AVBTP synchronization study Draft 0.00

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includes slides (some modified) from 802.1AS presentation by:

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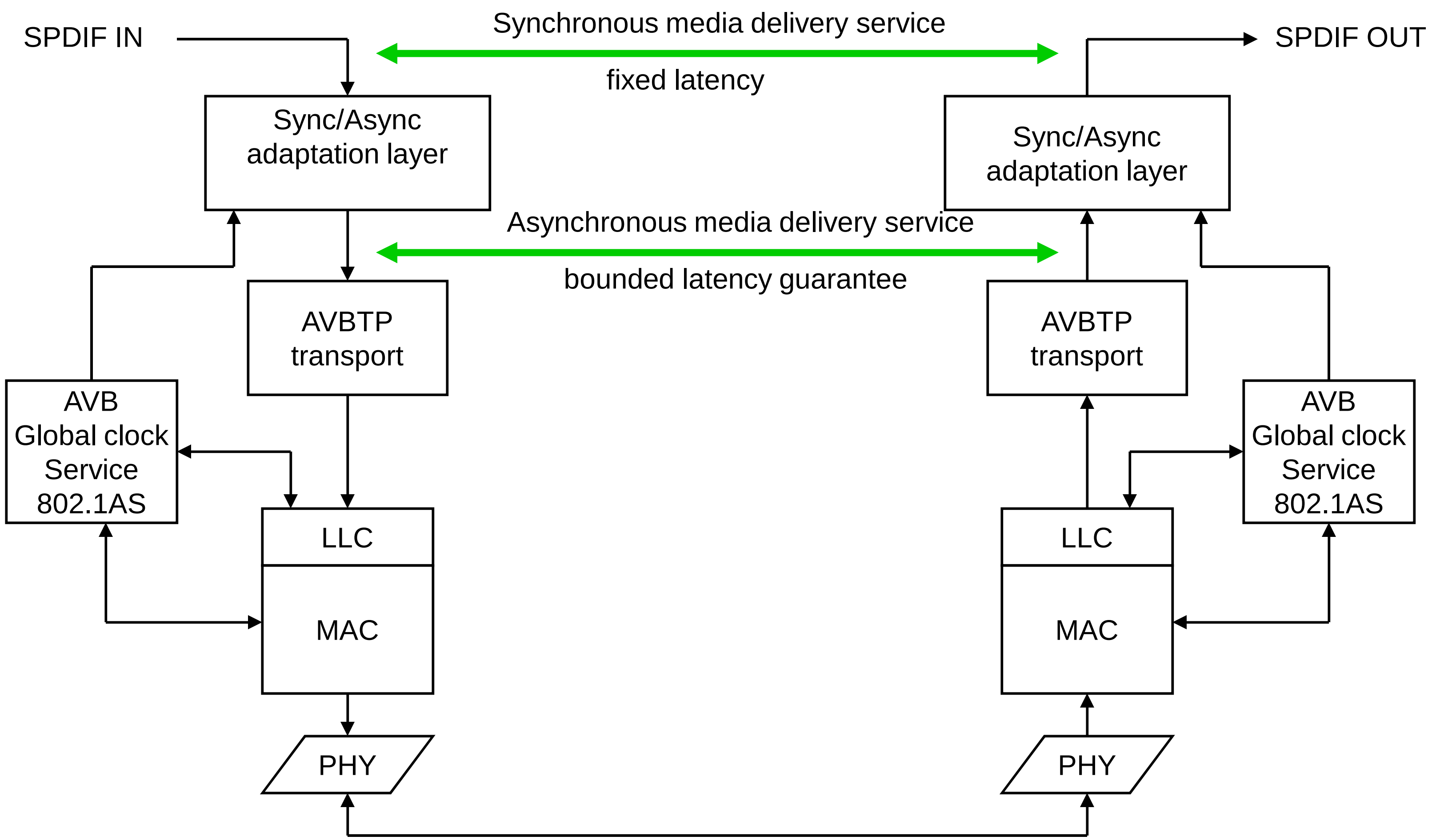
Revision History

Rev	Date	Comments
0.0	2007-04-20	First version for comments

Overview

- Disclaimer: “brainstorming” mode.
- Two client interface “styles”:
  - Synchronous: hard real time, e.g. would interface with I2S
  - Asynchronous: “soft” real time, e.g. ring buffer
- Synchronous service relies on existence of a global clock reference (802.1AS)
- Adaptation layer can map Synchronous on top of Asynchronous.

