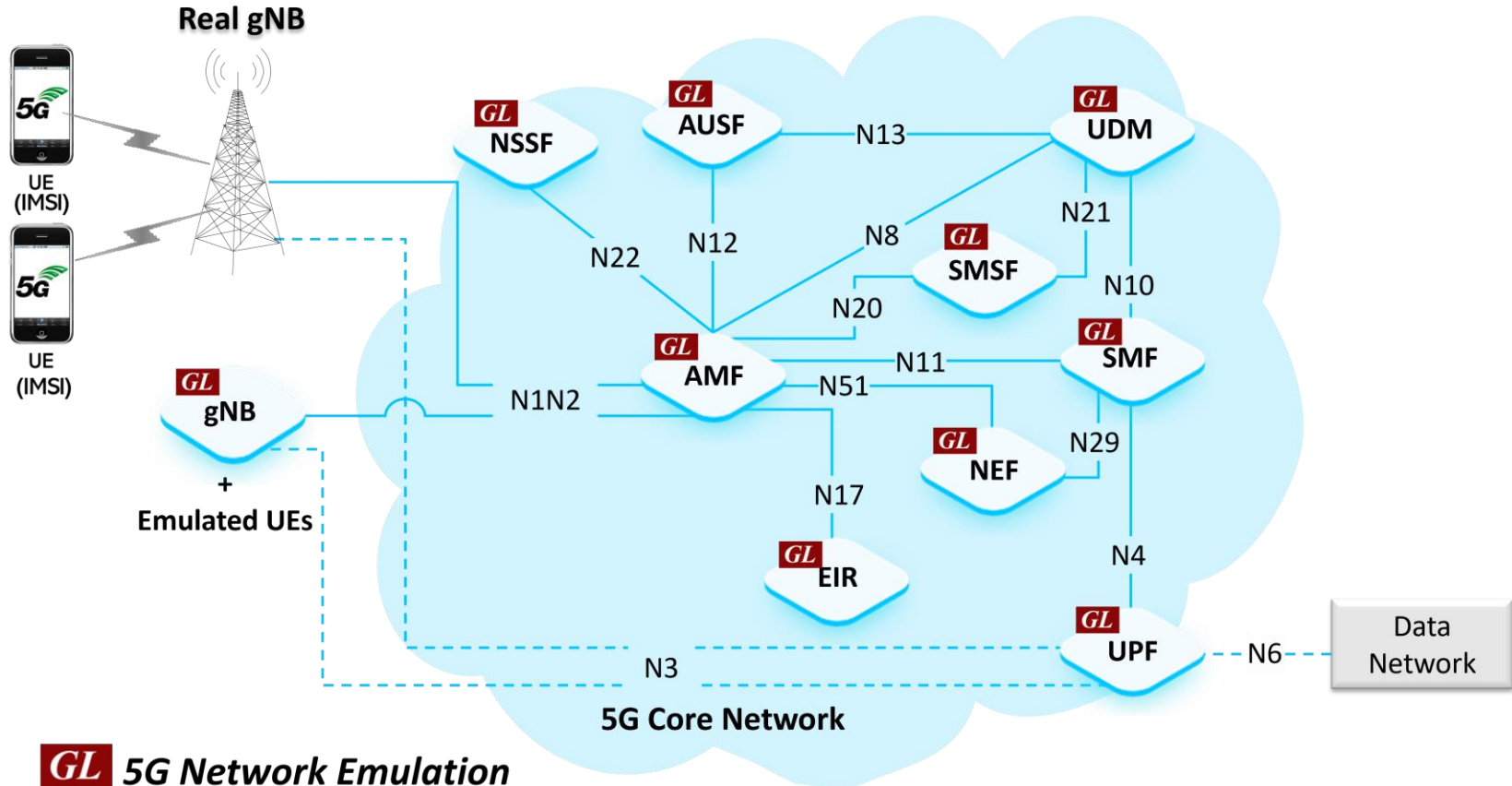

MAPS™ 5G N29 Interface Emulator



