Application Note

CONFIDENTIAL

Ethernet AVB Software Simple Application

Application Note

R-Car H3/M3/M3N/E3/D3 Series

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How to Use This Manual

- **[Readers]**
  This manual is intended for engineers who develop products which use the R-Car H3/M3/M3N/E3 processor.

- **[Purpose]**
  This manual is intended to give users an understanding of the functions of the R-Car H3/M3/M3N/E3 processor device driver and to serve as a reference for developing hardware and software for systems that use this driver.

- **[How to Read This Manual]**
  It is assumed that the readers of this manual have general knowledge in the fields of electrical
  — engineering, logic circuits, microcontrollers, and Linux.
  → Read this manual in the order of the CONTENTS.
  — To understand the functions of a multimedia processor for R-Car H3/M3/M3N/E3
  → See the R-Car H3/M3/M3N/E3 User's Manual.
  — To know the electrical specifications of the multimedia processor for R-Car H3/M3/M3N/E3
  → See the R-Car H3/M3/M3N/E3 Data Sheet.

- **[Conventions]**
  The following symbols are used in this manual.
  Data significance: Higher digits on the left and lower digits on the right
  Note: Footnote for item marked with Note in the text
  Caution: Information requiring particular attention
  Remark: Supplementary information
  Numeric representation: Binary ... 0b××××, or ××××B
  Decimal ... ××××
  Hexadecimal ... 0x×××× or ××××H
  Data type: Double word ... 64 bits
  Word … 32 bits
  Half word ... 16 bits
  Byte ... 8 bits

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1. Overview

1.1 Overview

This manual explains the simple application of EthernetAVB-IF on R-Car H3/M3/M3N/E3/D3. There are two applications, Talker application and Listener application. Talker application creates the data of Ethernet frame and transmits it. Listener application receives Ethernet frame and save the payload data to the file.

1.2 Reference

1.2.1 Standard

The following table shows the document related to module.

Table 1.1 Standards

Number	Issue	Title	Edition	Date
IEEE Std 802.1BA-2011	IEEE STANDARDS ASSOCIATION	IEEE Standard for Local and metropolitan area networks - Audio Video Bridging (AVB) Systems	-	30 September 2011
IEEE Std 802.1Qav-2009	IEEE STANDARDS ASSOCIATION	IEEE Standard for Local and metropolitan area networks - Virtual Bridged Local Area Networks Amendment 12: Forwarding and Queuing Enhancements for Time-Sensitive Streams	-	5 January 2010
IEEE Std 1722-2016	IEEE STANDARDS ASSOCIATION	IEEE Standard for a Transport Protocol for Time-Sensitive Applications in Bridged Local Area Networks	-	7 December 2016
IEEE P1722a/D5	IEEE STANDARDS ASSOCIATION	IEEE Standard for Layer 2 Transport Protocol for Time-Sensitive Applications in Bridged Local Area Networks	Draft 5	June 2013
IEEE Std 802.1Q-2014	IEEE STANDARDS ASSOCIATION	IEEE Standard for Local and metropolitan area networks - Bridges and Bridged Networks	-	19 December 2014

1.2.2 Related Document

The following table shows the document related to this module.

Table 1.2 Related documents

Number	Issue	Title	Edition
1	Renesas Electronics	R-Car Series, 3rd Generation User's Manual: Hardware	Rev.2.30
2	Renesas Electronics	R-CarH3-SiP System Evaluation Board Salvator-X Hardware Manual RTP0RC7795SIPB0011S	Rev.1.09
3	Renesas Electronics	R-CarM3-SiP System Evaluation Board Salvator-X Hardware Manual RTP0RC7796SIPB0011S	Rev.0.04
4	Renesas Electronics	R-CarH3-SiP/M3-SiP/M3N-SiP System Evaluation Board Salvator-XS Hardware Manual	Rev.2.04
5	Renesas Electronics	R-CarE3 System Evaluation Board Ebisu-4D (E3 board 4xDRAM) Hardware Manual	Rev.1.01
6	Renesas Electronics	Linux Interface Specification Yocto recipe Release Note	Rev.5.9.0
7	Renesas Electronics	Linux Interface Specification Yocto recipe Start-Up Guide	Rev.5.9.0
8	Renesas Electronics	Ethernet AVB Software AVB Streaming Driver User's Manual: Software	Rev.2.30
9	Renesas Electronics	Ethernet AVB Software Start-Up Guide	Rev.2.30
10	Renesas Electronics	R-CarD3 System Evaluation Board Draak Hardware Manual	Rev.1.20

1.3 Restrictions

Nothing.

