The Network Monitoring System Based on Cacti for EAST

C.C. Li, Z.S. Ji, F. Wang, P. Wang, Y. Wang, Z.C. Zhang

***Abstract*–During the smooth running of EAST (Experimental Advanced Superconducting Tokamak), a perfect network management system guaranteeing a robust network is important. In the present complex network infrastructure, it is a daunting task to manage all the devices manually in a network and make sure they are not only up and running but also performing optimally. Therefore, a web-based software system is developed to implement the real-time monitoring of the EAST experimental network in this paper.**

Written by the language of PHP, the system based on Cacti uses the RRDTool (Round-robin database tool) engine to store data, stores the systems configuration information by MySQL, and collects periodical data through Net-SNMP. It has realized data acquisition, network weathermap, fault alarm, user management and other modules. Compared with the previous management way, our system can dynamically monitor the network link state, bandwidth usage, the information of network devices load in real time, and give the real monitoring effect; it can also find the various faults and give alarm by sending text messages and emails respectively, so that we can take appropriate measures to resolve them in time. Compared to Email alarm, SMS (Short Message Service) based on the hardware of GSM Modem has the advantages of faster speed and more reliable communication signal.

So far, the monitoring system has been successfully applied in the network of EAST and greatly improved the efficiency of network management.

I. Introduction

WITH the fast development of science and technology, the scale of network, which contains a series of points or nodes interconnected by communication paths, is becoming more and more complex. As we know, the interconnectivity of networks is implemented by devices, such as switches, routers and so forth. In order to ensure the robustness of networks, maintaining the devices well is necessary and important.

As a large fusion reaction device, EAST[1,2] consists of a large number of subsystems being operated in distinct hardware and software environment. These heterogeneous tokamak subsystems should be communicated with each other in a stable manner to ensure EAST's reliable running[3]. So guaranteeing the network equipment work well which realizing subsystems' interconnectivity is very important. Fig.1 shows the topology structure of EAST experimental network and reflects the complexity of the netwok at the same time. From a practical point of view, it's very difficult, and even impossible to maintain and monitor these complicated devices manually. Furthermore, the following situations that a power supply burns out, some devices stop working, network bandwidth is out of the threshold value and so on, are out of control and we don't know when these things will happen. So, effective network managing and monitoring is very essential because it can help to solve the above problems and ensure the stable operation of the network.

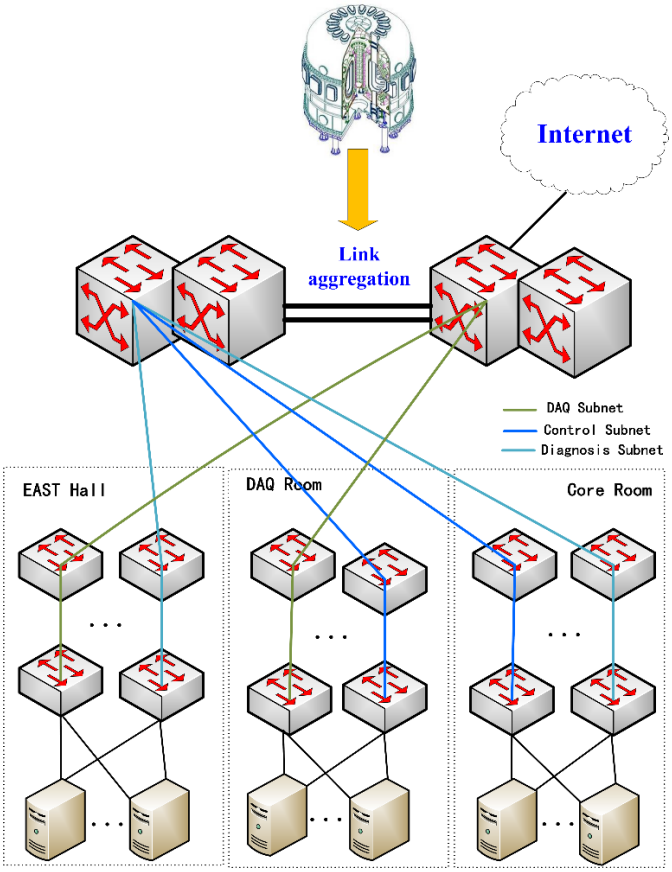

Fig. 1. The topology structure of EAST experimental network.

