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Group Standard

T/SUCA 001.1—2024

General Purpose Multimedia Interface Specification 1.0
Part 1: Architecture

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Issued by Shenzhen 8K UHD Video Industry Cooperation Alliance

Contents

Foreword

This document was drafted in accordance with GB/T 1.1-2020 *Directives for Standardization - Part 1: Rules for the Structure and Drafting of Standardizing Documents*.

This document is Part 1 of T/SUCA 001 *General Purpose Multimedia Interface Specification*. T/SUCA 001 includes the following parts proposed to be published:

—Part 1: Architecture, specifying a general purpose multimedia interface (GPMI) architecture that supports information transmission between consumer electronic devices.

—Part 2: Protocols, specifying the protocols of the electrical layer, logical layer, transport layer, and adaptation layer of the GPMI.

—Part 3: Connectors and Cables, specifying the technical requirements for connectors and cables using GPMI Type-B.

—Part 4: Power Supply, describing the architecture of the power supply for GPMIs, and specifying the electrical characteristics and timing requirements, physical layer, protocol layer, application layer, and power input and output requirements.

—Part 5: Alternate Mode over Type-C, specifying the method of using GPMI signals via USB Type-C ports.

This Standard was proposed by and is under the centralized management of Shenzhen 8K UHD Video Industry Cooperation Alliance.

This Standard was drafted by: Huawei Technologies Co., Ltd., HiSilicon Technologies Co., Ltd., China Electronics Standardization Institute, Shenzhen Chuangwei-RGB Electronics Co., Ltd., Shenzhen Skyworth Digital Technology Co., Ltd., China Mobile (Hangzhou) Information Technology Co., Ltd., National Engineering Laboratory for Digital TV (Beijing), Guilin University of Electronic Technology, Jiangsu Anlan-WK Electronics Co., Ltd., Shenzhen CESI Information Technology Co., Ltd., Sinolink Technologies (Beijing) Co., Ltd., Shenzhen TCL CSOT Semiconductor Display Technology Co., Ltd., Hisense Visual Technology Co., Ltd., Konka Group Co., Ltd., Hangzhou Hikvision Digital Technology Co., Ltd., Shenzhen National Engineering Laboratory of Digital Television Co., Ltd., Guangdong National UHD Video Innovation Center, Huanyu Trust (Beijing) Technology Co., Ltd., Malanshan Audio&Video Laboratory, Guangdong Wire & Cable Association, and Shenzhen 8K UHD Video Industry Cooperation Alliance.

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General Purpose Multimedia Interface Specification Part 1: Architecture

1. Scope

This document specifies a general purpose multimedia interface architecture that supports information transmission between consumer electronic devices, and the requirements for devices, components, links, routing, and adaptation.

This document is applicable to the design, development, test, and application of general purpose multimedia interfaces, and can also be used as a reference for information transmission between other types of electronic devices.

2. Normative References

The following documents constitute, through normative references in the text, indispensable provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

T/SUCA 001.3-2024 General Purpose Multimedia Interface Specification Part 3: Connectors and Cables

T/SUCA 001.4-2024 General Purpose Multimedia Interface Specification Part 4: Power Supply

T/SUCA 001.5-2024 General Purpose Multimedia Interface Specification Part 5: Alternate Mode over Type-C

IEC 60958-1 Digital Audio Interface—Part 1: General

IEC 60958-3 Digital Audio Interface—Part 3: Consumer Applications

IEC 60958-4 Digital Audio Interface—Part 4: Professional Applications

3. Terms, Definitions, and Abbreviations

3.1 Terms and Definitions

For the purposes of this document, the following terms and definitions apply.

3.1.1 general purpose multimedia interface

A general purpose high-speed multimedia interface standard for video, audio, data transmission between devices, and for power supply

3.1.2 lane

An entity consisting of a signal transmission line and its transmitting and receiving circuits

Note: A low-speed single-ended lane consists of a line and its transmitting and receiving circuits. A high-speed differential lane consists of a pair of lines and their transmitting and receiving circuits.

3.1.3 link

A collection of lanes with the same transmitting or receiving direction, or a line used for power supply

Note: A link is generally composed of one or more lanes.

3.1.4 main link

A point-to-point link based on one or more high-speed differential lanes

3.1.5 sideband link

A point-to-point link based on a low-speed single-ended lane

3.1.6 power bus link

A point-to-point link with power supply and management functions

3.1.7 cable information link

A point-to-point link with cable information identification and management functions

3.1.8 component

Hardware, software, or a collection of hardware and software that implements a specific function

3.1.9 router

A component that implements functions such as routing and forwarding, multiplexing and demultiplexing, and lane allocation of GPMI packets

3.1.10 adapter

A component that implements the function of mutual conversion between external component services and GPMI packets

Note: External component services include audio and video, third-party protocols, and management and control information.

3.1.11 port

A component with data transmitting and/or receiving functions

Note: The ports of main links are divided into master ports, slave ports, and dual role ports, which can be configured.

3.1.12 link master port

A port that has the function of initiating initial link establishment and contains at least one component with the transmitting function

3.1.13 link slave port

A port that has the function of responding to initial link establishment and contains at least one component with the receiving function

3.1.14 dual role port

A port that has the transmitting and receiving functions of a lane of the main link

3.1.15 source device

A device with audio and video transmitting adapters and ports, as well as routers

3.1.16 sink device

A device with audio and video receiving adapters and ports, as well as routers

3.1.17 downstream

Initial service direction of a source device

Note: For example, in audio and video services, the initial service direction of the source device is downstream.

3.1.18 upstream

Initial service direction of a sink device

Note: For example, in audio and video services, the initial service direction of the sink device is upstream.

3.1.19 dock

A device with audio and video receiving adapters and ports, as well as traditional audio and video interfaces

Note: Traditional audio and video interfaces include HDMI and DisplayPort.

3.1.20 routing device

A device with two or more ports and routers

3.1.21 composite device

A device with two or more types of service adapters and routers

Note: For example, a TV set with audio and video transmitting and receiving adapters is a composite device.

3.1.22 shuttle

In a GPMI system, a shuttle is formed by transmitting packets of the same service over a link between two ports.

3.1.23 channel

In a GPMI system, a channel is formed by cascading multiple shuttles between two adapters.

3.2 Abbreviations

For the purposes of this document, the following abbreviations apply.

ASP: audio sample packet
AVP: active video packet
DIP: descriptive information packet
DRP: dual role port
EDP: encryption description packet
FEC: forward error correction

HBP: horizontal blanking packet
HSync: horizontal synchronization
KDP: key distribution packet
LLCF: logical layer control frame
LLDP: logical layer data packet
LLMMP: logical layer main link management packet
LLSP: logical layer sideband link packet
LLSMP: logical layer sideband link management packet
LMP: link master port
LSP: link slave port
ML: main link
PCIe: peripheral component interconnect express
RBuff: receive buffer
RX: receiver
ShuttleID: shuttle identification
SL: sideband link
TBuff: transmit buffer
TLDP: transport layer data packet
TLMDP: transport layer management data packet
TLMMP: transport layer main link management packet
TLSMP: transport layer sideband link management packet
TX: transmitter
USB: universal serial bus
VSync: vertical synchronization

4. Basic Requirements

GPMIs are applicable to transmission services of audio and video devices, third-party protocol devices, etc. GPMI requirements are as follows:

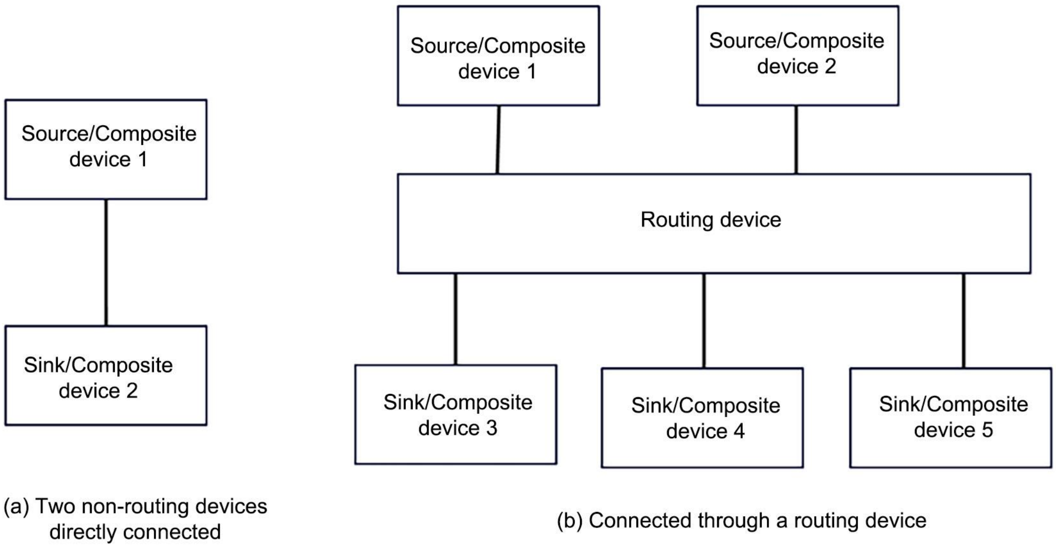
(a) GPMIs shall support unidirectional or bidirectional transmission of audio and video services to meet the requirements for audio and video transmission between TV sets, personal computers, mobile phones, set-top boxes, and displays, and should support audio and video content transmission protection and visual lossless compression.

