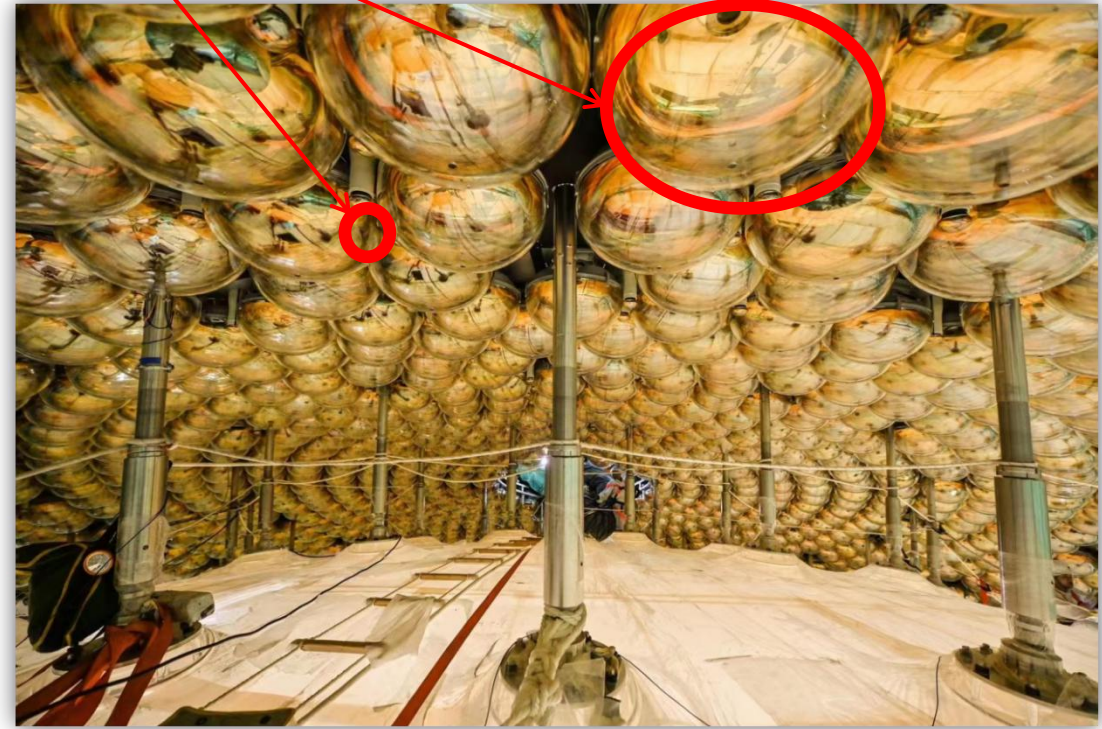
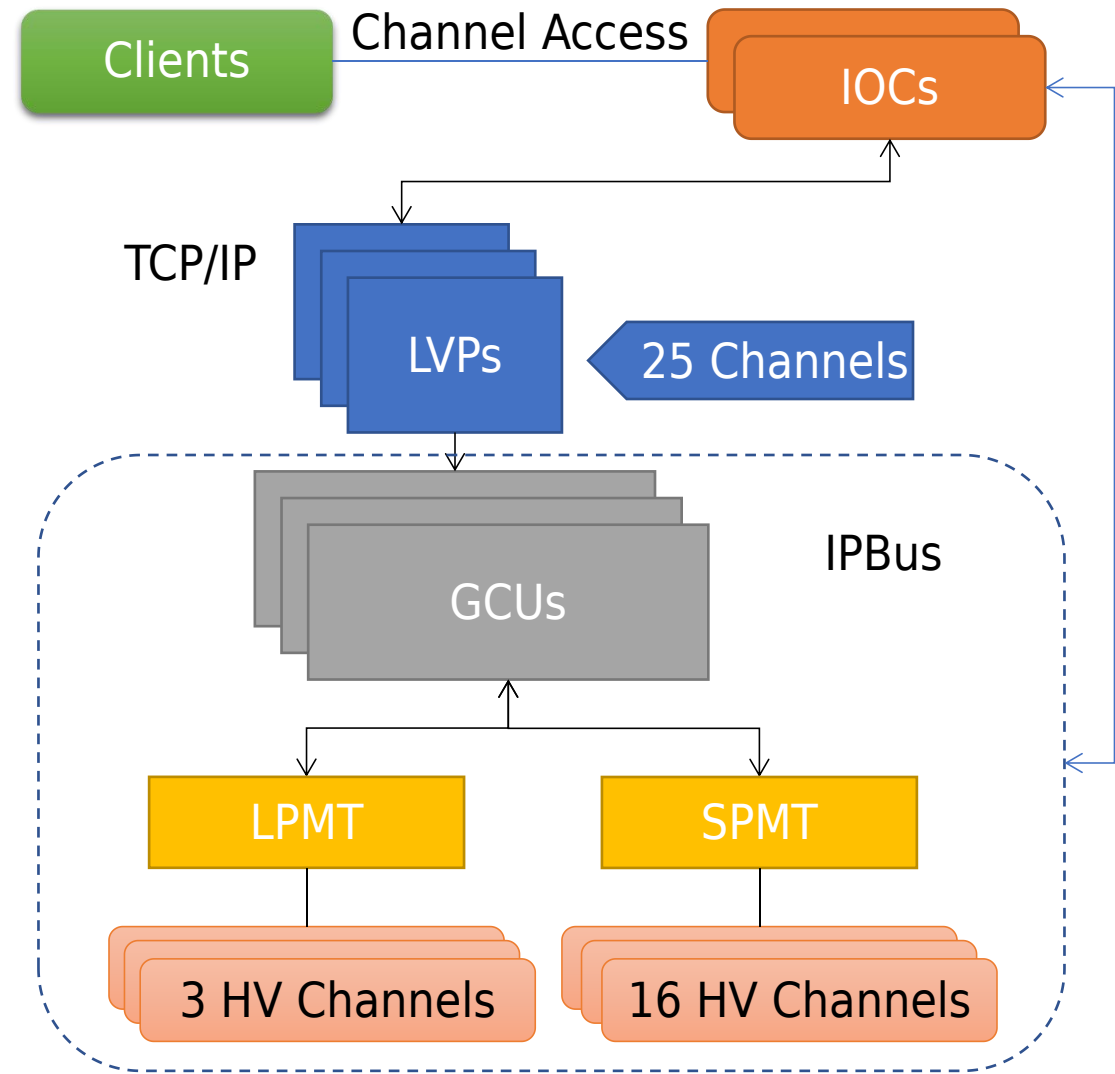


