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# MAPS™ 5G N10 Interface Emulator

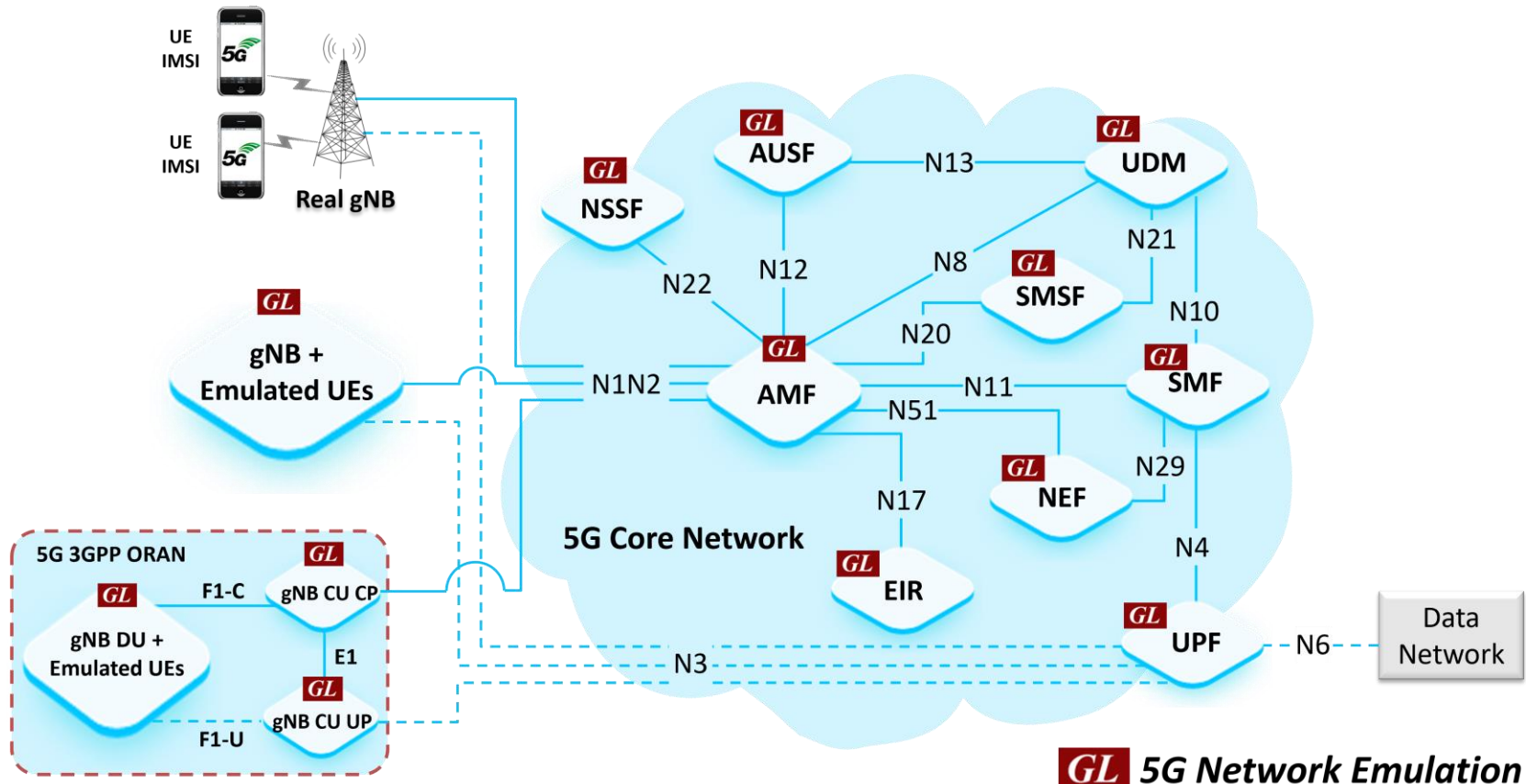
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