A COMPUTING ENVIRONMENT INTEGRATING DIAGNOSTICS AND CONTROL FOR REACTOR SYSTEMS

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This paper describes the Plant Computing Environment (PCE), a distributed computing environment supporting a high-level supervisory control and monitoring system. The goal is to coordinate plant fault detection, performance monitoring, and control system settings, so that the plant continues to meet performance specifications as plant conditions change. The study is aimed at future nuclear reactor systems.

The PCE is a communication and information service for the applications it supports. In this study those applications are (see Figure 1):

- Plant performance monitor [1]. This application evaluates the plant current status with respect to its ability to meet performance requirements. It uses current plant status information and a detailed plant model to evaluate changes in plant status, such as equipment failures.
- Fault detection and isolation monitor [2]. This application uses plant signals to detect that a fault exists and determine where the fault has occurred. Its diagnosis is passed to the performance monitor.
- Plant design information database. This database contains plant design information used by the system. It effectively assigns meaning to the data exchanged by the modules within the system (a common vocabulary).
- Operator interfaces. The Picasso display system [3] provides operator interfaces through an interface to the PCE or, alternatively, direct interfaces to an application using Picasso's built-in distributed applications functions.

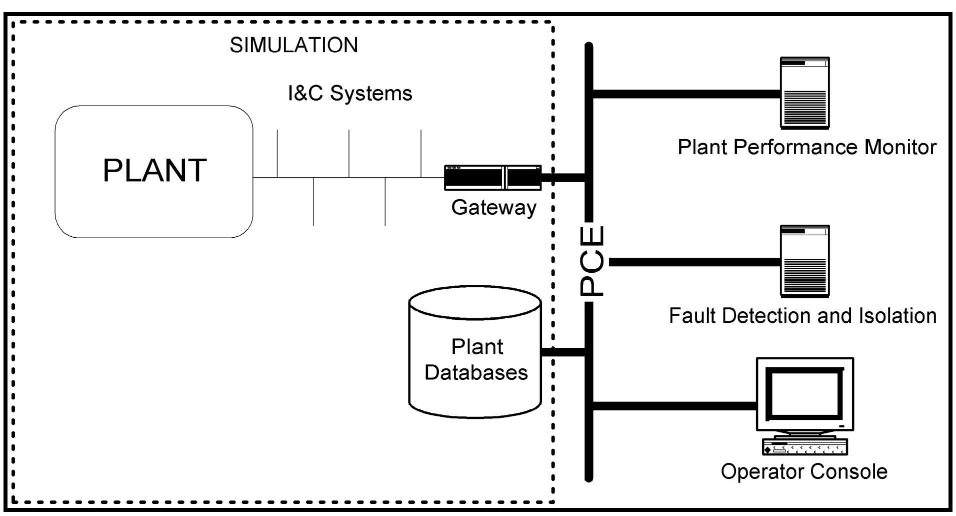

Figure 1 Plant Computing Environment and Applications.

For our project, these applications and the PCE server run on Windows workstations in a "virtual plant environment" supplied by a plant simulation program [4]. The PCE applications, PCE server, and plant simulator run on different computers and communicate over a network (using TCP/IP and sockets). Real-time instrumentation and controls (I&C) run in the plant simulation code, and the PCE supplies an application interface that can provide supervisory control over those I&C elements. The plant databases are currently simulated by the PCE server, which loads "flat files" of records laid out in relational database format.

In a manner of speaking, the PCE and similar efforts *close the information loop* by enabling islands of information to communicate and ultimately take action in response to plant changes. The PCE views the plant as a network of C++ objects connected by information flows. For example, every I&C object has inputs, outputs, functions, and parameters which guide how that object operates on the information it receives; all objects understand a standard set of messages. The PCE uses these objects to route information from "publishers" to "subscribers", and change functions and parameters of objects. All data has an associated "quality" flag, and each message carries a timestamp so that applications can synchronize themselves. This interface allows applications to change the control system operation in response to equipment failures. The PCE server coordinates these I&C changes for its applications. From the applications' point of view, the I&C systems behave as a sort of fieldbus system, consisting of smart I&C devices on a shared communications bus.

A key feature of the PCE is that it supplies plant design information through its database of I&C systems configuration. This effectively defines the meaning of the data exchanged by the applications, giving them a common vocabulary. This database describes how I&C elements are connected to each other and the plant equipment. For example, an application can use this information to find all I&C elements downstream of faulty data. Similarly, diagnosed fault conditions can be described by changes to plant model parameters using the information in a database.

Integration of computer applications and information sharing is a subject with broad interest. While this project's integration problem is simulated, it also has real aspects because the PCE applications are being developed by separate groups at the Oak Ridge National Laboratory, University of Tennessee at Knoxville, and North Carolina State University. In the utility industry, EPRI's Control Center Application Program Interface (CCAPI) is a broad program aimed at creating an application integration framework. This project will be considering how to tailor the PCE to fit within any standard adopted by the utility industry.

In summary, the PCE is a distributed computing environment being developed in support of supervisory control applications for nuclear power plants. It provides network communications between these applications and, in the longer term, will be the vehicle for studying how these applications must share information in order to work together.

Future work will be focused on supplying any specialized functions required by the supported applications.

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