

DTMF Best Practice Guide (BPG)

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Foreword

This NICC Document (ND) has been produced by NICC All IP TG (All Internet Protocol Task Group).

1 Scope

The present document is a Best Practice Guide (BPG) for conveying DTMF (Dual-Tone Multi-Frequency) over IP networks. As specified in ND1704 [1], for Voice Capable networks the preferred method of transmission for DTMF is RTP (Real-time Transport Protocol) Telephony Events, whilst for Voice-band Data (VBD) Capable networks DTMF is carried in-band. The latter is straightforward, although conversion between in-band DTMF and Telephony Events (where unavoidable) can be problematic. Consequently, this document is mostly concerned with RTP Telephony Events, but it also provides information in relation to interworking.

Note: whilst IETF RFC 4733 [2] is the main Internet standard for RTP Telephony events, this BPG summarises key considerations based on practical implementations.

2 References

2.1 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For non-specific references, the latest edition of the referenced document (including any amendments) applies.

- [1] NICC ND1704 End-to-End Network Performance Rules & Objectives for the Interconnection of NGNs
- [2] IETF RFC 4733 RTP Payload for DTMF Digits, Telephony Tones, and Telephony Signals
- [3] ETSI drafting rules Verbal Forms For The Expression Of Provisions Version 2015-06

2.2 Informative references

- [i1] ITU-T Rec. Q.24 Multifrequency push-button signal reception
- [i2] IETF RFC 2198 RTP Payload for Redundant Audio Data
- [i3] IETF RFC 7874 WebRTC Audio Codec and Processing Requirements
- [i4] ITU-T Rec. V.18: Operational and interworking requirements for DCEs operating in the text telephone mode
- [i5] BSI Group BS 8521: Specification for dual-tone multi-frequency (DTMF) signalling protocol for social alarm systems
- [i6] BSIA Publication 255: Guide for fast format protocol for intruder alarm reporting

3 Definitions, symbols and abbreviations

3.1 Key words

The key words “**shall**”, “**shall not**”, “**should**”, “**should not**”, “**may**”, “**need not**”, “**can**” and “**cannot**”, “**will**”, “**will not**” in this document are to be interpreted as defined in the ETSI Drafting Rules [3].

3.2 Abbreviations

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

All IP TG	All Internet Protocol Task Group
ATA	Analogue Telephone Adapter
BPG	Best Practice Guide
DCE	Data Circuit-terminating Equipment
DTMF	Dual-Tone Multi-Frequency
IP	Internet Protocol
IVR	Interactive Voice Response
PT	Payload Type
RTP	Real-time Transport Protocol
SDP	Session Description Protocol
TE	Telephony Event
VBD	Voice-band Data
VoIP	Voice over Internet Protocol

4 Guidelines for carrying DTMF using RTP Telephony Events

Use of Payload Type 101

As per IETF RFC 4733 [2], Voice Over Internet Protocol (VoIP) terminals use dynamic payload types (PT) for Telephony Events (TEs). Some implementations are hard-coded to use PT101, which may be considered the de facto payload type number, but terminals **should** accept offers/responses with non-101 payload type numbering and be able to run asymmetric payload type numbering.

In-band DTMF ‘leakage’

Ideally, Telephony Events will be generated natively from the point of user input. This may not be achieved in some configurations, for example, when using an analogue phone and ATA (Analogue Telephone Adapter) where electrical DTMF tones are detected and converted to Telephony Events. Additionally, some IP phones use a frequency generator and detector function from which TEs are subsequently generated.

In order to avoid problems with DTMF detection, terminals **should** be designed to minimise the amount of in-band leakage (less than 20 ms for ITU-T Rec. Q.24 [i1] compatibility, or 15 ms including a safety margin).

Complete removal of in-band DTMF **may** be advisable under some circumstances. For example, consider a scenario comprising inband-TE-inband-TE-inband conversion. Leakage from two inband-TE conversions may be present at the destination inband detector in conjunction with the wanted inband signal from the final TE-inband conversion. Precisely where this occurs in the signal can be unpredictable, but it is plausible that additive leaked signals (individually constrained to, for example, 15 ms) could lead to erroneous detection. Complete removal avoids such unpredictability.

Redundancy and Robustness

IETF RFC 2198 [i2] redundancy headers **may** be supported but implementations **shall** be capable of operating without them.

