

A New User Front End for EAST Remote Participation

Xiaoyang Sun¹, Member, IEEE, Zhenshan Ji, Feng Wang¹, Member, IEEE, and Yang Wang

Abstract—The Web-based remote participation system for experimental advanced superconducting tokamak (EAST RPS) has been developed to provide a high-efficient and low-cost way to meet international collaboration requirements. The EAST RPS team focused on the extension, update, and optimization for the RPS during last two years. In the first version, EAST RPS has established Apache-Flex based front-end components to provide a platform-independent user interface. However, some Web browsers, such as Firefox, Google Chrome, and Microsoft Edge, and operation systems (iOS and android) stop supporting or disable the flash player plugin by default, and the Flex technology will become less relevant in the future. The purpose of this paper is to provide an update of the RPD in EAST. The front-end migration should be a priority to update the EAST RPS. The open source, cross-platform, maintainability, and life cycle are the key features that the front-end platform must have. The technical solutions for the new user front end for EAST RPS are offered in this paper.

Index Terms—Experimental advanced superconducting tokamak (EAST), remote participation.

I. INTRODUCTION

THIS experimental advanced superconducting tokamak (EAST) facility [1], formerly HT-7U, whose goal is to explore high-performance plasma operation under steady-state conditions achieved first plasma in 2006. Remote participation system for EAST (EAST RPS) is an extension of EAST control and data access system. The first conception of the RPS was reported in the 9th IAEA technical meeting on control, data acquisition, and remote participation for fusion research in 2013 [2]. The EAST RPS provides an efficient and economical solution to international collaboration in fusion research.

The front-end application is the user interface (UI) for EAST RPS. In the previous version of EAST RPS, the front-end application was developed based on Apache-Flex [3] which is a free, open-source rich Internet application (RIA) framework. Apache-flex used to be the most popular front-end platform with high market share. However, with the developing of other front-end technology, some Web browsers,

and operation systems stop supporting or disable the flash player plugin by default for running performance and safety issues. The Apache-Flex technology will become less relevant in the future. And now the mobile devices such as tablet and smart phone become popular. The mobile devices support should be considered in the design and development of EAST RPS. The front-end migration should be a priority to update the EAST RPS.

This paper gives an overview of the update of EAST RPS and reports the technical solutions for the new front end.

II. TECHNICAL PROPOSAL

The front end of EAST RPS is the application which contains graphical UI, runs in the client computer, and communicates with back-end service through Internet. With the continuing development of Web technologies, it becomes more feasible for website like desktop applications. Web-based structure has the advantages of cross-platform compatibility, modular, and easing collaboration in software development and optimizing for performance over Internet. HTML5 [4] is the current version of the hypertext markup language (HTML) standard for creating Web pages and applications. It extends, improves, and rationalizes the markup available for documents, introduces markup and application programming interfaces for complex Web application [5]. Because of low-power consumption feature, HTML5 is also cross-platform for mobile application. HTML5 can be used as an alternative to Apache-Flex. The open source, cross-platform, maintainability, and life cycle are the key features the front-end platform must have. To reduce development time, some HTML5 toolkits were selected as listed in the following.

A. Application Framework

AngularJS [6] is a JavaScript-based open-source front-end Web application framework mainly maintained by Google. AngularJS components are embedded into the tag attributes in the HTML page. Double data binding mechanism will provide an automatic way of synchronization when the view or model changes.

B. UI Framework

Bootstrap [7], originally named Twitter Blueprint, is a free and open-source front-end UI framework for design Web application. It contains HTML and CSS design template for UI components. Bootstrap has four built-in grid systems not only for medium and large devices (desktop) but also for small and

Manuscript received June 30, 2017; accepted February 16, 2018. Date of publication March 13, 2018; date of current version May 8, 2018. This work was supported by the Major State Basic Research Development Program of China through the Special Foundation for ITER Project under Grant 2014GB103004. The review of this paper was arranged by Senior Editor E. Surrey. (Corresponding author: Xiaoyang Sun.)

The authors are with the Department of Computer Application, Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, China (e-mail: xysun@ipp.ac.cn).

Color versions of one or more of the figures in this paper are available online at <http://ieeexplore.ieee.org>.

