|  |
| --- |
| 3GPP TR 26.940 V0.0.2 (2025-04) |
| Technical ReportIn the document, delete either "TS" and "Specification" or "TR" and "Report" as applicable. These instances are shown with yellow highlighting. Also ensure the copyright date, version, spec number, title and Release (also highlighted) are correct.Below, replace <TSG name> by the [appropriate text](#tsgNames).  |
| 3rd Generation Partnership Project;Technical Specification Group Services and System Aspects;Study on Ultra Low Bit rate Speech Codecs(Release 20) |
|   |
|  |  |
|  |
| The present document has been developed within the 3rd Generation Partnership Project (3GPP TM) and may be further elaborated for the purposes of 3GPP.The present document has not been subject to any approval process by the 3GPPOrganizational Partners and shall not be implemented.This Specification is provided for future development work within 3GPPonly. The Organizational Partners accept no liability for any use of this Specification.Specifications and Reports for implementation of the 3GPP TM system should be obtained via the 3GPP Organizational Partners' Publications Offices. |

|  |
| --- |
|  |
| ***3GPP***Postal address3GPP support office address650 Route des Lucioles - Sophia AntipolisValbonne - FRANCETel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16Internethttps://www.3gpp.org |
| ***Copyright Notification***No part may be reproduced except as authorized by written permission.The copyright and the foregoing restriction extend to reproduction in all media.© 2025, 3GPP Organizational Partners (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC).All rights reserved.UMTS™ is a Trade Mark of ETSI registered for the benefit of its members3GPP™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational PartnersLTE™ is a Trade Mark of ETSI registered for the benefit of its Members and of the 3GPP Organizational PartnersGSM® and the GSM logo are registered and owned by the GSM Association |

Contents

Foreword 4

Introduction 4

1 Scope 5

2 References 6

3 Definitions of terms, symbols and abbreviations 6

3.1 Terms 6

3.2 Symbols 6

3.3 Abbreviations 7

4 Application scenarios for ultra-low bit rate communication services 7

5 Channel characteristics and service-related dependencies 7

6 Design constraints 7

7 Existing technologies and feasibility evidence 8

8 Performance requirements 8

9 Test methodologies 8

10 Considered work plan for potential normative work 8

11 Conclusions and recommendations 9

Proforma copyright release text block 10

X.1 The right to copy 10

Abstract Test Suite (ATS) text block 11

Y Abstract Test Suite (ATS) 11

Y.1 Introduction 11

Y.2 The TTCN Graphical form (TTCN.GR) 11

Y.3 The TTCN Machine Processable form (TTCN.MP) 11

Annex <A> (normative): <Normative annex for a Technical Specification> 12

Annex <B> (informative): <Informative annex for a Technical Specification> 13

B.1 Heading levels in an annex 13

Annex <F> (informative): Change history 15

For definitive guidance on drafting 3GPP TSs and TRs, see [3GPP TS 21.801](https://www.3gpp.org/DynaReport/21801.htm).

Ensure all blue guidance text is removed before submitting the TS/TR to the TSG for approval.

# Foreword

This clause is mandatory; do not alter the text in any way other than to choose between "Specification" and "Report".

This Technical Report has been produced by the 3rd Generation Partnership Project (3GPP).

The contents of the present document are subject to continuing work within the TSG and may change following formal TSG approval. Should the TSG modify the contents of the present document, it will be re-released by the TSG with an identifying change of release date and an increase in version number as follows:

Version x.y.z

where:

x the first digit:

1 presented to TSG for information;

2 presented to TSG for approval;

3 or greater indicates TSG approved document under change control.

y the second digit is incremented for all changes of substance, i.e. technical enhancements, corrections, updates, etc.

z the third digit is incremented when editorial only changes have been incorporated in the document.

In drafting the TS/TR, pay particular attention to the use of modal auxiliary verbs! TRs shall not contain any normative provisions.

In the present document, modal verbs have the following meanings:

**shall** indicates a mandatory requirement to do something

**shall not** indicates an interdiction (prohibition) to do something

The constructions "shall" and "shall not" are confined to the context of normative provisions, and do not appear in Technical Reports.

The constructions "must" and "must not" are not used as substitutes for "shall" and "shall not". Their use is avoided insofar as possible, and they are not used in a normative context except in a direct citation from an external, referenced, non-3GPP document, or so as to maintain continuity of style when extending or modifying the provisions of such a referenced document.

**should** indicates a recommendation to do something

**should not** indicates a recommendation not to do something

**may** indicates permission to do something

**need not** indicates permission not to do something

The construction "may not" is ambiguous and is not used in normative elements. The unambiguous constructions "might not" or "shall not" are used instead, depending upon the meaning intended.

**can** indicates that something is possible

**cannot** indicates that something is impossible

The constructions "can" and "cannot" are not substitutes for "may" and "need not".

**will** indicates that something is certain or expected to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**will not** indicates that something is certain or expected not to happen as a result of action taken by an agency the behaviour of which is outside the scope of the present document

**might** indicates a likelihood that something will happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

**might not** indicates a likelihood that something will not happen as a result of action taken by some agency the behaviour of which is outside the scope of the present document

In addition:

**is** (or any other verb in the indicative mood) indicates a statement of fact

**is not** (or any other negative verb in the indicative mood) indicates a statement of fact

The constructions "is" and "is not" do not indicate requirements.

# Introduction

This clause is optional. If it exists, it shall be the second unnumbered clause.

# 1 Scope

This clause shall start on a new page.

[The present document develops recommendations for potential normative work on an ultra-low bit rate codec for the use case of IMS voice services over Geostationary Orbit (GEO) access.]

