Control System

Current Status and Upgrade Plan

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Requirements for SuperKEKB

- Hearing from each hardware group
  - No much requirement is given
  - No drastic changes are required
  - Basically extension of the current system
- But…
  - Additional requirements sometimes come later. We need to prepare.
  - Replacements of the outdated components are necessary.

Structure of KEKB Control System (Current Status)

- EPICS based --- Distributed System
  - **EPICS** (Experimental Physics and Industrial Control System) is a toolkit to construct control systems
  - 2 layer model
    - OPI (Operation Interface) --- central servers
    - IOC (I/O Controller) --- frontend computers
  - CA (Channel Access)
    - Communication protocol over network
    - Key technology of EPICS

Version up of EPICS

- Current version in KEKB
  - Most part: R3.13.1
  - New part: R3.14.9 (or R3.14.8)
- Major difference of the versions
  - R3.13: VxWorks only
  - R3.14: Multi-platform (VxWorks, Linux, Windows etc.)

Upgrade of IOC

- VME/VxWorks IOC
  - Mostly installed at the beginning of the KEKB
    - Force SYS68K CPU-40B/16 (68040) 6
    - Force SYS68K CPU-64D (68060) 9
    - Force PPC603 (PowerPC603) 7
    - Force PPC750 (PowerPC750) 99
- Upgrade plan of the old CPU
  - CPU: Force PPC750 → MVME5500 (or MVME4100)
  - OS: VxWorks 5.3 → VxWorks 5.5
    - Evaluation of VxWorks 6.7 / 6.8
  - EPICS: R3.13 → R3.14

Upgrade of IOC --- Current Status

- One by one Replacement to MVME5500
- Examples (have done)
  - IOCBMD01B, IOCBMD02B (for BPM at IR)
    - → MVME5500 / VxWorks 5.5 / EPICS R3.14.9
  - IOCOPCCR (for bucket selection)
    - → MVME5500 / VxWorks 5.5 / EPICS R3.14.8.2
  - IOCTMCCCB (for Belle Status Signals)
    - → MVME5500 / VxWorks 5.5 / EPICS R3.14.8.2
  - IOCARVAW (for AR Vacuum)
    - → MVME5500 / VxWorks 5.5 / EPICS R3.14.9

New Type IOC

- **EPICS** can be **embedded** in various devices --- New trend of EPICS IOC
- F3RP61 --- EPICS embedded PLC
  - Yokogawa FAM3 series PLC
  - Linux is supported
  - EPICS R3.14
  - Real-Time Kernel (coming soon)
  - Applications in KEKB (Current Status)
    - Beam Mask Control
    - Pulsed Q-Magnet Control

F3RP61 (e-RT3 2.0)

