



## EAST MDSplus Log Data Management System

F. Wang<sup>1</sup>, J. Dai<sup>1,2</sup>, Q.H. Zhang<sup>1,2</sup>, Y.T. Wang<sup>1,2</sup>, F. Yang<sup>1,3</sup>

1. Institute of Plasma Physics, Chinese Academy of Sciences, Hefei, Anhui, 230031, China

2. University of Science and Technology of China, Hefei, Anhui, 230031, China

3. Department of Computer Science, Anhui Medical University, Hefei, China

\*Corresponding Author: Email: jin.dai@ipp.ac.cn

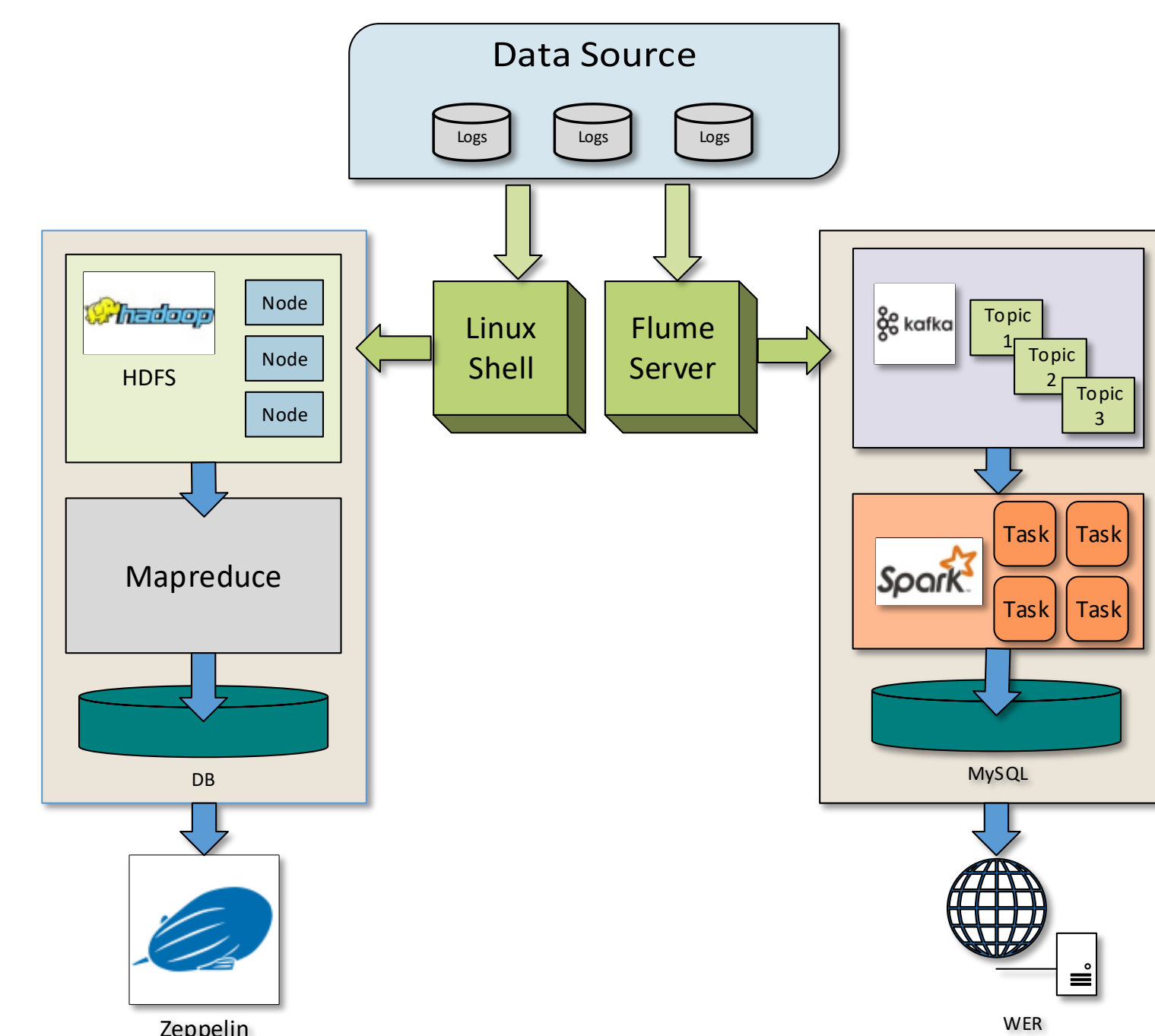
**ABSTRACT :** With the increasing of data storage and data access number in EAST experiment, standardized data access and user behavior monitoring become even more important. Therefore, a perfect EAST MDSplus logging system is required, and a mature log data management system is built on this basis. The EAST MDSplus log data management system architecture includes four parts: the log data collection layer, the data storage layer, the data analysis layer and the data application layer. The data collection layer uses hook function to improve the log system, and adopts Logrotate mechanism for log rotation cutting, which effectively avoids the problem of excessive log storage. The data storage layer uses HDFS for distributed offline data storage to support data multi-copy backup, which improves data security performance and non-volatility. Moreover, Kafka is also used as the stream data storage middleware to ensure the release and subscription of log messages with high throughput. The data analysis layer uses MapReduce to clean the offline data and establish the log data warehouse belonging to EAST. In addition, Spark Streaming is used to calculate log stream data to ensure the quasi-real-time nature of log data. The data application layer is designed to visualize analysis layer data and intuitively reflect the entire EAST log data access status. Each layer of the log management system framework provides a corresponding interface, which reduces the coupling degree of the system. EAST MDSplus log data management system provides a standardized management solution for the whole EAST experiment log data.