Therefore, we have developed a network monitoring system based on Cacti for EAST. This system is not only helpful to deal with the above mentioned situations and minimize down-time, but also helpful to collect the relevent information about the network, such as log files. It can generate log files, performance charts of system capabilities and responses, so

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that we can optimize and improve the network performance better and maintain a more robust network[4].

This paper introduces some relevant technologies and realization methods of establishing network monitoring system for EAST.

II. CACTI

A. Cacti overview

Cacti is the core of establing the EAST network monitoring system. It is an open source performance measurement and graphing application tool, and has the following features.

1. It is an open source software and easy to install.
2. It provides a very flxible and friendly web interface to users.
3. It has very strong data and user management functions.

The second feature is realized by the PHP programming language. This feature brings greate convenience to managers because they can complete the configuration of all aspects of the system, as well as automatic display mechanisms for viewing the graphs via the web interface. Compared with other network monitoring software, we find Cacti is much more robust, and has much powerful functions. The above mentioned is the important reasons why we choose Cacti as a network nonitoring tool[5].

B. Cacti basic framework

Multi technologies such as PHP, MySQL, SNMP(Simple Network Management Protocol), RDDTool(Round Robin Database tool) have been adopted by cacti to help produce good motoring and highly interaction interface.

The following is briefly introducing these technologies.

1. PHP: providing a friendly interface for manegers to configure easily and a complete web-based front-end for RRDTool without requiring users to understand how RRDTool works.
2. MySQL: storing the main configuration information(e.g. setting, user and display-related) for any Cacti installation and the devices, graphs information we defined.
3. SNMP: is an Internet-standard protocol for collecting and organizing information about the status, configuration and performance of managed devices on IP networks and for modifying that information to change device behavior[6].
4. RRDTool: storing time series data like CPU load, network bandwidth in an efficient and systematic manner. It lets managers log and analyze the data gathered from all kinds of data-sources (DS), which are capable of answering SNMP queries. The data analysis part of RRDtool is based on the ability to quickly generate graphical representations of the data values collected over a definable time period.[7]

The general schema of Cacti is shown in Fig.2. It describes the basic working principle of Cacti. From an architectural point of view, Cacti uses SNMP service to gather data from different network-attached devices (e.g. servers, switches, routers) in each interval decided by a cron-based poller, Round Robin Database (RRD) to store the polled data and generate graphs, MySQL database stores the relevant configuration information. The primary user interface is a PHP web application. Managers can visit it by multi-clients, such as smart phone, iPad, laptop, desktop computer, and perform a series of management operations. At last, the web show the related information to managers via various kinds of graphs.

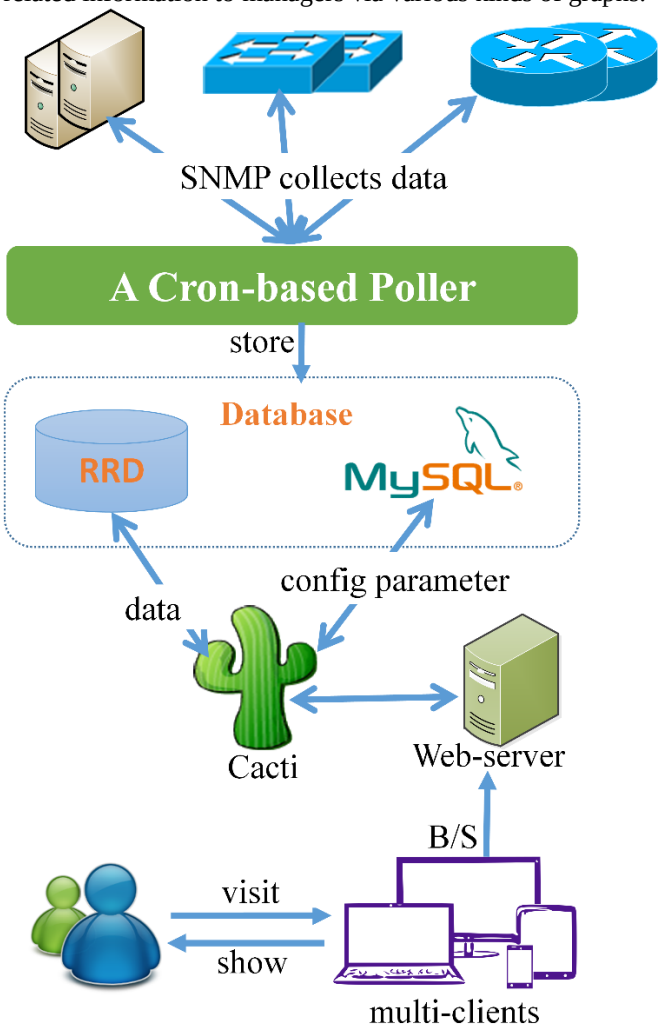

Fig. 2. The General schema of Cacti.