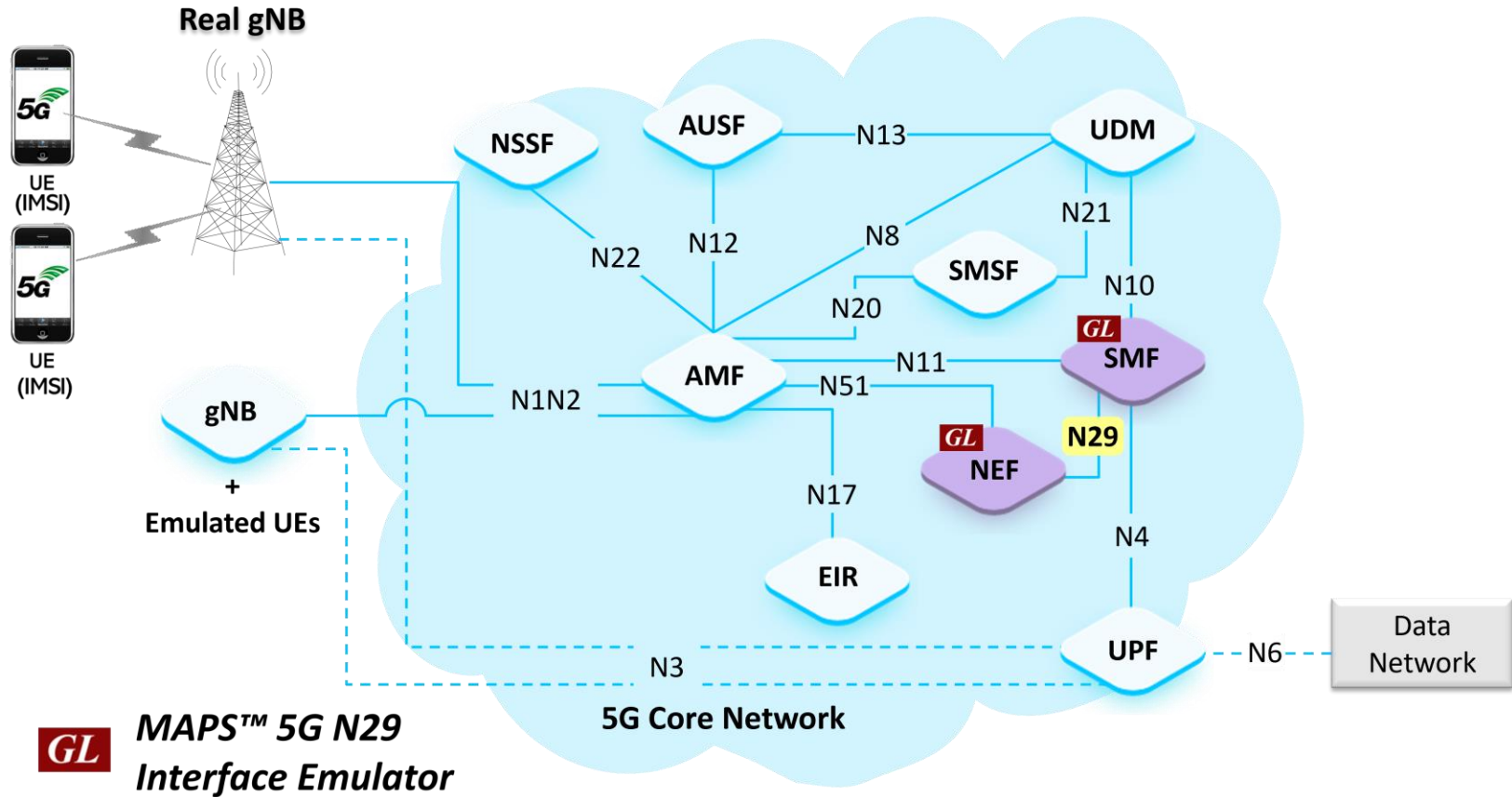
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N29 Interface

