Media Clocking

Professional Audio Ethernet AVB
Functional and Interoperability Specification

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1. Introduction

There are a number of methods that can be used for synchronizing media clocks on a local area network (LAN). This document defines the Avnu required method for providing interoperable and certified media clock synchronization for Professional Audio devices.

2. References

Name	*Reference*
AES11	AES11-2009, "AES recommended practice for digital audio engineering – Synchronization of digital audio equipment in studio operations".
AVDECC	IEEE 1722.1-2013, "IEEE Standard for Device Discovery, Connection Management, and Control Protocol for IEEE 1722 Based Devices".
AVTP	IEEE 1722-2016, "IEEE Standard for a Transport Protocol for Time-Sensitive Applications in Bridged Local Area Networks".
AVNU.IO.FMT	Avnu Professional Audio Functional and Interoperability Specification, Formats - Revision 2.0

3. Glossary

Term	*Meaning*
48kHz CRF Media Clock Input	A Stream sink capable of receiving a 48kHz CRF Media Clock Stream.
48kHz CRF Media Clock Listener	An AVDECC Listener capable of receiving a 48kHz CRF Media Clock Stream.
48kHz CRF Media Clock Output	A Stream source capable of transmitting a 48kHz CRF Media Clock Stream.
48kHz CRF Media Clock Stream	A Stream in the Avnu Pro Audio 48kHz CRF Media Clock Stream Format.
48kHz CRF Media Clock Talker	An AVDECC Talker capable of transmitting a 48khz CRF Media Clock Stream.
48kHz AAF Media Input	A Stream sink capable of receiving a 48kHz AAF Media Stream.
48kHz AAF Media Listener	An AVDECC Listener capable of receiving a 48kHz AAF Media Stream.
48 kHz AAF Media Output	A Stream source capable of transmitting a 48kHz AAF Media Stream.

48kHz AAF Media Stream	A Stream in the Avnu Pro Audio 48kHz AAF Media Stream Format.
48kHz AAF Media Talker	An AVDECC Talker capable of transmitting a 48kHz AAF Media Stream.
96kHz CRF Media Clock Input	A Stream sink capable of receiving a 96kHz CRF Media Clock Stream.
96kHz CRF Media Clock Listener	An AVDECC Listener capable of receiving a 96kHz CRF Media Clock Stream.
96kHz CRF Media Clock Output	A Stream source capable of transmitting a 96khz CRF Media Clock Stream Format.
96kHz CRF Media Clock Stream	A Stream in the Avnu Pro Audio 96kHz CRF Media Clock Stream Format.
96kHz CRF Media Clock Talker	An AVDECC Talker capable of transmitting a 96kHz CRF Media Clock Stream.
96kHz AAF Media Input	A Stream sink capable of receiving a 96kHz AAF Media Stream.
96kHz AAF Media Listener	An AVDECC Listener capable of receiving a 96kHz AAF Media Stream.
96kHz AAF Media Output	A Stream source capable of transmitting a 96kHz AAF Media Stream.
96kHz AAF Media Stream	A Stream in the Avnu Pro Audio 96kHz AAF Media Stream Format.
96kHz AAF Media Talker	An AVDECC Talker capable of transmitting a 96kHz AAF Media Stream.
192kHz CRF Media Clock Input	A Stream sink capable of receiving a 192kHz CRF Media Clock Stream.
192kHz CRF Media Clock Listener	An AVDECC Listener capable of receiving a 192kHz CRF Media Clock Stream.
192kHz CRF Media Clock Output	A Stream source capable of transmitting a 192khz CRF Media Clock Stream Format.
192kHz CRF Media Clock Stream	A Stream in the Avnu Pro Audio 192kHz CRF Media Clock Stream Format.
192kHz CRF Media Clock Talker	An AVDECC Talker capable of transmitting a 192kHz CRF Media Clock Stream.
192kHz AAF Media Input	A Stream sink capable of receiving a 192kHz AAF Media Stream.
192kHz AAF Media Listener	An AVDECC Listener capable of receiving a 192kHz AAF Media Stream.
192kHz AAF Media Output	A Stream source capable of transmitting a 192kHz AAF Media Stream.
192kHz AAF Media Stream	

