

# Development of new IP Protocols for e-VLBI

An RTP Profile for e-VLBI

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# Agenda

- RTP Capabilities
- VSI-E Model and Requirements
- RTP
- An RTP Profile for e-VLBI
- e-VLBI Development at Haystack

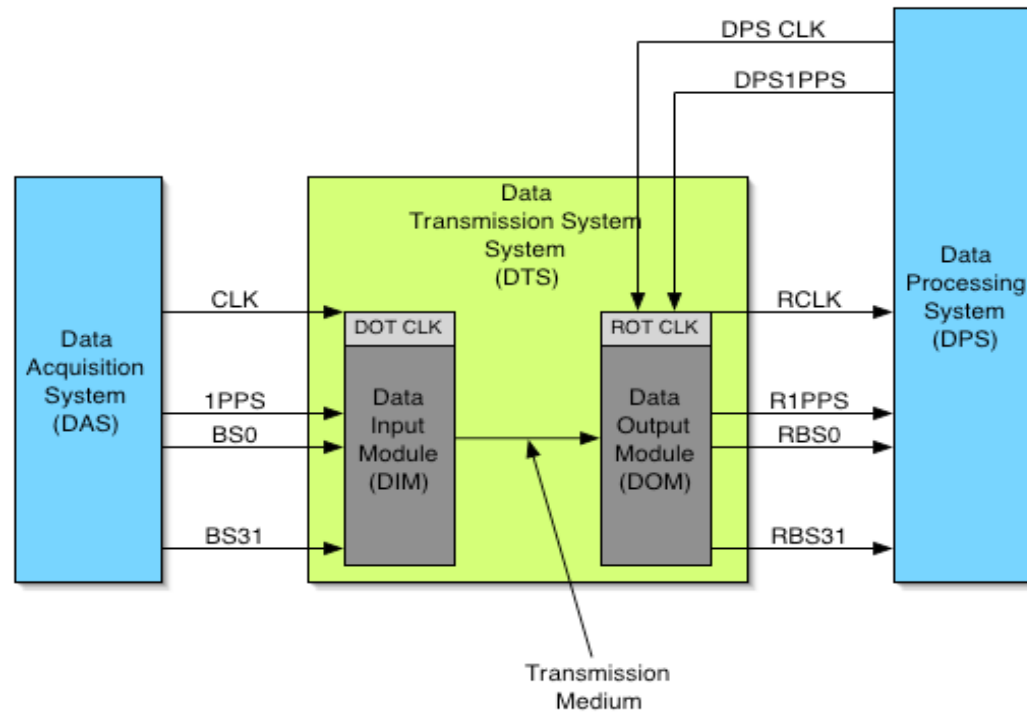
# RTP Capabilities

- RTP provides an Internet-standard format for:
  - Transmission of sampled analog data
  - Dissemination of session information
  - Monitoring of network and end system performance (by participants and third parties)
  - Adaptation to varying network capability / performance
  - Appropriate reliability / repair model
  - Message Sequencing / un-reordering
  - Multi-cast distribution of statistics, control and data

# RTP Capabilities

- RTP allows the reuse of many standard monitoring / analysis tools
- RTP seen as internet-friendly by the network community:
  - attention to efficiency
    - protocol designed to have minimum overhead for in-band data
  - attention to resource constraints
    - won't use up all your bandwidth with control information
  - attention to scaling issues

