

Real time data access log analysis system of EAST tokamak based on spark

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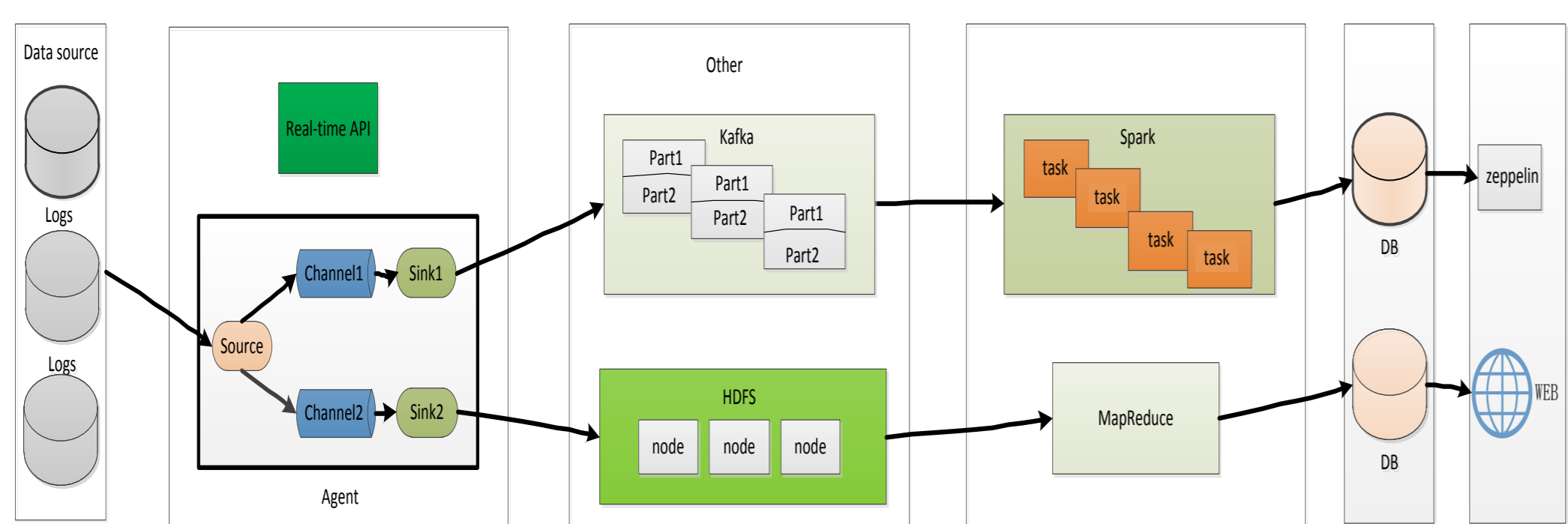
ABSTRACT :The experiment data generated by the EAST device is getting larger and larger, and it is necessary to monitor the MDSplus data storage server on EAST. In order to facilitate the management of users on the MDSplus server, a real-time monitoring log analysis system is needed. The data processing framework adopted by this log analysis system is the Spark Streaming framework in Spark ecosystem, whose real-time streaming data is derived from MDSplus logs. The framework also makes use of key technologies such as log monitoring, aggregation and distribution with framework likes Flume and Kafka which makes it possible for MDSplus mass log data processing power. The system can process tens of millions of unprocessed MDSplus log information at a second level, then model the log information and display it on the web. This report introduces the design and implementation of the overall architecture of real time data access log analysis system based on spark. Experimental results show that the system is proved to be with steady and reliable performance and has an important application value to the management of fusion experiment data. The system has been designed and will be adopted in the next campaign and the system details will be given in the paper.

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 real-time data access log system to watch all data status became much more significant. All functions of the real time data access log analysis system is made up of four components as list below.
 - Real-time data status monitoring;
 - Real-time client operation monitoring;
 - Off-line data analysis;
 - Data browser;
- So we intend to construct a real-time data access log analysis system of EAST Tokamak based spark that contains the above functions.

