
RTP Profiles

What is in the RTP Profiles

- Provides interpretation of generic fields
- Items which may be specified in a profile
 - Default mapping between payload type numbers and encoding
 - Use of marker bits
 - Frequency of the RTP clock used to generate timestamps

RTP Profiles (cont.)

- Other items which may be specified in a profile
 - RTP header extensions
 - Additional RTCP packet types
 - RTCP report interval
 - Use of security/encryption
- No support for negotiation of parameters or membership control

Profile Definition RFCs

- RFC 1890: Generic Profile for Audio/Video Conferences
- RFC 2032: Profile for H.261
- RFC 2190: Profile for H.263
- RFC 2198: Profile for Redundant Audio
- RFC 2250: Profile for MPEG-1/MPEG-2
- RFC 2435: Profile for Motion-JPEG
- RFC 2733: Generic Profile for Forward Error Correction
- RFC 3016: Profile for MPEG-4
- RFC 3047: Profile for G.722.1 Audio

This is not a comprehensive list; there are other less important profiles defined.

RFC 1890: Generic Audio/Video Profile

- Specifies payload type codes for audio and video data
- Follows the default and/or recommended aspects of the RTP specification
- Defines a standard key generation mechanism for security (not commonly used)
- No RTP header extensions or additions
- Recommends the use of two successive UDP ports for RTP/RTCP:
 - RTP uses the even port
 - RTCP uses the next (odd) port
 - Suggested values: 5004 and 5005

Audio-Specific Profile

- Marker bit is used to indicate the end of a silence (beginning of a talkspurt)
- RTP clock rate is equal to the sampling period (8000, 11025, 16000, 22000, 24000, 32000, 44100, 48000)
- Default packetization interval: 20 ms
- Receivers must be prepared to accept packets containing up to 200 ms of audio
- Defines payload codes for 15 audio codecs including G.711, G.723, GSM based, μ -law, a-law, and others.

Video-Specific Profile

- Only specifies payload type codes. Use of the marker bits, clock rate, and other parameters are specified in the payload definitions
- Payload type codes for H.261, H.263, MPEG1/2, JPEG, CelB, and others are specified.

Payload Type Codes

PT	Encoding	Type	Rate
0	PCMU	A	8000
1	1016	A	8000
2	G721	A	8000
3	GSM	A	8000
4	unassigned	A	8000
5	DVI4	A	8000
6	DVI4	A	16000
7	LPC	A	8000
8	PCMA	A	8000
9	G722	A	8000
10	L16	A	44100
11	L16	A	44100
12	unassigned	A	
13	unassigned	A	
14	MPA	A	90000

PT	Encoding	Type	Rate
15	G728	A	8000
16--23	unassigned	A	
24	unassigned	V	
25	CeIB	V	90000
26	JPEG	V	90000
27	unassigned	V	
28	nv	V	90000
29	unassigned	V	
30	unassigned	V	
31	H261	V	90000
32	MPV	V	90000
33	MP2T	AV	90000
34--71	unassigned	?	
72--76	reserved	N/A	N/A
77--95	unassigned	?	
96--127	dynamic	?	

JPEG Profile (RFC 2435)

- Restricts the type of JPEG images that can be used, for interoperation reasons.
 - Only sequential DCT mode is allowed
 - Only single-scan, interleaved images allowed
- RTP timestamp frequency is 90 kHz.
- All packets belonging to the same frame must have the same timestamp.
- RTP marker bit must be set in the last packet of the frame.
- No additional RTCP packets defined in the profile.

JPEG Profile (cont.)

- The profile also defines an 8-byte header following the RTP header and containing:
 - Fragment offset: offset of the current packet into the image.
 - JPEG type: indicates progressive/interlaced scan, and, for interlaced, which field this frame is.
 - Height and width of the image
 - Information about the quantization matrix
 - Pre-defined quantization matrix
 - Included quantization matrix (specified in the RTP packet)

H.261 Profile (RFC 2032)

- Packetization:
 - Audio and Video streams are packetized independently.
 - The H.261 frame is not used; the output of Huffman encoding is what is packetized and transmitted.
 - Each RTP payload must contain an integral number of macroblocks.
- Marker bit: set to 1 on the last packet of a frame
 - Allows for a decoder to start right away in the current without having to wait for the next one.
- Timestamp frequency: 90 kHz
 - Packets containing parts of the same frame must have the same timestamp.

H.261 Profile (cont.)