### Introduction

- The Experimental Advanced Superconducting Tokamak (EAST) is a larger fusion research device which has produced mass experimental raw data. The high-volume database such as MDSplus database which is a set of software tools for data acquisition and storage and a methodology for management of complex scientific data has stored more than five hundred TB experimental raw data that includes diagnostic DAQ raw data, analyzed data and engineering DAQ raw data, etc. So it is important for manager to watch the information and status of all the mdsplus data. At present all the acquired data except video/image are stored into MDSplus database which is a set of software tools for data acquisition and storage and a methodology for management of complex scientific data.
- At present all data access behavior can not be detailed recorded on MDSplus logs except poor EAST data access logs which are stored into mdsipd file. The whole log information including client's link information and data operation information are not fully recorded.
- It is really hard for manager to monitor the storage system based on above information. Problems will be occur when some hackers attack the server. In addition, the pressure can be formatted when a lot of clients access a single node of the server. In this case, the problem causes the traffic congestion on the storage server. To develop a mature log data management to watch all data status became much more significant. All functions of the log data management system is made up of four components as list below.
  - Log optimization and collection;
  - Off-line data analysis;
  - Real-time data analysis;
  - Data visualization;
- So we intend to construct log data management system of EAST Tokamak based on spark that contains the above functions.

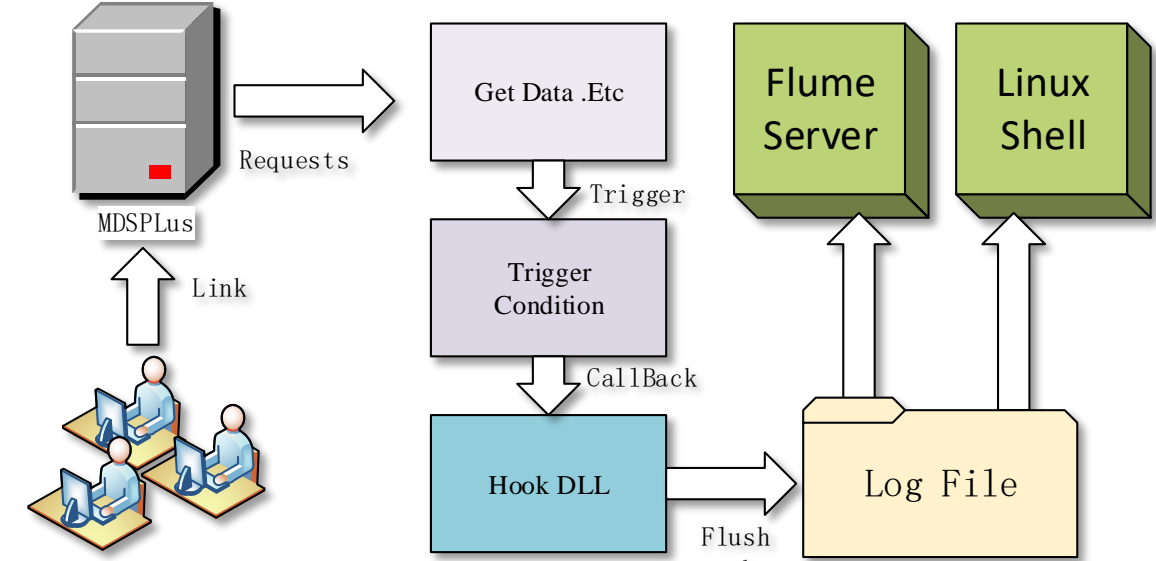
### System Architecture

- Part1 is the optimization and collection of MDSplus logging system, which can record the detailed log information When all remote client sends requests to the server. This part plays an important role in the whole system because it's the data source. The implement of the logging system makes full use of the hook functions and the mechanism of Logrotate, the flume server daemon watches the server log's file content all the time. When the data is collected, the crontab, Linux shell send the data to HDFS (Hadoop distributed file system) and flume sends the data to Kafka (topics subscription and release system, converting log messages into streaming data).
