

Codec Working Group  
Internet-Draft  
Intended status: Standards Track  
Expires: October 28, 2010

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April 29, 2010

**BroadVoice Speech Codecs  
draft-chen-bv-codec-00**

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Abstract

BroadVoice(R) [[bv-website](#)] is a family of two open-source speech codecs suitable for Voice over IP (VoIP) applications. It is designed to achieve high speech quality with relatively low complexity and a very low coding delay. BroadVoice consists of two variants: a 16 kb/s narrowband codec for 8 kHz sampling called BroadVoice16, or BV16, and a 32 kb/s wideband codec for 16 kHz sampling called BroadVoice32, or BV32. BV16 and BV32 are standard codecs of PacketCable(TM), SCTE(R), and ANSI for VoIP applications in cable telephony, and they are also listed as optional codecs in the ITU-T Recommendations J.161 and J.361, respectively. This document describes the BV16 and BV32 speech codecs.

Table of Contents

- [1.](#) Introduction . . . . . [3](#)
- [2.](#) Overview of the BroadVoice Family of Codec . . . . . [4](#)
- [3.](#) The BroadVoice16 (BV16) Codec . . . . . [6](#)
- [4.](#) The BroadVoice32 (BV32) Codec . . . . . [7](#)
- [5.](#) Security Considerations . . . . . [8](#)
- [6.](#) IANA Considerations . . . . . [9](#)
- [7.](#) Acknowledgments . . . . . [10](#)
- [8.](#) References . . . . . [11](#)
  - [8.1.](#) Normative References . . . . . [11](#)
  - [8.2.](#) Informative References . . . . . [11](#)
- Authors' Addresses . . . . . [12](#)

## 1. Introduction

This document describes the BroadVoice family of speech codecs, which consists of (1) a 16 kb/s narrowband codec called BroadVoice16, or BV16, operating at a sampling rate of 8 kHz, and (2) a 32 kb/s wideband codec called BroadVoice32, or BV32, operating at a sampling rate of 16 kHz. The BV16 codec was standardized by the cable industry through CableLabs(R) as a standard codec in PacketCable 1.5 and PacketCable 2.0. It was also standardized by the Society of Cable Telecommunications Engineers (SCTE) and by the American National Standard Institute (ANSI) as the ANSI/SCTE 24-21 2006 standard [[bv16-ANSI](#)]. BV16 is also listed as an optional codec in the ITU-T Recommendation J.161. Similarly, BV32 is a standard codec in the following standards: PacketCable 2.0, ANSI/SCTE 24-23 2007 [[bv32-ANSI](#)], and ITU-T Recommendation J.361.

Since the BV16 and BV32 coding algorithms are already specified in details in the ANSI/SCTE standard specification documents, there is no need to repeat the specifications here. Instead, links to the ANSI/SCTE specification documents for BV16 and BV32 will be given in Sections [3](#) and [4](#), respectively. The rest of this document gives an overview of the BroadVoice family of codecs, their attributes, and other relevant information.

The key words "MUST", "MUST NOT", "REQUIRED", "SHALL", "SHALL NOT", "SHOULD", "SHOULD NOT", "RECOMMENDED", "MAY", and "OPTIONAL" in this document are to be interpreted as described in [RFC 2119](#) [[rfc2119](#)].

## 2. Overview of the BroadVoice Family of Codec

BroadVoice [[bv-icassp](#)] is a family of speech codecs developed by Broadcom Corporation for Voice over IP (VoIP) applications. It is based on Two-Stage Noise Feedback Coding (TSNFC) [[tsnfc-icassp](#)] rather than the popular Code-Excited Linear Prediction (CELP) coding paradigm. The RTP [[rfc3550](#)] payload formats for BV16 and BV32 are specified in [RFC4298](#). BV16 and BV32 have very similar codec structures and share most of the algorithm modules, so if the two are implemented together, substantial code sharing and memory reduction can be achieved.

To encourage wide-spread use of BroadVoice in diverse speech compression applications, Broadcom is providing both the floating-point and fixed-point C source code of BroadVoice on a royalty-free basis under the GNU Lesser General Public License (LGPL), version 2.1, as published by the Free Software Foundation. Visit <http://www.broadcom.com/broadvoice> to download BroadVoice open source C code, get audio demonstration, or get relevant information.

BroadVoice was designed from the ground up to be optimized for voice transmission over IP networks. The main design goal of BroadVoice was to make the coding delay and codec complexity as low as possible while maintaining output speech quality as close to transparent as possible. The following list summarizes the attributes of BV16 and BV32:

- o Ultra-low algorithmic buffering delay (5 ms)
- o Relatively low computational complexity (about 12 MIPS for BV16 and 17 MIPS for BV32) and memory requirements
- o High output quality for voice; acceptable quality for music
- o Sampling rates of either 8 kHz (for BV16) or 16 kHz (for BV32)
- o Bit-rate of either 16 kb/s (for BV16) or 32 kb/s (for BV32)
- o Robustness to packet loss (typically 0.5 MOS degradation at about 5% random packet loss rate)
- o Open source implementation (floating-point and fixed-point C)
- o No known patent enforcement activities or royalty-bearing patent pools as of date of submission

- o BV16 and BV32 are not bit-exact standards; implementation details MAY deviate from those specified in the ANSI/SCTE specifications for BV16 and BV32 as long as the bit-stream compatibility with the ANSI/SCTE BV16 and BV32 standards is maintained.