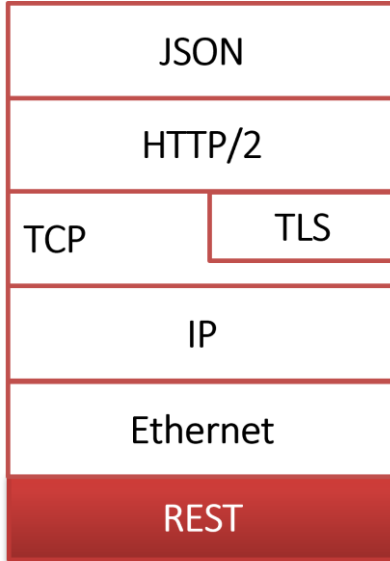


MAPS™ 5G N29
Interface Emulator

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

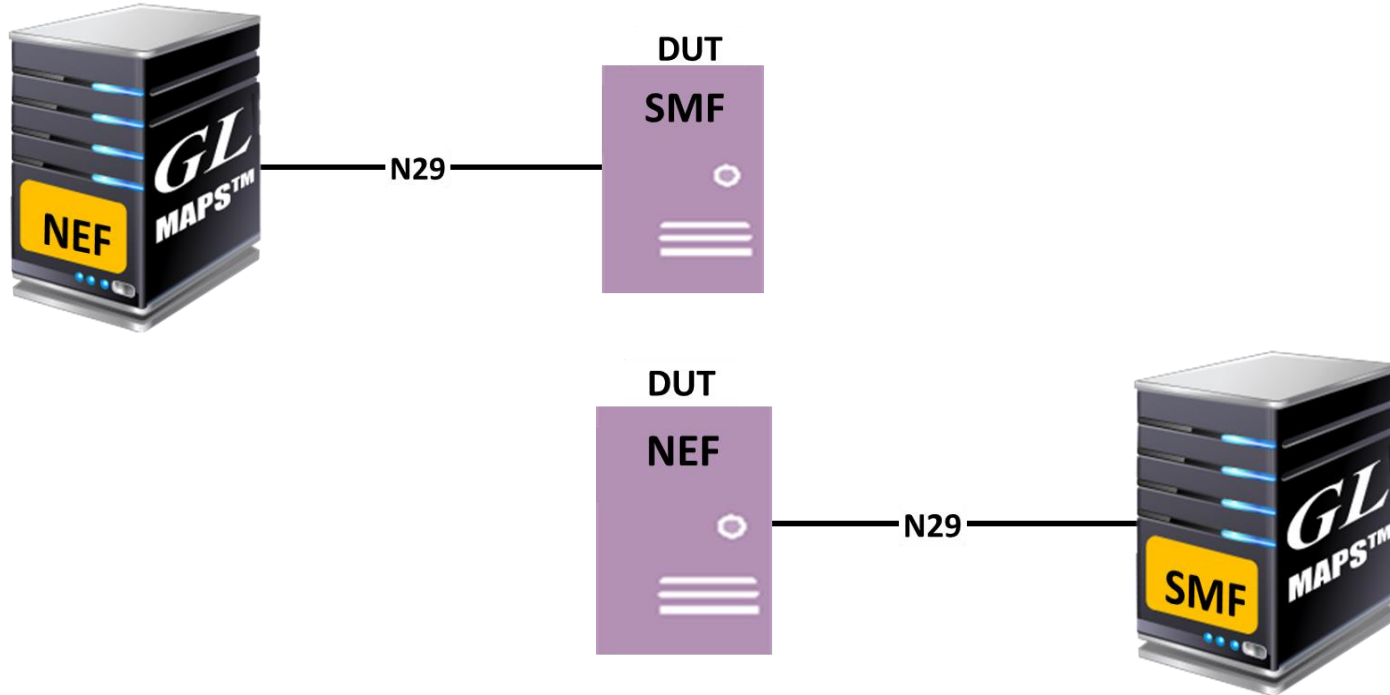
Protocol Stack



Supported Protocols	Standard / Specification Used
N29 Interface	
N29 Interface (NEF-SMF)	TS29.508 TS29.522
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)

