Discussion on GEO voice signaling

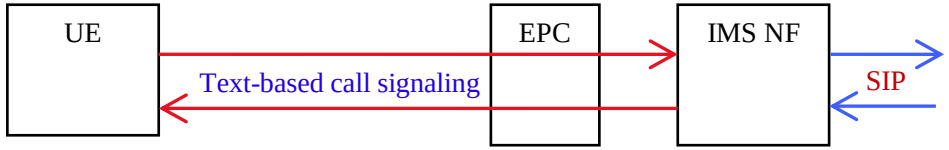
- Aspects that independent with KI#1

vivo

Contents

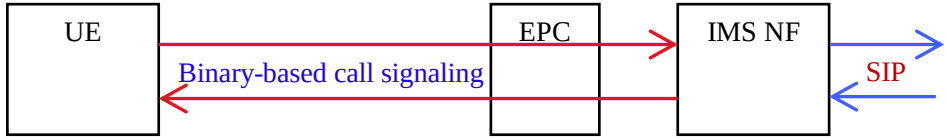
Message size reduction options description

Option#1: Text-based option



- Termination point is IMS NF (i.e., P-CSCF)
  - Necessary SIP headers and SDP lines are transmitted in hyper-text format
  - IMS NF reduces information for DL SIP messages and restores information for UL SIP messages
- Transport protocol aspect
  - Underlayer transport protocol is IP
- Architecture baseline
  - B2BUA required (IMS NF maintains different state machine per different side, and collaborates the two state machines)

Option#2: Binary-based option



- Termination point is IMS NF (i.e., P-CSCF, IMS AS)
  - Necessary information is transmitted in binary format
  - IMS NF reduces information for DL SIP messages and restores information for UL SIP messages
  - IMS NF translates between SIP protocol and binary formatted protocol
- Transport protocol aspect
  - Underlayer transport protocol is IP (e.g., Sol#18, Sol#19, Sol#20) or non-IP (e.g., Sol#19)
- Architecture baseline
  - B2BUA optional

NOTE: Solution#4 proposes an variant of Option#2 that IMS NF delegates UE to perform IMS registration when receiving PS-CS combined attach request from MME (IMS NF supports SGs interface to interact with MME).

YELLOW highlighted shows the major difference between Option#2 and Option#1

Comparison on different options – Functional comparison

Key aspects \ Options	Option#1: **Text-based option**	Option#2: **Binary-based option**
Message size without headers	Large, e.g., INVITE 340-700B, 180 Ring 120-650B (based on Sol#12, Sol#15)	Small, e.g., INVITE 33-37B, 180 Ring 10-15B (based on Sol#20, Sol#4)
Impact to IMS	1. IMS NF reduces and restores message information 2. B2BUA required	1. IMS NF reduces and restores message information 2. Translate between text and binary format
Flexibility / Future proof (i.e. easy to add features removed originally)	Naturally support	Need a Container-like solution for future proof
Functional Compatibility	B2BUA is a standardized option that can be used not only for GEO voice, but also for, e.g., call processing between mobile phone and PSTN phone, some VoWiFi scenario, etc.	Binary formatted protocol is only suitable for bandwidth limited network, e.g., network with GEO access, ICS

YELLOW highlighted shows the major advantage, CYAN highlighted shows the complexity

Comparison on different options – Call Setup Time (CST) analysis

How to estimate the call setup time for comparison between different options and variants

1. The formula for calculating estimated *CST* ($ECST_{satToTerr}$) can be referred to Annex A.1 in TR 23.700-19 (**NOTE**: UL message after Service Request procedure needs BSR mechanism for resource reservation, so requires 3x propagation delay):

$$ECST_{satToTerr}[s] \approx ET_{stateTransition}^{[MO]}[s] + ET_{imsDelay}^{[MO]}[s] + ET_{epsDelay}^{[MO]}[s] + ET_{terr}[s]$$

$$ET_{imsDelay}[s] \approx \frac{S_{signallingOfIMS}[bits] + S_{imsHeader}[bits]}{R_{transmission}[bps]}[s] + D_{propagation} \times (3 \times N_{UL-IMS} + N_{DL-IMS})[s]$$