Digital Object Identifier 10.1109/TPS.2018.2811413

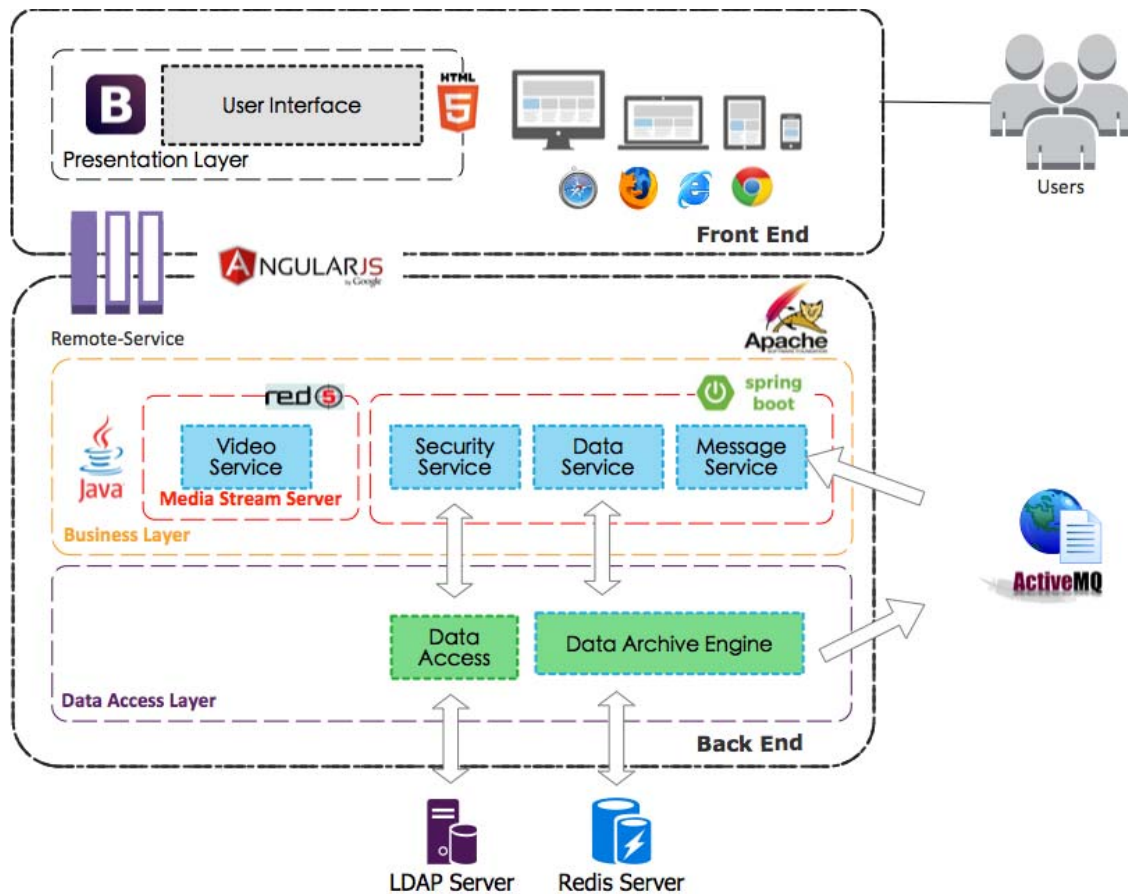


Fig. 1. EAST RPS architecture.

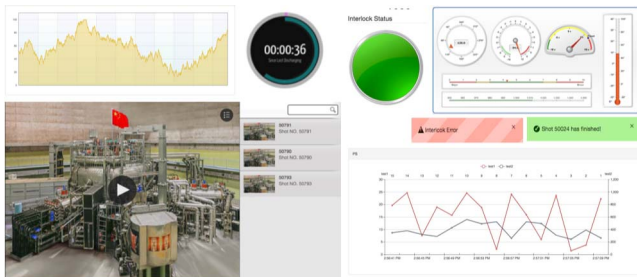


Fig. 2. HTML5 UI components.

extra small devices (tablets and phones). The page layout and viewpoint will be adjusted automatically for different devices by mobile first approach.

