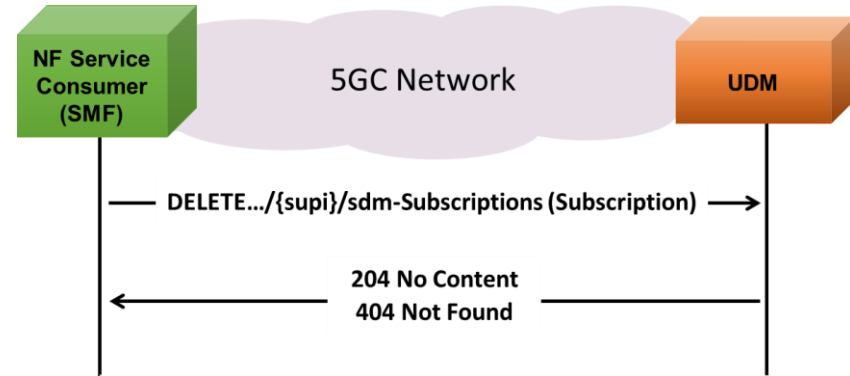
MAPS™ 5G N10 Interface Procedures

Nudm_SubscriberDataManagement Service (Contd.)

Modification of a subscription to notifications of data change



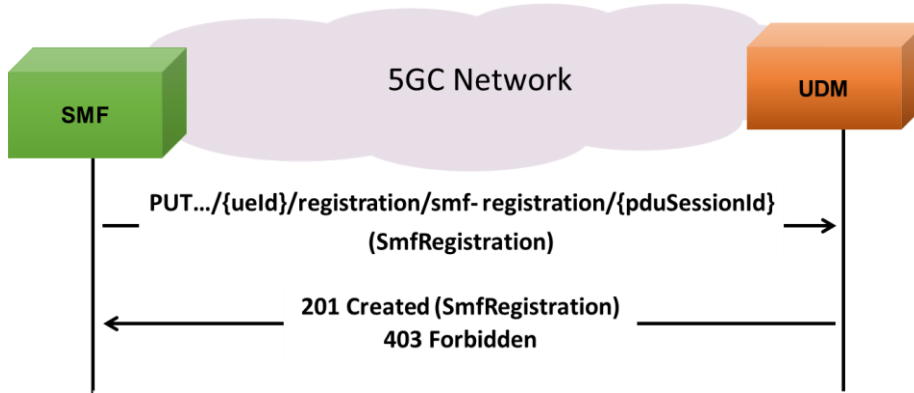
Unsubscribe notifications of data change



