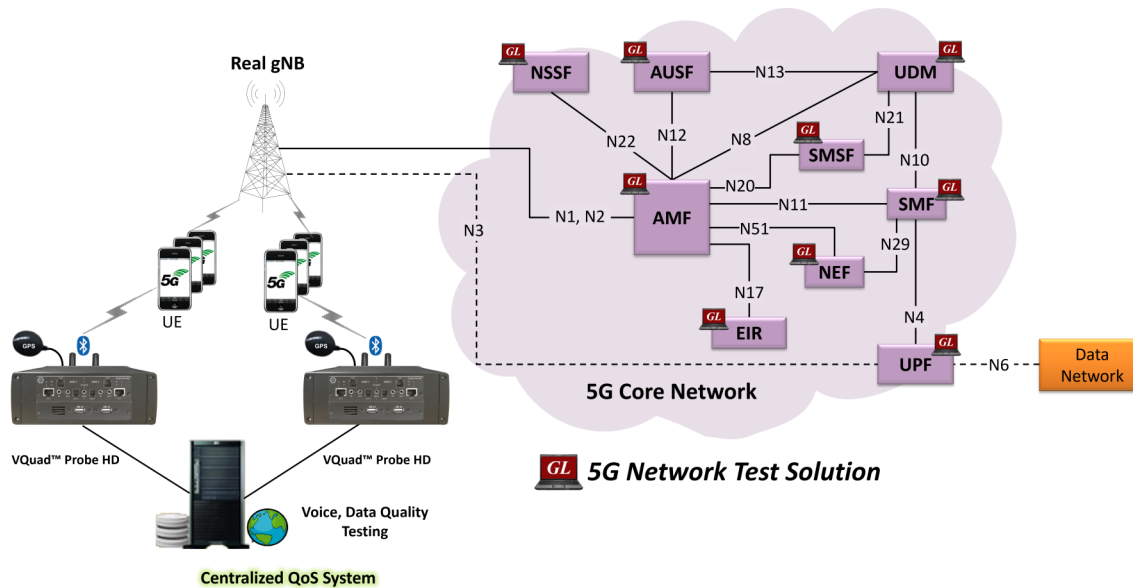




# 5G Core (5GC) Network Test Solutions

Feb 2023



- **5G Communications Network Lab**
- **5G Core Network Emulation -**

- ◆ MAPS™ 5G N1 N2 Interface Emulator
- ◆ MAPS™ 5G N4 Interface Emulator
- ◆ MAPS™ 5G N8 Interface Emulator
- ◆ MAPS™ 5G N10 Interface Emulator
- ◆ MAPS™ 5G N11 Interface Emulator
- ◆ MAPS™ 5G N12 Interface Emulator
- ◆ MAPS™ 5G N13 Interface Emulator
- ◆ MAPS™ 5G N17 Interface Emulator
- ◆ MAPS™ 5G N20 Interface Emulator
- ◆ MAPS™ 5G N21 Interface Emulator
- ◆ MAPS™ 5G N22 Interface Emulator
- ◆ MAPS™ 5G N29 Interface Emulator
- ◆ MAPS™ 5G N51 Interface Emulator

- **Monitoring 5G Core Network**
- **End-to-End Voice, and Data QoS Testing**

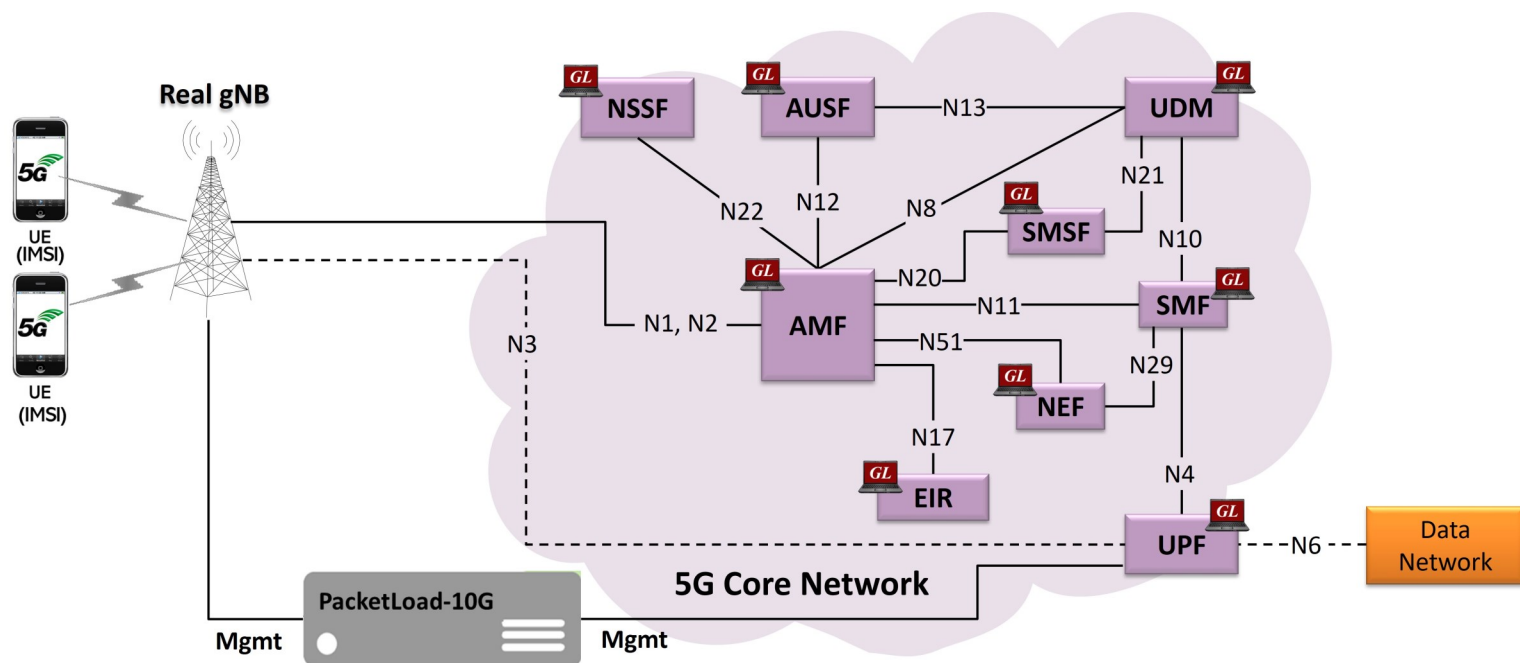
For more information, please visit [5G Core \(5GC\) Network Test Solution](#) webpage.

## GL Communications Inc.

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# 5G Core Network Emulation

## 5G Communications Network Lab



GL offers an end-to-end [5G Communication Network Lab](#) (CNL) with all components within the wireless infrastructure to emulate 5G Core and it provides an advanced full-fledged “Live Network” at premises in any customized package to suit test requirements. The test suite provides reliable integrated solutions to vendors and service providers for emulation, monitoring, troubleshooting the wireless network, including, 5G, 4G, 3G and 2G. All functionalities conform to industry standards.

MAPS™ 5GC Network emulator can emulate multiple UEs and elements such as UE+gNB, AMF, SMF, UPF, AUSF, UDM, SMSF and EIR which forms the 5GC network. The Emulator is designed to test 5G NR base stations (gNBs) and 5G Core Network Functions (NF) according to 3GPP standards. With the help of mobile phones, and other emulated wireless networks, the 5G Lab setup can be operated in real-time for making Voice over New Radio (VoNR) calls and for interworking with PSTN and VoIP networks. It includes ready-to-use scripts, as per IETF specification. Test scripts include general messaging and call flow scenarios for multimedia call session setup and control over IP networks.

GL’s MAPS™ supports emulation of 5GC network interfaces - N1N2, N4, N8, N10, N11, N12, N13, N17, N20, N21, N22, N29, N51, and other GTP interfaces.

Supported procedures include both roaming and non-roaming, including interworking between 5G System (5G RAN + 5GC) and Evolved Packet System (4G RAN + EPC), mobility within 5GS, QoS, policy control and charging, authentication and in general 5G System wide features such as SMS, Location Services, Emergency Services.

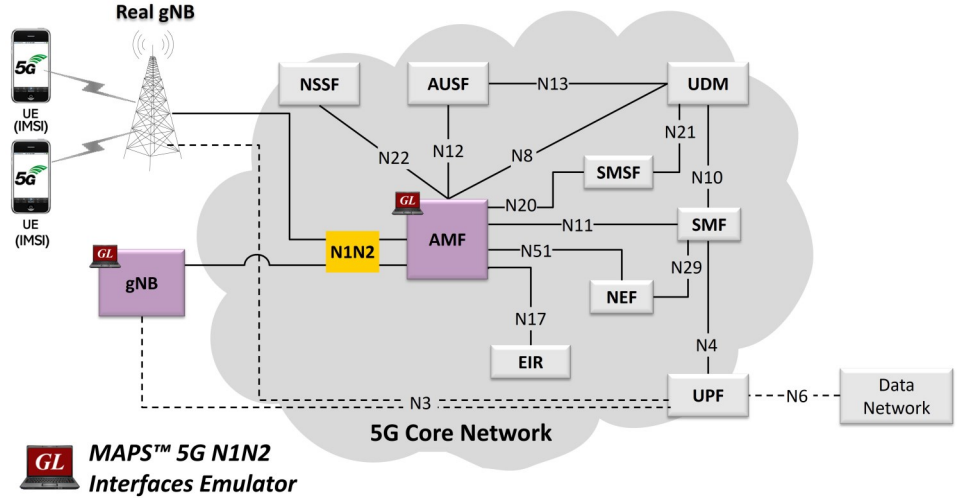
# 5G Core Network Emulation

## MAPS™ 5G N1N2 Interface Emulator

GL's Message Automation and Protocol Simulation (MAPS™) is enhanced to test 5G N1N2 interfaces, it can emulate gNodeB (gNB), and Access and Mobility Management Function (AMF) according to 3GPP standards.

It supports Non-Access-Stratum (NAS) signaling on N1 interface between UE and AMF. It supports NGAP to emulate signaling services between NG-RAN and AMF.

