RAVENNA

Draft 1.0

RAVENNA WDM Virtual Sound Card (RVSC) – Specification

This document describes the specification of the RAVENNA Virtual Sound Card (RVSC) with WDM API.

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1 INTRODUCTION

RAVENNA is a solution for real-time distribution of audio and other media content in IP-based network environments. Utilizing standardized network protocols and technologies, RAVENNA can integrate and operate on existing network infrastructures. Performance and capacity are scaling with the capabilities of the underlying network architecture. It emphasizes data transparency, tight synchronization, low latency and reliability. It aims at applications in professional environments, where networks are planned and managed, and where performance has to surpass the requirements of consumer applications.

RAVENNA technology is implemented in end nodes, which usually are media processing or converter devices (e.g. mixing desks, routing systems, audio workstations, signal converters, microphones, speakers etc.). Implementation can in general be executed in software on suitable platforms, but can be accelerated in terms of performance by dedicated hardware means (e.g. relocate stream processing into FPGA logic).

This document describes the specifications of the RAVENNA Virtual Sound Card (WDM) for Windows-operated PCs. The RAVENNA Virtual Sound Card makes RAVENNA streams on the network accessible to generic Windows audio applications through WDM audio device technology[1]. The notation "virtual sound card" has been chosen to indicate that it replaces a "real" sound card with a "virtual" sound card[2] - it virtually turns the network interface into an audio card.

[1] Implementations based on other technologies (i.e. ASIO) may also be available in the future; they will be specified separately.

[2] The notation "virtual sound card" is not to be mixed up with the operation of a "virtual PC", which denominates the emulation of a PC on server platforms.

2 INTENDED PURPOSE OF THE RVSC

The RVSC, once installed on a suitable PC, enables a generic Windows audio application to participate in RAVENNA stream exchange.

This is achieved through a two-faced service running on a Windows computer, which acts as a RAVENNA device towards the network, and as an audio device driver towards an application running on the computer. The service effectively translates between RAVENNA and the WDM audio driver model.

The main benefit is, that any existing audio application that can work with Windows audio devices, can also work with RAVENNA streams. To the application, the RAVENNA network appears as a set of multichannel record and playback devices.

2.1 Applications

The RVSC is intended to serve as an access method in any situation where a PC-based audio application needs to exchange audio signals with the RAVENNA network. Typical scenarios may include

- Play-out applications (e.g. broadcast automation system, clip player etc.)
- Recording applications (e.g. multi-track recorder, audio loggers etc.)
- Workstation / production applications in journalist's environment (e.g. audio clip production etc.)

Since the applicable media clock is derived from the RAVENNA network, any application exchanging audio data with the Windows file system can instantly process the audio data in a bit-transparent way, as the file system does not adhere to any other competing media clock. Data is transferred to / from the disk simply at the rate given by the WDM audio device.

The RVSC cannot be used to play-out, listen to or record from a discrete audio signal directly as it does not provide any means for interfacing to any "real" audio hardware. If signal exchange between discrete audio sinks or sources and RAVENNA streams is required, appropriate audio hardware and an audio application capable of interchanging audio data between the RVSC and the audio driver supplied by the audio hardware must be present. Furthermore, this audio application must be capable of converting the audio data between different media clock rates (sample rate conversion) as RVSC and the audio hardware device most probably run on different media clocks.[3]

