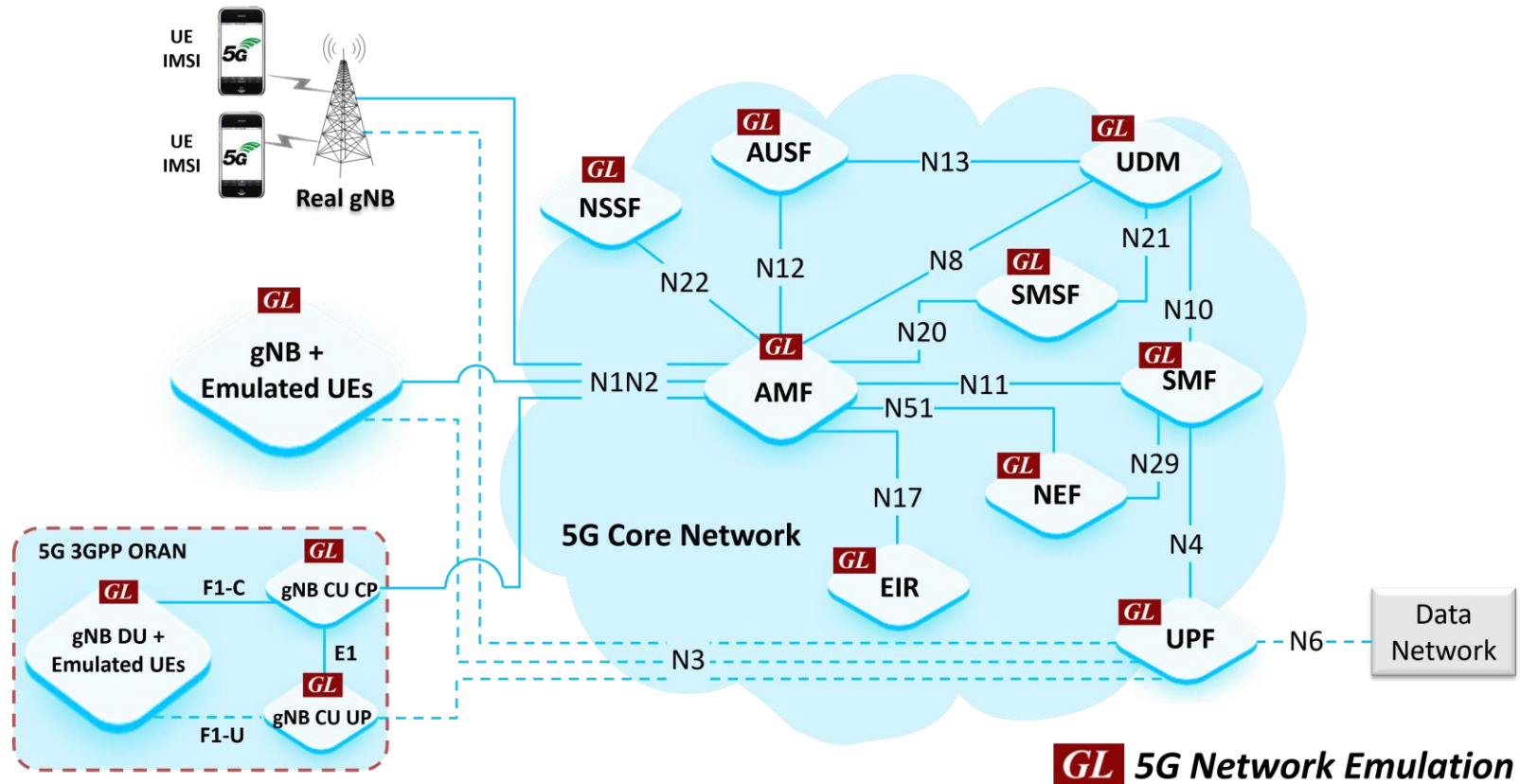

MAPS™ 5G N29 Interface Emulator



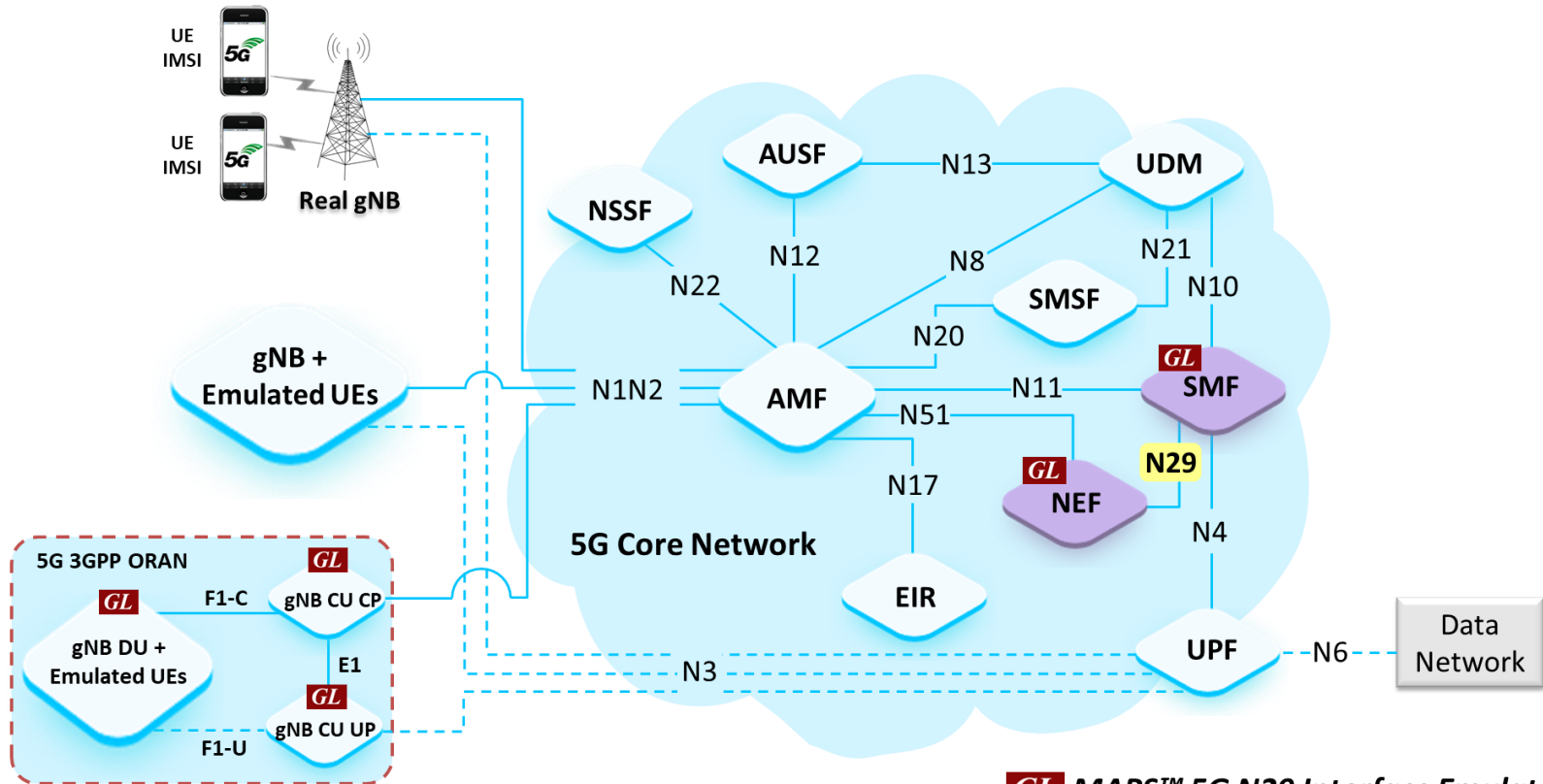
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N29 Interface

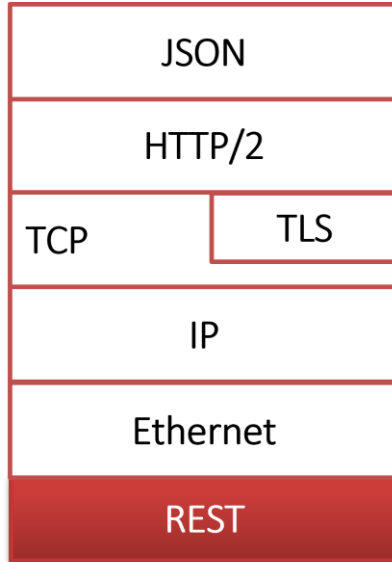


GL MAPS™ 5G N29 Interface Emulator

Main Features

- Emulate Network Exposure Function (NEF) and Session Management Function(SMF) elements
- Supports Nsmf_EventExposure 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 Message Editor
- Ready-to-use scripts for quick testing
- Provides Call Statistics and Events Status
- Generate multiple subscribers using CSV profiles

