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# PacketScan™ 5G Protocol Analyzer

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***GL Communications Inc.***

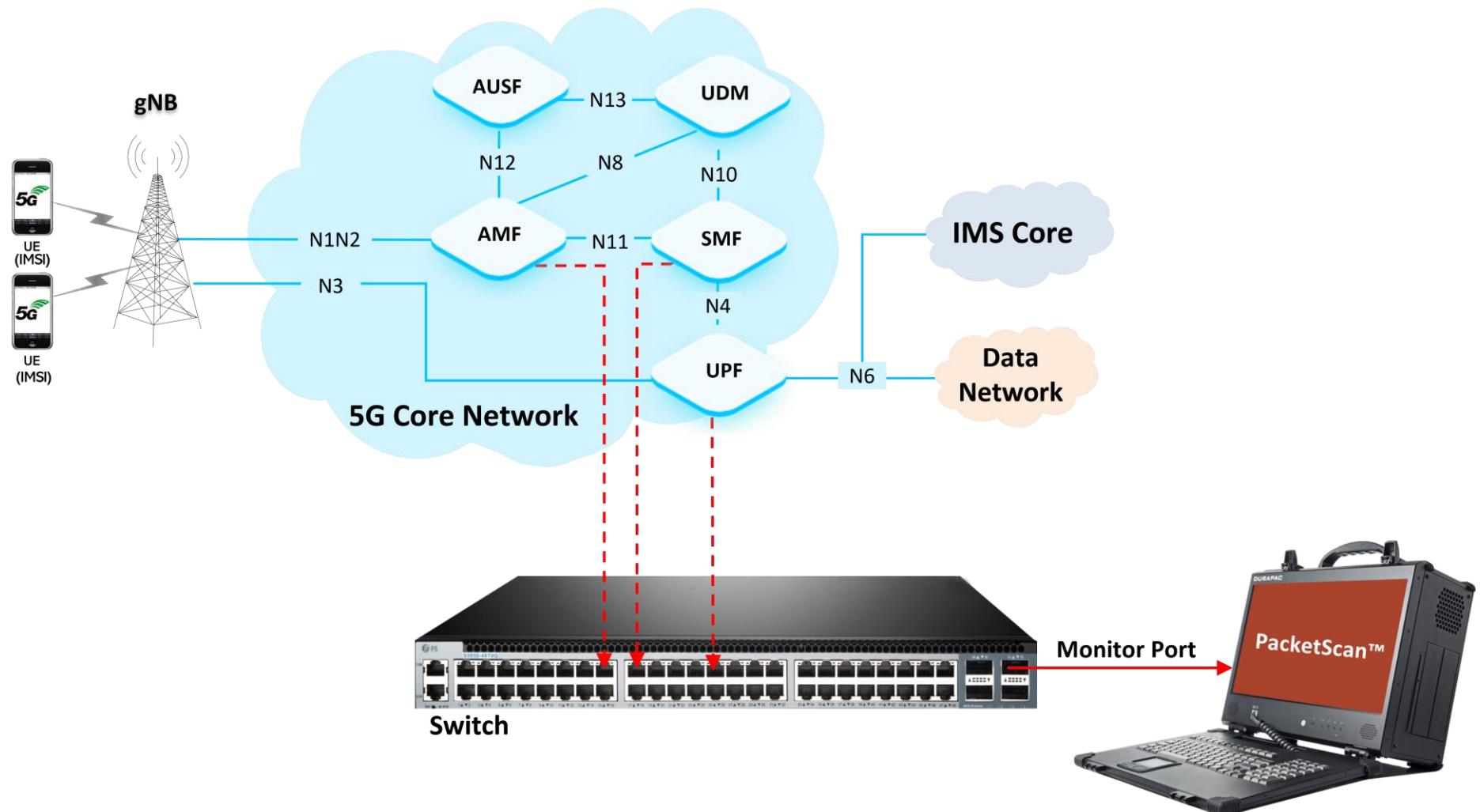
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# Introduction