In addition to control plane emulation, the application supports generation and verification of traffic, including VoNR (Voice) calls with SIP signaling & RTP Traffic generation. It also emulate mobile traffic such as HTTP, FTP, Video by playing back stateful real capture over established TCP connection with additional licenses - Mobile Traffic Core – GTP (ETH101) and Mobile Traffic Core – Gateway (ETH102).



**GL MAPS™ 5G N1N2 Interfaces Emulator**

- Setup a virtual real-time scenario simulating 5G interoperability with 4G-LTE network elements
- Emulates UE+gNodeB and AMF nodes
- Supports Control plane signaling and User plane traffic
- Supported Procedures in N1 and N2 interfaces includes -

- NG Reset
- NG Setup
- Initial Context Setup
- UE Context Release
- Registration
- De-registration
- Primary authentication
- key agreement procedure
- Security mode control
- Identification

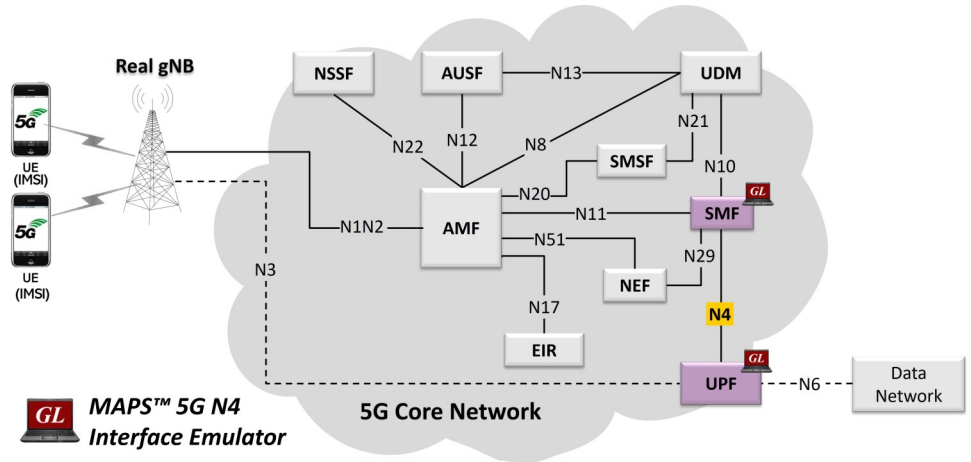
- Includes gateway functionality to forward mobile traffic over GTP to and from external IP network
- Generate and process NGAP/NAS (valid and invalid) messages
- Emulates tens of thousands of 5G subscribers (Load Testing)

**5G N1N2 interface Call Control Procedure at gNodeB Node (Call Generation)**

# 5G Core Network Emulation

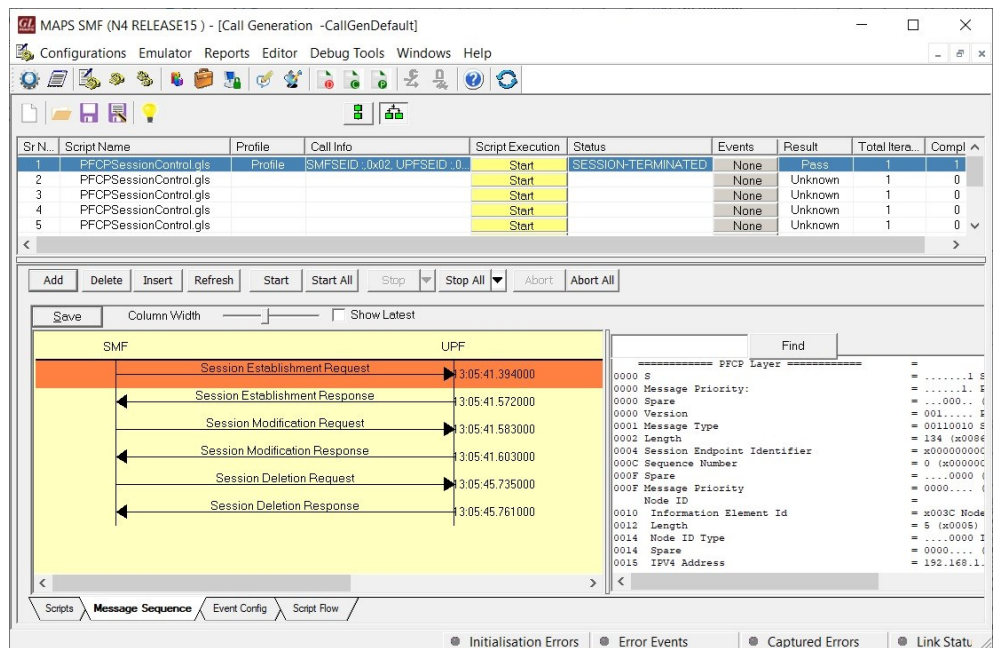
## MAPS™ 5G N4 Interface Emulator

GL's MAPS™ 5G-N4 Interface Emulator is an advanced protocol emulator for 5G emulation over N4 interface that can emulate PFCP signaling messages as defined by 3GPP standards. Packet Forwarding Control Protocol (PFCP) used on the interface between the control plane and the user plane function. As seen in the network diagram, N4 is the reference point in the control and user plane separation (CUPS) architecture.



MAPS™ 5G-N4 can emulate and test Session Management Function (SMF) and User Plane Function (UPF) elements. SMF in the 5G N4 interface is primarily concerned with managing the UE's PDU sessions. Its responsibilities include the establishment, modification, and release of the PDU sessions. UPF in the CUPS architecture is responsible for handling user data and reporting the traffic usage data to the SMF.

- Emulates Session Management Function (SMF) and User Plane Function (UPF) elements
- Supports 5G Control plane and User plane
- Supported procedures include - establishment, modification, and release of the PDU sessions
- Supported Traffic types include Mobile Traffic, Packet Traffic, and VoNR
- Generates and process PFCP (valid and invalid) messages
- Supports GTP Traffic (GTP User Plane Data), HTTP traffic generation capability
- Supports customization of call flow and message templates using Script and Message Editor
- Provides Call Statistics and Events Status
- Automation, Remote access, and Schedulers to run tests 24/7



# 5G Core Network Emulation

## MAPS™ 5G Service Based Interface Emulator

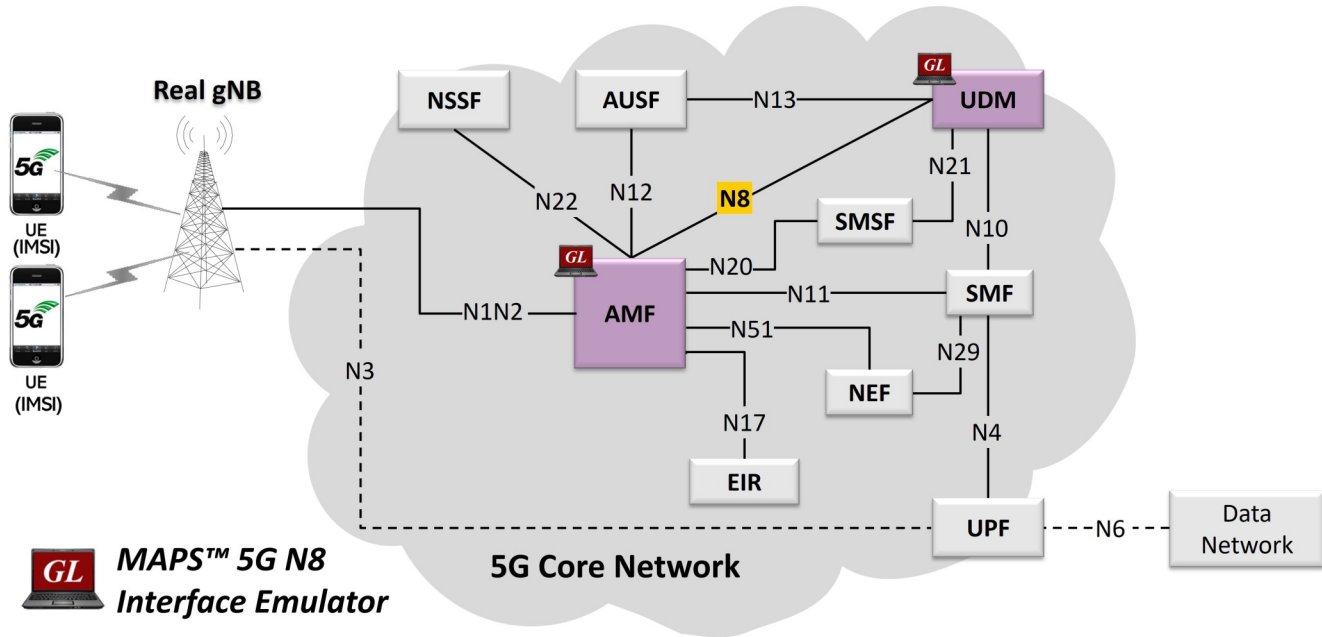
GL's MAPS™ 5G System as a Service Based Architecture, includes a set of network functions providing services as defined in 3GPP standards. The service-based interfaces use HTTP/2 protocol with JavaScript Object Notation (JSON) as the application layer serialization protocol.

### Main Features

- Services use REST APIs based on HTTP and JSON data format
- Supports TLS and TCP transport
- Supports scripted call generation and automated call reception
- Supports customization of call flow and message templates using Script Editor and JSON Messages
- Ready-to-use scripts for quick testing
- Provides Call Statistics and Events Status
- Emulates Multiple Subscribers using CSV Profiles
- Automation, Remote access, and Schedulers to run tests 24/7

# 5G Core Network Emulation

## MAPS™ 5G N8 Interface Emulator



MAPS™ 5G N8 can emulate Unified Data Management (UDM) and Access and Mobility Management Function (AMF) within the 5G Core network.

The Network Function UDM is the entity in the 5G Core Network (5GC) supports Nudm\_SubscriberDataManagement Services, Nudm\_UEContextManagement Services, Namf\_MT Service, Namf\_Location Service and Namf\_Communication services via the Nudm and Namf services-based N8 interface.