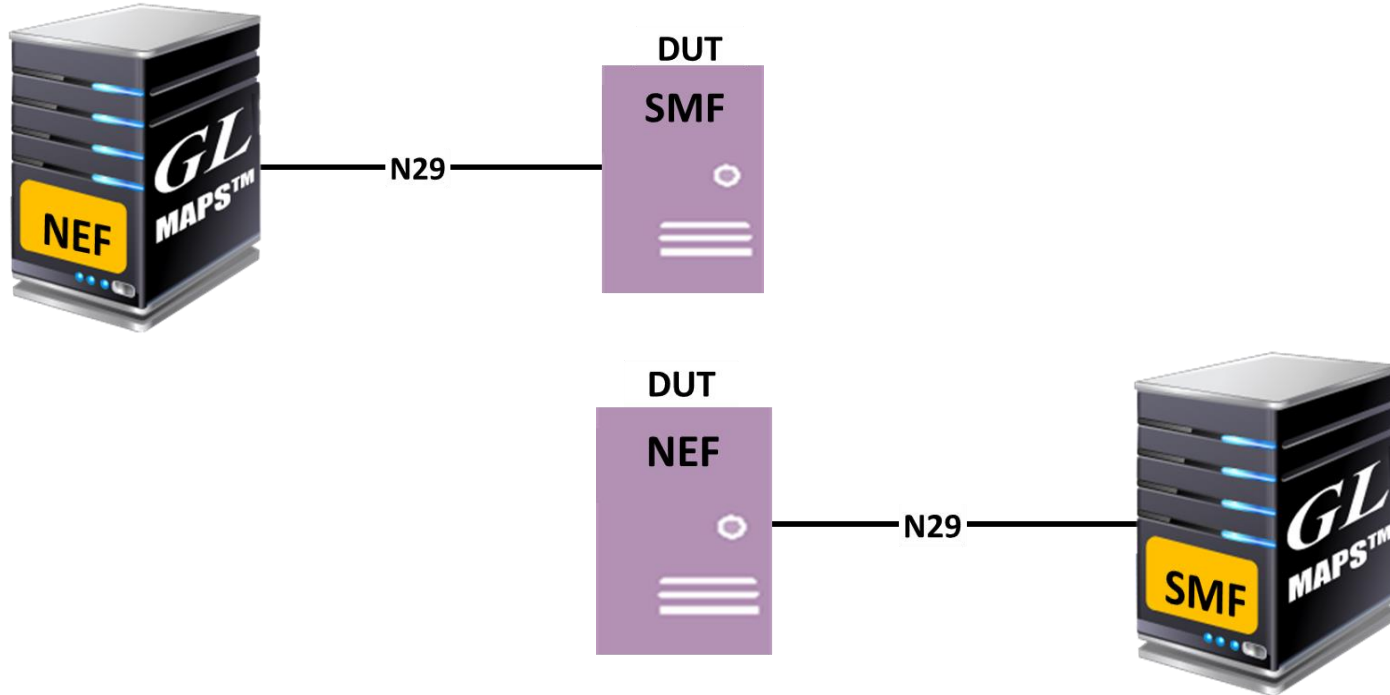
Protocol Stack



Supported Protocols	Standard / Specification Used
N29 Interface	
N29 Interface (NEF-SMF)	TS29.508 (Release 17) TS29.522 (Release 17)
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP/TLS	IETF RFC 793 IETF RFC 8446
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

User Cases

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



Testbed Setup (NEF)

MAPS NEF (N29 RELEASE17) - [Testbed Setup - TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config

Config	Value
NEF Configuration	
NEF	1
NEF 1	1
NEF IP Address	192.168.1.161
NEF Server Port	5055
URI Scheme	HTTP
NEF Client Name	NEFClient1
SMF	1
SMF 1	
SMF IP Address	192.168.1.31
SMF Server Port	5055
SMF EventExposure API Version	v1
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	UE_Profiles_N29NEF.xml
Auto Generated Users Info	100000
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_N29NEF.xml

Enable

Start Edit

Initialisation Errors Error Events

Testbed Setup (SMF)

The screenshot displays the MAPS SMF (N29 RELEASE17) configuration window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar with various icons. The main area is divided into a configuration tree on the left and a details pane on the right.

