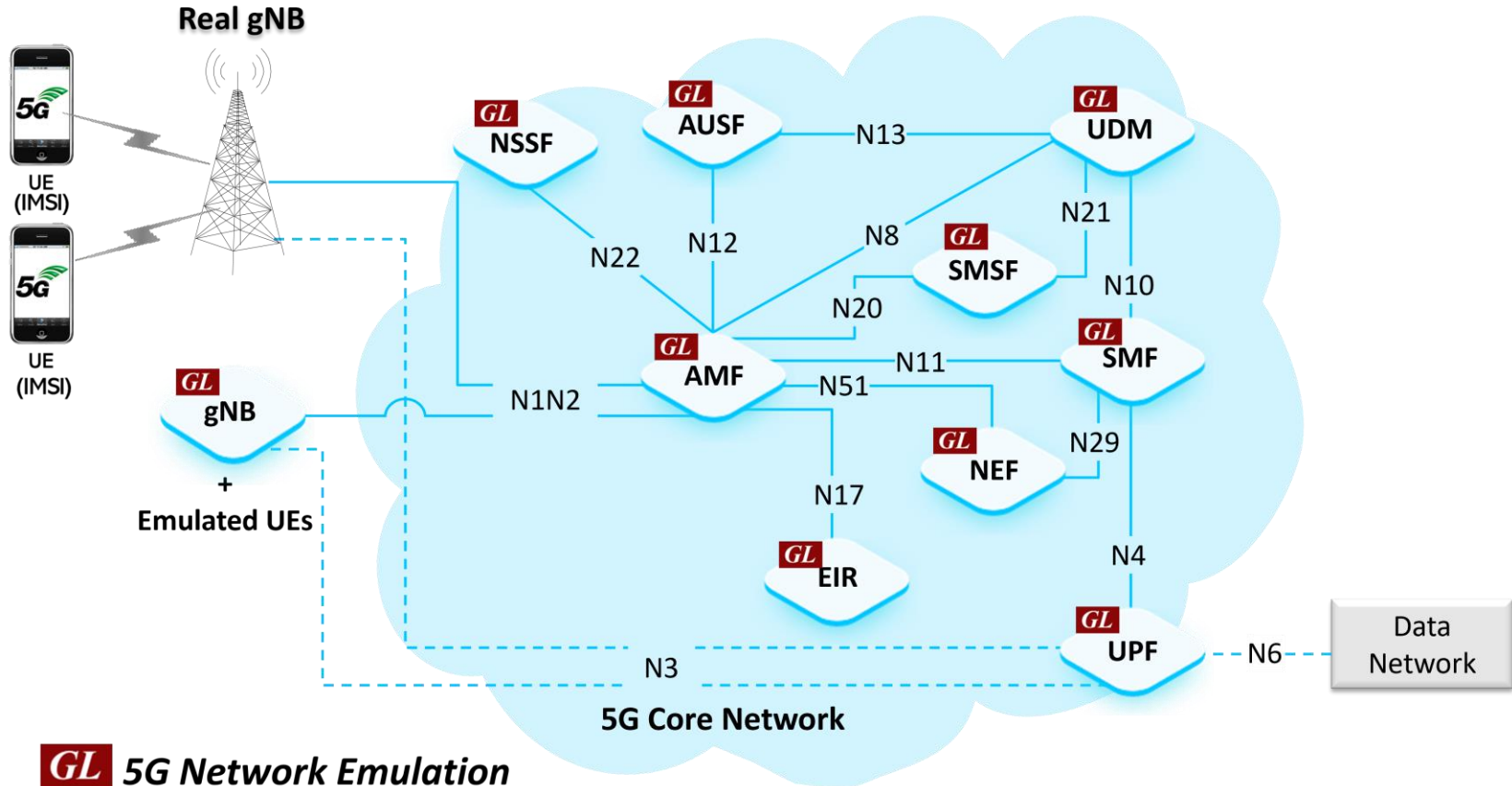

MAPS™ 5G N51 Interface Emulator



