**3GPP TSG SA WG4 Meeting #132 S4-251148**

**Fukuoaka, JP, May 19 – 23, 2025 revision of SP-250378**

**Source: China Mobile, Qualcomm Incorporated, Ericsson, Dolby Laboratories, Nokia, Xiaomi, Viasat, Sateliot, Thales, Airbus, Novamint, Fraunhofer IIS, ESA, EchoStar**

**Title: Draft Update on Ultra Low Bitrate Speech Codec**

**Document for: Agreement**

**Agenda Item: 7.9**

3GPP™ Work Item Description

Information on Work Items can be found at <http://www.3gpp.org/Work-Items>
See also the [3GPP Working Procedures](http://www.3gpp.org/specifications-groups/working-procedures), article 39 and the TSG Working Methods in [3GPP TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm)

Title: Study on Ultra Low Bitrate Speech Codec

Acronym: FS\_ULBC

Unique identifier: 1070055

Potential target Release: Rel-20

# 1 Impacts

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Affects: | UICC apps | ME | AN | CN | Others (specify) |
| Yes |  | X |  | X |  |
| No | X |  | X |  | X |
| Don't know |  |  |  |  |  |

# 2 Classification of the Work Item and linked work items

## 2.1 Primary classification

### This work item is a …

|  |  |
| --- | --- |
| X | Study  |
|  | Normative – Stage 1 |
|  | Normative – Stage 2 |
|  | Normative – Stage 3 |
|  | Normative – Other\* |

**\* Other = e.g. testing**

## 2.2 Parent Work Item

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| --- |
| Parent Work / Study Items  |
| Acronym | Working Group | Unique ID | Title (as in 3GPP Work Plan) |
|  |  |  |  |

### 2.3 Other related Work Items and dependencies

|  |  |  |
| --- | --- | --- |
| Unique ID | Title | Nature of relationship |
| 60149 | Mandatory speech codec for narrowband telephony service | May reference the study phase of narrowband speech codecs for lMS Voice Call Using GEO Access |
| 720005 | (Stage 1 of 5G) New Services and Markets Technology Enablers(SMARTER) | May reference channels characteristics of GEO satellite access serving as a baseline for further research on GEO channel characteristics and service experience. |
| 1030042 | Study on satellite access - Phase 4(FS\_5GSAT\_Ph4) | May reference the scenarios and KPl requirements for lMS Voice Call Using GEO Access. It also provides market motivation and scenario requirements for ULBC development. |
| 1060071 | Satellite access - Phase 4(5GSAT\_Ph4) | May reference as normative scenarios and KPI requirements for lMS Voice Call Using GEO Access to initiate ULBC development. (SA1 Rel-20 work item). |

# 3 Justification

3GPP SA1 has studied the use case IMS Voice Call Using GEO Access, and the results are documented in TR 22.887. Normative service requirements and KPIs on IMS voice call using GEO satellite access will be introduced in TS 22.261 at TSG#107. GEO satellites are on a 35,786 km distance from the earth, which noticeably impacts signal propagation delay (one way approx. 285ms), data rate, and channel conditions due to e.g. atmospheric attenuation. Compared to terrestrial links, this poses significant new challenges for the voice codecs and services:

* The overall transmission data rate assumed for GEO satellite systems is very constrained due to e.g. high path loss, atmospheric attenuation, energy constraints for terminals etc.. In TR 22.887, a total transmission data rate of [1-3] kbit/s is assumed. This transmission data rate are lower than what current 3GPP protocol stacks and codecs can supports.
* For GEO satellite access, the propagation delay (285ms) is much longer than for commonly used terrestrial links.
* The GEO satellite link imposes different channel characteristics, e.g., due to atmospheric attenuation.

Currently, no 3GPP voice codec seems to support all the expected requirements for this use case. Considering bitrate alone, the lowest supported bitrate of any 3GPP codec is 4.75 kbit/s as provided by the narrow band AMR codec (TS 26.071). This makes it necessary to have a new feasibility study relating to ultra-low bitrate codecs suitable for voice using GEO access.

The primary focus of this study is to develop design constraints and performance requirements for a codec supporting use cases like IMS Voice Call over GEO and the resulting transmission parameters. The requirements can provide guidance on the evaluation of the candidate codecs during potential normative work.

**1. General considerations**

**- Bitrate:** TR 22.887 concludes that the transmission rates are lower than what current 3GPP protocol stacks and codecs can supports. Detailed analysis on available bitrate requires more study..

**- Quality:** Despite of the low bit rate, a good audio quality of the codec is of importance, to ensure a reasonable QoE. Detailed QoE requirements for such services are for study..