Config	Value	Enable
SMF Configuration		<input checked="" type="checkbox"/>
SMF	1	
SMF 1		
SMF IP Address	192.168.1.31	
SMF Server Port	5055	
URI Scheme	HTTP	
SMF EventExposure API Version	v1	
NEF	2	
NEF 1		
NEF IP Address	192.168.1.161	
NEF Server Port	5055	
NEF 2		
NEF IP Address	192.168.1.161	
NEF Server Port	6055	
UE Simulation Parameters		
Type Of UE Simulation	Profiles	
End User Configuration	UE_Profiles_N29SMF.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_N29SMF.xml	

Buttons: Start, Edit

Status: Initialisation Errors, Error Events

Profile Editor (NEF)

MAPS NEF (N29 RELEASE17) - [Profile Editor -UE_Profiles_N29NEF]

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

Config

Config	Value
MSIN3012041631	
UE Identity	
SUPI	001013012041631
IMEI	359877068325248
IMEISV	1234567890123001
MSIN	3012041631
NEF Client Name	NEFClient1
Subscription Key Id	SUPI Only
SMF Parameters	
PDU Session Id	6
DNN Name	Internet
Include NSSAI	True
NSSAI	
SST	eMBB
SD	01
SMF Notify Request Events	1
SMF Notify Request Events 1	PDU Session Establishment ...
SMF Notify Method Type	ONE TIME
EventExposure Service Parameters	
EventExposure Service Request	Subscribe Event Notify
Notify URI Type	Local
External NEF IP Address	192.168.12.170
External NEF Server Port	5056

Enable

Add Insert Delete

Properties

Initialisation Errors Error Events Captured Err

Profile Editor (SMF)

The screenshot displays the 'Profile Editor - UE_Profiles_N29SMF' window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help) and a toolbar with various icons. A list of profiles is shown on the left, with 'MSIN3012041631' selected. The main area shows the configuration for this profile, including UE Identity, PDU Information, and SNSSAI. A 'Properties' dialog is open on the right, showing the 'Enable' checkbox checked and buttons for 'Add', 'Insert', 'Delete', and 'Properties'.

#	Profiles (Edit-F2)	Config	Value	Enable
1	MSIN3012041631	MSIN3012041631		<input checked="" type="checkbox"/>
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	
UE Identity	
SUPI	001013012041631
GPSI	3012041631
IMEI	359877068325248
IMEISV	1234567890123001
PDU Information	1
PDU Information 1	
PDU Session Id	6
Access Type	3GPP ACCESS
PDU Session Type	IPv4
QFI	1
DNN Name	internet
Allocated IPv4 Address	10.10.1.1
Allocated IPv6 Prefix	fe80::
Allocated IPv6 Address	fe80::192:168:12:22
SNSSAI	
SST	eMBB
SD	01
Event Notify Trigger Timer in msec	2000
Default Event Notify Period in msec	30000

Call Generation

GL MAPS NEF (N29 RELEASE17) - [Call Generation - CallGenDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	NEF_EventExp_Control.gls	MSIN3012041631	SUPI :_imsi-001013012041631	Start	Nsmf EE SessionEstEventNotify Response Sent	None		Pass	1	1

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

Save Column Width Show Latest

NEF SMF

POST /nsmf_event-exposure/v1/subscriptions 11:55:29.492000

201 CREATED 11:55:29.694000

POST /nsmf_event-exposure/v1/subscriptions/nefsubld-3012041631/pdusession_event_notify 11:55:32.726000