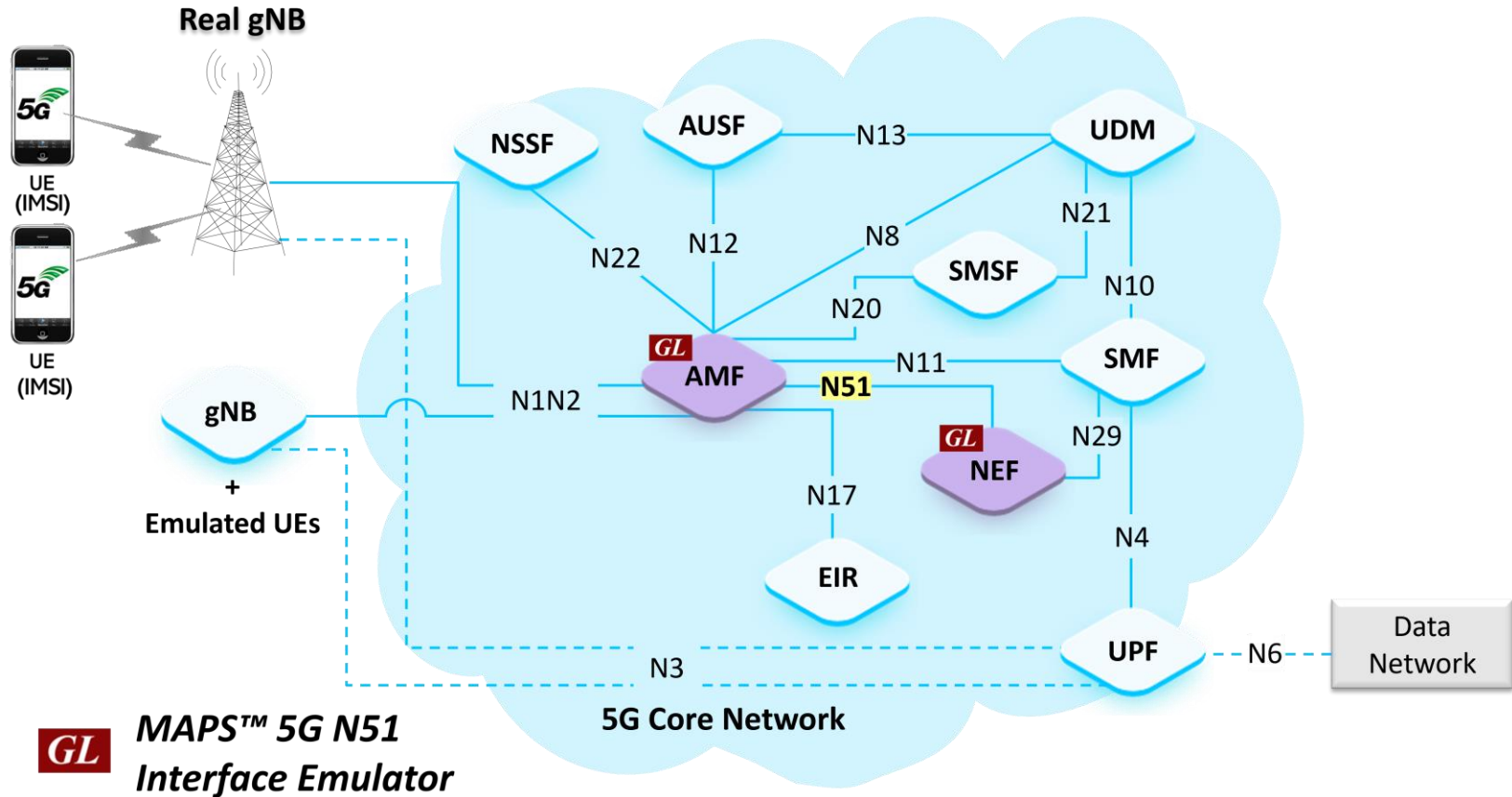
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N51 Interface