(b) GPMIs should support the transmission of third-party protocol services to realize the interaction between GPMI devices and third-party protocol devices.

(c) GPMIs should support unidirectional or bidirectional power supply to enable the device connected to the power supply to power the connected external devices that meet the requirements of this document.

Multiple electronic devices are connected together through GPMIs to form a GPMI system, as shown in Figure 1.

Figure 1 Schematic diagrams of GPMI devices



In Figure 1, source devices include DVD players, set-top boxes, split TV main units, and personal computers. Sink devices include TV sets, displays, and speakers. Composite devices include source devices or sink devices integrating third-party protocol adapters.

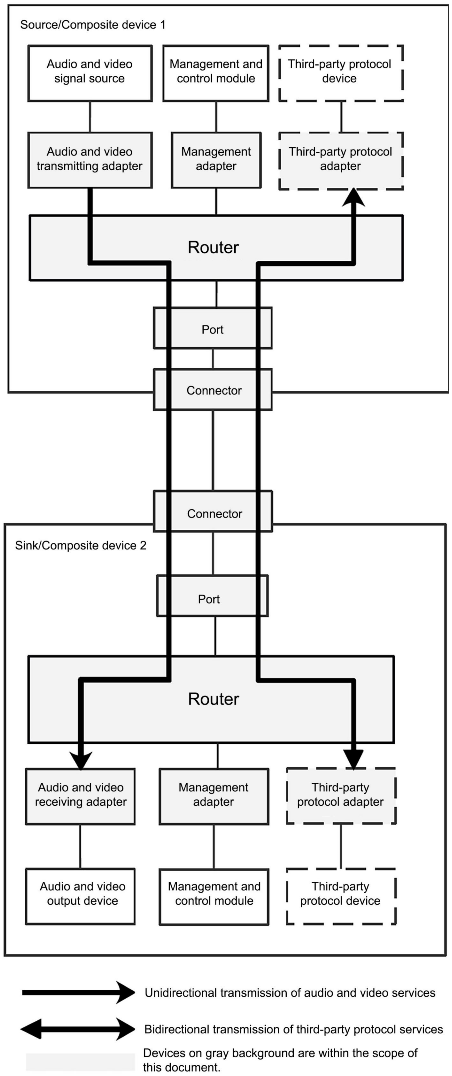
5. System Architectures

5.1 Physical Architecture

A GPMI system may include source devices, sink devices, routing devices, composite devices, connectors, and cables, and shall allow multiple source devices (like set-top boxes) and sink devices (like TV sets) to be connected in a network, either directly or through routing devices.

The schematic diagram of a GPMI system based on direct connection is shown in Figure 2. In the GPMI system, source/composite devices and sink/composite devices are connected without any routing device.

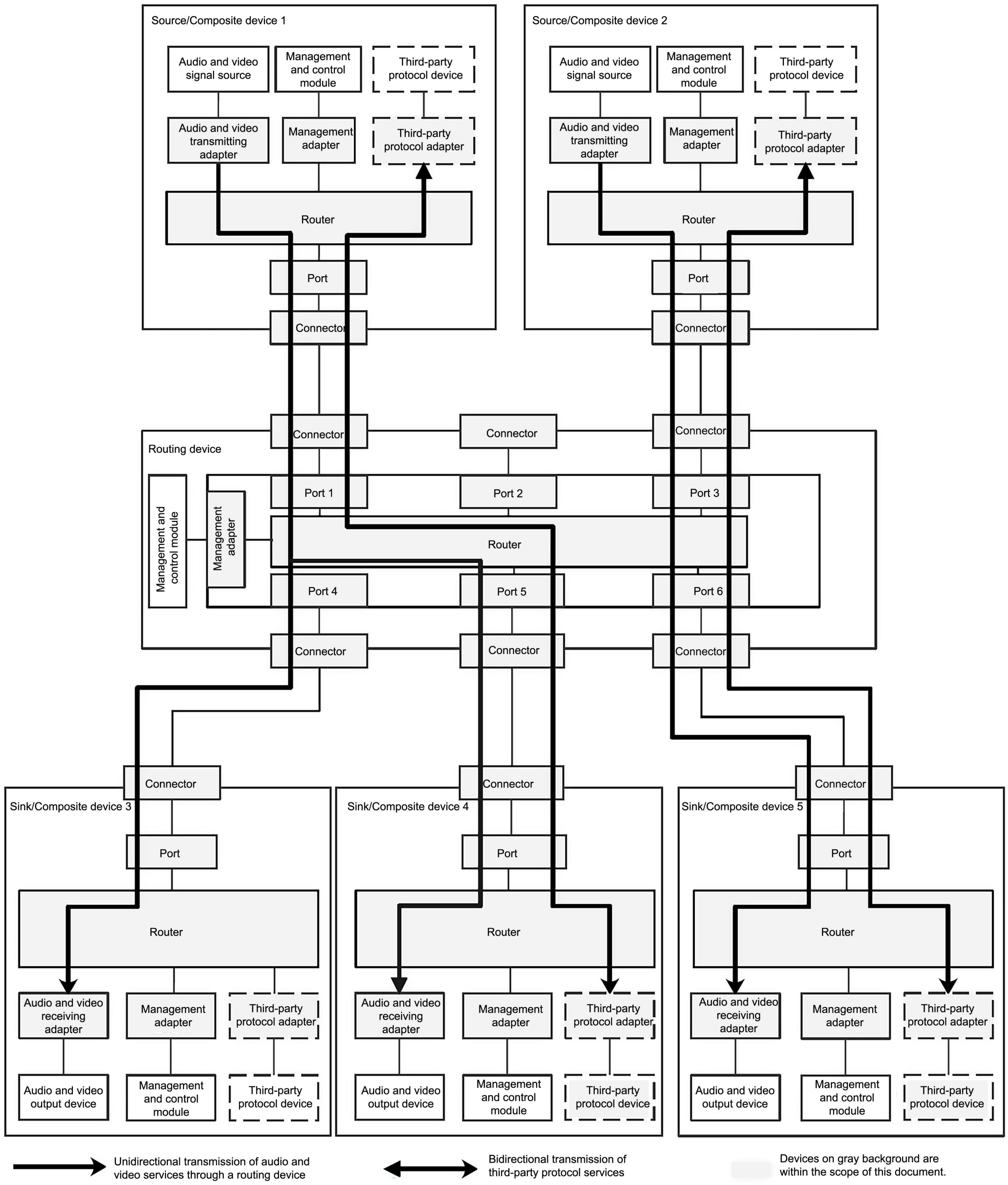
Figure 2 Schematic diagram of a GPMI system based on direct connection



Source/composite device 1 can be directly connected to sink/composite device 2 through a GPMI for audio and video service transmission, eliminating the need for routing devices.

The schematic diagram of a GPMI system based on routing devices is shown in Figure 3. In the GPMI system, multiple source/composite devices and sink/composite devices are connected through routing devices.

Figure 3 Schematic diagram of a connection based on GPMIs



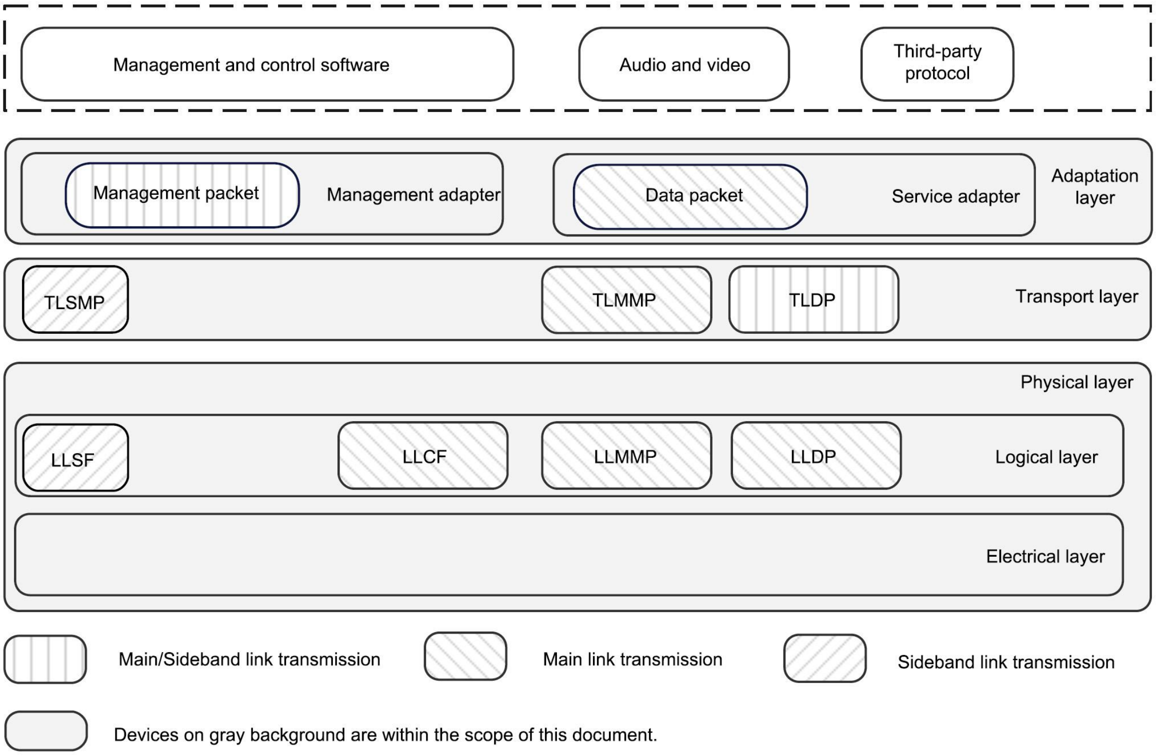
The audio and video services of source/composite device 1 are transmitted to sink/composite device 3 and sink/composite device 4. The audio and video services of source/composite device 2 are transmitted to sink/composite device 5.

