**3GPP TSG-SA2 Meeting #170** **[S2-2507478](C:\\Users\\baliarsi\\Downloads\\Docs\\S2-2507478.zip)**

**Stor-Göteborg, Sweden, August 25 – 29th, 2025 (revision of S2-2506431)**

**Source: Nokia**

**Title:** **KI #2: New Sol:** **Signaling optimizations for voice over GEO sessions**

**Document for:** **Approval**

**Agenda Item: 20.1.1**

**Work Item / Release: FS\_5GSAT\_Ph4\_ARC / Rel-20**

Abstract of the contribution: The contribution proposes a solution to Key Issue #2: IMS enhancement for GEO NB-IoT NTN access

# Introduction

This contribution proposes a solution for optimising/reducing the call setup time by enhancing the IMS signalling whereby the SDP parameters may/may not be pre-negotiated at the IMS registration procedure so that the call setup time is reduced.

# Discussion

GEO satellites have very limited bandwidth on the satellite link (typically 1 kbps) and a very high delay, typically around 1Sec. For NB-IoT devices to establish a voice call via a GEO satellite, their call setup time can be 30s or even longer. SA1 has specified a requirement of 30s as the maximum (excluding time for the called party to answer).

By moving the SDP negotiation (i.e. offer/answer) from the call setup procedure (i.e. SIP INVITE) to the IMS registration phase, we can reduce the number of messages and message size during the call setup. This will improve the overall call setup time.

Additionally, instead of using the existing clear text-based SIP protocol between the UE and P-CSCF for IMS session management, if we use a binary encoded protocol, the message size will be reduced significantly, thereby also further reducing the call setup time.

The IMS services using IP stack for both signalling and media is not efficient for low link budget access. Even if the ROHC can significantly reduce the transport header, a feedback mechanism is required to compress headers consistently and robustly. In a GEO satellite system, due to the distance and propagation delay, the feedback mechanism (between the decompressor and compressor) will cause a delay in packet transfer. The solution and procedure proposed in clauses 6.X.3.1, 6.X.3.2, and 6.X.3.3 will also work without UDP/IP protocol from UE to PGW using a Non-IP PDN connection. This will save payload size and ROHC feedback delays.

# Proposal

A solution is proposed for KI#2 for incorporation in the FS\_5GSAT\_Ph4\_ARC TR 23.700-19.

\*\*\* Start of changes (all new text) \*\*\*

## 6.X Solution #X: IMS Signaling optimizations for voice over GEO sessions with P-CSCF as SIP user agent using binary encoded call setup

### 6.X.1 High level principles

This solution aims to resolve Key Issue #2, "IMS enhancement for GEO NB-IoT NTN access".

The Gm interface between UE and P-CSCF uses the SIP protocol, which is a clear-text protocol. It is proposed that the Gm interface between UE and P-CSCF be enhanced to use a binary encoded format instead of clear text for SIP session management messages. This will reduce the size of the SIP session management messages exchanged between the UE and P-CSCF. Let us call this enhanced interface as Gm\*. In addition to using a binary encoded format, it is also proposed to support the following enhancements over the Gm\* interface that will further reduce the number of messages exchanged between the UE and P-CSCF for a call setup:

- UE information for IMS call setup (e.g. supported codecs, contact address etc) is provided to and stored by P-CSCF before call setup i.e. at IMS registration.

- Instead of using plain SIP (Gm) messages (INVITE, RINGING, 200 OK, etc.) for call-related signaling, the UE and the P-CSCF use the Gm\* protocol where only the information that cannot be determined by the P-CSCF is exchanged.

- Furthermore, the number of messages is dramatically reduced to just one INVITE request from UE to network and thereafter RINGING and 200 OK (INVITE) from network to UE.

- The P-CSCF plays the role of the SIP user agent, i.e. based on signalling received from UE via Gm\* the P-CSCF constructs and sends out SIP messages as per TS 24.229 to the IMS Core, and also converts the received SIP messages from the IMS Core into corresponding SIP messages over the Gm\* interface towards the UE.

