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Specification for chiplet interconnection interface - Part 2: Protocol layer technical requirements

芯粒互联接口规范 第2部分：协议层技术要求

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1 Scope

This document specifies the protocol layer functional requirements for the chiplet interconnection interface, the general transmission requirements for interfacing bus protocols, the transmission requirements for interfacing with the AXI bus protocol, the HAI protocol, the custom protocols, as well as the configuration between different protocols.

This document applies to the design, manufacture, application of the chiplet interconnection interface.

2 Normative references

GB/T 46280.1

GB/T 46280.3

3 Terms and definitions

The terms and definitions defined in GB/T 46280.1 apply to this document.

4 Abbreviations

The following abbreviations apply to this document.

AXI. Advanced Extensible Interface CCIX. Cache Coherent Interconnect for Accelerators CHI. Coherent Hub Interface CN. Channel Number CPIF. Chiplet PHY Interface CRC. Cyclic Redundancy Check CXL. Compute Express Link ECC. Error Correction Code FEC. Forward Error Correction Flit. Flow Control Unit HAI. High bandwidth memory Access Interface PAIF. Protocol Adapter Interface PCIe. Peripheral Component Interconnect Express SoC. System on Chip VC. Virtual Channel

5 Protocol layer functional requirements

The protocol layer is related to the specific service type it carries, which supports the following service protocols. - AXI4.0/3.0 Bus protocol;

- Custom protocol. A user-defined protocol that transmits service data transparently through the data link layer specified in GB/T 46280.3.

For different upper-layer service data, the protocol layer carries them through different adaptation processing mechanisms, as shown in Figure 1.

The protocol layer includes a bus adaptation unit and a HAI/custom processing unit.

The bus adaptation unit mainly implements the following functions.

- Defines a specific format and packages data from different bus protocols;

- Arbitration for multi-protocol bus transmission; - Data buffering.

Bus protocol data is segmented by the bus adaptation unit and then transmitted to the data link layer via PAIF.

HAI/custom data is processed by the HAI/custom processing unit and then directly transmitted to CPIF.

Figure 1 -- Protocol layer's bearing of different services

6 General transmission requirements for interfacing bus

protocols

6.1 General rules

The interfacing bus protocol is supported. The protocol layer encapsulates bus service data into Packets for transmission, through a bus adaptation unit. This document specifies the

Packet data format for interfacing bus protocol transmission. To ensure normal communication between the two parties, they shall use a consistent bus protocol.

After the protocol layer Packet is transmitted to the data link layer, the data link layer encapsulates the Packet into a Flit for transmission. The SoC bus transmission format is shown in Figure 2.

Figure 2 -- SoC Bus transmission format This document uses a fixed-format Packet to carry SoC bus data. The bit width P_Len of each Packet is related to the specific SoC bus type. The Packet bit width between the protocol layer and the data link layer is N x P_Len, where N > 0.The specific value needs to be determined based on the physical layer bandwidth and different protocol buses. When the Packet data length is inconsistent with the Flit payload length, the data link layer combines multiple Packets or splits a single Packet to adapt to the Flit payload length.

6.2 Packet general format

Each SoC bus defines its own service channel; the bit width of each service channel is fixed. This document uses VC to identify different bus service channels. Each VC is distinguished by CN, as shown in Figure 3.Each CN corresponds to a fixed service data width. CNs can be defined separately for each service channel of each SoC bus.

To improve data transmission efficiency, data from various service channels on the SoC bus needs to be concatenated before transmission through the data link layer. Packet data concatenation shall conform to the following rules.

a) Rule 1.Fixed mapping between service channel number and data length. Once the channel number of each service channel is determined, its corresponding data length is fixed; that is, there is a unique mapping relationship between the service channel number and the service channel data length. Through this mechanism, the sending end does not need to transmit length information; the receiving end automatically identifies the service data length corresponding to the service channel through the service channel number.

b) Rule 2.Service channel data boundary alignment. As shown in Figure 4, data from different service channels can be concatenated into a single Packet for transmission. The positions of the data from each service channel within the Packet shall be aligned according to 8-bit boundaries. Unaligned portions shall be filled with invalid data, preferably 0.The order of different channels is specified in the specific protocol requirements.

Figure 4 -- SoC bus service data boundary alignment

c) Rule 3.Maximum number of service channels in a single Packet. There is no limit to the number of service channels carried in a single Packet. The number depends on the bit width and alignment bit width of the service channels. In practical applications, the priority and padding efficiency of each service channel's data shall be considered

comprehensively, to select appropriate service channel data for concatenation.

d) Rule 4.Padding shall be added when the remaining bit width is insufficient. When the remaining bit width of the Packet data is less than or equal to the bit width of the CN field, this remaining bit width is used as Padding by default.

e) Rule 5.Padding channels. When there is no other valid service channel data to pad the data in a Packet, padding channels can be used. Padding channels are identified by a special CN service channel number (fixed to 0). After receiving the data, the receiving end discards the data of that service channel. It is recommended that the padding data content in the padding channel be 0; the receiving end shall discard this data directly.

7 Transmission requirements for AXI Bus protocol

Service channel A Service channel B .....