- Emulate AMF and UDM elements

The screenshot shows the MAPS AMF (N8 RELEASE 15) software interface. The top part displays a table of script execution results:

Sr No.	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterat...
1	Nudm_UECM_Control.gls	UEProfile0001	SUPI :imsi-00...	Start	AMF Registration is successful	None	Pass	1	1
2	Nudm_SDM_Control.gls	UEProfile0001	SUPI :imsi-00...	Start	default Single NSSAI's Received	None	Pass	1	1
3	Nudm_UECM_Control.gls	UEProfile0002		Start		None	Unknown	1	0

Below the table, there is a 'Message Sequence' diagram showing the interaction between AMF and UDM. The AMF sends a PUT request to the UDM, and the UDM responds with a 200 OK. The log shows the following details:

```

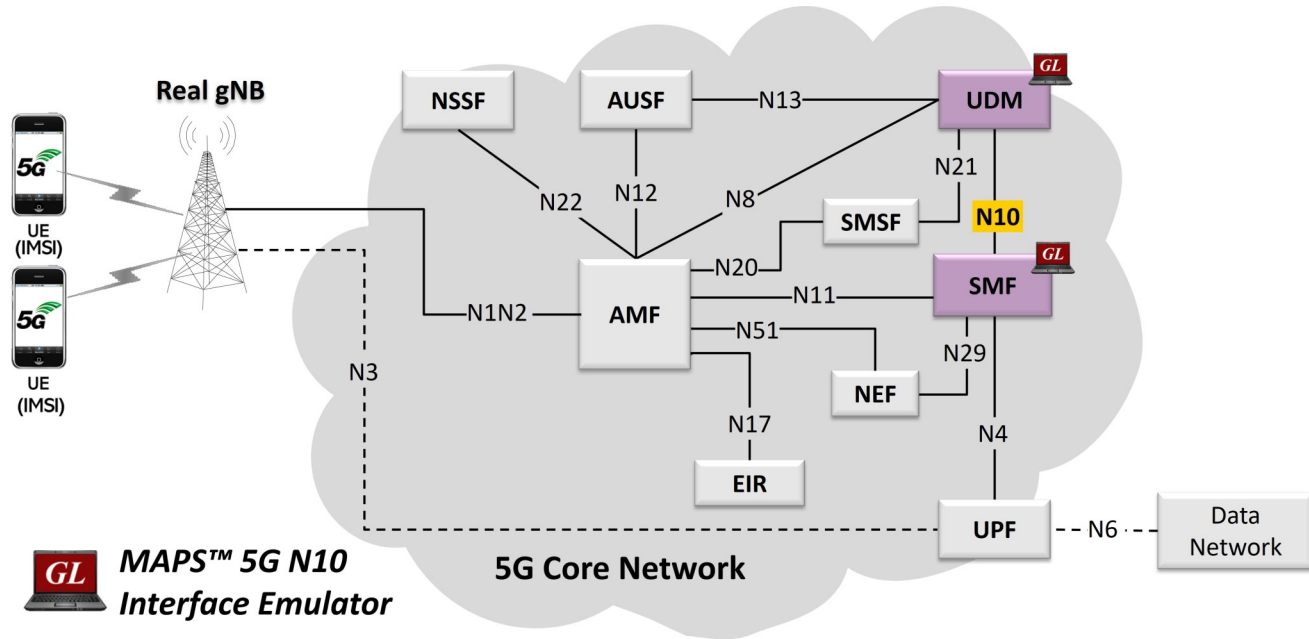
PUT http://192.168.1.20:33220/nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access
content-type : application/json
accept : application/json, application/problem+json

{
  "amfInstanceId": "ea57b649-1985-4106-a129-78ef79a12289",
  "deregCallbackUri": "http://192.168.1.20:36000/nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access",
  "guami": {
    "amfId": "2163",
    "plmnId": {
      "mcc": "001",
      "mnc": "01"
    }
  },
  "imsVoPs": "HOMOGENEOUS_SUPPORT",
}
    
```

5G N8 interface Call Generation at AMF Node

# 5G Core Network Emulation

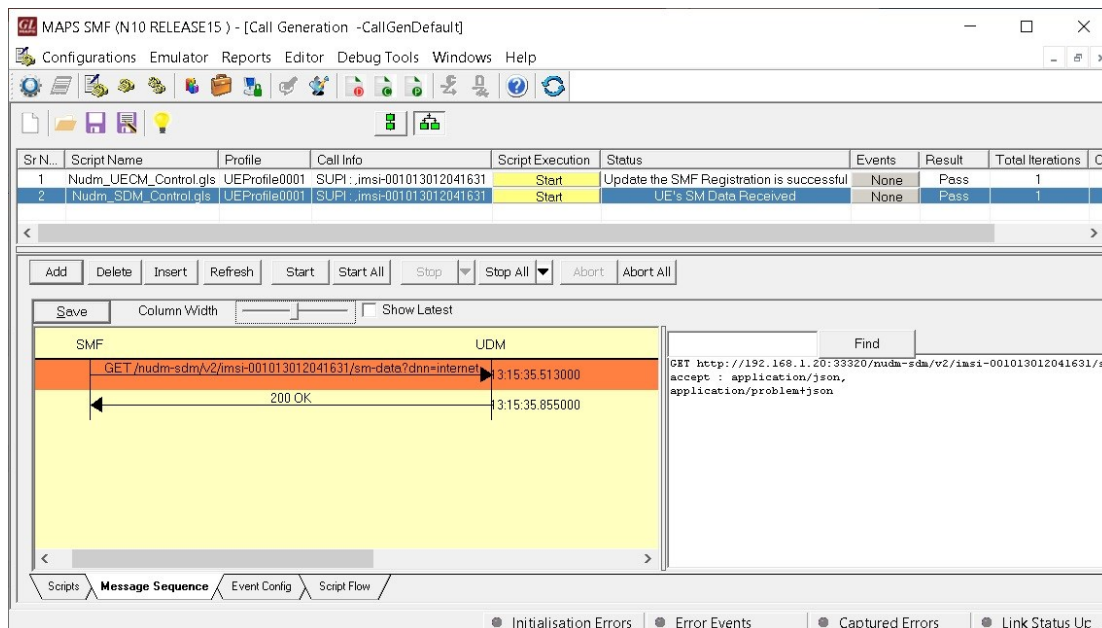
## MAPS™ 5G N10 Interface Emulator



MAPS™ 5G N10 can emulate UDM within the 5G Core offering services to the SMF via the Nudm service-based N10 interface respectively. The 5G network represents the service-based interface, with focus on N10 between UDM and SMF.

The network function UDM and SMF are the entities in 5G Core Network, which supports the following services via the Nudm service-based N10 interface respectively.

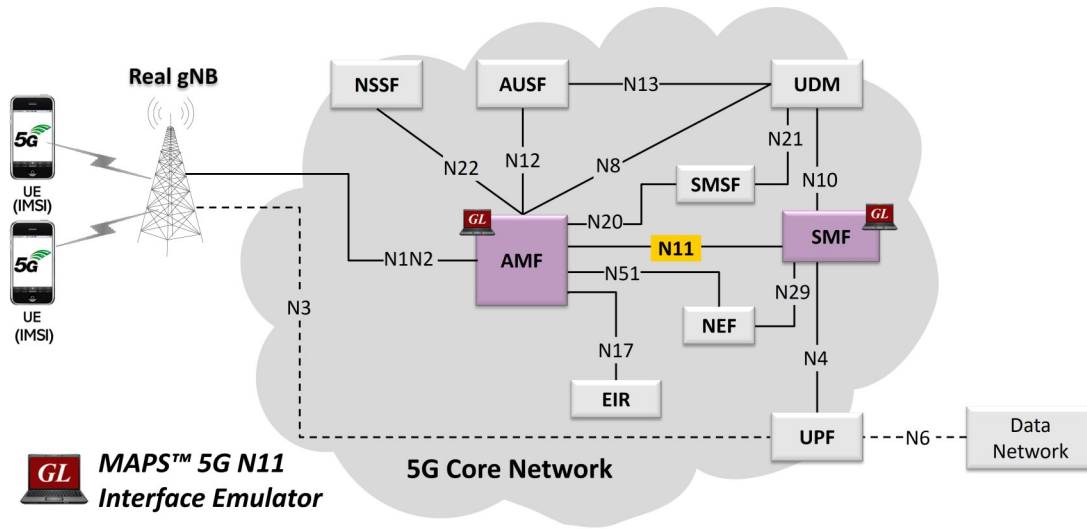
- **Nudm\_SubscriberDataManagement Services**
- **Nudm\_UEContextManagement Services:**



Emulate UDM and SMF elements 5G N10 interface Call Generation at SMF Node

# 5G Core Network Emulation

## MAPS™ 5G N11 Interface Emulator



MAPS™ 5G N11 can emulate Session Management Function (SMF) within the 5G Core offering services to the Access and Mobility Management Function (AMF) via the Nsmf service-based N11 interface. The network diagram represents the service-based interface, with focus on N11 between AMF and SMF. Here, both AMF and SMF act as "NF Producer".

The Network Function SMF and AMF are the entities in 5GC, which supports the following services via the Nsmf and Namf service-based N11 interface.