1.4 Terminology

The following table shows the terminology related to this module.

Table 1.3 Terminology

Terms	Explanation
AVB	Audio Video Bridging
AVTP	Audio Video Transport Protocol (IEEE Std 1722)
SRP	Stream Reservation Protocol (IEEE Std 802.1Q)
MAC	Media Access Control
MMRP	Multiple MAC Registration Protocol (IEEE Std 802.1Q)
MSRP	Multiple Stream Registration Protocol (IEEE Std 802.1Q)
MVRP	Multiple VLAN Registration Protocol (IEEE Std 802.1Q)
VLAN	Virtual LAN (IEEE Std 802.1Q)
PTP	Precision Time Protocol

2. Operating Environment

2.1 Hardware Environment

The hardware environment premises on "Chapter 1.3 Hardware environment" in Ethernet AVB Software Start-Up Guide.

2.2 Software relationship

The following figure shows the relationship of this module.

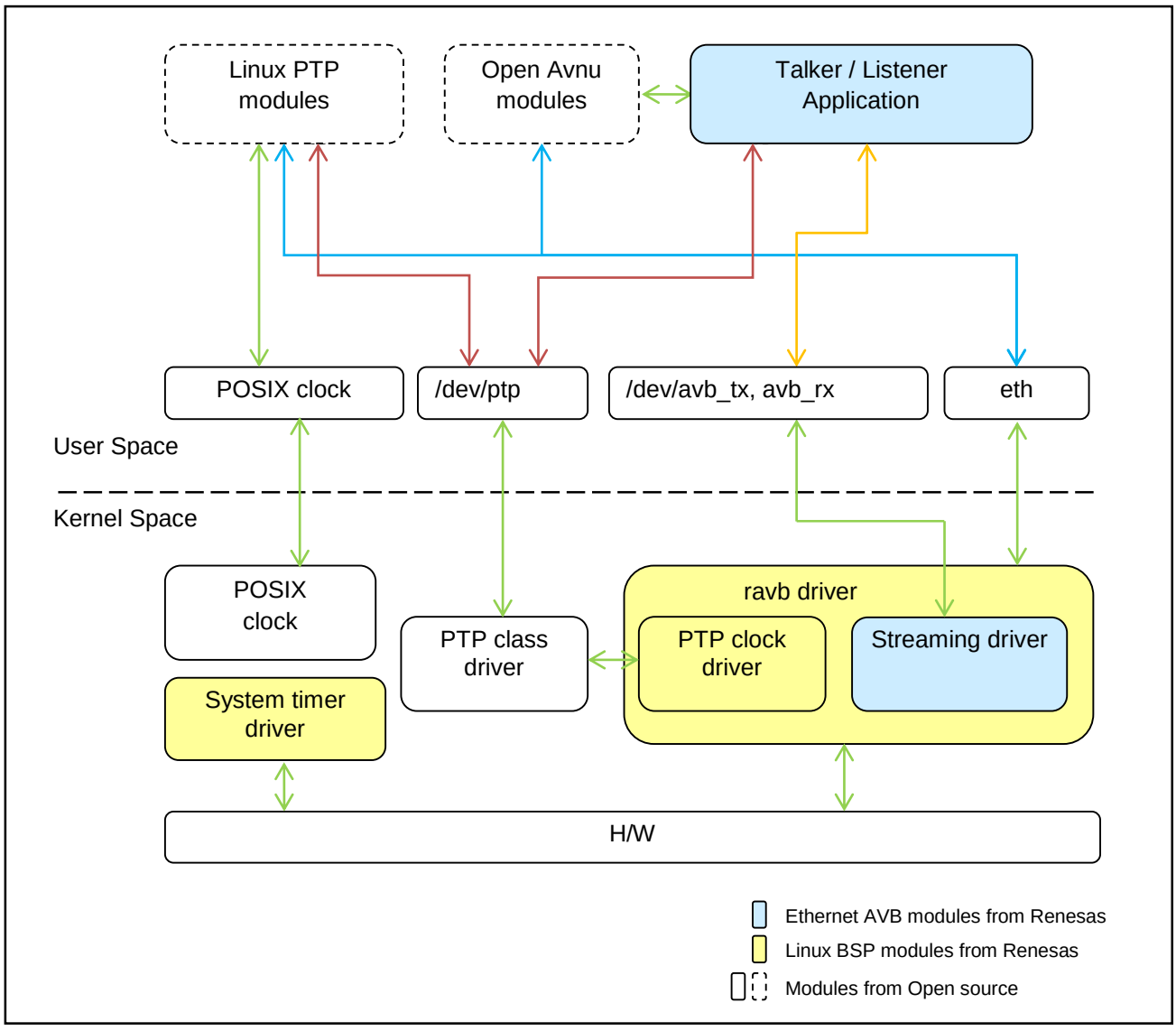

Figure 2.1 Software relationship

3. Software

3.1 Function

This application has the following functions.