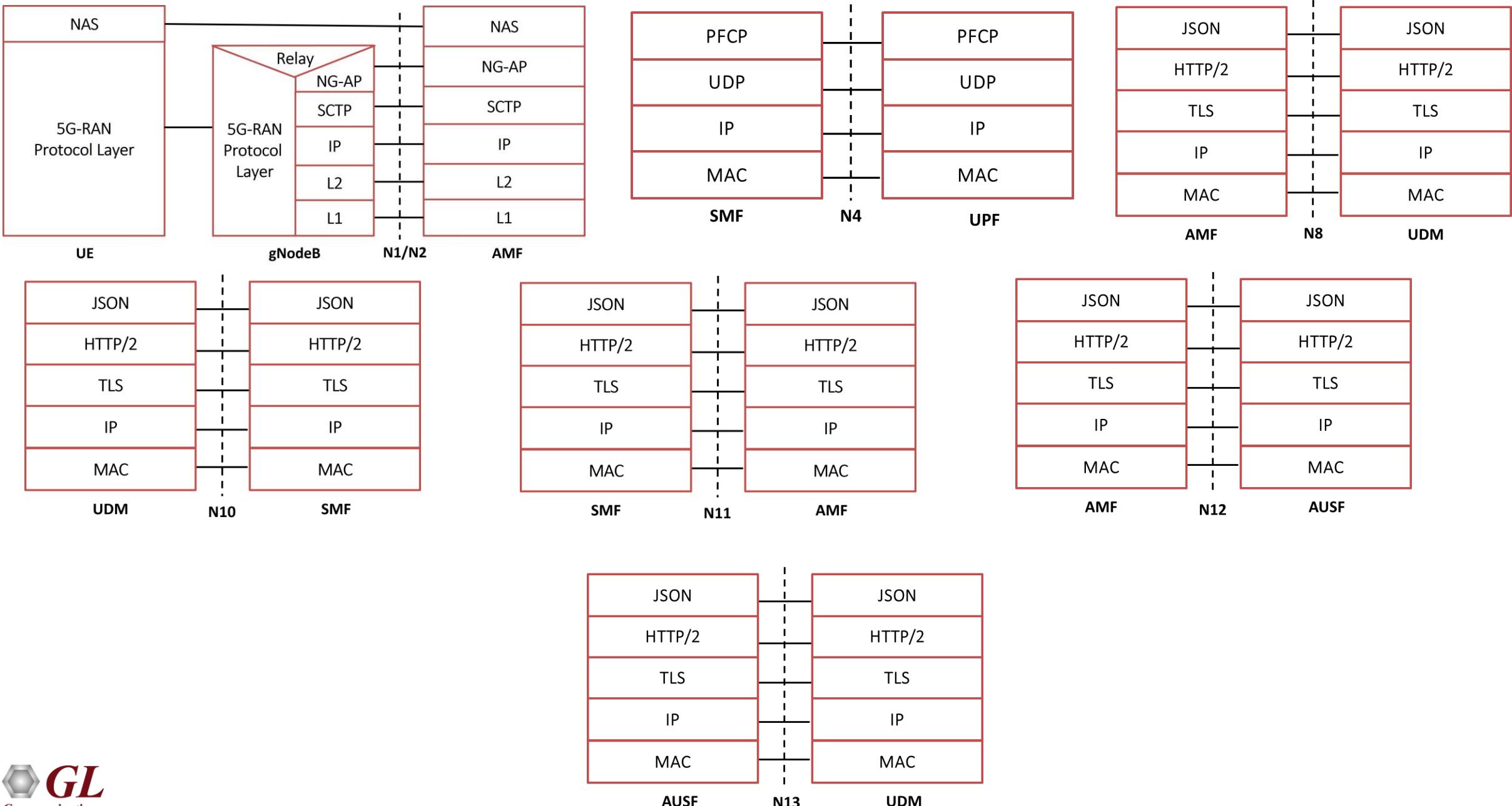
- PacketScan™ 5G protocol analyzer supports monitoring of 5G networks
- Captures, segregates, monitors and collects statistics on all calls over N1N2, N4, N8, N10, N11, N12, and N13 interfaces of the 5G network



# Main Features

- Capture, decode, and analyze calls in the 5G Network
- Supported protocols include Non-Access Stratum (NAS), Next Generation Application Protocol (NGAP), Packet Forwarding Control Protocol (PFCP)
- Supported interfaces:
  - N1N2 (NGAP and NAS) Interface - gNodeB (also called Next Generation RAN), and AMF (Access and Mobility Management Function) nodes
  - N4 (PFCP) Interface - Session Management Function (SMF) and User Plane Function (UPF) elements
  - N8 Interface - Unified Data Management (UDM) and Access and Mobility Management Function (AMF)
  - N10 Interface - Unified Data Management (UDM) and Session Management Function (SMF)
  - N11 Interface - Mobility Management Function (AMF) and Session Management Function (SMF)
  - N12 Interface - Authentication Server Function (AUSF) and Access and Mobility Management Function (AMF)
  - N13 Interface - Authentication Server Function (AUSF) and User Data Management (UDM)
- Provides VoNR call statistics such as caller, callee, MOS scores, discarded packets and voice storage
- Save calls to PCAP (Wireshark® format) and in HDL (GL Proprietary format)
- Packet Data Analyzer feature in Packetscan™ provide a complete call flow of a 5G session
- Displays Summary, Detail, Hex dump, Statistics, and Call Detail Views

