

# Management Tools for Distributed Control System in KSTAR

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The integrated control system of the Korea Superconducting Tokamak Advanced Research (KSTAR) has been developed with distributed control systems based on Experimental Physics and Industrial Control System (EPICS) middleware. It has the essential role of remote operation and supervising of tokamak device and conducting of plasma experiment without any interruption. Therefore, the availability of the control system affects directly on the entire device performance. For the non-interrupted KSTAR experiment it was developed a tool named as Control System Monitoring (CSM) to monitor the resources of EPICS Input/Output Controller (IOC) servers (utilization of memory, cpu, disk, network, user-defined process and system-defined process), the soundness of storage system

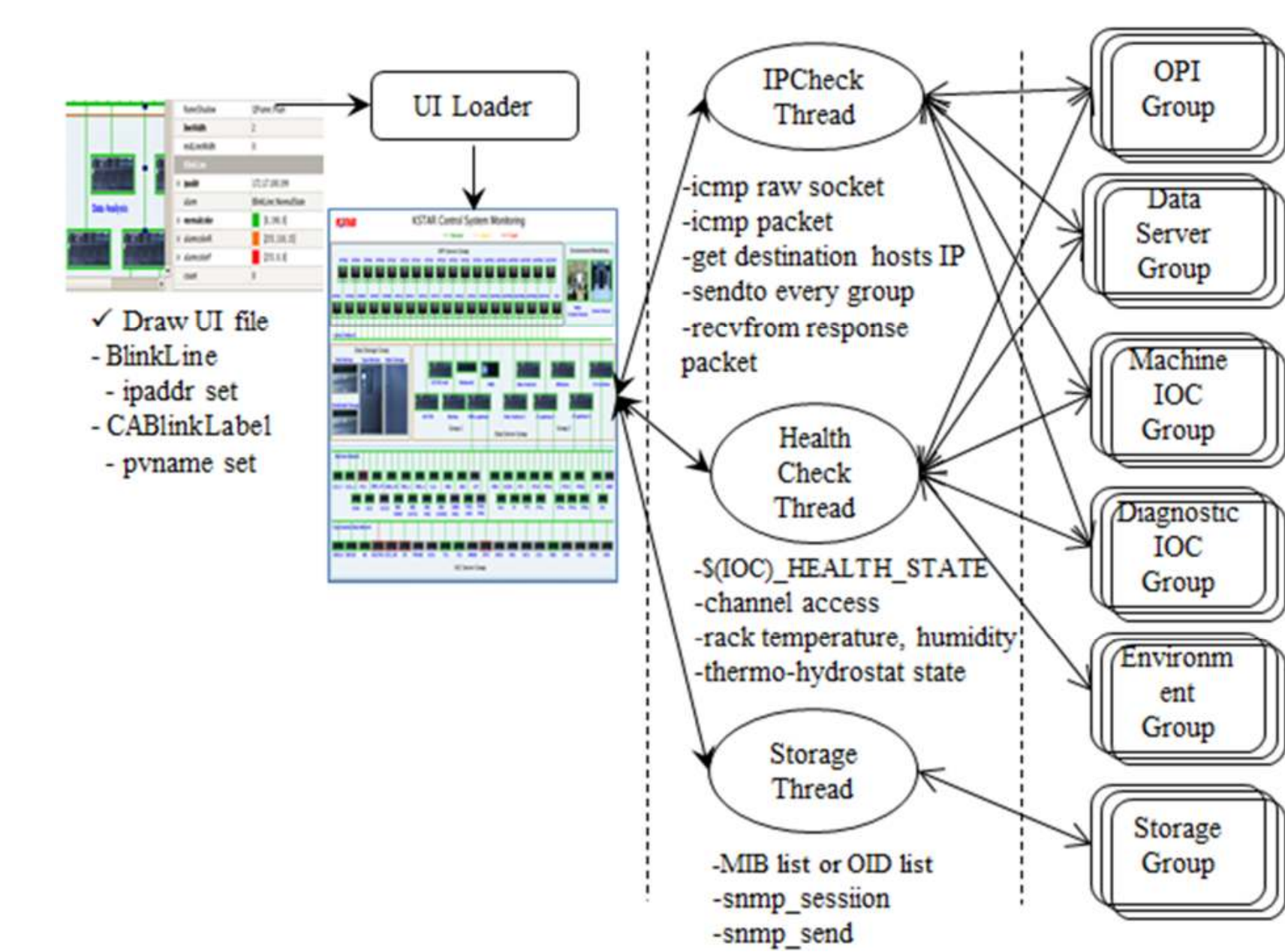
(storage utilization, storage status), the status of network switches using Simple Network Management Protocol (SNMP), the network connection status of every local control sever using Internet Control Message Protocol (ICMP), and the operation environment of the main control room and the computer room (temperature, humidity, electricity) in real time. When abnormal conditions or faults are detected by the CSM, it alerts abnormal or fault alarms to operators. If the critical fault relating to data storage should be happen among the faults, the CSM sends the related simple messages to operator's mobile phone. Other tools to manage the integrated control system for KSTAR operation in addition to the CSM will be introduced.

