Real-Time Transport Protocol

Kevin Gross

kevin.gross@avanw.com

6 December 2006

RTP RFCs

- RTP (and RTCP)
  - RFC 1998 (1996), RFC 3550 (2003)
- Basic audio and video profiles
  - RFC 1980 (1996), RFC 3551 (2003)
- High quality audio
  - RFC 3190 (2002)
- Session description protocol (SDP)
  - RFC 2327 (1998), RFC 4566 (2006)

Sessions

- Multimedia session
  - Set of concurrent RTP sessions among a common group of participants
- RTP session
  - A media stream. Separate RTP sessions may be used for associated audio and video.
    - Point-to-point
    - Point-to-multipoint
    - Multipoint-to-multipoint

RTP packet

Ethernet header
IP header
UDP header
RTP header
RTP header extension (optional, profile specific)
Payload
Ethernet frame check sequence

RTP IP parameters

- RTP datagrams uses even port numbers
- Corresponding RTCP messages uses next-higher odd port number
- Unicast or IP multicast destination address is used

RTP header

```
 0                   1                   2                   3
 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|V=2|P|X|  CC   |M|     PT      |       sequence number         |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|                           timestamp                           |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
|           synchronization source (SSRC) identifier            |
+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
|            contributing source (CSRC) identifiers             |
|                             ....                              |
+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

RTP header fields

- **V**ersion (2 bits) – 2 is current version
- **P**adding (1 bit) – 1 indicates presence of one or more padding octets are appended. First pad octet indicates amount of padding.
- E**X**tension (1 bit) – Header extension present
- **C**ontributing source **C**ount (4 bits) – Number of CSRCs following header
- **M**arker (1 bit) – Application specific marker bit
- ***P****ayload* ***T****ype (7 bits) – Determines payload interpretation. Static and dynamic payload types are supported.*
- Sequence number (16 bits) – Increments for each RTP packet sent
- *Timestamp (32-bits) – Synchronization information for payload.*
- *Synchronization source (32 bits) – Uniquely identifies a stream source in an RTP domain*
- Contributing sources (0 to 15 items, 32 bits each) – Identifies sources for mixed content.

Synchronization source (SSRC)

- Unique 32-bit identifier within an RTP session
- Applicable to sessions with multiple sources (i.e. multipoint-to-multipoint routing)
- Source IP address is not adequate due to NAT and possibility of multiple sources per device
- Collision resolution and loop detection procedures defined

Payload type

- 128 available payload types (PTs) in 7-bit PT field
- Common static PTs are defined in RFC 3551
  - 0 – 8 bit 64 kb telephone audio
  - 10 – Stereo 44.1 kHz, 16-bit audio
  - 11 – Mono 44.1 kHz, 16-bit audio
- PTs 96 through 127 are reserved for dynamic allocation within an RTP session
  - SIP and SDP are often used to communicate these assignments
- Source may change PT during a session
  - Telephone audio vs. comfort noise
  - HDMI mode change
  - Marker bit used to flag a change

Timestamp

- Reflects sampling instant for beginning of payload data
  - Origination time
  - Receivers determine presentation time
- Units and offset are PT and SSRC specific
- Sample period is used in audio applications
- Clock must advance monotonically and linearly (with 32-bit wrap)
- Resolution must meet greater of application synchronization accuracy requirements and requirements for producing useful jitter measurement at receivers
- Timestamp mapped to real time clock in RTCP sender reports

RTP Control Protocol (RTCP)

```
        0                   1                   2                   3
        0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
header |V=2|P|    RC   |   PT=SR=200   |             length            |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                         SSRC of sender                        |
       +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
sender |              NTP timestamp, most significant word             |
info   +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |             NTP timestamp, least significant word             |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                         RTP timestamp                         |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                     sender's packet count                     |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                      sender's octet count                     |
       +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
report |                 SSRC_1 (SSRC of first source)                 |
block  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  1    | fraction lost |       cumulative number of packets lost       |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |           extended highest sequence number received           |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                      interarrival jitter                      |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                         last SR (LSR)                         |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
       |                   delay since last SR (DLSR)                  |
       +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
report |                 SSRC_2 (SSRC of second source)                |
block  +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
  2    :                               ...                             :
       +=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+=+
       |                  profile-specific extensions                  |
       +-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+-+
```

RTCP message types

- Sender report
  - RTP to NTP time mapping
  - Packet and octet counts
- Receiver report
  - Packet loss, data and sender reports
  - Jitter on data packet arrivals
  - Round-trip delay
- Source description
  - Machine name, user name and contact info, etc.
- Goodbye
- Application specific

RTCP transmission

- Multiple reports may be packed into a single transmission
- Cooperative periodic scheduling desires to use a fixed percentage of bandwidth for RTCP vs. RTP
- Information refreshed at different rates based on priority and timliness

IEEE 1733

- Defines an application-specific RTCP message type (208) transmitted periodically by each source (talker)
  - StreamID (64 bits)
  - GMIdentity (64 bits)
  - 802.1AS to RTP time mapping