3.1.1 Simple Talker

- Send the message to the mrpd module.
- Receive the message from the mrpd module.
- Divide the specified file in specified payload size, and create Ethernet frames.
  - header format uses IEEE P1722a/D5 AVTP Video Format Experimental subtype.
- Transmit Ethernet frames using the AVB Streaming driver.
- When the SRP is valid and no available listener exists in MRP domain, the application ends the operation.

3.1.2 Simple Listener

- Send the message to the mrpd module.
- Receive the message from the mrpd module.
- Receive Ethernet frames by using the AVB Streaming driver.
  - header format uses IEEE P1722a/D5 AVTP Video Format Experimental subtype.
- Save the payload data of Ethernet frame to the specified file.

3.2 Module structure

The module structure is shown below.

```
$TOP_DIR
|-- demo/
|     |-- common/
|     |     |-- eavb_device.c          : Ethernet AVB device control functions
|     |     |-- eavb_device.h
|     |     |-- clock.c                : clock control functions
|     |     |-- clock.h
|     |     |-- common.h               : Common definition in the application
|     |     |-- netif_util.c           : Network interface control functions
|     |     |-- netif_util.h
|     |     |-- stats.c                : AVTP Packet statistics functions
|     |     `-- stats.h
|     |-- COPYING.MIT
|     |-- Makefile
|     `-- simple/
|           |-- config.h               : Application configuration
|           |-- Makefile
|           |-- packet.c               : AVTP Packet access functions
|           |-- packet.h
|           |-- simple_listener.c      : Application top-level functions for listener
|           |-- simple_listener.h
|           |-- simple_talker.c        : Application top-level functions for talker
|           `-- simple_talker.h
|-- lib/
|     |-- avtp/                        : AVTP access library
|     |-- eavb/                        : Ethernet AVB device control library
|     |-- Makefile
|     `-- msrp/                        : MSRP message handle library
|-- Makefile
`-- Makefile.include
```

Figure 3.1 Module structure

3.3 Configuration parameter

The constant used in application is shown.

Table 3.1 Configuration parameter

Definition	Value	Contents
DEST_ADDR	{0x91, 0xe0, 0xf0, 0x00, 0x0e, 0x80}	destination address for Ethernet frame
TS_OFFSET	2000ul	timestamp offset (unit: micro seconds)
DEBUG_LEVEL	1	Debug print level
CONFIG_INIT_ENTRYNUM	256	The initial value of the entrynum.
CONFIG_INIT_PAYLOAD_SIZE	100	The initial value of the payload size.
MSRP_RANK	MSRP_RANK_NON_EMERGENCY	SRP Stream Rank value. MSRP_RANK_NON_EMERGENCY is defined in "lib/msrp/msrp.h".
LATENCY_TIME_MSRP	3900	The default value of AccumulatedLatency.

3.4 The processing outline of Talker application

The following is an outline of operation in a program (main function).