Transmission Delay

Observation: The proportion of transmission delay in Estimated Call Setup Time decreases as data rate (i.e., $R_{transmission}$) increases

2. There will be 9 messages (2 of Random access, 3 of Connection setup, 2 of Connection Reconfiguration, and 2 of NAS SMC) back and forth between UE and EPS network for UE transition into CONNECTED state, we assume $ET_{stateTransition}^{[MO]} \approx 9 \times D_{propagation} = 2.565s \approx \mathbf{3}s$ **roughly**, wherein $D_{propagation} = 0.285s$
3. According to Annex A.1 in TR 23.700-19, $ET_{terr} = 2.5s$ (half VoLTE, 4-5s based on experience)
4. For simplifying the comparison, some aspects that only have very limited impact on ECST are not considered:
   A. No matter whether IMS signaling is over UP or not, let $S_{imsHeader} = 52B$ if IP+UDP used, and let $S_{imsHeader} = 4B$ if non-IP used
   B. To remove the difference related to when voice bearer is setup, we assume voice bearer is setup after call setup request (e.g., SIP INVITE) for all options and variants, wherein 3 messages (2 UL and 1 DL) back and forth are needed according to clause 5.4.1 in TS 23.401. We assume no more than 0.5s for transmission delay of the 3 messages, then the calculation of the $ET_{epsDelay}$ **roughly** is as follows according to Annex A.1 in TR 23.700-19:

$$ET_{epsDelay} \approx 0.5 + 0.285 \times (3 \times 2 + 1) = 2.495s \approx \mathbf{2.5}s$$

NOTE: Call setup Time for Satellite-to-Satellite communication is almost **5s less** than double of the Call Setup Time for Satellite-to-Terrestrial communication according to Annex A.1 in TR 23.700-19

Comparison on different options – Call Setup Time (CST) analysis

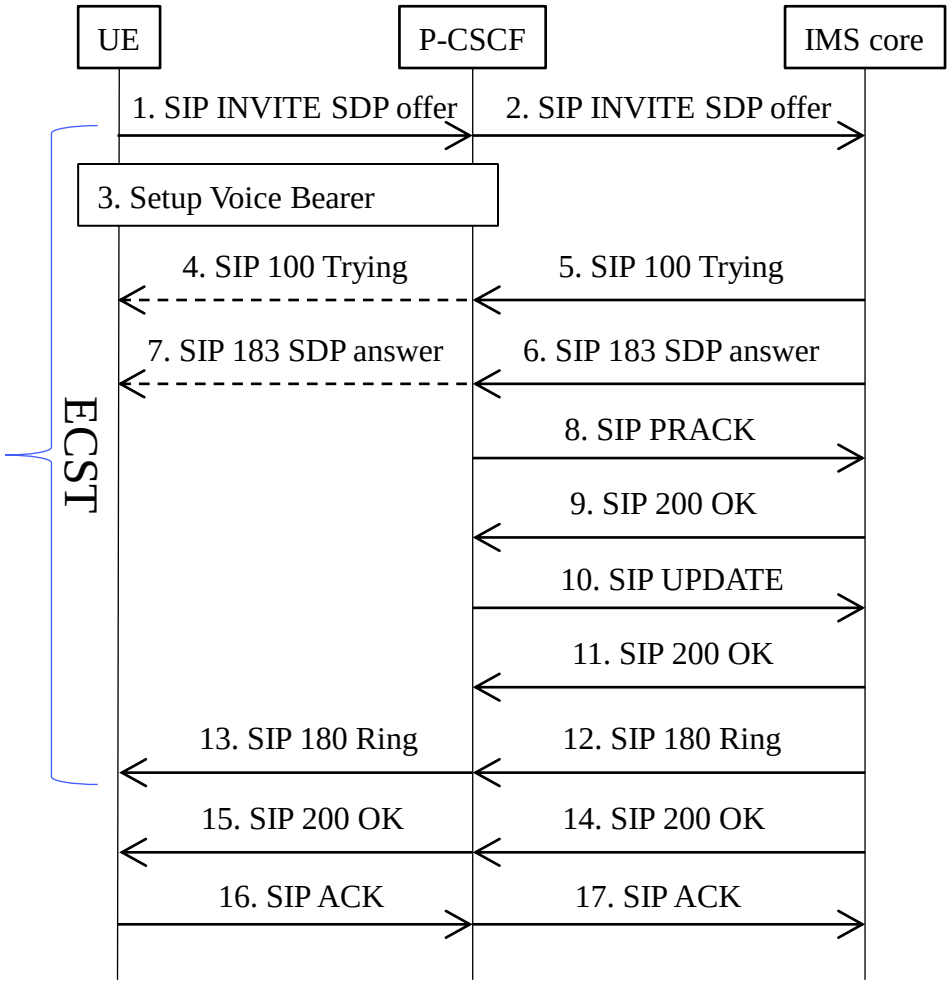
What is the reasonable minimal PHY data rate for GEO voice with quality (deduced from voice transmission options)