### 6.X.2 Description

GEO satellites have very limited bandwidth on the satellite link (typically 1 kbps) and a very high delay, typically around 1 Sec. For NB-IoT devices to establish a voice call via a GEO satellite, the call setup time can be 30s or even longer. SA1 has specified a requirement of 30s as the maximum (excluding time for the called party to answer).

By moving the SDP negotiation (i.e. offer/answer) from the call setup procedure (i.e. SIP INVITE) to the IMS registration phase, we can reduce the number of messages and message size during the call setup. This will improve the overall call setup time.

Additionally, instead of using the existing clear text-based SIP protocol between the UE and P-CSCF for IMS session management, if we use a binary encoded protocol, the message size will be reduced significantly, thereby also further reducing the call setup time.

Additionally, the IMS services using IP stack for both signalling and media is not efficient for low link budget access. Even if the ROHC can significantly reduce the transport header, a feedback mechanism is required to compress headers consistently and robustly. In a GEO satellite system, due to the distance and propagation delay, the feedback mechanism (between the decompressor and compressor) will cause a delay in packet transfer. A solution without UDP/IP protocol from UE to PGW using a Non-IP PDN connection can overcome these limitations. This will save payload size and ROHC feedback delays for the fixed headers.

### 6.X.3 Procedures

#### 6.X.3.1 IMS Registration



Figure 6.x.3.1-1: IMS registration procedure with Gm\* interface

Figure 6.x.3.1-1 above shows the UE's IMS registration procedure with SDP negotiation for future IMS Sessions.

1. UE establishes a PDN connection and receives P-CSCF info via DHCP/PCO etc.

- It is assumed that the PDN connection is of type IP over which the UE can exchange IP packets with the network.

- Based on the access used (e.g., NTN GEO), the PGW can send an address of a specific P-CSCF.

2. UE initiates SIP REGISTER to a P-CSCF with an indication of its capability to support Gm\* interface and includes information required for subsequent IMS call setup (e.g. contact address, SDP parameters like supported codecs etc.)

3. If no IMS level authentication is enforced, the P-CSCF asks the PCF to get the MSISDN corresponding to the UE IP address and checks if the registered IMPU maps to any of these MSISDNs.

4. If the UE indicated support for Gm\* interface, the P-CSCF stores the information related to call setup provided by the UE. The P-CSCF also stores the service-route received in REGISTER 200 OK from the S-CSCF and replaces it with its own IP address and port before sending REGISTER 200 OK to the UE.

#### 6.X.3.2 MO Call Setup



Figure 6.x.3.2-1: MO Call Setup procedure with Gm\* interface

- When requesting for an MO call, the UE sends a Gm\* message (to the P-CSCF address and port received at REGISTER 200 OK) with:

- A message type = INVITE

- The R-URI with the dialled number = called party number

- The codecs it supports (codec offer) (unless already provided in REGISTER)

- The port where the UE expects to receive audio media

- Optionally the IMPU (IMS user Id of the UE) corresponding to this call

This is sent as an IP packet over the signalling data bearer of the IMS PDN connection. The P-CSCF may retrieve the MSISDN corresponding to the UE IP address from the PCF.

- The P-CSCF transforms the Gm\* message into a regular SIP signalling message that it sends further towards the IMS Core via Mw interface. The P-CSCF

- adds the MSISDN received from PCF in the relevant Headers (FROM/ P-Asserted-Id) if none was provided by the UE, otherwise checks that the IMPU provided by the UE matches the 3GPP Access Network subscription corresponding to the source IP address and port.

- creates relevant SIP Headers such as Call Id, CSeq etc.

- adds the service Route

- creates a SDP based on the information received from UE at registration

- IMS signalling is exchanged within (and between) IMS networks

- The P-CSCF transforms the regular SIP signalling that it receives from the IMS Core via Mw interface into an answer sent to the UE over Gm\* providing the minimum set of information the UE needs such as the IMS AGW address.