5.2 Protocol Architecture

5.2.1 Overview

A GPMI protocol stack consists of an adaptation layer, a transport layer, and a physical layer. The physical layer consists of a logical layer and an electrical layer, as shown in Figure 4.

Figure 4 Schematic diagram of a protocol stack



5.2.2 Physical Layer

The physical layer consists of a logical layer and an electrical layer.

(a) The electrical layer implements signal modulation, transmitting, receiving, equalizing, spread spectrum, and clock recovery.

(b) The logical layer implements FEC encoding/decoding, scrambling/descrambling, and link training.

5.2.3 Transport Layer

The transport layer processes and forwards service streams, such as video, audio, and third-party protocols, as well as management and control information, and performs bandwidth management for all service streams.

5.2.4 Adaptation Layer

The adaptation layer connects end devices and external components, and through corresponding adapters, implements functions such as audio and video transmitting service adaptation, audio and video receiving service adaptation, third-party protocol service adaptation, and management and control adaptation. The adaptation layer includes a management adapter and a service adapter.

Source devices, sink devices, and docks are collectively referred to as end devices.

6. Devices

6.1 Source Device

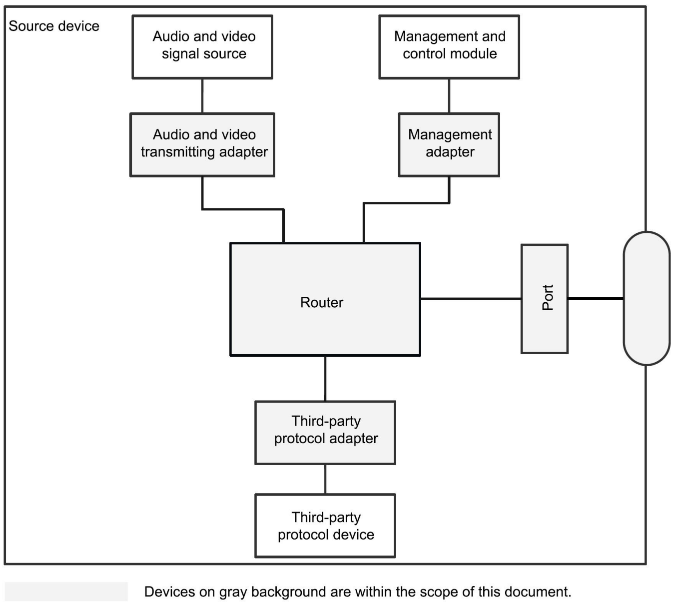
A source device may include multiple ports and multiple audio and video transmitting adapters, to support the simultaneous transmission of multiple audio and video service streams.

A source device includes at least a link master port, to implement the function of initiating initial link establishment.

The source device that provides the routing function externally shall have more than two ports.

The schematic diagram of a source device is shown in Figure 5.

Figure 5 Schematic diagram of a source device



6.2 Sink Device

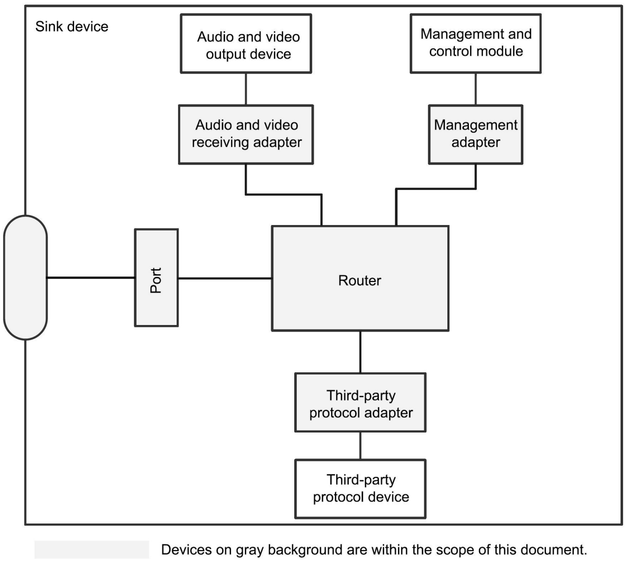
A sink device may include multiple ports and multiple audio and video receiving adapters, to support the simultaneous reception of multiple audio and video service streams.

A sink device includes at least a link slave port, to implement the function of responding to initial link establishment.

The sink device that provides the routing function externally shall have more than two ports.

The schematic diagram of a sink device is shown in Figure 6.

Figure 6 Schematic diagram of a sink device



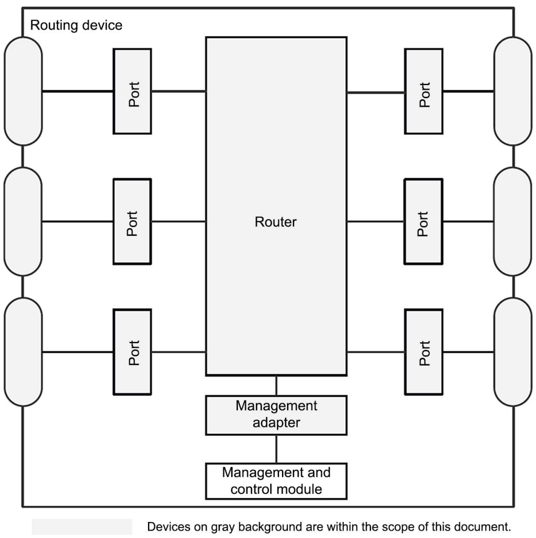
6.3 Routing Device

A routing device implements routing and forwarding, multiplexing and demultiplexing, and lane allocation of GPMI packets through a router.

The routing device has no need to encrypt/decrypt or encapsulate/decapsulate GPMI audio and video packets.

The schematic diagram of a routing device is shown in Figure 7.

Figure 7 Schematic diagram of a routing device



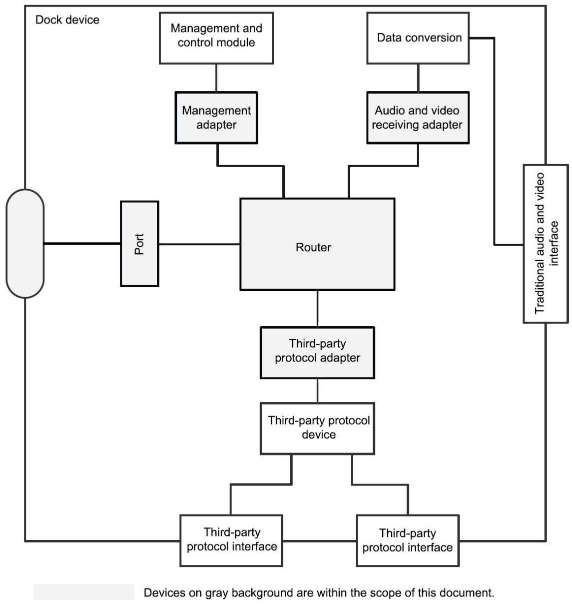
6.4 Other Devices

6.4.1 Dock

A dock supports the conversion of GPMI audio and video packets into traditional audio and video interface data.

The schematic diagram of a dock is shown in Figure 8.

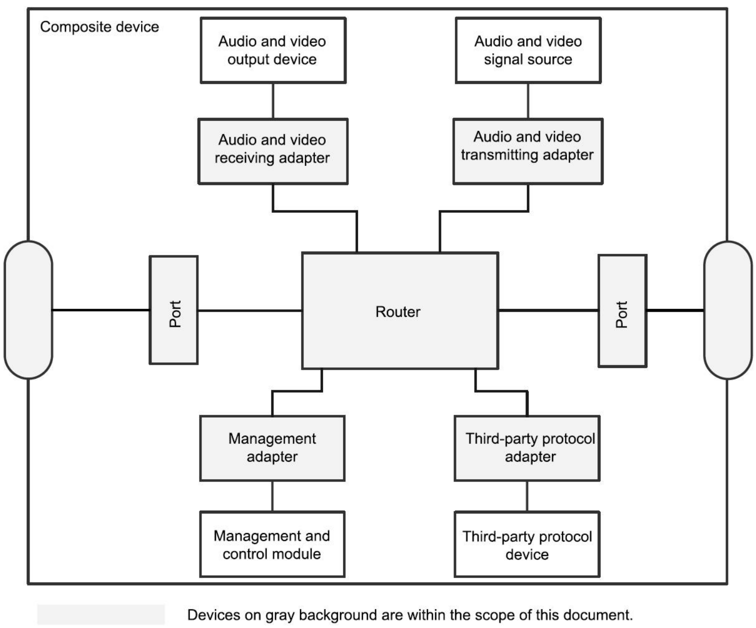
Figure 8 Schematic diagram of a dock



6.4.2 Composite Device

The schematic diagram of a composite device is shown in Figure 9.

Figure 9 Schematic diagram of a composite device



7. Components

7.1 Port

7.1.1 Port Types

Ports are divided into link master ports (LMP), link slave ports (LSP), and dual role ports (DRP). The ports are connected by connectors and cables. Dual role ports can be configured to link master ports or link slave ports.

