

Implementation of Network Weather Report System through Network State Observation

Donghyun Lim[†], Hyeakro Lee^{††}, Byungyeon Park^{††},
Haenggon Lee^{††}, Seongjin Ahn^{†††} and Jinwook Chung[†]

[†]Dept.of Information and Communication Engineering, Sungkyunkwan University

^{††}Korea Institute of Science and Technology Information

^{†††}Dept.of Computer Education, Sungkyunkwan University

Summary

This paper pursues to notify the floating situations changes of the whole network of an administrator immediately, to accumulate the network data, to enhance the efficiency of the future network operation and to develop the system which prevents the abnormal situations. The traffic information of Admin Node collected via SNMP agent is gathered in Admin server and provided to the administrator in more convenient and easy-to-see via web browsers. With long-term data accumulated, it's possible to forecast when the network traffic rapidly increases and read the average bandwidth use of certain network sections. So in case of the network resources lacked, it's possible to deal with the situation such as to install additional network equipment or to add the extra circuits.

Key words:

Network Weather System, Network management, SNMP

Introduction

Recently the data transmission quantity rapidly increases and the network adaptor for high-speed communication protocol such as Gigabit Ethernet is popularized, so the backbone network process performance of the corporation system is making a rapid progress. Network should always guarantee its reliance, stability and efficiency. It will be such a big loss if happens circuits terminated or bottle neck in a large ISP or finance industry's network.

When there is a problem in network, if the administrator can realize what is the cause and where is the problem from, it can be managed immediately. Keeping monitoring the network status, when the problem occurs, the administrator can read the situation, manage immediately and prevent the network problems.

This paper suggests Network Weather Report System. Collects the network traffic status information for each section via SNMP agent [1], analyze the bottle neck network that can be in trouble, when the traffic highly increases and what makes the traffic highly increases[3], and the administrator can read the network status easily via

web browsers. So, with the prevention works such as the system upgrade, circuits' extension and etc, a highly reliable network can be deployed [2] [4].

This paper consists of the several chapters; Chapter2 will explain the network administration system, MRTG, SNMP and Flash as a related study, chapter 3 will define the whole system structure and the functions of detail modules. Chapter 4 will explain the implemented system structure in real and chapter 5 will present the conclusion of this paper.

2. Related Study

2.1 MRTG

MRTG(Multi Router Traffic Grapher) ,as a tool which measures the traffic load on network, collects the traffic information from the router or switch via SNMP and shows the traffic status in real time.

MRTG consists of Perl and C, and works in UNIX and Windows NT. Its graph shows daily, weekly, monthly and yearly graph so it can be a good analyzing tool to read its changes for time difference. MRTG can make various transformations because it provides various monitoring with SNMP values (MIB values) as well as the traffic monitoring and it can use the external programs. And it treats the logs that MRTG creates and deploys new database and then it can apply to particular cases. There are the several ways to treat the logs, needless to use complex programs for CGI, with Perl or PHP, it can be applicable on the web. In most cases, MRTG is used in traffic analysis for each interface of network equipment, CPU or memory use rate analysis, ports use rate for each modem and etc.

2.2 SNMP

A Simple Network Management Protocol (SNMP) is a gathered form of detailed descriptions for network

administration including the protocol itself, a definition of database and related concepts.

SNMP is developed and improved together with TCP/IP in its development background. It has been through the similar course as the entire TCP/IP (transmission control protocol / internet protocol) has in historical. But because SNMP developers were free from various restrictions OSI's facilities had, its process to develop SNMP was fast and it could reflect the history of TCP/IP on. That is why SNMP was getting to be a standardized administration protocol that general users choose.

(1) SNMP Manager

It is a tool typically operated in individual but occasionally operated in the shared system. In general cases, SNMP manager provides an accessible interface to the network administrator to access to the network administration system. SNMP manager shall have the following factors at least.