Options for voice transmission	Protocol header required PHY data rate when ptime = 80ms	Total required PHY data rate with 1.2kpbs voice codec rate
CP Non-IP	**13B** protocol overhead (RTP/NAS/AS=2/7/4): required PHY data rate = 13*8/0.08 = **1.3kbps**	**1.3kbps + 1.2kbps** = **2.5kbps**
UP Non-IP	**6B** protocol overhead (RTP/AS=2/4): required PHY data rate = 6*8/0.08 = **0.6kbps**	**0.6kbps + 1.2kbps** = **1.8kbps**
UP IP	A. **5-7B** protocol overhead (ROHC-SO/AS=1-3/4): required PHY data rate = [5-7]*8/0.08 = **0.5-0.7kbps** B. **12B** protocol overhead (ROHC-FO/AS=8/4): required PHY data rate = 12*8/0.08 = **1.2kbps** C. **46B** protocol overhead (IR/AS=42/4): required PHY data rate = 46*8/0.08 = **4.6kbps**	**[0.5-0.7]kbps + 1.2kbps** = **1.7-1.9kbps** 1.2kbps + 1.2kbps = **2.4kbps** 4.6kbps + 1.2kbps = **5.8kbps**
CP IP	A. **12-14B** protocol overhead (ROHC-SO/NAS/AS=1-3/7/4): required PHY data rate = [12-14]*8/0.08 = **1.2-1.4kbps** B. **19B** protocol overhead (ROHC-FO/NAS/AS=8/7/4): required PHY data rate = 19*8/0.08 = **1.9kbps** C. **53B** protocol overhead (IR/NAS/AS=42/7/4): required PHY data rate = 53*8/0.08 = **5.3kbps**	**[1.2-1.4]kbps + 1.2kbps** = **2.4-2.8kbps** 1.9bps + 1.2kbps = **3.1kbps** 5.3kbps + 1.2kbps = **6.5kbps**

Observation: Although ~1kbps to 3kpbs is required by SA1, $R_{transmission} \approx$ **2kbps** is a reasonable minimal PHY data rate for GEO voice

Comparison on different options – Call Setup Time (CST) analysis

Option#1: Text-based option (B2BUA required) over IP in case of 2Kbps PHY data rate



IMS message size according to solution#12 and #15

Sequence	Message Name	Message Size from sol#12 (B)	Message Size from sol#15 (B)
1	INVITE (UL)	~335 (+52)	~715 (+52)
2	100 Trying (DL)	~117 (+52)	
3	183 Progressing (DL)	~260 (+52)	
4	180 Ringing (DL)	~117 (+52)	~644 (+52)

$$ECST_{satToTerr}[s]\ (\mathbf{4\ small\ messages})$$

$$\approx 3[s] + \frac{3096 + 1352 + 2496 + 1352}{\mathbf{2000}}[s] + 0.285 \times (3 \times 1 + 3)[s] + 2.5[s] + 2.5[s]$$

$$= 13.858\text{s} \approx 13.9\text{s}$$

$$ECST_{satToTerr}[s]\ (\mathbf{2\ big\ messages}, i.e., "no\ pre-condition"\ style)$$