The ports that only support the receiving direction of lanes ML0 and ML2 of the main link are link slave ports.

The ports that only support the transmitting direction of lanes ML1 and ML3 of the main link are link master ports.

The ports that support both transmitting and receiving directions of lanes ML0, ML1, ML2, and ML3 of the main link are dual role ports. If a dual role port works in the LMP or LSP state, its lane shall support both transmitting and receiving directions.

Ports can also be divided into simplified-specification ports (four-lane ports) and full-specification ports (eight-lane ports).

Each end device supports at least one port, and each routing device supports 16 ports at most.

Ports support bidirectional or unidirectional structures. A bidirectional structure includes a group of transmitting circuits and a group of receiving circuits. A unidirectional structure includes only a group of transmitting circuits or a group of receiving circuits. The port structure supported by GPMIs is shown in Table 1.

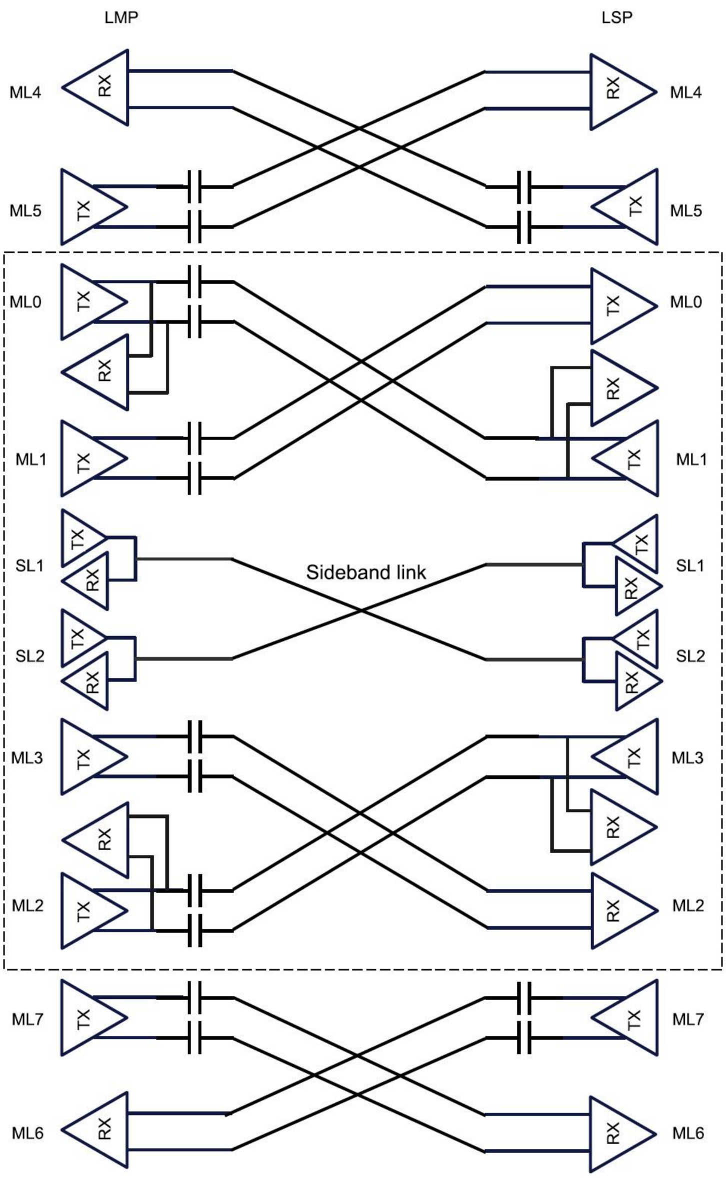
Table 1 Port structure list

Port Type		Port Circuit Structure	
		Unidirectional Structure	**Bidirectional Structure**
Simplified specification	LMP	4TX	2TX+2TRX
	LSP	4RX	2RX+2TRX
	DRP	-	4TRX
Full specification	LMP	8TX	4TX+4TRX 4TX+2RX+2TRX
	LSP	8RX	4RX+4TRX 4RX+2TX+2TRX
	DRP	-	8TRX
Note 1: Simplified-specification ports are compatible with Type-C connectors and cables, and with Type-B connectors and simplified-specification cables. Note 2: Full-specification ports are compatible with Type-B connectors and full-specification cables. Note 3: TX means transmitting, RX means receiving, and TRX means support for both transmission and receiving.			

7.1.2 Port Circuit Structure

The full-specification LMP, LSP, and their circuit structures and connection methods are shown in Figure 10, where the structure in the dotted box is the simplified-specification port circuit structure.

Figure 10 Schematic diagram of LMP and LSP circuit structure and connection



The link modes supported by full-specification LMPs are 8T0R, 7T1R, 6T2R, 5T3R, and 4T4R.

Note: 8T0R is a unidirectional link, only supporting eight-lane TX links. 6T2R is a bidirectional link, supporting six-lane TX links and two-lane RX links respectively. 4T4R is a bidirectional structure, supporting four-lane TX links and four-lane RX links.

The link modes supported by full-specification LSPs are 0T8R, 1T7R, 2T6R, 3T5R, and 4T4R.

The link modes supported by simplified-specification LMPs are 4T0R, 3T1R, and 2T2R.

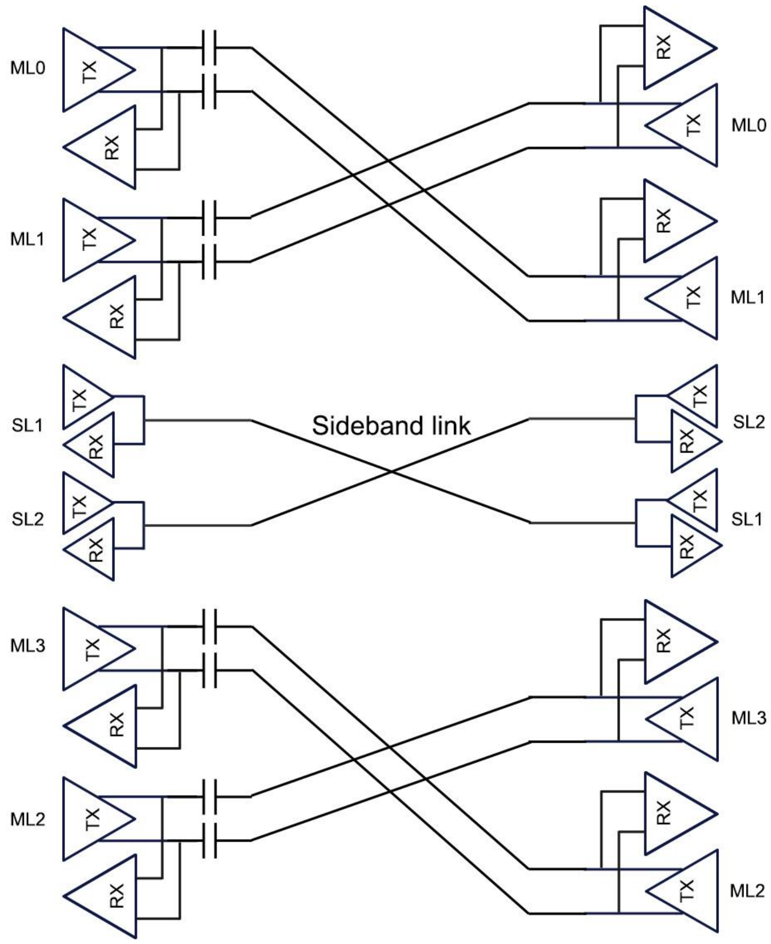
Note: 4T0R is a unidirectional link, only supporting four-lane TX links. 3T1R is a bidirectional link, supporting three-lane TX links and one-lane RX links. 2T2R is a bidirectional link, supporting two-lane TX links and two-lane RX links.

The link modes supported by simplified-specification LSPs are 0T4R, 1T3R, and 2T2R.

A simplified-specification DRP circuit and its connection method are shown in Figure 11.

The link modes supported by simplified-specification DRPs are 4T0R, 3T1R, 2T2R, 1T3R, and 0T4R.

Figure 11 Schematic diagram of a simplified-specification DRP port circuit structure and connection



The link modes supported by full-specification DRPs are 8T0R, 7T1R, 6T2R, 5T3R, 4T4R, 3T5R, 2T6R, 1T7R, and 0T8R.

If a DRP works in the LMP or LSP state, its link modes are consistent with those supported by DRPs.

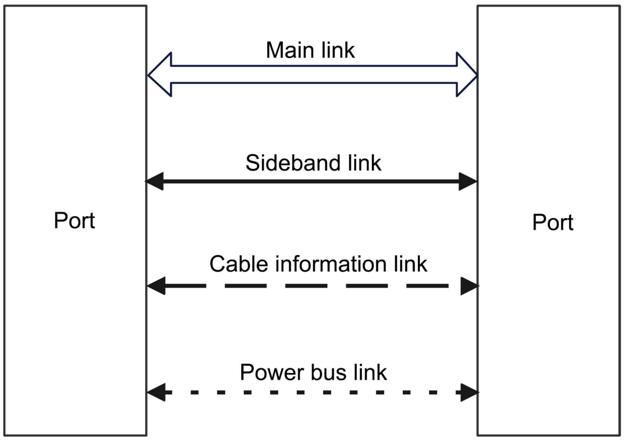
7.1.3 Link

7.1.3.1 Link Types

A link is a line composed of link master ports and link slave ports, as well as corresponding connectors and cables. A link carries and transmits signals through a line composed of ports, connectors, and cables.

