

网宿 flv-opus 方案

flv 标准并不支持 opus 音频格式, 为了使用 opus 进行 rtmp 推拉流, 故需要扩展 flv 的标准, 新增 opus 音频格式, 网宿采用 0xD, 即 13, 做为 opus 的 flv 音频 ID, 主要扩展如下:

AudioTagHeader

| Field | Type | Comment |
|---------------|-----------------------------|---|
| SoundFormat | UB [4] | Format of SoundData. The following values are defined: 0 = Linear PCM, platform endian 1 = ADPCM 2 = MP3 3 = Linear PCM, little endian 4 = Nellymoser 16 kHz mono 5 = Nellymoser 8 kHz mono 6 = Nellymoser 7 = G.711 A-law logarithmic PCM 8 = G.711 mu-law logarithmic PCM 9 = reserved 10 = AAC 11 = Speex 14 = MP3 8 kHz 15 = Device-specific sound Formats 7, 8, 14, and 15 are reserved. AAC is supported in Flash Player 9,0,115,0 and higher. Speex is supported in Flash Player 10 and higher. |
| SoundRate | UB [2] | Sampling rate. The following values are defined: 0 = 5.5 kHz 1 = 11 kHz 2 = 22 kHz 3 = 44 kHz |
| SoundSize | UB [1] | Size of each audio sample. This parameter only pertains to uncompressed formats. Compressed formats always decode to 16 bits internally. 0 = 8-bit samples 1 = 16-bit samples |
| SoundType | UB [1] | Mono or stereo sound 0 = Mono sound 1 = Stereo sound |
| AACPacketType | IF SoundFormat == 10 UI8 | The following values are defined: 0 = AAC sequence header 1 = AAC raw |

新增13 = opus

如果==13表示是opus

如果是opus表示是opus header

如果是opus表示是opus裸数据

opus header

| | | | | | | | | | | | | | | | | | |
|-----------------------------------|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| FLV structure | 0x000001C0: | 40 | 1F | E8 | 80 | 28 | 02 | 2D | 35 | 01 | 01 | 01 | 40 | 00 | 00 | 03 | 00 |
| File Header [0x00000000] | 0x000001D0: | 40 | 00 | 00 | 0C | A3 | C6 | 0C | 44 | 80 | 01 | 00 | 05 | 68 | EB | EC | 4C |
| First Tag Size [0x00000009]: 0 | 0x000001E0: | 80 | 00 | 00 | 00 | 3B | 08 | 00 | 00 | 17 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Metadata Tag [0x00000000] | 0x000001F0: | DF | 00 | 4F | 70 | 75 | 73 | 48 | 65 | 61 | 64 | 01 | 02 | 38 | 01 | 80 | BB |
| Pre Tag Size [0x000001A2]: 405 | 0x00000200: | 00 | 00 | 00 | 00 | 00 | C0 | 03 | 00 | 00 | 00 | 22 | 09 | 02 | 42 | 00 | 00 |
| Video Tag1 [0x000001A6] | 0x00000210: | 00 | 00 | 00 | 00 | 00 | 00 | 17 | 01 | 00 | 00 | 28 | 00 | 02 | 41 | F7 | 65 |
| Pre Tag Size [0x000001E1]: 59 | 0x00000220: | 88 | 84 | 00 | 9A | 37 | E6 | 34 | 6E | AB | 44 | CC | 5A | F2 | F4 | 22 | 67 |
| Audio Tag2 [0x000001E5] | 0x00000230: | 5D | 69 | 85 | 14 | 7C | 1F | 4F | 52 | 4D | 6A | C2 | 08 | 2C | FD | B8 | D1 |
| Tag Header [0x000001E5] | 0x00000240: | 08 | 6B | 64 | 27 | 0B | 02 | 87 | 65 | B0 | 0B | 8F | 1A | 58 | 19 | B1 | B0 |
| Tag Data [0x000001F0] | 0x00000250: | 47 | 5B | DD | CB | AC | 4E | F8 | 0B | A7 | 9C | 2F | 47 | AA | 11 | 5E | C3 |
| Pre Tag Size [0x00000207]: 34 | 0x00000260: | 5C | 5E | B9 | D6 | 99 | 8E | 92 | 6C | 8C | E6 | 08 | 0D | 1D | CC | 4E | 45 |
| Video Tag3 [0x0000020B] | 0x00000270: | 61 | 76 | 89 | 58 | AF | A6 | 09 | 51 | 94 | 43 | 87 | 03 | 9A | E8 | 97 | BB |
| Pre Tag Size [0x00024416]: 147979 | 0x00000280: | E3 | 36 | 00 | 71 | A1 | 13 | B5 | 96 | D8 | 43 | 06 | 06 | 90 | D0 | 31 | 99 |
| Audio Tag4 [0x0002441A] | 0x00000290: | 24 | 36 | 83 | 3C | AD | 05 | F8 | D1 | C1 | 8A | 35 | C0 | 80 | F7 | FF | A1 |