- ▶ Collection of administration applications such as data analysis, error recovery and etc.
- ▶ Interface that makes the network administrator can watch and control the network.
- ▶ Abilities that can actually watch and control the object on Network upon the Network administrator's request.
- ▶ Database information collected from MIB of individuals that can be managed on the entire network.

(2) Management Agent

It is a tool like Host computer, Bridge, Router or Hub and can be managed by SNMP Manager. A Management agent responds to a certain action request or the information request from SNMP manager and occasionally provides important but unpredictable information to SNMP Manager.

2.3 Flash GUI

(1) Special features and merits of Flash GUI

Flash, made by Macromedia Corp., is an optimized tool that can implement animation on the internet. The most valuable feature is its small-sized file capacity. It can also make high quality images due to its graphic type of a vector but it has the same quality regardless of its file size because a vector graphic is an image based on geometric and mathematical operation. That is a big advantage that it has no changes in its quality even if the size of image changes bigger or smaller. And it is easy to make a web site in conversation type.

(2) Action Script

Action Script is a scripting language used in Flash program. It contains commands to be executed when users click a mouse or a key on keyboard. That means that Action Script is used for making interactions between a user and a computer in Flash.

Flash can make animation with timeline and make multimedia contents including the strong and enriched interactions with Action Script as well. Using Action Script, the visual and audio elements in Flash movies are controlled by commands, and each command is called 'Action'. Action Script is a code consisted of those actions. In case Action Script is used in Flash movies, when the movie plays with a Flash player, it interprets and executes this Action Script.

2.4 Interworking of web server and Flash.

A Server side, as it is, means "jobs on the web server side." Jobs here are to save data from a web browser in database and to make results from certain mathematical operations in detail. These jobs are charged in 'web programs'. Generally PHP, ASP, Perl, Python and etc are used as a web program.

(1) Send out data from PHP to Flash

Flash loads data from the remote source with the following action: loadVariablesNum()

Table 1: How to load data from the remote source.

```
loadVariablesNum("http://www.skku.ac.kr/PHP.data.php", 0);
```

The name of variables is made in the external source. The form of the external variables loaded to character string field with 'loadVariablesNum()' used is as follows.

Table 2: How to load from the external source to character string field.

```
Variables name = data in variables.& new variables = other data
```

It shall be no blank among the name of variables, = and contents of variables. New variables are distinguished from the first variables with '&' and it shall follows the same rules as the first one does. And it shall be no blank between data of the first variables and '&'.

(2) Send out data from Flash to PHP

To send out data from Flash to PHP, there should be a way to load data from Flash and to make the data go away to somewhere. Same as HTML, Flash also provides two ways to send out data; GET and POST. As GET method is

known as the best method between platforms, so GET will be used here. The general form is as follows.

Table 3: How to load from the external source to character string field.

```
loadVariablesNum
("http://www.skku.ac.kr/PHP/grand.php",0,GET");
```

It is same in a loading form of variables from Flash, but different in adding GET after level values. And, what variables sent out from Flash? All variables are sent out. To get Flash variables, PHP adds '\$' at the front of each Flash variables. For example, Flash variables 'MyGreatVariable' is transferred to PHP as '\$MyGreatVariable'

3. Total System Structure

3.1 Total System Summary

This system is Network Weather Report System which collects SNMP information of Admin Node and read the status of Node on Admin Network.

In Admin server of the center, SNMP Manager collects Admin Information from Node where SNMP agent installed periodically and accumulates those in Admin server. With those information, various CGI modules working in Admin server provides the Administration function to the administrator via a web server. Also it supports the convenience of Network administration to the administrator, as it provides the interface that the administrator connected via web can easily read the status of Admin Network and be available to manage Weather Map via web as well.

3.2 Total System Organization

The organization of the total System this paper suggests is as the following <Fig.1>. The Total System consists of Network Admin server, Admin Console, Measured DB and Admin Node as the figure shows.