# VSI-E Model



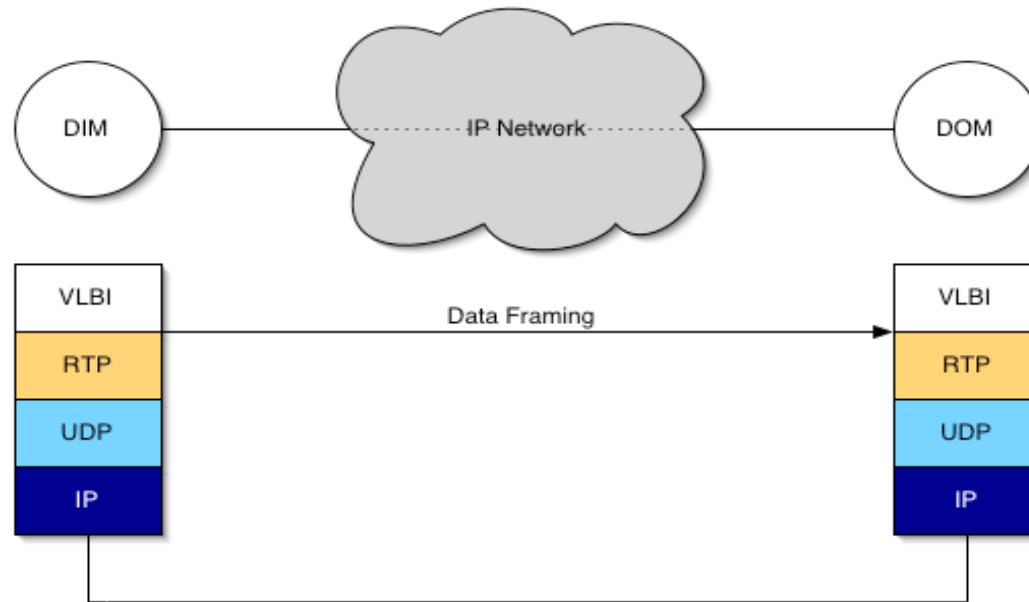
# VSI-E Requirements

- Standard e-VLBI data format that is transmitted from DIM to DOM
- data stream must contain embedded time and synchronization information
- data stream can be defined and managed as an array of 32-bit wide words
- Embedded time and synchronization information must not replace any data

# VSI-E Requirements

- The data format must support all features defined by the VSI-H specification
  - following information must be transmitted as part of the data stream:
    - Active bit-stream mask
    - Bit-stream information rate (BSIR)
    - Valid-data indicator
    - TVG-data indicator
    - PDATA

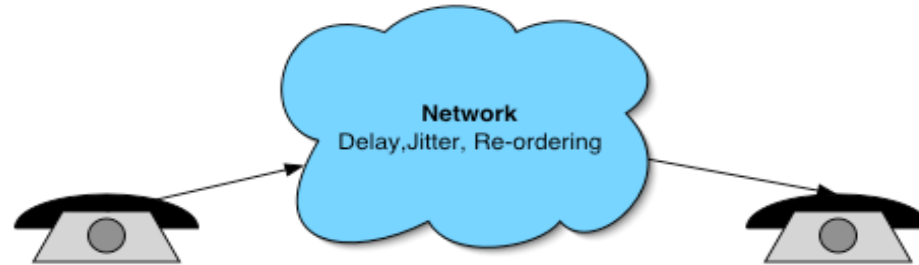
# e-VLBI Transport over RTP





# Real-Time Transport Protocol

"Come here, Watson" → Co *me*Here WatsO n → "Come here, Watson"



- Framework for transporting temporally structured data
  - Timing and synchronization
  - Merging, bridging, and translation support
  - Application-specific control data
    - e.g. PDATA, time, data collection parameters, antenna pointing, system temperature

# Real Time Control Protocol

- Monitors network's real-time data delivery performance
- Statistics collected from receivers
- Information delivered to
  - Senders (adapt to prevailing conditions)
  - Network management (identifies faults, provisioning problems)
- Adaptive, bandwidth-limited design