Main Features

- Emulate Network Exposure Function (NEF) and Access and Mobility Management Function (AMF) elements
- Supports Namf_EventExposure Service (Registration State, Connection State, Location Report, Presence Update operations)
- 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

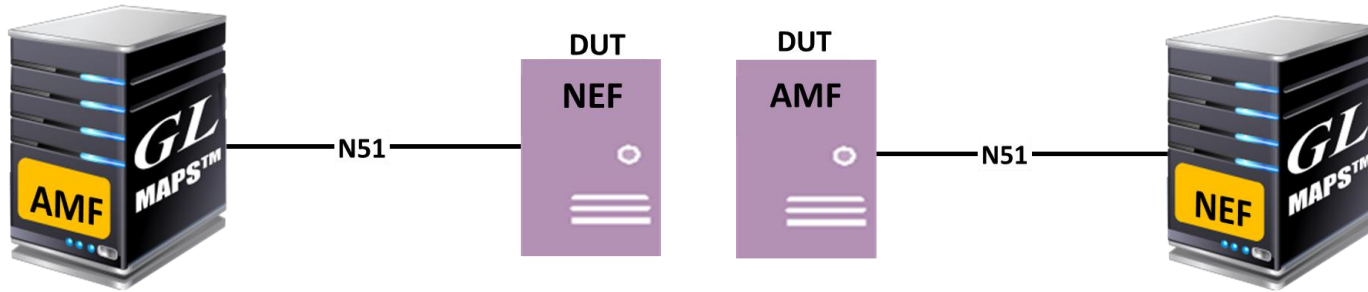
Protocol Stack

JSON	
HTTP/2	
TCP	TLS
IP	
Ethernet	
REST	

Supported Protocols	Standard / Specification Used
N51 Interface	
N51 Interface (NEF-AMF)	TS29.518
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2 (Hypertext Transfer Protocol)	IETF RFC 7540
TCP/TLS	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

User Cases

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



Testbed Setup

GL MAPS NEF (N51 RELEASE17) - [Testbed Setup -TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config	Value
NEF Configuration	
NEF	1
NEF 1	
NEF IP Address	192.168.12.170
NEF Server Port	6666
URI Scheme	HTTP
NEF Client Name	NEFClient1
AMF	1
AMF 1	
AMF IP Address	192.168.12.198
AMF Server Port	6666
AMF 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

Initialisation

GL MAPS AMF (N51 RELEASE17) - [Testbed Setup -TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config	Value
AMF Configuration	
AMF	1
AMF 1	
AMF IP Address	192.168.12.198
AMF Server Port	6666
URI Scheme	HTTP
AMF 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	AMF_Profiles.xml
Auto Generated Users Info	

Start Edit

Initialisation Errors

Profile Editor (NEF)

MAPS NEF (N51 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
19	UEProfile0019
20	UEProfile0020
21	UEProfile0021

Config

Config	Value	Enable
UEProfile0001		<input checked="" type="checkbox"/>
UE Identity		
SUPI	001013012041631	
IMEI	359877068325248	
PEI	1234567890123001	
MSIN	3012041631	
NEF Client Name	NEFClient1	
Subscription Key Id	SUPI Only	
AMF Parameters		
AMF Notify Request Events	1	
AMF Notify Request Events 1	REGISTRATION STATE ...	
Immediate Report Flag	False	
AMF Event Trigger Type	ONE TIME	
Arera List		
Location Filter List	TAI	
Presence State	UNKNOWN	
NR Cell Id	000000001	
TAC	001	
PLMN Id		
MCC	001	
MNC	01	
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

Profile Editor (AMF)

MAPS AMF (N51 RELEASE17) - [Profile Editor -AMF_Profiles]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	Profiles (Edit-F2)
1	AMFProfile0001
2	AMFProfile0002
3	AMFProfile0003
4	AMFProfile0004
5	AMFProfile0005
6	AMFProfile0006
7	AMFProfile0007
8	AMFProfile0008
9	AMFProfile0009
10	AMFProfile0010