Editor’s Note:

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.

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[22261] 3GPP TS 22.261: "Service requirements for the 5G system".

[22887] 3GPP TR 22.887: "Feasibility Study on satellite access - Phase 4".

[26071] 3GPP TS 26.071: "Mandatory speech CODEC speech processing functions; AMR speech Codec; General description".

…

[x] <doctype> <#>[ ([up to and including]{yyyy[-mm]|V<a[.b[.c]]>}[onwards])]: "<Title>".

It is preferred that the reference to TR 21.905 be the first in the list.

# 3 Definitions of terms, symbols and abbreviations

This clause and its three (sub) clauses are mandatory. The contents shall be shown as "void" if the TS/TR does not define any terms, symbols, or abbreviations.

## 3.1 Terms

For the purposes of the present document, the terms given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Definition format (Normal)

**<defined term>:** <definition>.

**example:** text used to clarify abstract rules by applying them literally.

## 3.2 Symbols

For the purposes of the present document, the following symbols apply:

Symbol format (EW)

<symbol> <Explanation>

## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

GEO Geostationary Orbit

# 4 Application scenarios for ultra-low bit rate communication services

Editor’s Note:

From the WID:

- 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.

- 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.

Input on further application scenarios is invited.

# 5 Channel characteristics and service-related dependencies

Editor’s Note:

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 in NB-IoT services is outside of the scope of the study and is expected to be addressed by other working groups.

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

# 6 Design constraints

Editor’s Note:

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

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

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

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

# 7 Existing technologies and feasibility evidence

Editor’s Note:

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

# 8 Performance requirements

Editor’s Note:

5a. Define performance requirements regarding speech quality, intelligibility, conversational quality, in particular taking into account:

- Clean speech and noisy speech

- Tandeming with existing IMS voice codecs

- Clean channel and GEO channel conditions

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 Test methodologies

Editor’s Note:

5b. Identify appropriate test methodologies, regarding speech quality, intelligibility, conversational quality, in particular taking into account:

- Clean speech and noisy speech

- Tandeming with existing IMS voice codecs

- Clean channel and GEO channel conditions

# 10 Considered work plan for potential normative work

Editor’s Note:

9. Define potential normative work item objectives and timeline.

# 11 Conclusions and recommendations

# Proforma copyright release text block

(e.g. for PICS and PIXIT Proformas)

This text block shall immediately follow the heading of an element (i.e. clause or annex) containing a proforma or template which is intended to be copied by the user. Such an element shall always start on a new page.

## X.1 The right to copy

Notwithstanding the provisions of the copyright clause related to the text of the present document, the 3GPP Organizational Partners grant that users of the present document may freely reproduce the <proformatype> proforma in this clause|annex so that it can be used for its intended purposes and may further publish the completed <proformatype>.

# Abstract Test Suite (ATS) text block

This text should be used for ATS using TTCN. The subdivision is recommended.

# Y Abstract Test Suite (ATS)

## Y.1 Introduction

This ATS has been produced using the Tree and Tabular Combined Notation (TTCN) according to ISO/IEC 9646‑3 [x].

The ATS was developed on a separate TTCN software tool and therefore the TTCN tables are not completely referenced in the table of contents. The ATS itself contains a test suite overview part which provides additional information and references.

# Y.2 The TTCN Graphical form (TTCN.GR)

The TTCN.GR representation of this ATS is contained in an Adobe Portable Document Format™ file (<pdf\_file\_name>.PDF contained in archive <zip\_file\_name>.ZIP) which accompanies the present document.

# Y.3 The TTCN Machine Processable form (TTCN.MP)

The TTCN.MP representation corresponding to this ATS is contained in an ASCII file (<mp\_file\_name>.MP contained in archive <zip\_file\_name>.ZIP) which accompanies the present document.

Annex <A> (normative):
<Normative annex for a Technical Specification>

Start each annex on a new page.

Annexes are labelled A, B, C, etc. and designated either "normative" or "informative" depending on their content.

Normative annexes only to appear in Technical Specifications. Use style "Heading 8".

Annex <B> (informative):
<Informative annex for a Technical Specification>

Informative annexes may appear in both Technical Specifications and Technical Reports. Use style "Heading 8" for use in TSs.

Informative annexes shall not contain requirements for the implementation of the Technical Specification.

# B.1 Heading levels in an annex

Heading levels within an annex are used as in the main document, but for Heading level selection, the "A.", "B.", etc. are ignored. e.g. **B.1.2** is formatted using ***Heading 2*** style.

Annex <F> (informative):
Change history

Use style "Heading 8" in TSs and "Heading 9" in TRs. Do not use "informative" in the title in TRs.

This is the last annex for TS/TSs which details the change history using the following table.
This table is to be used for recording progress during the WG drafting process till TSG approval of this TS/TR.
For TRs under change control, use one line per approved Change Request
Date: use format YYYY-MM
CR: four digits, leading zeros as necessary
Rev: blank, or number (max two digits)
Cat: use one of the letters A, B, C, D, F
Subject/Comment: for TSs under change control, include full text of the subject field of the Change Request cover
New vers: use format [n]n.[n]n.[n]n

|  |
| --- |
| Change history |
| Date | Meeting | TDoc | CR | Rev | Cat | Subject/Comment | New version |
| 2025-04 | SA4#131-bis-e | S4-250451 |  |  |  | Initial version submitted for SA4#131-bis-e | 0.0.1 |
| 2025-04 | SA4#131-bis-e | S4-250700 |  |  |  | Agreed version in SA4#131-bis-e | 0.0.2 |