C. Server-Side Java Template Engine

Thymeleaf [8] is a server-side Java template engine which is capable of processing HTML, XML, JavaScript, CSS, and plain text. The Thymeleaf templates are used to developing the HTML5 and JavaScript modules which can be reused.

The three HTML5 toolkits will work together as the development environment for front-end application of EAST RPS.

III. SYSTEM ARCHITECTURE AND DATA FLOW

As reported in [2], we analyzed the popular structure of RPS for tokamak facilities [9]–[14]. The Web-based RIA

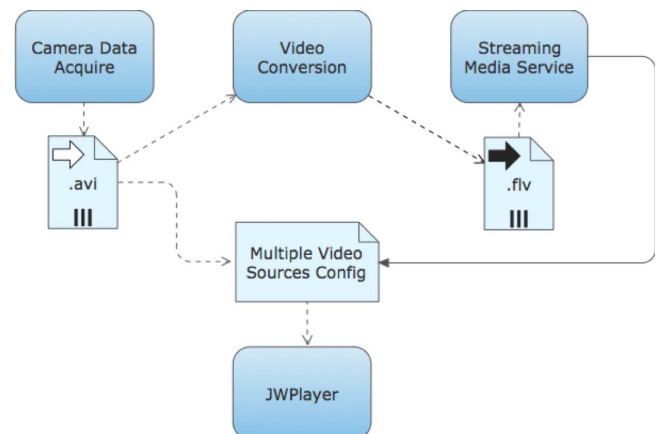


Fig. 3. Data flow of video service.

architecture is suitable for building the RPS. RIA allows the client-side to handle local activities which will reduce bandwidth and server load. The design of the EAST RPS is based on modular development. The EAST RPS is divided into front-end, back-end, and databases three dedicated parts. Each part can be developed and reused independently. The system and technology stack with HTML5-based new front end is described in Fig. 1.

A. Front End

The front end contains all the views and graphical components to the remote user. In the front end, AngularJS

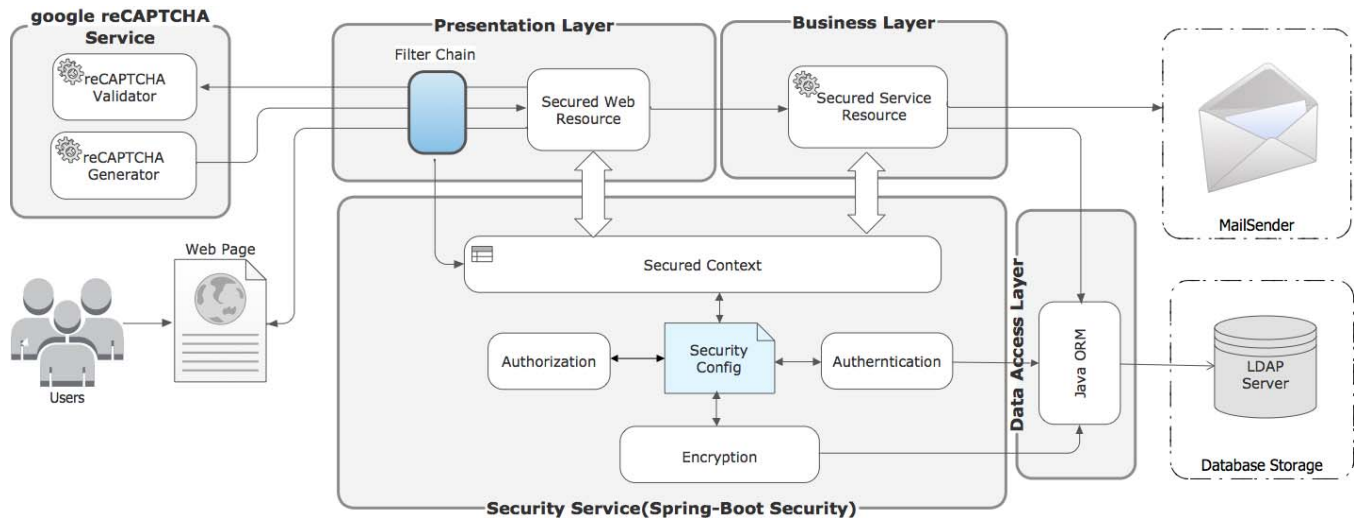


Fig. 4. Data flow of security service.

components, the models, and controllers, support two-way data binding feature. Any changes to the model are immediately reflected in the view and any changes in the view update the model. The front end can communicate with back-end service using XML Http request through hypertext transfer protocol (HTTP) or HTTPs calls to Web server.

