# ON UNIFIED COMMAND AND CONTROL APPLICATION DESIGN FOR ITER REMOTE HANDLING SYSTEM

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The ITER divertor Remote Handling (RH) maintenance concepts are currently under study at a full scale mockup facility, namely Divertor Test Platform 2 (DTP2), located in Tampere, Finland. The key devices to carry out these maintenance operations are Cassette Multifunctional Mover (CMM), Cassetter Toroidal Mover (CTM), Multi Axis Manipulators (MAM) and related tooling. CMM and CTM are designed to execute specific tasks of carrying heavy loads, such as divertor cassettes, with high positioning accuracy and repeatability. On the other hand, the purpose of the MAM is to execute a variety of sophisticated tasks, such as cutting and welding pipes, locking and unlocking cassettes, etc., using a master-slave teleoperation scheme. Despite these differences, in essence all of these devices are manipulators with varying specifications. Hence, from the operator's point of view, they perform similar operations, such as following predefined position trajectories, lifting and carrying tools and equipment, etc.

In earlier work [1], a unified software development process has been suggested to be used in the development of the control systems used to operate ITER RH devices. This would improve software reliability and safety of maintenance operations as well as decrease software development and maintenance costs. The ITER RH system can be conceptually and physically divided into RH Operator Interfaces, RH Controllers and RH Equipment layers [2]. The first two of these layers contain controlling applications and the third layer contains hardware devices and sensors to be controlled and monitored.

This paper focuses on the Command and Control application, otherwise known as Human Machine Interface (HMI), which is located on the RH Operator Interfaces layer [2]. This layer lies on top of the RH Controllers layer running the real-time RH Equipment Controllers. The idea is to find a way to develop small, relatively independent modules of a HMI, which can then be adopted to operate several different RH devices. An architecture model is then defined to call and combine these parts into a single cohesive HMI application. In this way, although the details of the controlled devices are different, the resulting HMI's would be very similar, minimizing the need to train operators to use specific Command and Control applications. The paper concentrates on exploring if- and how a single configurable Command and Control, or HMI, application could be developed for CMM and Water Hydraulic MANipulator (WHMAN) (CMM-MAM) control systems. The idea is then experimentally tested by implementing some common HMI modules for CMM and WHMAN and employing this HMI during the operation of these devices.

[1] L. Aha, et al., Unified Software Development Approach for the Safety-critical ITER Maintenance Devices, Fusion Engineering and Design, Volume 84, Issues 2-6, June 2009, Pages 369-374
[2] D. Hamilton, RH Control System Architectural Model, Version 1.2, March 2010