Linux 2.6.24

PPC 533MHz

128Mbyte RAM

100BaseTx x 2

USB

IEEE1394

Serial

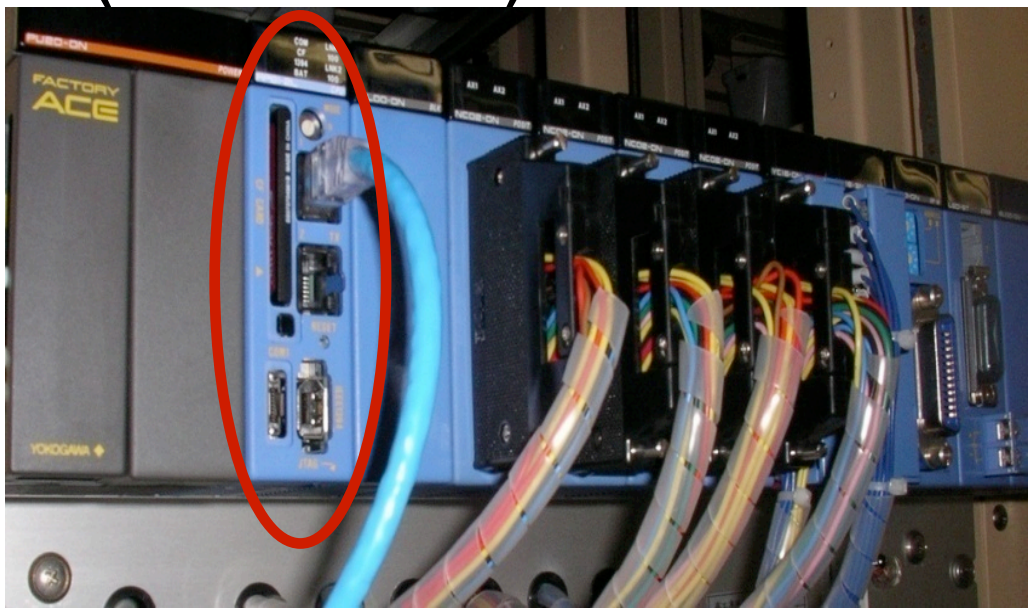
PCI

I/O Bus for FAM3 Module Interface

can access to mature FAM3 I/O Modules

Can be combined with conventional ladder CPU

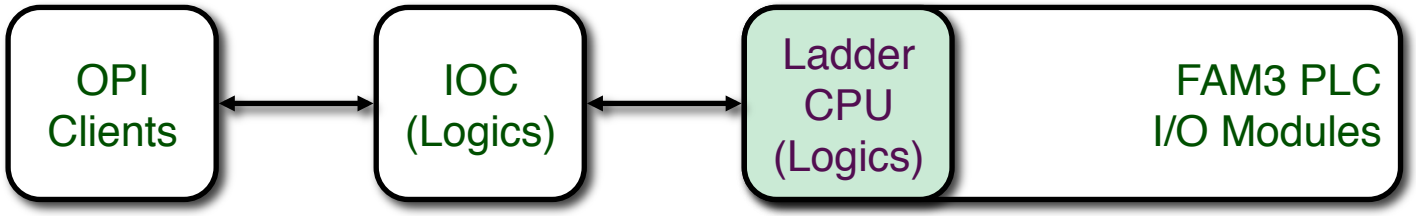
Software development environment (ELDK)



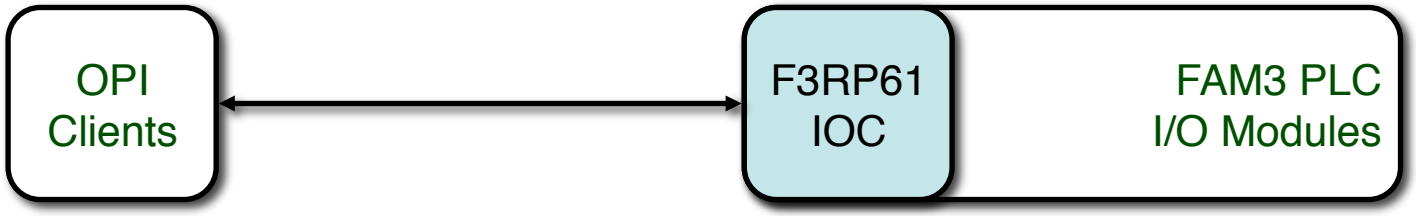
KEKB Beam mask controller

Simple PLC/F3RP61 Usage under EPICS

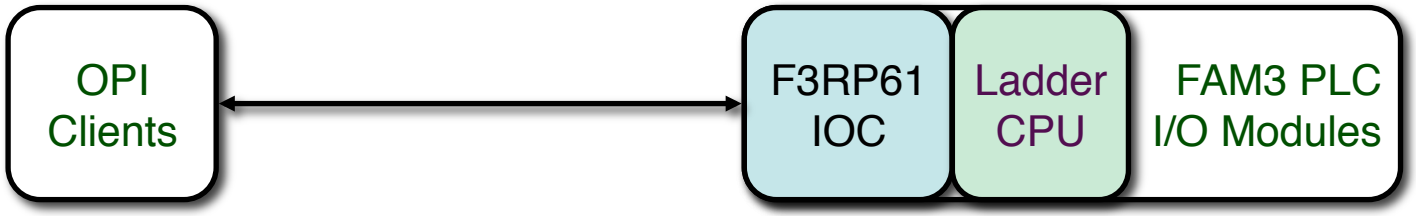
Conventional PLC usage with asynchronous access