System Architecture



- Part1 is the improvement of MDSplus logging system, which can record the detailed log information When remote client sends requests to the server. This part plays an important role in the whole system because it's the data source. But it's worth noting that the logs just provide the raw data without any processing. The implement of the logging system makes full use of the hook functions.

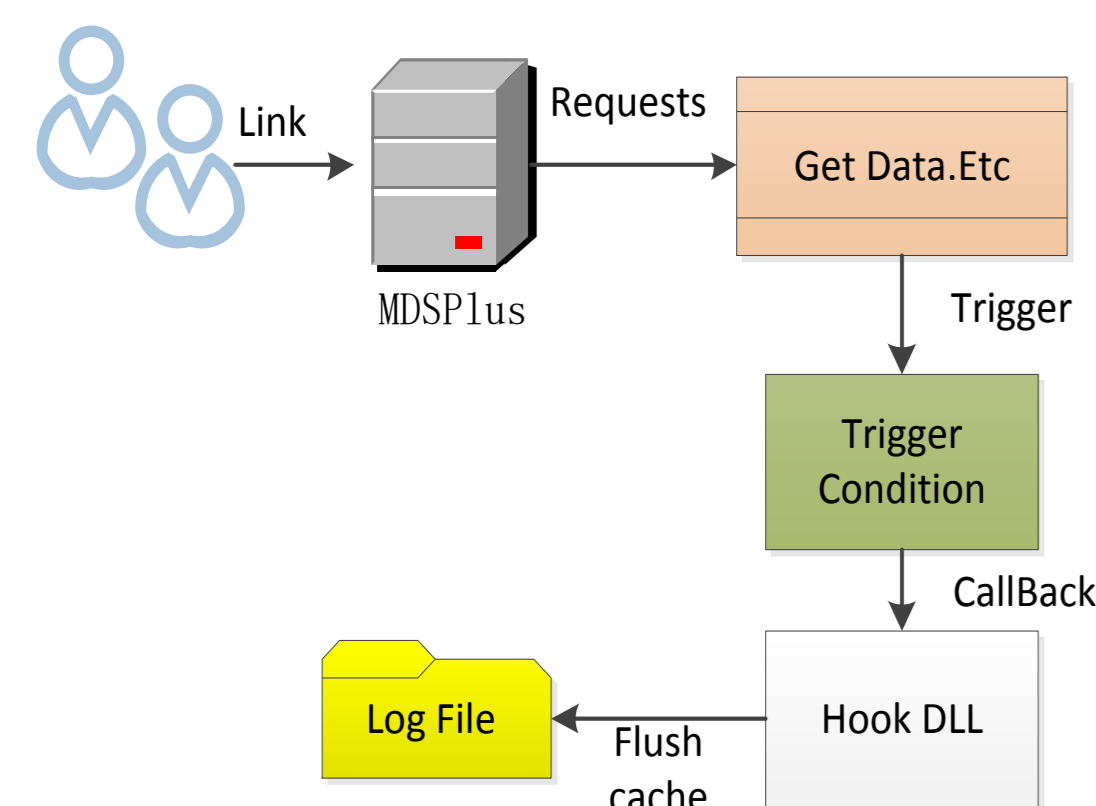
- Part2 is the logging data monitor, which uses the open source flume logging framework and other real-time API. To respond to changes in log information in real-time, the flume server daemon watches the server log's file content all the time. When the data is collected, the flume sends the data to different destinations, both HDFS (Hadoop distributed file system) and Kafka (topics subscription and release system, converting log messages into streaming data). Flume was chosen as a logging monitor because it's reliable, fault-tolerant, scalable, manageable, and customizable.

