

## 8 - 42 Design and Development of Embedded EPICS Structure Based on FPGA SoC for White Rabbit Master Node

An Shi, Ge Liang, Li Yanlin and Zhang Wei

White Rabbit (WR) is a technology that provides sub-nanosecond synchronization over Ethernet networks<sup>[1,2]</sup>. We develop the timing system for HIAF accelerator based on White Rabbit technology. The WR timing system network is mainly composed of White Rabbit master nodes (WRMN), White Rabbit switches, and White Rabbit nodes. Among them, the WRMN is mainly used for generating accelerator's acceleration sequence commands, distributing commands and other functions, the WRWN is a core component of the WR network. In order to facilitate the physical control software to configure the WR network, the WRMN needs to provide an EPICS PV interface.

Based on the above technical requirements, the processing unit of the WRMN uses Xilinx's Zynq 7000 series SoC chip. This series of SoC adopts dual-core ARM Cortex-A9 processor, can run multiple operating systems, and well meet our needs for developing and deploying embedded EPICS on the WRMN. Based on the chip, we have designed the structure as shown in Fig. 1.

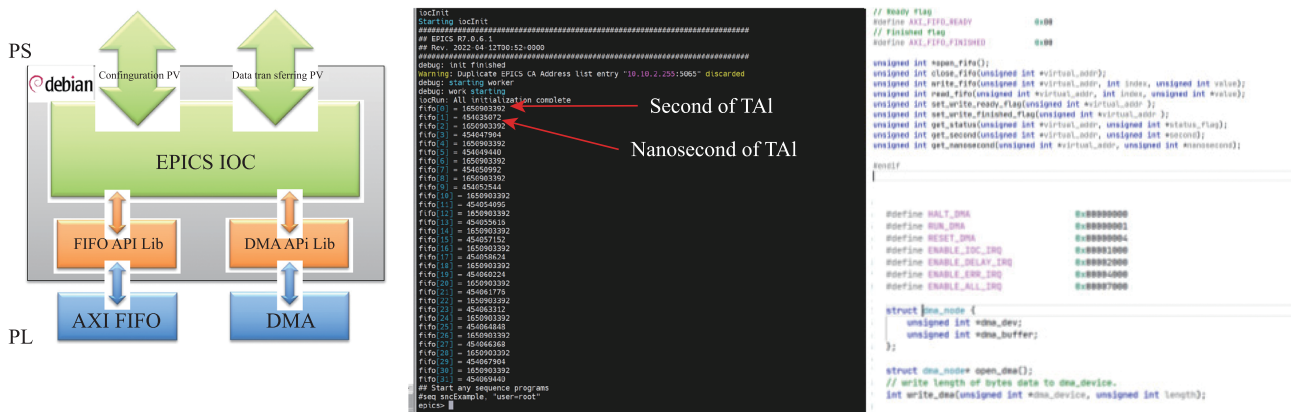


Fig. 1 (color online) The left figure shows the struct of the embedded EPICS for WRMN. The middle figure shows an EPICS IOC calls FIFO API for TAI timestamp reading test. The right figure shows the API interface design of FIFO and DMA.

The bottom layer in the structure diagram is the interface between the PS (Processing System) and PL (Programmable Logic) sides of the SoC for data interaction, which are AXI FIFO and DMA respectively. FIFO is used to store the configuration parameters of the upper layer into the PL through the PS side, and realizing some parameter configurations of the WRMN itself. DMA is used to send the run-time data of the upper layer to the PL side, and realizing all the synchronous data transmission work during the acceleration cycle. The PS side uses a Debian-based roots and equipped with a compilation tool package for convenient on-site program modification and debugging. Two types of PV are designed and developed through EPICS IOC, which are provided to the final physical control software for calling.

The system has undergone functional testing and long-term stability testing and can meet the requirements. Based on the completion of basic functional requirements, fault-tolerant and error-correcting functions will be added in future to further enhance the robustness of the system.

### References

- [1] White Rabbit Project - Wikipedia. [https://en.wikipedia.org/wiki/White\\_Rabbit\\_Project](https://en.wikipedia.org/wiki/White_Rabbit_Project).
- [2] White Rabbit-based Timing System ” Seven Solutions. <https://sevensols.com/white-rabbit-based-timing-system/>.