Admin Node on the bottom monitors the status of Network periodically and reports it to Admin server. Admin server gathers, saves data, process data easy-to-see and give the service to the administrator upon the administrator's request via Admin Console. Performance measured results are saved in Measured DB, after information accumulated, saved information can be shown as a report form.

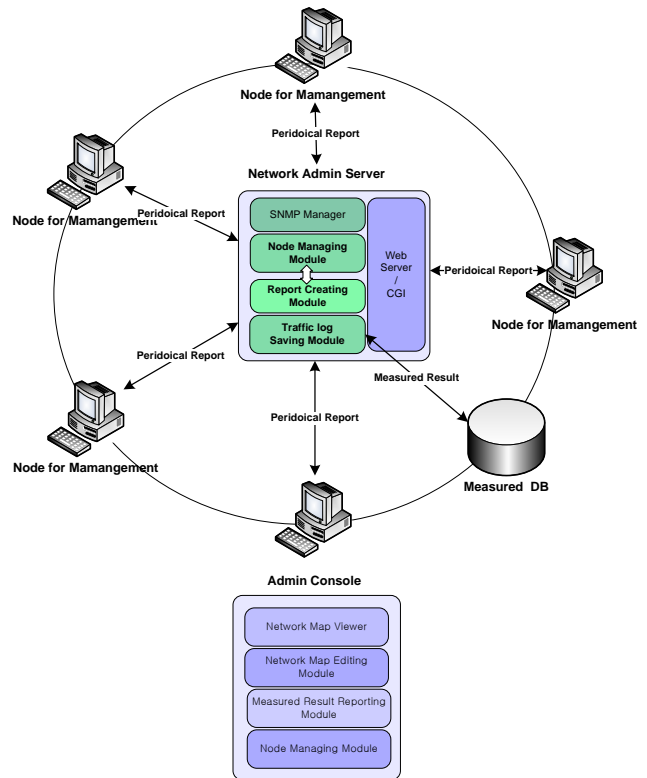


Fig. 1 The Concept of total system

3.3 Total System Functions

This system supports functions that the administrator can read the status of Admin Node via Admin Console in remote and edit Network Weather Map that shows Admin Node. The functions for each element of total System are as follows.

Admin server initializes Network Weather Map, edits Admin Node and provides the function which shows the status of Node with CGI on web server. Admin Console shows the real time information for Admin Node and provides the function that displays the filtered Admin Node via Network Weather Map. Admin Node sends out traffic information of Admin Node to Admin server according to the period set in Admin server. Measured DB keeps Admin Node information from Admin server with Agent list tables, creates tables for each interface IP of Admin Node and saves traffic information. The detailed functions descriptions of this system are as follows.

(1) Web based Administrator's Interface

This supports interface that makes the administrator monitor the status of Admin Node easily via web browser and Admin Node easily and efficiently. This interface can

make the administrator send a request to CGI of Admin server, get responses from Admin server and confirm the performance result on web browser. Information requested is such as the information about Admin Node, the request of Weather Map modification and etc. And information responded is such as the report and information offer about Admin Node and the requested modification of Weather Map. This interface provides the information of Admin Node to web browser via Shockwave files in Flash.

(2) Real time Traffic Status Display of Network Admin Node

Network Weather Report System updates the status of Admin Node on Weather Map without the administrator's special request according to the existing set period. And for the administrator who wants more detailed information, it provides traffic reports for each interface with selecting Network Interface Information of Admin Node Information and the status graphs that shows traffic status from the certain period to now via web browser on Admin Console. Information of graphs is updated whenever users ask.

(3) Management of Network Admin Node

This system supports the function that can observe the status of Admin Node on Admin Network via web browser. The functions divide into Management Information Display and Management function of Admin Node and Filtering by level and bandwidth that shows Admin Node in groups on Network Weather Map. This system receives Management Information periodically via SNMP Manager on Admin server and SNMP Agent on Admin Node. Management function of Admin Node means the same as SNMP Manager manages a list of SNMP Agent that SNMP Manager monitors. Filtering function by level and status information of Admin Node works on web browser of Admin Console. Network Weather Map gets all information of Admin Node to Flash with using an initialization module of Admin server CGI. Flash filters Nodes by information from Admin server, organizes Network Weather Map and provides the function that can make the administrator observe the status information of Node more convenient.