192kHz AAF Media Talker	A Stream in the Avnu Pro Audio 192kHz AAF Media Stream Format. An AVDECC Talker capable of transmitting a 192kHz AAF Media Stream.
Avnu Pro Audio CRF 48kHz Media Clock Stream Format	The AVTP Stream format defined by Avnu to distribute a 48kHz media clock on a Pro Audio AVB network.
Avnu Pro Audio AAF 48kHz Media Stream Format	The AVTP Stream format defined by Avnu to transmit a 48kHz audio signal on a Pro Audio AVB network. Please refer to AVNU.IO.FMT.
Avnu Pro Audio CRF 96kHz Media Clock Stream Format	The AVTP Stream format defined by Avnu to distribute a 96kHz media clock on a Pro Audio AVB network.
Avnu Pro Audio AAF 96kHz Media Stream Format	The AVTP Stream format defined by Avnu to transmit a 96kHz audio signal on a Pro Audio AVB network. Please refer to AVNU.IO.FMT.
Avnu Pro Audio CRF 192kHz Media Clock Stream Format	The AVTP Stream format defined by Avnu to distribute a 192kHz media clock on a Pro Audio AVB network.
Avnu Pro Audio AAF 192kHz Media Stream Format	The AVTP Stream format defined by Avnu to transmit a 192kHz audio signal on a Pro Audio AVB network. Please refer to AVNU.IO.FMT.
PAAD	A professional audio device with Ethernet AVB functionality compliant to this specification

4. Scope

The present document describes the requirements that a PAAD shall implement with regards to Media Clocking. In particular, it specifies which Input and Output Media Clock Streams a PAAD shall allocate, and the format these streams shall use.

5. General Requirements

5.1. Overview

Using an AVB stream to distribute the media clock allows to have several media clock domains in the same LAN.

A given entity may support one or several media clock domains at the same time. For each supported media clock domain, the entity may support one or several sampling rates (not at the same time).

5.2. Support for clock domains

A PAAD shall support at least one 48kHz media clock domain.

A PAAD may support a 96kHz media clock domain.

A PAAD may support a 192kHz media clock domain.

5.3. Support for media clock inputs and outputs

Support for 48kHz CRF Media Clock Inputs:

- For each supported 48kHz clock domain, a 48kHz AAF Media Talker shall implement a 48kHz CRF Media Clock Input.
- For each supported 48kHz clock domain, a 48kHz AAF Media Listener with two or more 48kHz AAF Media Inputs shall implement one 48kHz CRF Media Clock Input.

Support for 96kHz CRF Media Clock Inputs:

- For each supported 96kHz clock domain, a 96kHz AAF Media Talker shall implement a 96kHz CRF Media Clock Input.
- For each supported 96kHz clock domain, a 96kHz AAF Media Listener with two or more 96kHz AAF Media Inputs shall implement one 96kHz CRF Media Clock Input.

Support for 192kHz CRF Media Clock Inputs:

- For each supported 192kHz clock domain, a 192kHz AAF Media Talker shall implement a 192kHz CRF Media Clock Input.
- For each supported 96kHz clock domain, a 192kHz AAF Media Listener with two or more 192kHz AAF Media Inputs shall implement one 192kHz CRF Media Clock Input.

Support for 48kHz CRF Media Clock Outputs:

- For each supported 48kHz clock domain, a 48kHz AAF Media Talker capable of synchronizing to an external 48kHz source (non AVB stream) shall implement a 48kHz CRF Media Clock Output.
- For each supported 48kHz clock domain, a 48kHz AAF Media Listener with two or more 48kHz AAF Media Inputs shall implement a 48kHz CRF Media Clock Output.

Support for 96kHz CRF Media Clock Outputs:

- For each supported 96kHz clock domain, a 96kHz AAF Media Talker capable of synchronizing to an external 96kHz source (non AVB stream) shall implement a 96kHz CRF Media Clock Output.

- For each supported 96kHz clock domain, a 96kHz AAF Media Listener with two or more 96kHz AAF Media Inputs shall implement a 96kHz CRF Media Clock Output.

Support for 192kHz CRF Media Clock Outputs:

- For each supported 192kHz clock domain, a 192kHz AAF Media Talker capable of synchronizing to an external 192kHz source (non AVB stream) shall implement a 192kHz CRF Media Clock Output.