The screenshot shows the MAPS NEF (N29 RELEASE17) configuration window titled "[Testbed Setup - TestBedDefault]". The window has a menu bar with "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". Below the menu bar is a toolbar with various icons. The main area is divided into a tree view on the left and a configuration table on the right. The tree view shows a hierarchy: "NF Configuration" (expanded) -> "NEF" -> "NEF 1" -> "NEF IP Address", "NEF Server Port", "URI Scheme", "NEF Client Name", "SMF" -> "SMF 1" -> "SMF IP Address", "SMF Server Port", "SMF EventExposure API Version", "UE Simulation Parameters" -> "Type Of UE Simulation", "End User Configuration", "Auto Generated Users Info" -> "No Of Users To Be Simulated", "Starting IMSI", "MSIN", "Auto Generated End User Configuration". The configuration table on the right has columns "Config" and "Value". The "Enable" checkbox is checked. At the bottom right, there are "Start" and "Edit" buttons. At the bottom of the window, there are status indicators for "Initialisation Errors" and "Error Event".

Config	Value
NEF	1
NEF 1	
NEF IP Address	192.168.12.170
NEF Server Port	6666
URI Scheme	HTTP
NEF Client Name	NEFClient1
SMF	1
SMF 1	
SMF IP Address	192.168.12.198
SMF Server Port	6666
SMF EventExposure API Version	v1
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	NEF_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 (SMF)

The screenshot shows the MAPS SMF (N29 RELEASE17) configuration window. The title bar reads "GL MAPS SMF (N29 RELEASE17) - [Testbed Setup - TestBedDefault]". The menu bar includes "Configurations", "Emulator", "Reports", "Editor", "Debug Tools", "Windows", and "Help". The toolbar contains various icons for settings, help, and navigation. The main area is divided into a tree view on the left and a configuration table on the right.

Config	Value
SMF Configuration	
SMF	1
SMF 1	
SMF IP Address	192.168.12.198
SMF Server Port	6666
URI Scheme	HTTP
SMF EventExposure API Version	v1
NEF	1
NEF 1	
NEF IP Address	192.168.12.170
NEF Server Port	6666
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	SMF_Profiles.xml
Auto Generated Users Info	

On the right side of the configuration table, there is a checkbox labeled "Enable" which is checked. Below the table are "Start" and "Edit" buttons. At the bottom of the window, there is a status bar with "Initialisation Errors" and "E".

Profile Editor (NEF)

GL MAPS NEF (N29 RELEASE17) - [Profile Editor -NEF_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
17	UEProfile0017
18	UEProfile0018

Config

Config	Value
UEProfile0001	
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 Release Notify
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	7777

Enable

Add Insert Delete

Properties

Insert Delete Clear

Initialisation Errors Error Events Captured

Profile Editor (SMF)

The screenshot displays the 'Profile Editor - SMF_Profiles' window. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help), a toolbar with various icons, and a main workspace. The workspace is divided into three main sections: a list of profiles on the left, a configuration tree in the center, and a properties panel on the right.