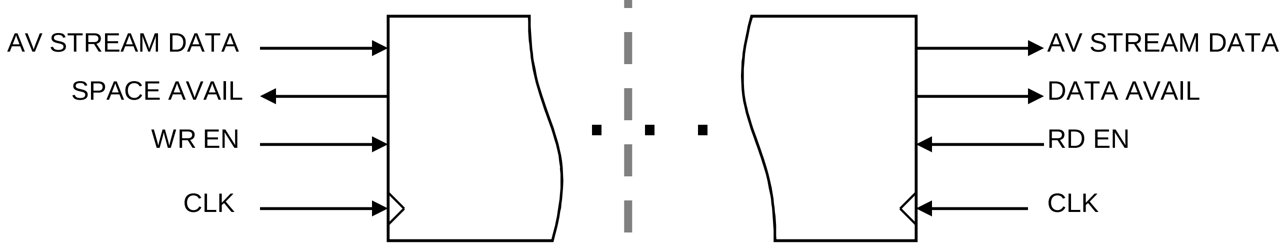
Baseline audio example



Asynchronous Interface: Example implementations

Sender Stack | **Receiver Stack**

for hardware jockeys:

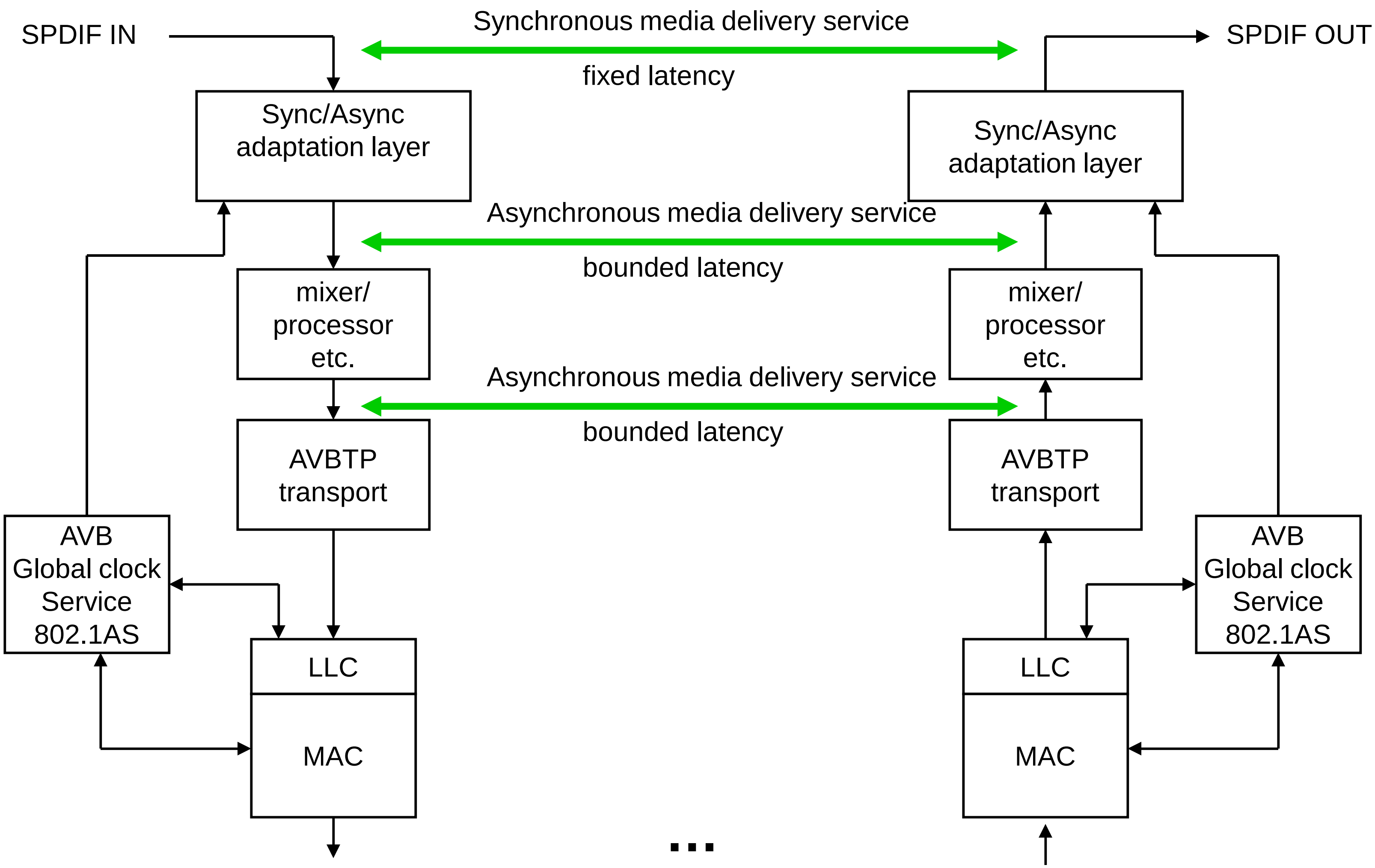