- Part2 is offline data analysis. The function of offline log storage relies on HDFS, a Hadoop distributed storage file system. The metadata for the log is stored on the master node, and the data blocks for the log are stored on the slave node. MapReduce, the core off-line computing framework, performs statistical calculation of log data according to the specified time and date, and then normalizes the processed data into MYSQL database.
- Part3 is real-time data analysis. Kafka, as a data message middleware, make log messages became streaming data which is data source of spark streaming procedure. Each spark steaming Job has been divided into many parallel tasks. Each task can process one batch data from Kafka server, and the data results written to MySQL database.
- Part4 is the data visualization section including web presentation and Zeppelin. The web presentation adapts traditional technology such as JS, JQuery, Echart etc.



### Log optimization and collection

- The log system has been greatly improved. The entitle process is shown as list below.
- Thin client mode connects MDSplus server.
- Operations such as Tree Open, Get Data, Put Data will trigger TreeCallHook function and be recorded.
- libTreeShrHook.so flush the log information into mdsip log file
- Client disconnects link.
- This log information is monitored by the Flume service in real time and Linux shell in offline.
- The configuration of log collection system is Flume NG 1.7.0.



### Off-line data analysis

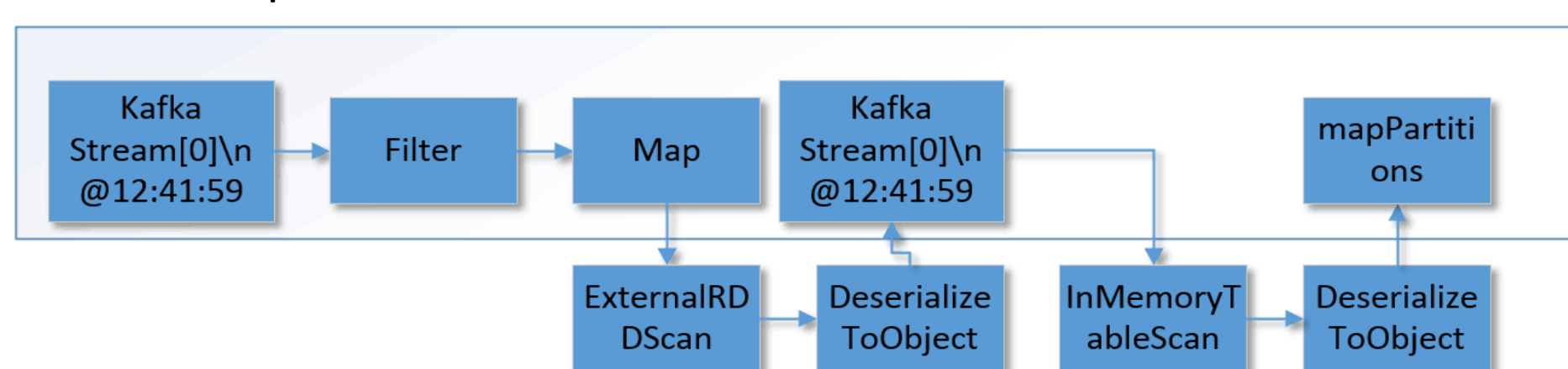
- The storage content in HDFS is the log information stored in days after the Linux shell executed periodically.

- Hadoop's MapReduce computing framework is used to decompose log information into two different data models: the customer model and the operation model.

linkTime	pid	user	host	status	linkTime	pid	hooktype	tree	shot	nodepath
Mon Oct 30 11:16:40 2017	2782	linguo	202.127.204.3	ON	Mon Oct 30 11:20:08 2017	2783	OpenTree	SE_TREE	1	N/A
Mon Oct 31 11:26:13 2017	2783	qihuang	202.127.204.3	ON	Mon Oct 30 11:28:03 2017	2783	GetData	SE_TREE	1	USE_TREE:TOPSIG
Mon Oct 31 12:32:48 2017	2788	irguo	202.127.204.3	OFF	Mon Oct 30 11:33:08 2017	2783	OpenTree	SE_TREE	1	N/A
Mon Oct 31 15:36:23 2017	2797	guie	202.127.204.3	ON	Mon Oct 30 11:33:19 2017	2783	GetNo	SE_TREE	1	USE_TREE:TOPSIG
Mon Oct 31 18:56:13 2017	2780	zhu	202.127.204.3	OFF	Mon Oct 31 15:36:28 2017	2797	OpenTree	SE_TREE	1	N/A