As shown in Figure 12, links are divided into the main link, sideband link, power bus link, and cable information link. GPMIs shall support the main link and the sideband link, and should support the cable information link and the power bus link.

Figure 12 Schematic diagram of links



7.1.3.2 Main Link

A main link can transmit GPMI audio and video services and third-party protocol services, and consists of four or eight lanes.

Note: Each main link lane consists of a pair of differential lines and transceiver circuits, and each lane only supports unidirectional transmission.

A main link includes a transmitting link and/or a receiving link.

In full-function mode, a maximum of eight lanes are supported, and they are numbered ML0, ML1, ML2, ML3, ML4, ML5, ML6, and ML7.

In simplified mode, a maximum of four lanes are supported, and they are numbered ML0, ML1, ML2, and ML3.

The main link supports two transmission modes: asymmetric transmission and symmetric transmission. GPMI ports shall have the capability to identify the number of main link cable lanes. The link types, link modes, and corresponding LMP and LSP configurations are shown in Table 2.

Through configuration, DRPs can be in the link modes of the LMP or the LSP in the table.

Table 2 Main link modes

Link Type		**Link Mode**	**LMP**		**LSP**	
			Number of Transmitting Lanes (TX)	**Number of Receiving Lanes (RX)**	**Number of Transmitting Lanes (TX)**	**Number of Receiving Lanes (RX)**
Simplified specification	Asymmetrical	4+0	4	0	0	4
		3+1	3	1	1	3
		1+3	1	3	3	1
	Symmetrical	2+2	2	2	2	2
Full specification	Asymmetrical	8+0	8	0	0	8
		7+1	7	1	1	7
		1+7	1	7	7	1
		6+2	6	2	2	6
		2+6	2	6	6	2

		5+3	5	3	3	5
		3+5	3	5	5	3
	Symmetrical	4+4	4	4	4	4
Note: The link modes 1+3 in the simplified specification and 1+7, 2+6, and 3+5 in the full specification are only supported when DRPs are working in the corresponding mode.						

The lane rates and identifiers that the main link lanes can support are shown in Table 3.

Table 3 Main link lane rates

Application Scenario	Rate Type	Lane Rate
Long distance	HS1	2 Gbps and 4 Gbps
Medium and long distance	HS2	6 Gbps and 8 Gbps
General	HS3	10 Gbps, 12 Gbps, and 16 Gbps
Short distance	HS4	20 Gbps and 24 Gbps

7.1.3.3 Sideband Link

The sideband link shall have 12.5 Mbps full-duplex communication capability, and is used for device management and control, such as device discovery, port capability query, and device control.

7.1.3.4 Cable Information Link

The cable information link supplies power to active electronic devices in the cable, and obtains electronic tag information of the cable in two modes: single-chip and dual-chip.

7.1.3.5 Power Bus Link

When connectors and cables specified in T/SUCA 001.3-2024 are used, the power supply capacity of the power bus link shall meet the requirements of T/SUCA 001.4-2024.

7.2 Router

7.2.1 Overview

In routing devices, routers receive GPMI packets from ports or management adapters, and forward the packets to the ports or management adapters according to forwarding policies.

In end devices, the workflow of routers is as follows:

(a) Through adapters, routers encapsulate the data generated by external components and management and control components into GPMI packets to form GPMI service streams, and forward the service streams to ports.

(b) The ports multiplex the service streams to form data streams and distribute them to corresponding link lanes to generate GPMI service signals.

(c) The GPMI signals are transmitted to the peer GPMI device through connectors and cables.

The workflow for routers to obtain GPMI service streams from ports and restore them is as follows:

(a) Obtaining signals from the peer GPMI device.

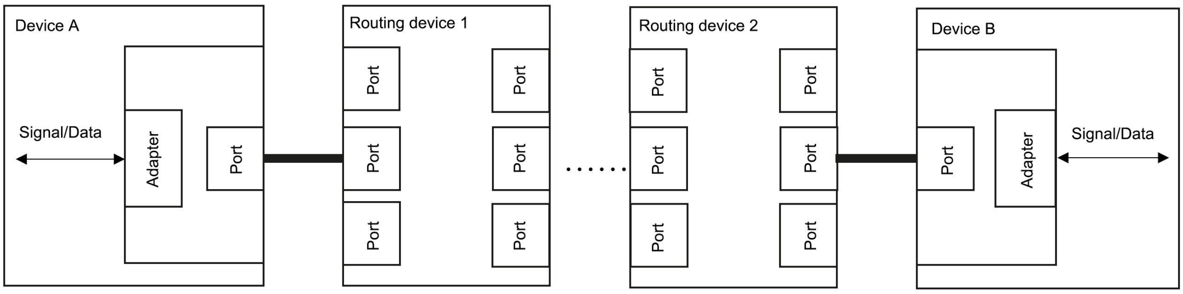
(b) Restoring the GPMI signals on each lane into GPMI data streams.

(c) Restoring the data streams into GPMI service streams.

7.2.2 Communication Model

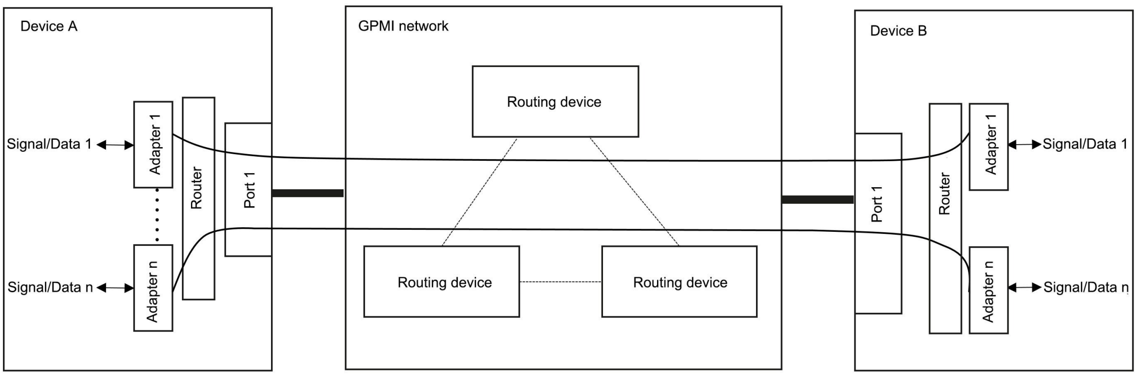
The communication model is shown in Figure 13. In a GPMI device, an adapter converts the signals or data to be transmitted into a GPMI packet which is transmitted to the target device via the GPMI network and then restored into data and signals by the adapter of the target device.

Figure 13 Schematic diagram of the communication model



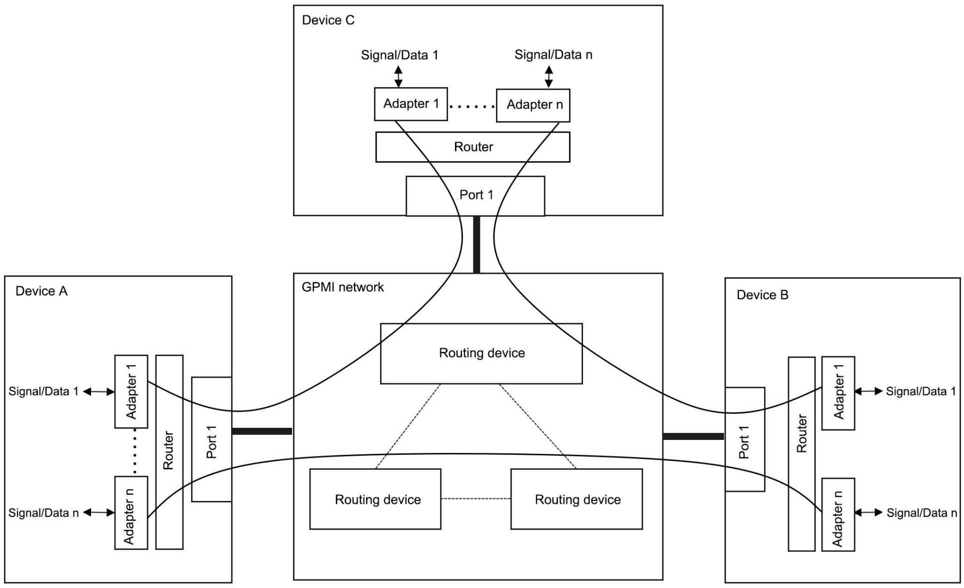
The communication model through the GPMI network, as shown in Figure 14, can exchange multiple types of signals/data between two devices at the same time.

Figure 14 Schematic diagram of point-to-point communication model



The communication model for exchanging multiple types of signals/data between multiple devices is shown in Figure 15.

Figure 15 Schematic diagram of point-to-multipoint communication model

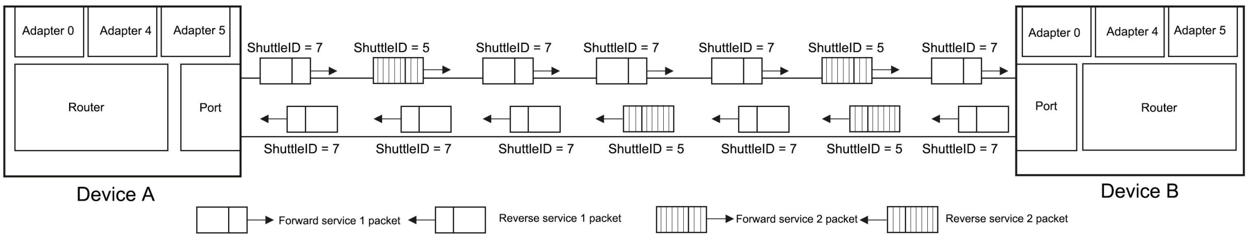


7.2.3 Shuttle

A shuttle is formed by transmitting packets of the same service stream on a single link. Shuttles of different service streams are distinguished by ShuttleID.