for software jockeys:

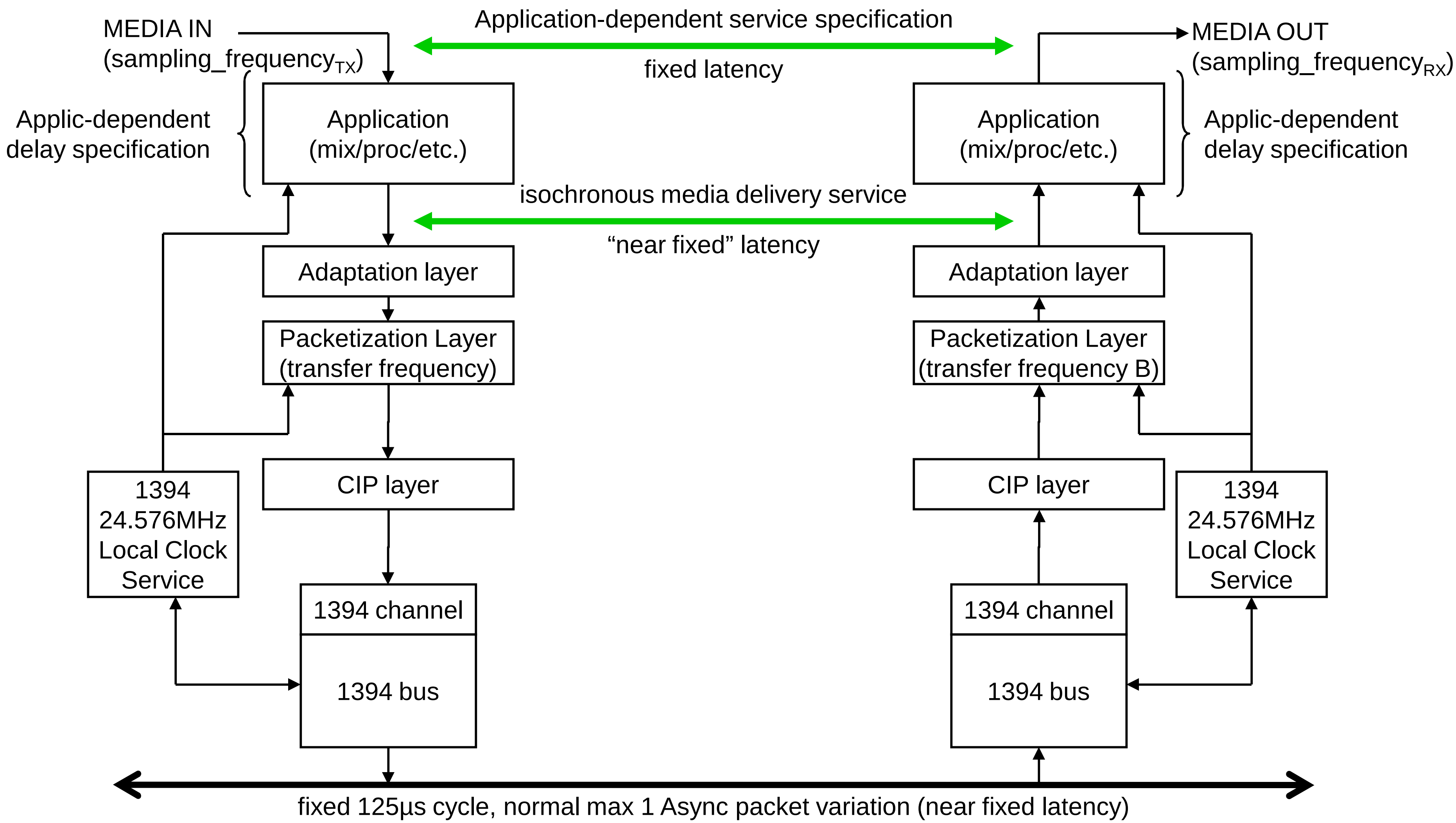
```
if( SpaceAvail(Q_AV_XMT) )
  Enqueue(Q_AV_XMT, avData);
```

```
Success =
  ((avData=Dequeue(Q_AV_RCV)) != NULL);
```

