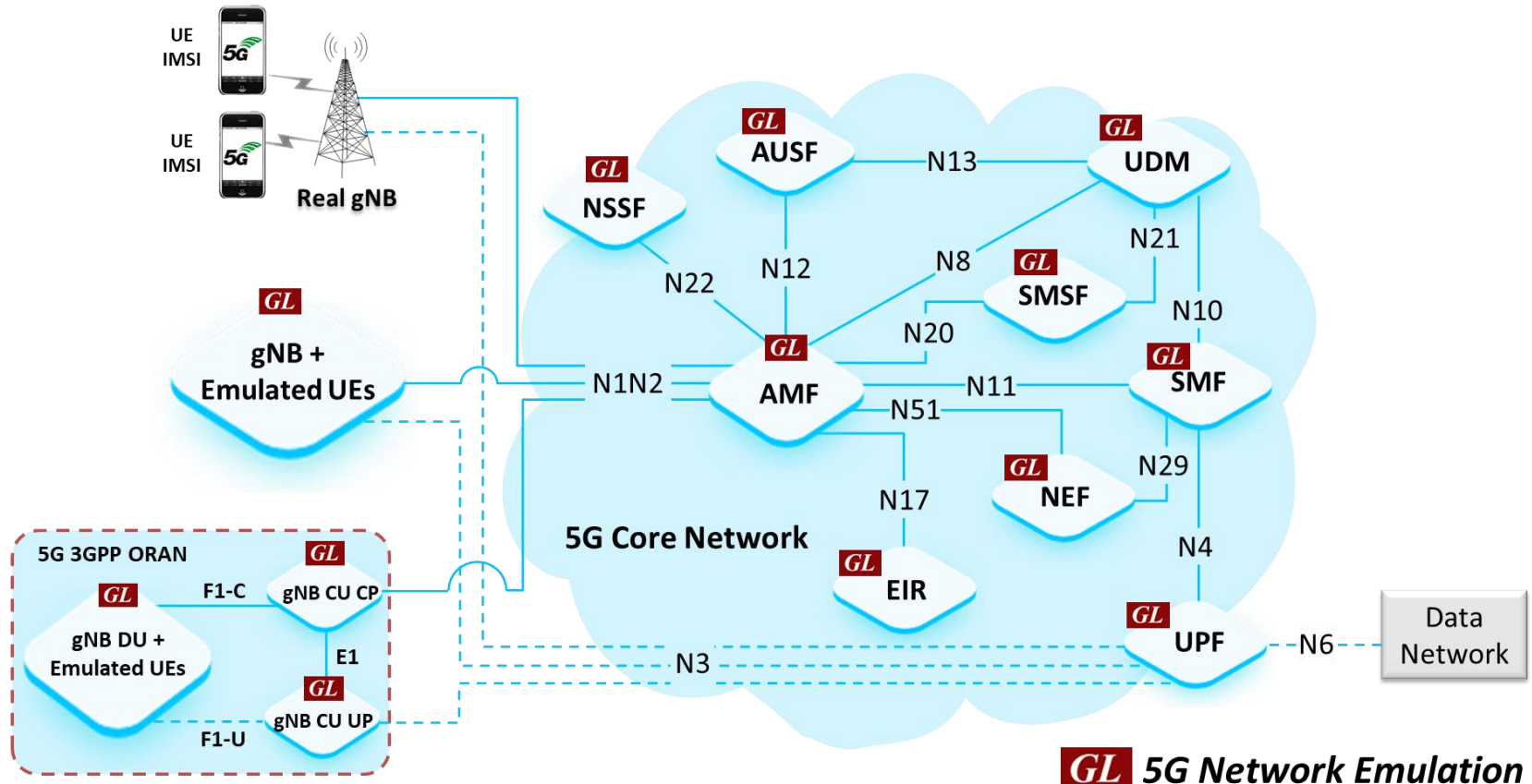

MAPS™ 5G N51 Interface Emulator



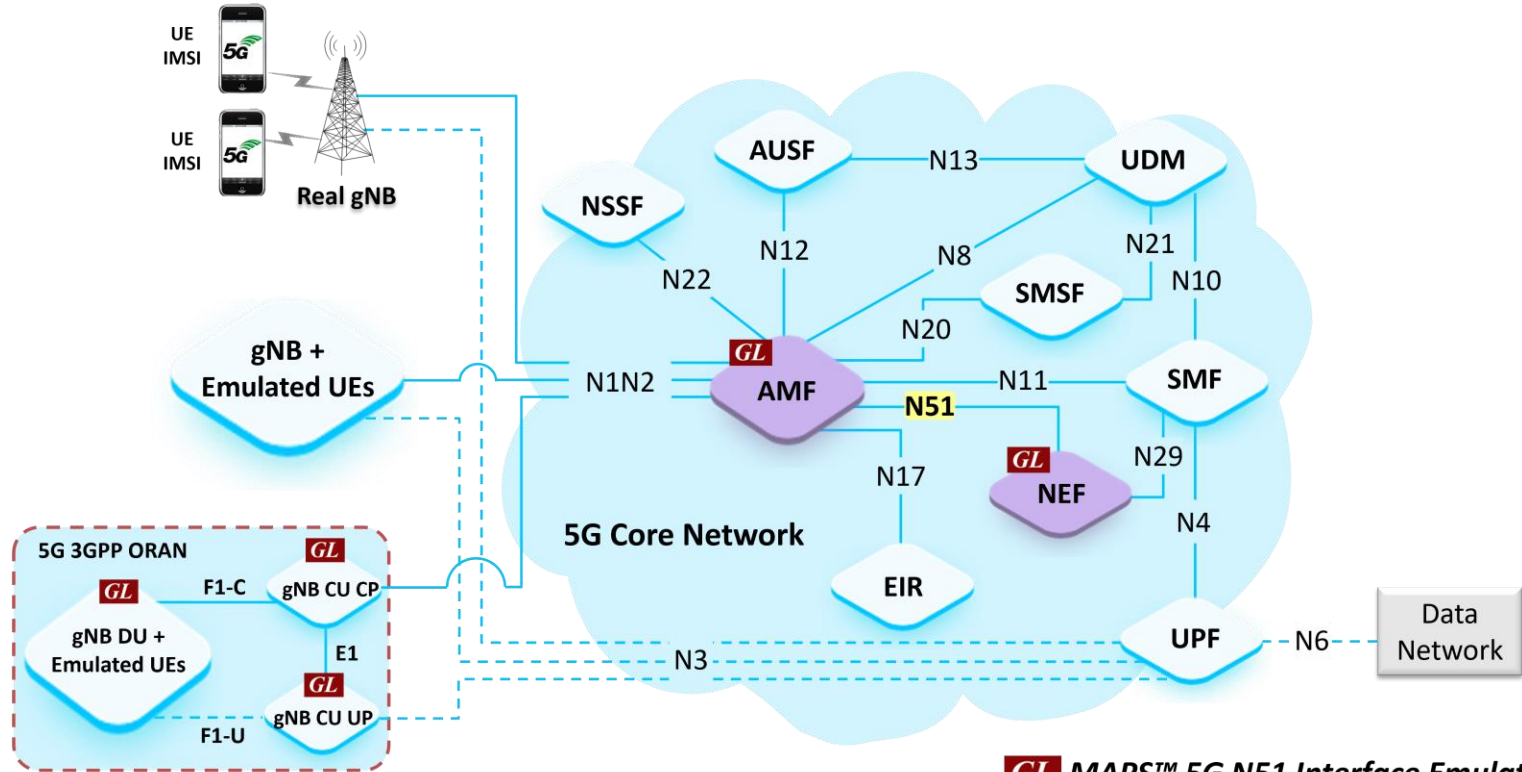
818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784 Fax: (301) 670-9187 Email: info@gl.com
Website: <https://www.gl.com>