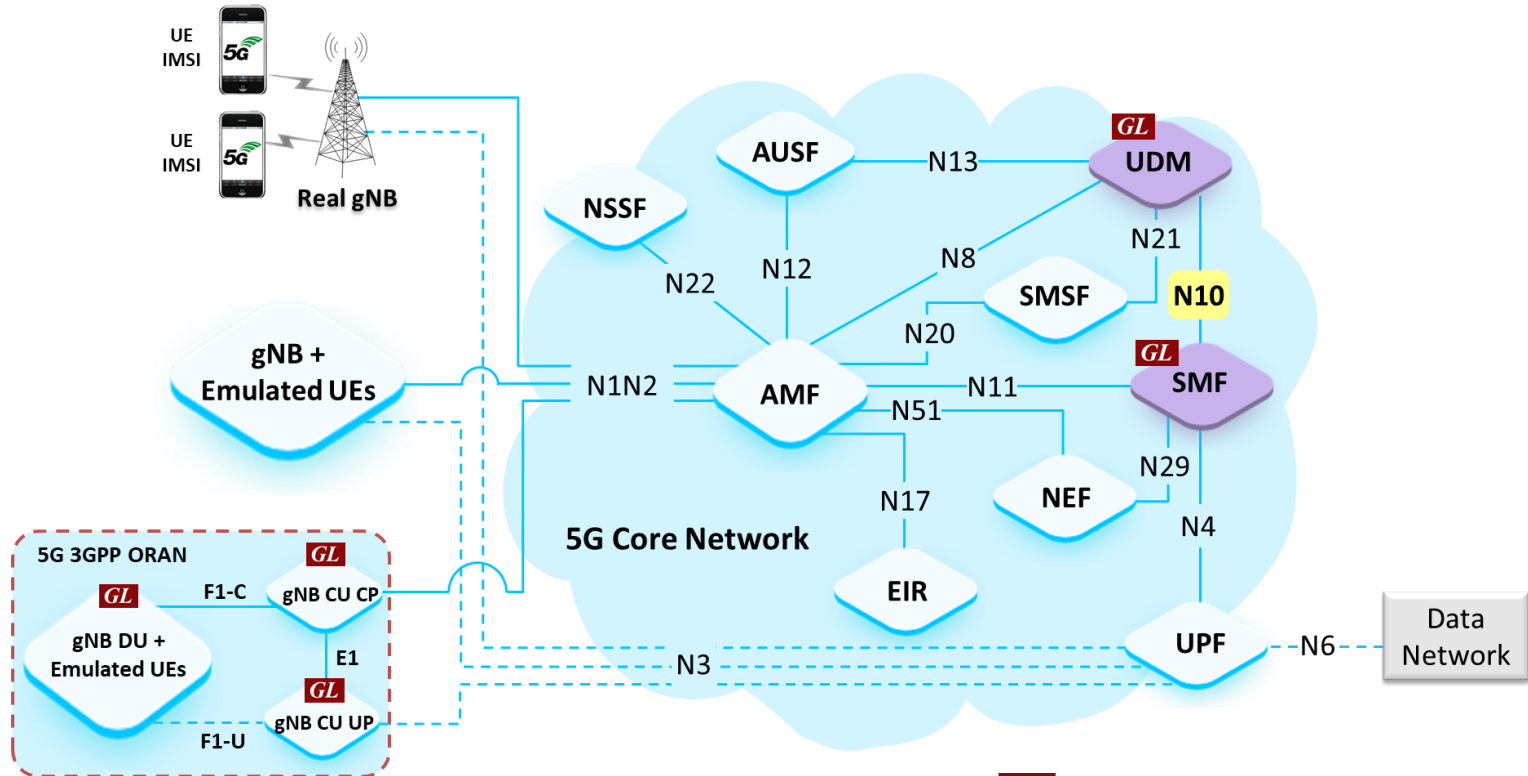
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878  
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Website: <https://www.gl.com>