(4) Management of Network Weather Map

This system supports the function that can manage the organization of Network Weather Map via web browser of Admin Console. There are five functions of Network Weather Map Management. First, it is the function that can add Admin Node on Network Weather Map and display the status information.

When adding Admin Node, all the management information displayed such as name and location of Node, contact number of the administrator, IP information, Network Interface information installed in Node and etc can be inserted. And it sets the level of Admin Node and makes the display icon of Admin Node according to the level set. The number of interfaces that Admin Node can set is from minimum 1 to maximum 5, and in case only that it sets the normal type of IP for each interface, Admin Node can be added. Reporting function can be available according to IP set to Interface.

Second, it is the function that deletes Admin Node. Select 'delete' and 'Node', Admin Interface of web browser sends the information of selected Node to CGI of Admin server. CGI of Admin server receives the information of Admin Node, deletes the Node information about Measured DB and sends out the message; successfully deleted.

Third, it is the function that modifies information of Admin Node. This can modify all information put in except for the name of Admin Node when adding Admin Node. If selecting 'Modify', the existing information is displayed on Admin Interface, and all information can put in as the same as the Admin Node newly added. To modify IP allocated to Interface, the number of interfaces shall be adjusted first. When the same IP puts in, DB table is updated and it shows the information before modification consecutively. When new IP puts in, it creates new table in Measured DB and gets data, and in case that the existing IP is deleted, and it deletes the related Interface information on DB table. To modify the name of Admin Node, first it is deleted and then new one shall be added.

(5) Saving measured traffic and Creating a report.

This system saves traffic information of Admin Node as logs, creates a report and provides the report upon the administrator's request via web browser on Admin Console. Admin Node makes SNMP Manager receive traffic information via SNMP Agent periodically and save traffic information as logs. Logs saved consist of UNIX timestamp/ traffic input/ traffic output/ max. traffic output for 5 min./ max. traffic output value for 5 min. The format of logs will be referred later. It creates a traffic report about Network Interface according to Admin Node and provides the report when the administrator requests a report of Interface information via web browser on Admin Console.

3.4 Design of total System

To implement Network Weather Report System, this paper presents the entire system divided into Weather Map System, MRTG System, Measured DB System, DB

System and Weather Map Interface System of Admin Console.

Weather Map System consists of Map initialization module, the status of Admin Node and graph data transmission modules, Admin Node location saving module, Admin Node editing module and a module that saves traffic information in Measured DB. Map initialization module is designed to be the upper module than all the other modules. After Admin Node edited, Map initialization module is always executed.

MRTG System is implemented based on SNMP Manager System. It manages SNMP Agents with management module of Admin Node and collects traffic information. Collected traffic information are saved as logs for each IP and saved for each IP table in Measured DB upon the periodical request of Weather Map System. And it creates reports for each Network Interface (IP) and provides reports via web browser on Admin Console upon the Weather Map System's request.

