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Progress on ITER remote experimentation centre

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ABSTRACT

Construction of ITER remote experimentation centre (REC) based on the broader approach (BA) activity of the joint program of Japan and Europe (EU) is progressing. In order to make the future experiments of ITER and JT-60SA effectively and efficiently implemented, development of a remote experiment system by using the Satellite Tokamak (JT-60SA) facilities was planned and the development of software for the remote experiment is ongoing, including the systems for the remote connection and the communication between the remote site and the on-site facility. The network system from REC in Rokkasho-site of Japan to the network in EU was established in collaboration with the National Institute of Informatics (NII). Effective data transfer method that is capable of fast transfer speeds in the gigabit range is investigated. Data transfer at the rate of several Gbps was successfully obtained between the institutes in Japan. The preliminary versions of the software for data analysis are developed, such as for visualization of time dependent experimental data and transport simulations, visualization of plasma boundary/equilibrium and spatial profiles of diagnostic data. The remote data access program and an integrated platform for Documentation and Experiment Management are also being developed. A remote experiment room in the Rokkasho-site in Japan was designed and the construction started. The function of REC will be tested and the total system will be demonstrated by the middle of 2017.

1. Introduction

ITER is an international facility for the next step of the fusion energy development, which is being constructed in Saint Paul-lez-Durance, France and is operated, as a joint program of world seven parties. ITER is an experimental reactor to demonstrate the scientific and technological feasibility of fusion energy, therefore, remote participation to experiments is crucially important in ITER. This is also a common issue for the large facilities in the international joint program.

In the joint program, it is important to unite researchers and research resources from participant parties. A system for remote participation and analysis is demanded to concentrate the wisdom for an experiment facility, in particular, by using the Information Technology (IT). Because of this background, the National Fusion Collaboratory project [1] was started in the US. Developments of the remote participation technology are progressing in the EU [2–6] and the US [7–9]. The remote participation was carried out in some facilities and demonstrated/operated in large fusion facilities such as JT-60U [10], LHD [11,12], JET [4,13,14], DIII-D [9,15,16] etc.

Broader Approach (BA) Activities is the joint implementation based on the agreement between the Government of Japan and the EURATOM for support of ITER project and an early realization of fusion energy. BA activities comprise the three projects: (1) Engineering Validation and Engineering Design for Activities for the International Fusion Materials Irradiation Facility (IFMIF/EVEDA: 2007–2017), (2) International Fusion Energy Research Centre (IFERC: 2007–2017) and (3) Satellite Tokamak Programme (2007–2019) for Participation to upgrade of JT-60 Tokamak to JT-60SA and its exploitation. IFERC project (Project leader is N. Nakajima) consists of three sub-projects: (a) DEMO Design and R&D Coordination Centre, (b) Computational Simulation Centre and (c) ITER Remote Experimentation Centre.

The ITER Remote Experimentation Centre (REC) will be made in Rokkasho Village, Aomori Prefecture for the remote participation to ITER experiments as the BA activities. The design of the REC was progressed based on the discussion among experts of both EU and Japan [17], and the development of software and a part of the hardware of REC started [18]. In this paper, the progress of the activity of REC is described.

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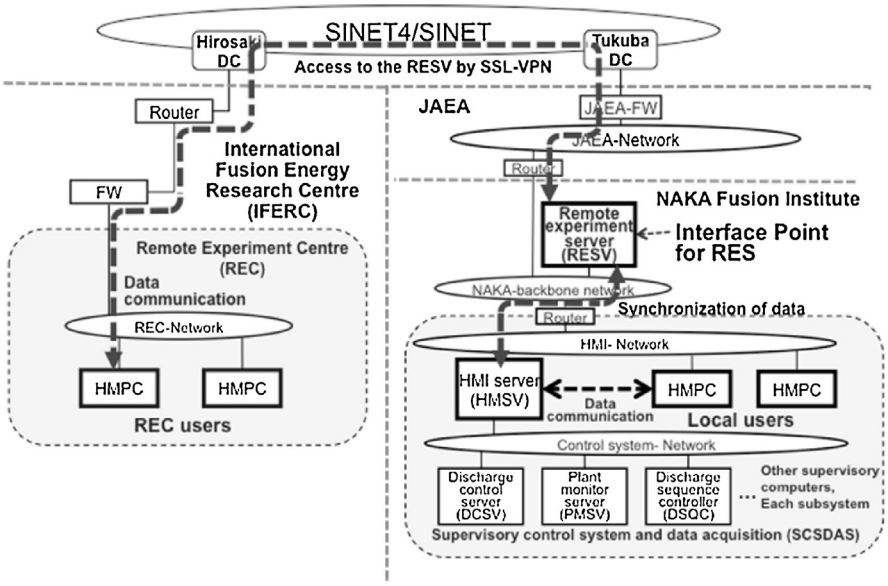

Fig. 1. Connection system from the remote site to the on-site facility. Connection from PC of the remote user (HMPC) to the remote experiment server (RESV) is established by the SSL-VPN. The data on RESV is synchronized with the data on HMSV of the control system in JT-60SA.

