A SOA Based Design of JUNO DAQ

Online Software

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Introduction

JUNO:
- determine neutrino mass hierarchy, precisely measure oscillation parameters
- the largest liquid scintillator detector with the best energy resolution in the world
- central detector with 18000 20” PMTs and 25000 3” PMTs, Water Cherenkov with 2400 20” PMTs

Since the numerous PMTs and large-scaled front-end electronic readout channels, DAQ will be: Large scaled with thousands of software processes distributed over several hundreds of computing nodes

Online Software: A distributed system which is designed to control and monitor the whole DAQ system, plays an important global role during the whole data taking period, including configuring, monitoring, controlling, multi-processes management, information sharing...

Online Software design:
- SOA: service oriented architecture–loosely-coupled, modular, reusable
- Message exchange–ZeroMQ
- PARTITION: DAQs run concurrently
- HA: high availability–Zookeeper
- Other functional modules: Configuration, Run Controller, Information sharing...

The total DAQ architecture:
- Green: framework services. SOA based framework of the online software–Run Control, Information service...
- Orange: user parts, Data flow system
- Blue: underlying layer–ZeroMQ Zookeeper Redis...
- SOA: deployment methodology relying on the integration and interaction between loosely coupled services.
- Any service could be service provider or service consumer.
- Message exchanges among all services using TCP/IP encapsulated by ZeroMQ.

Underlying communication layer: ZeroMQ
- ZeroMQ seems like traditional Berkeley socket, encapsulates low-levels statement and error handling complexities.
- advantages: zero brokers, low latency, cross-platform and support of multiple widely used programming languages.
- ZeroMQ provides several advanced communication patterns:
  - Message serialization tools:
    - Google Protocol buffers: serializing structured data
    - Easy, language-neutral, platform-neutral

Online Software architecture Design

Configuration:
- Histograms, event rates...
- Any DAQ components could publish its information to IS, and anyone could query information from IS.
- Redis is a good choice to act as database for its high performance:
  Load balance:
  1. Static way: specific define which IS server the information will send to.
  2. Dynamic way: dispatcher server determines in running time.

Tree-like controller:
- Intention: Multiple DAQs run concurrently. Operate a sub-set in stand-alone mode, Command dispatch and state collection
- The top level RootController taking the roles of the overall control and coordination of the system.
- Each controller level controls the next level controllers.
- State: each controller will wait a timeout time unless all children’s state have been received and then switch the state.
- The ‘Initial Partition’ is a common component that accomplish initialization and public function.

Summary
- The architecture design of JUNO DAQ Online software has been achieved.
- The core functions have been accomplished and the whole system runs well with dummy data.
- The JUNO onsite is still under construction, however. So the design is in laboratory and the further development and optimization is ongoing.