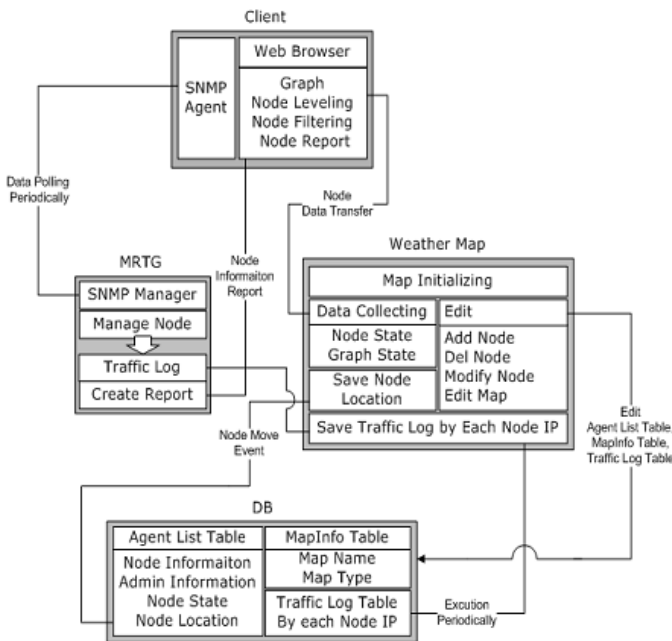


Fig. 2 A design of a total system

Measured DB System is to save all information and Weather Map files information of Admin Node and traffic information for each IP of Admin Node. The administrator can access to Measured DB via CGI of Admin server with web browser of Admin Console used. And traffic logs of MRTG System are saved in IP table of Measured DB by periodical calling of CGI in Admin server.

Weather Map Interface System at Admin Console works at web browser and sends & receives transmission variables to/from Weather Map System of Admin server. It supports the status display of Admin Node and Interface of Admin

function, and supports filtering function using Node information received from Admin server according to level and use rate of Admin Node.

3.5. Design of detailed function modules.

(1) Map initialization module

Weather Map initialization module is executed when Web browser first loads Network Weather Report System. It consists of the part that loads Map picture files and modules that transmits information for each name of Node and for each Interface (IP).

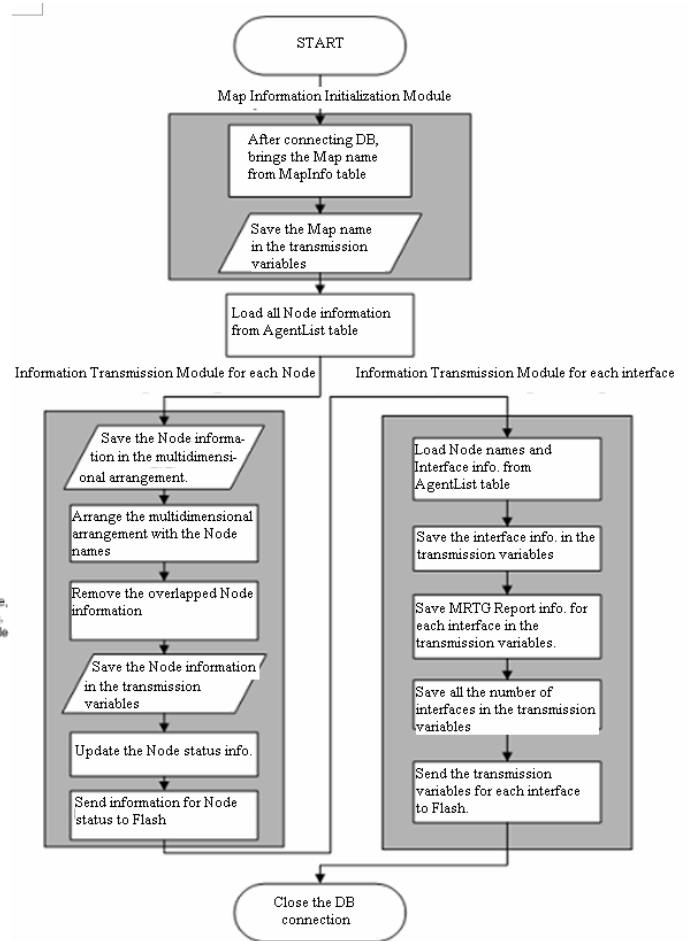


Fig. 3 Map Initialization modular configuration

There are AgentList table that manages information and lists for agents, MapInfo table and Interface (IP) table in Measured DB. Once the initialization module is loaded, it gets the file name which is Weather Map's background, from MapInfo table and loads the file.