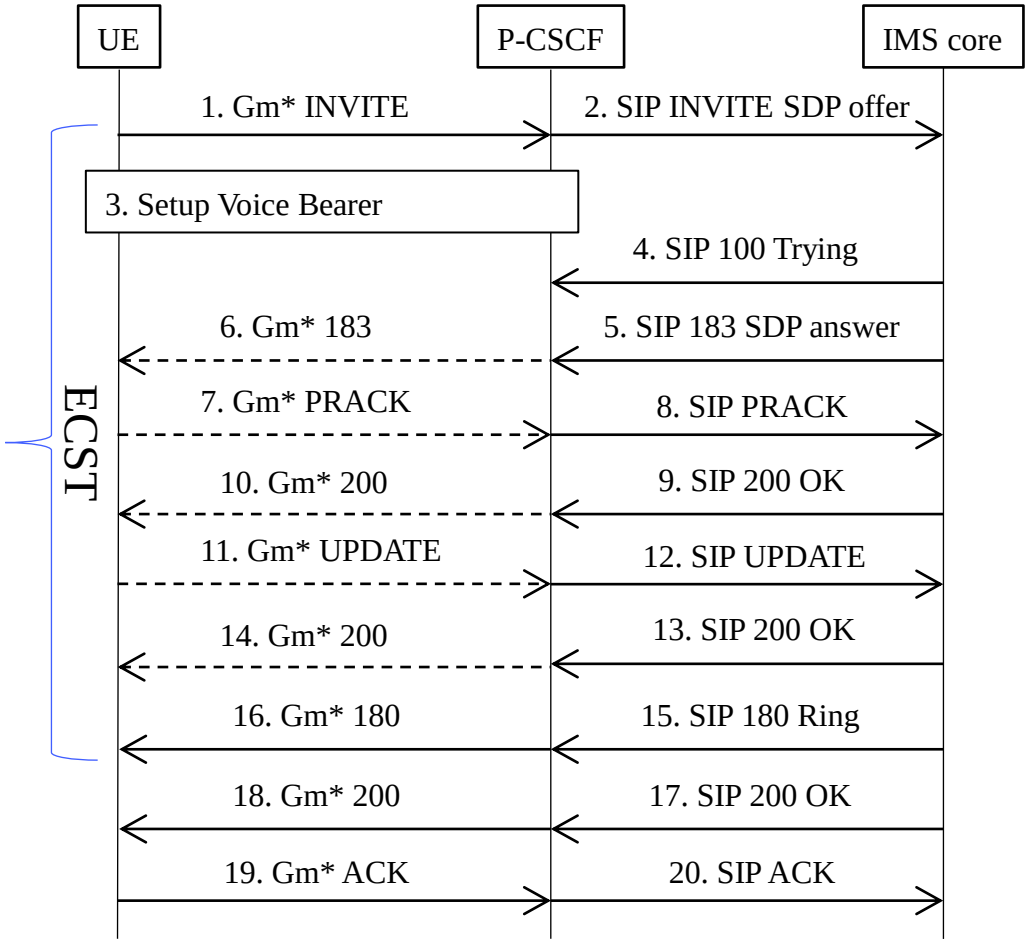
$$\approx 3[s] + \frac{6136 + 5568}{\mathbf{2000}}[s] + 0.285 \times (3 \times 1 + 1)[s] + 2.5[s] + 2.5[s] = 14.992\text{s} \approx 15\text{s}$$

$$ECST_{satToTerr}[s]\ (\mathbf{2\ small\ messages}, i.e., "no\ pre-condition"\ style)$$

$$\approx 3[s] + \frac{3096 + 1352}{\mathbf{2000}}[s] + 0.285 \times (3 \times 1 + 1)[s] + 2.5[s] + 2.5[s] = 11.364\text{s} \approx 11.4\text{s}$$