JUNO High Voltage & LVP Control System Upgrade Based On EPICS

- IOC: (Input/Output Controller) ~**360**
- LVP: Low Voltage Power ~**6800**
- GCU: Global Control Unit (Electronics Box) ~**6800**
- LPMT: 20" Large Photomultiplier Tube **17612**
- SPMT: 3" Small Photomultiplier Tube **25600**



Max: 43212 High Voltage channels





JUNO High Voltage & LVP Control System Upgrade Based On EPICS

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Introduction

The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose neutrino experiment designed to determine neutrino mass hierarchy and precisely measure oscillation parameters. In order to improve the control efficiency of High Voltage (HV) and Low Voltage Power (LVP) control systems, the proposed solution, Read-Write Thread Separation and Data Aggregation (RWTS-DA), presented in this paper, aims to enhance the utilization of hardware resources through adjustments in thread allocation and parameter optimization. Additionally, it leverages web technologies to enable online control of the 3D detector structure.

Original System

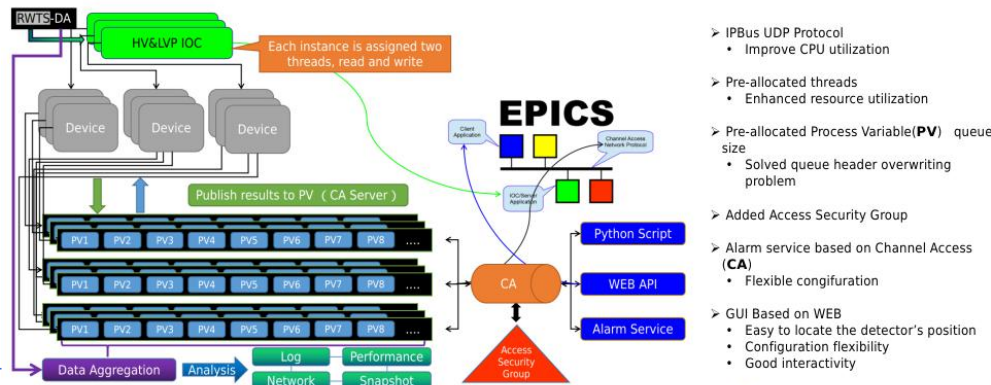
- IPBus ControlHub TCP Protocol
- Alarm service based on CSStudio
- GUI based on CSStudio