Map initialization module has a part that reads all Node information existed on AgentList table and puts into multidimensional arrangement. The reason why it does not use the information of Measured DB and puts into multidimensional arrangement is the input way of Node information in AgentList table. Because Node names are saved overlapped as much as the number of Interface (IP) in AgentList table. So, in case of the Node that has 2 or more Network Interface cards and IPs, there are 2 or more data that have the same information except for IP and Interface information. That is why first it moves the information to the multidimensional arrangement, after then, arranges the name of Admin Node, and picks out the information whose names are not overlapped to the arrangement. And it saves Node information to transmission variables one by one, adds the status of Node and transmits them to Flash.

(2) Node adding module

Node adding module is a file that is executed when selecting 'Add' menu on Network Weather Map. When the administrator selects 'Add' menu on web browser of Admin Console, pop-up window pops up to insert Management information of Node.

The information shall puts into when adding Nodes are as follows.

- ① Node name
- ② Location
- ③ Administrator
- ④ Contact number
- ⑤ The number of Interfaces (Select 1~5)
- ⑥ Node level (to fix icons)
- ⑦ IP (Pop-up windows pops up according to the number of Interfaces)

Putting the information in and clicking 'Confirm' button, Node adding module is loaded and the added Node information is transmitted from Admin Console to Admin server. If Node adding module is loaded in Admin server, it verifies whether the information inserted is right or not over 2 times. First it verifies there exists a value in variables and then verifies whether it is the right one. For IP, first verifies there are 3 '.' in character string and verifies each number is in 0 to 255. After judging whether the variables are normal, verifies whether there are no overlapped Node names and IP compared with values of AgentList table in Measured DB. As this system does not allow the overlapped Node names and IP, if putting the overlapped Node names and IP, Node adding process is failed and the failed message displays.

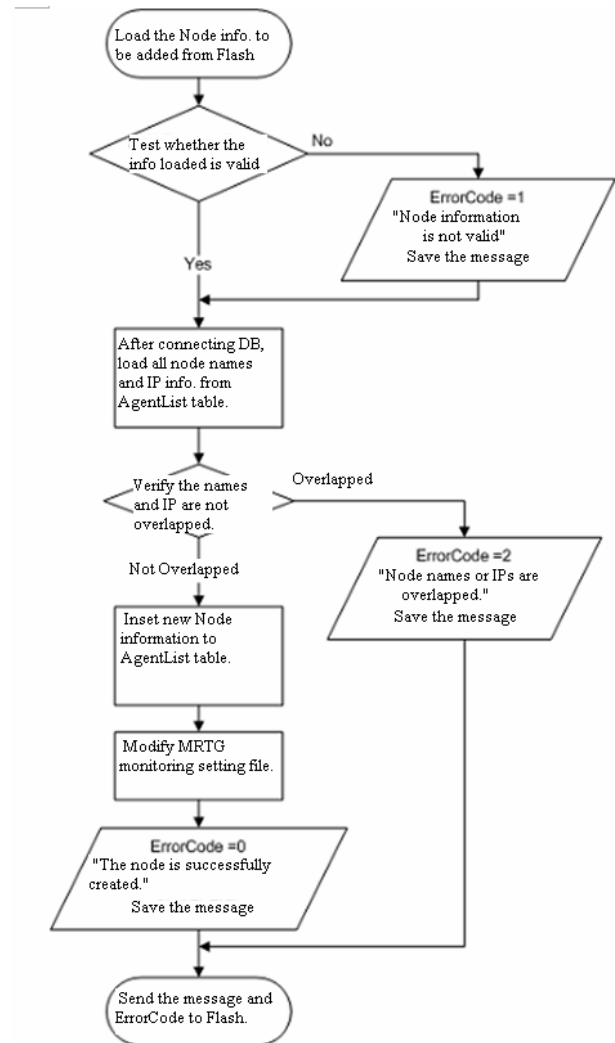


Fig. 4 Node additional modular configuration

(3) Node deleting module

Node deleting module is a file that is executed when selecting 'Del' menu on Network Weather Map. When the administrator selects Node deleting menu and selects the Node to be deleted, pop-up window pops up to re-confirm whether deleting it or not. Selecting 'Confirm' button again and then the selected Node information are transmitted to Admin server and Node deleting module is executed.