- For each supported 192kHz clock domain, a 192kHz AAF Media Listener with two or more 192kHz AAF Media Inputs shall implement a 192kHz CRF Media Clock Output.

6. Media Clock Streams

6.1. Overview

A number of Stream formats can be used to distribute a media clock through an AVB network. But for interoperability purpose, Avnu defines a common format that shall be supported by all devices capable of transmitting/receiving a media clock through an AVB stream in a Pro Audio AVB network.

6.2. Avnu Pro Audio CRF Media Clock Stream Format

The Avnu Pro Audio 48kHz CRF Media Clock Stream Format is CRF (Clock Reference Format) as defined in AVTP, Clause 10. The base frequency shall be 48000Hz. Each PDU shall contain 1 timestamp, and the timestamp interval shall be 96 (i.e. 2ms, leading to a timestamp frequency of 500Hz). This stream format shall be used to distribute a 48kHz media clock in a 48kHz media clock domain.

The Avnu Pro Audio 96kHz CRF Media Clock Stream Format is CRF (Clock Reference Format) as defined in AVTP, Clause 10. The base frequency shall be 96000Hz. Each PDU shall contain 1 timestamp, and the timestamp interval shall be 192 (i.e. 2ms, leading to a timestamp frequency of 500Hz). This stream format shall be used to distribute a 96kHz media clock in a 96kHz media clock domain.

The Avnu Pro Audio 192kHz CRF Media Clock Stream Format is CRF (Clock Reference Format) as defined in AVTP, Clause 10. The base frequency shall be 192000Hz. Each PDU shall contain 1 timestamp, and the timestamp interval shall be 384 (i.e. 2ms, leading to a timestamp frequency of 500Hz). This stream format shall be used to distribute a 192kHz media clock in a 192kHz media clock domain.

6.3. Media Clock Stream Frequency

Please pay attention that, to avoid phase shift issues in the rendering of audio streams, a CRF Media Clock Talker supporting several sampling rates should not use a 48kHz CRF Media Clock Stream to distribute the media clock of a 96kHz or 192kHz media clock domain. Likewise, it should not use a 96kHz CRF Media Clock Stream to distribute the media clock of a 192kHz media clock domain.

6.4. Media Clock Stream Reservation Class

An AVB Class A Stream Reservation shall be used to transmit an Avnu Pro Audio CRF Media Clock Stream.

6.5. Summary

Table 1 below summarizes the two possible formats for the Avnu Pro Audio CRF Media Clock Streams:

	48kHz	**96kHz**	**192kHz**
v	0	0	0
subtype	4 (CRF)	4 (CRF)	4 (CRF)
type	1 (CRF_AUDIO_SAMPLE)	1 (CRF_AUDIO_SAMPLE)	1 (CRF_AUDIO_SAMPLE)
timestamp_interval	96	192	384
timestamps_per_pdu	1	1	1
pull	0	0	0
base_frequency	48000	96000	192000
AVDECC format string	0x041060010000BB80	0x0410C00100017700	0x041180010002EE00

Table 1: Stream formats

7. Media Clock Source Quality

In accordance to AES11, oscillators used as source in a media clock domain shall produce a clock whose frequency tolerance is better than +/-50PPM.

Annex A (informative) Media clock domains

A media clock domain is a subset of an AVB domain composed of end stations using the same common media clock for sampling, transmission and rendering of audio signals. According to this specification, this common media clock is distributed using a CRF Media Clock Stream.

A given PAAD can belong to several media clock domains if it supports multiple simultaneous media clock domains. Some of the audio signals used by this PAAD will be clocked by a media clock and some other by another media clock.