- Nsmf\_PDUSession: Create SM Context, Update SM Context, Release SM Context, Notify SM Context Status and Retrieve SM Context operations
- Namf\_Communication Service: N1N2 Message Transfer (UE Specific) operations based on N20 interface
- Emulate SMF and AMF elements

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iterations
1	Namf_Session_Control.gls	MSIN3012041631	imsi-001013012041631	Start	SM Context Released	None	Pass	1	1
2	Namf_Session_Control.gls	MSIN3012041632	imsi-001013012041632	Start	SM Context Released	None	Pass	1	1
3	Namf_Session_Control.gls	MSIN3012041633	imsi-001013012041633	Start		None	Unknown	1	0
4	Namf_Session_Control.gls	MSIN3012041634	imsi-001013012041634	Start		None	Unknown	1	0

```

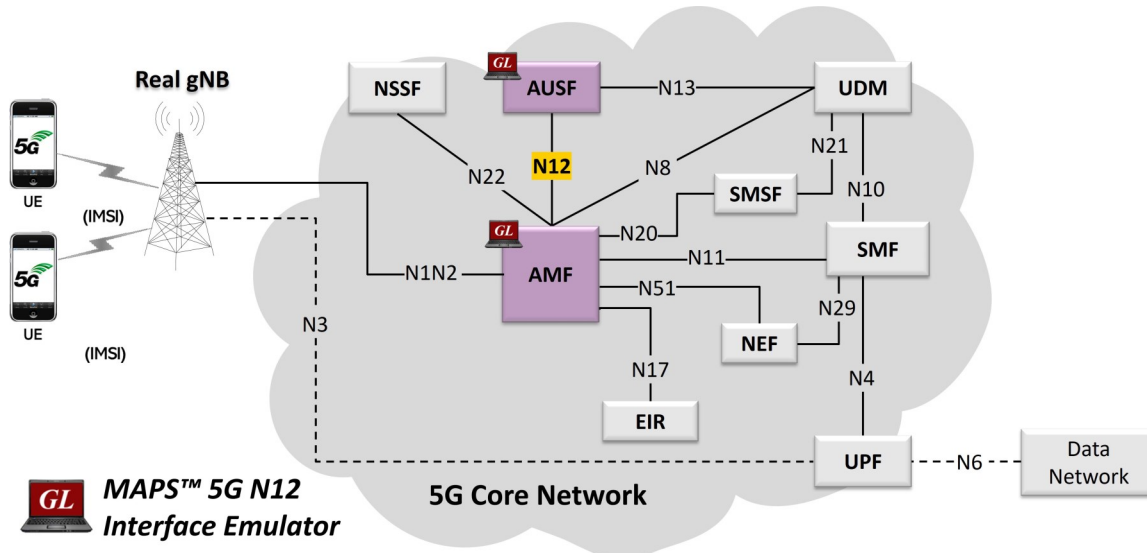
POST http://192.168.1.20:6666/nsmf-pdusession/v1/sm-contexts
accept : application/json,
application/vnd.3gpp.ngap,
application/problem+json
content-type : multipart/related; boundary=5e58f3b916a10be387c5
--5e58f3b916a10be387c5
Content-Type: application/json
{
  "anType": "3GPP_ACCESS",
  "dn": "internet",
  "gpsi": "msisdn-3012041631",
  "n1SmfMsg": {
    "contentId": "5gmas-sa"
  },
  "pduSessionId": 1,
  "pei": "imei-359877068925248",
  "ratType": "NR",
  <
  
```

5G N11 interface Call Generation at AMF Node



# 5G Core Network Emulation

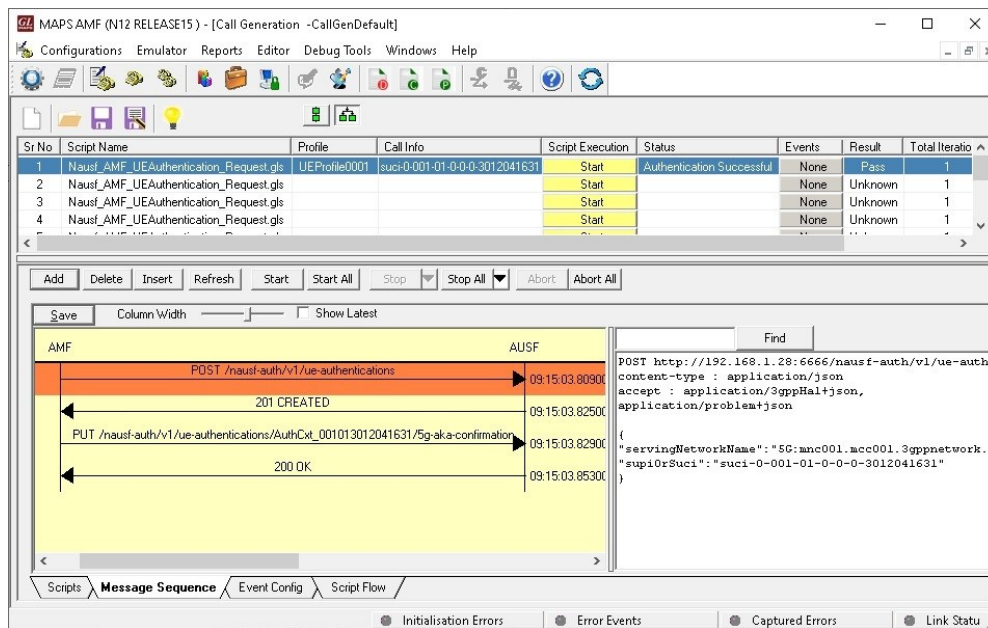
## MAPS™ 5G N12 Interface Emulator



MAPS™ N12 emulates Authentication Server Function (AUSF) within the 5G Core offering services to the Access and Mobility Management Function (AMF) via the Nausf service-based N12 interfaces. The 5G network represents the service-based interface, with focus on the AUSF and AMF. Here, AUSF act as producer.

The Network Function AUSF is the entity in the 5GC, which supports the following services via the Nausf service-based N12 interface:

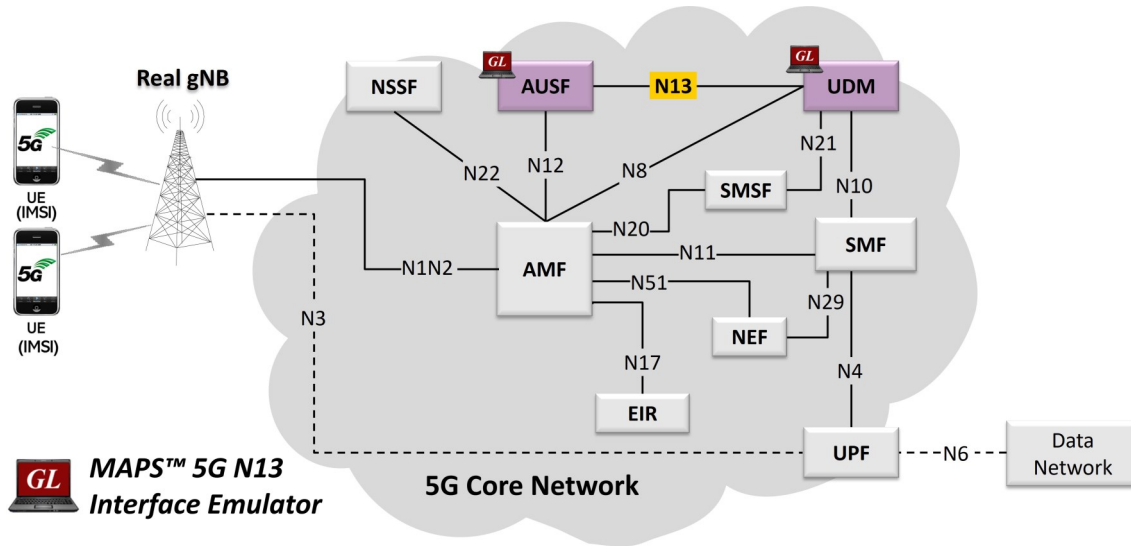
- Nausf\_UEAuthentication (Authentication and Key Agreement)
- Nausf\_SoRProtection (Steering of Roaming)
- Nausf\_UPUProtection (UE Parameters Update)
- Emulate SMF and AMF elements



5G N12 interface Call Generation at AMF Node

# 5G Core Network Emulation

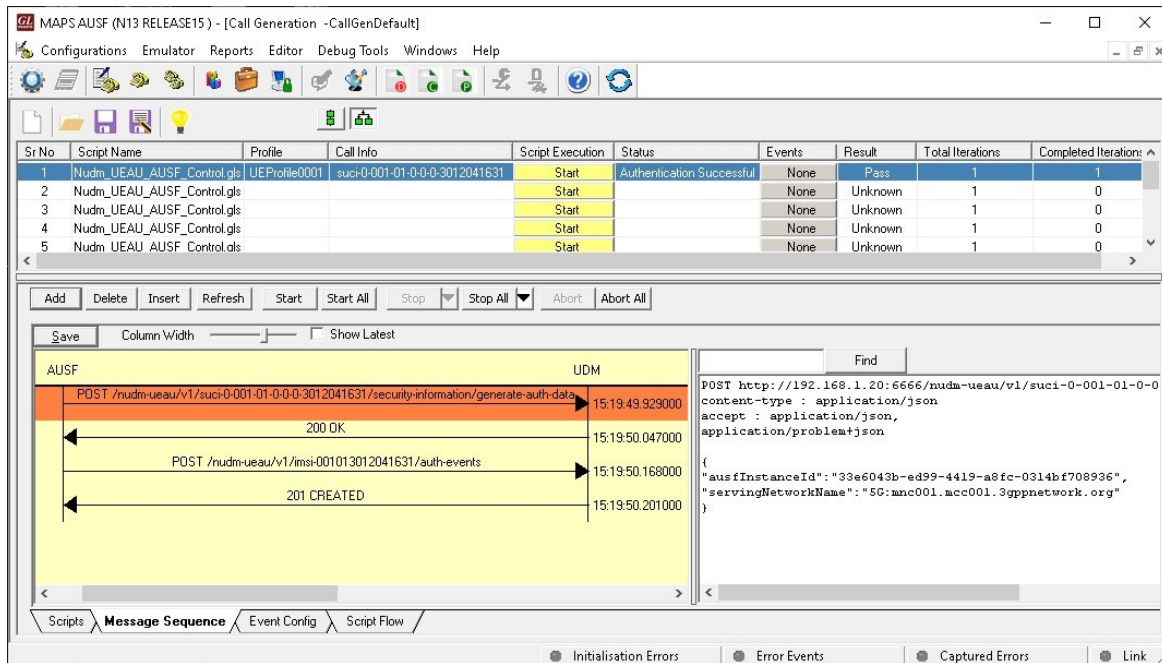
## MAPS™ 5G N13 Interface Emulator



MAPS™ 5G N13 Authentication Server Function (AUSF) within the 5G Core offering services to the User Data Management (UDM) via the Nausf and Nudm service-based N13 interface respectively. The 5G network represents the service-based interface, with focus on N13 between AUSF and UDM. Here, UDM acts as producer.