Profiles List (Left):

#	Profiles (Edit-F2)
1	SMFProfile0001
2	SMFProfile0002
3	SMFProfile0003
4	SMFProfile0004
5	SMFProfile0005
6	SMFProfile0006
7	SMFProfile0007
8	SMFProfile0008
9	SMFProfile0009
10	SMFProfile0010
11	SMFProfile0011
12	SMFProfile0012
13	SMFProfile0013
14	SMFProfile0014
15	SMFProfile0015

Configuration Tree (Center):

- Config
 - SMFProfile0001
 - UE Identity
 - SUPI: 001013012041631
 - GPSI: 3012041631
 - 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

Properties Panel (Right):

- Enable
- Buttons: Add, Insert, Delete, Properties

Bottom Status Bar:

- Initialisation Errors
- Error Events
- Captured

Call Generation

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	Results
1	SMF_HTTP2_Connection_Monitor.gls		SMF Server Clients : .NEF,	Stop		Connect Server	Unknown
2	Nsmf_EventExp_Control.gls		SubId : .nefsubld-3012041631, .SUPI : .imsi-001013012041...	Completed	Successful Subscribe Response Sent	None	Pass
3	Nsmf_EventExp_Control.gls		SubId : .nefsubld-3012041631, .SUPI : .imsi-001013012041...	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 12:11:25.017000

204 NO-CONTENT 12:11:25.036000

Find

```
POST http://192.168.12.170:6666/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": "2024-01-25T12:11:24+05:30"
    }
  ],
  "notifId": "pdu_statusId-3012041631-6"
}
```

Scripts **Message Sequence** Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Status Up:

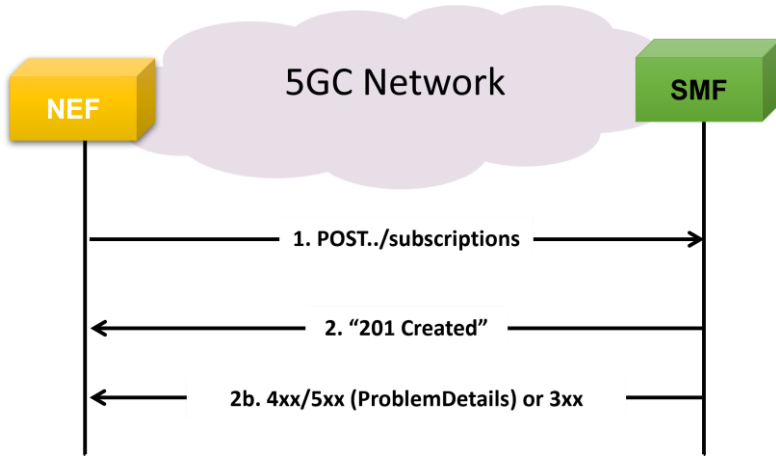
MAPS™ 5G N29 Interface Procedures

- **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

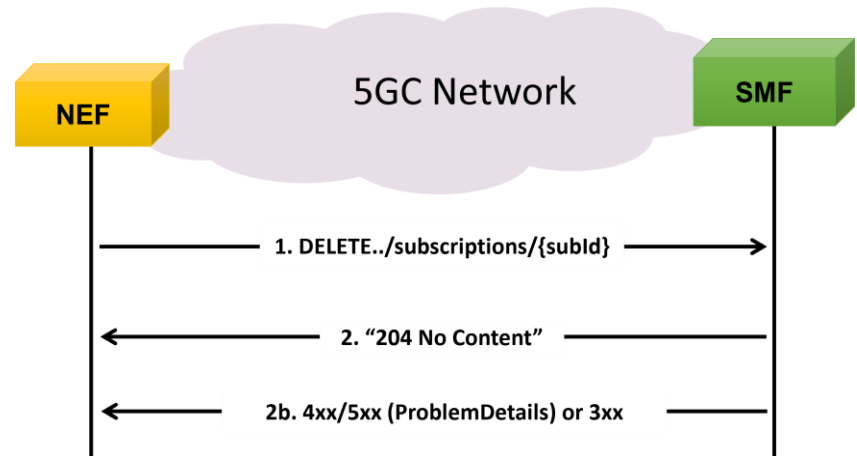
MAPS™ 5G N29 Interface Procedures

Nsmf_EventExposure Service

Subscription Procedure



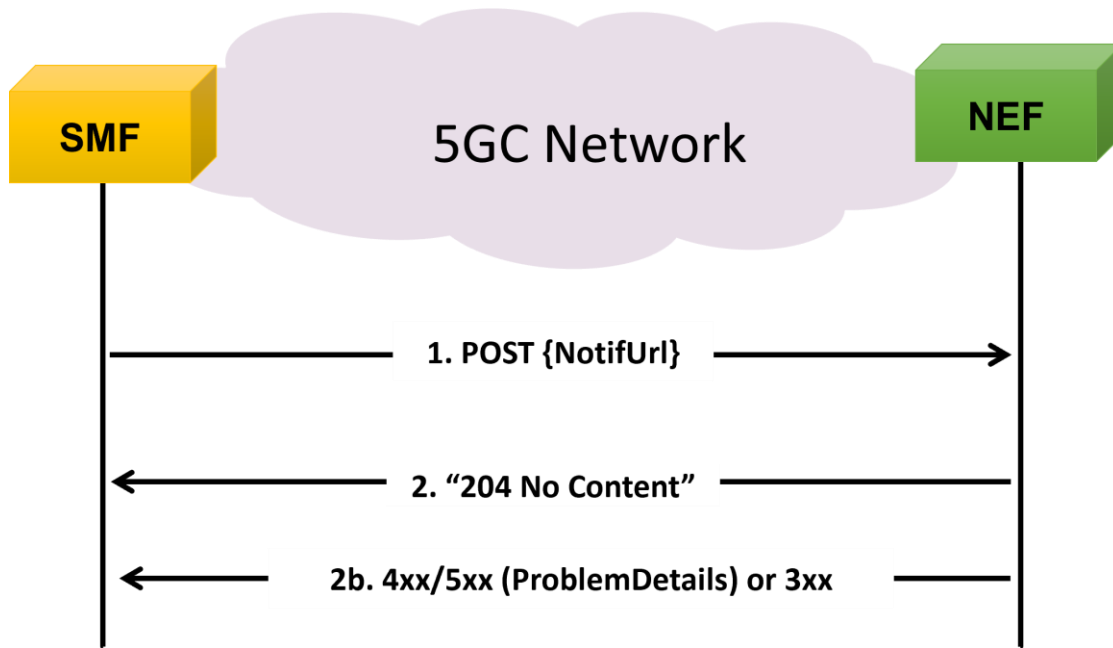
Unsubscription Procedure



MAPS™ 5G N29 Interface Procedures (Contd.)