5G Network Diagram



GL 5G Network Emulation

MAPS™ 5G N51 Interface



GL MAPS™ 5G N51 Interface Emulator

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

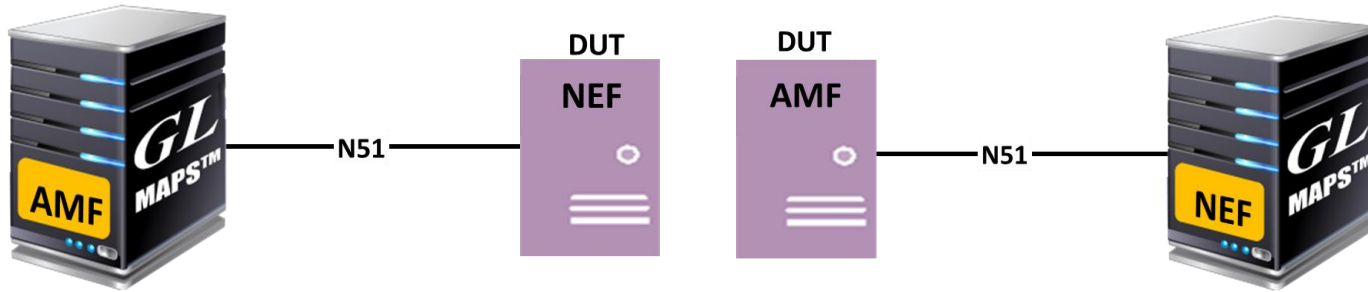
Protocol Stack

JSON	
HTTP/2	
TCP	TLS
IP	
Ethernet	
REST	

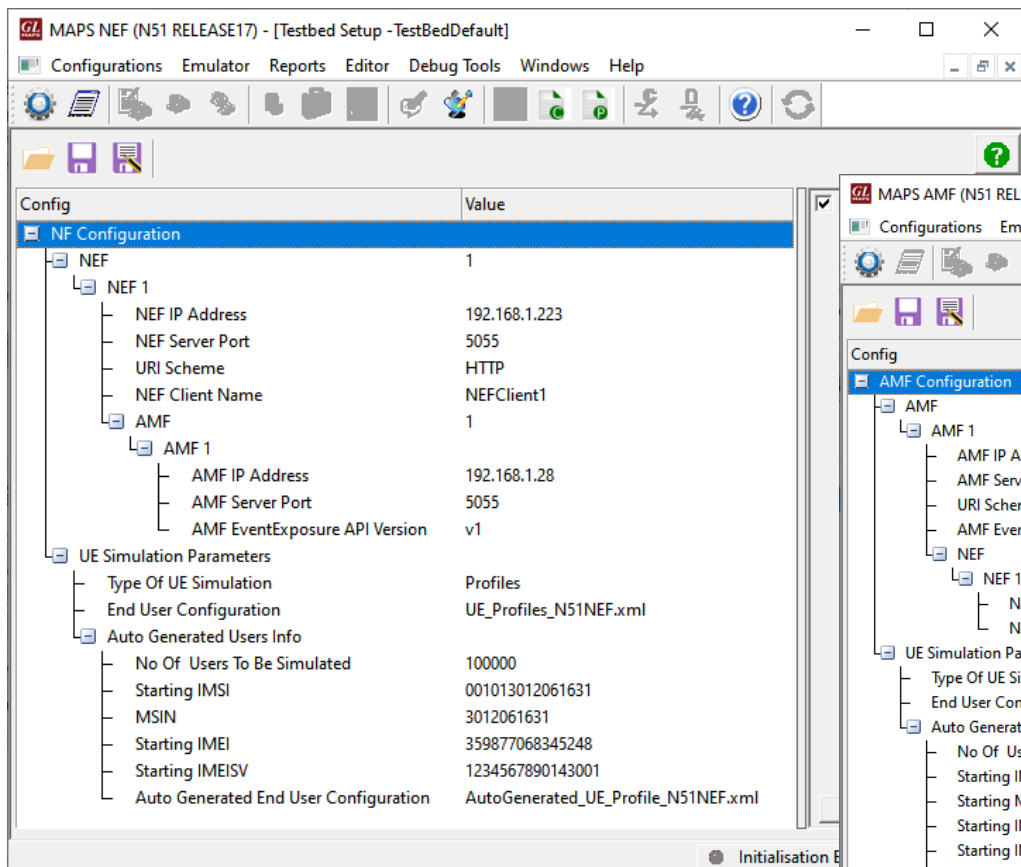
Supported Protocols	Standard / Specification Used
N51 Interface	
N51 Interface (NEF-AMF)	TS29.518 (Release 17)
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2 (Hypertext Transfer Protocol)	IETF RFC 7540
TCP/TLS	IETF RFC 793
IPv4	IETF RFC 791 [5] IETF RFC 2460 [6]

