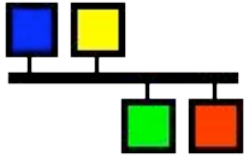


Real-time Performance Improvement of “EPICS on F3RP61”

Yokogawa Electric Corporation



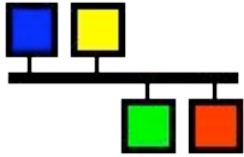
EPICS



EPICS on F3RP61

- EPICS users placed a request for our controller product line “e-RT3” to run Linux
- To transform PLC into IOC
 - To replace ladder programs with EPICS
- For fully EPICS-based front-end control
 - Rapid application development
 - Easier maintenance
 - More detailed and flexible control

EPICS



Features of F3RP61

Pb free
RoHS



Linux and VxWorks available

- Linux kernel 2.6.24.3 model name : **F3RP61**
- VxWorks 6.4 model name : F3RP62

High performance RISC processor

Rich interface

Easy maintenance at the field

A wide Selection of Modules, Multi-CPU

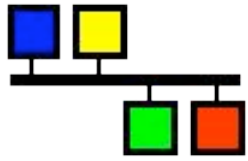
I/O Open partnership

- 32bit 533MHz PowerPC (Over 1000MIPS)
- 128MB RAM, 64MB Flash-ROM, 4MB SRAM
- 29.8(W)x100(H)x83.2(D) mm

Applications in accelerator control

- KEKB
 - Power supply control for pulse Q-magnets
 - Stepping motor control for movable masks
- J-PARC
 - Power supply control
 - Electrostatic and magnetic septa of the slow extraction line
 - Stepping motor control
 - Electrostatic and magnetic septa of the slow extraction line
 - Data acquisition from beam monitors
 - Beam loss monitors
 - Fast current transformer
 - Interlock status monitor
 - The fast extraction line and the slow extraction line
- RIKEN
 - RIBF
 - 28GHz superconductivity ECR ion source control
- Other domestic and foreign institutes are also adopting “EPICS on F3RP61”

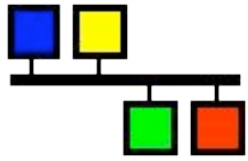
EPICS



Stability and Real-time Performance

- Standard kernel 2.6.24.3-based
 - Minimum modification
 - More than one year of on-site experiences has proven the stability
- CONFIG_PREEMPT enabled
 - Good soft real-time responsiveness
 - Can meet the need for most of the control applications

EPICS

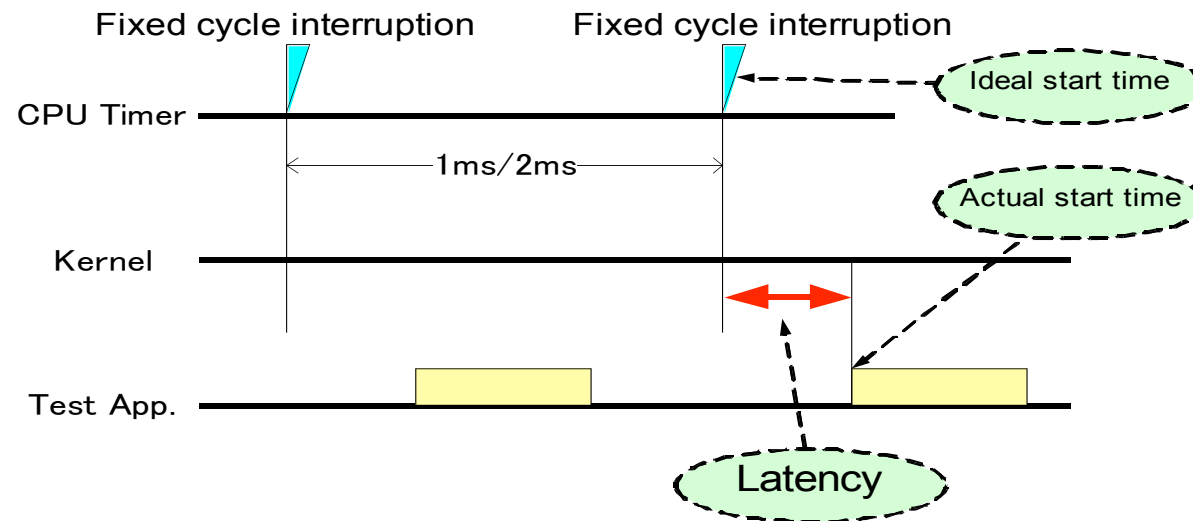


Further Enhancement PREEMPT_RT

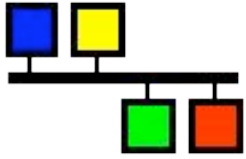
- PREEMPT_RT is basic improvement of the real-time performance enhancement following Kernel2.6
 - Developed by OSADL Project
 - All improvement is given the Kernel inside
 - Main improvements
 - Increase Pre-emption points
 - A large part of interrupt procedure is processing in a thread
 - Replace of Spinlock by Semaphore

Performance measurement

- Measurement latency distribution of application start of fixed cycle.
 - 16 words IO access in the fixed-cycle application
 - Add load by hackbench
 - The hackbench create many process. Created process are switched by scheduler and communicate each other.