## Management Tools for Distributed Environment

- Control System Monitoring (CSM)
- Version Control System using Subversion
- Virtualization for Flexible IT Infrastructure

## Control System Monitoring (CSM)

- Monitoring Components : Server Resources and Network Status
  - OPI Server Group (25 OPIs, 10 Addon OPIs)
  - Data Server Group (3 Gateways, MDS+, CHArchiver, Data Analysis, Backup, Standby, Web, RDB)
  - Plant System IOC Group (37 IOCs, Linux/ VxWorks/ Windows)
  - Diagnostic System IOC Group (21 IOCs, Linux/Windows)
  - Storage Group (Main Storage, Backup, Tape Library)
  - Environment Monitoring (Each Rack Temperature, Thermo-hydrostat, HPC Water-leak)

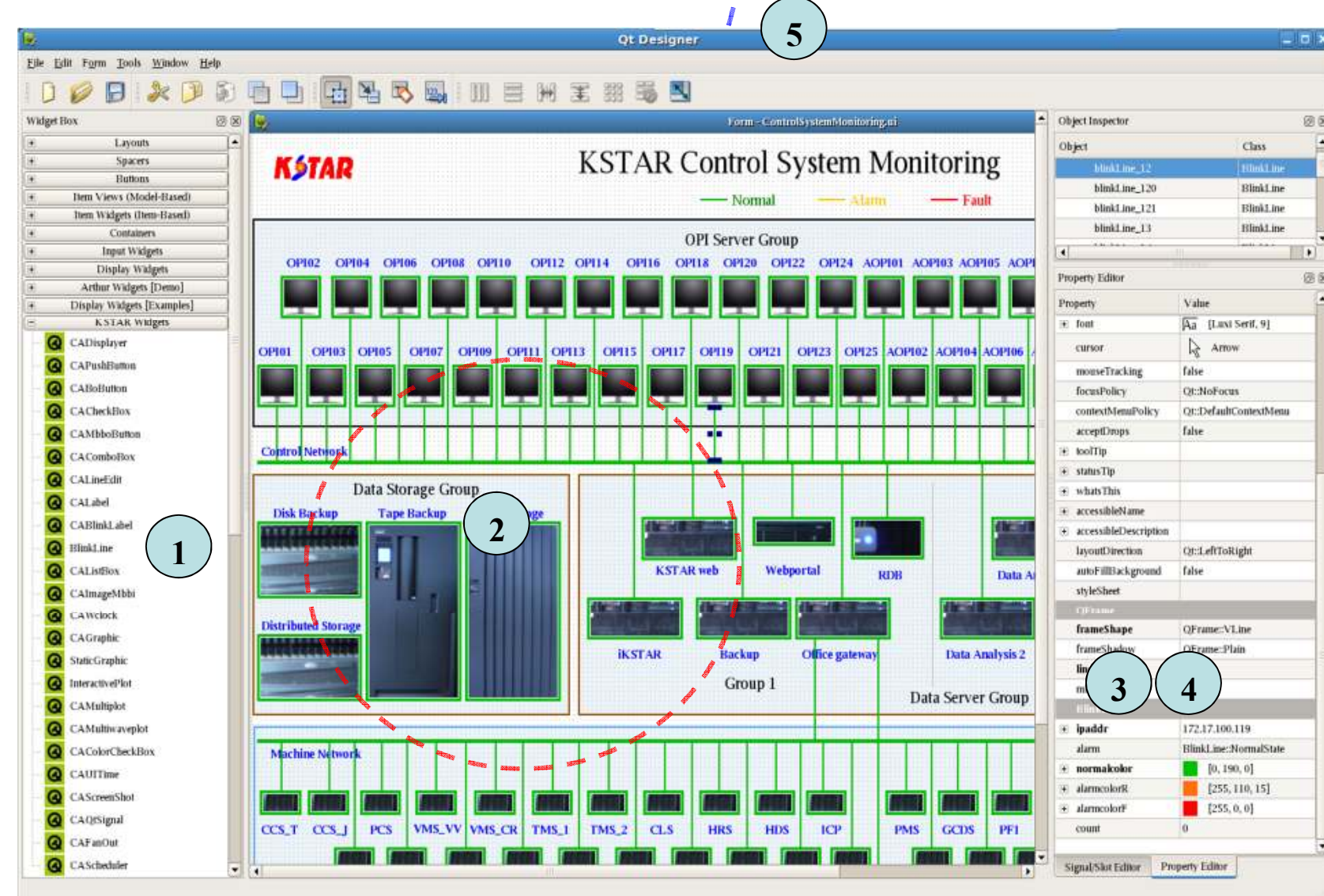


## Two Widgets for CSM among KSTAR Widgets

- BlinkLine Widget: ICMP(Internet Control Message Protocol)
  - Alarm Condition:
    - Red Blinking: Time out for ICMP response packet
    - Green: Normal, ICMP response packet
- CABlinkLabel Widget: \$(IOC)\_HEALTH\_STATE and SNMP (Simple Network Management Protocol) for Storage/Switch Monitoring
  - Alarm Condition:
    - Yellow Blinking: High alarm for the resource problem of the IOC server
    - Red Blinking: High High alarm for the fault of the IOC server
    - Green: Normal state for the IOC server