The Network Function AUSF and UDM are the entities in 5GC, which supports the following services via Nudm service-based N13 interface:

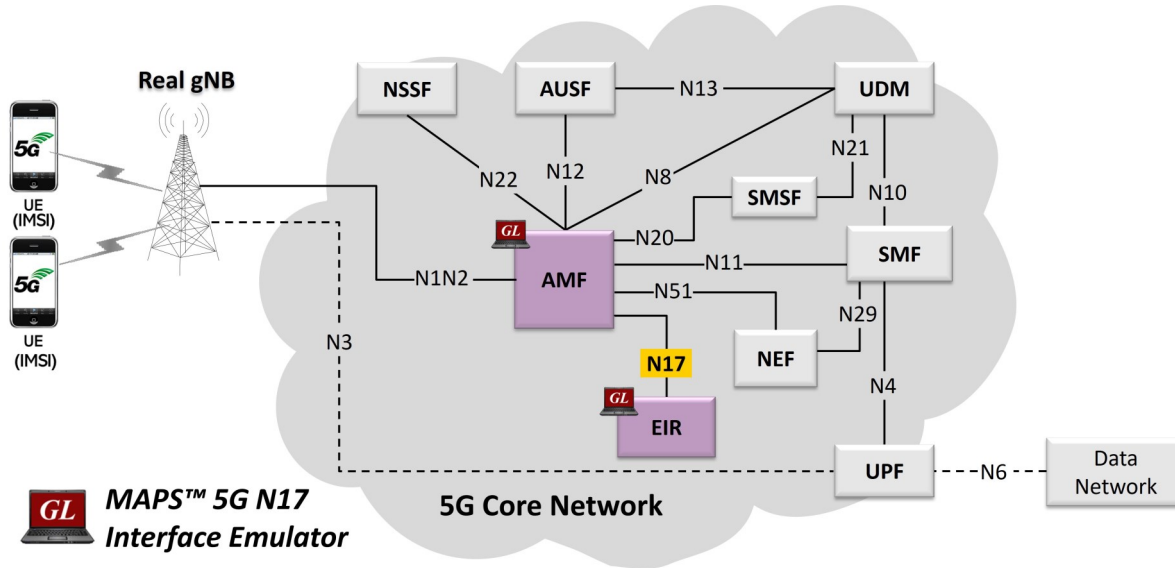
- Nudm\_UEAuthentication Services : Get and ResultConfirmation operations
- Emulate AUSF and UDM elements
- Supports Nudm\_UEAuthentication Services Procedure



5G N13 interface Call Generation at AUSF Node

# 5G Core Network Emulation

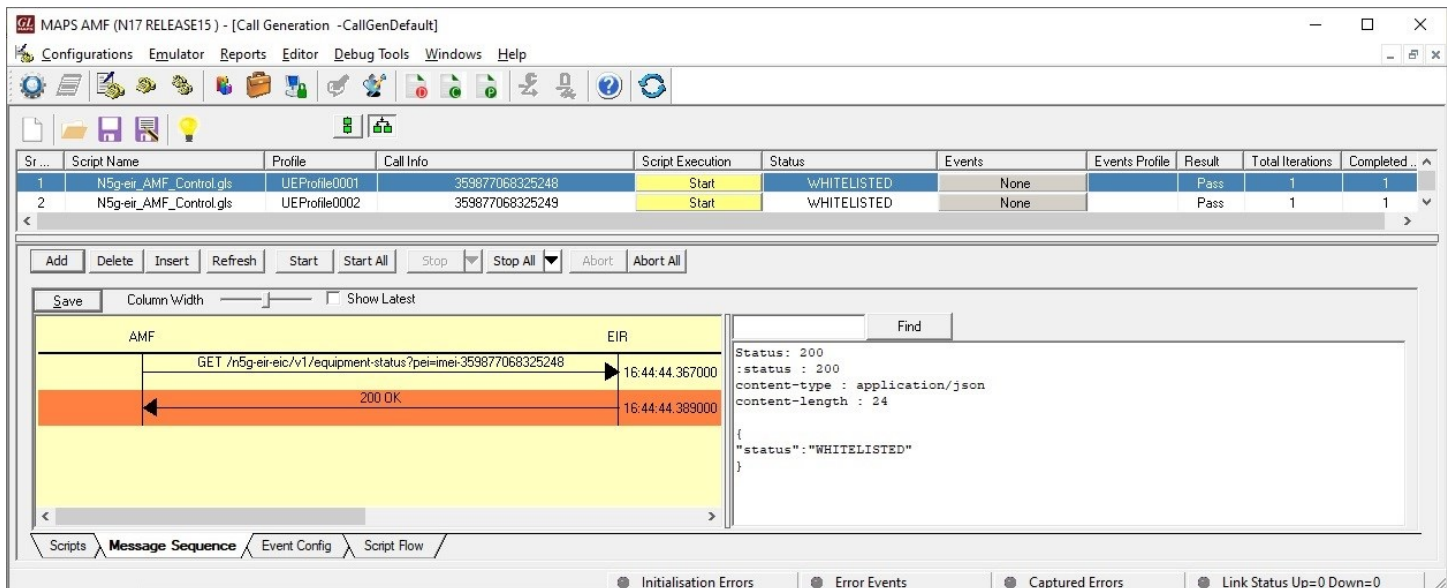
## MAPS™ 5G N17 Interface Emulator



MAPS™ 5G N17 emulate Equipment Identity Register (EIR) within the 5G core offering services to the AMF via the N5g-eir service based interface. The 5G network represents the service based interfaces, with focus on the EIR and AMF.

The EIR and AMF support N5g-eir\_EquipmentIdentityCheck Service. In N17 interface, EIR acts as NF Service Producer and AMF acts as NF Service Consumer .

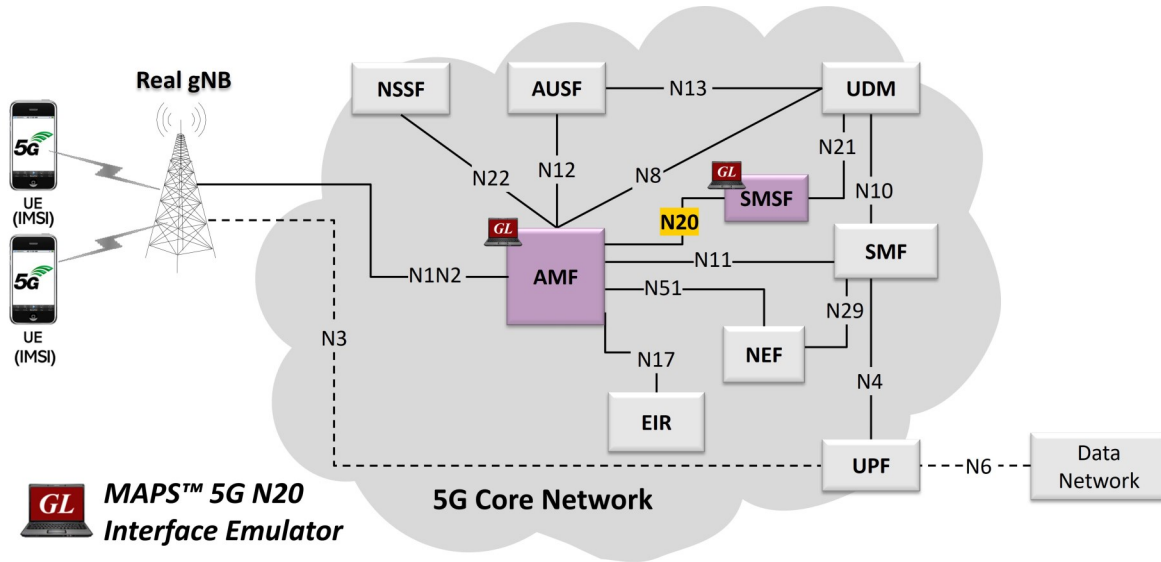
- Emulate EIR and AMF network functions
- Supports Equipment Identity services via the N5g-eir service based N17 interface



5G N17 Interface Call Generation at AMF Node

# 5G Core Network Emulation

## MAPS™ 5G N20 Interface Emulator



MAPS™ 5G N20 emulates Short Message Service Function (SMSGF) within the 5G core offering services to the AMF via the Nsmsf service-based N20 interface. The 5G network represents the service-based interfaces, with focus on the SMSGF and AMF.

- Emulate SMSGF and AMF network function.
- Supported procedures are -
  - Nsmsf\_SMSGF : Activate, Deactivate and UplinkSMS (MOSMS)
  - Namf\_Communication Service : N1N2MessageTransfer(UE Specific) operations based on N20 interface

The screenshot shows the MAPS AMF (N20 RELEASE15) software interface. The top part displays a table of call generation results:

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Itm
1	Nsmsf_AMF_SMSGF_Activation.gls	MSIN3012041631	imsi-001013012041631	Start	SMSGF Activation Successful	None	Pass	1
2	Nsmsf_AMF_SMSGF_Deactivation.gls	MSIN3012041631	imsi-001013012041631	Start	SMSGF Deactivation Successful	None	Pass	1
3	Nsmsf_AMF_Mo_SMS.gls	MSIN3012041631	imsi-001013012041631	Start	SMSGF Submit Report acknowledged	None	Pass	1

Below the table, there is a 'Message Sequence' diagram showing the interaction between the AMF and SMSGF. The diagram shows a PUT request from the AMF to the SMSGF at 17:06:45.430000, followed by a 204 NO-CONTENT response from the SMSGF to the AMF at 17:06:45.447000.