When deleting module is executed in Admin server, it brings the Node information to be deleted from Flash. After receiving the information to be deleted, it drops the related IP table in Measured DB and deletes the Node information in AgentList. After working done in Measured DB, transmits the message with the successfully done

ErrorCode to Flash. When Flash receives the message with the successfully done ErrorCode, loads the initialization module and re-organizes Map. As Node information disappeared in Measured DB, when re-organizing Map, Nodes are displayed except for the deleted Node.

(4) Node Information modifying module

It is a module that is executed when selecting Node modifying menu on Network Weather Map and selecting Node to be modified. Flash shows Node information that is saved temporarily on web browser of Admin Console. The value that Flash has is the same as the current value of Measured DB. The administrator verifies the current Node information and puts the information to be modified. To modify IP information of Network Interface, adjust the number of Interface first. It is the same when allocating IP to other Network Interface. Node names are unavailable to modify in policy. To change Node names, delete the Node first, and then create new one.

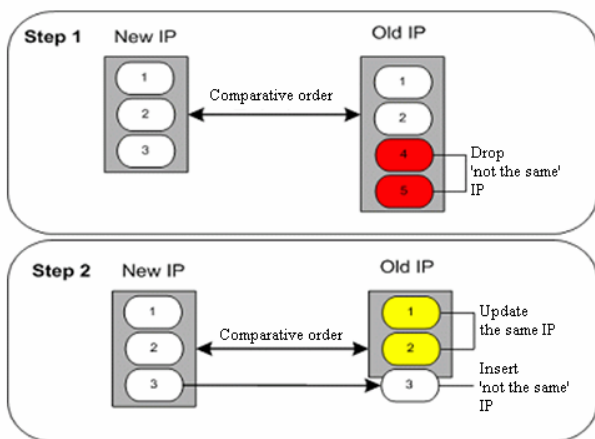


Fig. 5 A node information revised module IP comparative order

After putting the information in Flash, click 'Confirm'. And Node information is transmitted to Admin server and Node information modifying module is executed. Node information modifying module, same as Node adding module, first performs Input Error Test. Test the variables received from Admin Consol and check whether it is overlapped. There could be no overlapping error because Node names are not modified. So the number of error messages decreased in comparison with Node adding work can make.

After finishing Input error test and overlapping test, perform Node information modifying work. For Admin information, if it is inserted normally, all information is updated. For Interface IP, there is a case that it allocates the same IP to other interface. At that time, it is better to update than to drop IP table and delete Node information.

And compare new IP and the existing IP over 2 steps. First, drop the different IP from the existing IP and second, insert the different IP. The same IP updates other Node information. As the Node name does not change, it plays a role as a key value that distinguishes Node from Measured DB.

(5) Node position saving module

Selecting 'Move' menu on Network Weather Map, it is possible to move the fixed Admin Nodes. A position of displays in Flash has a coordinate value, and Node position saving module saves the position where the Node already moved out in AgentList of Measured DB after the administrator selects and moves the Node out.

Node position saving module is executed when the administrator finishes moving the Node. It consists of a simple structure, and after the Node finishes moving, it brings the Node name and the coordinate value of X and Y from Flash. Node position saving module searches Measured DB for the brought Node name and updates the coordinate value of the corresponding Node position. When initially created, Node has 'null' value as its position, and it is located at the basic position of Network Weather Map.