# Protocol Stack



# Protocol Specifications

Supported Protocols	Standard / Specification
System Architecture for the 5G	3GPP TS 23.501
NG Application Protocol (NGAP)	3GPP TS 38.413
Non-Access-Stratum (NAS)	3GPP TS 24.501
GPRS Tunneling Protocol for User Plane (GTP-U)	3GPP TS 29.281
NR and NG-RAN Overall Description	3GPP TS 28.300
Packet Forwarding Control Protocol (PFCP)	3GPP TS 29.244
UDP	IETF RFC 768
IPv4	IETF RFC 791 [5]
IPv6	IETF RFC 2460 [6]
JavaScript Object Notation (JSON)	IETF RFC 8259
HTTP/2	IETF RFC 7231 IETF RFC 7540/RFC 7541
TLS	IETF RFC 8446
TCP	IETF RFC 793

# 5G Configuration Settings

Configuration Editor of PacketScan Settings. C:\Program Files\GL Communications Inc\Pa...

- ▷ GMM
- ▷ SMG
- ▷ BSSAP
- ▷ RANAP
- ▷ MM
- ▷ CC
- ▷ T.38
- ▷ IS-41
- ▷ TCAP
- ▷ CNAM
- ▷ TCP and/or UDP
- ▷ SCTP
- ▷ PDA
- ▷ PDA Performance Log
- ▷ LTE
- ▷ UMTS
- ▷ IMS
- ◀ 5G

NgAP Protocol Version:	Release 15 V.2
NAS-5G Protocol Version:	Release 15 V.2

- ▷ MISCELLANEOUS

**5G**

Settings.

# 5G Real-time Analysis (NGAP Layer Decode)

- Default panes - summary, detail, and hex dump of the frame data views
- Optional panes – statistics and call trace views

PacketScan 64-bit

File View Capture Statistics Database Call Detail Records Configure Help

Device Frame# TIME (Relative) Length (Bytes) Error Length/Protocol Type MAC Packet Type MAC Source IP Address IPv4 Destination IP Address IPv4

Device	Frame#	TIME (Relative)	Length (Bytes)	Error	Length/Protocol Type MAC	Packet Type MAC	Source IP Address IPv4	Destination IP Address IPv4
✓ 0	0	00:00:00.000000000	130		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	1	00:00:00.070066000	126		Internet IP(IPv4)		192.168.31.77	192.168.31.55
✓ 0	2	00:00:00.400049000	102		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	3	00:00:00.472182000	130		Internet IP(IPv4)		192.168.31.77	192.168.31.55
✓ 0	4	00:00:05.829074000	230		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	5	00:00:05.883006000	82		Internet IP(IPv4)		192.168.31.77	192.168.31.55

003A Payload Protocol Identifier = x0000003C NGAP  
Parameter Padding = x0000  
===== NGAP Layer ====== 003E NGAP-PDU = InitiatingMessage (0)  
003E InitiatingMessage =  
003F ProcedureCode = 4 id-DownlinkNASTransport  
0040 procedureCriticality = 1 ignore(1)  
0042 Value =  
0042 DownlinkNASTransport =  
0042 ProtocolIE-Container = 3 Items  
0045 Item = 0  
0045 ProtocolIE-Field =  
0045 ProtocolIE-ID = 10 id-AMF-UE-NGAP-ID  
0047 procedureCriticality = 0 reject(0)  
0049 Value =  
004A AMF-UE-NGAP-ID = 2  
004B Item = 1  
004B ProtocolIE-Field =  
004B ProtocolIE-ID = 85 id-RAN-UE-NGAP-ID  
004D procedureCriticality = 0 reject(0)  
004F Value =  
0050 RAN-UE-NGAP-ID = 2  
0051 Item = 2  
0051 ProtocolIE-Field =  
0051 ProtocolIE-ID = 38 id-NAS-PDU  
0053 procedureCriticality = 0 reject(0)  
0055 Value =  
0055 NAS-PDU =  
0056 NAS PDU Dump = x7E0056000200002188821DE340CB350DB1EFA850501A484A20103AE3588D45F780000CBE535FE4F4B155  
===== 5G NAS Layer ====== 0056 Extended Protocol Discriminator = 01111110 5GS Mobility Management Messages  
0057 Security Header Type = ....0000 Plain NAS message, not security protected

Filter is active. C:\Program Files\GL Communications Inc\PacketScan\Idle filr 23 of 113 395 frames Missed Frames : 0