Distribution of the media clock through an AVB stream allows a lot of flexibility in the design of the audio system. Figure 1 below shows a very simple example of a Pro Audio AVB network with 2 non-overlapping media clock domains, one running at 48kHz and the other one running at 96kHz:

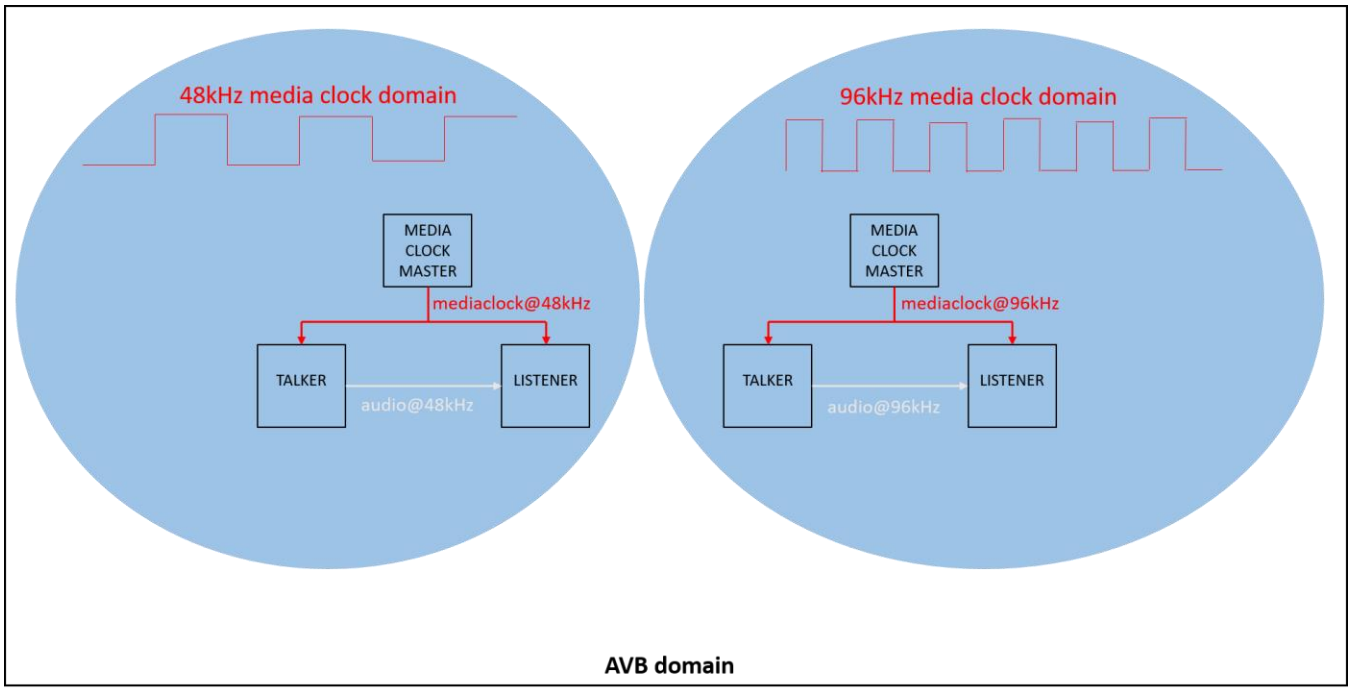

Figure 1: AVB domain with two media clock domains

A general design rule is not to transmit a media clock stream from a media clock domain to another one when the target frequency is lower than the initial one. Figure 2 and figure 3 below show two different bad usages of media clock transmission across media clock domains. In Figure 2, a 96kHz media clock stream is used as a source to derive a 48kHz physical media clock. In Figure 3, a 96kHz physical media clock is used as source to derive a 48kHz media clock stream.

