# NIF Device Health Monitoring

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⤷ Abstract

The Integrated Computer Control System (ICCS) at the National Ignition Facility (NIF) uses Front-End Processors (FEP) controlling over 60,000 devices. Often device faults are not discovered until a device is needed during a shot, creating run-time errors that delay the laser shot. This paper discusses a new ICCS framework feature for FEPs to monitor devices and report its overall health, allowing for problem devices to be identified before they are needed. Each FEP has different devices and a unique definition of healthy. The ICCS software uses an object oriented approach using polymorphism so FEPs can determine their health status and report it in a consistent way. This generic approach provides consistent GUI indication and the display of detailed information of device problems. It allows for operators to be informed quickly of faults and provides them with the information necessary to pin point and resolve issues. Operators now know before starting a shot if the control system is ready, thereby reducing time and material lost due to a failure and improving overall control system reliability and availability.
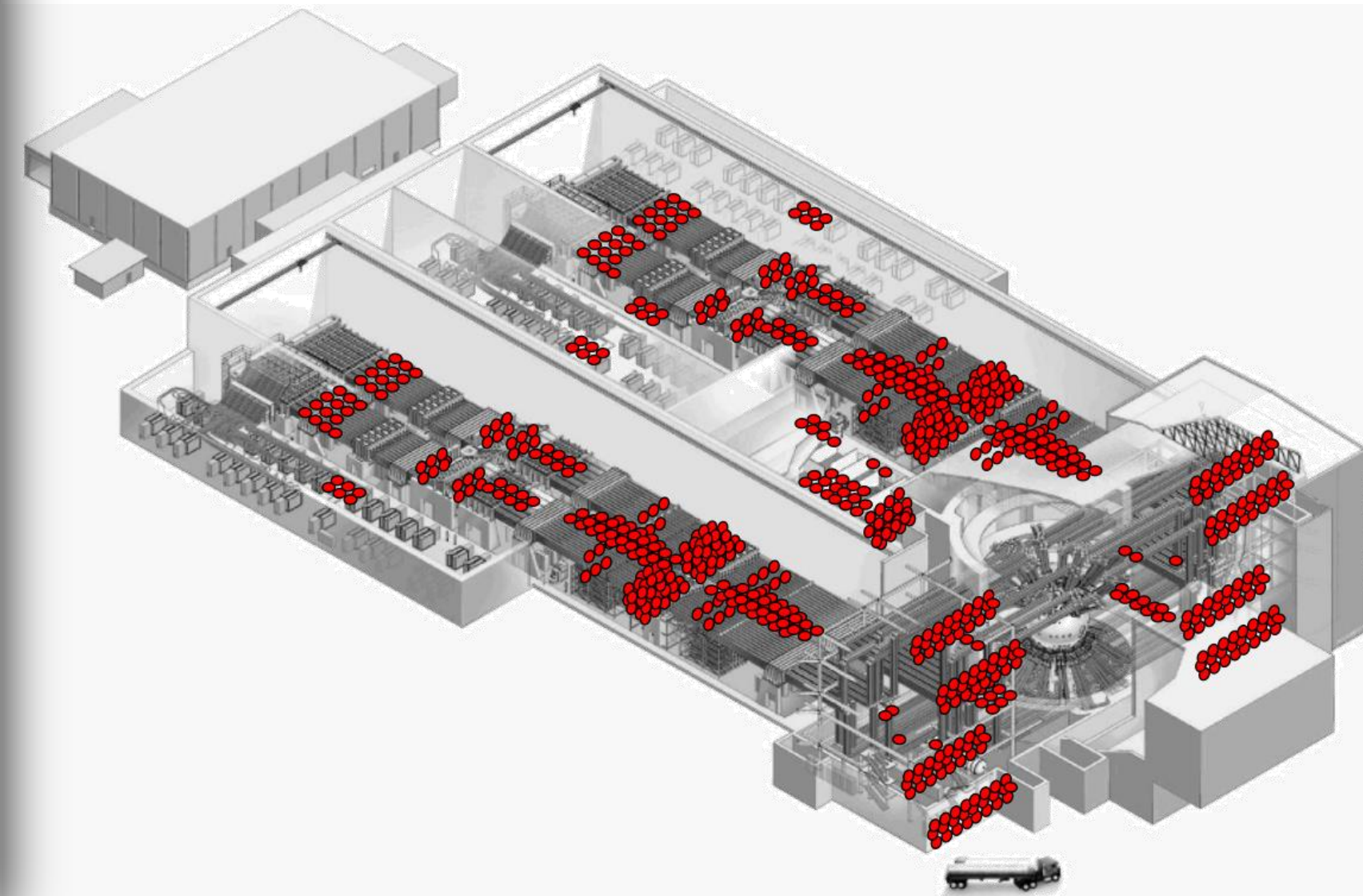
The Need for More Timely Problem Notification