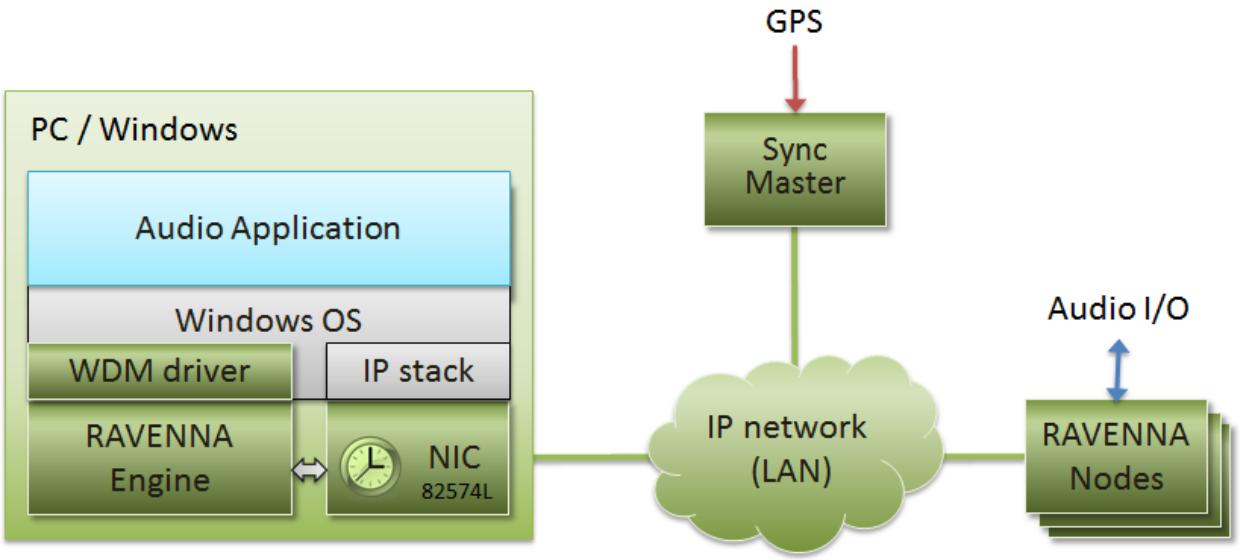
[3] An example of an audio application capable of interfacing to multiple available audio devices would be the JADE engine by Lawo.

3 DESIGN OUTLINE

This section gives a brief overview on the principle design of the RVSC.

3.1 Overview

The principle system design is pictured below; for better understanding relevant elements of a typical RAVENNA network installation are also shown.



Functional block diagram of RVSC with other RAVENNA network components

From an audio application's point of view, the Windows operating system provides a WDM audio device interface. However, no real audio card is present, rather the WDM audio device is generated by the RAVENNA "engine"[4]. Audio data exchange between the audio application and the RAVENNA engine is facilitated through the WDM audio device interface, no modification or specific knowledge about RAVENNA is required with the audio application. The audio data is sent to or received from the RAVENNA network through the IP stack provided by the Windows operating system.

The audio data synchronization is taken care of by the RAVENNA engine. It maintains a local copy of the system-wide RAVENNA wall clock time distributed via PTP. The internal media clock, which drives the WDM audio device, is derived from the local clock.

[4] The structure of the RAVENNA „engine" is much more complex in reality; it is simplified here for basic understanding of the functional approach.

4 FEATURES AND PERFORMANCE SPECIFICATION

In general, the RVSC complies with the RAVENNA Generic Profile[5]. However, some mandatory performance requirements cannot be met due to restrictions induced by the PC / Windows platform. This section lists all relevant specifications and exceptions.

4.1 PC operating environment

The RVSC can run on a standard PC system operating under Windows 7. As described above, for PTP synchronization a specific Intel Ethernet controller with hardware time stamping support is required.

In addition, it is essential that the selected PC hardware is capable of properly handling real-time media data streams. Improperly implemented kernel-mode device drivers may cause excessive latencies of Deferred Procedure Calls (DPCs) which may then result in audible drop-outs when processing real-time audio streams. The maximum DPC latency of the selected system can be checked with a third-party tool[6].