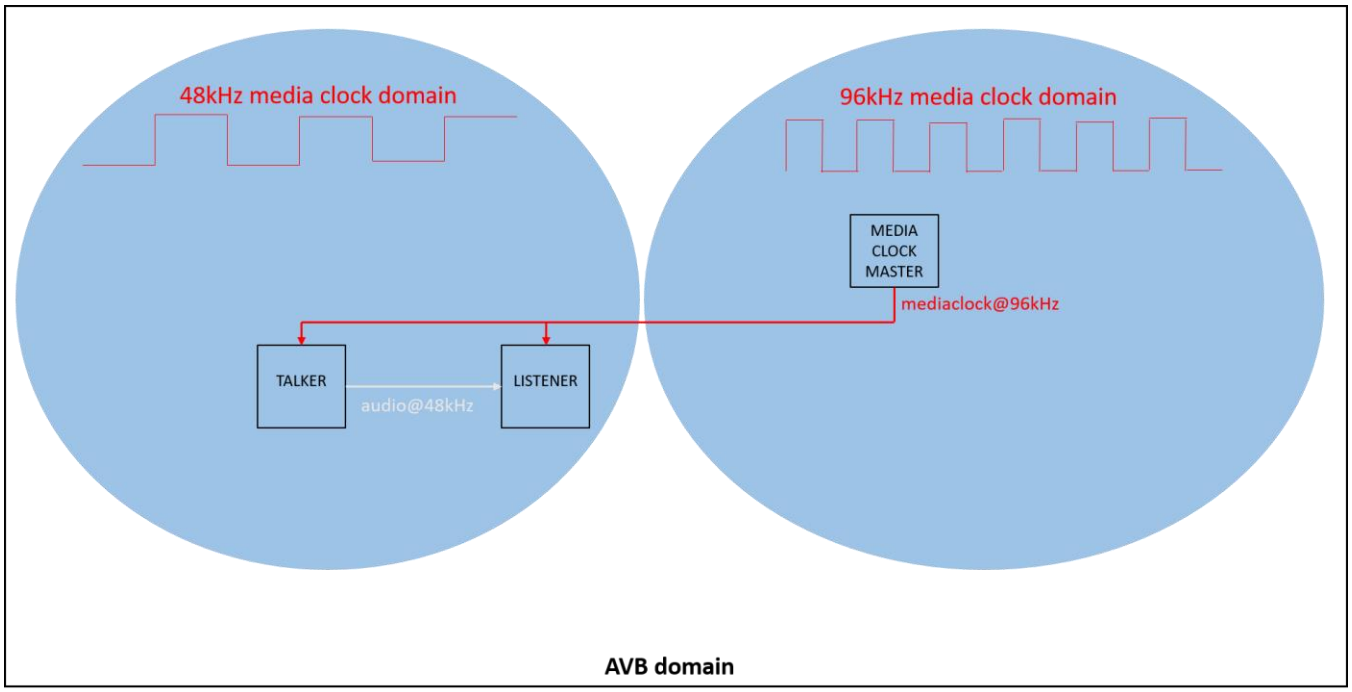

Figure 2: Bad usage of media clock streams - generation of a 48kHz clock from a 96kHz media clock stream