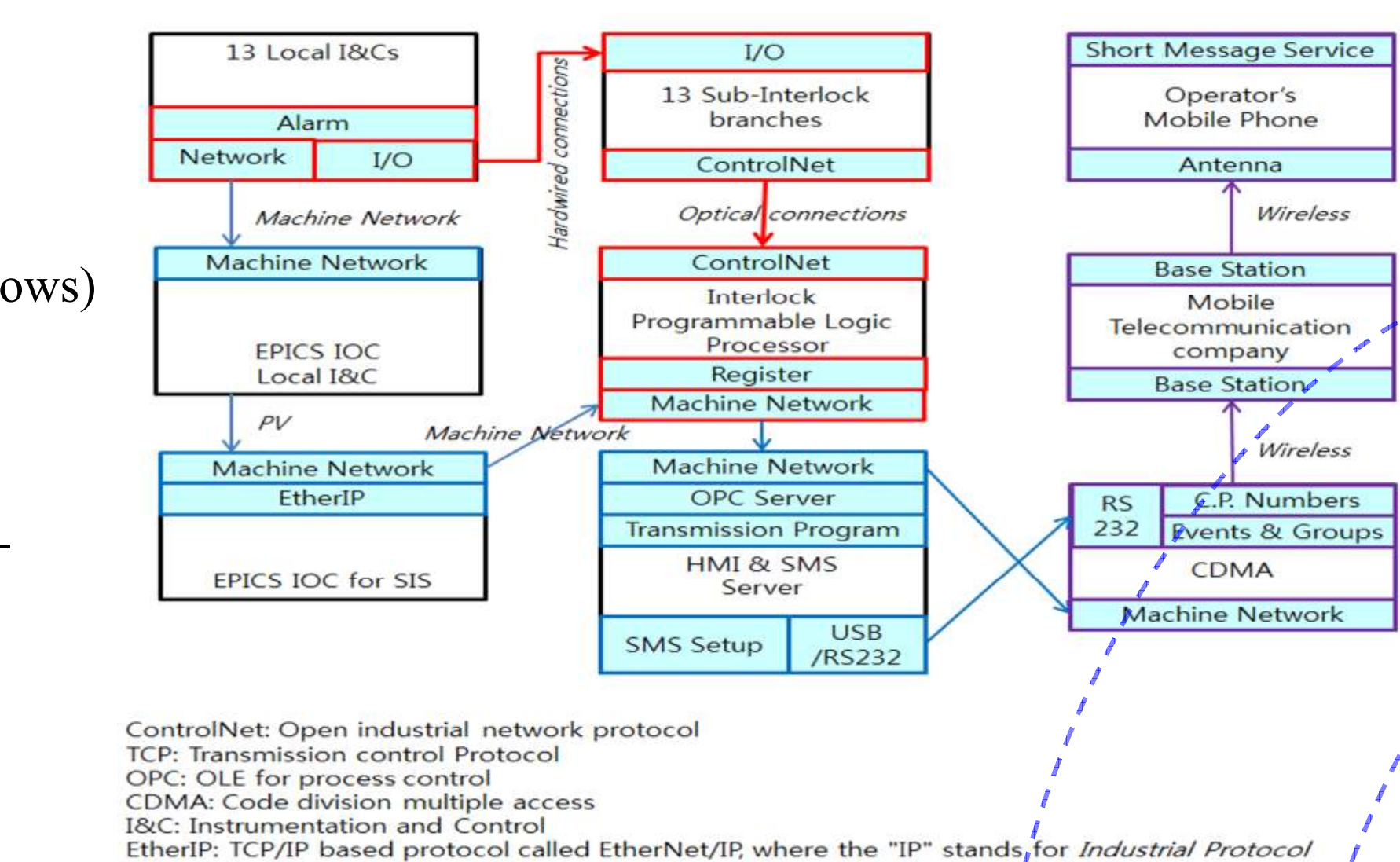
## Making CSM program with KWT

- CSM UI file designs using Qt designer with KWT
- Layout widgets(BlinkLine and CABlinkLabel) for CSM
- Fill out IP address to "ipaddr" property in the "BlinkLine" widget
- Fill out EPICS process variable to "pvname" property in the "CABlinkLabel" widget
- Loading the UI file Using Automation Engine

