DESIGN AND IMPLEMENT OF WEB BASED SCADA SYSTEM FOR HUST FIELD-REVERSED CONFIGURATION DEVICE

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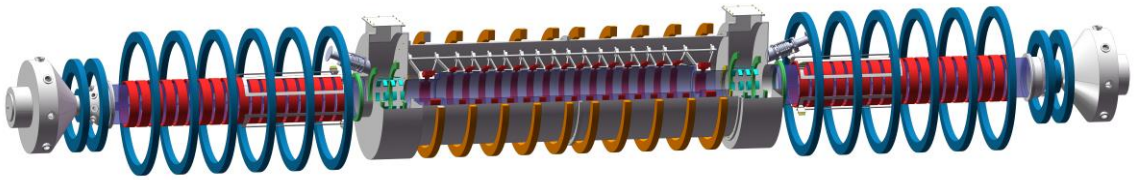
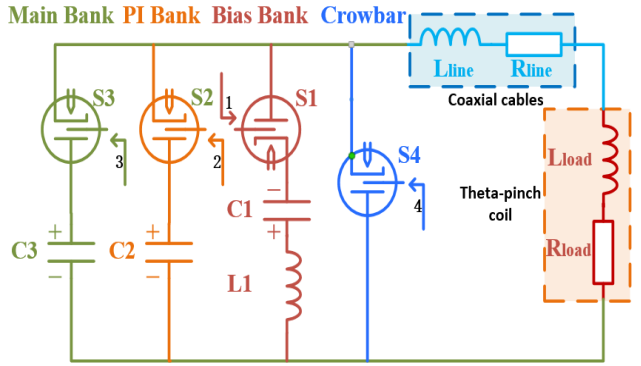
• Introduction

➢ HFRC and its SCADA system.



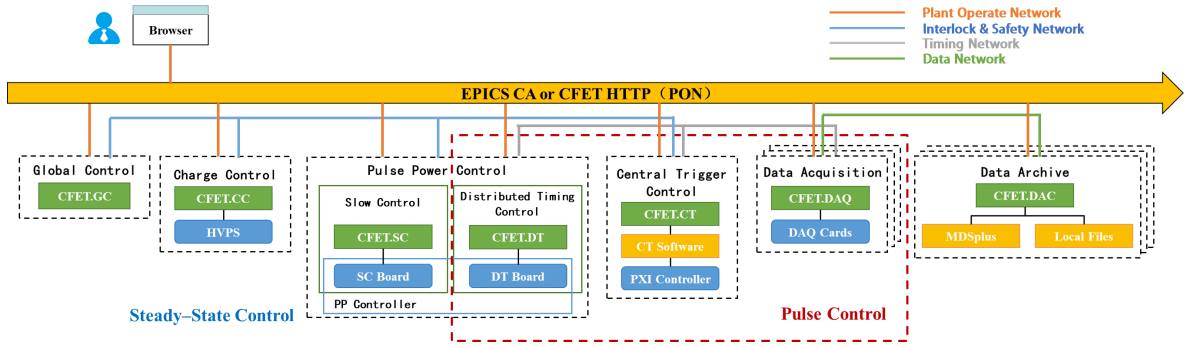
Design of HFRC device

• HFRC Control Requirements



Topology of HFRC formation area power module

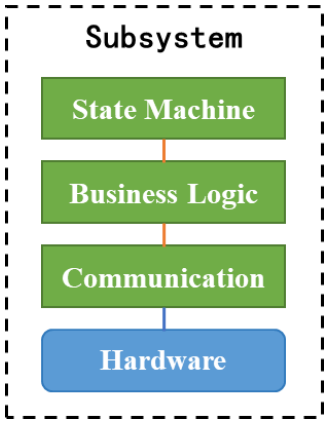
• Overall Design of HFRC SCADA



Overall structure of the whole system

• Subsystems

➢ Introduction of the service each subsystem offers.