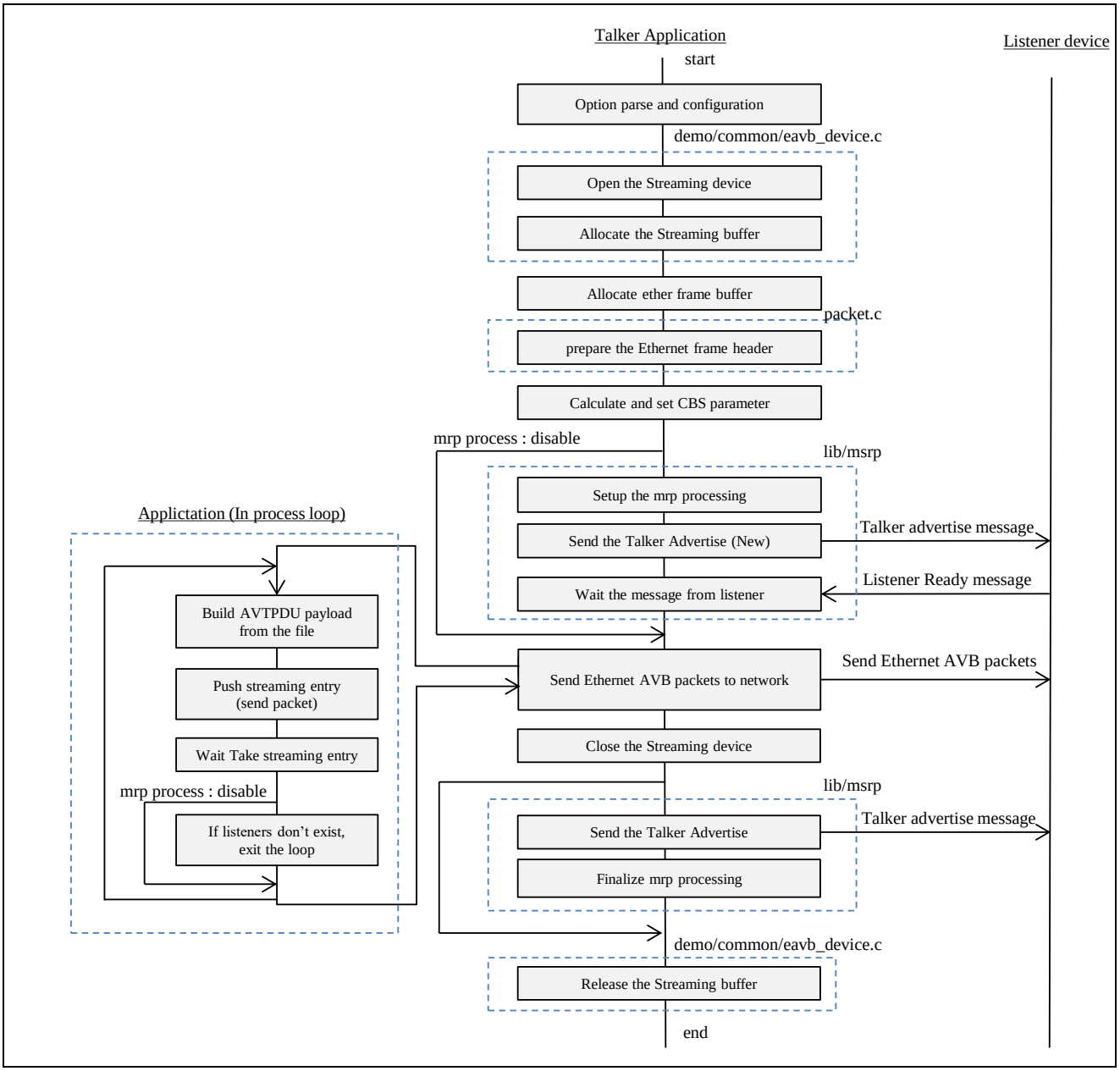

Figure 3.2 Outline of process for Talker application

3.5 The processing outline of Listener application

The following is an outline of operation in a program (main function).