The right side of the interface shows the raw HTTP request and response:

```

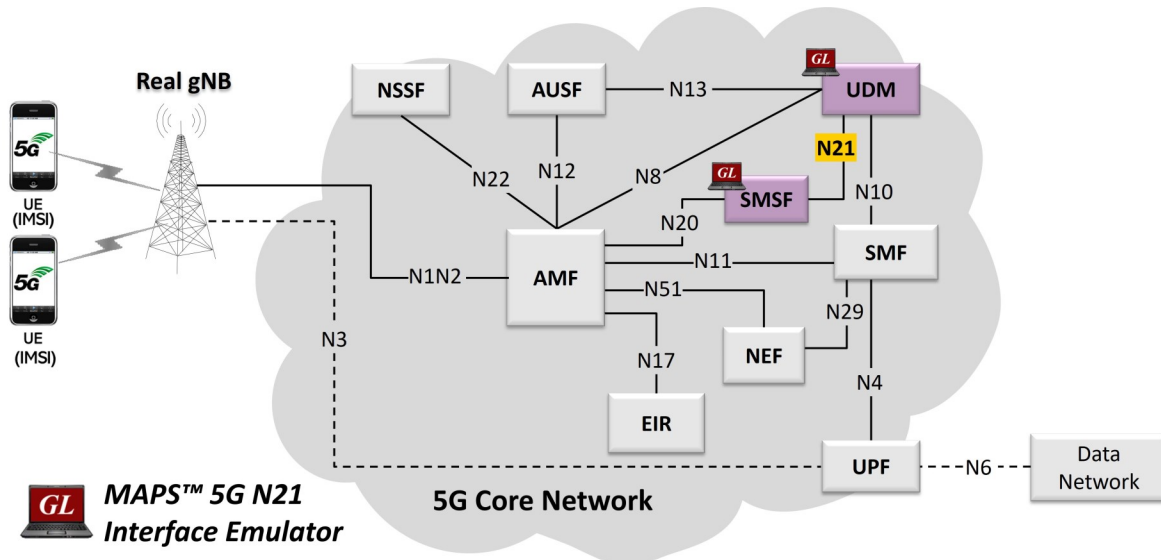
PUT http://192.168.1.20:33260/nsmsf-sms/v2/ue-contexts/imsi-001013012041631
content-type : application/json
accept : application/json, application/problem+json

{
  "accessType": "3GPP_ACCESS",
  "amfId": "eebcf540-de47-4cbe-9da9-1b500e0caded",
  "ratType": "NR",
  "supi": "imsi-001013012041631"
}
    
```

5G N20 interface Call Generation at AMF Node

# 5G Core Network Emulation

## MAPS™ 5G N21 Interface Emulator



MAPS™ 5G N21 emulates Unified Data Management (UDM) within the 5G Core offering services to the Short Message Service Function (SMSF) via the Nudm service-based N21 interface respectively. The 5G network represents the service-based interface, with focus on N21 between UDM and SMSF. Here UDM node can act as "NF Producer".

The SMSF and UDM are the entities in 5G Core Network, which supports the following services .

- Nudm\_UEContextManagement Service
- Nudm\_SubscriberDataManagement Service
- Emulates Short Message Service Function and Unified Data Management (UDM) elements

The screenshot shows the MAPS SMSF (N21 RELEASE15) interface. The top part displays a table of script execution results:

Sr...	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed...
1	Nudm_UECM_Control.gjs	UEProfile0001	SUPI : .imsi-001013012041631	Start	SMSF Registration for 3GPP access is successful	None		Pass	1	1
2	Nudm_SDM_Control.gjs	UEProfile0001		Start		None		Unknown	1	0

The bottom part shows a message sequence diagram between SMSF and UDM. A PUT request is sent from SMSF to UDM with the URL `PUT /nudm-uecm/v1/imsi-001013012041631/registrations/smsf:3gpp-access` at 12:58:07.957000. The response is 201 CREATED at 12:58:08.068000. The response body is:

```

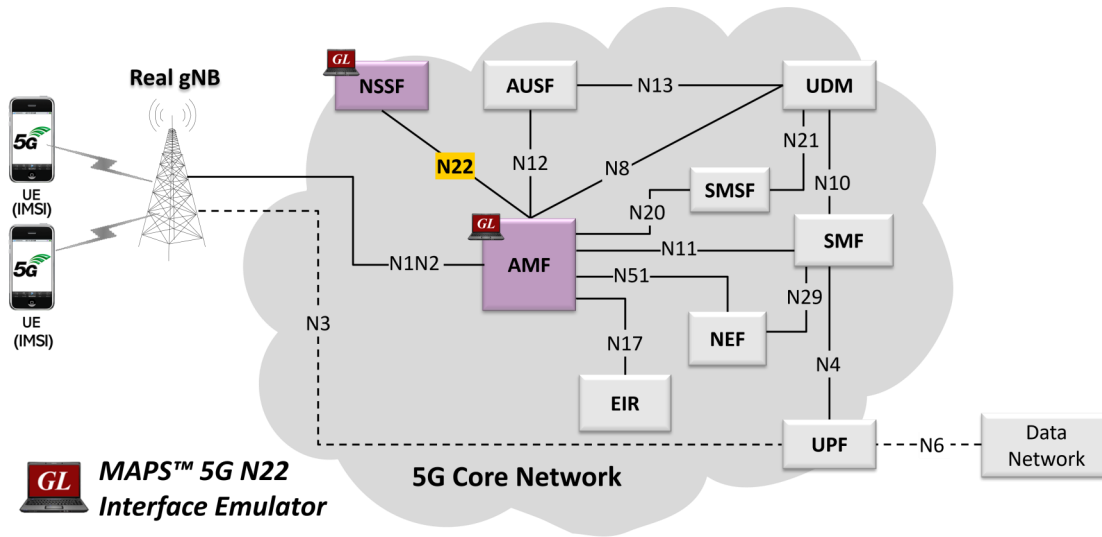
{
  "plmnId": {
    "mcc": "001",
    "mnc": "01"
  },
  "smsfInstanceId": "2adbbe9a-be79-4bc7-a47d-1dc094fb54d5",
  "supportedFeatures": "0"
}

```

5G N21 interface Call Generation at SMSF Node

# 5G Core Network Emulation

## MAPS™ 5G N22 Interface Emulator



MAPS™ N22 emulate Network Slice Selection Function (NSSF) within the 5G Core offering services to the Access and Mobility Management Function (AMF) via the Nnssf service-based N22 interface. The above network architecture represents the servicebased architecture, with focus on N22 between NSSF and AMF. Here, node NSSF can act as "NF Producer".

The AMF and NSSF are the entities in 5G Core Network (5GC), which supports the following services .

- Nnssf\_NSSelection
- Nnssf\_NSSAIAvailability
- Emulates Short Message Service Function and Unified Data Management (UDM) elements

Sr No	Script Name	Profile	Call Info	Script Execution	Status	Events	Result	Total Iterations	Completed Iteratio
1	Nnssf_AMF_NSSelection_Get_Request_Registration.gls	UEProfile0001	01878504-b35f-4a8f-a-	Start	Slice Selected for Registration	None	Pass	1	1
2	Nnssf_AMF_NSSelection_Get_Request_PDUSession.gls	UEProfile0001		Start		None	Unknown	1	0
3	Nnssf_AMF_NSSAIAvailabilityPut_Request.gls	UEProfile0001		Start		None	Unknown	1	0

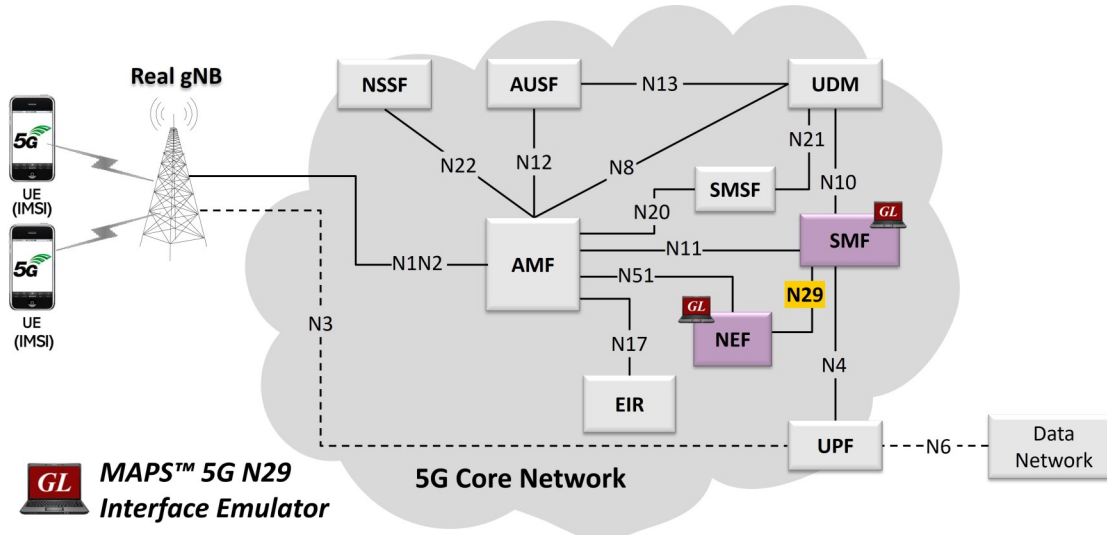
```

GET http://192.168.1.20:6666/nnssf-nssselection/v2/network-slice-information?
"mcc":"10",
"mnc":"100"
}&nf-Id=0f87850d-b35f-4a8f-a429-5be1e9931248&nf-type=AMF&requestedNssai={
"sd":"04",
"sst":1
}&slice-info-request-for-registration={
"subscribedNssai":{
"defaultIndication":true,
"subscribedNssai":{
"sd":"01",
"sst":1
}
}
}
accept : application/json,
application/problem+json
    
```