# Detail View of 5G NAS Layer

PacketScan 64-bit

File View Capture Statistics Database Call Detail Records Configure Help

Device	Frame#	TIME (Relative)	Length (Bytes)	Error	Length/Protocol Type MAC	Packet Type MAC	Source IP Address IPv4	Destination IP Address IPv4
✓ 0	0	00:00:00.0000000000	130		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	1	00:00:00.070066000	126		Internet IP(IPv4)		192.168.31.77	192.168.31.55
✓ 0	2	00:00:00.400049000	102		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	3	00:00:00.472182000	130		Internet IP(IPv4)		192.168.31.77	192.168.31.55
✓ 0	4	00:00:05.829074000	230		Internet IP(IPv4)		192.168.31.55	192.168.31.77
✓ 0	5	00:00:05.883006000	82		Internet IP(IPv4)		192.168.31.77	192.168.31.55

```

0049      Value          =
004A      AMF-UE-NGAP-ID   =
004B      Item           =
004B      ProtocolIE-Field =
004B      ProtocolIE-ID    =
004D      procedureCriticality =
004F      Value           =
0050      RAN-UE-NGAP-ID   =
0051      Item           =
0051      ProtocolIE-Field =
0051      ProtocolIE-ID    =
0053      procedureCriticality =
0055      Value           =
0055      NAS-PDU          =
0056      NAS PDU Dump     =
0056      ===== 5G NAS Layer =====
0056      Extended Protocol Discriminator =
0057      Security Header Type      =
0058      Message Type           =
        ngKSI
0059      NAS Key Set Identifier =
0059      Type of Security Context Flag (TSC) =
        ABBA
005A      Length          =
005B      ABBA            =
        Authentication Parameter RAND
005D      Information Element Id =
005E      RAND Value       =
        Authentication Parameter AUTN
006E      Information Element Id =
006F      Length          =
0070      AUTN Value       =

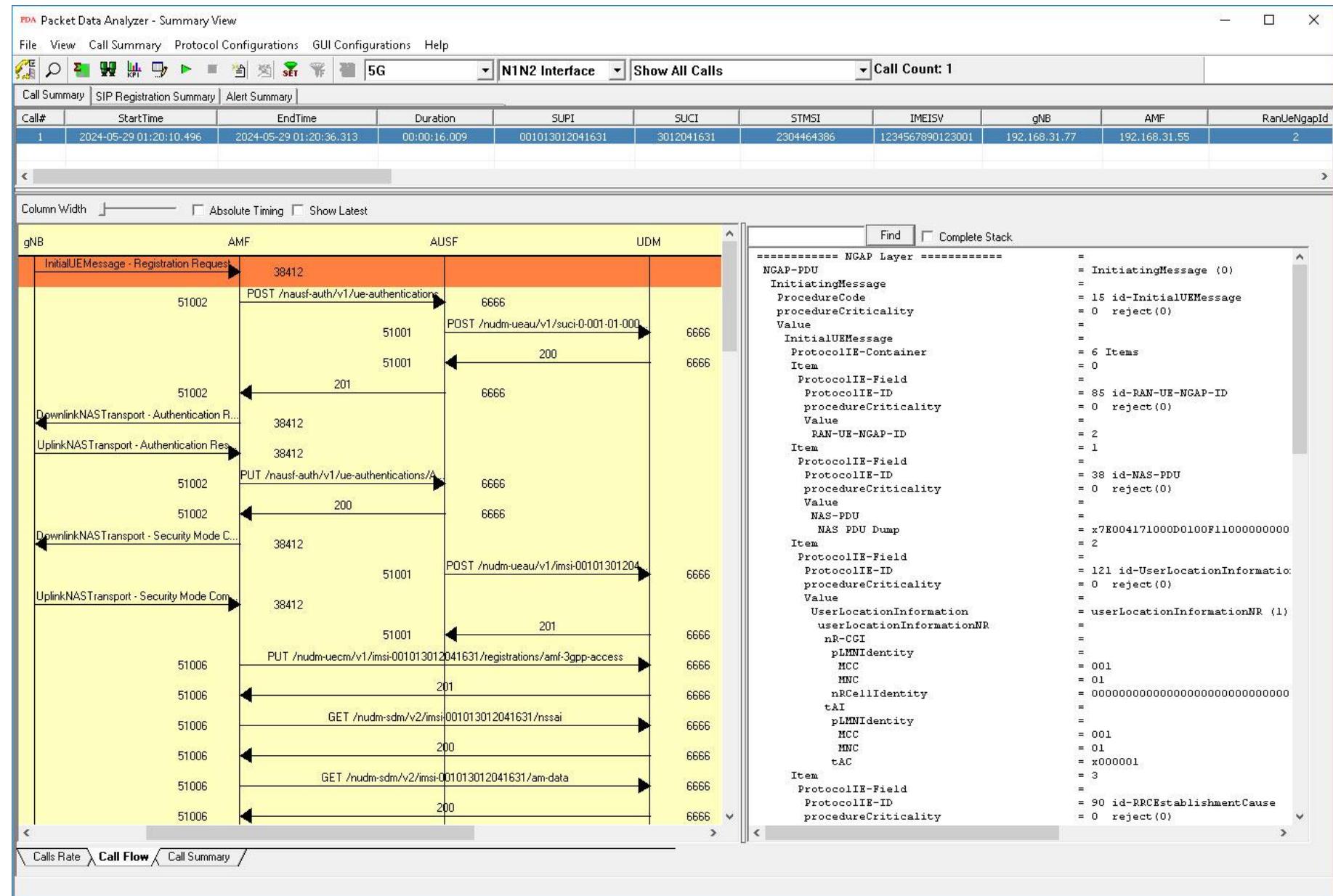
```