B. Back End

The back end which is based on spring framework [15] includes the business layer and the data access layer. The business layer represents the business service of application. The business services for EAST remote participation include security service, data service, message service, and video service. The data access layer provides the methods to save, send, and retrieve data. Publish and subscribe model to get message from java message system (JMS) and data retrieval from Redis database are the main data access approach for the back end of EAST RPS.

C. Database

The engineering data for remote access was stored in a Redis [16] database which is a popular in-memory and key-value database. The back-end accesses engineering data via spring data Redis module which provides configuration and access to Redis database from spring application.

The scientific data are acquired from dozens of EAST subsystems. This raw data are transferred to and stored on centralized MDSplus [17] data servers which was a part of EAST data acquisition system.

In the previous version, the user and resource data for security service were stored into a dedicated MySQL database. For unified management, the security related data have been migrated to a lightweight directory access protocol (LDAP)-based EAST user management database.

IV. FUNCTION BREAKDOWN AND NEW UI COMPONENTS

The front end of EAST RPS is a user-oriented application. The main function of front end is to provide a Web-based

GUI for the remote user to access EAST data. According to different functions, the front-end application will be broken down into several modules as listed in the following:

- 1) interlock, scientific, engineering data access;
- 2) remote control console;
- 3) camera data display;
- 4) instant messaging.

The remote data access is the core function of the EAST RPS. The front end will provide a friendly UI to display the data for remote users. Remote control console is a remote UI for EAST control system [18]. Remote users can access preset parameter, monitor interlock, or operation state, and dynamic discharging signal through it. The regular data retrieval and data-push through JMS are the main data update methods. Some UI components have been used to provide friendly UI, as shown in Fig. 2.

V. VIDEO SERVICE

The main function of multimedia service is to display the video record from EAST charge coupled devices (CCD) diagnostic system. The CCD system can produce 300 MB of data per shot. For remote access, the uncompressed video files will be converted to flash video (flv) format. Red5 [19] is a free flv media streaming server. EAST discharging video will be convert to flv format file and publish to Red5 server. Because some browsers do not support flv format, multiple source configuration will be provided to the JW player [20] using a real-time messaging protocol stream as a primary media file and with an uncompressed file as a backup. Fig. 3 describes the data flow of video service.

VI. SECURITY SERVICE

Security is the key issue for a Web-based application. The main function of security service is to provide security mechanism to EAST RPS including authorization, authentication, and preventing brute force password attacks. The authorization and authentication functions were provided by

integrated spring-boot security module. In the new version, the Google reCaptchaV2 [21] service was integrated to the security service to protect the EAST RPS website from spam and abuse and the separated RPS user database will be integrated to the LDAP-based user management system for EAST. As shown in Fig. 4, when the user tries to get access the EAST RPS, the reCAPTCHA service will check the access is whether or not from a human being. If passed, the authentication process checks the validity of the user by matching the encrypted using name and password against the database, then the authorization process retrieves all permission resources to the user's role.

VII. CONCLUSION

The front end of EAST RPS has been migrated from Apache-Flex framework to HTML5. This update will improve in running performance and cross-platform support for mobile devices. The EAST RPS is still a prototype. We will gather feedback from users and improve the user experience.