5G N21 interface Call Generation at SMSF Node

# 5G Core Network Emulation

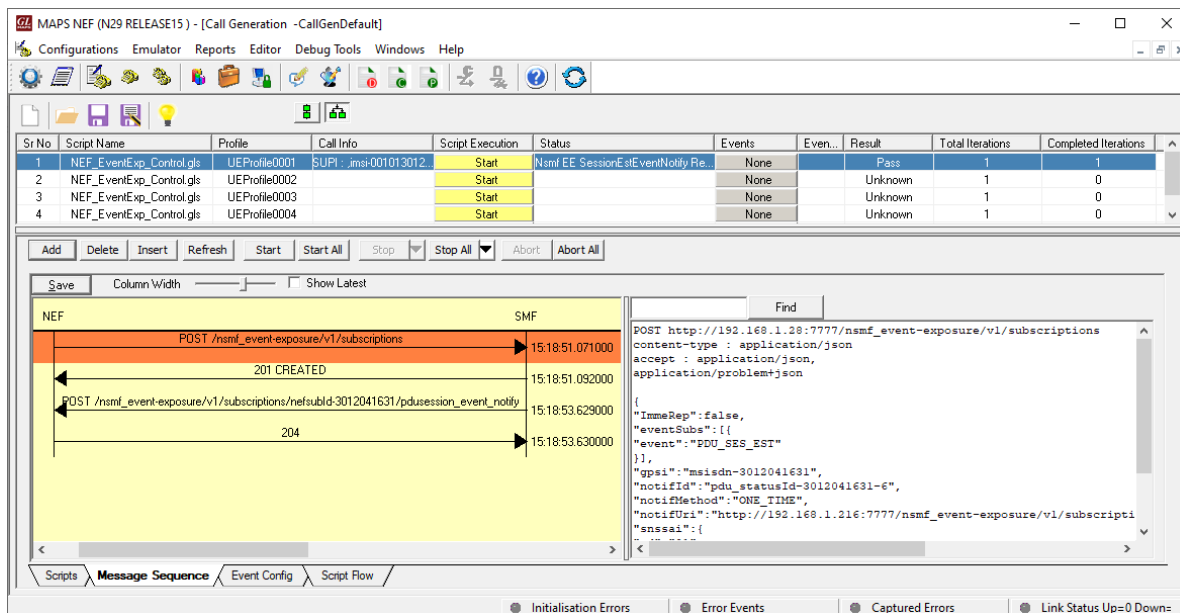
## MAPS™ 5G N29 Interface Emulator



MAPS™ 5G N29 Interface emulate Network Exposure Function (NEF) within the 5G Core offering services to the Session Management Function (SMF) via the Nsmf service-based N29 interface. The above network architecture represents the servicebased architecture, with focus on N29 between NEF and SMF. Here, node NEF can act as "NF Producer".

The NEF and SMF are the entities in 5G Core Network (5GC), which supports the following services

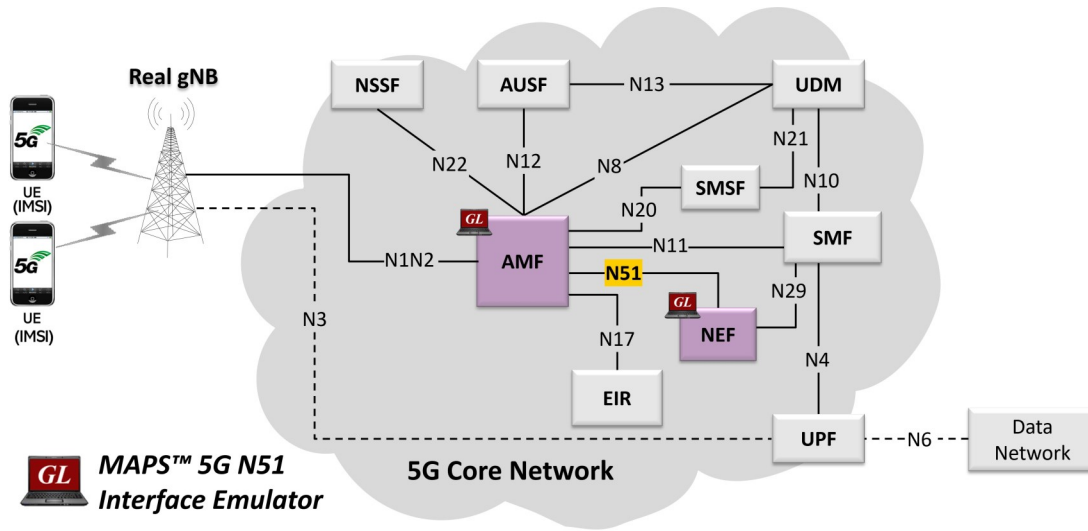
- UE Subscription for notification for one time event detection
  - PDU session release Event
  - QFI allocation Event
  - UE IP address/prefix change Event



5G N29 interface Call Generation at NEF Node

# 5G Core Network Emulation

## MAPS™ 5G N51 Interface Emulator



MAPS™ 5G N51 emulate Network Exposure Function (NEF) within the 5G Core offering services to the Access and Mobility Management Function (AMF) via the Namf service-based N51 interface. The above network architecture represents the servicebased architecture, with focus on N51 between NEF and AMF. Here, node NEF can act as "NF Producer".

The NEF and AMF are the entities in 5G Core Network (5GC), which supports the following services

- UE Subscription for notification for one time event detection
  - Registration State Change Event
  - Connection State Change Event
  - Location Report Event
  - Presence In Area of Interest Event

Sl.	Script Name	Profile	Call Info	Script Execution	Status	Events	Events Profile	Result	Total Iterations	Completed Iterations
1	Client_Connection.gls			Start		None		Unknown	1	0
2	NEF_EventExp_Control.gls	UEProfile0001	SUPI:imsi-001013012041631	Namf_EE_SessionEstablishmentResponseSent	Pass	None		Unknown	1	1
3	NEF_EventExp_Control.gls			Start		None		Unknown	1	0
4	NEF_EventExp_Control.gls			Start		None		Unknown	1	0
5	NEF_EventExp_Control.gls			Start		None		Unknown	1	0
6	NEF_EventExp_Control.gls			Start		None		Unknown	1	0
7	NEF_EventExp_Control.gls			Start		None		Unknown	1	0
8	NEF_EventExp_Control.gls			Start		None		Unknown	1	0

**Message Sequence Diagram:**

```

sequenceDiagram
    participant NEF
    participant AMF
    Note over NEF: POST /namf-evt/v1/subscriptions
    NEF->>AMF: POST /namf-evt/v1/subscriptions
    Note over AMF: 14:19:11.593000
    AMF-->>NEF: 201 CREATED
    Note over AMF: 14:19:11.842000
    Note over NEF: POST /namf-evt/v1/subscriptions/notifyid-3012041631/amf_report_event_notify
    NEF->>AMF: POST /namf-evt/v1/subscriptions/notifyid-3012041631/amf_report_event_notify
    Note over AMF: 14:19:13.899000
    AMF-->>NEF: 204
    Note over AMF: 14:19:13.901000
    
```

**JSON Payload:**

```

POST http://192.168.1.31:6666/namf-evt/v1/subscriptions
content-type: application/json
accept: application/problem+json

{
  "subscription": {
    "eventList": [
      {
        "immediateFlag": false,
        "type": "REGISTRATION_STATE_REPORT"
      }
    ],
    "eventNotifyUri": "http://192.168.1.31:6666/namf-evt/v1/subscriptions/notifyid-3012041631",
    "notifyCorrelationId": "notifyid-3012041631",
    "options": {
      "trigger": "ONE_TIME"
    }
  },
  "supi": "imsi-001013012041631"
}
    
```

5G N51 interface Call Generation at NEF Node



# 5G Core Network Monitoring & Diagnosis

The screenshot shows the PacketScan (IpProt) 64-bit software interface. The top window displays a table of captured packets with columns for Device, Frame#, TIME (Relative), Length (Bytes), Error, Length/Protocol Type MAC, Packet Type MAC, Source IP Address IP, Destination IP Address IP, and Source U. The table shows several packets, with the last one (Frame# 32) selected. Below the table, the detailed view of the selected packet is shown, including fields like Extensibility Marker, Contents, NAS Layer, Extended Protocol Discriminator, Security Header Type, Message Type (Registration Request), and various registration parameters like Registration Type, Follow-On Request, NAS Key Set Identifier, Type of Security Context Flag (TSC), and SUPI Format.

Device	Frame#	TIME (Relative)	Length (Bytes)	Error	Length/Protocol Type MAC	Packet Type MAC	Source IP Address IP	Destination IP Address IP	Source U
✓ 0	27	00:01:03.055829	78		Internet IPI(Pv4)		192.168.12.205	192.168.12.90	
✓ 0	28	00:01:03.059762	78		Internet IPI(Pv4)		192.168.12.205	192.168.12.90	
✓ 0	29	00:01:03.061048	78		Internet IPI(Pv4)		192.168.12.90	192.168.12.205	
✓ 0	30	00:01:04.047791	174		Internet IPI(Pv4)		192.168.12.205	192.168.12.90	
✓ 0	31	00:01:04.062544	62		Internet IPI(Pv4)		192.168.12.90	192.168.12.205	
✓ 0	32	00:01:04.412270	130		Internet IPI(Pv4)		192.168.12.90	192.168.12.205	