Filter is active. C:\Program Files\GL Communications Inc\Pa Idle fltr 23 of 113 395 frames Missed Frames : 0

# Packet Data Analyzer (PDA) Call Graphs

# 5G End-to-End Lab Setup

- Displays 5G end-to-end call
- Decodes of the selected N1N2 message is displayed on the right pane



# 5G N4 Interface

- Decodes of the selected N4 message is displayed on the right pane. The N4 interface is between **SMF** and **UPF**

The screenshot shows the PDA (Packet Data Analyzer) interface. The title bar reads "PDA Packet Data Analyzer - Summary View". The menu bar includes File, View, Call Summary, Protocol Configurations, GUI Configurations, and Help. The toolbar contains various icons for file operations and analysis. The main window has tabs for Call Summary, SIP Registration Summary, and Alert Summary, with Call Summary currently selected. A dropdown menu shows "5G" and "N4 (smf-upf)". The "Call Count: 2" is indicated. Below this is a table with columns: Call#, SmfNodeId, NetworkInstance, QFI, GnbTeid, GnbTunIPv4, GnbTunIPv6, UpfTeid, and UpfTunIPv4. Two entries are listed: Call 1 (SmfNodeId 192.168.31.79, NetworkInstance ims, QFI 1, GnbTeid 3, GnbTunIPv4 192.168.31.78, UpfTeid 198, UpfTunIPv4 192.168.31.58) and Call 2 (SmfNodeId 192.168.31.79, NetworkInstance internet, QFI 1, GnbTeid 5, GnbTunIPv4 192.168.31.79, UpfTeid 200, UpfTunIPv4 192.168.31.58). The "Call Flow" tab is selected, showing a sequence of messages between SMF (Frame# 30340, 30344, 30396, 30400) and UPF (Frame# 8805). The messages are: PFCP Session Establishment Request, PFCP Session Establishment Response, PFCP Session Modification Request, PFCP Session Modification Response, PFCP Session Deletion Request, and PFCP Session Deletion Response. The right pane displays the decoded details of the selected PFCP Session Establishment Request message. It includes fields like S (Session Endpoint Identifier), Message Priority, Version, Message Type, Length, Sequence Number, Node ID, Information Element Id, Length, Node ID Type, IPV4 Address, CP F-SEID, and V6. The decoded values are: S = x0000000000000000, Message Priority = 0000..., Version = 001..., Message Type = 00110010, Length = 172, Sequence Number = 0, Node ID = x003C, Information Element Id = 5, Length = 5, Node ID Type = 0000..., IPV4 Address = 192.168.31.79, CP F-SEID = x0039, and V6 = 1.

# 5G N8 Interface

- Decodes of the selected N8 message is displayed on the right pane. The N8 interface is **AMF** and **UDM**

The screenshot shows the PDA (Packet Data Analyzer) interface with the following details:

- Top Bar:** PDA Packet Data Analyzer - Summary View, File, View, Call Summary, Protocol Configurations, GUI Configurations, Help.
- Toolbar:** Includes icons for search, zoom, KPI, and various analysis tools.
- Network Selection:** 5G, N8 [amf-udm], Show All Calls, Call Count: 8.
- Call Summary:** Shows three calls (Call# 1, 2, 3) with details: NfInstanceId, ServiceName, DNN, APIRoot, Method, OperationId, SubscriptionId, and SUPI.
- Call Flow View:** Displays the sequence of messages:
  - AMF (Frame# 29640, 51006) sends a PUT /nudm-uecm/v1/imsi-001013012041631/registration to UDM (IP 6666).
  - UDM (IP 6666) returns a 201 Created response to AMF.
- Message Details:** The right pane shows the decoded message structure for the PUT request:

```
:method:PUT
:path:/nudm-uecm/v1/imsi-001013012041631/registrations/amf-3gpp-access
:scheme:http
:authority:192.168.31.53:6666
:content-type:application/json
:accept:application/json,application/problem+json
:content-length:316

=====
{"amfInstanceId":"f617eea4-7ee8-464a-b67c-8355e05f4b36"
" deregCallbackUri ":"http://192.168.31.55:6666/nudm-uecm/v1/imsi-001013012041631/"
" guami":{"amfId": "2163"
" plmnId": {"mcc": "001"
" mnc": "01"}
" imsVoPs": "HOMOGENEOUS_SUPPORT"
" initialRegistrationInd": true
" ratType": "NR"}
```
- Bottom Navigation:** Calls Rate, Call Flow, Call Summary.