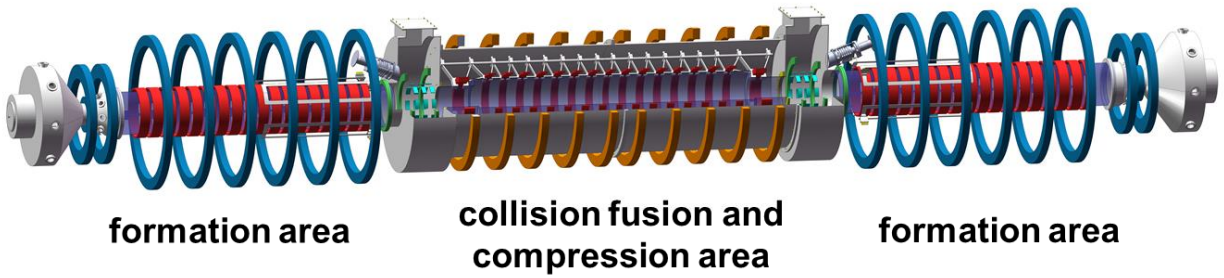


Design template of the subsystem

• Introduction

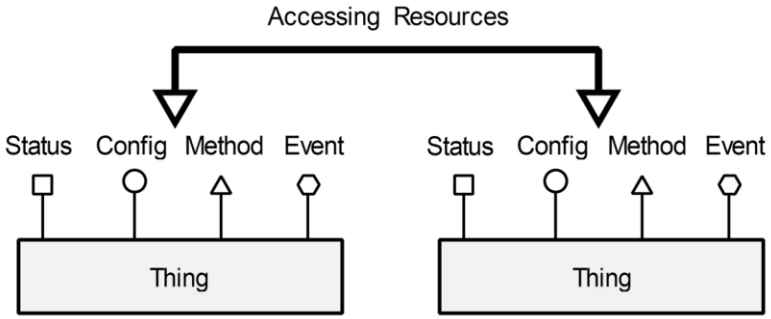
- HFRC(HUST Field-Reversed Configuration) is a magnetically constrained plasma device, which is composed of many different subsystems.
- HFRC device contains two plasma formation areas, collision fusion and compression area.

Design of HFRC device



- HFRC SCADA (Supervisory Control And Data Acquisition) system is designed to coordinate all systems and ensure the correct, orderly and stable operation of the whole experimental device.
- HFRC SCADA adopts the de-centralized, modularized and micro service architecture, as well as Observer and FSM patterns.
- HFRC SCADA has selected the in-house developed CFET(Control system Framework for Experimental Devices Toolkit) as the control framework, with advantages of strong abstraction, simplified frame-work, transparent protocol and flexible extension due to Web technology.
- CFET adopts HTTP protocol and RESTful design principle as the general communication protocol of the system.
- Under the CFET framework, the object realizing the same business function logic is called as a Thing.

CFET abstract model

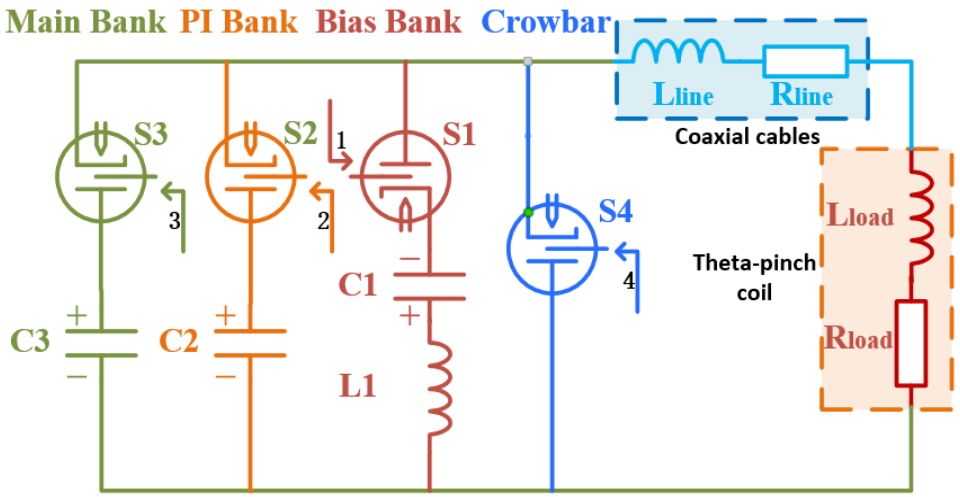


- All resources in CFET system can be accessed by an URL through the internet.

• HFRC Control Requirements

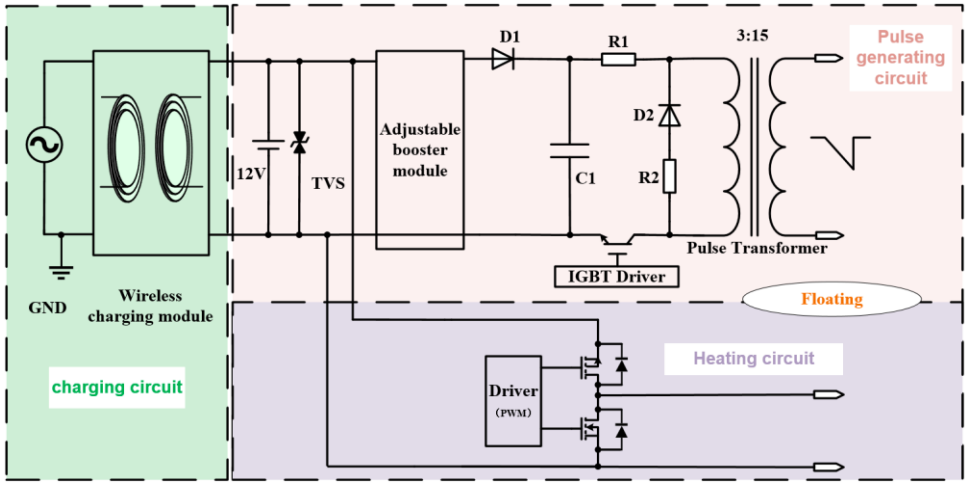
- The control system controls the discharge process mainly by orchestrating the power supply in the formation area.