III. SYSTEM REALIZATION

According to the requirements of network monitoring system, Cacti has implemented various functions. Fig.3 shows the main functions of Cacti and briefly describes the role they play respectively. The detail description about the functions are as follow.

A. Graph

Just as before to introduce, the all graphs of Cacti are generated by RRDTool, which contains all the RRD files that hold the performance data. The graph functionality is the most important because it is the basis of other functions. We will create different graphs for each device according to many kinds of performance information such as memory usage, network traffic, load average and so on.

The first picture of the Fig.3 shows the information of CPU usage of device. It displays different types of values(current, average and maximum) on the aspects of system, user, nice and total respectively. Therefore, we can easily acquire the

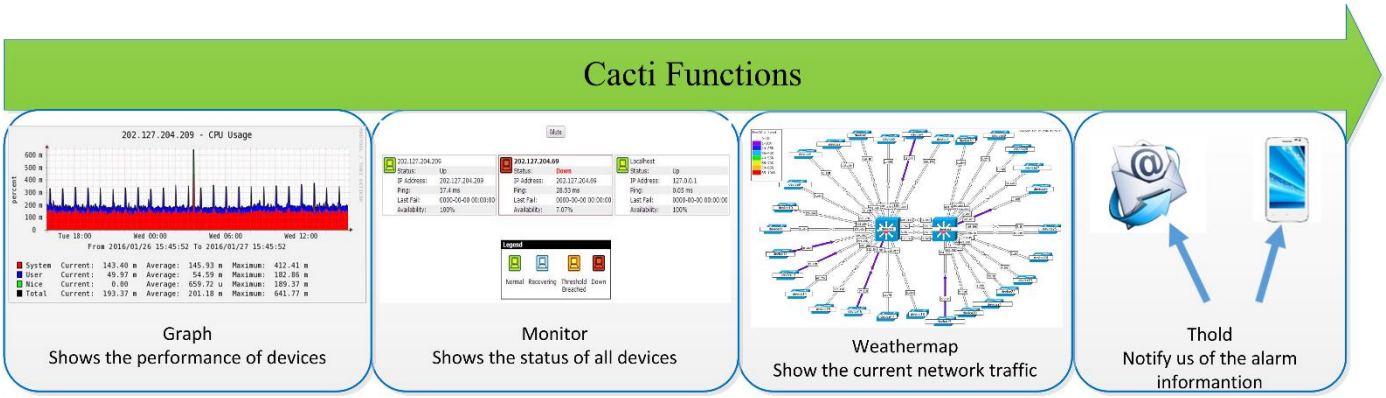

Fig. 3. The display of various functions of Cacti.

detailed performance information of all device by the graphs.

B. *Monitor*

The function of monitor provides a fast and brief way for us to view the status of all monitored devices, and alert us with voice prompt. The status of devices is divided into four different types. They are respectively normal, recovering, threshold breached and down. The second picture of Fig.3 shows these four status clearly in four different colours, which is helpful for manegers to identify the different status of devices quickly.

C. *Weathermap*

Weathermap is one of many implementations of the same basic idea - take data from the network devices and use it to provide a single-page overview of the current state of network[8]. It is a method of realizing network visualisation.In the weathermap, there are two primary elements: node and link. Node represents the monitored device in the network, and link is responsible for the connection between nodes, which can show the current bandwidth by the form of value or usage percentage. Weathermap produces stunning maps by collecting data from RRD files or other data-collection source. Then it will shows the current network link state and performance in a single easy-to-understand graph.

Due to the complexity and reliability of EAST experiment network, some devices such as core switches need to be connected in the way of load balancing. Therefore we should focous on the multi links between devices in order to let each link be able to make contributions to the traffic load, which helps to avoid the problem of single link fault. At the same time, the requirement of displaying the total traffic of the links between devices (namely, aggregate traffic) is also needed to meet. The graph of aggregate traffic is created based on two or more relevant existing graphs. By this function, it will help us to acquire the total traffic of the link clearly and easily, and reduce the usage of memory by reducing the number of graphs. Fig.4 shows the information of load balancing between devices Center95 and Acquisition95; the middle of the graph displays briefly the aggregate traffic of four links between them by putting the mouse on the position of the node of Acquisition95; and the bottom of the graph shows the same content as the middle one in detail, which gives the information of each port.