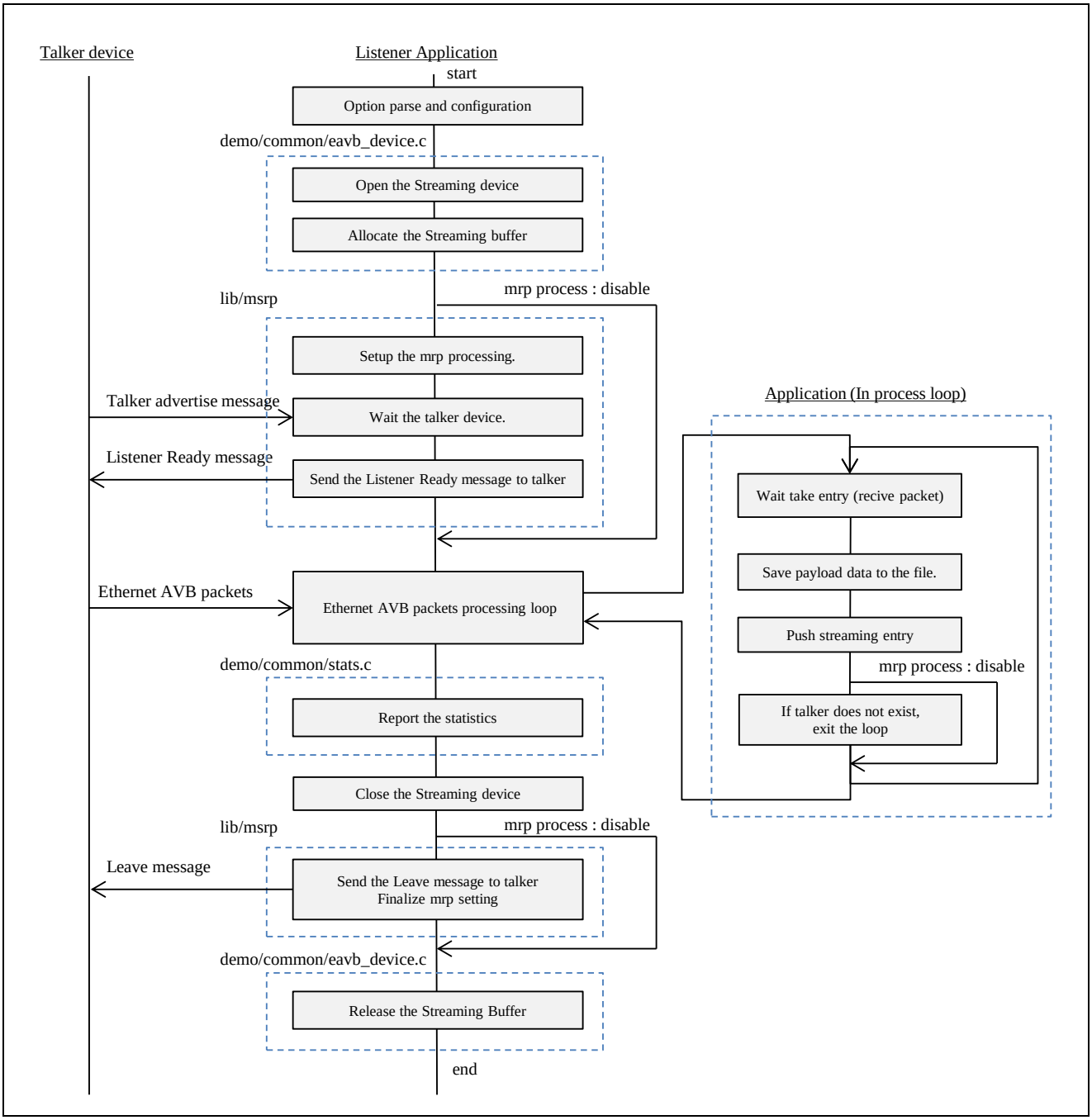

Figure 3.3 Outline of process for Listener application

4. Integration

4.1 Build process with Yocto recipe

Please refer to "Chapter 3 Build the kernel and rootfs" in Ethernet AVB Software Start-Up Guide.

4.2 Build process without Yocto recipe

If you want to build application without bitbake, please run these steps in this chapter.

Step 1 Set environment variables

```
# source /opt/poky/${YOCTOVERSION}/environment-setup-aarch64-poky-linux
```

Step 2 Clone source code

```
# git clone git://github.com/renesas-rcar/avb-applications.git -b rcar-gen3
# git clone git://github.com/renesas-car/avb-streaming.git -b rcar-gen3
# cd avb-applications/avb-demoapps
```

Step 3 Execute make

Please execute "make".

```
# make CC="$CC" -C lib/avtp
# make CC="$CC" -C lib/msrp
# make CC="$CC" INCSHARED=$(pwd)/../../avb-streaming -C lib/eavb
# make CC="$CC" TOP_DIR=$(pwd) INCSHARED=$(pwd)/../../avb-streaming -C demo/simple
```

Step 4 Install to the target file system

Please install executables to your Root File system.

```
# cp -r etc/linuxptp/avb-demoapps.cfg /export/rfs/etc/linuxptp/
# make install INSTALL_DIR=/export/rfs/usr/bin
```

5. Execute the applications

This chapter shows an example about how to perform application. Talker application creates Ethernet frames from the specified file, and transmits Ethernet frames. Listener application receives Ethernet frames which Talker application has sent, and saves payload data to specified file. Please start Linux on the target board and execute the following commands.