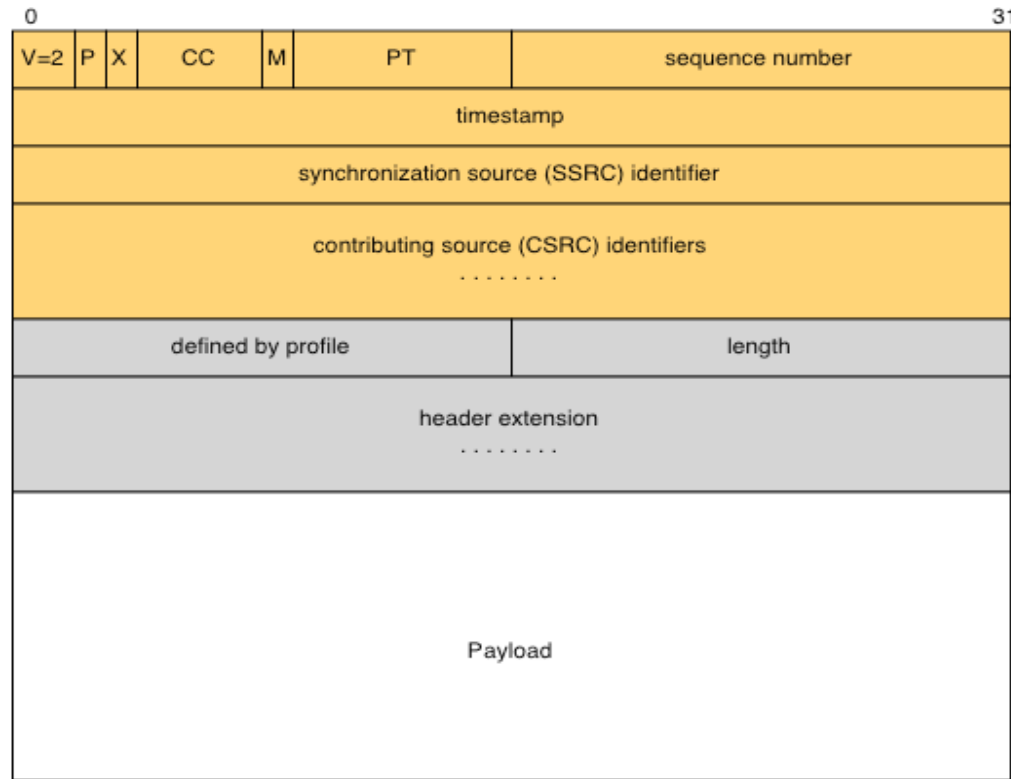
# RTP Components

- RTP is extensible
  - Core specification
  - Application profiles
    - Usage rules for a particular application class
      - » IP Telephony
      - » Broadcast video distribution
  - Payload formats
    - Transport rules for specific real-time data formats
      - Video
        - » H.261, H.263, JPEG, MPEG/MPEG 2, others...
      - Audio
        - » PCM, G.72x, GSM, CELP, others...
- Create Profile for e-VLBI data

# An RTP Profile for e-VLBI

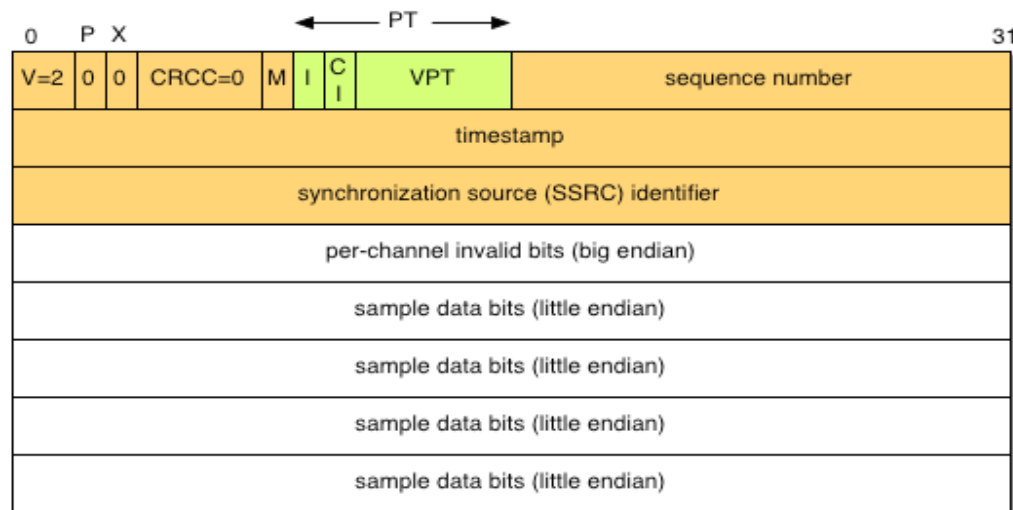
- Requirements
  - support required capabilities of data transport system described in the VSI-H document
  - Performance is critical
  - Profile should follow the RTP standards in all possible respects
  - Profile should not limit future use of RTP aspects