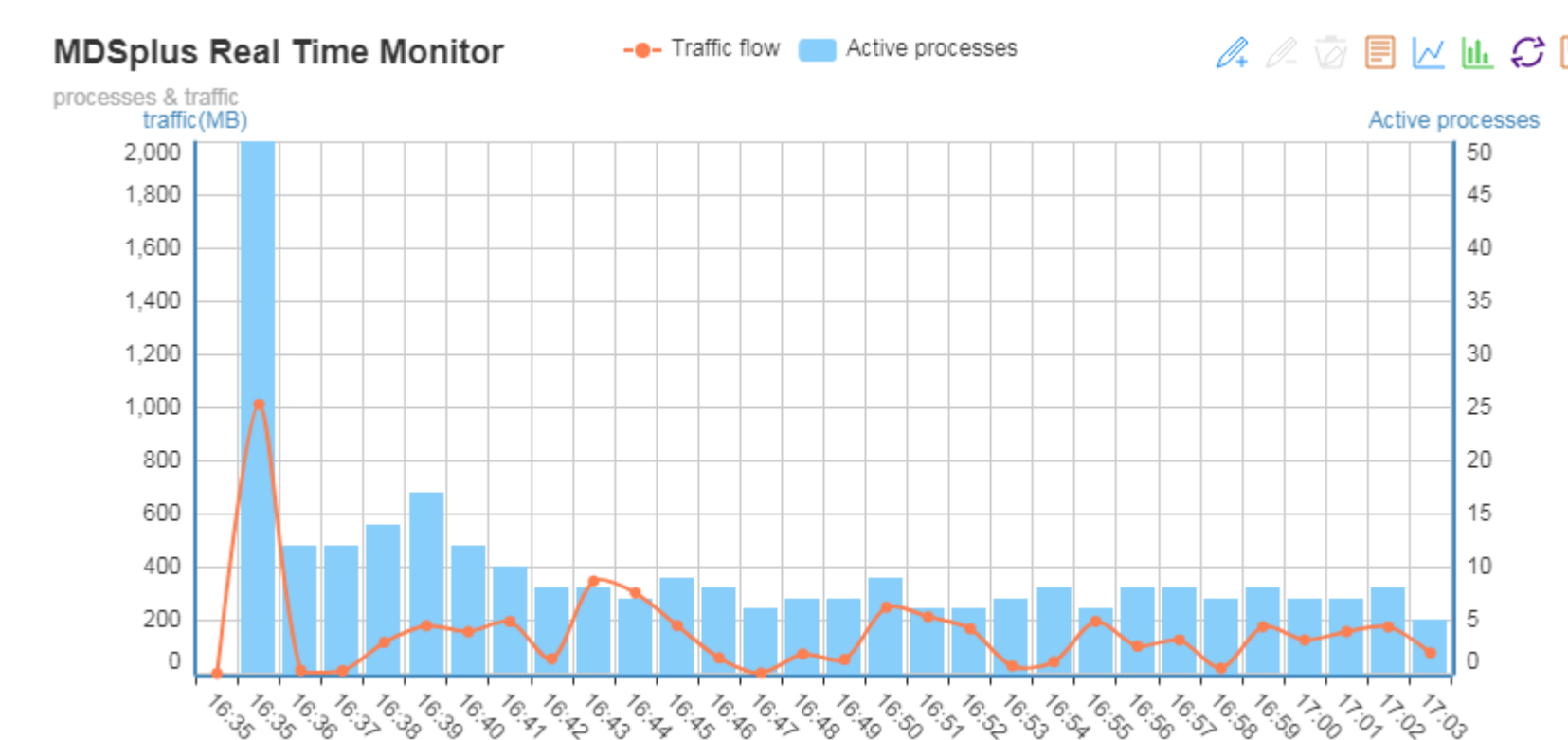
### Real-time data analysis

- The Spark Streaming can analyze the batch real-time data streaming which is pulled from Kafka topics and can be described as RDD (resilient distributed datasets).
- The job is divided into different stages. At the same time, the stage is divided into different tasks. While the RDD's transformation includes filter, map, and so on.
- Two main format of the log message after processing in real time. Client table and Operation table on show.



### Data Monitoring

- The MySQL table does not directly reflect the value of the data. To solve this problem, building a data browser is quite necessary. Combining Zeppelin with traditional web can present server status perfectly.



### Test Results

- To test the log analysis system's usability, the test method adapts multiply threads access data storage server. The following Table is an off-line and real-time comparison of the log information processing.

Test Case	Speed pieces/s
Real-time	~1,000,000
Off line	~3,000

### Summary

- To monitor the MDSplus data storage server on EAST, a new log data management system has been designed which includes 4 parts including log optimization and collection, off-line data analysis, real-time data analysis and data browser.
- The log data management system has been implemented and adopted in the campaign of EAST.

### Future Plan

- more data analysis components will be added into the log data management system to mining more useful data.
- more advanced machine learning algorithm will be implemented according to the requirements.

### Acknowledgements

This work is supported by National MCF Energy R&D Program of China (Grant No: 2018YFE0302100).