5.1 Execute the application

Step 1 Setup the application

Step 1.1 Setup separation filter (for Listener)

Please execute this procedure, when a separation filter setting is required. This procedure is unnecessary when '/etc/avbtool.conf' is used and the separation filter is already set up. Please refer Ethernet AVB Software Startup Guide for detail.

```
# avbtool -r [device name] streamid [XX:XX:XX:XX:XX:XX:XX]
```

Execution example:

```
# avbtool -r /dev/avb_rx0 streamid 76:90:50:00:00:00:00:01
```

Step 2 Execute 'mrpd'

Please execute "mrpd".

```
# mrpd -dlmvs -i [interface]
```

Execution example:

```
# mrpd -dlmvs -i eth0
```

Step 3 Execute 'ptp4l'

Please execute "ptp4l".

```
# ptp4l -i [interface] -f /etc/linuxptp/avb-demoapps.cfg &
```

Execution example:

```
# ptp4l -i eth0 -f /etc/linuxptp/avb-demoapps.cfg &
```

Step 4 Execute application

Step 4.1 Exectue application for Listener
Please execute "simple_listener". Refer to Chapter 5.2 for the details of option parameter. Ethernet frame are received based on the separation filter setting of Step1.

```
# simple_listener -d [DEVNAME] -f [NAME]
```

Execution example:

```
# simple_listener -d /dev/avb_rx0 -f /tmp/filename
```

Step 4.2 Exectue application for Talker
Please execute "simple_talker". Refer to Chapter 5.2 for the details of option parameter.

```
# simple_talker -c [SRCLASS] -i [IFNAME] -u [UNIQUEID] -s [SIZE] -f [NAME]
```

Execution example:

```
# simple_talker -c A -i eth0 -u 1 -s 100 -f /filename
```

5.2 Command parameters

The command to be used is shown below when executing the application.

Table 5.1 Command parameters for Talker application

short option	long option	Default value	Contents
-c	--class	A	SRClassID (A or B or C)
-i	--interface	eth0	specify Network interface name
-p	--ptp	/dev/ptp0	specify PTP clock name
-u	--uid	1	specify the unique ID. The value specified in this option will be used to StreamID and destination MAC Address. e.g.) -u 1 if your HW addr is "76:90:50:00:00:00", StreamID is set to "76:90:50:00:00:00:00:01". Because the lower 8bit of the specified value will be set to the lower 8bit of DEST_ADDR, destination MAC Address will be the following. "91:e0:f0:00:0e:01"
-s	--payload-size	100	Ethernet frame payload size
-f	--file	-	Specified the file which is transmitted. e.g.) -f /tmp/filename
-F	--frame-intervals	1	Specified number of frame in interval of SR class.
-n	--frame-num	0	The number of frames which transmits is specified. When 0 is specified, Ethernet frames are transmitted to the termination of the specified file. e.g.) -n 1000
-m	--msrp	1	SRP mode 0:static 1:dynamic When 0 is specified, processing about MRP is not performed. e.g.) -m 0
-w	--waitmode	0	Specify wait mode to change polling or blocking during streaming. 0:poll, 1:blocking(NOWAIT) 2:blocking(WAITALL) e.g.) -w 0
-a	--dest-addr	91:e0:f0:00:0e:xx	Specify destination MAC address. If this option is not specified, destination MAC address will be created using the DEST_ADDR and unique id. See also contents of "-u" option.
-h	--help	-	Command Help is displayed
-	--version	-	Version information is displayed.

Table 5.2 Command parameters for Listener application

short option	long option	Default value	Contents
-d	--device	/dev/avb_rx0	Specify Ethernet AVB device name.
-m	--msrp	1	SRP mode 0:static 1:dynamic When 0 is specified, processing about MRP is not performed. e.g.) -m 0
-f	--file	-	Specify the file name. e.g.) -f /tmp/filename
-n	--frame-num	0	The number of frames which receiving is specified. When 0 is specified, receiving a frame without a limit is continued. When 1000 packets are received. e.g.) -n 1000
-w	--waitmode	0	Specify wait mode to change polling or blocking during streaming. 0:poll, 1:blocking(NOWAIT) 2:blocking(WAITALL) e.g.) -w 0
-h	--help	-	Command Help is displayed
-	--version	-	Version information is displayed.

6. Ethernet AVB Packet Format

This application supports following packet format.

- IEEE P1722a/D5 AVTP Video Format Experimental subtype

6.1 Ethernet frame format

The format of an Ethernet frame is shown below.