PLC usage with F3RP61 with only synchronous access and maybe with sequencer

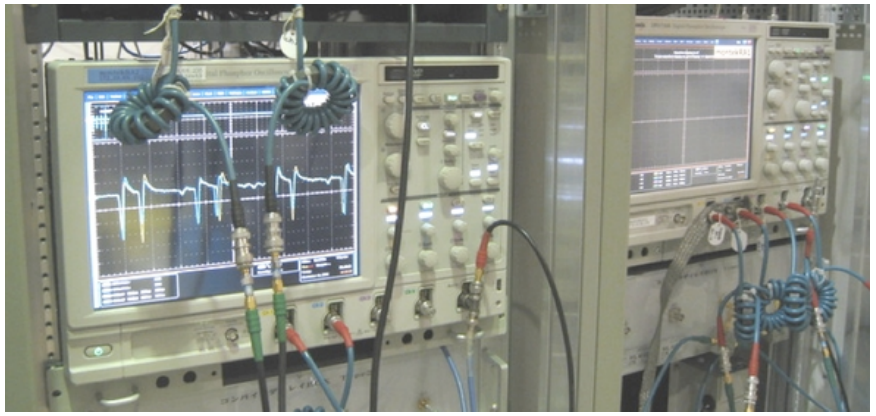


If necessary, we can combine



New Type IOC

- EPICS Embedded Oscilloscope
  - Tektronix DPO7104
  - Windows embedded
  - EPICS R3.14.8.2
  - Applications in KEKB (Current Status)
    - Linac BPM
    - BT BPM



Upgrade of OPI, Networks

- OPI host computers (Central servers)
  - HP-UX servers → Linux servers
  - Linux Blade servers: easy to upgrade
  - Some software still depend on HP-UX server
- Replacement of Network switches (Currently partially installing)
    - Redundant configuration
    - VLAN
    - 10Gbase (future option)
  - Central core switch --- Catalyst 6509E
  - Some edge switches in local control room
  - Additional optical fibers

Replacement of Field buses

- CAMAC
  - At the beginning of KEKB, CAMAC system is good heritage from TRISTAN system.
  - But, currently it become hard to maintain. (>20 years old system)
  - Mainly used in RF control
  - Partially used in Vacuum and BT control

CAMAC (continued)

- Candidate of replacement
  - EPICS embedded PLC (F3RP61)
  - Handling of high density signal cables is a problem
- New LLRF system
  - Embedded EPICS on the new LLRF card (μTCA)