Topology of HFRC formation area power module



- Three high-voltage banks discharge sequentially to the Theta-Pinch coil to create plasma inside the device by generating a specific current waveform.
- In order to generate the desired waveform, HFRC has strict requirements on the discharge timing.

The schematic circuit diagram of formation area high-voltage pulse trigger



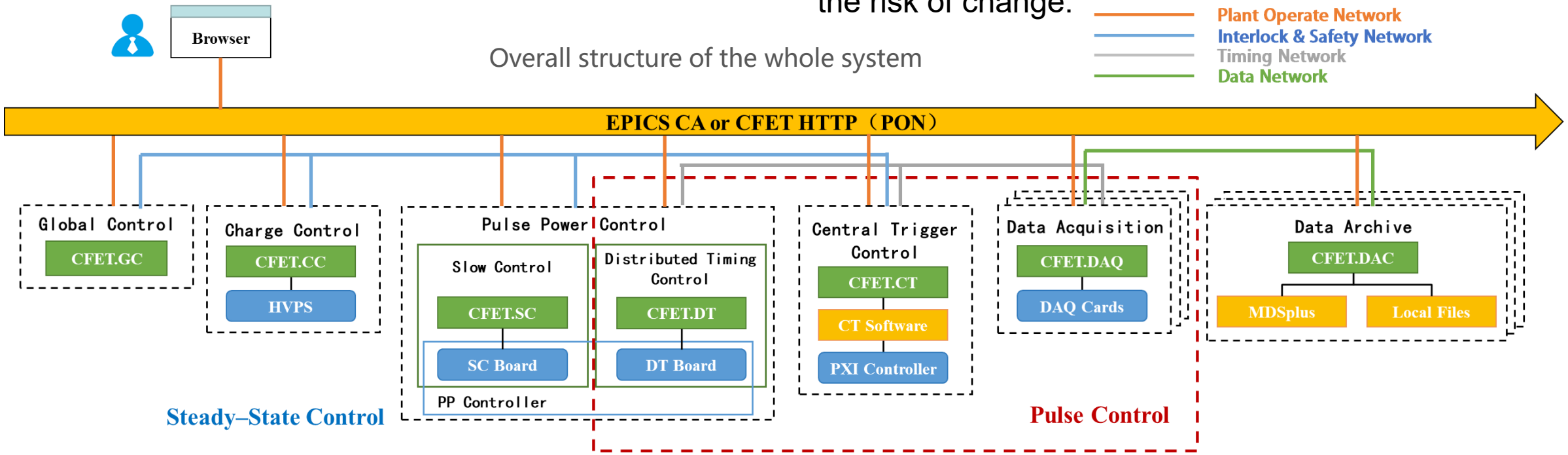
- Amount of control signals are provided to the high-voltage pulse trigger to realize a series of operations.
- The discharge process of HFRC can be seen as a sequential transitions of states.
- HFRC SCADA uses dynamic FSM pattern to control the flow of discharging and handle exceptions.

• Overall Design of HFRC SCADA

- HFRC SCADA adopts the decentralized model.
- Divided as
  - Functionally:
    - Steady State Control System
    - Pulse Control System
  - Structurally:
    - Central Control System
    - Subsystems

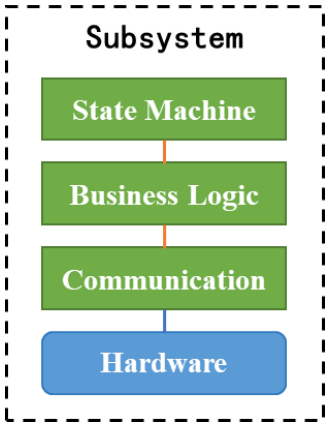
- HFRC SCADA builds the whole system as a suite of small services, each running in its own process and is independently deployable.
- Each subsystem offers its own service to others by accessing control networks.
- Modularized architecture makes the system simpler to deploy and understand, and minimizes the risk of change.