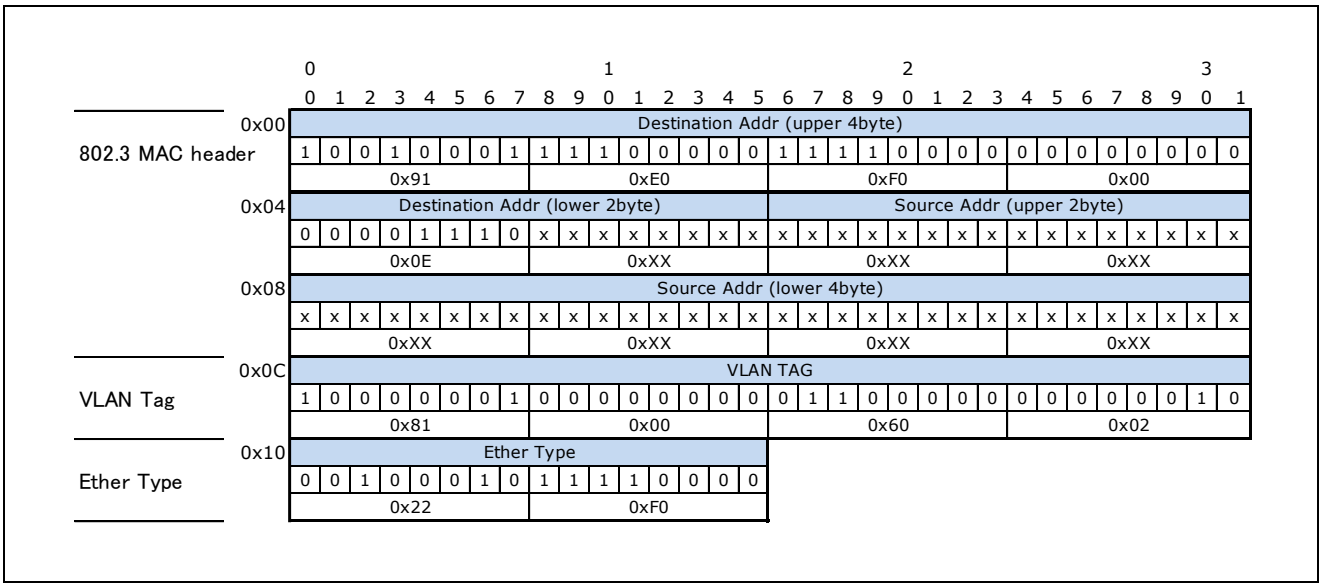

Figure 6.1 Ethernet header format

6.2 IEEE 1722 AVTPDU header format

Talker application uses IEEE P1722a/D5 AVTP Video Format Experimental subtype. Format is shown below.