# 5G Network Diagram



**GL 5G Network Emulation**

# MAPS™ 5G N10 Interface

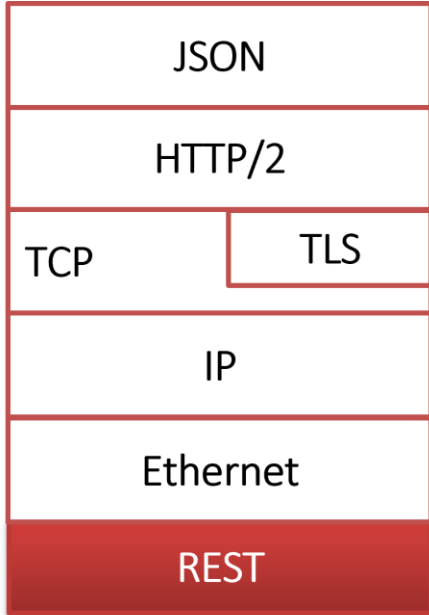


**GL** MAPS™ 5G N10 Interface Emulator

# 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

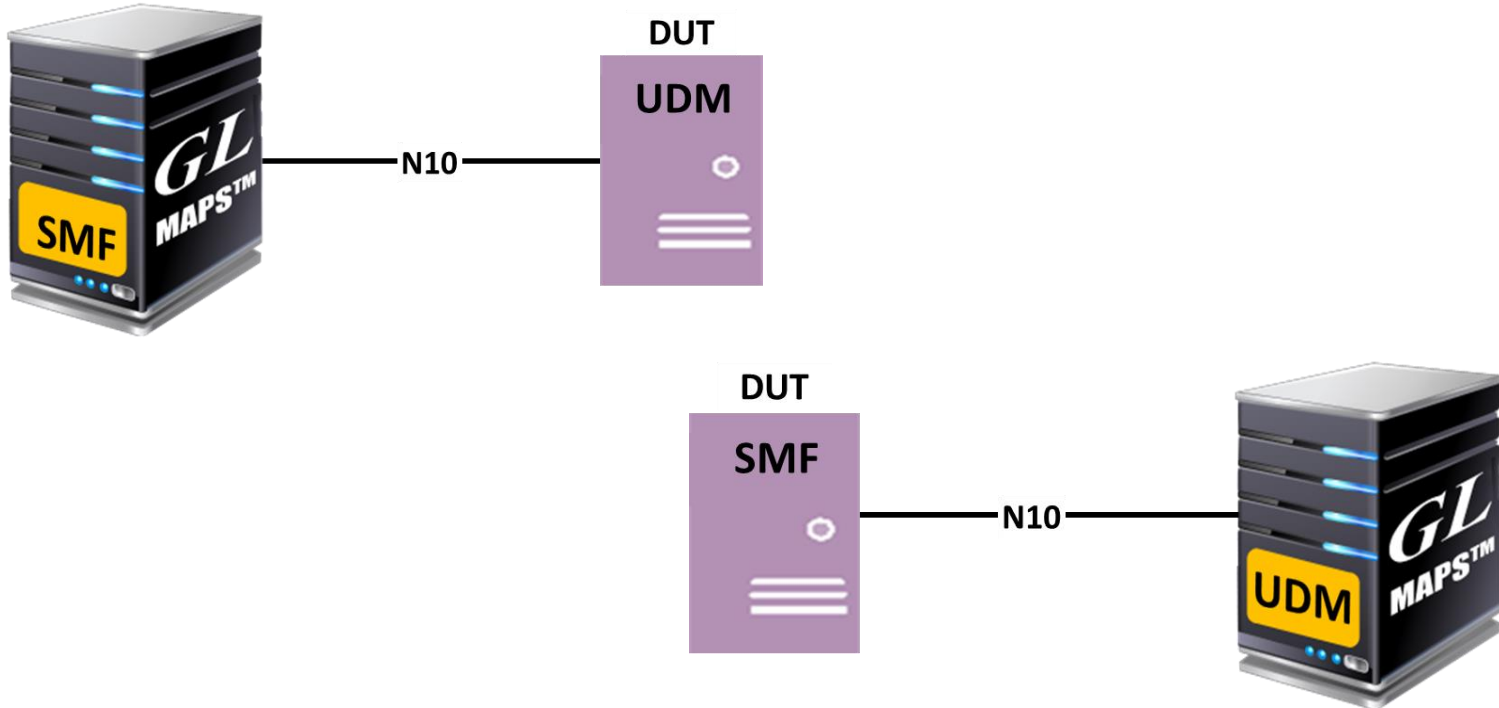
# Protocol Stack Specification



Supported Protocols	Standard / Specification Used
<b>N10 Interface</b>	
N10 Interface (UDM - SMF)	TS29.503 (Release 17)
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 tree view on the left and a table on the right. The tree view shows a hierarchy starting with "SMF Configuration", followed by "SMF", "SMF 1", "UDM", "UDM 1", and "UE Simulation Parameters". The table on the right lists the configuration items and their values. A "Start" button and an "Edit" button are located at the bottom right of the table. At the bottom of the window, there are two status indicators: "Initialisation Errors" and "Error Even".

Config	Value	Enable
SMF Configuration		<input checked="" type="checkbox"/>
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_N10SMF.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_N10SMF.xml	

# Testbed Setup (UDM)

The screenshot shows the MAPS UDM (N10 RELEASE17) configuration window. The window title is "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 displays a tree view of configurations under "UDM Configurations". The "UDM" node is expanded, showing "UDM 1" with its settings. The "UDM API Versions" node is also expanded, showing settings for various services. The "UE Simulation Parameters" node is expanded, showing settings for simulation type, end user configuration, and auto-generated users info. The "Auto Generated Users Info" node is expanded, showing settings for