Comparison on different options – Call Setup Time (CST) analysis

Option#2: Binary-based option in case of 2Kbps PHY data rate



IMS message size according to solution#20

Sequence	Message Name	Message Size (B) (proportional)
1	INVITE (UL)	37 (+52)
2	183 (DL)	75 (+52)
3	PRACK (UL)	16 (+52)
4	200 OK (PRACK) (DL)	10 (+52)
5	UPDATE (UL)	17 (+52)
6	200 OK (UPDATE) (DL)	17 (+52)
7	180 Ringing (DL)	10 (+52)

$$ECST_{satToTerr}[s]\ (\boldsymbol{No\ B2BUA}, 7\ messages, i.e., "pre-condition"\ style)$$

$$\approx 3[s] + \frac{712 + 1016 + 544 + 496 + 552 + 552 + 496}{\mathbf{2000}}[s] + 0.285 \times (3 \times 3 + 4)[s]$$

$$+ 2.5[s] + 2.5[s] = 13.889s \approx 13.9s$$

$$ECST_{satToTerr}[s]\ (\boldsymbol{B2BUA}, 2\ messages, i.e., "no\ pre-condition"\ style)$$

$$\approx 3[s] + \frac{712 + 496}{\mathbf{2000}}[s] + 0.285 \times (3 \times 1 + 1)[s] + 2.5[s] + 2.5[s] = 9.744s \approx 9.7s$$

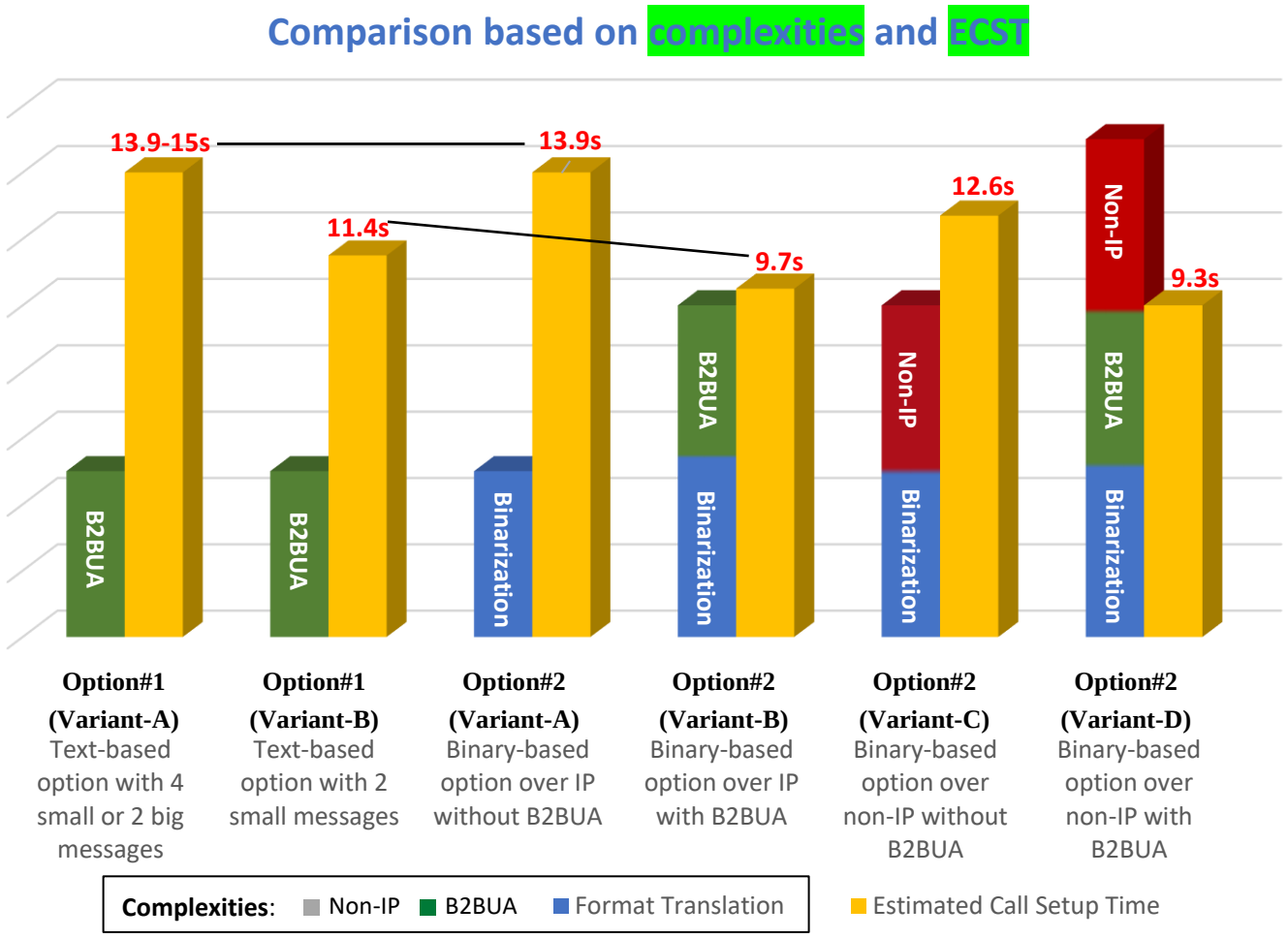
NOTE: For variants of non-IP (reduce IP+UDP header, whose size is assumed to be 48), if B2BUA is not used, the ECST is reduced by about **1.3s** (48*8*7/2000) from 13.9s, if B2BUA is used, the ECST is reduced about **0.4s** (48*8*2/2000) from 9.7s