204 11:55:32.726000

Find

```
POST http://192.168.1.31:5055/nsmf_event-exposure/v1/subscriptions
content-type : application/json
accept : application/json,
application/problem+json

{
  "ImmeRep": false,
  "eventSubs": [{
    "event": "PDU_SES_EST"
  }],
  "notifId": "pdu_statusId-3012041631-6",
  "notifMethod": "ONE_TIME",
  "notifUri": "http://192.168.1.161:5055/nsmf_event-exposure/v1/subscriptions/nefsubId-3012041631",
  "snsai": {
    "sd": "01",
    "sst": 1
  },
  "subId": "nefsubId-3012041631",
  "supi": "imsi-001013012041631"
}
```

Scripts Message Sequence Event Config Script Flow

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

Call Reception

GL MAPS SMF (N29 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	SMF_HTTP2_Connection_Monitor.gls		SMF Server Clients : ,NEF,	Stop		Connect Server		Unknown
2	Nsmf_EventExp_Control.gls		SubId : ,nefsubld-3012041631,.....	Completed	Successful Subscribe Response Sent	None		Pass
3	Nsmf_EventExp_Control.gls		SubId : ,nefsubld-3012041631,S...	Completed	Nsmf EE Notify Response Received	None		Pass

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

Save Column Width Show Latest

SMF NEF

POST /nsmf_event-exposure/v1/subscriptions/nefsubld-3012041631/pdusession_event_notify 11:55:32.716000

204 NO-CONTENT 11:55:32.744000

Find

```
POST http://192.168.1.161:5055/nsmf_event-exposure/v1/subscriptions/nefsubld-3012041631/pdusession_event_notify
content-type : application/json

{
  "eventNotifs": [
    {
      "dnn": "internet",
      "event": "PDU_SES_EST",
      "ipv4Addr": "10.10.1.1",
      "pduSessType": "IPV4",
      "supi": "imsi-001013012041631",
      "timeStamp": "2025-01-14T11:55:32+05:30"
    }
  ],
  "notifId": "pdu_statusId-3012041631-6"
}
```

Scripts Message Sequence Event Config Script Flow

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

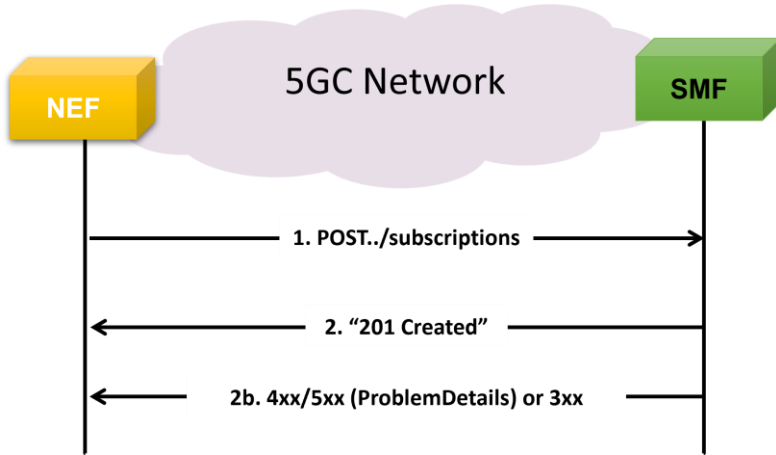
MAPS™ 5G N29 Interface Procedures

- **Nsmf_EventExposure Procedures**
 - Subscription
 - Unsubscription
 - Notify
 - Session Management Event Exposure Event Types:
 - PDU session establishment Event
 - PDU session release Event
 - QFI allocation Event
 - UE IP address/prefix change Event