Problem: Hardware Faults Go Undetected
- Most device hardware is not actively monitored, so faults are only detected when an attempt is made to use a device
- Resolving the fault is then on the critical path; troubleshooting results in shot cycle delays

Problem: Display of Fault Information is Not Centralized
- Device health is displayed only on specific GUI panels
- Device problems that occur after process startup are not reflected in the process' state

Solution: NIF Device Health Monitoring Framework
- Added monitoring of remote embedded Ethernet networked system used by FEPs
- Provided the framework for ICCS FEP processes to report and display failures with devices they control
- Added new process state 'Unhealthy' and tied FEP process state to the health of the devices it controls
- Centralized GUI display of 'Unhealthy' FEP processes
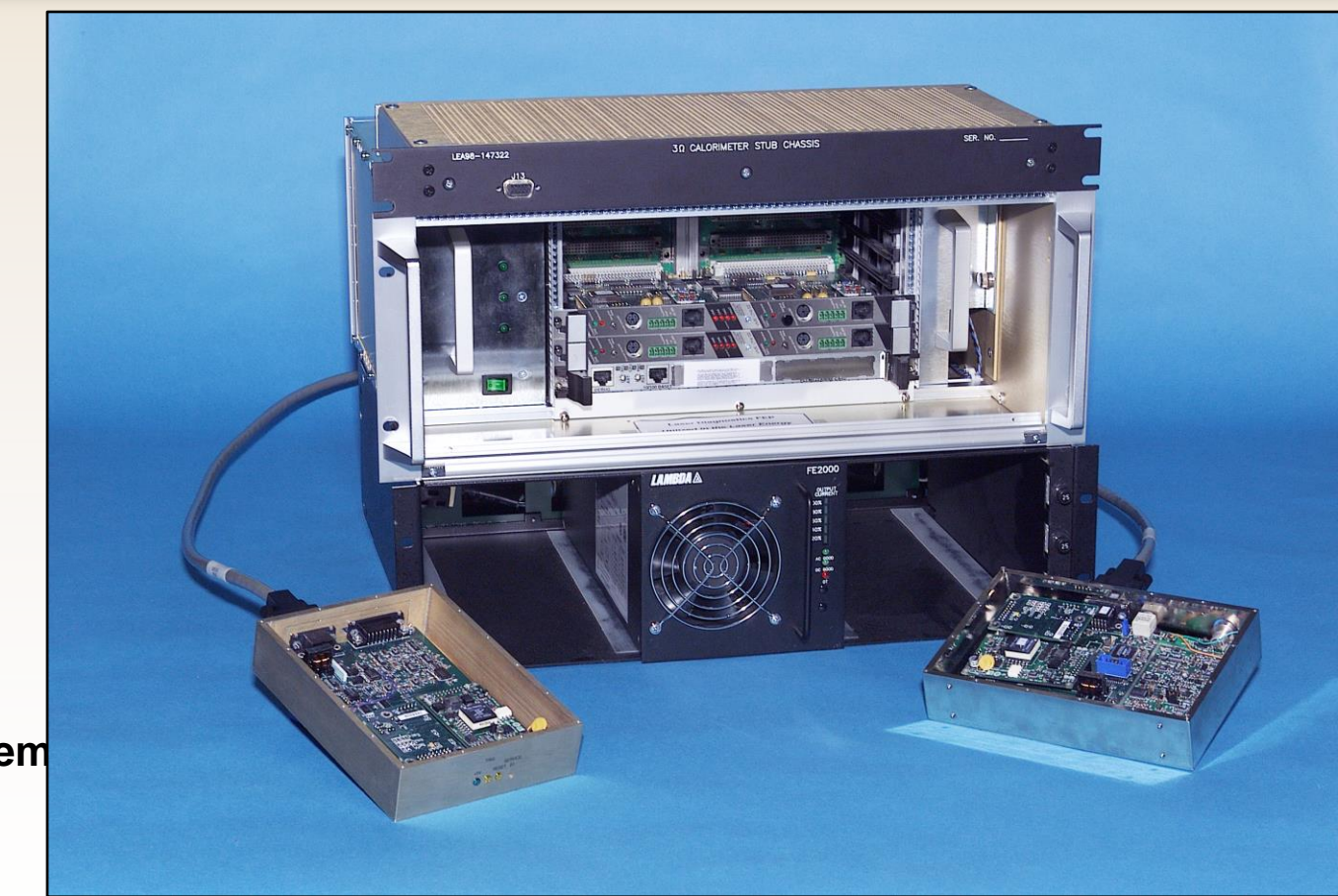
One of Two of NIF's Laser Bays