# 5G N10 Interface

- Decodes of the selected N10 message is displayed on the right pane. The N10 interface is between **SMF** and **UDM**

PDA Packet Data Analyzer - Summary View

File View Call Summary Protocol Configurations GUI Configurations Help

Call Summary SIP Registration Summary Alert Summary

Call# NfInstanceId SUPI APIRoot Method OperationId ServiceName Version StartTime EndTime

Call#	NfInstanceId	SUPI	APIRoot	Method	OperationId	ServiceName	Version	StartTime	EndTime
1	f84f2235-6c02-4364-8dc1-f7dd8df...	imsi-001013012041631	http://192.168.31.53:6666	PUT	GetSmfRegistration	nudm-uecm	v1	2024-05-29 01:20:21.999	2024-05-29 01:20:22.
2		imsi-001013012041631	http://192.168.31.53:6666	GET	GetSmData	nudm-sdm	v2	2024-05-29 01:20:22.316	2024-05-29 01:20:22.
3	f84f2235-6c02-4364-8dc1-f7dd8df...	imsi-001013012041631	http://192.168.31.53:6666	POST	Subscribe	nudm-sdm	v2	2024-05-29 01:20:22.352	2024-05-29 01:20:22.

Column Width   Absolute Timing  Show Latest

Time Frame# SMF UDM

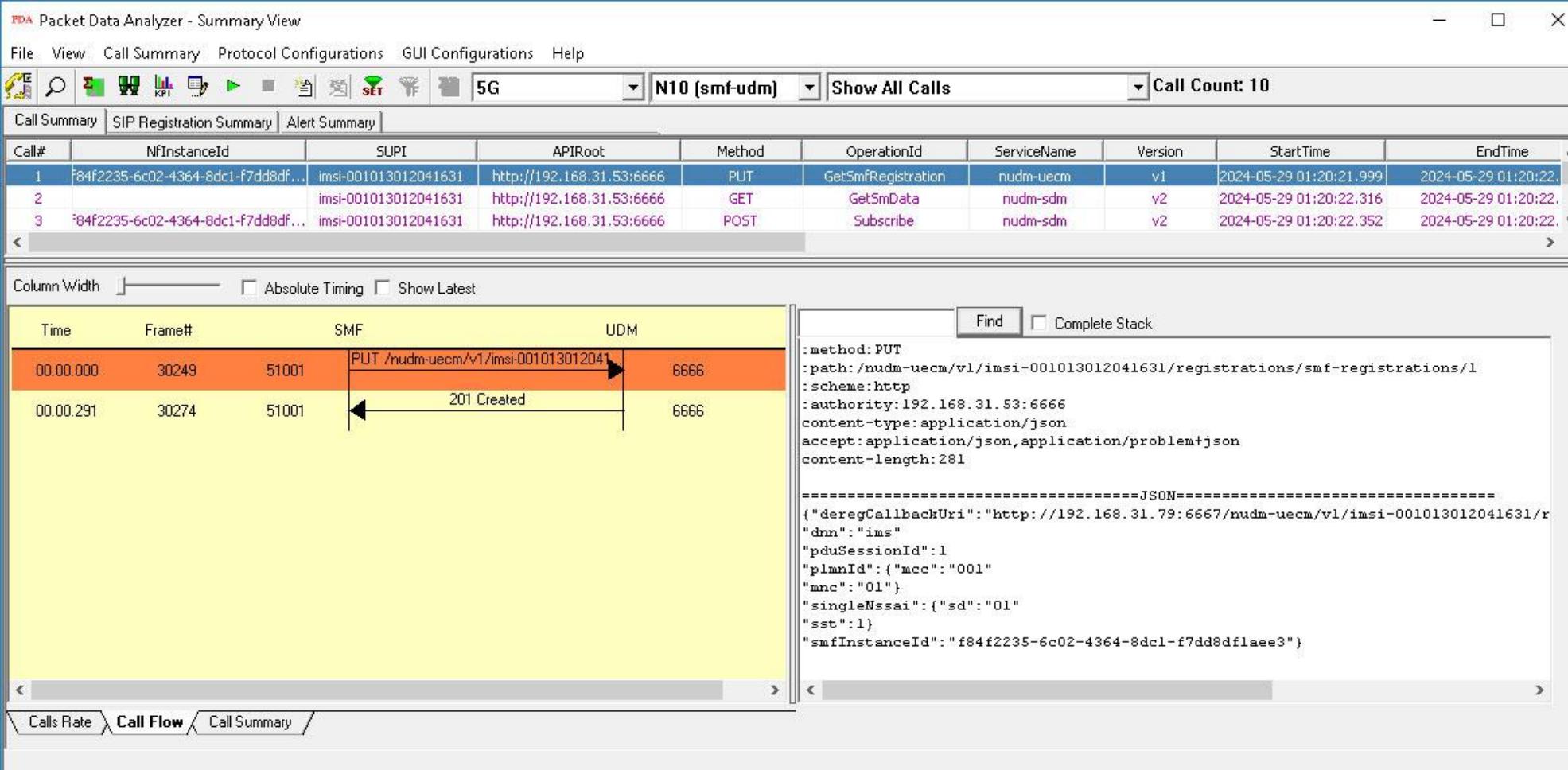
Time	Frame#	SMF	UDM
00.00.000	30249	51001	PUT /nudm-uecm/v1/imsi-001013012041631/registrations/smf-registrations/1 6666
00.00.291	30274	51001	201 Created 6666