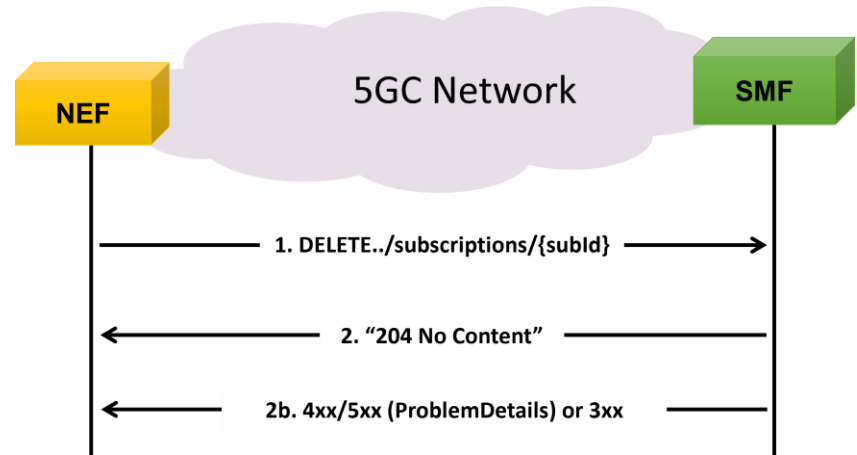
MAPS™ 5G N29 Interface Procedures

Nsmf_EventExposure Service

Subscription Procedure



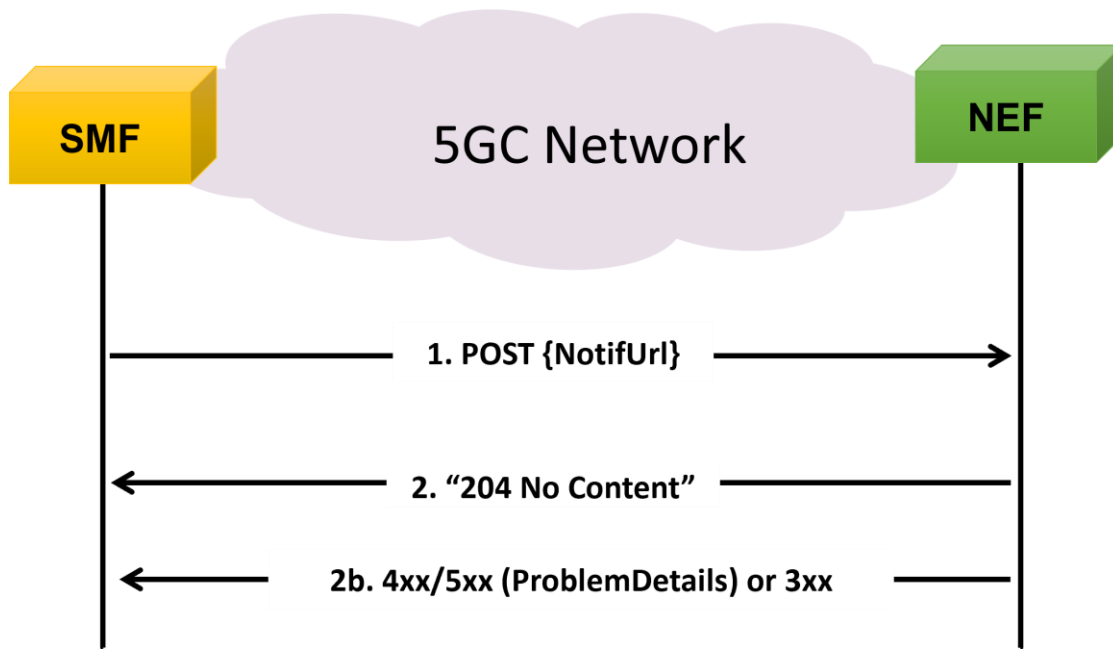
Unsubscription Procedure



MAPS™ 5G N29 Interface Procedures (Contd.)