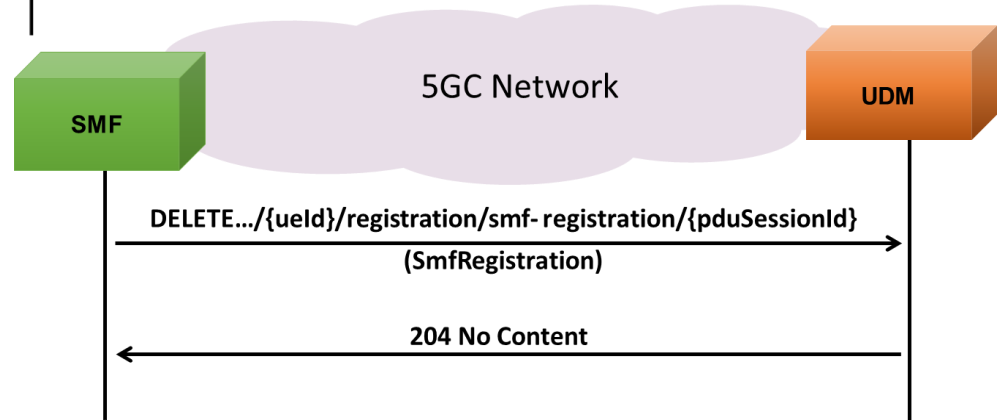
MAPS™ 5G N10 Interface Procedures

Nudm_UEContextManagement Service

SMF registration

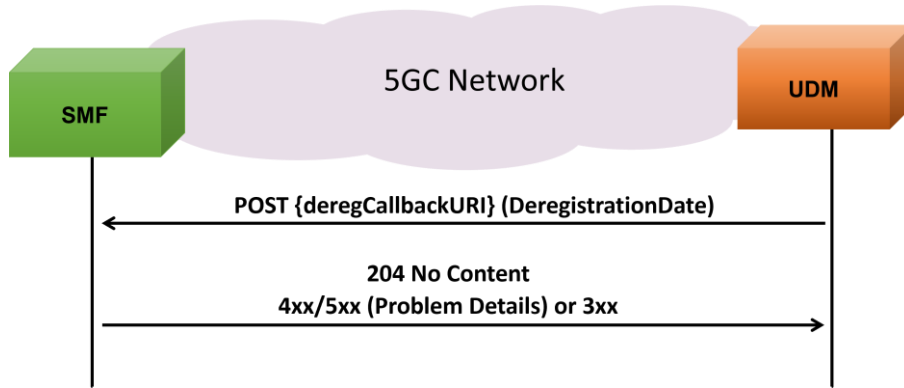


SMF deregistration

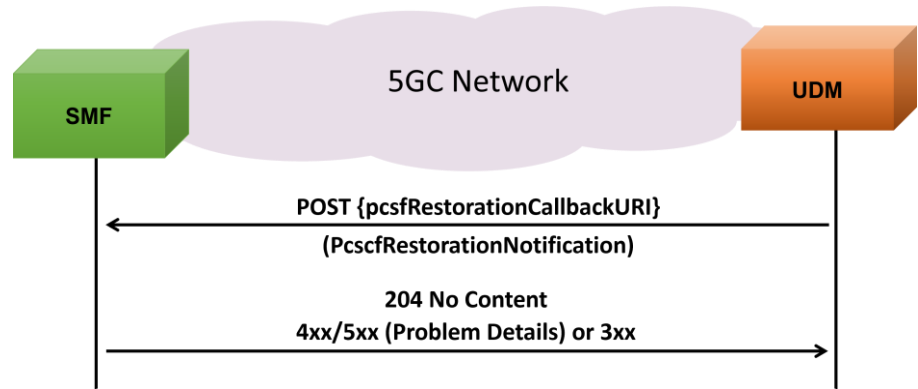


MAPS™ 5G N10 Interface Procedures

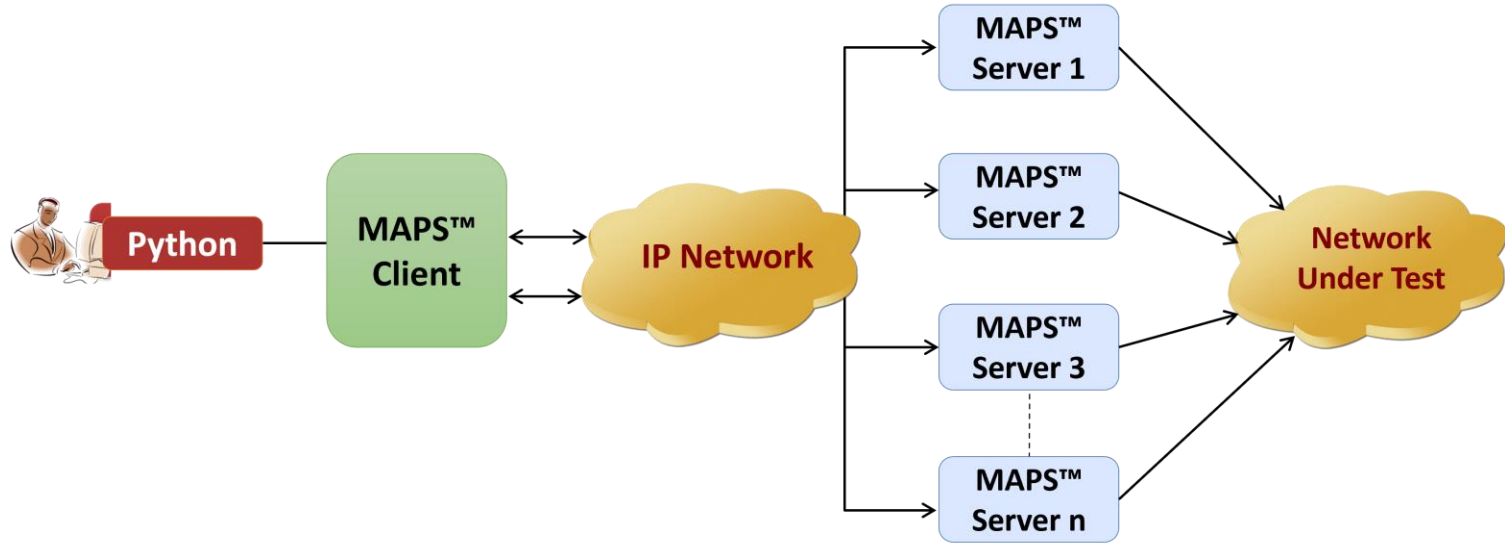
UDM Initiated SMF Deregistration



UDM Initiated P-CSCF-Restoration



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

Python Client and MAPS™ CLI Server

```
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-N10\MAPSCLI\PythonClie
t\examples\SMF\N10_PlaceCall.py
N10 CLI Server Connection... True
N10 Testbed Starting ... True
N10 Profile Loading... True
N10 Nudm_SDM_Control.gls Script Started... start_call_s
ng
True
Call Initiation Status ... sm-data : True
Call Response Status... Request Sent
ConfirmationResponse = UE's SM Data Received
MAPS N10 MsgCount: 2
MAPS LastMSGRcv.....
Time Stamp      Route      Message
15:30:40.229    <-        200
*****MAPS N10 Message Flow *****
Time Stamp      Route      Message
Message decode...
15:30:39.930    ->        GET - /nudm-sdm/
sm-data?dnn=internet
15:30:39.930    ->        GET - /nudm-sdm/v2/imsi-00101301
rnet
Message decode...
15:30:40.229    <-        200
15:30:40.229    <-        200
{"dnnConfigurations":{"internet":{"5gQosProfile":{"5qi":9,"arp":{"preemptCap":"N
OT_PREEMPT","preemptVuln":"NOT_PREEMPTABLE","priorityLevel":15},"priorityLevel":