Config

Config	Value
AMFProfile0001	
UE Identity	
SUPI	001013012041631
IMEI	359877068325248
PEI	1234567890123001
NR CellId	000000001
TAC	001
Default Registration State	DEREGISTERED
Default Connection State	IDLE
Default UE Presence State in Network	INACTIVE
Event Notify Trigger Timer in msec	5000
Default Event Notify Period in msec	30000

Enable

Add Insert Delete

Properties

Initialisation Errors Error Events Captured Err

Global Profile

The screenshot shows the 'Global Configuration - Globalprofile' window in the MAPS NEF (N51 RELEASE17) application. The window has a menu bar with 'Configurations', 'Emulator', 'Reports', 'Editor', 'Debug Tools', 'Windows', and 'Help'. Below the menu is a toolbar with various icons. The main area is divided into a tree view on the left and a configuration panel on the right. The tree view shows 'Global Configuration' expanded to 'General Timers', with a table of settings. The configuration panel on the right has an 'Enable' checkbox checked and 'Apply' and 'Edit' buttons at the bottom. At the bottom of the window, there are two status indicators: 'Initialisation Errors' and 'Error Ever'.

Config	Value
Global Configuration	
General Timers	
Response Wait Timer in msec	65000
Retransmission Count	0
SDM Auto Unsubscribe Data Change Notification	Disable
Unsubscribe Data Change Notification Timer in msec	10000
Subscription For All UE	Disable
Sbi Connection Monitor Timer in sec	5

Enable

Apply Edit

Initialisation Errors Error Ever

Call Generation

The screenshot displays the MAPS NEF (N51 RELEASE17) - [Call Generation - CallGenDefault] application. The interface includes a menu bar (Configurations, Emulator, Reports, Editor, Debug Tools, Windows, Help), a toolbar with various icons, and a table showing script execution results.

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	NEF_EventExp_Control.gls	UEProfile0001	SUPI :_imsi-001013012041631	Start	Namf EE SessionEstEventNotify Response Sent	None	Pass	1	1

Below the table, there are buttons for Add, Delete, Insert, Refresh, Start, Start All, Stop, Stop All, Abort, and Abort All. A section for saving and showing latest data is also present.

The Message Sequence diagram shows the interaction between NEF and AMF:

- NEF sends POST /namf-evts/v1/subscriptions to AMF at 12:10:41.880000.
- AMF responds with 201 CREATED at 12:10:42.253000.
- NEF sends POST /namf-evts/v1/subscriptions/notifyid-3012041631/amf_report_eve... to AMF at 12:10:47.787000.
- AMF responds with 204 at 12:10:47.788000.

The JSON response for the second POST request is:

```
POST http://192.168.12.198:6666/namf-evts/v1/subscriptions
content-type : application/json
accept : application/problem+json

{
  "subscription": {
    "eventList": [ {
      "immediateFlag": false,
      "type": "REGISTRATION_STATE_REPORT"
    } ],
    "eventNotifyUri": "http://192.168.12.170:6666/namf-evts/v1/subscriptions/notifyid-3012041631/amf_report_event",
    "nfId": "4b7412b5-760a-41b6-a673-edc55aa6850d",
    "notifyCorrelationId": "notifyid-3012041631",
    "options": {
      "trigger": "ONE_TIME"
    }
  },
  "supi": "imsi-001013012041631"
}
```

At the bottom, there are tabs for Scripts, Message Sequence, Event Config, and Script Flow. The status bar shows: Initialisation Errors, Error Events, Captured Errors, and Link Status Up=0.