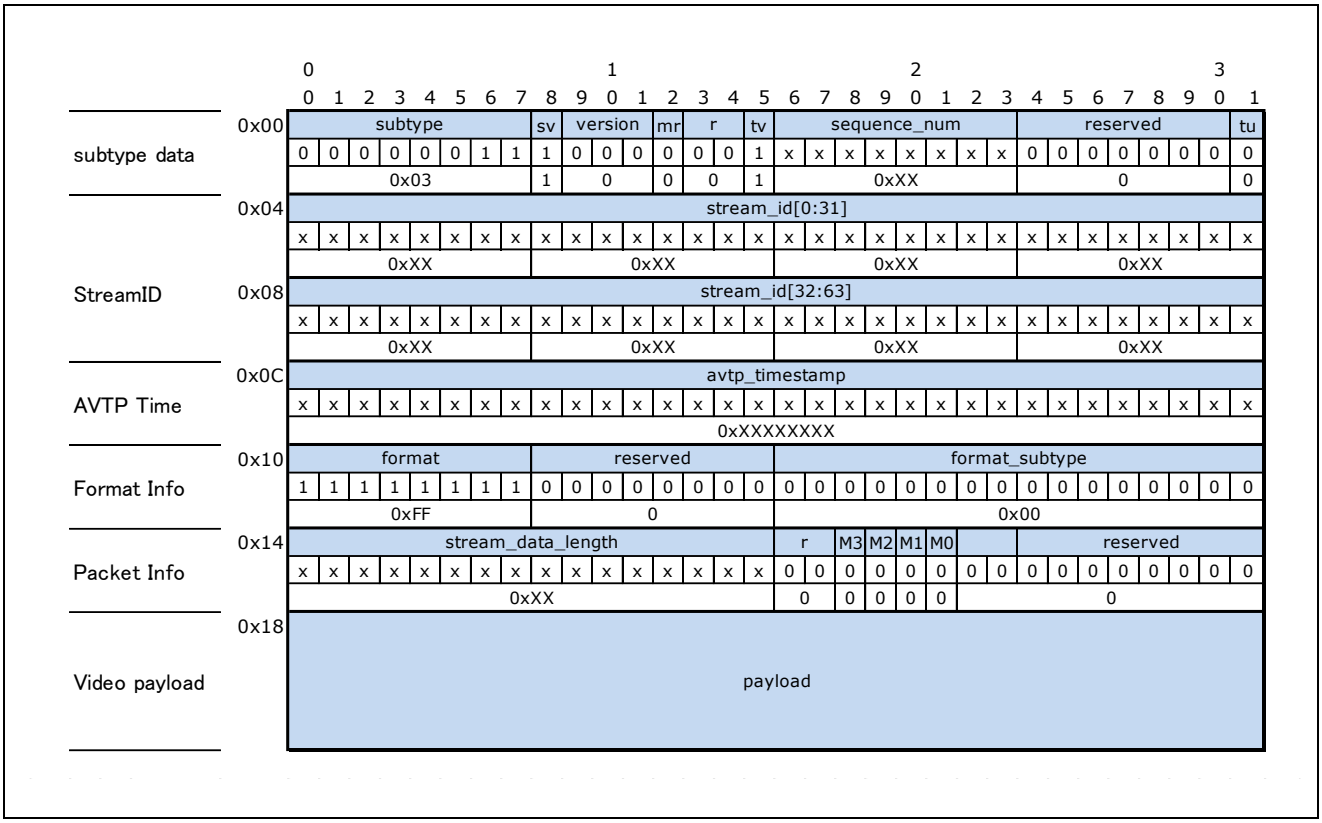

Figure 6.2 IEEE P1722a/D5 AVTP Video Format Experiment subtype

REVISION HISTORY	Ethernet AVB Software Simple Application Application Note

Rev.	Date	Description	
		Page	Summary
0.10	Oct. 26, 2015	-	First edition issued
0.20	Apr. 22, 2016	2	1.2.2 Related Document Update of Table1.2 - Update the version of related document.
		5	3.1.2 Simple Listener Delete the termination function of simple_listener when the talker disappeared
		6	3.2 Module structure Add "common/common.h"
		7	3.3 Configuration parameter Update Table 3.1 - Add a new definition
		10	4.2 Build process without Yocto recipe Modify the build process according to the updating of yocto environment
		10	4.2 Build process without Yocto recipe Change Step 2, as using source code download by Github.com.
		12	5.2 Command parameters Update of Table5.1 and Table5.2 - Modify the description of the command.
0.30	May. 20, 2016	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
0.40	Aug. 24, 2016	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		10	4.2 Build process without Yocto recipe Delete command example for 32 bit SDK.
		11	5.2 Command parameters Update of Table 5.1 - Add -a/--dest-addr option for destination MAC address
		11	5.2 Command parameters Update of Table 5.1 - Modify the description of the "-u" option
0.50	Jan. 13, 2017	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		10	4.2 Build process without Yocto recipe Modify the build process according to the updating of the application.
		11-12	5.1 Execute the application Add command example in following steps - step2 mrpd - step3 ptp4l
		12	5.1 Execute the application Split step 4 to step 4.1 (Listener) and 4.2 (Talker).
0.60	Mar. 15, 2017	1	1.2.1 Standard Update of Table 1.1 - Update the version of IEEE Std 1722
		2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		4	2.2 Software releationship Update of Figure 2.1 - Modify project name of Open AVB to Open Avnu

1.00	Jul. 12, 2017	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
1.10	Nov. 14, 2017	All	Add R-Car M3N support.
		2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
1.20	Jan. 29, 2018	-	Update Arm trademark
		2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
		7	3.3 Configuration parameter Update of Table 3.1 - Update CONFIG_INIT_ENTRYNUM to 256.
		10	4.2 Build process without Yocto recipe Update the version of Yocto SDK to 2.4.1.
1.30	Feb. 22, 2018	All	Add R-Car E3 support.
		2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
1.40	Sep. 26, 2018	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
2.00	Dec. 25, 2018	2	1.2.2 Related Document Update of Table 1.2 - Update the version of related document.
2.10	Apr. 06, 2021	-	Update AddressList
2.20	Aug. 16, 2021	1	Add R-Car D3 support
		2	Table 1.2 Related documents - Update revision - Add R-Car D3 Hardware Manual
		10	Change poky version from 2.4.1 to “${YOCTOVERSION} for general
2.30	Dec. 01, 2021	-	Update Notice page
		2	Table 1.2 Related documents: Update version of “R-Car Series, 3rd Generation User's Manual: Hardware” from v1.00 to v2.30
2.31	Dec. 25, 2023	All	Update version of the document.

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