# RTP Data Packet



- PT for identifying payload encoding
- Sequence Number for un-re-ordering
- Timestamp for synchronization
- SSRC and CSRC to identify sources of information
- Header extension feature
- Payload for carrying real-time data samples

# e-VLBI RTP Data Packet



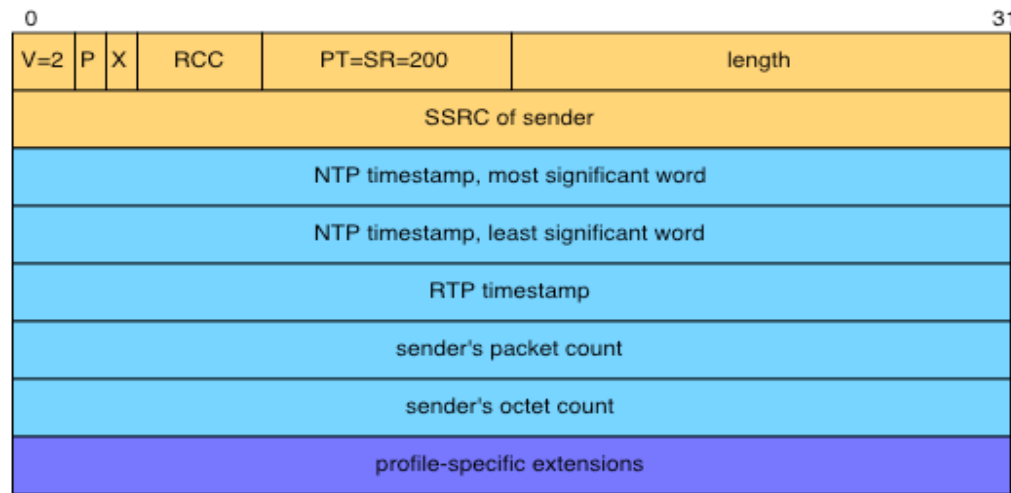
- Used to transport data
- Padding and Xtension bits set to 0
- M bit used to indicate TOST sample
- PT divided into three:
  - Invalid bit for packet
  - Channel Invalid bit
  - e-VLBI Payload Type
- First 32-bit word of payload contains “per-channel invalid bits”
- Remainder of packet is payload

# e-VLBI RTCP Data Profile

- Used by e-VLBI for:
  - statistical information about network quality and performance
  - carry information correlating SSRC tags with human-understandable source ids
  - to carry “session information” needed by e-VLBI sender, receivers, and monitors
- RTCP has a host of features that are directly applicable to current e-VLBI applications
  - RTCP also has some features that may be useful in the future for supporting “advanced” e-VLBI applications

