Nuclear Automation

Distributed Control Systems Simulator Solutions

Background

Different methodologies are employed for the simulation of the distributed control systems (DCS), including stimulation, emulation and functional simulation. Westinghouse's design utilizes combinations of these for the safety and non-safety DCS systems. Depending on the training need, the system's human-system interface (HSI) is either stimulated or emulated, and similarly, the controller functions are emulated or virtually-stimulated, with peripheral subsystems functionally simulated. Selected combinations of designs can be integrated into full-scope training simulators with a control room environment or classroom environment. The simulators can be used for both operator and engineering training, for testing, as a live-test facility, and to improve outage performance by closed-loop testing prior to installation.

Description

Main Control Room Training Simulator

Both the non-safety (Ovation®- based) and the safety (Common Q™-based) systems are of a hybrid design. For the non-safety system, the HSI is stimulated and controller functions are emulated. The HSI stimulation consists of hardware and software essentially identical to the corresponding elements of the base system, with the following exceptions:

- The simulator hardware is non-redundant and non-isolated
- The simulator hardware is cost- and size-reduced via repackaging in commercial-grade enclosures

It also includes simulator-specific functions in addition to the base functions of each of the standard drops in the system. The master simulator SimStation is a workstation drop that allows the interface between the stimulated Ovation equipment and the plant-model computer. The controller functions are emulated with tool-generated codes that execute under the supervision of the simulation executive in the plant model computer.

For the safety system, the HSI (Westinghouse Flat Panel Display System) is stimulated with equipment identical to the plant equipment, and the processor module functions are emulated with tool-generated codes executing under the supervision of the simulation executive in the plant model computer. The HSI directly interfaces with the plant model computer via a TCP/IP interface on the simulation run-time network.

Classroom/Development Simulator

For the nonsafety system, both the HSI and the controller functions are emulated. The emulated HSI provides a means of executing the Ovation operator workstation functions without an Ovation environment, and the tool-generated controller emulation codes execute under the supervision of the simulation executive on the plant model computer. On the safety-system side, the processor module functions are emulated and the HSI is stimulated. However, the stimulation of the HSI is performed with virtual machines that are hosted by the same plant model computer. All the emulation codes are generated automatically with migration tools that use input data directly from the plant, achieving highest fidelity.

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March 2012 NA-0027

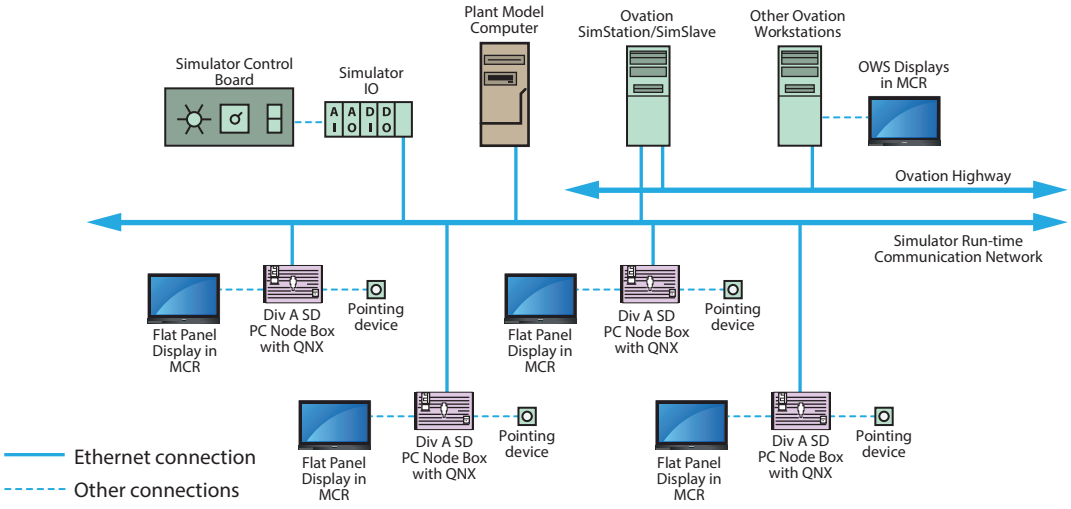
Benefits

Depending on the selected hybrid design combinations, the benefits can include some of the following:

- Provides design flexibility for control room simulators and classroom/development simulators
- Reduces the software effort required to simulate the instrumentation and control (I&C) systems
- Controls maintenance costs associated with simulator upgrades
- Minimizes the software upgrade cost
- Provides high-fidelity simulation by reusing actual system components and software
- Provides software reusability
- Easily clone emulated codes or virtual machine stimulation
- Can execute combinations of emulated and virtual machine solutions on a single box (plant model computer)
- Provides I&C time response consistent with the plant
- Allows the simulator to be used for functional upgrade verification, control tuning and operator training prior to introduction into the plant
- Provides many benefits associated with its dual role as an engineering tool during initial project implementation
- Allows open- or closed-loop testing of actual control/information system software, independent of the target hardware
- Decouples hardware and software during production, allowing the two to proceed in parallel
- Allows engineering test and vertical integration of software in a true system environment without incurring the cost and schedule impact of hardware signal injectors and input/output (I/O) gear attached to production equipment
- Does not include software and hardware interfaces to physical plant I/O (these interfaces are provided via the communications interface between the SimStation workstation and the plant model computer)
- Allows application software of the stimulated equipment to be largely re-used from the system application, saving time and cost by application testing once for both the plant and simulator systems

Experience

Westinghouse has delivered more than 20 simulator DCS systems with designs of different hybrid combinations on all major simulation platforms.



Typical main control room simulator DCS architecture

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