Big Data Testbed for Research and Education Networks Analysis

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Abstract—An important platform is Big Data which has emerged as for data intensive computing. UniNets is the complex network infrastructure, which is one of the biggest research and education network in Thailand, the network analysis is crucial to operate and maintain the network. Netflow is one of the valuable tools for collect data from routers to log files for analyzing the problems. Unfortunately, Netflow generates large amount of data. Comparison between Hadoop platform and APACHE Spark by using TestBed to choose the appropriate storage and analysis data. Two format: Hadoop and APACHE Spark can both store data and process the analysis jobs. Typical Hadoop system operates in a simple network topology and difficult to work in complex network topology like UniNet network, which has two layers: Backbone and Distribution layers. In this case, it needs more than on Hadoop systems working together in this network. In principle, OpenFlow enables an application to adjust topology as required by the computation, providing additional network bandwidth to those resources requiring it and also support fault-tolerance when fail-over has happened.

Index Terms—Big Data, Networks Analysis

I. INTRODUCTION

NATIONAL Research and Education Network (NREN) is a specialized internet service provider dedicated to support the research and education communities within a country. It supports a high-speed backbone network and dedicates channels for individual research projects. NRENs are usually the places for new Internet protocols and architectures that introduced before deployment through the Public Internet. Two examples of these protocols are IPv6 and IP multicast. Two example of architecture are client/server and cloud computing[8]. Many countries have their own NREN such as MYREN in Malaysia, AARNET in Australia, SINET in Japan, and ThaiREN in Thailand. There are some NRENs collaboration such as APAN (Asia Pacific Advanced Network), TEIN (Trans-Eurasia Information Network) and Internet2. Applications using of NRENs are essential for finding solutions to many issues currently facing the world including scientific, research and educational experiments in medicine, climate and environmental monitoring, high energy physics and agriculture. The major application is Medical Tele-Collaboration project, live surgeries, tele-education and tele-communication. The recently application activities have also been promoted in Future Internet areas such as cloud computing, OpenFlow-based software defined network (SDN) technology, open web-based IPTV services, an online university (e-learning), weather forecasting & climate modeling, and grid computing.

Nowadays the REN network infrastructure has become larger and larger, which supports many users and many applications. The network administrators need to have applications which are suitable for monitoring and analyse the problems called “Traffic Analysis” as we have better known that a traffic of data. It needs to have Log file that the traffic data on the network. Log file is very necessary for analyze the network systems, but a number of log file is depend on a number of size of network. In case of network is large, Log file will be generated enormously called “Big Data”. Big data is certainly one of the biggest network consumption, therefore combines with virtualization and cloud computing, big data is a technological capability that will affect data centers to significantly transform and evolve within the near future. It is similar to virtualization, big data infrastructure is unique and can create an architectural upheaval in the way systems, storage, and software infrastructure are connected and managed. The previous business analytics solutions, the real-time capability of new big data solutions can provide mission critical business intelligence that can change the efficiency and speed of enterprise decision making forever. Hence, the way in which network infrastructure is connected and distributed warrants an up-to-date and critical analysis. Unfortunately, current Internet technology is not design for Big data transfer. This paper was proposed big data testbed using two popular applications, namely Hadoop and Apache Spark on research and education networks (REN) and apply future internet model namely Software define Network (SDN), which designed to deliver high-performance and scalable big data analysis. The experiment is working on ThaiREN (National Research and Education Network or REN in Thailand) using Netflow, which is the important tool for network analysis. In addition, the testbed will also design to experiment on TEIN (Trans-Eurasia Information Network). The main contribution of our work is twofold. First, this works
show the study and analysis of various network data exchange between the nodes in Hadoop cluster and Apache Spark that has been built on ThaiREN testbed. Second, a fault-tolerant system is used with the Hadoop framework and Apache Spark for the efficiency is following, this paper is organized as follows. Section I, presented Network Analysis on research and education network. Section II, described the brief overview of Hadoop architecture and Software-Defined Networking (SDN). Section III, proposed testbed to compare Hadoop and Apache Spark. Related works were presented in Section IV. Finally, Section V is conclusion and future works of this paper.

