A FLEXIBLE SOFTWARE ARCHITECTURE FOR TOKAMAK DISCHARGE CONTROL SYSTEMS*

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Active control of discharge parameters is playing an increasingly important role in present-day tokamak experiments and is expected to be a key design feature in future experiments such as The Tokamak Physics Experiment (TPX) and the International Thermonuclear Experimental Reactor (ITER). For example, the advanced tokamak concept involves control of the radial profile of the current density and radiative divertor designs require precise control of the position of the X-point and strike point. Flexible implementation of active discharge control is made possible by the use of real time digital control systems in which control algorithms are implemented entirely in software. This paper describes the software architecture of the digital discharge control system in use on the DIII–D tokamak experiment. In this architecture, low level software provides a framework and the tools to implement control algorithms that are defined by separate, mid-level software. This allows new control functions to be added easily without affecting previously implemented functions. The real time computation can be spread among multiple computers. The application designer determines the allocation of computation resources and the low level software automatically handles the proper distribution of the required data. This flexible architecture provides the capability for rapid implementation of new control techniques that is required in a research environment. At the same time, good quality control, to protect the tokamak and ensure efficient operation, is maintained through facilities for testing the control system off-line that make use of software-based tokamak simulators. Through the use of a simulator both the control algorithm and the implementation of that algorithm can be tested. The tokamak operator uses an X-windows based interface to the control system that provides a high level view and does not require detailed knowledge of the control system operation. The operator has flexibility in programming the time evolution of the discharge including the capability to change the control algorithm as a function of time. There is also provision for an asynchronous change to an alternate discharge time evolution in response to an event that is detected in real time. This provides the framework to control both pulsed and steady-state experiments.

*Work supported by U.S. DOE Contracts DE-AC03-89ER51114 and W-7405-ENG-48.

ABSTRACT SUBMISSION FORM
16th IEEE/NPSS Symposium on Fusion Engineering

September 30 — October 5, 1995
Champaign, Illinois, USA

Paper Title: **A Flexible Software Architecture For Tokamak Discharge Control Systems**

Technical Topic Number: **10**

Keywords:
(1)
(2)
(3)

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