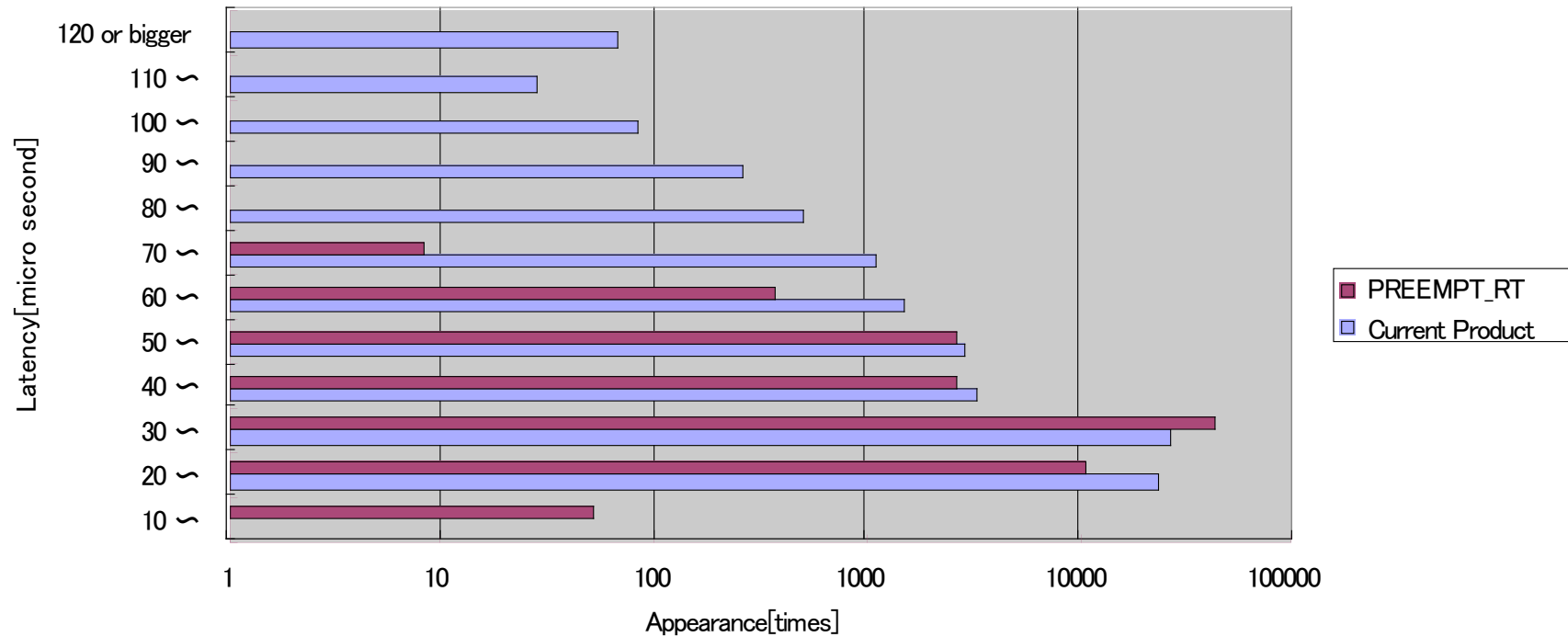
EPICS



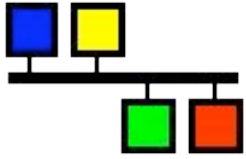
Measured Performance

	Current Product (Kernel2.6)	PREEMPT_RT
Max. Latency	1,065 μ s	92 μ s

Table for Latency frequency distribution of application start of fixed cycle with I/O process(load : hackbench)

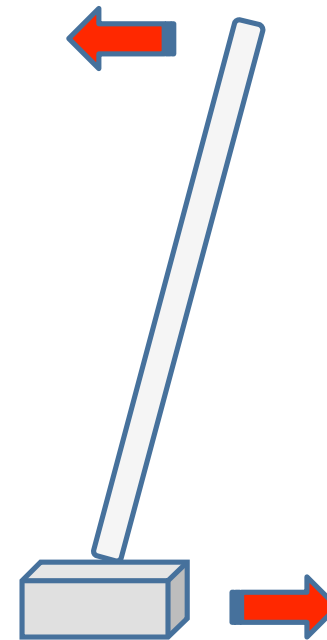


EPICS

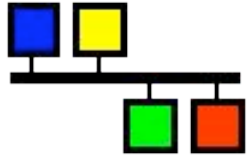


Demonstration Video

- Inversed pendulum controlled by EPICS on F3RP61
 - A metal bar on a movable cart
 - Monitor input
 - Angle of the pendulum
 - Position of the cart
 - Control output
 - Velocity of the cart
- Using an EPICS special record
 - Developed by Dr. N. Yamamoto (KEK)
 - To calculate the feedback output
 - Being processed at “0.1 second”



EPICS



Conclusions

- A new type of IOC was realized on F3RP61
- Widely adopted in EPICS-based accelerator control for various purposes
- Significantly improved real-time performance with PREEMPT_RT patch
 - To Extend the range of applications
- We do need feedback from EPICS users for further improvement of our products