opus 音频数据

| | | | | | | | | | | | | | | | | | |
|-----------------------------------|-------------|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|
| FLV structure | 0x00024420: | 21 | 00 | 00 | 00 | 00 | DF | 01 | FC | 7F | F7 | 0A | 9B | 83 | 90 | F8 | CC |
| File Header [0x00000000] | 0x00024430: | 0D | F1 | FD | EC | D6 | CE | B3 | 7A | 3A | F1 | 53 | E6 | 19 | CF | 13 | 17 |
| First Tag Size [0x00000009]: 0 | 0x00024440: | 6B | 85 | D5 | 9B | 6A | CD | D7 | 28 | D4 | 04 | B4 | B3 | F5 | 81 | 15 | AF |
| Metadata Tag [0x00000000] | 0x00024450: | 08 | A1 | 3C | 68 | 4E | DC | 5A | 3F | 36 | 1E | D3 | E5 | 93 | B4 | CD | 5F |
| Pre Tag Size [0x000001A2]: 405 | 0x00024460: | 63 | EB | A9 | 64 | D9 | 3C | 0B | D5 | 53 | B0 | C3 | D8 | E4 | FD | 72 | B1 |
| Video Tag1 [0x000001A6] | 0x00024470: | FC | C4 | B0 | 3A | F9 | 6A | DA | 39 | F6 | C6 | CB | B1 | AF | B9 | 78 | F0 |
| Pre Tag Size [0x000001E1]: 59 | 0x00024480: | 8B | B5 | A7 | AC | AD | 48 | BF | 20 | 3D | 6A | 61 | F3 | 38 | E7 | 5F | 63 |
| Audio Tag2 [0x000001E5] | 0x00024490: | C6 | 48 | 65 | 7C | DA | A3 | F8 | 87 | C5 | BA | 4D | 35 | 6D | 28 | BB | 2E |
| Tag Header [0x000001E5] | 0x000244A0: | D3 | 28 | B9 | 95 | 03 | A5 | D8 | EF | A3 | BA | 54 | DB | 3A | 03 | CA | 55 |
| Tag Data [0x000001F0] | 0x000244B0: | A1 | 4B | 70 | DA | 88 | B2 | C4 | 3F | 9F | D4 | 33 | 91 | 86 | F7 | A8 | 69 |
| Pre Tag Size [0x00000207]: 34 | 0x000244C0: | 5D | CA | 79 | D6 | 50 | 06 | 18 | 49 | 14 | 12 | 3A | 79 | 66 | 14 | 5B | 03 |
| Video Tag3 [0x0000020B] | 0x000244D0: | 09 | D2 | 99 | 07 | 68 | 2A | 9E | E1 | E0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Pre Tag Size [0x00024416]: 147979 | 0x000244E0: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Audio Tag4 [0x0002441A] | 0x000244F0: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Tag Header [0x0002441A] | 0x00024500: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Tag Data [0x00024425] | 0x00024510: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Pre Tag Size [0x000245D9]: 447 | 0x00024520: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Video Tag5 [0x000245DD] | 0x00024530: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Pre Tag Size [0x0002B8A2]: 29381 | 0x00024540: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Audio Tag6 [0x0002B8A6] | 0x00024550: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Pre Tag Size [0x0002BA6C]: 454 | 0x00024560: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Audio Tag7 [0x0002BA70] | 0x00024570: | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| Pre Tag Size [0x0002BB71]: 257 | 0x00024580: | 03 | FC | C3 | F0 | C0 | FE | CE | 17 | B4 | 28 | BC | 7C | B8 | 92 | F1 | 6F |
| Video Tag8 [0x0002BB75] | 0x00024590: | 86 | B2 | 80 | A2 | 08 | 3C | 5C | CD | 81 | 47 | 32 | FE | A4 | 55 | EC | 32 |
| Pre Tag Size [0x0002D531]: 6588 | 0x000245A0: | 25 | 3B | 9F | 10 | 7B | 53 | 8D | 18 | E8 | 9F | A5 | 56 | 30 | 75 | 12 | 35 |
| Audio Tag9 [0x0002D535] | 0x000245B0: | 83 | 4F | 45 | F0 | C0 | 9C | 1D | 29 | 1F | C1 | 74 | BC | E0 | 3F | F0 | 0C |
| Pre Tag Size [0x0002D701]: 460 | 0x000245C0: | A6 | 11 | C7 | 7A | A2 | 10 | 64 | 44 | 80 | 2A | DB | 30 | 00 | 0B | 40 | B5 |
| Audio Tag10 [0x0002D705] | 0x000245D0: | 2D | BF | 49 | B9 | 1B | 06 | FC | 16 | 89 | 00 | 00 | 01 | BF | 09 | 00 | 72 |
| | 0x000245E0: | BA | 00 | 00 | 28 | 00 | 00 | 00 | 00 | 27 | 01 | 00 | 00 | 50 | 00 | 00 | 72 |

其中 opus header 封装按如下格式:

// http://www.opus-codec.org/docs/opus_in_isobmff.html

// 4.3.2 Opus Specific Box

```
class ChannelMappingTable (unsigned int(8) OutputChannelCount){
    unsigned int(8) StreamCount;
    unsigned int(8) CoupledCount;
    unsigned int(8 * OutputChannelCount) ChannelMapping;
}

aligned(8) class OpusSpecificBox extends Box('dOps'){
    unsigned int(8) Version;
    unsigned int(8) OutputChannelCount;
    unsigned int(16) PreSkip;
    unsigned int(32) InputSampleRate;
    signed int(16) OutputGain;
    unsigned int(8) ChannelMappingFamily;
    if (ChannelMappingFamily != 0) {
        ChannelMappingTable(OutputChannelCount);
    }
    unsigned int(16) FrameSize;
}
```

其中红框表示的 FrameSize 是新增的，表示一帧样本数，默认是 960
 针对整数类型采用的是小端序，通过 ffmpeg 的 api 按如下方式设置 opus 头：

```

    bytestream_put_buffer(&p, "OpusHead", 8);
    bytestream_put_byte(&p, 1); /* Version */
    bytestream_put_byte(&p, channels);
    bytestream_put_le16(&p, avctx->initial_padding); /* Lookahead samples at 48kHz */
    bytestream_put_le32(&p, avctx->sample_rate); /* Original sample rate */
    bytestream_put_le16(&p, 0); /* Gain of 0dB is recommended. */

    /* Channel mapping */
    bytestream_put_byte(&p, mapping_family);
    if (mapping_family != 0) {
        bytestream_put_byte(&p, stream_count);
        bytestream_put_byte(&p, coupled_stream_count);
        bytestream_put_buffer(&p, channel_mapping, channels);
    }

    /* frame size, 960 for 20ms per frame */
    bytestream_put_le16(&p, frame_size);
    
```

首先是 opus 的标准头，然后在标准头后面新增一个 frame_size，用于表示一帧样本数
 frame_size = frame_duration * 48000 / 1000，frame_duration 默认是 20ms，所以 frame_size
 默认是 960

| | | | | | | | | |
|-----------|----|----|----|----|----|----|----|----|
| 000001E5: | 08 | 00 | 00 | 17 | 00 | 00 | 00 | 00 |
| 000001ED: | 00 | 00 | 00 | DF | 00 | 4F | 70 | 75 |
| 000001F5: | 73 | 48 | 65 | 61 | 64 | 01 | 02 | 38 |
| 000001FD: | 01 | 80 | BB | 00 | 00 | 00 | 00 | 00 |
| 00000205: | C0 | 03 | 00 | 00 | 00 | 22 | | |

上图的 opus 头中，DF 表示是 opus 的 tag，00 表示是 opus 头

4F 70 75 73 48 65 61 64 是"OpusHead"字符串

01 是版本号，固定值

02 是声道数，表示双通道

38 01 转为正常序是 01 38，转为 10 进制是 312，表示 opus 标准里的 PreSkip

80 BB 00 00 转为正常序是 00 00 BB 80，转为 10 进制是 48000，表示音频采样率

00 00 表示 Gain

00 表示 mapping family

最后红框的 C0 03 是新增的，表示 frame_size，转为正常序是 03 C0，转为 10 进制就是 960，
 表示一帧样本数

可以通过附件提供的 opus.flv 查看 flv-opus 格式

通过 flvbugger 工具分析音频格式是否是 opus，音频帧的时间戳是否正确，即是否是 20ms
 一帧

| | | | | | | |
|----|--------|----------|-------|-------------|------------|--------|
| 1 | Script | 0:00.000 | - | 2 元素 | 0x00000018 | 394 |
| 2 | Video | 0:00.000 | H.264 | keyframe | 0x000001B1 | 48 |
| 3 | Audio | 0:00.000 | Opus | - | 0x000001F0 | 23 |
| 4 | Video | 0:00.000 | H.264 | keyframe | 0x00000216 | 147968 |
| 5 | Audio | 0:00.033 | Opus | - | 0x00024425 | 436 |
| 6 | Video | 0:00.040 | H.264 | inter frame | 0x000245E8 | 29370 |
| 7 | Audio | 0:00.054 | Opus | - | 0x0002B8B1 | 443 |
| 8 | Audio | 0:00.074 | Opus | - | 0x0002BA7B | 246 |
| 9 | Video | 0:00.080 | H.264 | inter frame | 0x0002BB80 | 6577 |
| 10 | Audio | 0:00.094 | Opus | - | 0x0002D540 | 449 |
| 11 | Audio | 0:00.114 | Opus | - | 0x0002D710 | 382 |
| 12 | Video | 0:00.120 | H.264 | inter frame | 0x0002D89D | 37374 |
| 13 | Audio | 0:00.134 | Opus | - | 0x00036AAA | 200 |
| 14 | Audio | 0:00.154 | Opus | - | 0x00036B81 | 198 |