- Part3 are both the data backup storage designed based on HDFS storage and the streaming data conversion based on Kafka. On the one hand, using HDFS storage to prepare for off-line processing. On the another hand, Kafka make log messages became streaming data which is data source of spark streaming procedure.
- Part4 is the streaming data processing program based on spark streaming. Each spark steaming Job has been divided into many parallel tasks. Each task can process one batch data from Kafka server. In this

- case, it acts as the consumer role. At the same time, up stream Kafka became producer role. In addition to real-time part, the MR calculation can perform offline data mining.
- Part5 is the data browser section including web presentation and Zepplin which is a big data visualization tools. The web presentation adapts traditional technology such as JS, JQuery, Echart, etc.

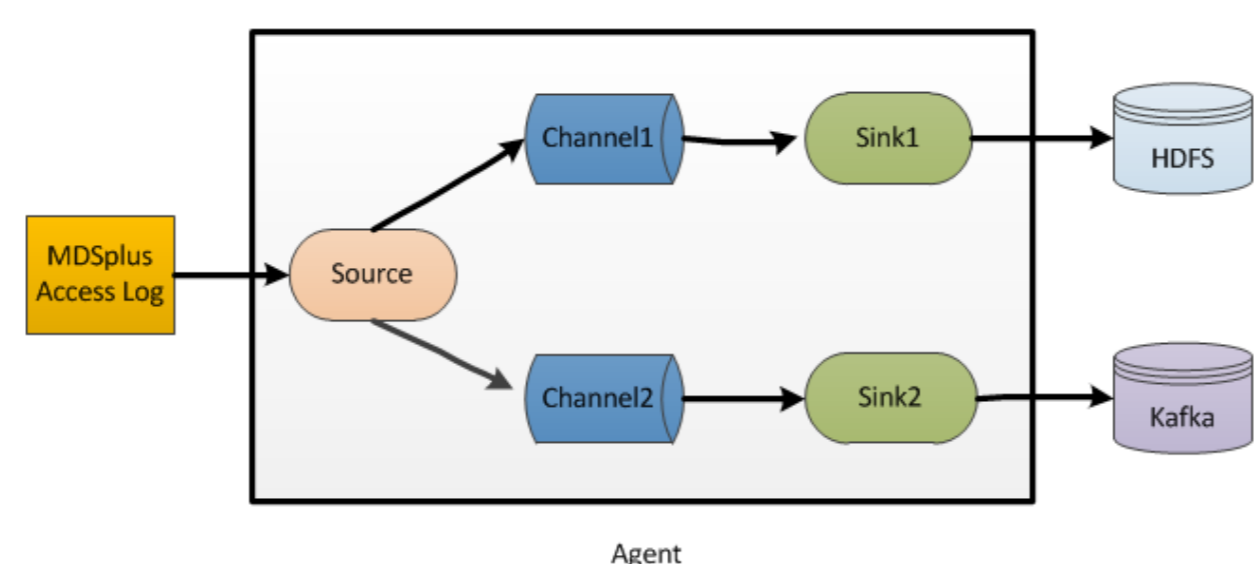
Log optimization

- The log system has been greatly improved. The entire 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.