2. Progress on ITER remote experiment centre

2.1. Remote experiment system

In order to develop a remote experiment system and to verify functions required for the remote experiment, Remote experiment system (RES) is being made based on the JT-60SA control system. In the RES, the following functions will be required:

- Establishment of the secure connection to the on-site system from the remote site.
- Setup of the discharge parameters and their validation.
- Retrieval of the setup data of the discharge and the configuration data for the experiments.
- Monitoring the operational status of the main tokamak machine, the plant status of the facility relevant for the operation, and main plasma parameters (plasma current, plasma shape, etc.).

These functions of the remote experiment system on the remote site are the same as those available at the on-site facility of JT-60SA. Here, configuration data are reference waveforms for the plasma current, plasma shape reference, pre-programmed reference for the additional heating systems, parameters of specific control systems such as the stabilization control system, heating system, limits of the currents in the PF coils, etc.

The remote connection between the on-site facility of JT-60SA in Naka-JAEA and the remote site of IFERC in Rokkasho was developed, using SSL-VPN through the Internet, such as SINET. Fig.1 shows the route of the connection from the on-site facility (JT-60SA) to the remote site (REC). Human–machine interface PC (HMPC) on the remote site are the dedicated client PCs, which can connect to the remote experiment server (RESV) at the on-site facility. Using HMPC, remote participants can setup the discharge parameters, and also they can monitor the status of the operation of the tokamak machine/related facilities and main plasma parameters. The parameters set on HMPC are transferred to the RESV and used for the operation in the JT-60SA control system.

An important function of the remote experiment is setting and validating the discharge parameters. At the beginning of the remote connection, the setting function of HMPC becomes available by

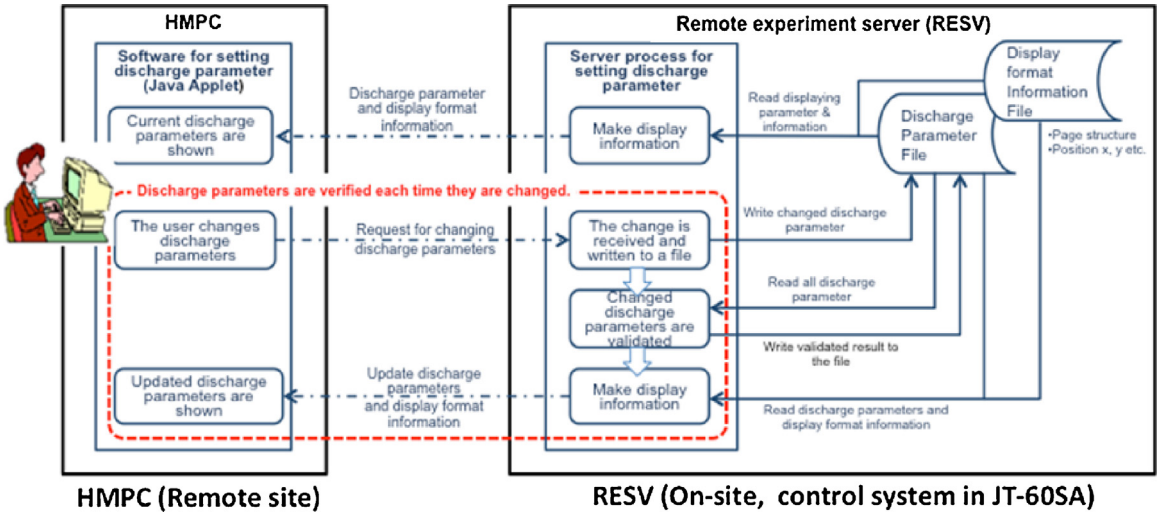

Fig. 2. Setting and validating the discharge parameters of the on-site facility, JT-60SA, from the remote site.

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