It should be noted that some algorithm modules described in the ANSI/SCTE BV16 and BV32 specification documents are meant to illustrate the concepts behind the algorithm modules and may not be the most efficient way to implement the modules. For example, version 1.1 of the BroadVoice open source code implements some of the efficient excitation vector quantization (VQ) codebook search methods described in [[tsnfc-icassp](#)] and [[bv-efficient-vq](#)] that are mathematically equivalent to the excitation VQ codebook search method described in the ANSI/SCTE BV16 and BV32 specifications but are computationally more efficient.

Broadcom licenses, on a royalty-free basis, its patents that are necessary to practice techniques used in Broadcom's official version of the BroadVoice open source code. Implementations that deviate from the techniques used in Broadcom's BroadVoice codecs may increase exposure to third-party patents. Therefore, to minimize potential intellectual property issues, it is RECOMMENDED that implementers of BroadVoice codecs use only techniques implemented in Broadcom's official version of BroadVoice open source C code.

### **3. The BroadVoice16 (BV16) Codec**

The BroadVoice16 codec [[bv16-asilomar](#)] has a frame size of 5 ms and operates at a sampling rate of 8 kHz. For every 40 samples of 8 kHz sampled input speech, BV 16 encodes the 40 samples into 80 bits, resulting in a bit rate of 2 bits/sample, or 16 kb/s.

A detailed description of the encoding and decoding principles of the BV16 codec is given in the ANSI/SCTE 24-21 2006 standard specification document [[bv16-ANSI](#)], which is available at the following link:

<http://www.scte.org/documents/pdf/Standards/ANSISCTE24212006.pdf>

A BV16 decoder MAY include an adaptive postfilter (PF) to reduce the perceived level of coding noise. It MAY also include packet loss Concealment (PLC) to conceal (at least partially) the quality-degrading effects of packet loss. Both PF and PLC are post-processing steps after the speech signal is decoded, so they do not affect bit-stream compatibility. Therefore, PF and PLC are not an essential part of the BV16 specification. The ANSI/SCTE BV16 specification describes an example PF and an example PLC scheme, but implementers can implement their own PF and PLC schemes without affecting bit-stream compatibility with BroadVoice codecs.

#### **4. The BroadVoice32 (BV32) Codec**

The BroadVoice32 codec also has a frame size of 5 ms but operates at a sampling rate of 16 kHz. For every 80 samples of 16 kHz sampled input speech, BV32 encodes the 80 samples into 160 bits, resulting in a bit rate of 2 bits/sample, or 32 kb/s.

A detailed description of the encoding and decoding principles of the BV32 codec is given in the ANSI/SCTE 24-23 2007 standard specification document [[bv32-ANSI](#)], which is available at the following link:

[http://www.scte.org/documents/pdf/Standards/ANSI\\_SCTE24-232007.pdf](http://www.scte.org/documents/pdf/Standards/ANSI_SCTE24-232007.pdf)

A BV32 decoder MAY include an adaptive postfilter (PF) to reduce the perceived level of coding noise, although it is not really necessary because even without a postfilter the output speech quality of BV32 is already quite high. A BV32 decoder MAY also include packet loss Concealment (PLC) to conceal (at least partially) the quality-degrading effects of packet loss. Both PF and PLC are post-processing steps after the speech signal is decoded, so they do not affect bit-stream compatibility. The ANSI/SCTE BV32 specification describes an example PLC scheme, but implementers can implement their own PLC schemes without affecting bit-stream compatibility.

## **5. Security Considerations**

A potential denial-of-service threat exists for data encoding using compression techniques that have non-uniform receiver-end computational load. The attacker can inject pathological datagrams into the stream which are complex to decode and cause the receiver to become overloaded. However, the decoder complexity of BV16 and BV32 do not exhibit any significant non-uniformity.



## **6. IANA Considerations**

This document has no actions for IANA.

## **7. Acknowledgments**

The authors would like to thank Cheng-Chieh Lee and Robert Zopf for their partial contributions in the following areas: floating-point C codes, fixed-point C codes, optimized assembly codes, and performance testing of BroadVoice codecs.

## **8. References**

### **8.1. Normative References**

- [rfc2119] Bradner, S., "Key words for use in RFCs to Indicate Requirement Levels", [RFC 2119](#).
- [bv16-ANSI] "BV16 Speech Codec Specification for Voice over IP Applications in Cable Telephony", American National Standard, ANSI/SCTE 24-21 2006.
- [bv32-ANSI] "BV32 Speech Codec Specification for Voice over IP Applications in Cable Telephony", American National Standard, ANSI/SCTE 24-23 2007.
- [rfc3550] Schulzrinne, H., Casner, S., Frederick, R., and V. Jacobson, "RTP: A Transport Protocol for real-time applications", [RFC 3550](#).

### **8.2. Informative References**

- [bv-website] BroadVoice(R) Speech Codec Open Source C Code, BroadVoice website <http://www.broadcom.com/broadvoice/>.
- [bv-icassp] Juin-Hwey Chen and Jes Thyssen, "The Broadvoice Speech Coding Algorithm", Proceedings of 2007 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2007), Volume 4, April 2007.
- [tsnfc-icassp] Juin-Hwey Chen, "Novel Codec Structures For Noise Feedback Coding of Speech", Proceedings of 2006 IEEE International Conference on Acoustics, Speech, and Signal Processing (ICASSP 2006), Volume 1, May 2006.
- [bv16-asilomar] Juin-Hwey Chen and Jes Thyssen, "BroadVoice(R)16: A PacketCable Speech Coding Standard for Cable Telephony", Proceedings of Fortieth Asilomar Conference on Signals, Systems and Computers, ACSSC 2006, October - November 2006.

[bv-efficient-vq]

Thyssen and Juin-Hwey Chen, "Efficient VQ Techniques and  
General Noise Shaping in Noise Feedback Coding",  
Proceedings of Interspeech 2006 ICSLP, September 2006.

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