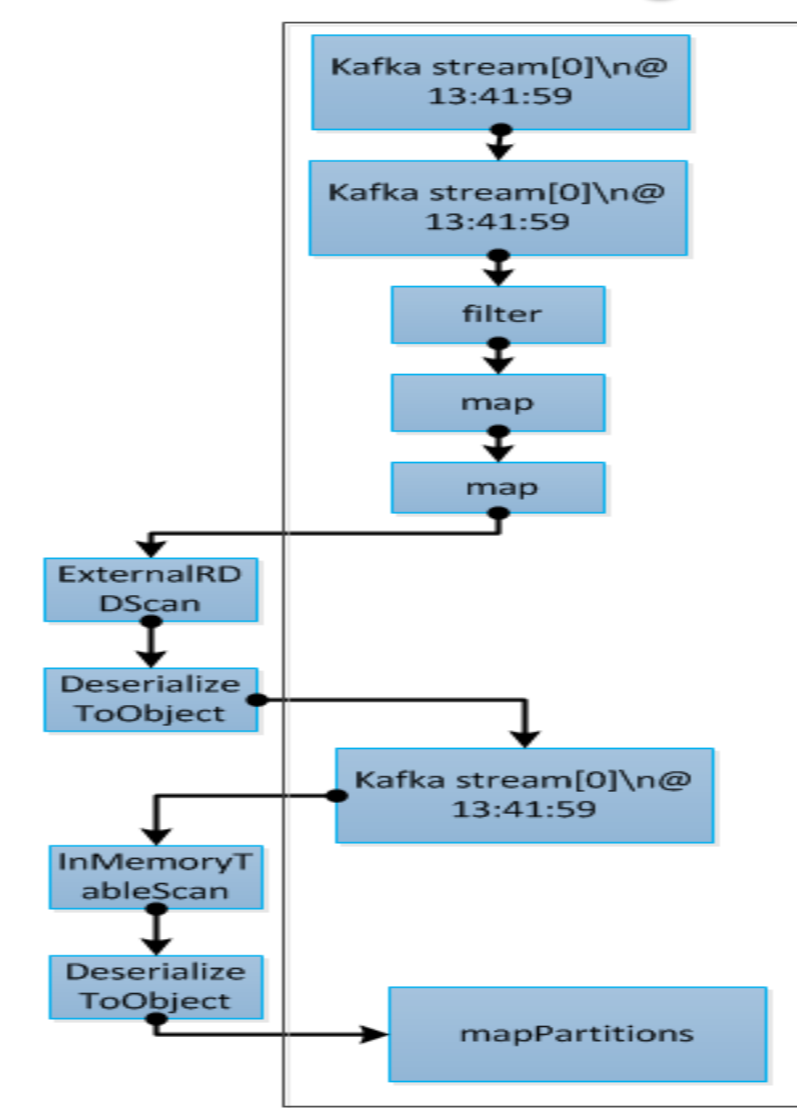


Real-time log Collection

- The log message through channel1(disk cache) is sent to HDFS for storage, and it is also sent to Kafka for converting through channel2(memory buffer).
- Once Kafka server receives log message from Flume server, it can put message into topic for Spark streaming 's consumption.
- The real-time log collection system as flowing configuration.
 - Flume NG 1.7.0.
 - Kafka 2.11.



Real-time log analysis



- The Spark Streaming can analyse 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.

tableName	pid	user	host	status	tableName	pid	hostname	time	cost	rowdepth
Mon Oct 30 15:04:01 2017	2783	shiqun	202.127.204.3	OK	Mon Oct 30 15:06:08 2017	2783	OpenFlow	SE_FREE	1	N/A
Mon Oct 30 15:04:01 2017	2783	shiqun	202.127.204.3	OK	Mon Oct 30 15:06:08 2017	2783	OpenFlow	SE_FREE	1	USE_FREE-TOP1000
Mon Oct 30 15:04:01 2017	2788	shiqun	202.127.204.3	OK	Mon Oct 30 15:06:08 2017	2788	OpenFlow	SE_FREE	1	N/A
Mon Oct 31 15:04:01 2017	2797	guo	202.127.204.3	OK	Mon Oct 31 15:04:01 2017	2797	OpenFlow	SE_FREE	1	USE_FREE-TOP1000
Mon Oct 31 15:04:01 2017	2799	shiqun	202.127.204.3	OK	Mon Oct 31 15:04:01 2017	2799	OpenFlow	SE_FREE	1	N/A

Real-time data monitor

- 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 real-time access log analysis system has been designed which includes 5 parts including log optimization, real-time log information collection, log information storage, real-time log analysis and data browser.
- The real-time data access log analysis system has been implemented and adopted in the campaign of East tokamak.

Future Plan

- More real-time analysis components will be added into the log analysis system to mining more useful data, more advanced machine learning algorithm will be implemented according to the requirements.
- To help and improve the primary database design of next fusion device of China (CFETR).

Acknowledgements

This work is supported by National Key R&D Program of China (Grant No: 2017YFE0300500, 2017YFE0300505).