15},"pduSessionTypes":{"allowedSessionTypes":["IPV4","IPV6","IPV4V6"],"defaultSe
ssionType":"IPV4"},"sessionAmbr":{"downlink":"1000 Mbps","uplink":"2000 Mbps"},"
sscModes":{"allowedSscModes":["SSC_MODE_1"],"defaultSscMode":"SSC_MODE_1"}}, "si
ngleNssai":{"sst":1}}
Stopping Script... True
Stopping N12 TestBed... True
N10 Server Disconnecting... True
>>> |
```

```
CLI MapsCLI SMF (N10 RELEASE17)
File Edit View
View Latest Command
1 :: 2024-1-19 15:30:34.251000 : Start "TestBedDefault.xml" # "_SMF[0].UDM[0].UDMIPAddress"="192.168.12.198", "_TypeOfUESimulation"="XML", "_DefaultProfile"="UE_Profiles.xml";
1 :: 2024-1-19 15:30:37.206000 : LoadProfile "UE_Profiles.xml"
1 :: 2024-1-19 15:30:39.506000 : StartScript 1 "Nudm_SDM_Control.gls" "UEProfile0001" 1 # "IMSI"="( binarystring)001013012041631,"EnableCLI"=1;
1 :: 2024-1-19 15:30:39.731000 : UserEvent 1 "Request_Nudm_SDM_GetSmData";
1 :: 2024-1-19 15:30:40.061000 : UserEvent 1 "GetCallStatus";
1 :: 2024-1-19 15:30:41.370000 : UserEvent 1 "GetMessageCount";
1 :: 2024-1-19 15:30:41.475000 : UserEvent 1 "GetLastReceivedMessage";
1 :: 2024-1-19 15:30:41.580000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
1 :: 2024-1-19 15:30:41.700000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
1 :: 2024-1-19 15:30:41.805000 : StopScript 1;
1 :: 2024-1-19 15:30:41.910000 : Stop TestBedSetup;
ServerLog:errCode = 0,errString = connection has been gracefully closed for ClientId=1
```

Thank you