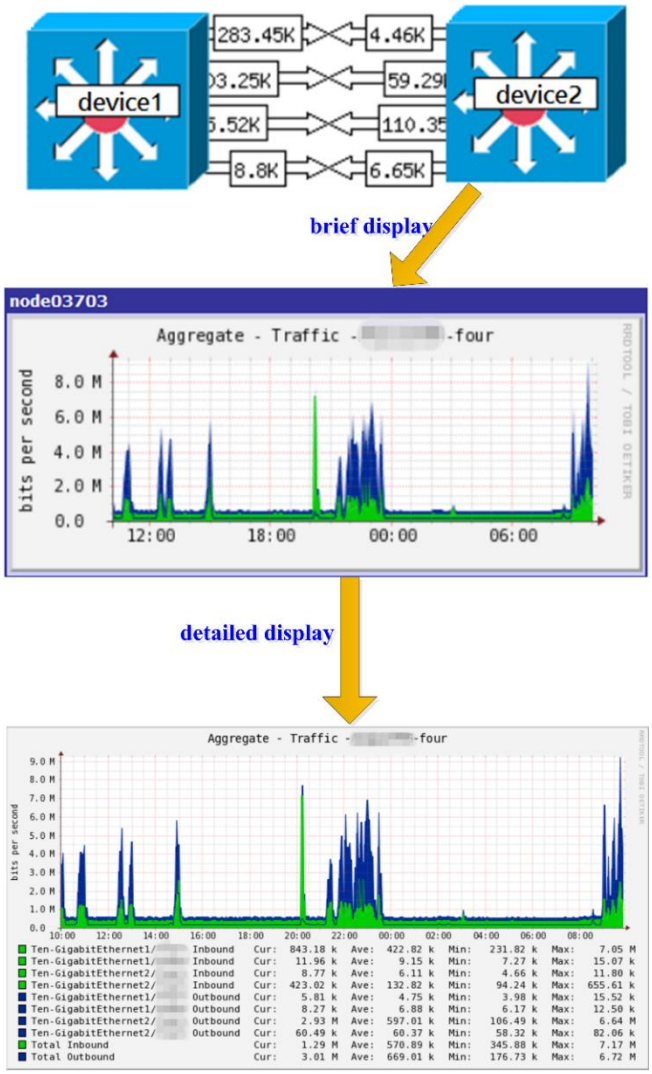

Fig. 4. The graph of load balancing and aggregate traffic.

D. *Threshold monitoring*

During the running of EAST experimental network, it is difficult to predict when some situations happen, such like that network bandwidth overflows or a device just stops working. However, as managers of network system, we should be able to get the above information in time, and take appropriate measures to deal with them so that EAST Tokamak can enter

the state of stable operation as soon as possible. Therefore, our network monitoring system should have a function of threshold monitoring aiming to the above metioned situations.

After installing the plugin of thold, we can set some corresponding thresholds via the web interface in order to meet the demands of our system. The system will automatically send alarm email to the specified mailbox, once the value of monitored performance data is beyond of the threshold. The email describes the content of alarm in detail and gives the current value which exceeds the threshold. As we know, Email alarm is aimed to help us to analyze better the reason of the fault according to the description and the graph. But considering the factors of speed and reliability, we also design SMS alarm on the basis of thold. It pays more attention to the speed that we receive the message when fault happens, which provides much more timeliness and convenience than email alarm.