Call Reception

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Results
1	AMF_HTTP2_Connection_Monitor.gls		AMF Server Clients : ,	Stop		Connect Server	Unknown
2	Namf_EventExp_Control.gls		imsi-001013012041631	Completed	Successful Subscribe Response Sent	None	Pass
3	Namf_EventExp_Control.gls		SUPI : imsi-001013012041631	Completed	Namf 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

NEF AMF

POST /namf-evts/v1/subscriptions 12:10:42.238000

201 12:10:42.243000

Status: 1
:method : POST
:path : /namf-evts/v1/subscriptions
:scheme : http
:authority : 192.168.12.198:6666
content-type : application/json
accept : application/problem+json
content-length : 361

```
{
  "subscription": {
    "eventList": {
      "immediateFlag": false,
      "type": "REGISTRATION_STATE_REPORT"
    }
  },
  "eventNotifyUri": "http://192.168.12.170:6666/namf-evts/v1/subscriptions",
  "nfId": "4b7412b5-760a-41b6-a673-edc55aa6850d",
  "notifyCorrelationId": "notifyid-3012041631",
  "options": {
    "trigger": "ONE_TIME"
  }
}
```

Scripts Message Sequence Event Config Script Flow

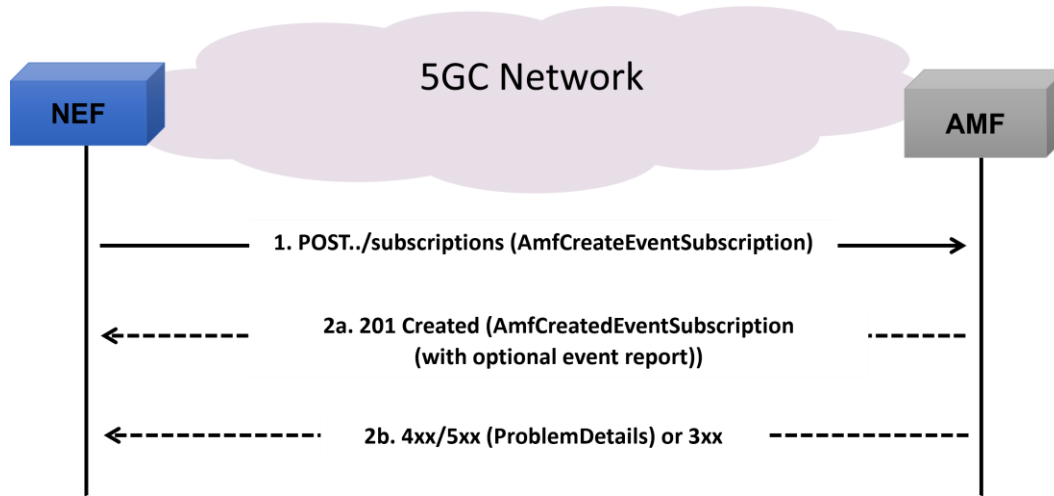
Initialisation Errors Error Events Captured Errors

MAPS™ 5G N51 Interface Procedures

- **Namf_EventExposure Services**
 - Event Notification Subscription Procedure
 - Unsubscribe Event Notification Procedure
 - Event Notification Procedure – includes the below event types:
 - Registration State Change Event
 - Connection State Change Event
 - Location Report Event
 - Presence In Area of Interest Event