the number of users to be simulated and their identifiers. The "Value" column lists the corresponding values for each setting. The "Enable" checkbox is checked. The "Start" and "Edit" buttons are visible at the bottom right of the configuration area. The status bar at the bottom shows "Initialisation Errors" and "Error Events".

Config	Value	Enable
UDM Configurations		<input checked="" type="checkbox"/>
UDM	1	<input checked="" type="checkbox"/>
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_N10UDM.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_N10UDM.xml	

# Profile Editor (SMF)

The screenshot displays the Profile Editor (SMF) application window. The title bar reads "MAPS SMF (N10 RELEASE17) - [Profile Editor -UE\_Profiles\_N10SMF]". 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 interface is divided into three main sections:

- Profiles List (Left):** A table listing profiles with columns for index and profile name.
- Config View (Center):** A tree view showing the configuration for the selected profile, MSIN3012041631. It includes sections for Subscriber Info, PLMN ID, UECM Service Parameters, and SDM Service Parameters.
- Properties Panel (Right):** A panel for the selected configuration item, showing a checked "Enable" checkbox and buttons for "Add", "Insert", "Delete", and "Properties".

#	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

Config	Value
MSIN3012041631	
Subscriber Info	
SUPI	001013012041631
MSIN	3012041631
IMEI	359877068325248
IMEISV	1234567890123001
SMF Client Selection	Client1
PLMN ID	
MCC	001
MNC	01
UECM Service Parameters	
UECM Service Request	SMF Deregistration
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	
Single Nssai 1	
SST	1
SD	01