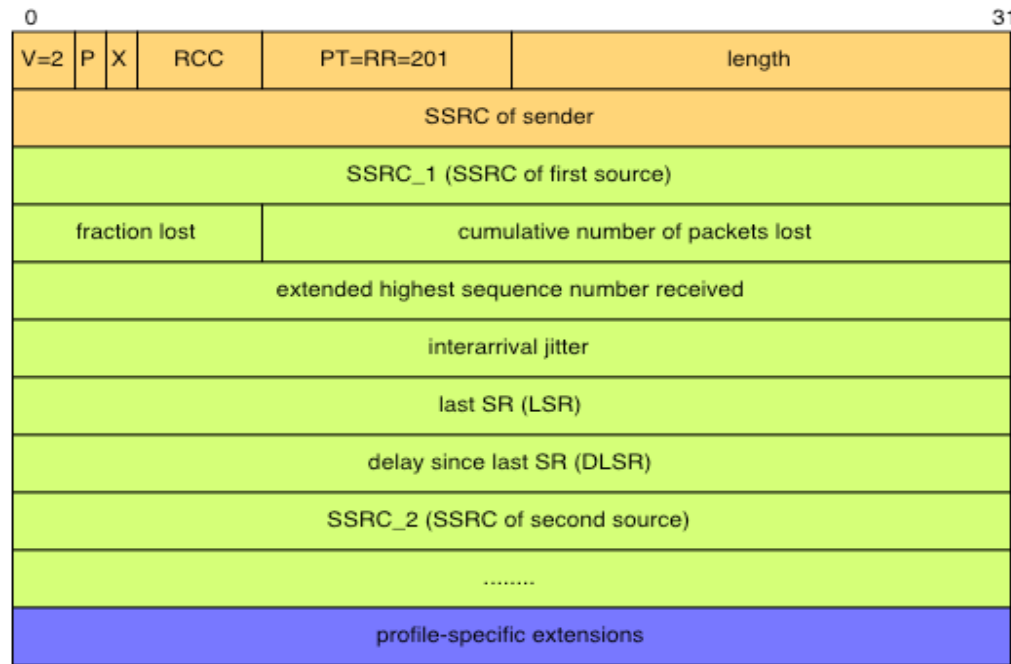
# RTCP Sender Report Packet

- Used to allow sources (antennas) to distribute transmission statistics and relationship between sender RTP timestamp and absolute time reference (e.g. from NTP)





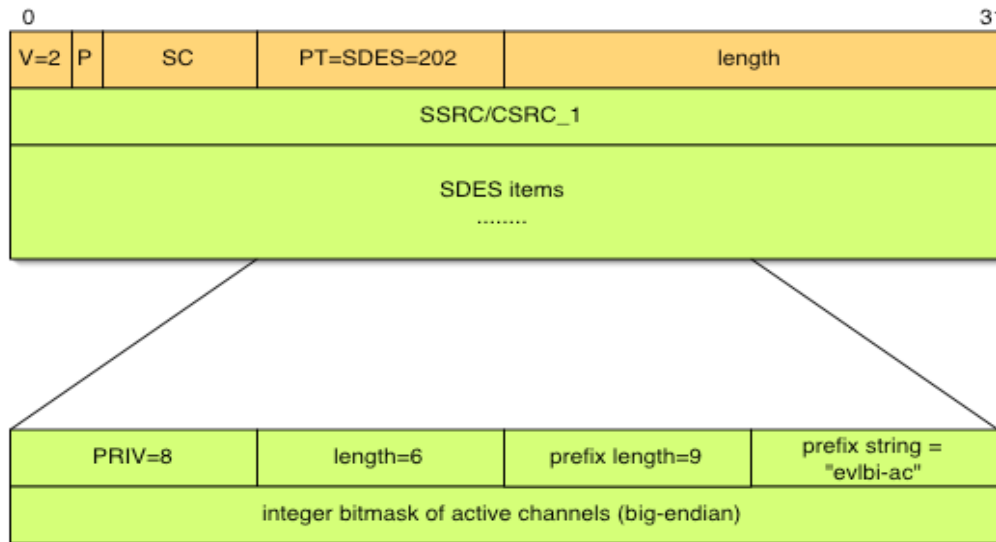
# RTCP Receiver Report Packet



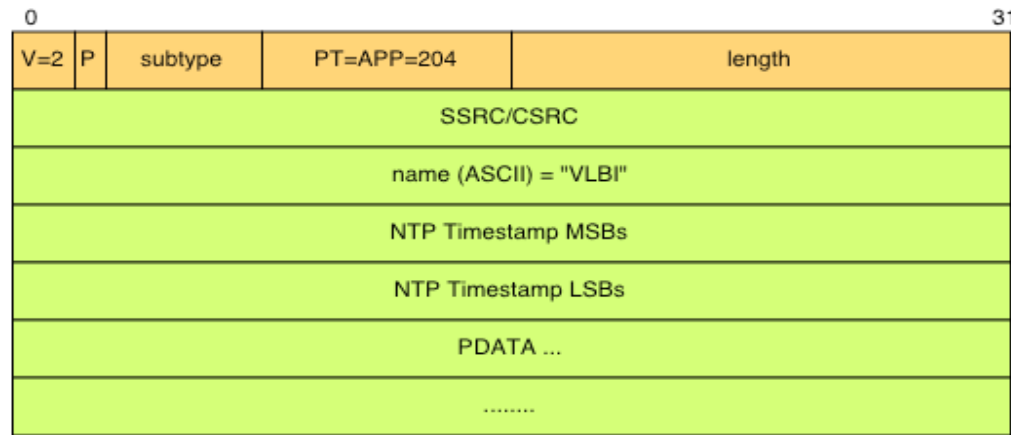
- Used by receivers (e.g. correlator) to distribute quality of reception statistics:
  - E.g. fractional packet losses, cumulative number of packets lost, interarrival jitter etc.
  - Also provides a mechanism for sources to calculate round trip times