Multiple asynch interfaces



Current 61883 reference model

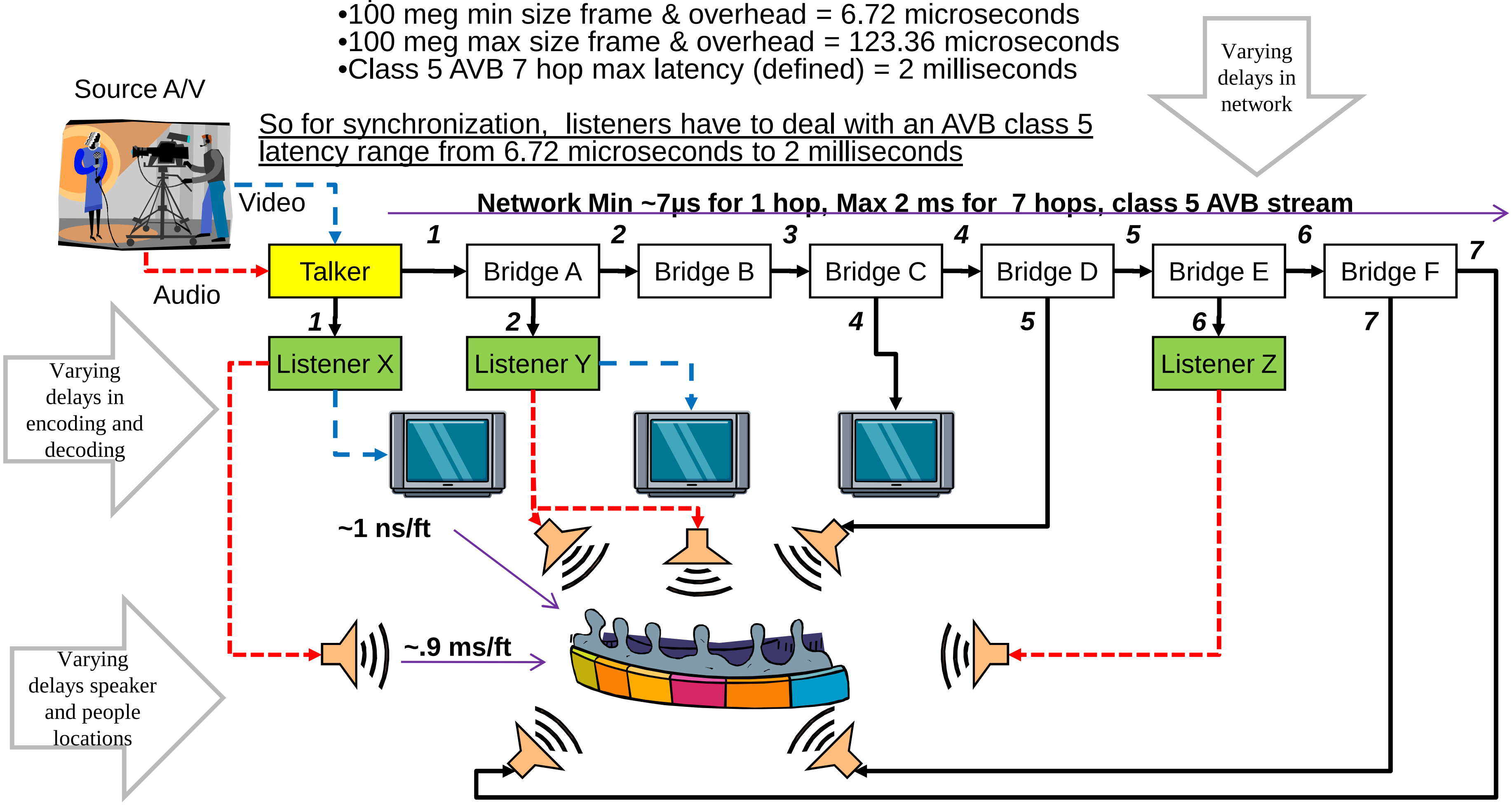


Mixed bridged and P2P AVB

Misc time info:

- •Speed of light = ~ 1 nanosecond / foot
- •Speed of sound = ~ .9 milliseconds / foot
- •100 meg min size frame & overhead = 6.72 microseconds
- •100 meg max size frame & overhead = 123.36 microseconds
- •Class 5 AVB 7 hop max latency (defined) = 2 milliseconds

So for synchronization, listeners have to deal with an AVB class 5 latency range from 6.72 microseconds to 2 milliseconds



1394/61883 sync concepts

- Source data time stamped at periodic intervals based on local clock
- Source adds Fixed Time amount for each time stamped packet, stores new value in packet as “presentation time”.
- Packets sent at 8 kHz fixed intervals on local 1394 bus, empty or no packet sent if nothing to send at a given time.
- Sink optionally parses presentation time from packet and if capable and enabled, waits to deliver data to codec until time period reached.
- If Sink has “adjustable” sample clock, Sink uses presentation time relative to 1394 local clock and/or embedded time data in stream (example: SMPTE) to adjust the clock frequency of the stream to the codec.

61883-6 “professional use” and “consumer use” classes

- 61883-6 mentions options for “professional use” versus “consumer use” devices in 2 places in section 7:
  - On processing receive SYT field:
    - A receiver for professional use **shall** have the capability of presenting events at the time specified by the transmitter.