Find  Complete Stack

```
:method:PUT
:path:/nudm-uecm/v1/imsi-001013012041631/registrations/smf-registrations/1
:scheme:http
:authority:192.168.31.53:6666
:content-type:application/json
:accept:application/json,application/problem+json
:content-length:281

=====
=====JSON=====
{"deregCallbackUri":"http://192.168.31.79:6667/nudm-uecm/v1/imsi-001013012041631/r
"dnr":"ims"
"pduSessionId":1
"plmnId":{"mcc":"001"
"mnc":"01"}
"singleNssai":{"sd":"01"
"sst":1}
"smfInstanceId":"f84f2235-6c02-4364-8dc1-f7dd8df1ae3"}
```

Calls Rate Call Flow Call Summary



# 5G N11 Interface

- Decodes of the selected N11 message is displayed on the right pane. The N11 interface is between **AMF** and **SMF**

TDA Packet Data Analyzer - Summary View

File View Call Summary Protocol Configurations GUI Configurations Help

Call Summary SIP Registration Summary Alert Summary

5G N11 [amf-smf] Show All Calls Call Count: 8

Call#	SUPI	MCC	MNC	sNssai-sd	sNssai-sst	ServingNfId	PDUSessionID	PDUSessionType	SSC-Mo
1	imsi-001013012041631	001	01	01	1	617eea4-7ee8-464a-b67c-8355e05f4b36	1	IPv4	1
2	imsi-001013012041631				1		49	IPv4	
3	imsi-001013012041631					617eea4-7ee8-464a-b67c-8355e05f4b36		IPv4	

Column Width   Absolute Timing  Show Latest

Time Frame# AMF SMF

00.00.000 30148 51005 POST /nsmf-pdusession/v1/sm-contexts → 6666

00.02.235 30343 51005 ← 201 Created 6666

Find  Complete Stack

```
:method: POST
:path: /nsmf-pdusession/v1/sm-contexts
:scheme: http
:authority: 192.168.31.79:6666
:accept: application/json,application/vnd.3gpp.ngap,application/problem+json
:content-type: multipart/related; boundary="cac45F25820d774FF331"
:mime-version: 1.0
:content-length: 676

=====
("anType": "3GPP_ACCESS"
"dnr": "ims"
"gpis": "msisdn-3012041631"
"nlSmMsg": {"contentId": "nlmsg"}
"pdusessionId": 1
"pei": "imeisv-1234567890123001"
"ratType": "NR"
"requestType": "INITIAL_REQUEST"
"rrcRadioFunction": "D1"
```

Calls Rate Call Flow Call Summary

# 5G N12 Interface

- Decodes of the selected N12 message is displayed on the right pane. The interface is between **AMF** and **AUSF**

Packet Data Analyzer - Summary View

File View Call Summary Protocol Configurations GUI Configurations Help

Call Summary SIP Registration Summary Alert Summary

5G N12 [amf-ausf] Show All Calls Call Count: 2

Call#	SUCI	ResStar	AuthResult	Kseaf	APIRoot	Method	OperationId	AuthCnxtId
1	suci-0-001-01-0000-0-0-3012041631				http://192.168.31.78:6666	POST	ue-authentications	AuthCxt_00101301204163
2	suci-0-001-01-0000-0-0-3012041631 FDE40291D09D87886A24505CED7...		AUTHENTICATION_SUCCESS	5415B009A30D73A4148AA...	http://192.168.31.78:6666	PUT	5g-aka-confirmation	AuthCxt_00101301204163