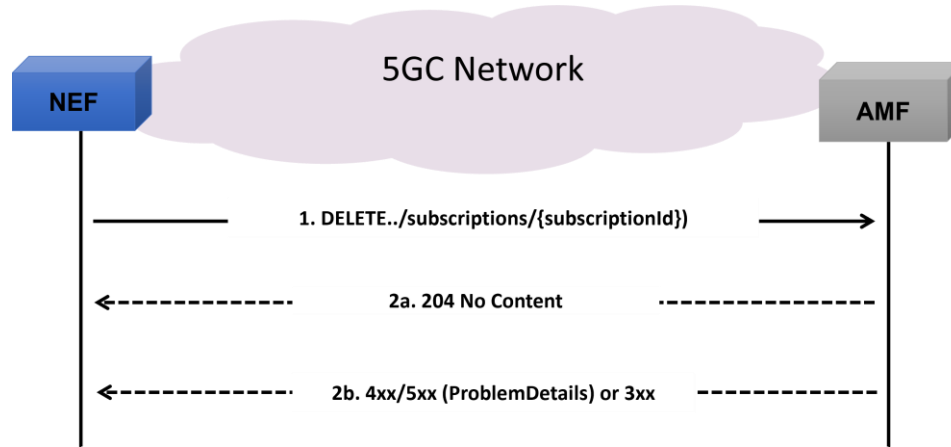
MAPS™ 5G N51 Interface Procedures

Event Notification Subscription Procedure



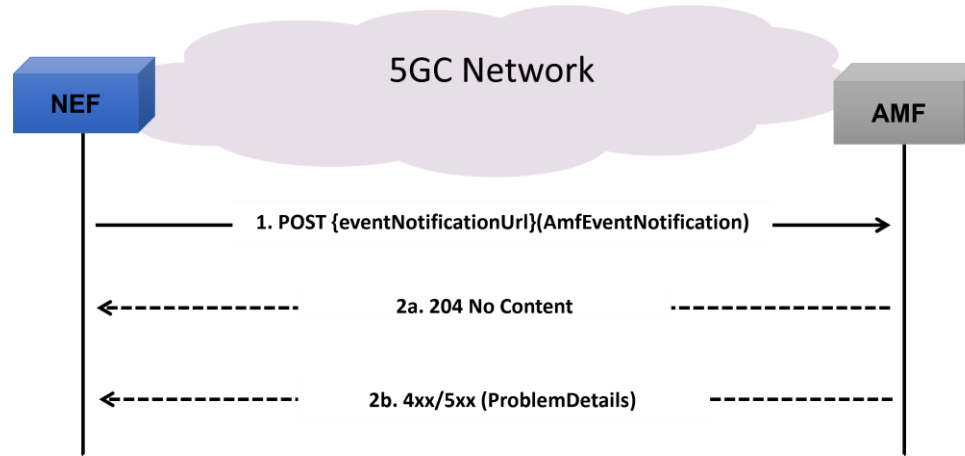
MAPS™ 5G N51 Interface Procedures (Contd.)

Unsubscribe Event Notification Procedure



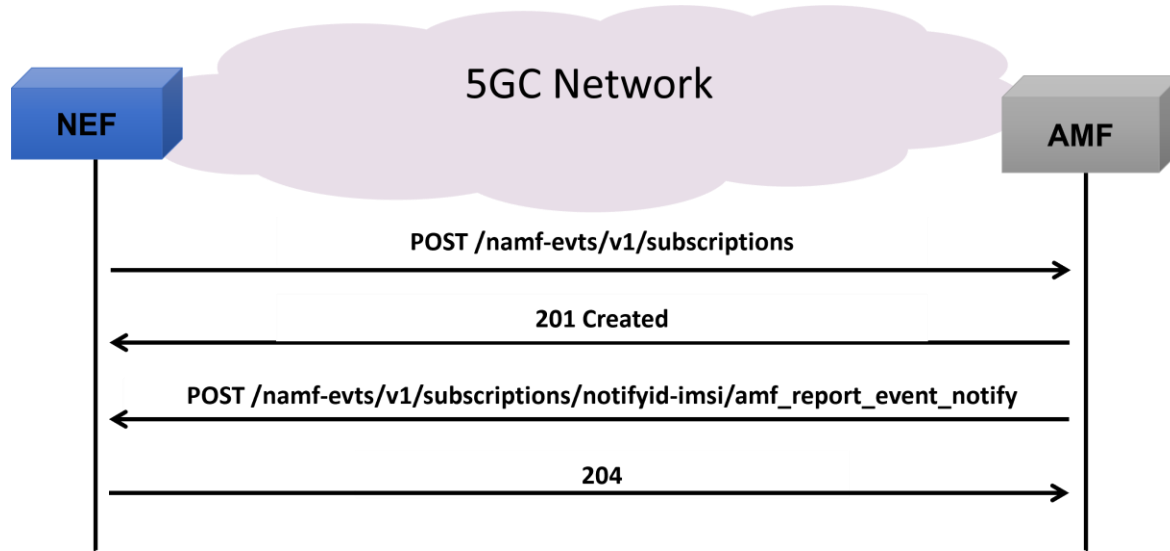
MAPS™ 5G N51 Interface Procedures (Contd.)