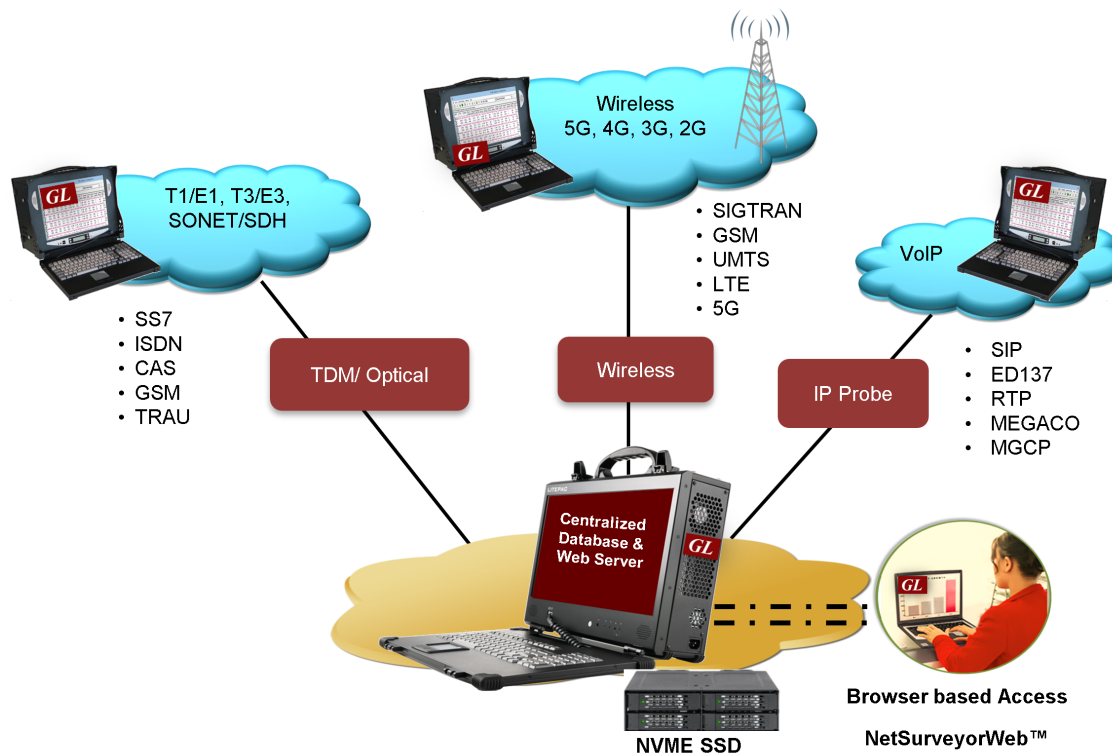
0051 Extended Protocol Discriminator = 01111110 SGS Mobility Management Messages  
0052 Security Header Type = 00000000 Plain NAS message, not security protected  
0053 Message Type = 01000001 Registration Request  
SGS Registration Type and NAS Key Set Identifier =  
0054 Registration Type = 00000001 Initial Registration  
0054 Follow-On Request = 00000000 No follow-on Request Pending  
0054 NAS Key Set Identifier = 01111111 (?)  
0054 Type of Security Context Flag (TSC) = 00000000 Native security context (for KSIAMF)  
SGS Mobile Identity  
0055 Length = 19 (x0013)  
0057 Type of Identity = 00000001 SUCI  
0057 SUPI Format = 00000000 IMSI  
MCC = 001  
MNC = 01e  
Routing Indicator Digit = 1111  
Protection Scheme Identifier = 00000000 Null scheme  
Home Network Public Key Identifier = 0 (x00)

## 5G Network Call Capture

GL's [PacketScan™ - an All-IP Network Monitoring](#) software offers powerful features to capture and monitor live signaling and traffic over IP. [PacketScan™](#) with Voice, Data, and Video QoS capability addresses customers long felt need of call quality analysis in IP networks.

- Capable of capture, decode and perform various test measurements between any two nodes across various interfaces of the 5G network
  - Support for wide-range of codecs, including AMR and AMR WB – visit [Voice Codec](#) webpage for more details.
  - Supports QoS parameters such as E-model (G.107) based MOS/R-Factor scores, Media Delivery Index (Delay Factor: Media Loss Rate) for video calls, Jitter, Delay, and Gap for Audio and Video traffic
  - Segregates, captures, and collects statistics on VoIP and Wireless calls
  - Live monitoring of traffic statistics - digits, tones, voice, video, and T.38 fax over IPv4 and IPv6 (version 4 and version 6) networks
  - Monitors QoS (quality of service) on voice and video calls
  - Supports both real-time and offline analysis
  - Trace files for analysis can be loaded through simple command-line arguments
  - Decode and analyze N1N2 and N4 protocol stack
  - Test gNodeB or UE over N1, N2, N4, N8, N10, N11, N12, N13, N17, N20, and N21 interfaces of 5G network
  - The protocols supported for decoding across all these interfaces are NAS, NGAP, GTP-U, SCTP, UDP, TCP, and IP
- High-Density Packet Monitoring Tool (**PacketScan™ HD**): [PacketScan™ HD](#) is a high density multi-protocol VoIP monitoring, reporting and diagnostic network monitoring appliance. It can capture and process high volumes of communication protocols over IP and Wireless at 1GigE (PKV120) and 10GigE (PKV122) data rates. Visit [PacketScan™ for Wireless Networks](#) webpage for more details.

# 5G Core Network Monitoring & Diagnosis



## NetSurveyorWeb™ - Centralized System

GL's [NetSurveyorWeb™ \(PKV170\)](#) is a centralized web-based client that facilitates display of call data records and call summary using a web interface based on a scalable and flexible architecture. It is used in conjunction with GL's LTE Protocol Analyzer and IMS Protocol Analyzer probes to non-intrusively monitor the entire network from a central remote testing location.

GL's 5G Protocol Analyzers have unlimited ability to capture, decode, and measure KPIs. The analyzers support decoding of all 5G protocols. GL's 5G protocol analysis probes feed data to centralized database (Oracle) in real-time for further analysis. The probes provide instant visibility into the performance with extensive KPIs, and also the operation of nodes in 5G networks.

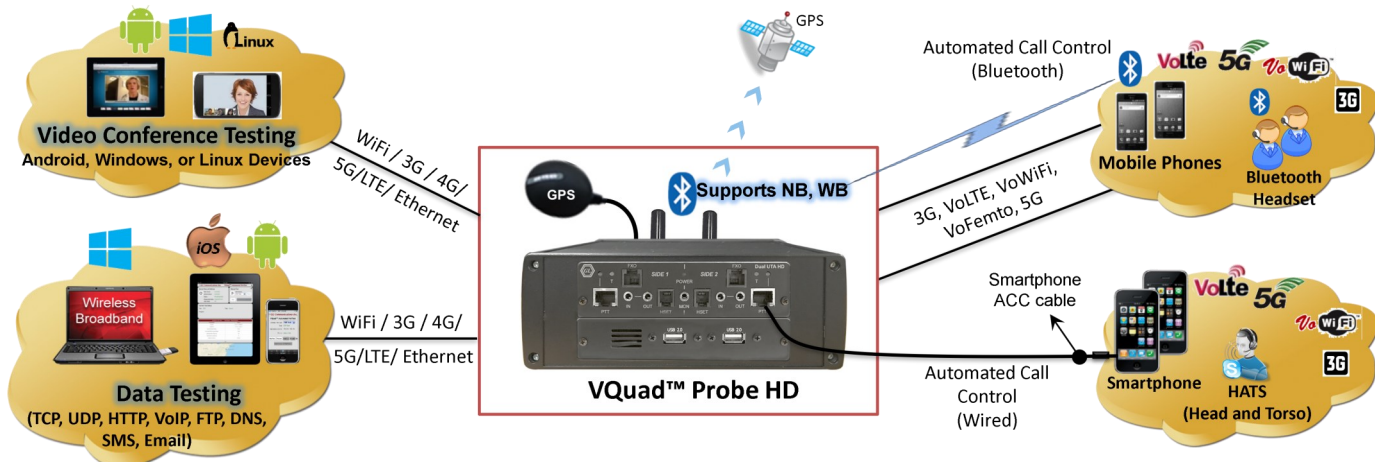
For more information, refer to [NetSurveyorWeb™ - Centralized System](#) webpage.

## NetSurveyorWeb™ Lite - Distributed Probe Level System

[NetSurveyorWeb™ Lite](#) (PKV169) is an integrated and a cost-effective monitoring system that works at the probe-level as an add-on tool with all real-time Protocol Analyzers. It is a web-based client that allows to view historical and real-time call data records. It enhances the capabilities of protocol analyzer to process large volumes of calls, filter for specific calls, build custom statistics and KPIs, automation and graphical features to analyze the call detail records (CDRs).

For more information on Lite version, refer to [NetSurveyorWeb™ Lite System](#) webpage.

# End-to-End Voice, Data QoS Testing



Using GL's [VQuad™](#) with the [Dual UTA HD](#), or all-in-one [VQuad™ Probe HD](#), along with centralized analytical tools, voice as well as data quality can be tested simultaneously on a wireless or wired network.

Since the GL's [VQuad™](#) solution is network independent, all Voice and Data networks are supported including **3G**, **WiMax**, **4G LTE**, **Advanced LTE** and the **5G**.

GL's [VQuad™ NetTest](#) solution provides automated data testing on Mobile Devices (Android and Apple) as well as PC based internet connections. The Data Testing includes TCP, UDP, HTTP, FTP, DNS, VoIP, SMS, and Email tests.

GL's Voice Quality Testing ([VQT](#)) supports automated voice quality between any two nodes within the network using latest ITU based algorithms including Perceptual Objective Listening Quality - POLQA (ITU-P.863) and PESQ (ITU-P.862). The POLQA algorithm is specifically used for testing Wideband voice networks.

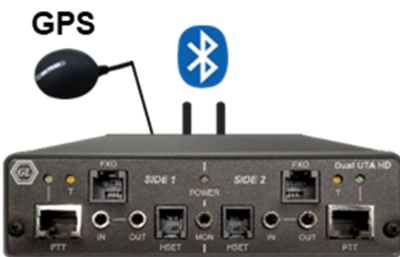
Visit [Complete Voice and Data Quality](#) webpage for more details.

## 5G Network Voice, & Data Quality Testing



**VQuad™ Probe HD**

**Supports NB, WB**



**Dual UTA HD unit**

[VQuad™ Probe HD](#) is a self-contained unit used to objectively evaluate Signal Strength, Voice, & Data Quality on Cellular networks (5G, 4G VoLTE, 3G, 2G), Land Mobile Radios, and Wired networks.

It includes VQuad™ software, Dual Universal Telephone Adapter (Dual UTA HD), and NUC in a portable platform. VQuad™ Probe HD can connect to practically any end-point, wired or wireless devices, independent of underlying network type.

Various associated analytical applications (Voice Quality, Data tests, Echo and Delay tests, Fax tests, Voice Band Analysis) work with the base VQuad™ software to provide "end-to-end assessment" of the network performance.

GL's Voice Quality Testing (VQT) supports automated voice quality between using - POLQA (ITU-P.863) and PESQ (ITU-P.862). The POLQA algorithm is specifically used for testing Wideband 5G networks.

GL's VQuad™ NetTest solution supports egress/ingress Data analysis along with Voice Quality Testing and GPS.