Example: As shown in Figure 16, the shuttle with ShuttleID = 7 transmits packets of service stream 1, and the shuttle with ShuttleID = 5 transmits packets of service stream 2.

Figure 16 Schematic diagram of shuttles



Shuttles support bidirectional data transmission.

Example: As shown in Figure 16, device A transmits the packets of service stream 1 to device B through shuttle 7 of its port 1, and device B transmits the packets of service stream 1 to device A through shuttle 7 of its port 1.

For a shuttle, the bandwidth in the two directions may be different.

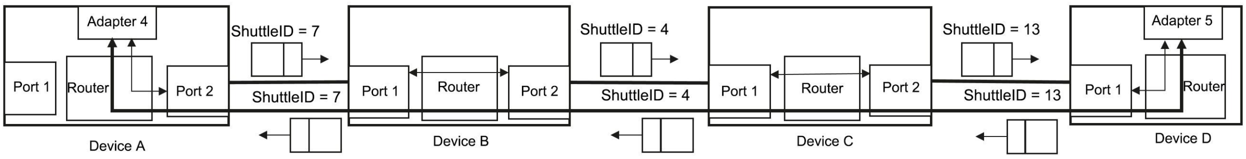
For a unidirectional shuttle, the bandwidth in one direction is greater than 0, and that in the other direction is 0.

7.2.4 Channel

A channel is formed by cascading multiple shuttles between two adapters.

Example: As shown in Figure 17, the bidirectional connection line from adapter 4 of device A to adapter 5 of device D is a channel. This channel includes 3 shuttles: the shuttle with ShuttleID = 7 between devices A and B, the shuttle with ShuttleID = 4 between devices B and C, and the shuttle with ShuttleID = 13 between devices C and D.

Figure 17 Schematic diagram of a channel



The channel in a GPMI is a bidirectional channel by default, where the direction from the adapter with subtype = 01h to the adapter with subtype = 02h is the forward direction, and the direction from the adapter with subtype = 02h to the adapter with subtype = 01h is the reverse direction. For a channel, the bandwidth in the two directions may be different. A unidirectional channel is a special channel with the bandwidth in the reverse direction being 0. The unidirectional channel in a GPMI is a channel with the bandwidth in the reverse direction being 0.

Adapter types are shown in Table 5.

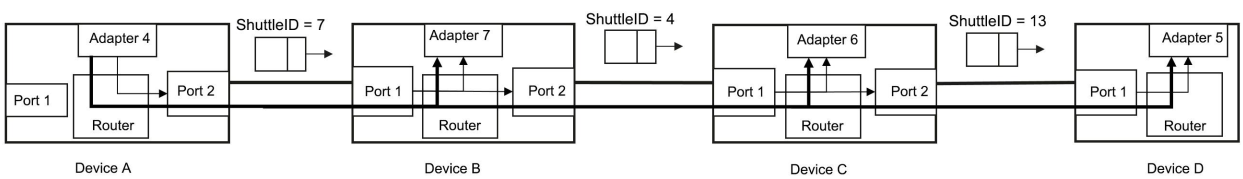
Example: A channel can be represented by a 4-tuple.

The channel shown in Figure 17 can be represented as (device A, adapter 4, device D, adapter 5).

The GPMI supports the multicast function, and the data/audio and video streams generated by the same adapter can be transmitted to multiple adapters.

Example: As shown in Figure 18, the stream from adapter 4 of device A is received by adapter 7 of device B, adapter 6 of device C, and adapter 5 of device D at the same time. The corresponding three channels are (device A, adapter 4, device B, adapter 7), (device A, adapter 4, device C, adapter 6), and (device A, adapter 4, device D, adapter 5). During multicast, one shuttle can be used by multiple channels. As shown in Figure 18, the shuttle with ShuttleID = 7 between devices A and B is used by the above 3 channels at the same time.

Figure 18 Schematic diagram of channel multicast



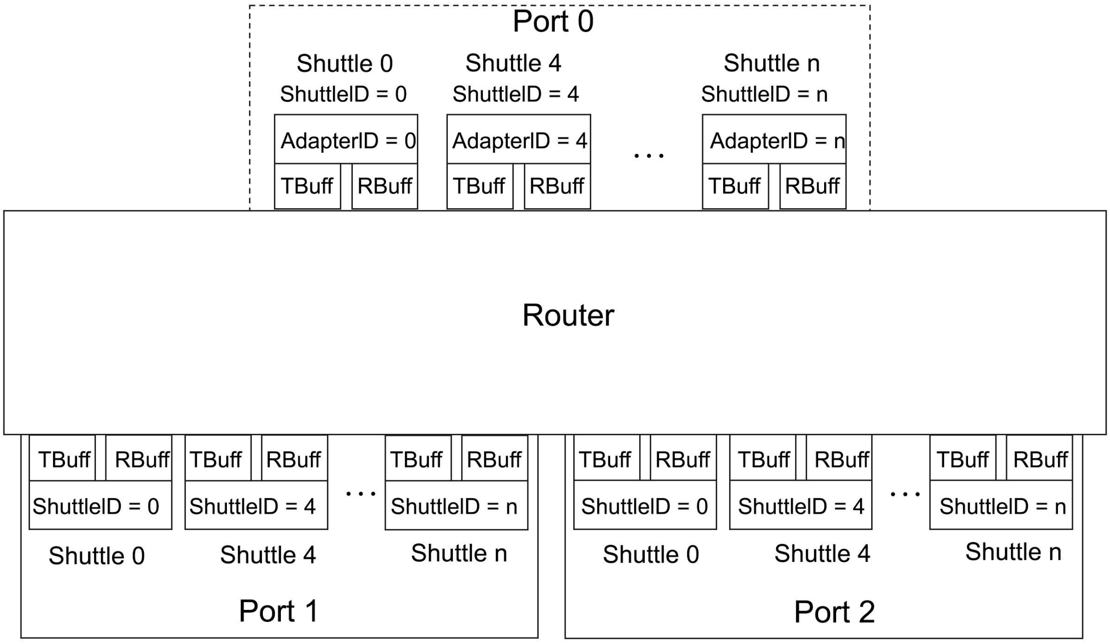
7.2.5 Routing and Forwarding

7.2.5.1 Overview

When a router performs packet routing and forwarding, it receives packets from the receive buffer (RBuff) of an adapter or a shuttle, and forwards them to the transmit buffer (TBuff) of other adapters or shuttles.

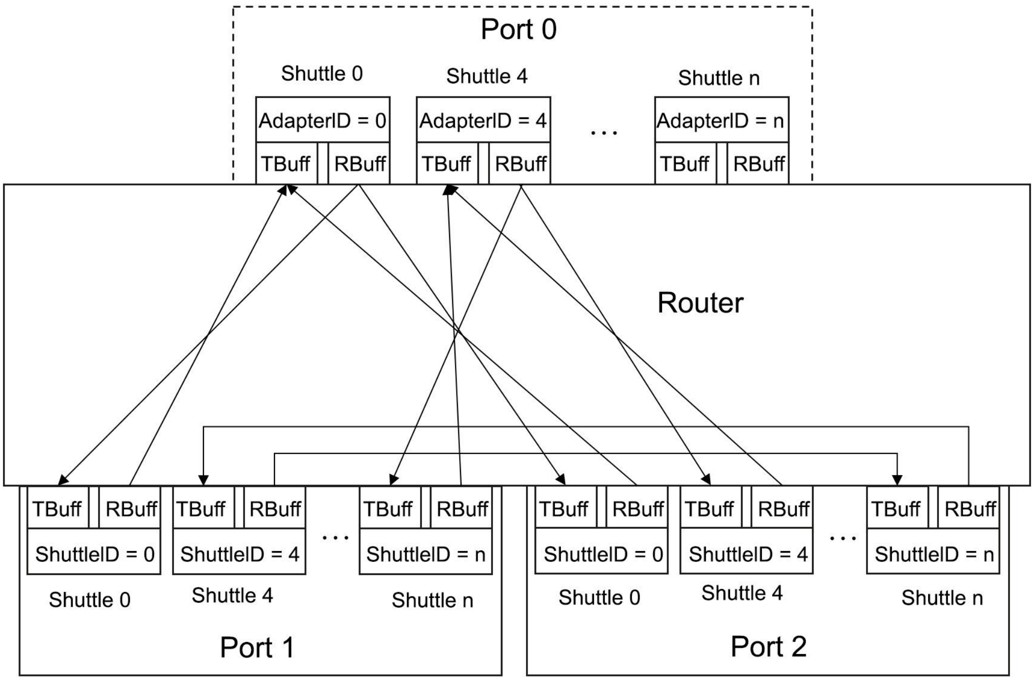
Logically, adapters and shuttles are equivalent. All adapters corresponding to a router constitute a virtual port 0, and each adapter is a shuttle on port 0. AdapterID is ShuttleID. As shown in Figure 19, TBuff is a buffer for the data sent by the router to the adapter, and RBuff is a buffer for the data to be received by the router from the adapter.