Comparison on different options – Call Setup Time (CST) analysis

Following options and variants are compared:

- Option#1: Text-based option with following variants:
  - Variant-A: 4 small or 2 big messages
  - Variant-B: 2 small messages
- Option#2: Binary-based option with following variants:
  - Variant-A: B2BUA is not used, IP transport
  - Variant-B: B2BUA (2 messages) is used, IP transport
  - Variant-C: B2BUA is not used, non-IP transport
  - Variant-D: B2BUA is used (2 messages), non-IP transport

NOTE: The complexities (i.e., B2BUA, Binarization, and Non-IP) in the figure are not quantitative



Observation#1: Comparing between Option#1 Variant-A, Option#1 Variant-B, and Option#2 Variant-A, in case of 2kbps PHY data rate, CST of Option#2 Variant-B is almost the same as Option#1 Variant-A or larger than Option#2 Variant-B, i.e., **text-based option performs at least as well as binary-based option without B2BUA** in minimal reasonable PHY data rate

Observation#2: Comparing between Option#1 Variant-B and Option#2 Variant-B**, extra complexity of Binarization only achieves 1.7s gain on 11.4s (~15%),** and **the gain will be less if PHY data rate increasing** (e.g., **when 3kbps used, only ~10% gain**) according to slides 5, 7, and 8

Observation#3: Complexity of non-IP achieves ~1.3s / 0.4s gain on ~14s / 10s, It is questionable whether the complexity of non-IP is justified

Pros and Cons

Pros & Cons / Options	Pros	Cons
Option#1: **Text-based option**	1. Naturally support flexible / future proof 2. No format translation 3. SIP protocol between UE and IMS network	1. Message size is large, e.g., INVITE is around 400B 2. B2BUA is required to mitigate message size disadvantage
Option#2: **Binary-based option**	1. Message size is small, e.g., INVITE is around 40B 2. B2BUA is optional	1. Need a container-like solution to support flexible / future proof 2. Format translation required 3. Newly defined protocol between UE and IMS network

Proposals

Based on current analysis, the performance of both option#1 (text-based) and option#2 (binary-based) fulfills SA1 requirement, and the complexity needs to be selected between B2BUA and format translation:

- Text-based option: B2BUA is required, IMS signaling between UE and IMS network is based on SIP protocol
- Binary-based option: B2BUA is optional, IMS signaling between UE and IMS network is based on binary formatted protocol

vivo's initial view: it is proposed to tentatively reach consensus on:

A. UE is required to perform IMS registration

B. If B2BUA is required to be deployed, text-based option is selected, otherwise binary based option is selected, and further down-scope needed

Thanks