User Cases

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



Testbed Setup

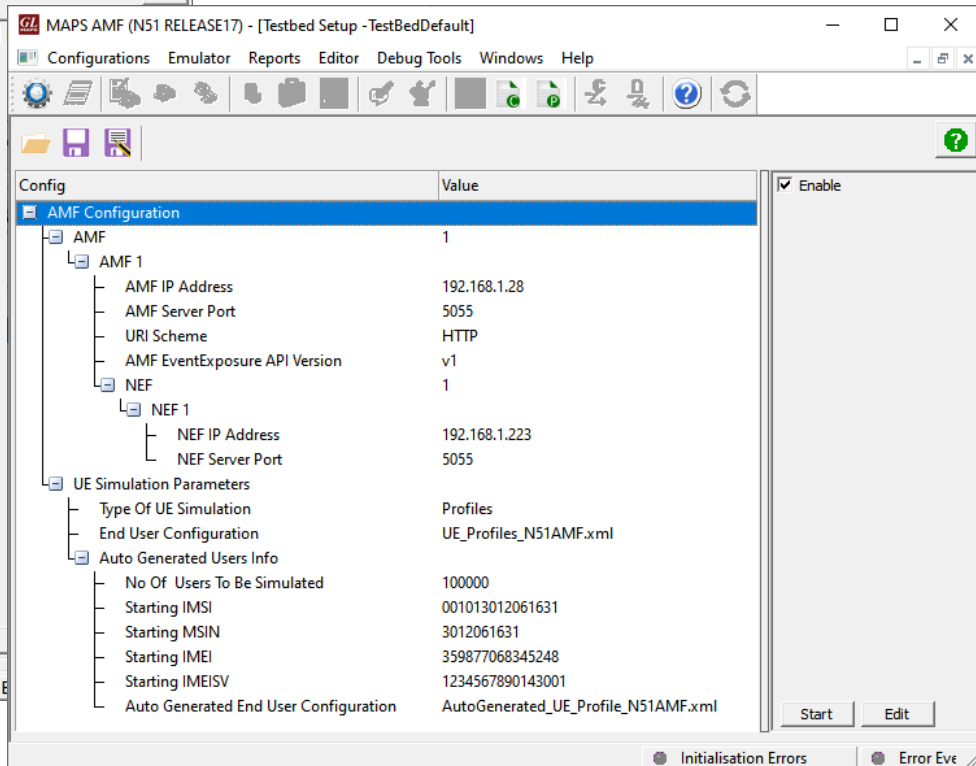


MAPS NEF (N51 RELEASE17) - [Testbed Setup - TestBedDefault]

Configurations Emulator Reports Editor Debug Tools Windows Help

Config	Value
NEF Configuration	
NEF	1
NEF 1	
NEF IP Address	192.168.1.223
NEF Server Port	5055
URI Scheme	HTTP
NEF Client Name	NEFClient1
AMF	1
AMF 1	
AMF IP Address	192.168.1.28
AMF Server Port	5055
AMF EventExposure API Version	v1
UE Simulation Parameters	
Type Of UE Simulation	Profiles
End User Configuration	UE_Profiles_N51NEF.xml
Auto Generated Users Info	
No Of Users To Be Simulated	100000
Starting IMSI	001013012061631
MSIN	3012061631
Starting IMEI	359877068345248
Starting IMEISV	1234567890143001
Auto Generated End User Configuration	AutoGenerated_UE_Profile_N51NEF.xml

Initialisation Errors



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

Configurations Emulator Reports Editor Debug Tools Windows Help

Config	Value	Enable
AMF Configuration		<input checked="" type="checkbox"/>
AMF	1	
AMF 1		
AMF IP Address	192.168.1.28	
AMF Server Port	5055	
URI Scheme	HTTP	
AMF EventExposure API Version	v1	
NEF	1	
NEF 1		
NEF IP Address	192.168.1.223	
NEF Server Port	5055	
UE Simulation Parameters		
Type Of UE Simulation	Profiles	
End User Configuration	UE_Profiles_N51AMF.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_N51AMF.xml	

Start Edit

Initialisation Errors Error Events

Profile Editor (NEF)

MAPS NEF (N51 RELEASE17) - [Profile Editor -UE_Profiles_N51NEF]

Configurations Emulator Reports Editor Debug Tools Windows Help

Profiles (Edit-F2)

#	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			
18	MSIN3012041648			
19	MSIN3012041649			
20	MSIN3012041650			

Config

- MSIN3012041631
 - UE Identity
 - SUPI: 001013012041631
 - IMEI: 359877068325248
 - IMEISV: 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 CHANG REPORT
 - 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: External
 - External NEF IP Address: 192.168.1.223
 - External NEF Server Port: 5056