    - A consumer-use or cost-sensitive receiver **is not required** to support this presentation-time adjustment capability.
  - On setting transmit SYT field value:
    - For professional use, TRANSFER_DELAY **may** be changed to achieve a shorter TRANSFER_DELAY value, according to the bus configuration.
    - Products for consumer use **are not required** to support the modification of TRANSFER_DELAY.
- For AVBTP, we will probably still need to classify different classes of devices/applications, but we should consider being more specific and perhaps coming up with our own categories here.

Listener device capabilities

- Sampling clock control:
  - Fixed
    - No adjustments capable. Cases:
      - Listener device needs to source sample clock
        - » If Source device also is master clock for its data, can get queue overruns or underruns.
        - » Editor's Note: USB has a mode where sink can provide feedback to source to have it adjust its clock if it is capable. Do we want to support this in AVBTP as well?
  - Multi-rate
    - Capable of multiple rates (e.g. 16 kHz, 32 kHz, 48 kHz)
      - Editor's note: Does adjustable SRP tie into this?
  - Tunable:
    - Capable of adjusting clock to match source. Possible data points to adjust queue:
      - Queue depth (similar to ATM circuit emulation adaptive timing)
      - Comparison of Presentation time versus global time averaged over time
      - Time embedded in data stream (e.g. SMPTE).