4.1.1 Minimal system requirements

- PC hardware: standard PC, dual-core CPU, 4GB RAM
- Gigabit Ethernet controller: Intel 82574L[7] [8]
- OS: Microsoft Windows 7 Home / Professional / Ultimate, 32 and 64-bit, any language

4.2 Synchronization & media clock generation

4.2.1 Time distribution / 1588-specific parameters

4.2.1.1 General

- Protocol / encapsulation: IEEE 1588-2008 (PTPv2) via IPv4
- Delay request method: methods: TC e2e, two-step[9]
- Time Domain adjustable (default 0)
- Slave-only mode
- Control for configuration of all relevant parameters

[5] RAVENNA Generic Profile, Draft 0.4

[6] Refer to http://www.thesycon.de/deu/latency_check.shtml for further information.

[7] If this controller chip is not available on the motherboard, a separate plug-in network card with this controller can be used instead (i.e. Intel EXPI9301CT desktop Gbit Ethernet PCIe card)

[8] Other suitable Ethernet controller may be supported at a later stage.

[9] TC p2p would generally be preferable, but cannot be provided due to implementation-specific limitations

4.2.1.2 Slave mode

- Sync message interval: $2^{-2}..2^{1}$ seconds
- Delay request message interval: $2^{0}..2^{4}$ seconds

4.2.1.3 Grandmaster mode

- Not supported

4.2.2 Internal media clock generation

- Sample rate: 48 kHz[10], synchronized to Grandmaster on RAVENNA network

4.3 Streaming

4.3.1 Protocols

- RTP/AVT & RTCP as defined in RFC 3550
- Multicast[11]
- IGMPv2 support

4.3.2 Data formats[12]

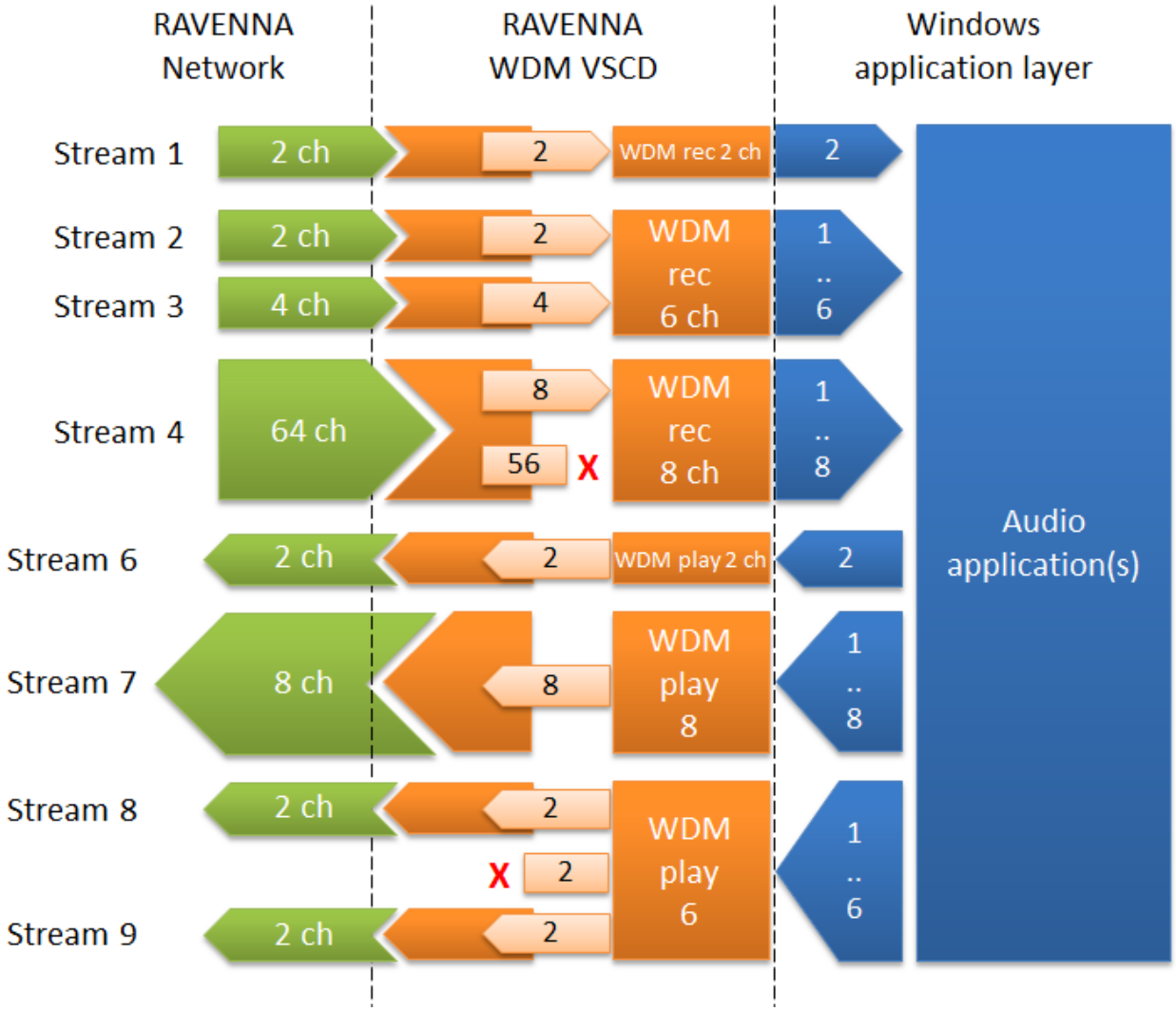
- Linear data formats: L16/48, L24/48
- Transparent AES/EBU @ 48 kHz: non-standardized 32-bit format based on AM824 (label values 0..47 only, for representation of S/PDIF / AES3 meta data)[13] [14]