- The H.261 profile specifies a 4-byte header containing:
 - Padding bit offsets at the beginning and end of the packet, since the H.261 encoder may not be byte-aligned
 - Flags that indicate whether or not the stream is completely intra-coded and whether it has motion vectors
 - GOB addresses, quantizer scale, motion vectors
- The purpose of the header is to help decoders “place” the packet in case of loss.
- The profile also specifies two additional RTCP packets for loss recovery:
 - Request for a Full I-Frame
 - Negative Acknowledgment for a group of packets

These packets are sent unicast directly to the data source.

MPEG-1/2 Profile (RFC 2250)

- Specifies two encapsulation methods:
 - Encapsulation of MPEG System/Program/Transport Streams
 - Encapsulation of MPEG Elementary Streams
- Timestamp frequency: 90 kHz, derived from the MPEG clock.
- System/Program/Transport Encapsulation:
 - No additional headers
 - No packetization constraints (except to require an integral number of 188-byte transport packets per RTP payload)
 - Timestamp indicates target transmission time of the first byte in the packet
 - Marker bit indicates discontinuity in timestamp

MPEG-1/2 Elementary Streams

- Preferred way to packetize for Internet applications
 - Used in Cisco's IPTV and others.
- Separate RTP streams are used for video and audio.
- Video packetization:
 - The MPEG video_sequence_header must be at the beginning of the RTP packet.
 - The MPEG GOP_header must be at the beginning of the packet or follow a video_sequence_header.
 - The MPEG picture_header must be at the beginning of the packet or follow a GOP_header.
 - ES headers must not be fragmented across packets - network must support a minimum packet size of 261 bytes.
 - MPEG slices must be at the beginning of the packet (after ES headers) or follow an integral number of slices.

MPEG-1/2 ES (cont.)

- Audio Packetization:
 - Small frames: an integral number of frames is contained in one packet
 - Larger frames: one frame may straddle multiple packets
- RTP Header usage:
 - Different payload types are assigned for audio and video.
 - Marker bit:
 - For video, set to 1 if the packet contains MPEG frame end code
 - For audio, set to 1 if this is the beginning of a talkspurt
 - Timestamp: presentation time of the audio or video frame. Same for all packets containing parts of the same frame. For video, if the stream contains B-frames, the timestamp may not be monotonically increasing

Additional Headers

- Additional headers (following the RTP header) have been defined for audio and video streams.
- The video-specific headers are 4 bytes long and include:
 - Flags to indicate beginning and end of slice, presence of sequence header, and picture type (I, P or B).
 - Temporal reference of the current picture within the GOP.
 - Forward and backward motion vectors.
 - Support for optional MPEG-2 extensions, with additional information.
- The audio-specific header is 4-bytes long and contains only the packet fragment offset in the frame.

Generic Profile for Forward Error Correction (RFC 2733)

- Using today's technology, bit errors in packets are very rare.
 - Even when errors happen, checksums and CRCs at layers 2, 3 and 4 catch them and cause the packet to be automatically discarded.
 - Bit Error = Packet Loss
- In the Internet, packets are much more likely to be dropped due to congestion.
- Forward Error Correction (FEC) techniques can be used to recover missing data
 - Redundant packets are sent along with the stream
 - If packets are lost, it may be possible to reconstruct them from the received data
 - Technically, these are “Erasure Codes” (to recover from data you never received)

FEC Example

Simplest form of FEC: parity (exclusive-or)

$$\begin{array}{rcccccccc}
 1 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & & \text{Packet 1} \\
 0 & 0 & 1 & 1 & 0 & 1 & 1 & 1 & \oplus & \text{Packet 2} \\
 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & \oplus & \text{Packet 3} \\
 \hline
 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & = & \text{FEC Packet}
 \end{array}$$

Assume that Packet 2 is dropped by the network

$$\begin{array}{rcccccccc}
 1 & 0 & 1 & 0 & 1 & 1 & 1 & 0 & & \text{Packet 1} \\
 0 & 1 & 0 & 0 & 0 & 1 & 0 & 1 & \oplus & \text{Packet 3} \\
 \hline
 1 & 1 & 0 & 1 & 1 & 1 & 0 & 0 & \oplus & \text{FEC Packet} \\
 0 & 0 & 1 & 1 & 0 & 1 & 1 & 1 & = & \text{Packet 2}
 \end{array}$$

Lost packet is recovered by the exclusive-or operation

RFC 2733 Highlights

- Designed to be used with XOR-type FEC.
- Protects both the RTP header and payload of the media packets.
 - Augment the media packets with a size indication
 - Pad the packets so they are all of the same size
 - Compute the FEC
 - Send using standard RTP header plus FEC header
 - RTP Payload Type chosen dynamically and communicated externally to RTP
- Independent of the actual media being carried.
- FEC packets are transmitted as a separate stream to allow easy interoperability with receivers that do not implement the mechanism