Listener device capabilities

- Output queue control
  - Basic Min/Max Depth (not presentation time capable)
    - Number of samples, no presentation time capability
  - Presentation time queue capable
    - Ability to read presentation time from ingress packets and deliver to codec based on time from those packets.
  - Presentation time adjustable
    - Ability on the listener to add or subtract from presentation time in packet to adjust the delivery time to the codec in order to adjust ultimate time to the user(s).

Possible AVBTP Listener device classes

- Class A:
  - Fixed clock
  - Presentation time capable: optional
  - Presentation time adjustable: optional
- Class B:
  - Tunable clock
  - Multi-Rate Clock optional
  - Presentation time capable: required
  - Presentation time adjustable: optional
- Class C:
  - Tunable clock
  - Multi-Rate Clock: required (if allowed by application)
  - Presentation time capable: required
  - Presentation time adjustable: required

Backup

61883-6 section 7.1

- 7.1 Packet transmission method
  - When a non-empty CIP is ready to be transmitted, the transmitter shall transmit it within the most recent isochronous cycle initiated by a cycle start packet.
  - The behavior of packet transmission depends on the definition of the condition in which “a non-empty CIP is ready to be transmitted.” There are two situations in which this condition is defined.
    - a) In order to minimize TRANSFER_DELAY, the condition of a non-empty CIP being ready for transmission is defined to be true if one or more data blocks have arrived within an isochronous cycle. This transmission method is called non-blocking transmission and is described in detail in 7.4
    - b) The condition of “non-empty CIP ready” can also be defined as true when a fixed number of data blocks have arrived. This transmission method is called blocking transmission and is described in Annex A.

61883-6 section 7.2

- 7.2 Transmission of timing information
  - A CIP without a source packet header (SPH) has only one time stamp in the SYT field. If a CIP contains multiple data blocks, it is necessary to specify which data block of the CIP corresponds to the time stamp.
  - The transmitter prepares the time stamp for the data block which meets this condition:
    - mod(data block count, SYT_INTERVAL) = 0
    - Where:
      - data block count is the running count of transmitted data blocks;
      - SYT_INTERVAL denotes the number of data blocks between two successive valid SYTs, which includes one of the data blocks with a valid SYT. For example, if there are three data blocks between two valid SYTs, then the SYT_INTERVAL would be 4.
    - The receiver can derive the index value from the DBC field of a CIP with a valid SYT using the following formula:
      - index = mod((SYT_INTERVAL – mod(DBC, SYT_INTERVAL)), SYT_INTERVAL)
    - where
      - index is the sequence number;
      - SYT_INTERVAL denotes the number of data blocks between two successive valid SYTs, which includes one of the data blocks with a valid SYT;
      - DBC is the data block count field of a CIP.
      - The receiver is responsible for estimating the timing of data blocks between valid time stamps.
      - The method of timing estimation is implementation-dependent.

61883-6 section 7.3

- 7.3 Time stamp processing
  - A data block contains all data arriving at the transmitter within an audio sample period. The data block contains all the data which make up an “event”.
  - The transmitter shall specify the presentation time of the event at the receiver.
    - A receiver for professional use shall have the capability of presenting events at the time specified by the transmitter. A consumer-use or cost-sensitive receiver is not required to support this presentation-time adjustment capability.
  - If a function block receives a CIP, processes it and subsequently re-transmits it, the SYT of the outgoing CIP shall be the sum of the incoming SYT and the processing delay.
  - The transmitter shall add TRANSFER_DELAY to the quantized timing of an event to construct the SYT. The TRANSER_DELAY value is initialized with the DEFAULT_TRANSFER_DELAY value.
    - For professional use, TRANSFER_DELAY may be changed to achieve a shorter TRANSFER_DELAY value, according to the bus configuration.
    - Products for consumer use are not required to support the modification of TRANSFER_DELAY.
  - The DEFAULT_TRANSFER_DELAY value is 354,17 + 125 µs, which accommodates the maximum latency time of CIP transmission through an arbitrated short bus reset.