Event Notification Procedure

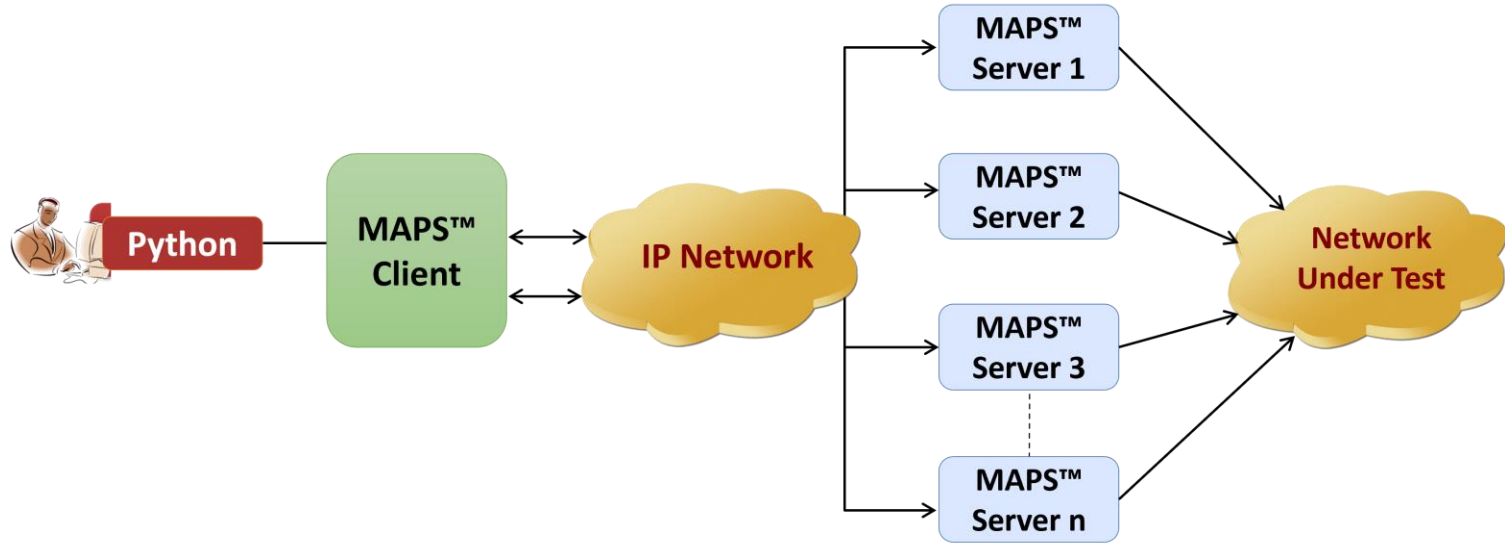


MAPS™ 5G N51 Interface Procedures (Contd.)