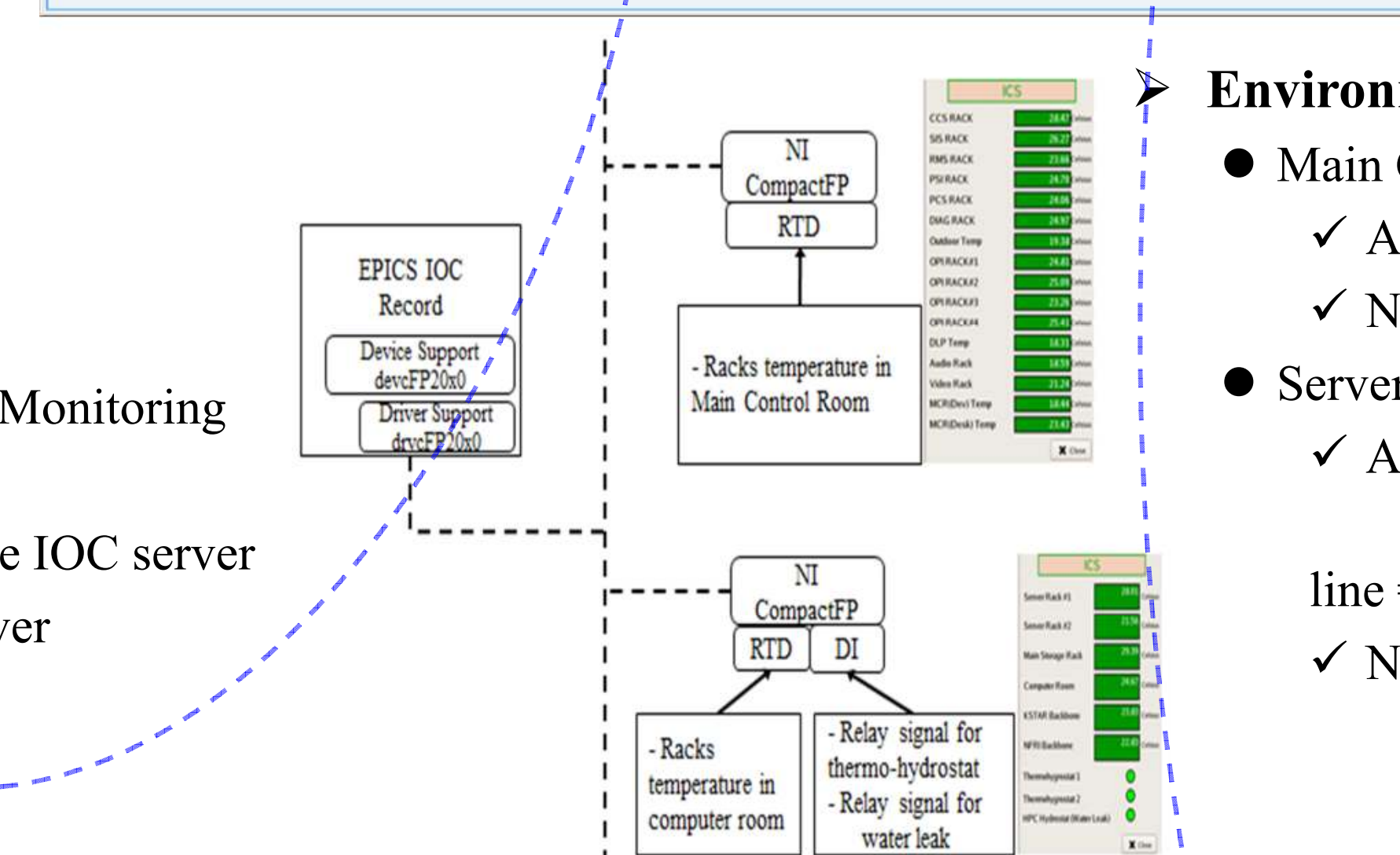