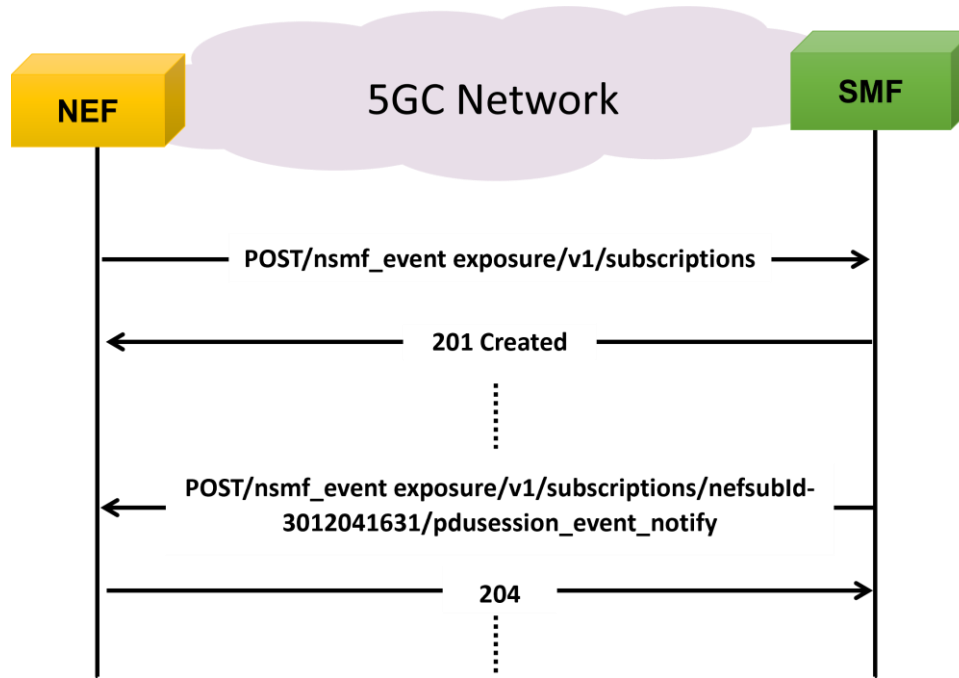
Nsmf_EventExposure Service

Notification Procedure

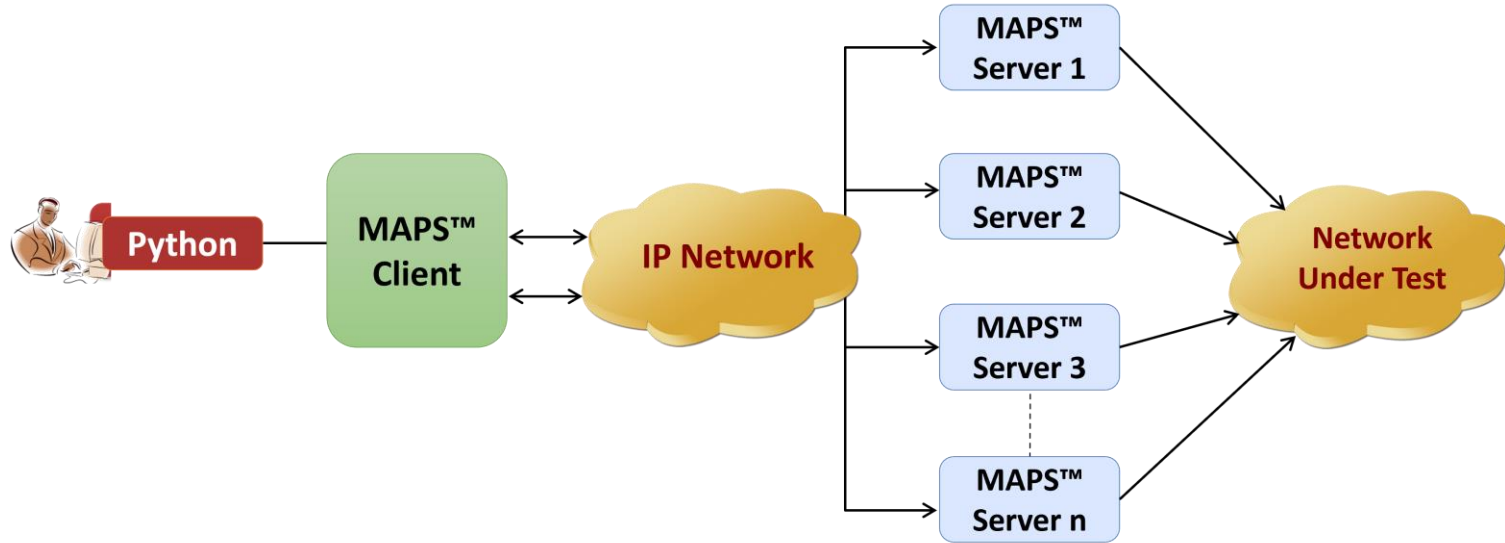


MAPS™ 5G N29 Interface Procedures (Contd.)