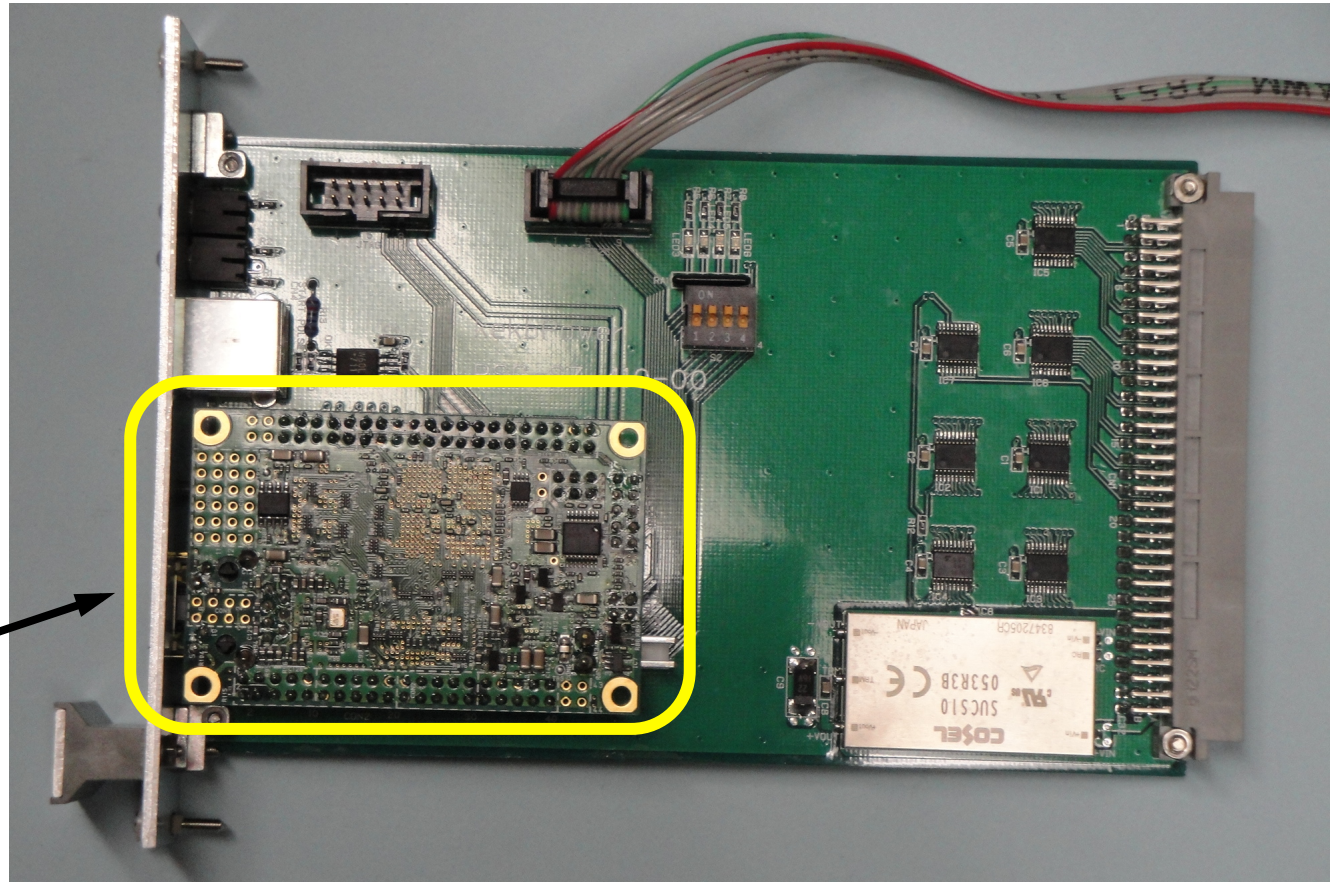
New interface for Magnet PS

- PSICM (Power Supply Interface Controller Module)
  - Interface card plugged in power supply
    - Microprocessor is embedded
    - ARCNET controller and driver
    - Timing signal input to start synchronous ramping
  - New version of PSICM (Design plan) --- “ePSICM”
    - Ethernet (100Mbps) instead of ARCNET
    - High level communication protocol (commands) is compatible
    - Fully compatible to the current version for the Magnet PS

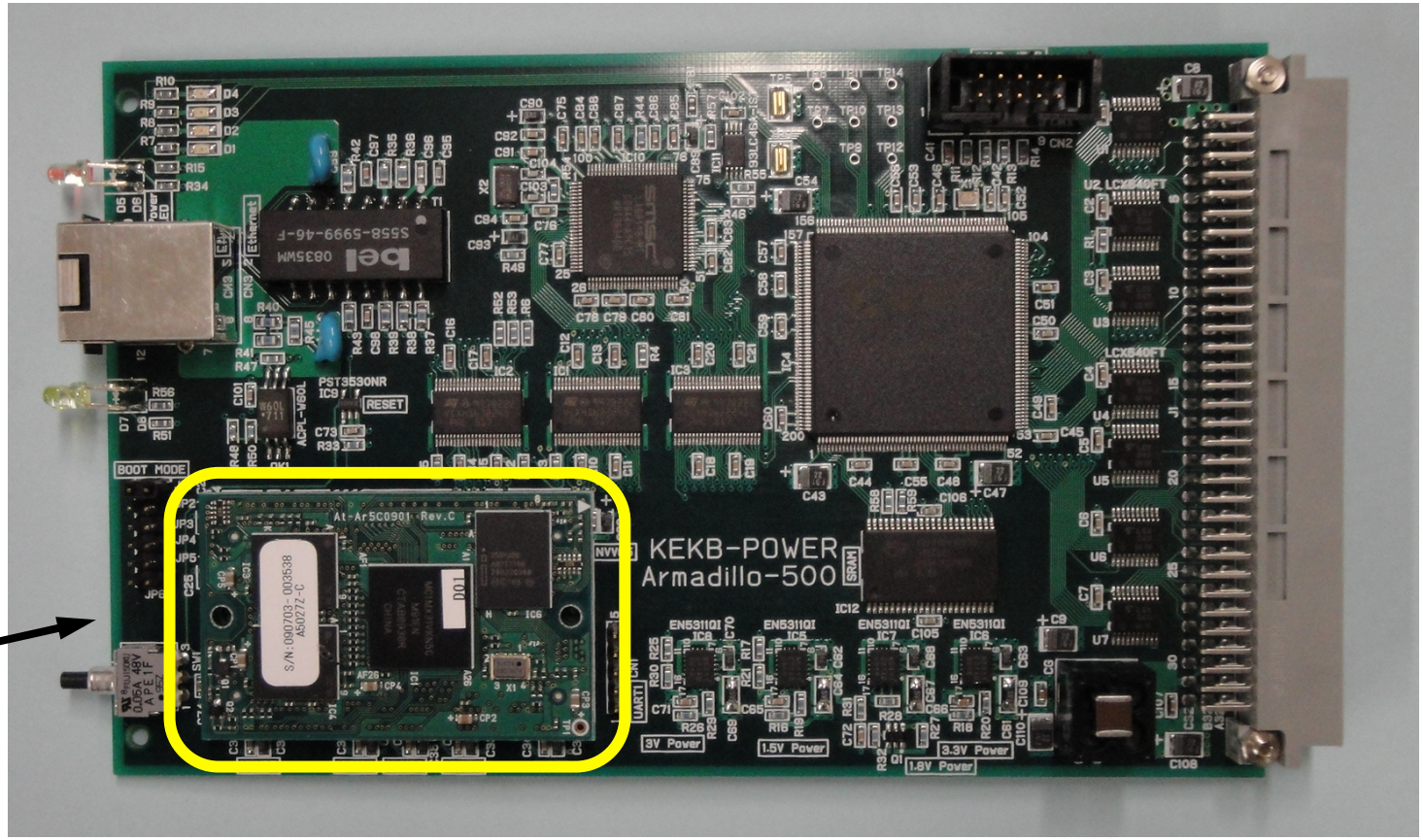
New PSICM (continued)