System Manager GUI

Extend Existing Process Display
- Operators already look to the System Manager GUI for process state information
- The new Unhealthy State is displayed in an off-red color, quickly indicating a problem
- Existence of Unhealthy processes can be readily seen on bar graph
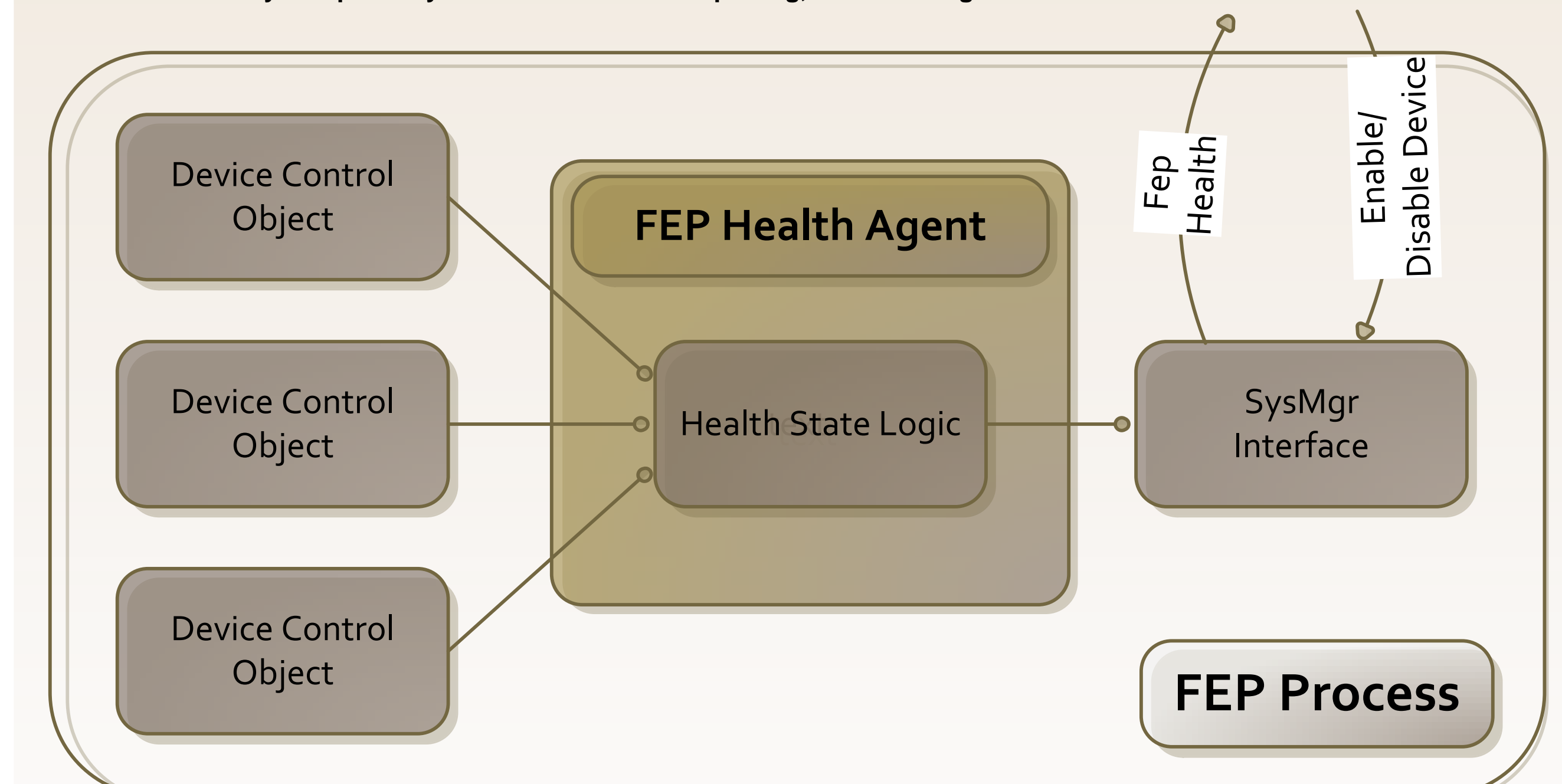- Right-clicking on Unhealthy process on tree list drills down to show details on all devices in the process
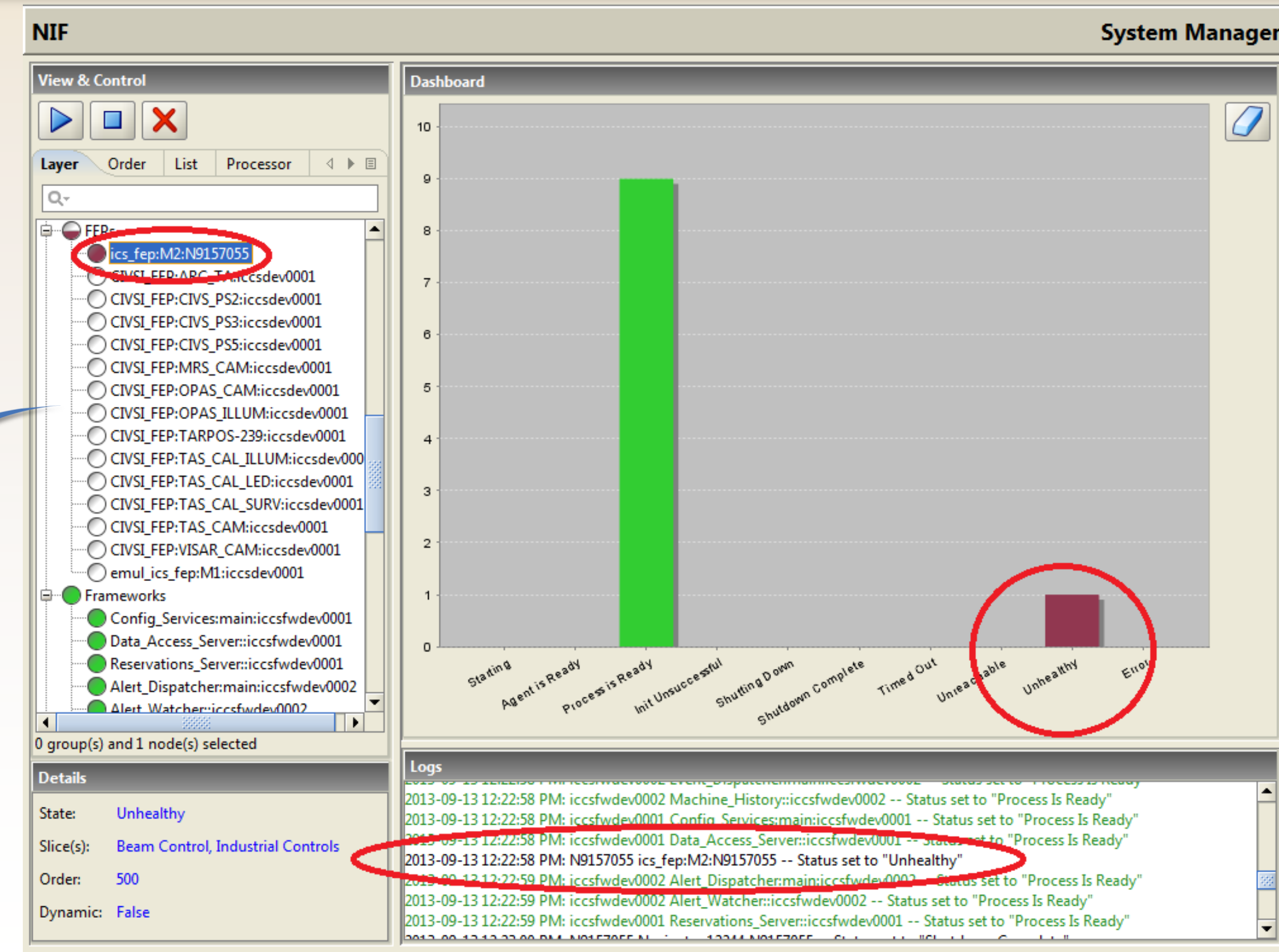
NIF's Centralized Control Room has 14 Operators