**- Complexity and memory demands:** Modern low bitrate codecs exhibit a large scale of complexity and memory demands. The codec is expected to be deployable on the processing capabilities as can be found in today’s smartphones. Exact complexity requirements are for study.

**- Robustness to network conditions**: the codec is expected to operate in typical network conditions (delay, loss, jitter, etc.). Details are for further study.

**2. Functional requirements**

- **Speech transcoding functions**: To achieve integration with the terrestrial voice communication system (4G/5G IMS architecture), it is necessary to consider tandeming with existing IMS voice codecs.

NOTE: Additional study areas or use cases, such as assessing the market potential and potential market-readiness of a new ULBC codec should be added with lower priority if time permits and once the exact requirements can be given.

It is expected that coordination with other working groups, e.g. SA2, CT1, RAN2 is needed in order to substantiate the design constraints of such a codec. However, it is not expected that this work creates any dependency for studies and normative in other working groups.

# 4 Objective

The objective of this study is to develop recommendations for potential normative work on an ultra-low bit rate codec with primary application for voice over GEO. Specifically, the following objectives are identified:

1. Document the application scenarios for ultra-low bit rate communication services taking into account the use cases and potential requirements documented in TR 22.887 related to IMS Voice Call Using GEO Access.

NOTE: Other application scenarios and related objectives, such as IMS voice call over 3GPP NGSO/GSO Satellites and Terrestrial Networks, are not excluded from the scope of the study but addressed with lower priority and shall not impact the completion timeline of the study while completing all objectives for the primary application.

2. Study GEO channel characteristics and derive service-related dependencies, e.g. bitrates, mouth-to-ear delay or loss/delay/jitter profiles.

NOTE: Any impact of ultra-low bitrate voice codec on other NB-IoT services is outside of the scope of the study and is expected to be addressed by other working groups.

3. Identify the relevant design constraints for such a codec, in coordination with other WGs, including

- Bit rates

- Sample rate and audio bandwidth

- Frame length

- Complexity and memory demands

- Algorithmic delay

- Packet loss concealment (PLC)

- Potential use of noise suppression as part of the codec

- Discontinuous transmission including voice activity detection and comfort noise

- Speech quality

- Robustness to non-speech input

4. Provide some evidence that the design criteria can be met, for example existing reference codecs.

5. Define performance requirements and identify appropriate test methodologies, regarding speech quality, intelligibility, conversational quality, in particular taking into account

a) Clean speech and noisy speech

b) Tandeming with existing IMS voice codecs

c) Clean channel and GEO channel conditions

6. Identify or develop objective measures to verify the design constraints as necessary (e.g., to measure complexity and memory demands)

7. Identify relevant reference codecs for comparison and evaluation purposes.

8. Coordinate work with other 3GPP groups e.g. SA2, RAN, CT1, and others as needed.

9. Define potential normative work item objectives and timeline.

# 5 Expected Output and Time scale

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| --- |
| **New specifications** |
| Type  | TS/TR number | Title | For info at TSG#  | For approval at TSG# | Rapporteur |
| External TR | 26.940 | Study on Ultra Low Bitrate Speech Codecs | SA#111(Mar. 26) | SA#112(Jun. 26) |  |
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| --- |
| Impacted existing TS/TR |
| TS/TR No. | Description of change  | Target completion plenary# | Remarks |
|  |  |  |  |
|  |  |  |  |

# 6 Work item Rapporteur(s)

Xu Jiayi, China Mobile, xujiayi@chinamobile.com

# 7 Work item leadership

SA4

# 8 Aspects that involve other WGs

SA2 for architectural enhancements to enable NB-IoT (GEO) satellite access to support IMS voice call.

RAN WGS for bitrates, channel characteristics and protocol overheads.

CT1 for User Equipment (UE) to Core Network interfaces and protocol overheads..

CT4 for transcoding operations, if applicable.

NOTE: It is not expected that this work creates any dependency for studies and normative work in other working groups.

# 9 Supporting Individual Members

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| **Supporting IM name** |
| Airbus |
| AT&T |
| Bytedance |
| China Mobile |
| China Unicom |
| CSCN |
| Deutsche Telekom |
| Dolby Laboratories Inc. |
| EchoStar |
| Ericsson LM |
| ESA |
| ETRI |
| Fraunhofer IIS |
| Huawei |
| Inmarsat |
| KT Crop. |
| Nokia |
| Novamint |
| Orange |
| Qualcomm Incorporated |
| Sateliot |
| Spreadtrum |
| SyncTechno Inc. |
| Thales |
| Verizon |
| Viasat |
| vivo |
| Vodafone |
| VoiceAge Corporation |
| Xiaomi |
| ZTE |