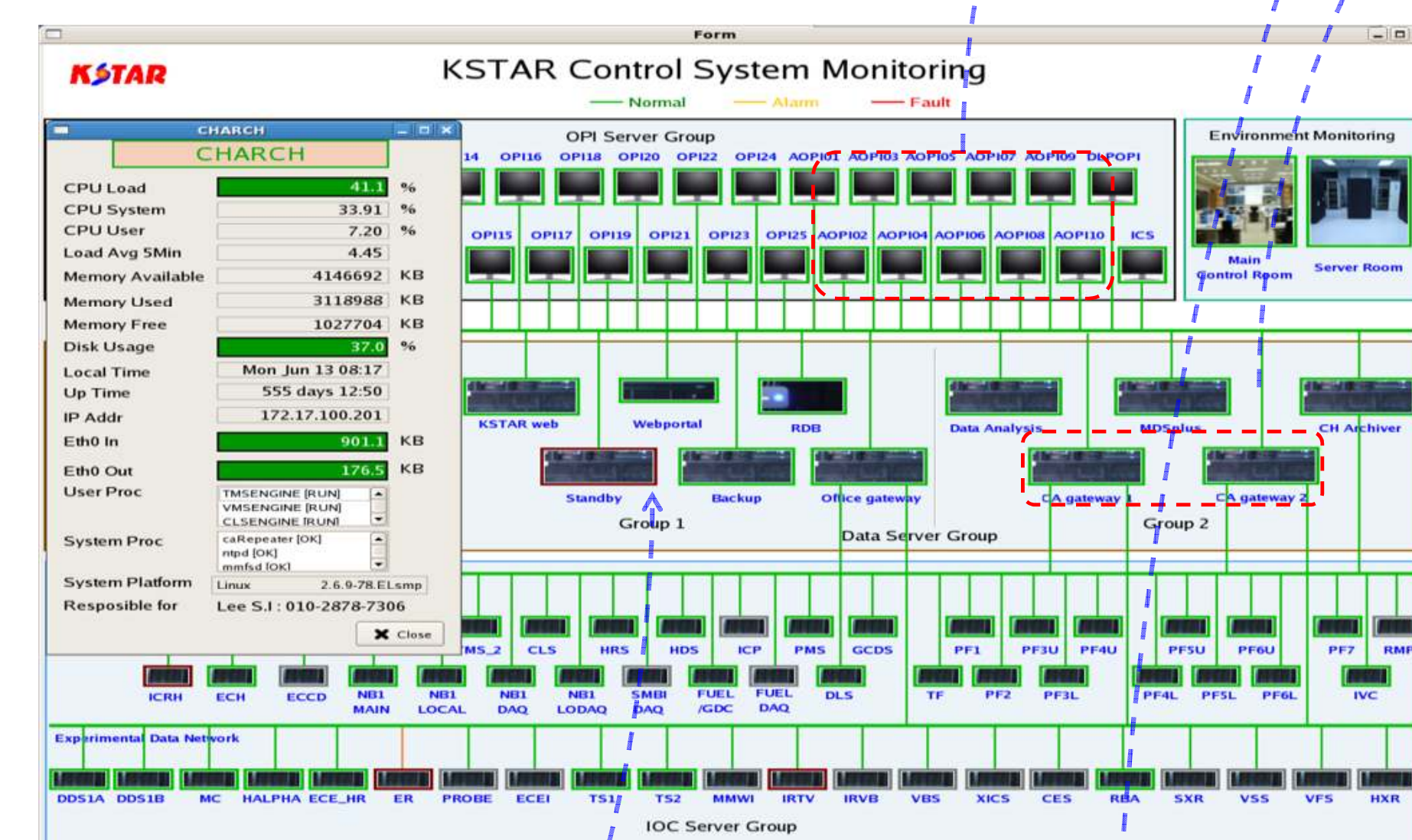