Column Width   Absolute Timing  Show Latest

Time Frame# AMF AUSF

00.00.000 29384 51002 POST /nausf-auth/v1/ue-authentications → 6666

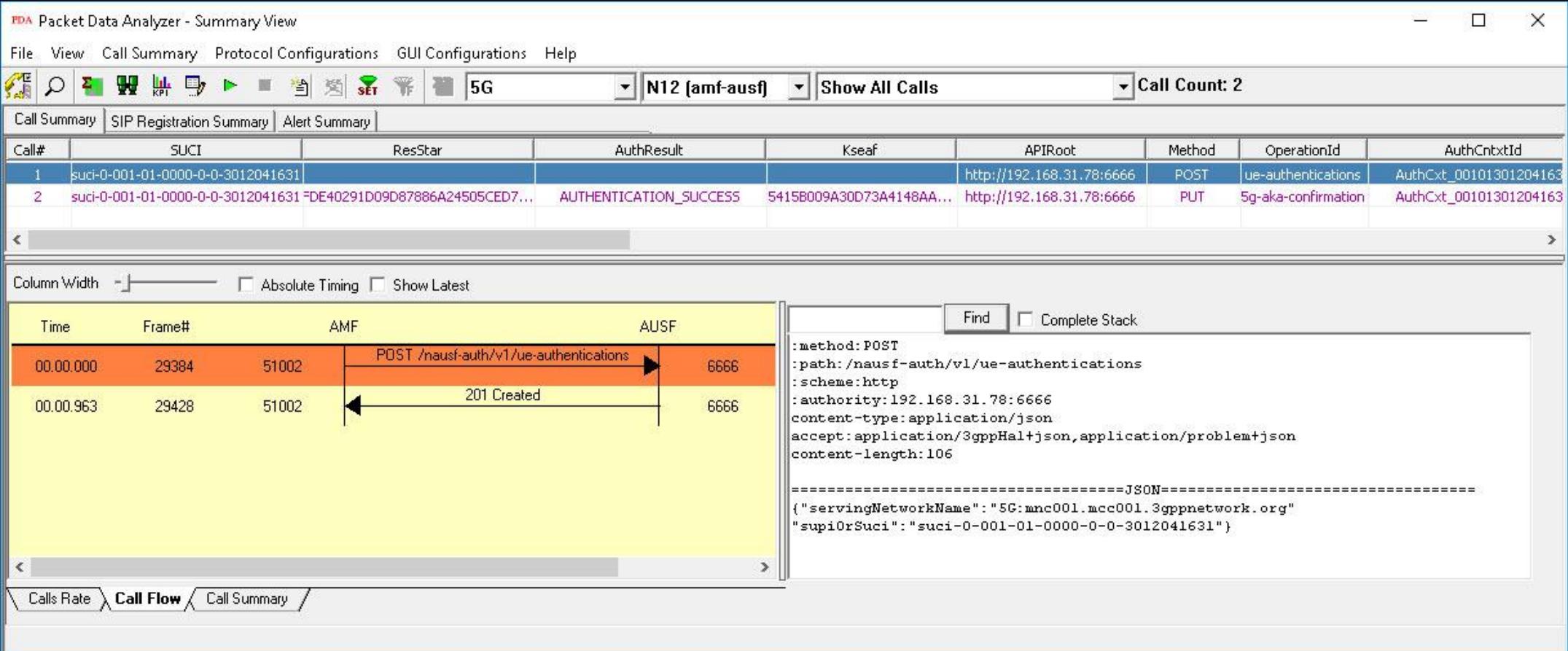
00.00.963 29428 51002 ← 201 Created 6666

Find  Complete Stack

```
:method:POST
:path:/nausf-auth/v1/ue-authentications
:scheme:http
:authority:192.168.31.78:6666
:content-type:application/json
:accept:application/3gppHalt+json,application/problem+json
:content-length:106

=====
=====JSON=====
{"servingNetworkName": "5G:mnc001.mcc001.3gppnetwork.org"
"supiOrSuci": "suci-0-001-01-0000-0-0-3012041631"}
```

Calls Rate Call Flow Call Summary



# 5G N13 Interface

- Decodes of the selected N13 message is displayed on the right pane. The N13 interface is between **AUSF** and **UDM**

The screenshot shows the PDA (Packet Data Analyzer) interface with the following details:

**Call Summary View:**

Call#	SUPI	AuthEventSuccess	AuthEventTimestamp	AuthEventId	APIRoot	Method	OperationId
1					http://192.168.31.53:6666	POST	GenerateAuthData
2	imsi-001013012041631	true	2024-05-29T01:20:13-05:00	authEventId-001013012041631-d...	http://192.168.31.53:6666	POST	ConfirmAuth

**Call Flow View:**

Time Frame# AUSF UDM

00.00.000	29418	51001	POST /nudm-ueau/v1/suci-0-001-01-0000-0-0-3012	6666
00.00.186	29425	51001	200 Ok	6666

**Decoded Message (Right Pane):**

```
:method: POST
:path: /nudm-ueau/v1/suci-0-001-01-0000-0-0-3012
:scheme: http
:authority: 192.168.31.53:6666
:content-type: application/json
:accept: application/json,application/problem+json
:content-length: 113

=====JSON=====
{"ausfInstanceId": "dd8517ce-3529-4359-8693-5bbcd227a20a",
 "servingNetworkName": "5G:mnc001.mcc001.3gppnetwork.org"}
```

**Thank you**