Enable

Add Insert Delete

Properties

Initialisation Errors Error Events Captured

Profile Editor (AMF)

MAPS AMF (N51 RELEASE17) - [Profile Editor -UE_Profiles_N51AMF]

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

Config Value

MSIN3012041631

- UE Identity
 - SUPI 001013012041631
 - MSIN 3012041631
 - IMEI 359877068325248
 - IMEISV 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

Global Profile

The screenshot shows the 'Global Configuration - Globalprofile' window in the MAPS NEF (N51 RELEASE17) application. The window title bar includes the GL logo and standard window controls. The menu bar contains 'Configurations', 'Emulator', 'Reports', 'Editor', 'Debug Tools', 'Windows', and 'Help'. The toolbar features various icons for configuration, help, and refresh. 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 parameters and their values. The configuration panel on the right has an 'Enable' checkbox checked and 'Apply' and 'Edit' buttons at the bottom. The status bar at the bottom shows '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

GL MAPS NEF (N51 RELEASE17) - [Call Generation -Default]

Configurations Emulator Reports Editor Debug Tools Windows Help

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	E..	Result	Total Iter...	Completed Iterations
1	NEF_EventExp_Control.gls	MSIN3012041631	SUPI : .jmsi-001013012041631	Start	Namf 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 AMF

POST /namf-evts/v1/subscriptions 11:00:41.2100

201 CREATED 11:00:41.4390

POST /namf-evts/v1/subscriptions/notifyid-3012041631/amf_report_event_notify 11:00:47.4630

204 11:00:47.4630

Find

```
POST http://192.168.1.28:5055/namf-evts/v1/subscriptions
content-type : application/json
accept : application/problem+json

{
  "subscription":{
    "eventList":[{
      "immediateFlag":false,
      "type":"REGISTRATION_STATE_REPORT"
    }],
    "eventNotifyUri":"http://192.168.1.223:5055/namf-evts/v1/subscriptions
    "nfId":"b8637479-fd0b-41d3-9d99-afe4e519408f",
```

Scripts Message Sequence Event Config Script Flow

Initialisation Errors Error Events Captured Errors Link Stat

Call Reception

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Ev...	Results
1	AMF_HTTP2_Connection_Monitor.gls		AMF Server Clients : .NEF,	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

AMF NEF

POST /namf-evts/v1/subscriptions/notifyid-3012041631/amf_report_event_notify 11:00:47.447000

204 NO-CONTENT 11:00:47.473000

Find

```
POST http://192.168.1.223:5055/namf-evts/v1/subscript
content-type : application/json
accept : application/json,
application/problem+json

{
  "notifyCorrelationId": "notifyid-3012041631",
  "reportList": [{
    "gpsi": "msisdn-3012041631",
    "pei": "imeisv-0",
    "rmInfoList": [{
```

Scripts **Message Sequence** Event Config Script Flow

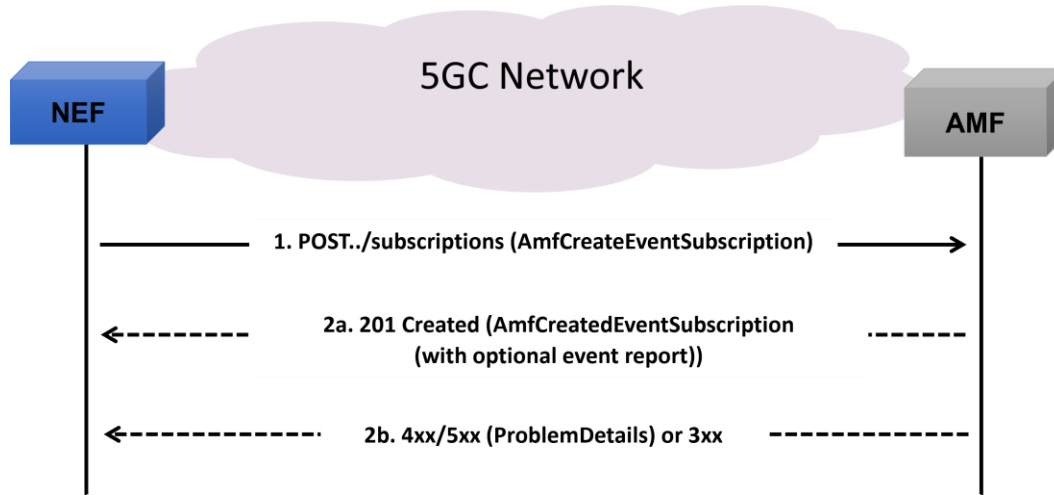
Initialisation Errors Error Events Captured Errors