## Short Message Service System (SMS)

- 16 Groups, 64 Messages, 64 Operators
  - Messages Service in Groups
  - Prioritized Messages
- Automation of Sending Alarm/Fault Messages to Operators' Mobile
- Communication with Supervisory Interlock System
  - 13 Hardwired Local I&C and Utilities
  - EPICS Bitwise SoftPV (11 Data Servers)
  - User-defined Messages
- RS 232 Communication with CDMA Device



## Control System Monitoring



## Conclusions

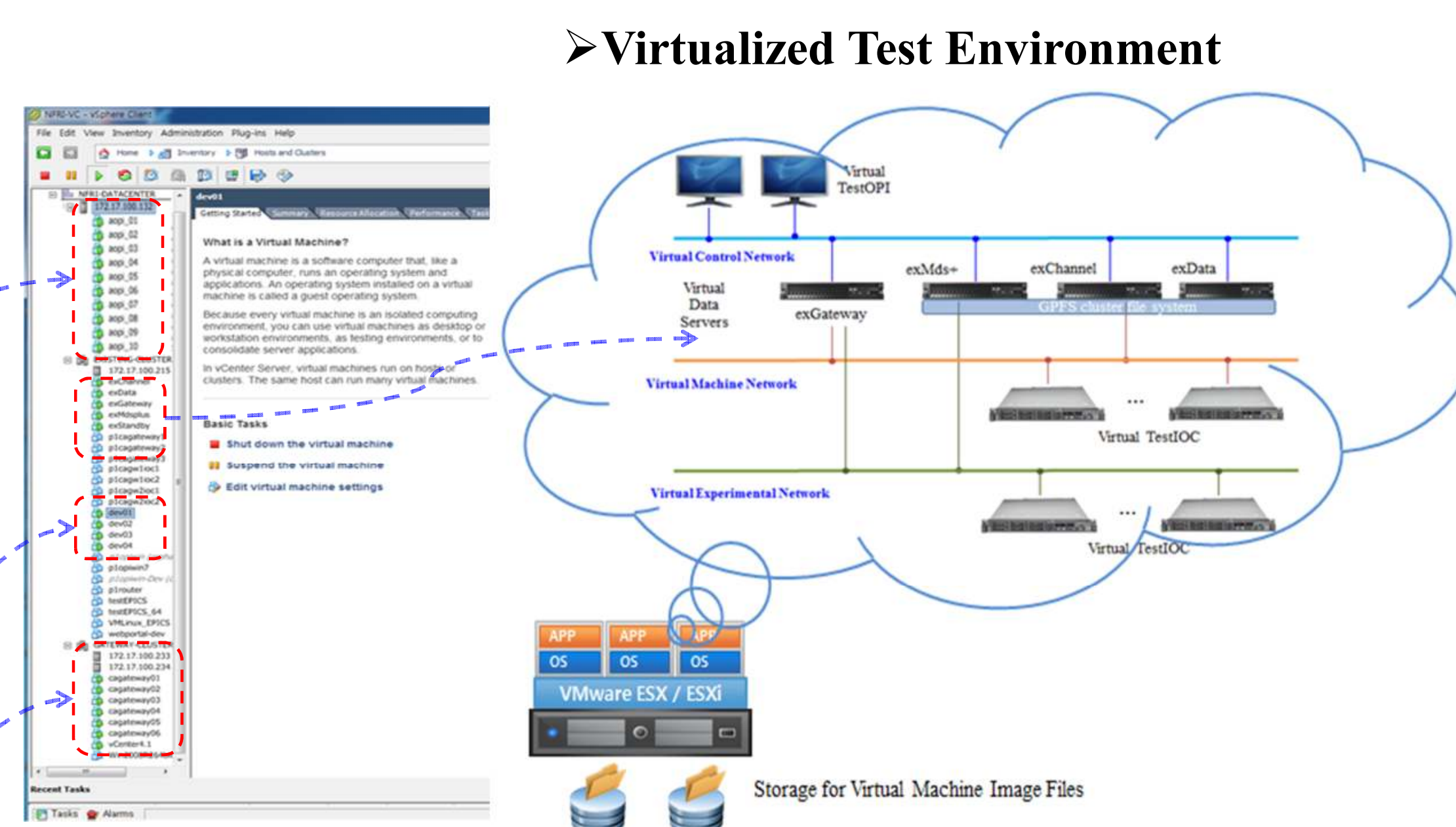
- Non-interruptible Operation and Experiment
- Finding and Debugging Defective or Incomplete Systems
- Finding Bottleneck Point (Network or Server)
- In the future, Background Data of Load Balancing System
- System Status Overview for All IT Resources
- Reliable Software Management through Version Control Tool, Subversion
- Rapid and Cost Effective IT Environment Construction using Virtualization
- Increase for Reliability for Distributed Control System