# Profile Editor (UDM)

The screenshot displays the MAPS UDM (N10 RELEASE17) Profile Editor window. The main area is divided into three panes: a list of profiles on the left, a configuration tree in the center, and a value table on the right. The selected profile is MSIN3012041631. The configuration tree shows a hierarchy of settings, with 'Subscriber Info' expanded to show IMSI, IMEI, IMEISV, and MSIN. Other expanded sections include HPLMN ID (MCC, MNC), NSSAI for HPLMN, GPSIs (GPSIs 1), Internal GroupIds, VN GroupInfo, Shared VnGroup DataId, Authentication Parameters, Subscribed UE AMBR, RAT Restrictions, Forbidden Areas (Forbidden Areas 1, TACS), Service Area Restriction, Core Network Type Restrictions, UPU Info, SOR Info, Closed Access Group Data, RAT or Frequency Selection Priority Index, Subscribed Periodic Registration Timer, UE Usage Type, MPS Priority, and MNC Priority. The value table on the right lists the corresponding values for each configuration item. An 'Enable' column is present on the far right, with a checked box for the selected profile. At the bottom, there are buttons for 'Add', 'Insert', and 'Delete', and a 'Properties' button. The status bar at the bottom shows 'Initialisation Errors', 'Error Events', and 'Captured Errors'.

#	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"/>

# 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	E..	Result	Total Iterati...	Completed Iterations
1	Nudm_UECM_Control.gls	MSIN3012041631		Start		None		Unknown	1	0
2	Nudm_SDM_Control.gls	MSIN3012041631	SUPI : ,imsi-001013012041631	Start	UE's SM Data Received	None		Pass	1	1

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 10:30:56.167000

200 OK 10:30:56.373000

Find

```
GET http://192.168.1.223:6666/nudm-sdm/v2/imsi-001013012041
accept : application/json,
application/problem+json
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors

# Call Reception

Sr No	Script Name	Prof...	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_SDM_Control.gls		SUPI : ,imsi-001013012041631	Completed	Successful Response Sent	None		Pass

Control Bar:      Show Records  Select Active Call  Auto Trash

Message Sequence Diagram:

```
sequenceDiagram
    participant SMF
    participant UDM
    SMF->>UDM: GET /nudm-sdm/v2/imsi-001013012041631/sm-data
    UDM-->>SMF: 200
```

Find:

```
Status: 0
:method : GET
:path : /nudm-sdm/v2/imsi-001013012041631/sm-data?dnn=in
:scheme : http
:authority : 192.168.1.223:6666
accept : application/json,
application/problem+json
```

Bottom Bar:  Initialisation Errors  Error Events  Captured Errors  L

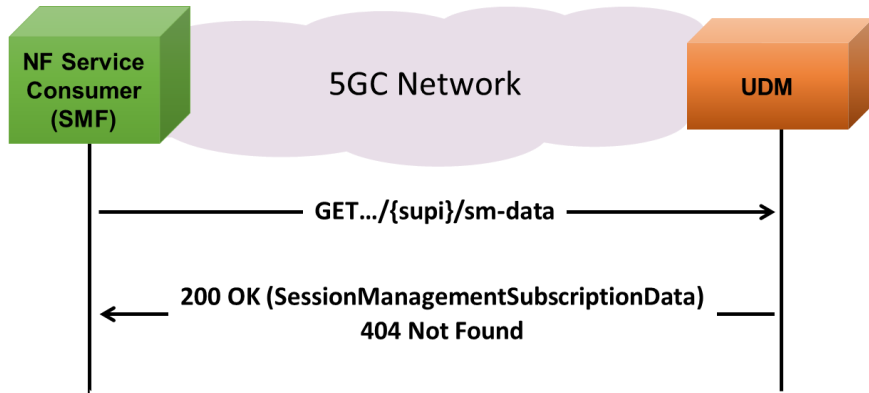
# MAPS™ 5G N10 Interface Procedures

- 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

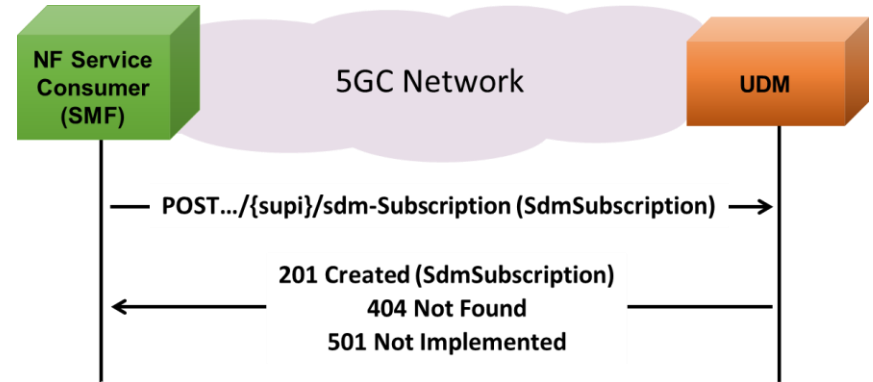
# MAPS™ 5G N10 Interface Procedures

## Nudm\_SubscriberDataManagement Service