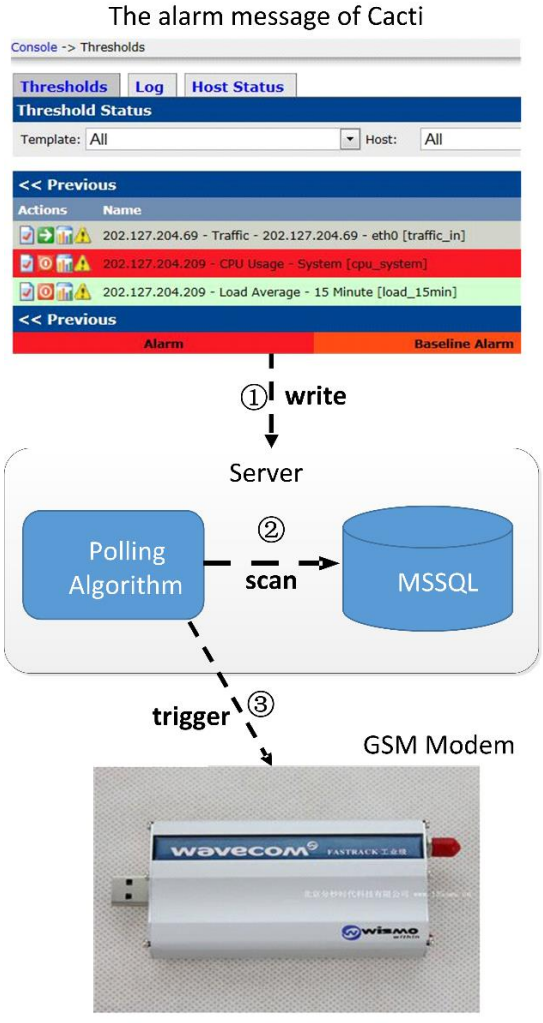

Fig. 5. The working principle of SMS alarm.

Fig.5 descbibes the working principle of SMS alarm. In the Fig.5, MSSQL (Microsoft SQL) and polling algorithm are running on a server, and the hardware of SMS (Short Message Service), namely, GSM Modem, is connected with the server through USB2.0. The main work steps(marked by the dotted line in Fig.5) are as follow.

1. Write the alarm message of Cacti into MSSQL.
2. The polling algorithm is still scanning MSSQL and check if it has a new message.
3. If there is a new message, polling algorithm triggers GSM modem work at once and the hardware sends the message to the manager.

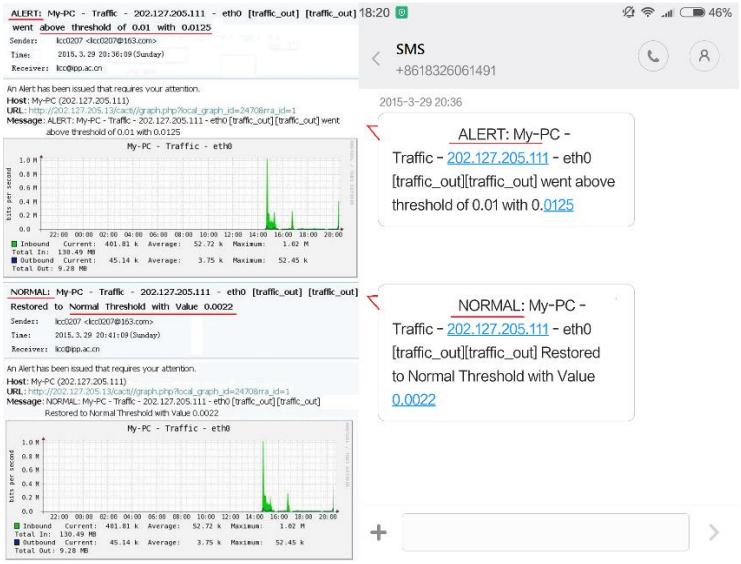

Fig. 6. The test result of email alarm and SMS alarm.

Next, we perform a test about the overflow and recovery of network traffic of the monitored device, named “My_PC”. The threshold of traffic_out is setted to 0.01MBps(Byte per second). Once the current value goes above the threshold or recovers to the normal value, the system will send SMS alarm and email alarm respectively to notify manegers. Fig.6 displays the test result of two alarm methods.The left of the graph is email alarm. The upper left shows the information that current traffic_out value(0.0125) exceeds the threshold(0.01); and the bottom left shows the current value recovers to normal state(0.0022). The right of the graph is SMS alarm, which shows the same content by message.

By the function of threshold monitoring, we can avoid spending much time on looking at all the graphs of device everyday, and take preventive measures in advance before there are real problems, in order to minimize the frequency of fault occurence.

IV. Conclusion

In this paper, we have presented a network monitoring system based on Cacti for EAST. This system realizes multi functions such as device performance management, fault monitoring and the display of current network state. In order to generate log fies and performance charts of system capabilities and responses, the system will gather sufficient amounts of data about the network periodically. The collected information will greatly improve our work efficiency, and let us be able to prepare for the faults in advance. Finally, we can maintain a robust EAST experimental network and even optimize the performance of our network by using this system.

Future effort is ongoing for the EAST experimental network steady state running. Due to the limited range of chart types

and the lack of 3D option, We will pay more attention to these aspects in order to improve and perfect the network monitoring system futher.

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