Figure 19 Schematic diagram of a device model with a router



Each shuttle of each port can be identified by a 2-tuple [PortID, ShuttleID], and each adapter can also be identified by a 2-tuple [0, AdapterID]. In general, AdapterID and ShuttleID are consistent and are not distinguished.

Figure 20 Schematic diagram of a routing and forwarding model



Example 1: As shown in Figure 20, [1, 4] represents shuttle 4 of router port 1.

Example 2: As shown in Figure 20, when the port number is 0, [0,4] indicates an adapter with AdapterID = 4.

7.2.5.2 Shuttle Types

Shuttle 0 is a management shuttle, used for transmitting a transport layer management data packet (TLMDP). The router processes the packet of the management shuttle as follows:

(a) The router directly forwards the TLMDP received from a non-zero port management shuttle to the management adapter of the device for processing, and does not forward the TLMDP to other ports.

(b) When the management adapter generates a new TLMDP, the forwarding output port of the TLMDP shall also be provided. The router transmits the TLMDP to the management shuttle of a designated port of the management adapter.

Shuttles 1 to 3 are reserved for future expansion.

Shuttles 4 to n are service shuttles for transmitting service stream packets, and the packets are forwarded according to the router forwarding table.

7.2.5.3 Routing and Forwarding

The router forwarding table is shown in Table 4.

Table 4 Router forwarding table

Inflow Information	Outflow Information
[0,4]	[1,n], [2,4]
[1,n]	[0,4]
[2,4]	[0,4]
[1,4]	[2,n]
[2,n]	[1,4]

The router forwarding table shows a shuttle-based packet forwarding rule, that is, a rule for forwarding packets received from an inflow shuttle to an outflow shuttle.

Example 1: As shown in Table 4, a router forwarding table entry can be represented by {inflow information | outflow information}. The inflow information consists of a single inflow node, and the outflow information consists of one or more outflow nodes. The inflow node mainly describes the PortID and ShuttleID corresponding to the inflow, and the outflow node mainly describes the target PortID, target ShuttleID, and other information related to packet forwarding.

Example 2: The first router forwarding table entry in Table 4 can be expressed as {[0,4] | [1,n], [2,4]}, where only one inflow node [0,4] is included in the inflow information, indicating that the stream receives packets from the receiving buffer of adapter 4 of the router. Two outflow nodes are included in the outflow information, namely [1,n] and [2,4], indicating that the packets of the stream need to be forwarded to shuttle n of port 1 and shuttle 4 of port 2 at the same time. This example routing forwarding table entry corresponds to Figure 20.

Except for port 0, no other port is allowed to forward packets of a shuttle to another shuttle of the port.

Example 3: When a shuttle forwards packets to another port, at most one such shuttle is allowed on that port. For example, when the shuttle [0,4] in Table 4 forwards packets to port 1, at most one shuttle [1,n] can be configured on port 1, and the packets cannot be forwarded to other shuttles of port 1.

7.2.5.4 Multicast

When the multicast function is used, a shuttle can be used by multiple channels.

To facilitate the management of the router forwarding table, ReceiverCount is added to the outflow information to describe the number of channels using the shuttle. After ReceiverCount is added, the outflow information is described by a 3-tuple [Port, ShuttleID, ReceiverCount].

An example multicast routing is described in Appendix A.

7.3 Adapter

7.3.1 Overview

Adapters include management adapters and service adapters.

- The management adapters discover, manage, and configure entities in the GPMI network, and provide management data packet transmitting and receiving functions for other modules.
- The service adapters convert service signals and data of external components into GPMI

packets, or convert GPMI packets into service signals or data of external components.

The service adapters include audio and video adapters and third-party protocol adapters.

- The audio and video adapters include audio and video transmitting adapters and audio and video receiving adapters. The audio and video transmitting adapters obtain audio and video data from the audio and video source component and encapsulate it into GPMI audio and video packets to form GPMI audio and video service streams. The audio and video receiving adapters decapsulate the audio and video packets in GPMI service streams into audio and video data, and output these data to the audio and video output device components.
- The third-party protocol adapters receive the third-party protocol data from third-party protocol components, encapsulate these data into GPMI third-party protocol packets to form third-party protocol service streams, or process the third-party protocol service streams to obtain the third-party protocol data and transmit these data to the third-party protocol components.

7.3.2 Adapter Type Representation

The adapter types, versions, and subtypes supported by GPMIs are shown in Table 5. Only adapters of the same type and version can communicate.

Table 5 Adapter types

Adapter Name	Type	Version	Subtype
Reserved	00h	00h	00h
Management adapter	01h	01h	00h
Audio and video transmitting adapter	02h	01h	01h
Audio and video receiving adapter	02h	01h	02h

Note: Subtypes are used to identify different adapters of the same type and version:
- Subtype 01h: It indicates a transmitting adapter in unidirectional flow and a downstream adapter in bidirectional flow.
- Subtype 02h: It indicates a receiving adapter in unidirectional flow and an upstream adapter in bidirectional flow.
- Subtype 00h: It indicates that an adapter can be used as a transmitting adapter or receiving adapter in unidirectional flow, and can also be used as an upstream adapter or downstream adapter in bidirectional flow.

7.3.3 Management Adapter

The management adapter may have the following functions:

(a) Device management: device and topology management, including topology discovery and update.

(b) Port management: port negotiation, configuration, and status management, including capability negotiation, link configuration, and standby.

(c) Bandwidth management: channel establishment, maintenance, and removal, including bandwidth query, bandwidth application, bandwidth adjustment, bandwidth release, and channel removal.

(d) Device control: inter-device control, including device status query, device wake-up, device standby, device name obtaining, adapter list obtaining, adapter binding, and adapter unbinding.

(e) Content protection: transmitting and receiving of content protection tunnel packets, such as device certification, key negotiation, and revocation lists.

The AdapterID of the management adapter is 0, and the ShuttleID of the GPMI management packet generated by the management adapter is 0, that is, the GPMI management packet is transmitted between devices through a shuttle with port ShuttleID = 0.

After the router receives the GPMI management packet with ShuttleID = 0 from the port, it directly transmits the packet to the local management adapter for processing, and does not forward the packet to other ports. After the router receives the GPMI management packet from the local management adapter, it forwards the packet to the port specified by the management adapter.

The management adapter parses the GPMI management packet and forwards it to the corresponding port according to its addressing type, or transmits it to the corresponding module for processing according to its type.

7.3.4 Audio and Video Adapter

7.3.4.1 Overview

Audio and video adapters encapsulate the audio into ASPs for the transmission of audio data.

Audio and video adapters shall support uncompressed video transmission and should support compressed video transmission.

Audio and video adapters shall support audio in LPCM format as specified in IEC 60958.

Audio and video adapters shall support HDR video transmission.

Audio and video adapters should support encryption control and protection for the transmission of audio and video data. See bibliography for details.

Audio and video adapters include transmitting adapters and receiving adapters.

7.3.4.2 Audio and Video Transmitting Adapter

Audio and video transmitting adapters obtain audio and video signals such as vertical synchronization, horizontal synchronization, pixel clock, video data, and display enable signals, as well as descriptive information, and encapsulate them into packets.

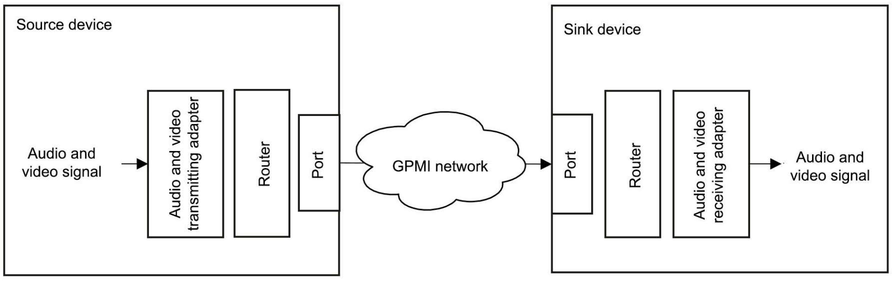
The process of transmitting audio and video signals through an audio and video transmitting adapter is shown inFigure 21:

(a) The audio and video signals are converted into GPMI packets through the audio and video transmitting adapter.

(b) The GPMI packets are transmitted to the corresponding audio and video receiving adapter at the peer end through the GPMI network.

(c) The audio and video receiving adapter converts the GPMI packets into audio and video signals.

Figure 21 Schematic diagram of transmission of an audio and video stream



When the content protection function is enabled, the process of transmitting audio and video signals through an audio and video transmitting adapter is shown in Figure 22:

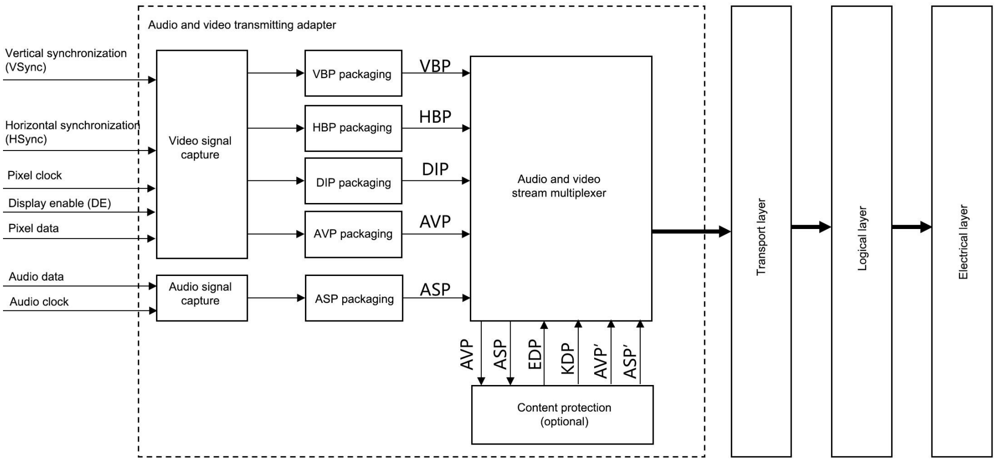
(a) The source device encrypts the active video packet (AVP) and audio sample packet (ASP) through the content protection encryption module to obtain encrypted AVP' and ASP'.