### Session Management Subscription Data Retrieval



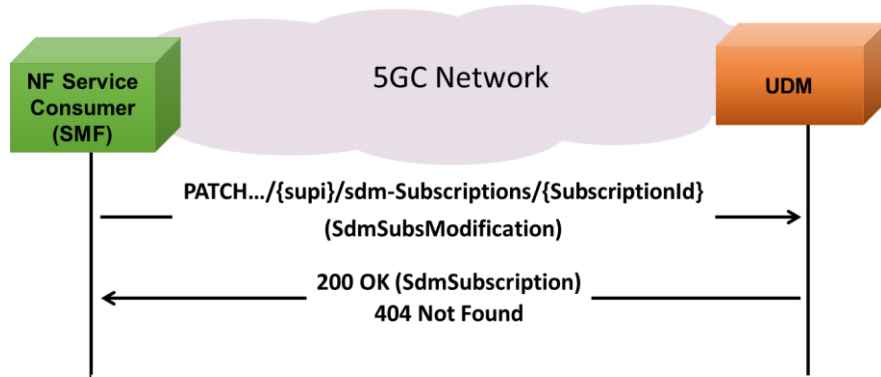
### Subscription to notifications of data change



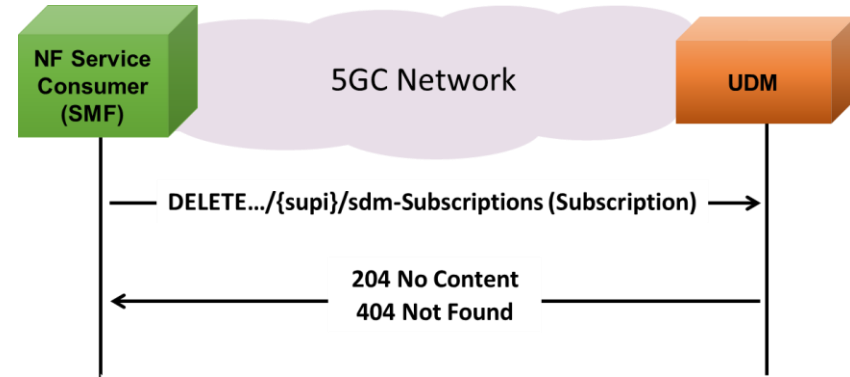
# MAPS™ 5G N10 Interface Procedures

## Nudm\_SubscriberDataManagement Service (Contd.)

### Modification of a subscription to notifications of data change



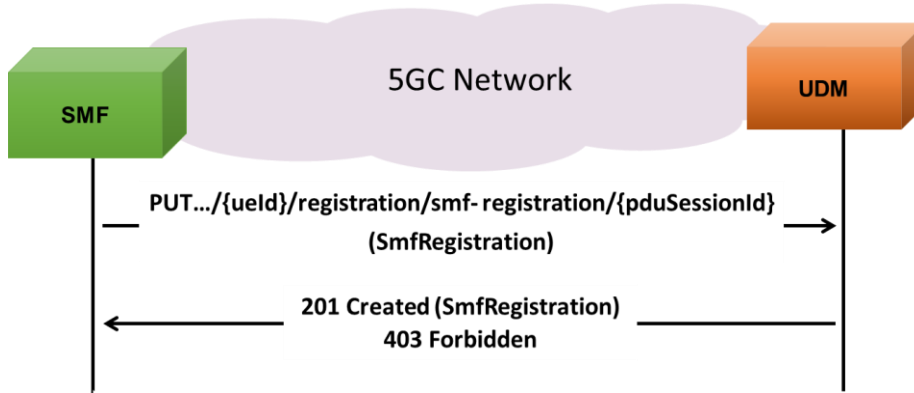
### Unsubscribe notifications of data change



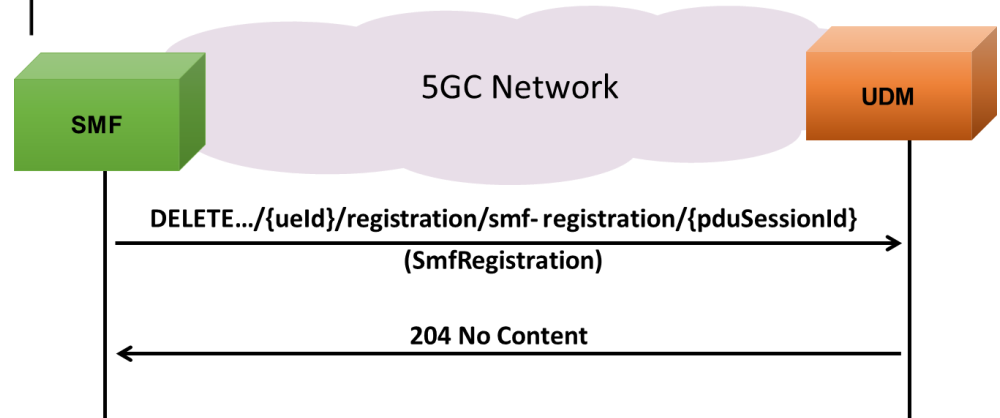