The final ‘E’ bit **should** be sent three times (in accordance with guidelines in IETF RFC 4733 [2]) in order to guard against packet loss.

The receiver **should** choose to delay (if required) playout of the tones by a small interval (e.g. 40 ms) after playout of the preceding audio has ended. This is to ensure downstream equipment can discriminate tones properly.

IETF RFC 4733 [2] does not state what the receiver behaviour should be in the event of total loss of start marked, update marked and/or end marked telephony event packets. At the time of publication of ND1444 version 1.1.1, no known solution has been proposed for this issue.

Duration

As defined in IETF RFC 4733 [2], a DTMF event is not a state, therefore it **should** not be sent with duration 0. IETF RFC 7874 [i3] specifies ‘*DTMF events generated by a WebRTC endpoint MUST have a duration of no more than 8000 ms and no less than 40 ms. The recommended default*

duration is 100 ms for each tone. 100 ms is probably safe to use in most Human-Machine DTMF scenarios.

The Initial Duration/Timestamps can be considered the best estimate of when a tone actually started. Similarly, the duration sent in end packets can be considered the best estimate of when a tone has stopped (with duration no lower than that set by the initial or intermediate packets).

Volume (Level)

Ideally, TEs **should** be generated natively, in which case the volume **should** be set to zero (indicating that the volume is not applicable) in accordance with IETF RFC 4733 [2]. Where absolute volume is important, the terminal should measure/set or read/playout the correct level accordingly.

Event Gap

IETF RFC 7874 [i3] states *'The gap between events MUST be no less than 30 ms; the recommended default gap duration is 70 ms.'* and IETF RFC 4733 [2] states *'A natural interval is the spacing between non-event audio packets.... Alternatively, a source MAY decide to use a different spacing for event updates, with a value of 50 ms RECOMMENDED'*.

Therefore, support is required for TEs sent at a refresh rate that is different to the packetisation time. However, where possible, setting the TE refresh rate to equal the p-time is recommended in order to simplify receiver requirements.

Sampling Frequency

Where wideband codecs (except G.722) sampled at 16 kHz are offered, support for 16 kHz TEs **shall** also be provided and offered in Session Description Protocol messages (SDP) potentially in addition to 8 kHz TEs to be used in conjunction with narrowband codecs and/or G.722.

5 Notes on support for DTMF-based VBD and interworking

A number of implementations use machine generated DTMF sequences as opposed to tones generated directly as a result of human input (e.g. responding to Interactive Voice Response prompts by selecting digits on a keypad). This includes the following implementations and respective tone duration specifications:

- ITU-T Rec. V.18 Annexe B [i4]. *The DCE (Data Circuit-terminating Equipment) shall detect characters at least 40 ms in length with silent intervals of at least 40 ms. The DCE shall transmit DTMF characters at least 70 ms in length with silent intervals of at least 50 ms.*
- BSI Group BS8521 [i5] Telecare protocol: *On duration = 80 ms (+/-5 ms). Tone sequences are sent with a (80 ± 5) ms gap between tones.*

- BSIA Publication 255 [i6] Fast Format Alarm protocol: *The duration of each DTMF digit is nominally 60 ms followed by an inter-digit pause of 60 ms silence. The minimum is 50 ms and the maximum should be 100 ms, in each case.*

In order to minimise message transmission times, these sequences may use very short pulse lengths and gaps. As such, they may be susceptible to pulse length distortion caused by tandem encoding/decoding from inband=>TE=>inband to the extent that pulse or inter-digit gap lengths are below minimums guaranteed to ensure correct digit detection.

Any terminal should not distort either pulse lengths or inter-digit gap lengths by more than +/- 10 ms when various lengths of pulse & gap (at least as great as the minimum defined above) are played through a back-to-back encoder/decoder.

Conversely, there are some applications that use quite long digit durations with tight tolerances, e.g. BSI Group BS8521 [i5] telecare protocol, which uses 1000 ms (+/-5 ms) digits.

However, adhering to Rule VBD1 in ND 1704 [1] 'DTMF, fax and data **should** be carried in-band to reliably handle time sensitive, machine-machine transmission of DTMF, fax and data.' avoids such issues.

History

Document history		
V1.1.1	August 2018	Initial publication