(b) The encryption parameters and the encryption key are encapsulated separately to generate an encryption description packet and a key distribution packet.

(c) All packets are compounded into one audio and video stream through the audio and video stream multiplexer.

(d) The audio and video stream is transmitted to the audio and video receiving adapter of the peer sink device through the transport layer, logical layer, and electrical layer of the GPMI.

Figure 22 Logic block diagram of an audio and video transmitting adapter



7.3.4.3 Audio and Video Receiving Adapter

The audio and video receiving adapter receives audio and video packets, including vertical blanking packets, horizontal blanking packets, active video packets, audio sample packets, and descriptive information packets, and restores audio and video signals such as vertical synchronization (VSync)/horizontal synchronization (HSync)/pixel clock/pixel data/display enable (DE) signals, as well as descriptive information according to corresponding packets.

Descriptive information describes information related to audio and video, such as audio control, video compression parameters, video metadata information, and manufacturer extension information.

Descriptive information can be obtained from the blanking area of the pixel data path or through an independent descriptive information interface, or directly generated based on user configuration data.

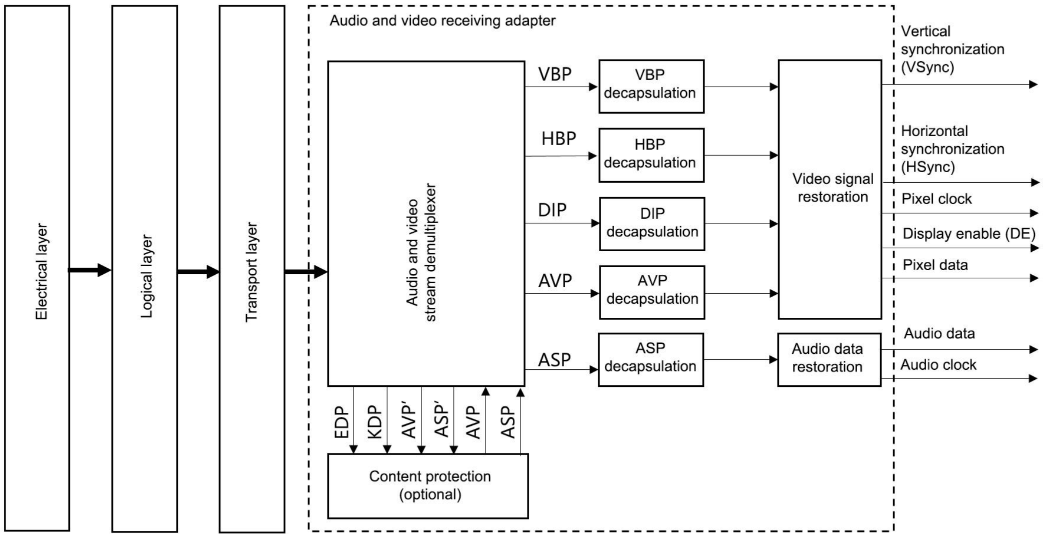
When the content protection function is enabled, the process of transmitting audio and video signals through the audio and video receiving adapter is shown inFigure 23.

(a) The audio and video receiving adapter parses the encryption description packet and the key distribution packet from the audio and video stream.

(b) The decryption module decrypts the encrypted AVP' and ASP' according to the encryption parameters in the encryption description packet and the key in the key distribution packet.

(c) Then, the decrypted AVP and ASP are obtained.

Figure 23 Logic block diagram of an audio and video receiving adapter



7.3.5 Third-Party Protocol Adapter

GPMIs can support third-party protocol adapters.

Note: Third-party protocols may include but are not limited to USB and PCIe.

8. Audio and Video Services

Audio and video services include GPMI downstream and upstream services.

The process of downstream services is as follows:

Services generated by the source device are GPMI downstream services. Data streams, service streams, and packets corresponding to the GPMI downstream services are GPMI downstream data streams, downstream service streams, and downstream packets.

Services generated by the sink device are GPMI upstream services. Data streams, service streams, and packets corresponding to the GPMI upstream services are GPMI upstream data streams, upstream service streams, and upstream packets.

The source device processes the GPMI downstream audio and video packets generated by the audio and video transmitting adapter to generate GPMI downstream services. The process is as follows:

(a) The audio and video transmitting adapter obtains downstream audio and video data from the audio and video source component and encapsulates these data into a GPMI downstream audio and video packet.

(b) The GPMI downstream audio and video packet and necessary downstream audio and video packets are multiplexed through the router component to generate a GPMI downstream data stream.

(c) The GPMI downstream data stream is allocated to the corresponding main link lane, to generate a GPMI downstream signal.

(d) The downstream signal generated by the source device is transmitted to the port of an available routing device or sink device at the peer end through connectors and cables.

The process of upstream services is as follows:

The sink device processes the GPMI upstream audio and video packets generated by the audio and video transmitting adapter to generate GPMI upstream services. The process is as follows:

(a) The audio and video transmitting adapter obtains upstream audio and video data from the audio and video source component and encapsulates these data into a GPMI upstream audio and video packet.

(b) The GPMI upstream audio and video packet and necessary upstream audio and video packets are multiplexed through the router component to generate a GPMI upstream data stream.

(c) The GPMI upstream data stream is allocated to the corresponding main link lane, to generate a GPMI upstream signal.

(d) The upstream signal generated by the sink device is transmitted to the port of an available routing device or source device at the peer end through connectors and cables.

The GPMI routing device routes and finally forwards the GPMI downstream audio and video packets obtained from the source device to the corresponding sink device's audio and video receiving adapter, which processes these packets and generates downstream audio and video data. These data are transmitted to the audio and video processing component.

The GPMI routing device routes and finally forwards the GPMI upstream audio and video packets obtained from the sink device to the corresponding source device's audio and video receiving adapter, which processes these packets and generates upstream audio and video data. These data are transmitted to the audio and video processing component.

Appendix A
(Informative)
Multicast Routing Example

In Figure A.1, the router forwarding table entry [0,4] | [2,7,3] in device A indicates that shuttle 7 of target port 2 in device A has 3 receivers (used by 3 channels). When the channel (device A, adapter 4, device C, adapter 6) is released, subtract 1 from the value of ReceiverCount of the channel in the forwarding node [2, 7, 3] of the router forwarding table entry in device A, the forwarding node [2, 4, 2] of the router forwarding table entry in device B, and the forwarding node [0, 6, 1] of the router forwarding table entry in device C. If the value of ReceiverCount is not 0 after 1 is subtracted, the router forwarding table entry has other receivers and the forwarding node shall not be deleted. If the value of ReceiverCount is 0 after 1 is subtracted, the forwarding node has no receivers and shall be deleted. The forwarding list after release is described in Figure A.2.

Figure A.1 Schematic diagram I of channel routing and forwarding

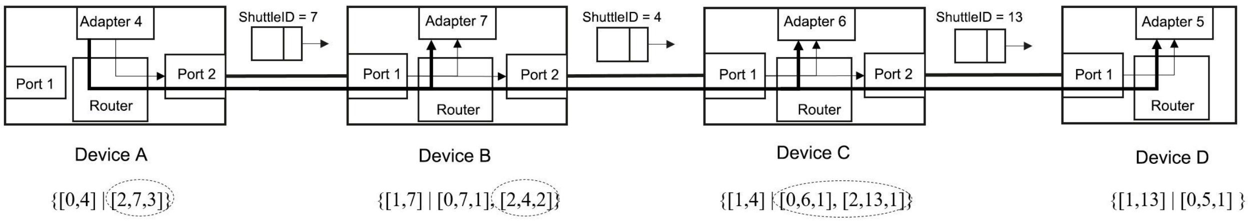
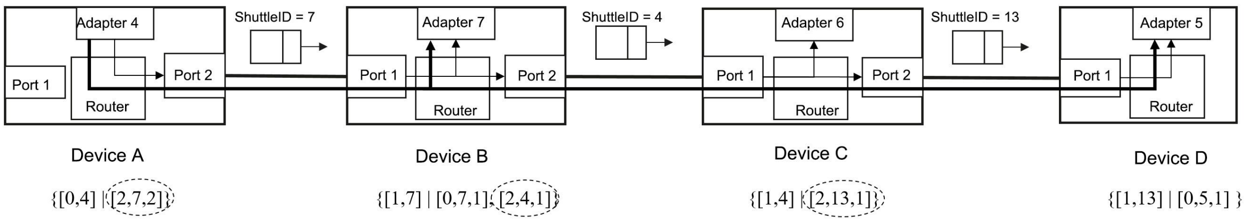


Figure A.2 Schematic diagram II of channel routing and forwarding



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