# MAPS™ 5G N10 Interface Procedures

## Nudm\_UEContextManagement Service

### SMF registration

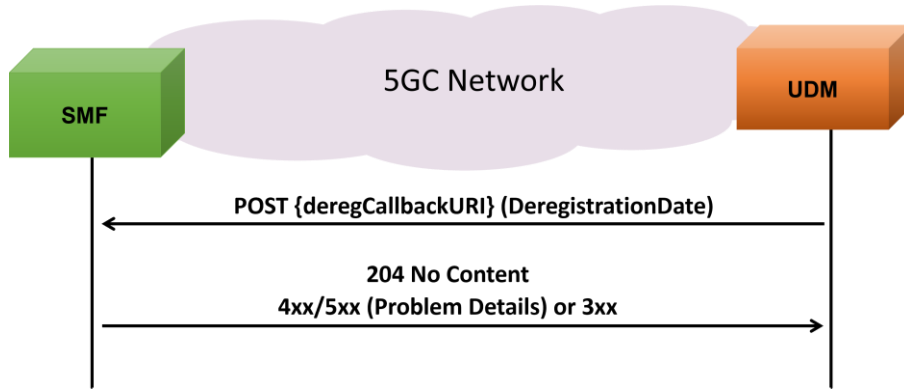


### SMF deregistration

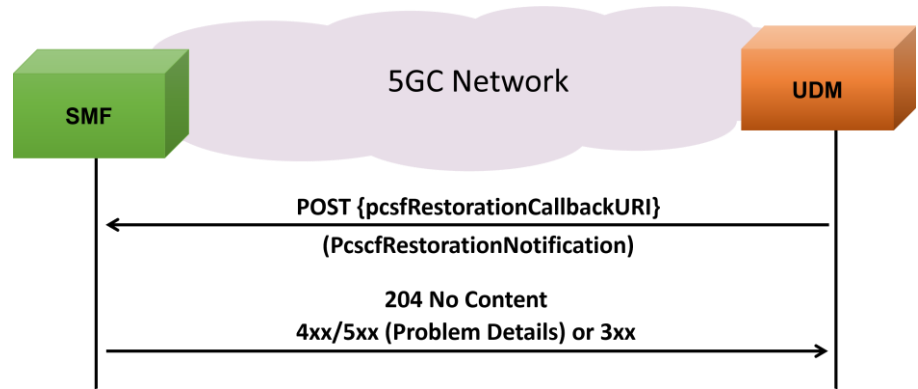


# MAPS™ 5G N10 Interface Procedures

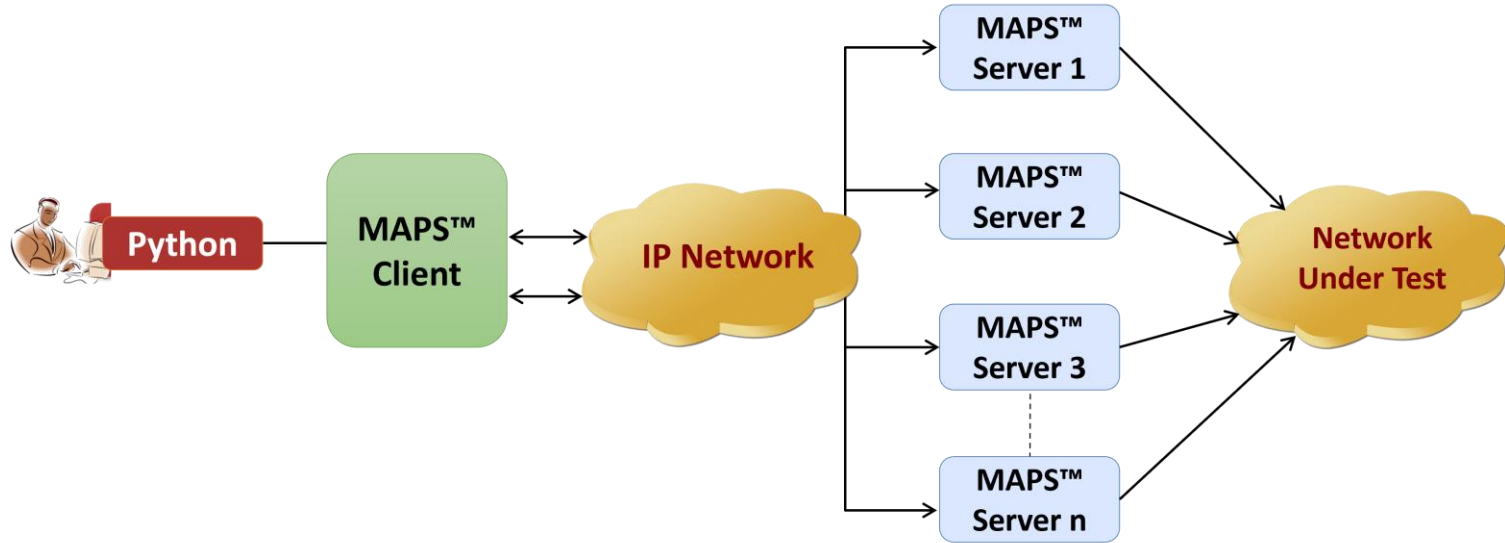
## UDM Initiated SMF Deregistration



## 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","priorityLevel1":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
>>> |
Ln: 30 Col: 4
```

```
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
NUM
```

**Thank you**