II. OVERVIEW OF BIG DATA AND FUTURE INTERNET ARCHITECTURES

A. Network Analysis on research and education network

The research infrastructure is developed in Thai national and research network (ThaiREN) [13], which is a specialized Internet Service Provider dedicated to support the need of the research and education communities within a country. It is usually distinguished by using a high-speed backbone network, offering dedicated channels for individual research projects. ThaiREN has many members, research institutes and Government Information Network (GIN) which provide links to government sectors. ThaiREN also has an international links to Internet2 in USA, JGN2 in Japan, TEIN (Trans Eurasia Information Network) and APAN (Asia Pacific Advanced Network). ThaiREN is consisted of two major network infrastructures including NECTEC and UniNet [13]. UniNet supports usage of the entire education system with the following institutes 1) 293 universities connected by dark fiber, which will have bandwidth 1-10 Gbps, 2) 415 vocational institutions, which will have bandwidth 100-1,000 Mbps, and finally 9,000 schools, which will have bandwidth 10-100 Mbps. In this paper, we concentrated in UniNet only. The topology of UniNet is a hierarchical model consisted of 2 layers including: Backbone Nodes and Distribution Nodes. Backbone links have bandwidth 50 Gbps and Distribution links have bandwidth 10 Gbps. The UniNet topology was shown in Fig 1.

UniNet is a complex network and provides bandwidth to many organizations, therefore network traffic analysis is an important issue to analyze the network traffic problems such as failure, attach, or congestion. UniNet has a plan to implement network analysis using Netflow. However, Netflow generates a large number of data. UniNet network has about 120 routers. Each router collects traffic about 3.5 GB/hour in log file. Therefore, all routers will generate 9.8 TB/day or 3.4 PB/year. If UniNet implements Netflow in the current technology, the network congestion will be occurred. Because all Netflow data will be sent to the network center in Bangkok to aggregate and analyze.

Netflow is the protocol for collecting statistics traffic, which developed by Darren Kerr and Barry Bruins of Cisco Systems [10]. The process used IP data packet of Data flow from Netflow buffer which data as same as cache information submitted in the data flow. Flow is a unidirectional data packet which means a two-Flow for each connection, one Flow from Server to Client and another Flow for Client to Server between the two terminals, so Flow can be identified from Key-field. The Key-field is IP source, IP destination, source port and destination port. Therefore, Key-field will be formatted differently based on version of Netflow widely used is version 5, 7, 8, and 9. Any time after receipt the Packet, the router will check Key-field and then identify condition that if a member of the Flow Packet available at the time of Flow Traffic Stats corresponding to the increasing. Otherwise, the new Flow will be created instead. The concept of technology, Cisco, Flow is created continuously recorded on Flow expired. Example of Netflow data was shown in table 1.

<table>
<thead>
<tr>
<th>Date first seen</th>
<th>Duration Proto</th>
<th>Src IP Addr:PortDst IP Addr:Port</th>
<th>Packets</th>
<th>Bytes Flows</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-12-01</td>
<td>00:10:45.481</td>
<td>82.496 UDP</td>
<td></td>
<td></td>
</tr>
<tr>
<td>134.219.234.83:53026 -&gt; 202.28.78.151:12905</td>
<td>11</td>
<td>1056</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Hadoop Architecture

Hadoop architecture is primarily engineered in two parts [7]. The first part called HDFS (Hadoop Distributed File System). It is a distributed file system for storage and replicate data in Hadoop cluster. The second part is Map Reduce functions to process huge data sets. Hadoop architecture has been built for reliability to store data and prepared in the fault-tolerance using principles of replication data on multiple nodes.

The Hadoop cluster is operated by using NameNode with many DataNodes. NameNode is the Master node for storing metadata of the track to the holds list of block in HDFS and liss the block addresses and particular Data Nodes. Data Node is a commodity hardware, which works independently and responsible for collecting the data block. Hadoop has a fault-tolerance mechanism by replicating master Name Node to secondary NameNode and backup Data Nodes.

Map Reduce is composed of 2 parts including Map and Reduce [7], which each part will create key value pairs. Node in the Hadoop cluster performs classification called Job...
Tracker and Task Tracker that Job Tracker controls the entire cluster in the Task Tracker will get from Job Tracker as the map reduce and shuffle. After the task has been processed the results well be sent back to the Job Tracker.

Fig 2 shows the Hadoop architecture and HDFS mechanism.

Fig. 2. Hadoop Architecture.

C. Spark Architecture

Apache Spark [9] architecture has two key concepts. First, the Resilient Distributed Datasets (RDD). Spark supports two types of RDDs: parallelized collections and Hadoop datasets. Parallelized collections are based on existing Scala and Hadoop datasets use the file stored on HDFS to create. RDDs support two types of operations: transformations and actions. Transformations create new datasets from the input and then actions return a value after executing calculations on the dataset. Second, is the directed acyclic graph (DAG) engine that helps to eliminate the MapReduce multi-stage execution model and offer significant performance improvements. Spark Architecture was shown in Fig 3.