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

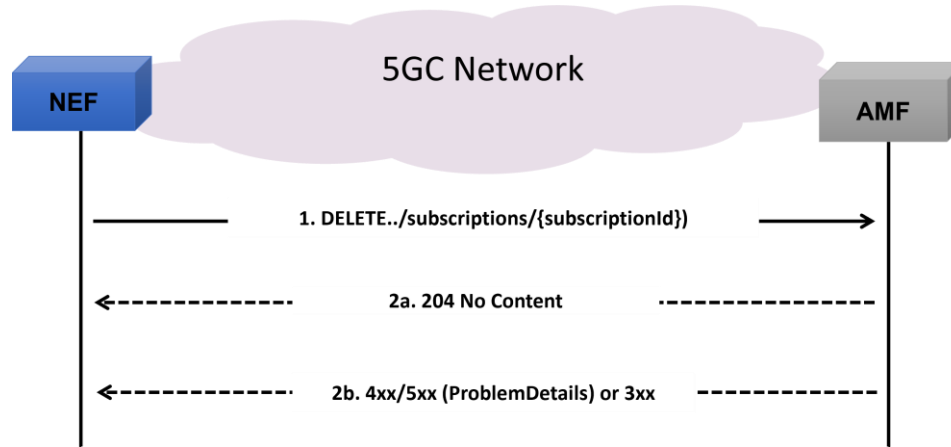
MAPS™ 5G N51 Interface Procedures

Event Notification Subscription Procedure



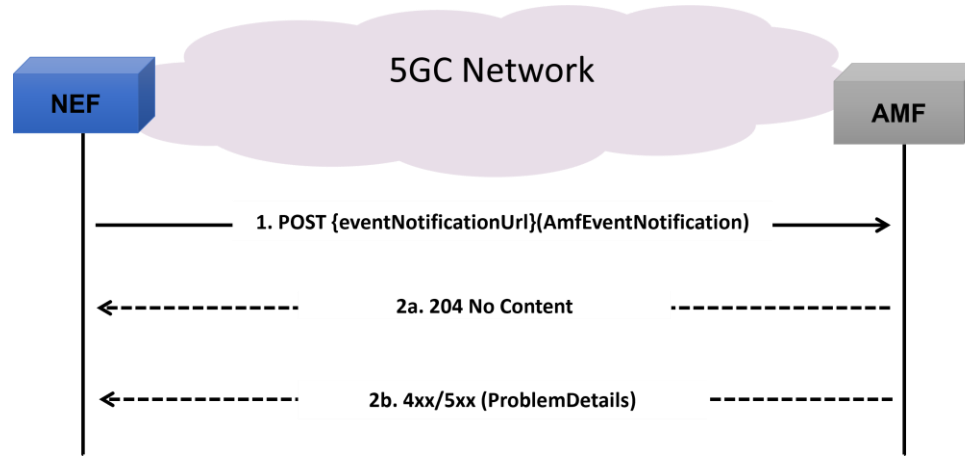
MAPS™ 5G N51 Interface Procedures (Contd.)