## Future Works

- Cluster Server System for Non-interruptible Service
- Fault Tolerant Server System (Hardware and Software)
- Automatic Dynamic Channel Access Connection for Gateway Pool Using Virtualization Technology
- Load Balancing System

## Virtualization for Flexible IT Infrastructure

- VMWare (ESX / ESXi)
- Virtualization of OPI Servers for Remote Experiment Participants (10 Remote OPI Servers, ESXi)
- Virtualized Servers for Software Testing Simulated for Real Distributed Environment (ESXi)
- Virtualized Development Servers (ESXi)
- Operation of Virtualized Gateway Servers for EPICS Channel Access : CA gateway redundant / vMotion, ESX



## Virtualized Test Environment

## IOC Health Status: \$(IOC)\_HEALTH\_STATE

- Alarm:
  - CPU Load  $\geq 85\%$  or
  - Disk Usage  $\geq 95\%$  or
  - Ethernet Packet  $\geq 20\text{MBytes}$  or
  - User-defined System Process bit count  $\geq 1$
- Normal:
  - CPU Load  $< 85\%$  and
  - Disk Usage  $< 95\%$  and
  - Ethernet Packet  $< 20\text{MBytes}$  and
  - User-defined System Process bit count  $= 0$

## Environment Alarm Conditions: NI DAQ modules (cFP-2120, cFP-RTD-124, cFP-DI-304)

- Main Control Room : ICS\_CTRLROOM\_TEMP
  - Alarm: 1 Rack temperature of 16 racks' temp  $\geq 32$  degree
  - Normal: Every rack temp  $< 29$  degree
- Server Room : ICS\_SVRROOM
  - Alarm: 1 Rack temperature of 6 racks' temp  $\geq 32$  degree or 1 Thermo-hydrostat of two thermo-hydrostats == alarm or Water leak for HPC cooling line == alarm
  - Normal: 1 Rack temperature of 6 racks' temp  $< 29$  degree and 1 Thermo-hydrostat of two thermo-hydrostats == normal and Water leak for HPC cooling line == normal

## Version Control System using Subversion

- Deploy Developed Software (Execution File or Object Library File)
- Development Source Code Control for Distributed Environment
- Switching from CVS to Subversion as a Version Control Tool