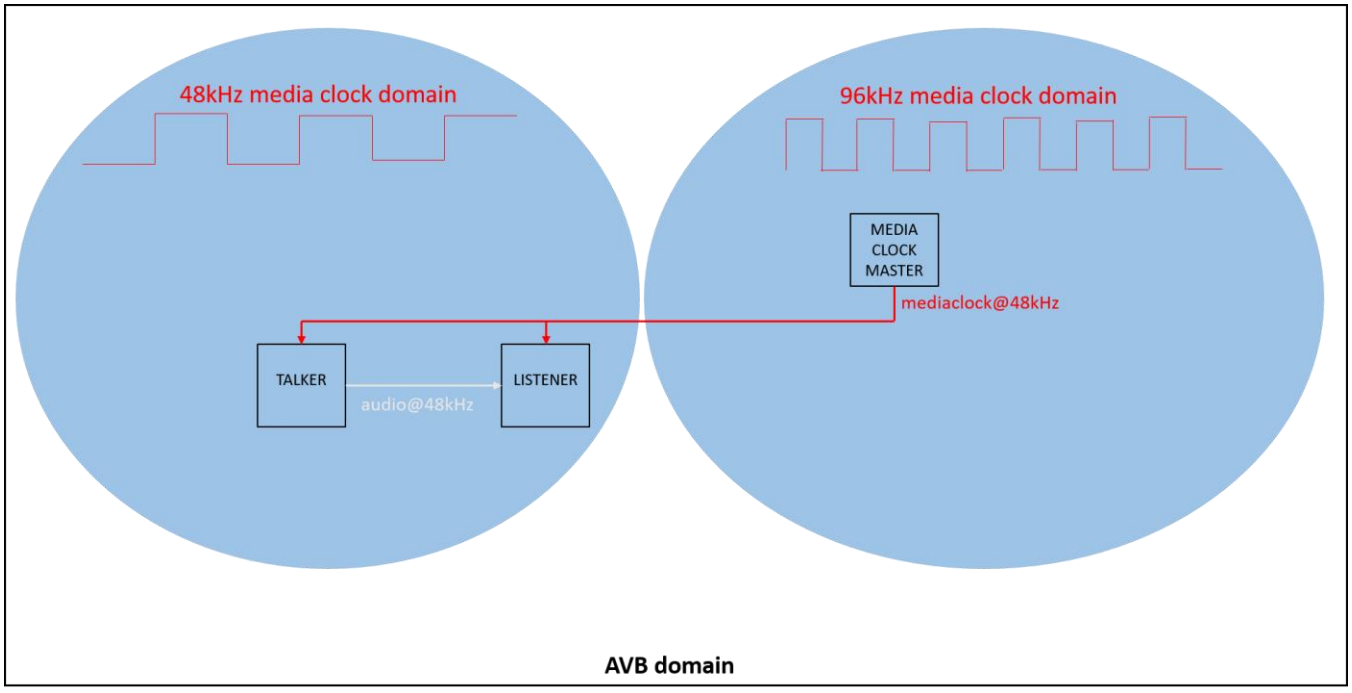

Figure 3: Bad usage of media clock streams - generation of a 48kHz media clock stream from a 96kHz clock

This should never be done because several versions (actually two versions) of a 48kHz media clock can be derived from a single 96kHz media clock. The two versions are identical except a 180° phase difference. This is shown in Figure 4 below.

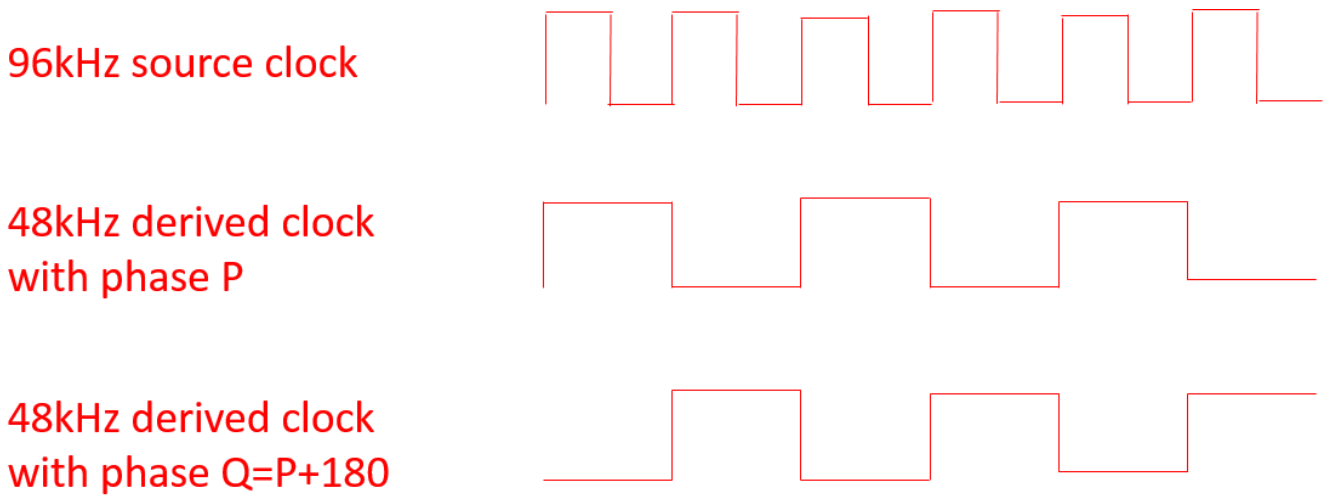

Figure 4: Uncertainty on phase after a clock division

In the example of Figure 2, this can lead to the following issue: the talker is deriving a 48kHz media clock with phase P while the listener is deriving a 48kHz media clock with phase Q.

In the example of figure 3, this can lead to the following issue: the media clock master is deriving a 48kHz media clock with phase P, then for some reason is rebooted and now derives a 48kHz media clock with phase Q. The transition triggered by the phase offset between the media clock before reboot of the media clock master, and the media clock after reboot of the media clock master, may create some audible artifacts on the rendering of the audio stream.

Please note that although these issues don't exist when the target frequency is higher than the initial one, it is still not recommended to transmit a media clock stream across different media clock domains.