4.3.3 Capacity / performance

- Configurable number of WDM audio devices[15]
- Up to 8 audio channels per WDM audio device possible
- Total channel capacity: 64 playback / 64 record (up to 8 WDM audio devices w/ 8 channels per direction) [16]
- Free assignment capability between stream and IO channels, including capability of receiving streams with larger stream channel count (possibility to dump / ignore

[10] Other sample rates may be supported in later version
[11] Unicast will be added later by sw enhancement
[12] Other data formats may be supported at a later time
[13] Refer to *AM824 - RTP payload format for AES3* document for further details
[14] AES/EBU meta data is not processed as no means for meta data interchange via WDM exist (meta data is stripped, L24 is passed on)
[15] The free version of the RVSC features 2 WDM playback and 1 WDM recording devices
[16] The free version of the RVSC features up to 16 playback and 8 recording channels

unwanted stream channels) and possibility of assigning multiple streams to any given WDM audio device



Examples of possible stream / WDM audio device configurations

- Stream capacity: min. 8 streams w/ 8 channels ea. direction
- Min. packet size: 48 samples[17]
- Max packet size: standard frame size (MTU 1500 bytes → 1460 bytes payload)

4.3.4 Latency

- Configurable WDM audio frame size: multiple of 64 / 128 / 256 / 512 / 1024samples
- Typical processing latency: < 20 ms[18]

[17] Reception of 48 samples / packet is required by RAVENNA Generic Profile, Draft 0.4; it is also required for transmission of 8 channels with L24/48 payload in one stream.

- Max. latency buffer upon reception: 32768 samples per channel (682 ms @ 48 kHz)

4.3.5 Redundancy

- Not supported

[18] Measured from point of packet reception, assuming stream w/ defined minimum packet size and smallest audio frame size; network latency and audio application processing time excluded – depending on system performance

5 NETWORK REQUIREMENTS

General network requirements for RAVENNA operation are specified in an external document[19]. These also apply to the RVSC, with the following specifics:

- Although operation on Fast Ethernet infrastructure is technically possible, it is not considered to be a valid use case for the RVSC (all specifications in section 4 apply to Gigabit Ethernet only)

[19] RAVENNA Network Requirements - Draft 0.1

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