Registration State Change Event



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
14:32:28.903 <-
{"subscription":{"eventList":[{"immediateFlag":false,"type":"REGISTRATION_STATE_REPORT"}],"eventNotifyUri":"http://192.168.12.170:6666/namf-evts/v1/subscription
s/notifyid-3012041631/amf_report_event_notify","nfId":"987c9bb2-87bd-4cf6-849d-8
77e9982115d","notifyCorrelationId":"notifyid-3012041631","options":{"trigger":"O
NE_TIME"},"supi":"imsi-001013012041631"},"subscriptionId":"subid-notifyid-301204
1631"}
Message decode...
14:32:28.963 <- POST /namf-evts/v1/subscriptions/notifyi
d-3012041631/amf_report_event_notify
14:32:28.963 <- POST /namf-evts/v1/subscriptions/notifyid-3012041631/amf
_report_event_notify
Status: 1
:method: POST
:path: /namf-evts/v1/subscriptions/notifyid-3012041631/amf_report_event_notify
:scheme: http
:authority: 192.168.12.170:6666
:content-type: application/json
:accept: application/problem+json
:content-length: 340
{
  "notifyCorrelationId":"notifyid-3012041631",
  "reportList":[{"
    "gpsi":"msisdn-3012041631",
    "pei":"imeisv-1234567890123001",
    "rmInfoList":[{"
      "accessType":"3GPP_ACCESS",
      "rmState":"DEREGISTERED"
    }]},
  "subscriptionId":"subid-notifyid-3012041631",
  "supi":"imsi-001013012041631",
  "timeStamp":"2024-01-23T14:32:28+05:30",
  "type":"REGISTRATION_STATE_REPORT"
}]
}
Message decode...
14:32:28.964 -> POST - /namf-evts/v1/subscriptions
14:32:28.964 -> POST - /namf-evts/v1/subscriptions
{"subscription":{"eventList":[{"immediateFlag":false,"type":"REGISTRATION_STATE_
REPORT"}],"eventNotifyUri":"http://192.168.12.170:6666/namf-evts/v1/subscrip
tion
s/notifyid-3012041631/amf_report_event_notify","nfId":"987c9bb2-87bd-4cf6-849d-8
77e9982115d","notifyCorrelationId":"notifyid-3012041631","options":{"trigger":"O
NE_TIME"},"supi":"imsi-001013012041631"}}
Stopping Script... True
Stopping N51 TestBed... Stop TestBed = Stopped
True
N51 Server Disconnecting... True
>>>
```

```
CLI MapsCLI NEF (N51 RELEASE17)
File Edit View
View Latest Command
1 :: 2024-1-23 14:32:07.356000 : Start "TestBedDefault.xml" # "NEF[0].AMF[0].AMFIPAddress"="192.168.12.198","_TypeOfUESimulation"="XML","_DefaultProfile"="NEF_Profiles.xml";
1 :: 2024-1-23 14:32:10.192000 : LoadProfile "NEF_Profiles.xml"
1 :: 2024-1-23 14:32:12.384000 : StartScript 1 "NEF_EventExp_Control.gls" "UEProfile0001" 1 # "IMSI"=(binarystring)001013012041631,"EventType"="REGISTRATION_STATE_REPORT","AmfEventTrigger"
1 :: 2024-1-23 14:32:22.567000 : UserEvent 1 "Request_Namf_EE_Subscribe";
1 :: 2024-1-23 14:32:23.228000 : UserEvent 1 "GetCallStatus";
1 :: 2024-1-23 14:32:30.003000 : UserEvent 1 "GetMessageCount";
1 :: 2024-1-23 14:32:30.109000 : UserEvent 1 "GetLastReceivedMessage";
1 :: 2024-1-23 14:32:30.229000 : UserEvent 1 "GetMessageInfo"# "Index"=0;
1 :: 2024-1-23 14:32:30.334000 : UserEvent 1 "GetMessageInfo"# "Index"=1;
1 :: 2024-1-23 14:32:30.544000 : UserEvent 1 "GetMessageInfo"# "Index"=2;
1 :: 2024-1-23 14:32:30.654000 : UserEvent 1 "GetMessageInfo"# "Index"=3;
1 :: 2024-1-23 14:32:30.877000 : StopScript 1;
1 :: 2024-1-23 14:32:30.982000 : Stop TestBedSetup;
ServerLog:errCode = 0,errString = connection has been gracefully closed for ClientId = 1
NUM SCRL
```

Thank you