Unsubscribe Event Notification Procedure



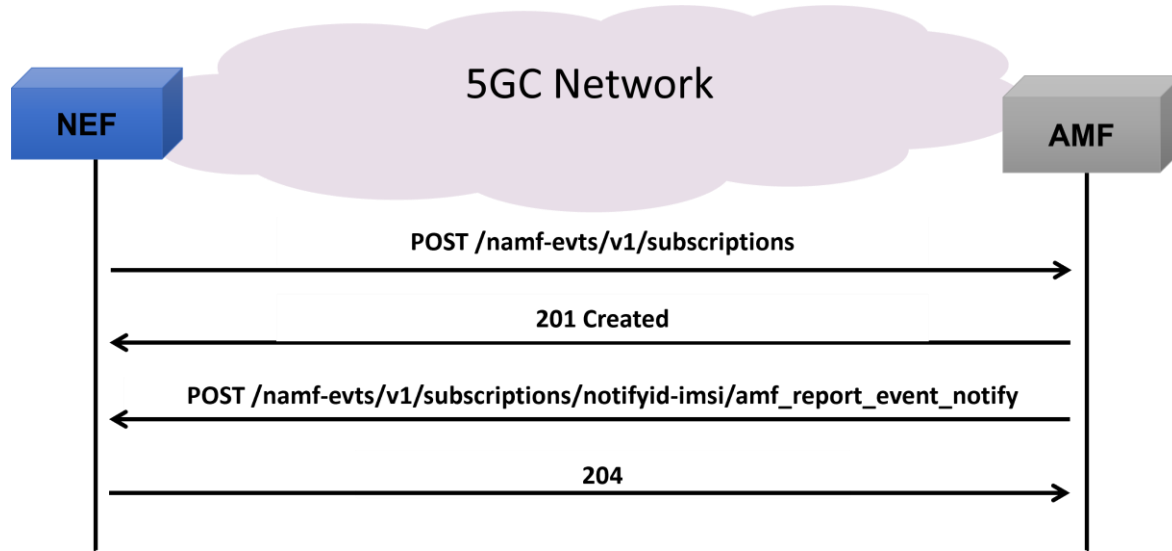
MAPS™ 5G N51 Interface Procedures (Contd.)

Event Notification Procedure

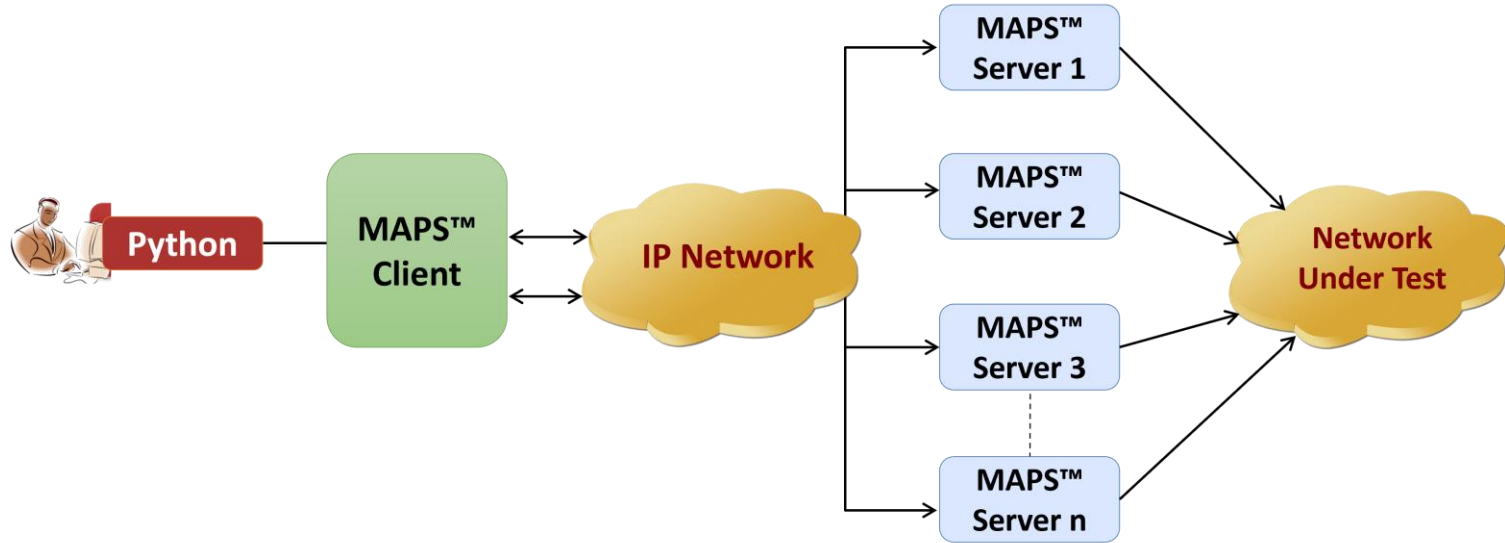


MAPS™ 5G N51 Interface Procedures (Contd.)

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/json,
application/problem+json
:content-length : 340

{
  "notifyCorrelationId":"notifyid-3012041631",
  "reportList":[{"
    "gpsi":"msisdn-3012041631",
    "pep1":"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