Session Management Event Exposure Service



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 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-N29\MAPSCLI\PythonClient\exam
ples\NEF\N29_NEF_PlaceCall.py
in protocol specific:: TestBedDefault.xml
N29 CLI Server Connection... True
N29 TestBed Starting ... --- generic :: start_status == Sta
True
N29 Profile Loading... True
N29_NEF_EventExp_Control.gls Script Started... start_call_s
True
Call Initiation Status ... subscribe : True
Call Response Status... UE's Subscription DataChange Notifi
Waiting for SMF Notification ...
NotificationMessage Status = Namf_EE_Notify_Requested
MAPS N29 MsgCount: 4
MAPS LastMSGRcv.....
Time Stamp Route Message
12:49:37.722 <- POST /nsmf_event-expo
subId-3012041631/pdusession_event_notify
*****MAPS N8 Message Flow *****
Time Stamp Route Message
Message decode...
12:49:35.207 -> POST - /nsmf_event-e
12:49:35.207 -> POST - /nsmf_event-exposure/v1/subsc
{"ImmeRep":false,"eventSubs":[{"event":"PDU_SES_EST"}],"notifi
631-6","notifMethod":"ONE_TIME","notifUri":"http://192.168.12.170:6666/nsmf_event-expo
sure/v1/subscriptions/nefsubId-3012041631/pdusession_event_notify","snssai":{"sd":"01
","sst":1},"subId":"nefsubId-3012041631","supi":"imsi-001013012041631"}
Message decode...
12:49:35.326 <- 201
12:49:35.326 <- 201
{"ImmeRep":false,"eventSubs":[{"event":"PDU_SES_EST"}],"gpsi":"","notifId":"pdu_status
Id-3012041631-6","notifMethod":"ONE_TIME","notifUri":"http://192.168.12.170:6666/nsmf
event-exposure/v1/subscriptions/nefsubId-3012041631/pdusession_event_notify","snssai":
{"sd":"01","sst":1},"subId":"nefsubId-3012041631","supi":"imsi-001013012041631"}
Message decode...
12:49:37.722 <- POST /nsmf_event-exposure/v1/subscriptions/nef
subId-3012041631/pdusession_event_notify
12:49:37.722 <- POST /nsmf_event-exposure/v1/subscriptions/nefsubId-3012041631
/pdusession_event_notify
Status: 1
:method: POST
:path: /nsmf_event-exposure/v1/subscriptions/nefsubId-3012041631/pdusession_event_not
ify
Ln: 60 Col: 4
```

MAPS™ CLI Server

```
CLI MapsCLI NEF (N29 RELEASE17)
File Edit View
View Latest Command
1 :: 2024-1-25 12:49:17.684000 : Start "TestBedDefault.xml" # "NEF[0].SMF[0].SMFIPAddress"="192.168.12.198", "TypeOfUESimulation"="XML", "DefaultProfile"="NEF_Profiles.xml";
1 :: 2024-1-25 12:49:22.057000 : LoadProfile "NEF_Profiles.xml"
1 :: 2024-1-25 12:49:24.199000 : StartScript "NEF_EventExp_Control.gls" "UEProfile0001" 1 # "TMSI"=(binarystring 3001013012041631,"SmfEvent"="PDU_SES_REL","NotifMethod"="ONE_TIME","Notify_URI_type"="Local","EnableCLI"=1;
1 :: 2024-1-25 12:49:34.363000 : UserEvent 1 "Request_Nsmf_EE_Subscribe";
1 :: 2024-1-25 12:49:35.357000 : UserEvent 1 "GetCallStatus";
1 :: 2024-1-25 12:49:38.856000 : UserEvent 1 "GetMessageCount";
1 :: 2024-1-25 12:49:38.962000 : UserEvent 1 "GetLastReceivedMessage";
1 :: 2024-1-25 12:49:39.067000 : UserEvent 1 "GetMessageInfo" # "Index"=0;
1 :: 2024-1-25 12:49:39.173000 : UserEvent 1 "GetMessageInfo" # "Index"=1;
1 :: 2024-1-25 12:49:39.293000 : UserEvent 1 "GetMessageInfo" # "Index"=2;
1 :: 2024-1-25 12:49:39.503000 : UserEvent 1 "GetMessageInfo" # "Index"=3;
1 :: 2024-1-25 12:49:39.623000 : StopScript 1;
1 :: 2024-1-25 12:49:39.833000 : Stop TestBedSetup;
ServerLoggerCode = 0, errString = connection has been gracefully closed for ClientId=1
```

Thank you