Fig.3. Spark Architecture[11]

D. Software-Defined Networking (SDN)

Software-Defined Networking (SDN) is an emerging architecture that are dynamic, manageable, cost-effective, and adaptable, making it ideal for the high-bandwidth, dynamic nature of today's applications [12]. This architecture decouples the network control and forwarding functions enabling the network control to become directly programmable and the underlying infrastructure to be abstracted for applications and network services. The OpenFlow™ protocol is a foundational element for building SDN solutions [11]. OpenFlow-based SDN technologies enable IT to address the high-bandwidth, dynamic applications, adapt the network to business needs, and significantly reduce operations and management complexity [11]. OpenFlow compose of 3 layers including: Application layer, Control Layer and Infrastructure layer, that shown in Fig 4.

Fig. 4. OpenFlow Architecture [11]

The benefit of OpenFlow architecture is enable to the fault-tolerance and improve network interconnectivity. The Job Tracker in Backbone and Distribution Name Node are modified to get the OpenFlow Controller to change to properties of flow paths dynamically, depending on the execution stage and jobs. During a Map job, the flow-path among Data Nodes can be given higher priority for passing the data needed for the job. Likewise, during a Reduce job the flow-path among Data Nodes gets higher priority. OpenFlow also supported fault-tolerant distributed switching architecture between master and slave when fail-over has happened. Fig 5 shows the improvement of Hadoop with OpenFlow.

Fig. 5. Interconnectivity of OpenFlow
Computer servers were divided into 2 systems; Hadoop and Spark they will be installed for using Testbed, so the computer servers will be installed the Hadoop application for Hadoop cluster. Then the Hadoop cluster will be created into 2 sets which use the different network. Each set will communicate each other by OpenFlow switch. The connection speed is 1 GB. The Hadoop cluster will processes Logfile data for analysis the traffic network. While, Spark application used in the same process. Finally, Hadoop and Spark efficiency were compared by using Benchmark. Comparison of performance on UniNet network between Hadoop and Spark by using the same network and equal data size was shown in Fig 6.

IV. RELATED WORKS

Several different approaches have been taken to improve Hadoop. N. Abdul and et al. [4] reported Hadoop-OFE, which presented fault tolerance by using Hadoop cluster with OpenFlow enable interconnectivity. This system runs assignment job in MapReduce program for estimation and setup 2 queues in Open vSwitch for observing the effect of OpenFlow queue on Hadoop performance in congested network. The result showed that time taken of Hadoop-OFE has more efficient. N. Sandhya and et al. [5] studied experiments on Networking of Hadoop by using LINC-Switch in OpenFlow to solve problem about network distributed system of computer. They used fault-tolerance with LINC-Switch format as Distribute switch to connect nodes of a Hadoop cluster. The result showed that the delay of recovery from failures has been reduced. H. Asami and et al. [1] presented using Replica Reconstruction Schemes for Multi-rack HDFS cluster for balancing the load of each Data node and finding effective replica reconstruction schemes. The result was a 16% reduction in time required compared to the default scheme. S. Lixing and et al. [6] studied distributed MapReduce engine by using Distributed Hash Table (DHT) algorithm for solving the SPOF problem. They created two master network each network has 2 master node. The evaluation focuses on the latency, success ratio of the master switch in failure cases and the incurred network traffic overhead when compared with MapReduce1. This method had more performance than MapReduce1. K. Aye Chan and Z. Wint Thida [2] studied about using Erasure Code to replicate on HDFS for protect data lost and reduce storage area. They tested performance of writing and reading a different file sizes and measured storage consumption and storage space utilization. The result was erasure coded replication can save up to 33% of space while outperforming the original HDFS scheme. M. Zaharia and et al. [3] Spark: Cluster computing with working sets, Spark was developed by using caching techniques to improve the performance for repeated operations. Spark has resilient distributed dataset (RDD) which is main abstraction. RDD is maintained in memory across iterations and fault tolerant. In addition, Spark is better than Hadoop and in sub-second response time it can be used to query a 39 GB dataset in sub-second response time.

V. CONCLUSION AND FUTURE WORKS

This paper described the future internet model to improve the Big Data system of Thai research and education network (ThaiREN) on Hadoop platform. Big data is log data of Netflow, which collect data from Backbone and Distribution routers and forwarded to Hadoop clusters. This model used OpenFlow to improve the performance of Hadoop in completing the submitted jobs and provided fault-tolerant distributed switching architecture between master and slave when fail-over has happened. We intend to demonstrate the proposed model in the existing network of UniNet by setting up the testbed and benchmark with typical Big data system. After this experiment, we will expand to the whole network and the other research and education networks such as TEIN or APAN.

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REFERENCES

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