#### 6.X.3.3 MT Call Setup



Figure 6.x.3.3-1: MT Call setup procedure with Gm\* interface

- When there is an MT call, the P-CSCF transforms SIP signalling received from the IMS Core into Gm\* SIP INVITE message as described below and sends it to the registered UE IP address and port received at REGISTER:

- A message type = INVITE

- The calling party number

- The offered codecs

- The IP address and port where the network expects to receive audio media

This is sent as an IP packet over the signalling data bearer of the IMS PDN connection using a proper DSCP (to support paging policy differentiation). The P-CSCF may store the information received from the IMS Core such as Call Id, CSeq, Route, etc to use this information upon the UE answer.

- The UE answers to the INVITE and sends a Gm\* message with

- A message type = 200 OK

- The codecs it accepts (codec answer)

- The port where the UE expects to receive audio media

- The P-CSCF transforms the Gm\* message into a regular SIP signalling that it sends further towards the IMS Core via Mw interface and

- adds a Call Id, a CSeq

- adds the Route

- creates a SDP based on the information received from the UE over Gm\* interface

#### 6.X.3.4 Usage of Non-IP PDN

The IMS services using IP stack for both signalling and media is not efficient for low link budget access. Even if the ROHC can significantly reduce the transport header, a feedback mechanism is required to compress headers consistently and robustly. In a GEO satellite system, due to the distance and propagation delay, the feedback mechanism (between the decompressor and compressor) will cause a delay in packet transfer. The solution and procedure proposed in clauses 6.X.3.1, 6.X.3.2, and 6.X.3.3 will also work without UDP/IP protocol from UE to PGW using a Non-IP type PDN connection. This will save payload size and ROHC feedback delays for fixed header type. The IMS signalling optimisations and related procedures in clauses 6.X.3.1, 6.X.3.2, and 6.X.3.3 can be applied through a Non-IP PDN from the UE with the following differences:

**Registration**

* The UE initiates a PDN connection [APN=IMS; PDN type = non-IP; PCO = non-IP support for IMS] for IMS signalling.
* The PGW accepts the Non-IP PDN connection and provides the IP address to be used for IMS registration (e.g. to be used as contact header) via PCO to the UE. Optionally the PGW may also provide an UDP port for sip signalling.
* UE sends the IMS registration request with contact header containing the allocated IP address and port (if provided) without adding any UDP/IP header.
* PGW adds the UDP/IP header with source address containing the IP address allocated to the UE and destination address set to P-CSCF IP address.
* When the response comes from P-CSCF (200 OK), the PGW removes the UDP/IP header and sends only the SIP message block to UE.

**Call Setup**

* During an MT call, the P-CSCF asks for dedicated bearer creation towards PGW/IP-CAN session via PCRF.
* The PGW issues a dedicated bearer set up request (for Non-IP PDN type to UE with an indication for port allocation in PCO;
* P-CSCF sends the SIP INVITE (SDP) to UE. The PGW removes the UDP/IP header before forwarding the SIP INVITE.
* The UE allocates a local UDP port, retrieves the remote port for media from the INVITE and sends back the information in PCO to PGW in bearer setup response.
* The PGW stores the IP and UDP port information for exchanging RTP media packets with IMS-AGW.
* When the UE sends any media (RTP), it shall not include any UDP/IP header. The PGW will add the UDP/IP (i.e. UDP Src=UE allocated port, UDP Dst= IMS-AGW port) before forwarding to IMS-AGW
* Similarly, when the DL RTP media is received from IMS-AGW, the PGW removes the UDP/IP header and sends the RTP payload to UE over the corresponding dedicated EPS bearer.

Editor’s note: it is FFS on how to deal with transport security between UE and P-CSCF in non-IP based PDN.