Purpose of Upgrade

- Improve real-time control efficiency
- Realize online-control based on WEB GUI

Upgraded System

The RWTS allocates threads and PV queue sizes according to the number of devices, which can effectively improve resource utilization. After aggregating the data, the DA distributes data to analysis component for logging, performance and network packet loss analysis and finally saves the runtime-snapshot.



- IPBus UDP Protocol
 - Improve CPU utilization
- Pre-allocated threads
 - Enhanced resource utilization
- Pre-allocated Process Variable(PV) queue size
 - Solved queue header overwriting problem
- Added Access Security Group
- Alarm service based on Channel Access (CA)
 - Flexible configuration
- GUI Based on WEB
 - Easy to locate the detector's position
 - Configuration flexibility
 - Good interactivity



Alarm Service

The Alarm service directly retrieves PV values from CA and sends notifications via WeChat and Email and when the threshold is exceeded. It has been utilized in JUNO Integration (light-off) Tests.

Results

The diagram shows the network topology. User Applications connect to Control Hubs, which in turn connect to multiple Devices. The Control Hubs manage the communication between the devices and the EPICS system.

IPBus ControlHub TCP

The ControlHub is excellent software that forms a single point of access for IPBus control of each device; it implements the IPBus reliability mechanism for the UDP packets travelling between the ControlHub and the IPBus target devices, and it has sophisticated congestion mitigation and flow-control algorithms.

IPBus UDP

Due to performance limitations and the immense scale of the experiment, an IPBus UDP solution was adopted after multiple tests. From the experimental results, there has been a significant reduction in CPU overhead. As UDP is used, to ensure reliability, this system employs the same recursive algorithm as ControlHub and limits the recursion depth based on the data acquisition frequency. This ensures that commands are reachable while reducing CPU usage.



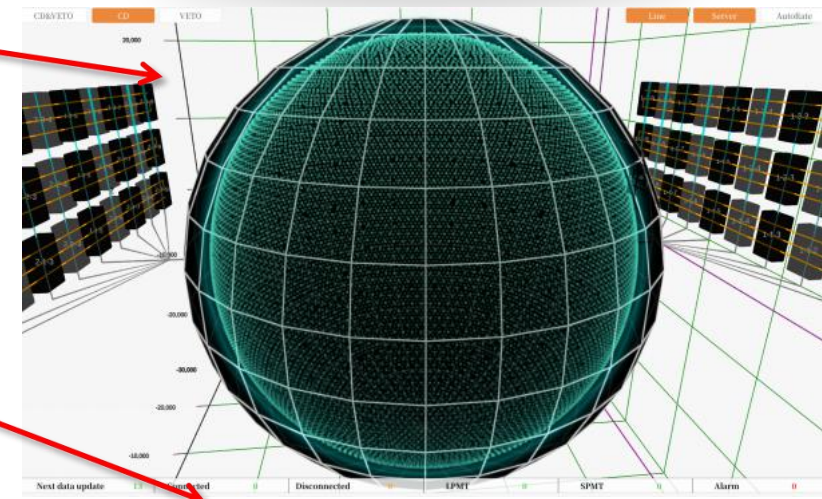
Summary

The upgraded system uses the IPBus UDP protocol and supports pre-allocation of threads, PV queues, and IOC ports. In terms of security, ASG (Access Security Group) has been added. Additionally, the upgraded system has successfully completed JUNO Integration (light-off) tests in real experiments, demonstrating significant improvements in resource utilization and real-time control efficiency.

Original System & Goal



JUNO Central Detector(CD)



WEB GUI

Motivation and Background Information

Architecture and optimization methods

Online WEB control GUI and Alarm service

Results & Summary