# RTCP Source Description message

- Source DEscription message used to distribute information about a source to other session participants
- Defined information elements include:
  - CNAME, UNAME, EMAIL, PHONE, LOC, TOOL, NOTE
- Private extension to SDES used to transport active channel bitmask



# Application-defined RTCP message

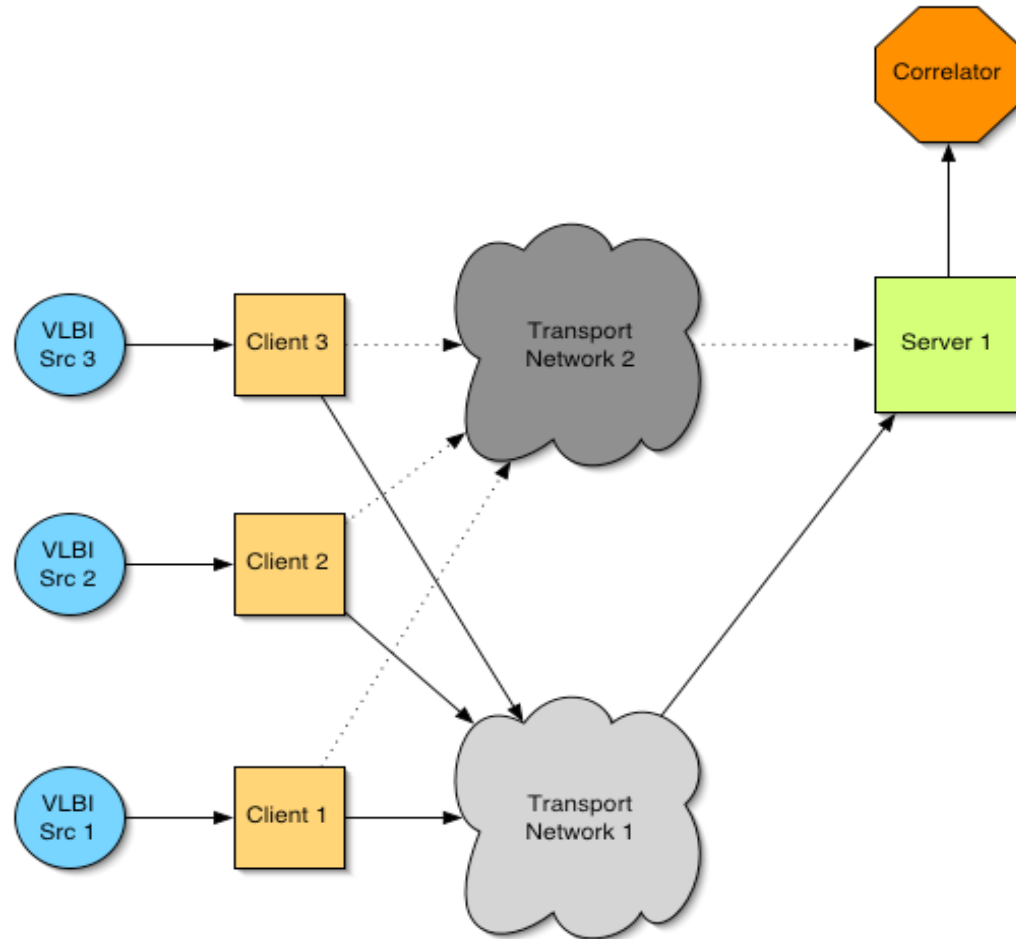


- RTCP allows applications to define their own messages
- e-VLBI profile uses this feature to carry PDATA information
- Data carried as an ASCII string and associated with an absolute time value in the format used by RTP