#### 6.X.3.4 Performance Gains of Gm\* interface

The estimated packet length savings in Gm\* messagin in comparison to Gm interface messaging via SIP.

Table 6.x.3.4-1: Overhead and delay of MT Call setup procedure via Gm interface and Gm\* interface

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Message** | **Packet Length (bytes) via Gm interface** | **Delay (sec) via Gm interface** | **Packet Length (bytes) via Gm\* interface** | **Delay (sec) via Gm\* interface** | **Comments** |
| INVITE | 2616 | 20.93 | 67 | 0.54 | Assuming the “Via”, “Route” and “contact” headers are not considered. Also, 1 SDP element (codec) is considered in the SDP body. |
| 100 Trying | 497 | 3.98 | 61 | 0.49 | Assuming the “Via” header is not considered |
| 180 Ringing | 1757 | 14.06 | 67 | 0.54 | Assuming the “Via”, “Route” and “contact” headers are not considered. Also, 1 SDP element (codec) is considered in the SDP body. |
| PRACK | 1106 | 8.85 | 64 | 0.51 | Assuming the “Via” header is not considered |
| 200 OK | 778 | 6.22 | 61 | 0.49 | Assuming the “Via” and “contact” header are not considered. |
| UPDATE | 1981 | 15.85 | 61 | 0.49 | Assuming the “Via” and “contact” header are not considered. |
| 200 OK (UPDATE) | 1546 | 12.37 | 61 | 0.49 | We assume that “Via” and “contact” header are not considered. |
| 183 Session Progress | 1035 | 8.28 | 61 | 0.49 | We assume that “Via”, “Route” and “contact” header are not considered. Also, 1 SDP element (codec) is considered in the SDP body. |
| **SUM** | 11316 | 90.53 | 503 | 4.02 |  |
| NOTE 1: The size of the message will increase when the number of Via headers, Router headers, or any other informative headers is included in the call setup.  NOTE 2: The above message size calculation for Gm\* is based on 3 Bytes for "To", 3 Bytes for "From", 2 Bytes for "Call ID", 1 Byte for "Cseq", 6 Bytes for "Message Body = SDP".  NOTE 3: The above calculation is a rough estimate based on assumptions taken in NOTE 3, the actual message size will be based on the encoding mechanism to be decided by stage 3. | | | | | |

6.X.4 Impacts on services, entities and interfaces

UE:

- UE to indicate Gm\* interface support for SIP session management during SIR REGISTER

- UE includes information required for IMS call setup (e.g. contact address, SDP parameters like supported codecs etc.) in SIP REGISTER

- UE to support SIP session management using Gm\* interface

- UE establishes a non-IP PDN connection for IMS services.

P-CSCF:

- Support receiving from the UE an indication for Gm\* support and information required for IMS call setup (e.g. contact address, SDP parameters like supported codecs etc.) in SIP REGISTER

- Convert Gm\* SIP messages received from UE to SIP message compliant to TS 24.229 [x] before sending to the S-CSCF. If UEs SDP is pre-configured, the P-CSCF shall include the information in the SIP message.

- Convert SIP messages received from S-CSCF to Gm\* SIP message before sending to the UE. Not all SIP messages are sent to the UE. For some SIP messages (e.g. TRYING, PRACK etc) are handled by the user agent at the P-CSCF and not forwarded to the UE over Gm\*.

P-GW:

- Upon the reception of a non-IP PDN connection request, P-GW performs the establishment of a non-IP PDN and provides an IP address to the UE that can be used for the signaling with the IMS

- adds the UDP/IP header in the packets received from the UE when their destination is the P-CSCF (i.e., for IMS control signaling) or the IMS-AGW (for IMS voice traffic) and forwards the packets to the target destination

- removes the UDP/IP header from the packets received from the P-CSCF (i.e., for IMS control signaling) or the IMS-AGW (for IMS voice traffic) that should be transmitted to the UE via the non-IP PDN and forwards the data packets to the target UE.

\*\*\* END of changes \*\*\*