Health Monitoring Framework

Front-End Processor (FEP) Health Agent
- Provides a standardized way to report FEP health to the System Manager GUI
- Health Agent is a singleton object instantiated in each FEP process
- Agent aggregates device states and reports changes to the System Manager
- Devices may be optionally omitted from health reporting, useful during maintenance

Determining FEP Health State
- FEP Health Agent subscribes to device state updates
- Health state logic evaluated when a device changes state
- Default logic declares FEP Unhealthy if any device is faulted
- FEP developers can easily override the default logic if needed
- FEP health state change reported as quickly as device classes can detect problems with the hardware, eliminating delays
- Device fault state event contains detailed run-time information used by operators to help diagnose root cause

Drilling Deeper to get Device Fault Details

FEP Device Informational Dialog
- Pop-up dialog launched by right-clicking on process in System Manager GUI
- Status of all devices in the process are displayed
- Selecting a device displays details published when the state change was reported
- Device fault detection in the FEP provides run-time details that aid in problem diagnosis and repair

Active Notification

How to alert operators when they are not looking at the System Manager GUI?
- System Manager GUI may be covered by other windows
- When a process goes into an Unhealthy state, a popup window is displayed with information on the process
- Popup window stays visible on top of all other windows
- Immediately alerts operators of problems regardless of which screen they are using

Future Plans

What's Next?
- Utilizing FEP Health Monitoring Framework
  - FEP developers are beginning to add monitoring to device classes to detect and report faults
  - Next phase will focus on remote and networked devices
- Extending fault detection beyond FEPs
  - Continuous effort to detect problems across all parts of the ICCS system
  - Database monitoring
  - Processor resource monitoring (CPU, memory usage, network bandwidth, etc.)

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