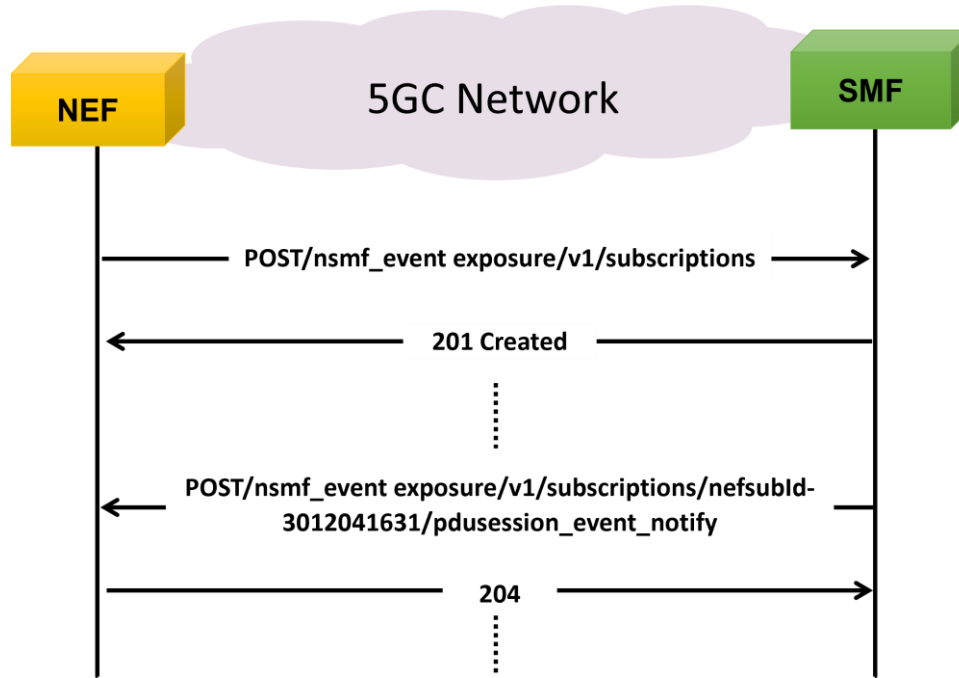
Nsmf_EventExposure Service

Notification Procedure

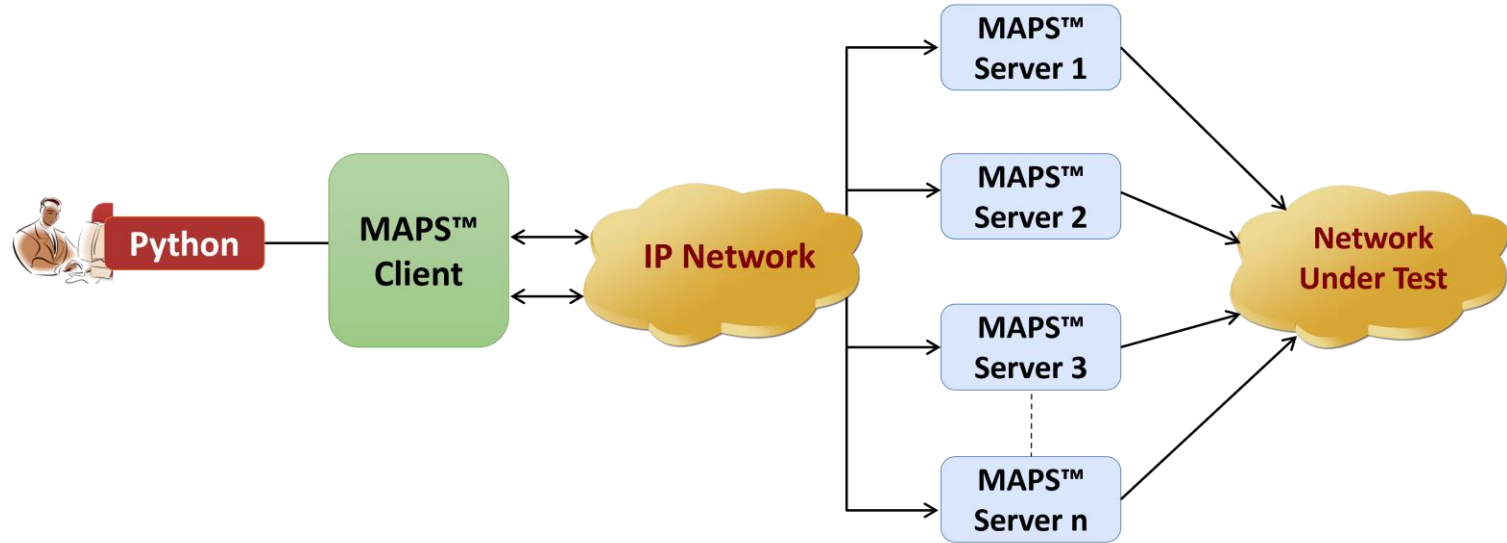


MAPS™ 5G N29 Interface Procedures (Contd.)

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","notifiMethod":"ONE_TIME","notifiUri":"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":"","notifiId":"pdu_status
Id-3012041631-6","notifiMethod":"ONE_TIME","notifiUri":"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","NotifiMethod"="ONE_TIME","Notifi_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