Overall structure of the whole system

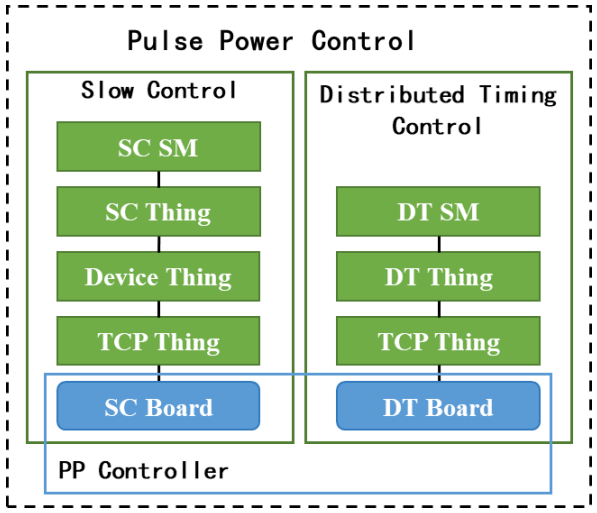


• Subsystems

- Subsystems are designed and implemented based on the template.
- Template could be adjusted according to requirements of the subsystem.



Design template of the subsystem

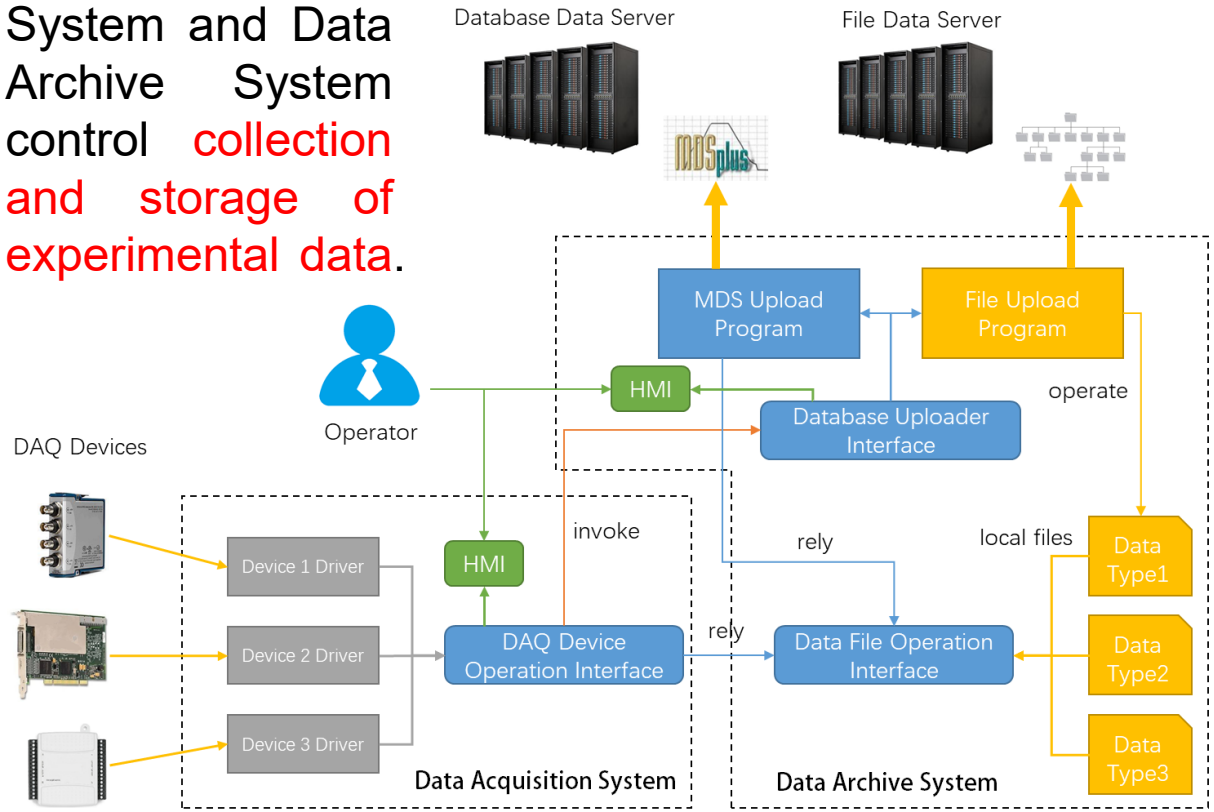


Structure of Pulse Power Control System

- Pulse Power Control System controls the formation area power controller, which is connected to the formation area high-voltage pulse trigger.

- Global Control System coordinates all subsystems.

- Central Trigger Control System generates trigger signals.
- Charge Control System controls the charging process of the capacitors of high-voltage banks.
- Data Acquisition System and Data Archive System control collection and storage of experimental data.



Structure of Data Acquisition and Archive System