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## Integrated real-time supervisory management for handling of off-normal-events and feedback control of tokamak plasmas

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For long-pulse-tokamaks, one of the main challenges in control strategy is to simultaneously reach multiple control objectives using a limited set of actuators and to robustly handle in real-time (RT) off-normal-events (ONE). We have developed a flexible and generic architecture of the plasma control system (PCS) to deal with these issues. The PCS is separated into a tokamak-dependent and a tokamak-agnostic-layer. The first one converts tokamak-specific signals to a generic-state-description used by the tokamak-agnostic-layer and vice-versa. The latter includes:

- a plasma-event-monitor and supervisor to evaluate ONE, plasma and actuator states, decide the appropriate control scenario (list of control tasks), activate and prioritize control tasks
- an actuator manager to decide the best actuator resource allocation to active tasks and distribute commands to corresponding actuators
- controllers that execute control laws to fulfil their tasks with assigned resources and ask for more/less resources if necessary

Thanks to the modular and interface-standardized features of the tokamak-agnostic-layer, it facilitates the implementation, improves maintenance and development capabilities, as well as to be easily transferable to different devices.

We present here the recent development of RT decision-making by the supervisor to switch between various control-scenarios (normal, backup, shutdown, etc.). First, for each ONE, a danger-level and a corresponding ONE-reaction-level are determined. Then, a ONE-to-Scenario mapping decides the appropriate control-scenario based on the set of ONEs and the associated ONE-reaction-levels. The whole PCS has been implemented on the TCV, applied to disruption avoidance experiments with edge-density-limit, demonstrating the excellent capabilities of a RT integrated strategy.

### Minioral

Yes

### IEEE Member

No

### Are you a student?

No

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