- Current status --- developing prototype
  - Prototype using Suzaku
    - Suzaku: FPGA(Vertex-4) with CPU(PowerPC405)
  - Prototype using Armadillo
    - Armadillo: CPU(ARM11)
  - Rapid prototyping
    - Linux / EPICS embedded
    - EPICS CA as the low level communication protocol
      - Socket programming is not necessary.

Prototype of the ePSICM using Suzaku



Prototype of the ePSICM using Armadillo



Application programs

- EPICS Standard tools
  - Evaluation of CSS (Control System Studio)
- Scripting Languages
  - Python and SAD Script
- Electric Logbook system --- ZLog
  - Continue development
- Data Archiving system --- KEKBLog
  - Slow retrieval speed → semi-offline data structure conversion is planned.

Task Management

- Task of control group
  - Provide infrastructures and general tools.
- Task of hardware groups
  - Construct the device specific software using EPICS
- Link-person
  - Interface person from the hardware group, who communicates with the control group

Task Management (continued)

- At the construction phase of the KEKB, we had
  - Link-person meeting (regular meeting)
  - Training course of EPICS
- Again we need restarting the same procedure now.

Task Management (continued)

- Man power
  - Limited number of staffs in KEKB control group
  - Persons from companies
    - EPICS training is important.
- Collaboration to share experience
  - In KEK (PF, J-PARC control groups)
  - With companies (Mitsubishi, Yokogawa, etc.)
  - In Japan (RIKEN RI beam factory, etc.)
  - In Asia (China (IHEP, SINAP, Hefei), Korea (PAL, KSTAR), Taiwan (NSRRC), India (RRCAT), etc.)
  - World wide EPICS collaborations

Summary

- Control System for SuperKEKB is basically extension of the current system --- **EPICS**-based system.
- Replacements and/or Version up of the outdated components are necessary. Some of them have started.
  - EPICS R3.13 → R3.14
  - VME CPU
  - CAMAC
  - Server Computers, Network, Applications, …
- New Type of IOC, interface modules, equipments have been developed.
  - F3RP61 --- EPICS embedded PLC
  - EPICS Embedded Oscilloscope
  - ePSICM --- Ethernet-based Power Supply Interface Controller Module
  - EPICS on μTCA card (New LLRF)
- Adequate task sharing between the Control Group and the Hardware Groups is important.
  - Link-person meeting & EPICS Training