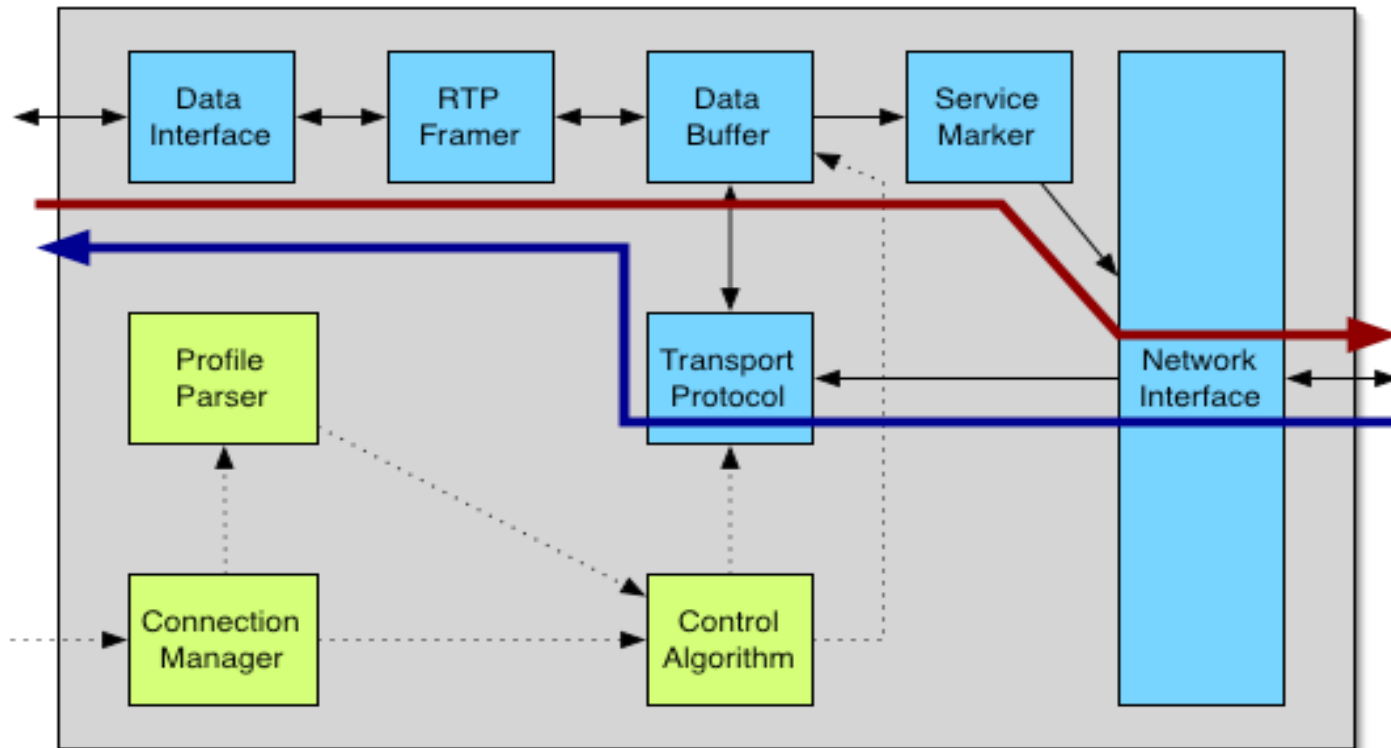
# e-VLBI Development at Haystack

- Experiment Guided Adaptive Endpoint:
  - Interfaces VLBI hardware to IP networks and transmits VLBI data
    - Uses low priority “scavenged bandwidth”
      - Internet2
      - Commercial Protection and Backup links
      - Statistical multiplexing on Commercial networks
    - Adapts transmission rates to suit network congestion
    - Allows characteristics of adaptive behaviour to be determined by high level experimental profile

# Architecture



# Experimental Guided Adaptive Endpoint Architecture



# References

- <http://www.ietf.org/html.charters/avt-charter.html>
  - RFC1889 RTP: A Transport Protocol for Real-Time Applications
  - RFC1990 RTP Profile for Audio and Video Conferences with Minimal Control
- An RTP Profile for e-VLBI data
- <http://www.haystack.mit.edu>

# Thank you!

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