REFERENCES

- [1] Y. Wan, "Overview of steady state operation of HT-7 and present status of the HT-7U project," *Nucl. Fusion.*, vol. 40, no. 6, pp. 1057–1068, 2000.
- [2] X. Y. Sun, F. Wang, Y. Wang, and S. Li, "Conceptual design of remote control system for EAST tokamak," *Fusion Eng. Des.*, vol. 89, no. 5, pp. 741–744, 2014.
- [3] J. A. Madisyn, *Apache Flex*. New York, NY, USA: PlicPress, 2012, pp. 10–12.
- [4] L. Hickson and D. Hyatt. (Oct. 2014). *HTML5-A Vocabulary and Associated API for HTML and XHTML*. [Online]. Available: <https://www.w3.org/TR/2014/REC-html5-20141028/>
- [5] S. Pieters. (Dec. 2014). *HTML5 Differences From HTML4*. [Online]. Available: <https://www.w3.org/TR/html5-diff/>
- [6] B. Green. (Mar. 2016). *Angular 2 and the Future of HTML5 App*. [Online]. Available: <https://www.oreilly.com/ideas/angular-2-and-the-future-of-html5-apps>
- [7] F. Cimo, *Bootstrap Programming Cook Book*. Attica, Greece: Exelixis Media P.C., 2015, p. 8, [Online]. Available: <https://www.webcodegeeks.com/wp-content/uploads/2015/12/Bootstrap-Programming-Cookbook.pdf>
- [8] The Thymeleaf Team. (Apr. 2017). *Tutorial: Using Thymeleaf Version 20170418*. [Online]. Available: <http://www.thymeleaf.org/doc/tutorials/3.0/usingthymeleaf.html>
- [9] S. Sudo *et al.*, "Control, data acquisition and remote participation for steady-state operation in LHD," *Fusion Eng. Des.*, vol. 81, nos. 15–17, pp. 1713–1721, 2006.
- [10] W. Suttrop *et al.*, "Remote participation at JET task force work: Users' experience," *Fusion Eng. Des.*, vol. 60, no. 3, pp. 459–465, 2002.
- [11] J. How and V. Schmidt, "The technical infrastructure for remote participation in the European fusion programme," *Fusion Eng. Des.*, vol. 60, no. 3, pp. 449–457, 2002.
- [12] J. M. Theis and J.-M. Larsen, "Remote experiment participation on Tore-Supra," *Fusion Eng. Des.*, vol. 71, nos. 1–4, pp. 257–261, 2004.
- [13] K. Iba *et al.*, "Development and verification of remote research environment based on 'Fusion research grid,'" *Fusion Eng. Des.*, vol. 83, nos. 2–3, pp. 495–497, 2008.
- [14] S. Sakata, T. Totsuka, K. Kiyono, T. Oshima, M. Sato, and T. Ozeki, "Progress of data processing system in JT-60—Development of remote experiment system," *Fusion Eng. Des.*, vol. 81, nos. 15–17, pp. 1775–1778, 2006.
- [15] R. Johnson *et al.* (Mar. 2017). *Spring Framework Reference Documentation Version 4.3.7*. [Online]. Available: <http://docs.spring.io/spring/docs/current/spring-framework-reference/htmlsingle/>
- [16] RedisLabs, Mountain View, CA, USA. *Redis Design Drafts*. Accessed: Mar. 31, 2017. [Online]. Available: <http://redis.io/topics/rdd>
- [17] G. Manduchi. *The MDSplus Tutorial*. Accessed: Mar. 31, 2017. [Online]. Available: <http://www.mdsplus.org/index.php?title=Documentation: Tutorial&open=41338000618048317292593&page=Documentation%2FThe+MDSplus+tutorial>
- [18] X. Sun, J. Luo, Z. Ji, and Y. Wu, "The central control system for EAST," *IEEE Trans. Nucl. Sci.*, vol. 57, no. 2, pp. 515–518, Apr. 2010.
- [19] D. Wang and K. Xu, "Red5 Flash server analysis and video call service implementation," in *Proc. IEEE 2nd Symp. Web Soc. (SWS)*, Aug. 2010, pp. 397–400.
- [20] JWPlayer Team. *JW Player Developer Guide*. Accessed: Jun. 25, 2017. [Online]. Available: <https://developer.jwplayer.com/jw-player/docs/developer-guide/>
- [21] reCAPTCHA Team. (Jun. 2017). *reCAPTCHA Developer's Guide*. [Online]. Available: <https://developers.google.com/recaptcha/intro>

Authors' photographs and biographies not available at the time of publication.