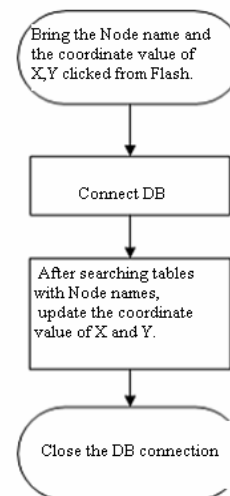


Fig. 6 Node position saving modular configuration

(6) Module storing traffic log in DB

SNMP Manager receives traffic data that SNMP Agent sends and creates traffic log file. Admin server saves these traffic log periodically in DB.

This module inspects IP table of Measured DB and saves the traffic log file of the corresponding IP in DB. Accordingly, if Node adding module inserts Node

information in AgentList and SNMP Manager creates logs with the periodically received information, this module creates IP table, reads and process logs and saves logs in DB. Without the administrator's commands, it is saved in DB according to the set period. Generally it works at the same intervals as SNMP Manager creates traffic logs. After reading traffic logs and calculating the use rate, update the use rate information of AgentList. This information is used to display the real time Node status.

(7) Graph data transmission module

A graph data transmission module is executed when the administrator selects the interface information of Node information. When a web browser of Admin Console asks the information, a graph data transmission module works and brings all the saved traffic data in Measured DB from 30 minutes ago to the latest. When selecting the interface information of Node, Flash transmits IP of data to be brought to the graph data transmission module and the graph data transmission module receives IP and searches the tables of Measured DB. If there is a table of the corresponding IP, transmit the result data.

(8) Node status data transmission module

A Node status data transmission module is similar with a graph data transmission module. A graph data transmission module is executed upon the administrator's request, however, a Node status data transmission module transmits data to Flash without the administrator's request periodically as the same as a module storing traffic log in DB does.

It brings names and status information of all Nodes existed in AgentList of Measured DB, arranges them, saves them in the transmission variables and transmits them to Flash.

(9) Map file upload module

Using Map editing menu on Network Weather Map system, a Map file upload module is executed. Execute this menu on Admin Console, and a file explorer pops up over Flash UI and an image to upload can be selected. Select and upload the image on Admin Console, and the image file moves to a web server page of Admin server, and a Map file information in MapInfo table of Measured DB is revised to newly uploaded information. A Map file upload module consists of two processes.

First, select and upload the file in Flash, execute step 1, open a session and upload the file in the designated route. Second, step 2 works after uploading. Receive the file name uploaded from Flash and update Map information table in Measure DB.

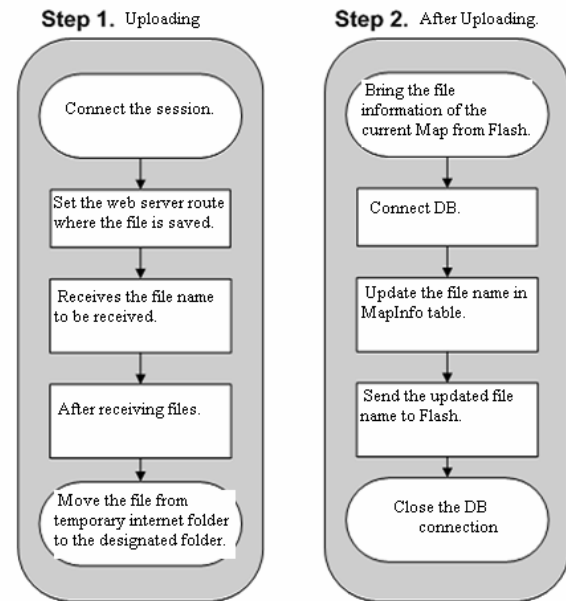


Fig. 7 A Map file upload module

4. System Implementation

4.1 Administrator's GUI

<Fig. 8> shows the implemented Network Weather Map GUI. This system supports the real time status display for Admin Node, a filtering function for each Node status, Node information display, Network Weather Map editing function that shows Admin Node, Weather Report offer and etc. The summarized functions that this system supports are as follows.

- ▶ Real time status display of Network Admin Node
- ▶ Accumulated admin information display in graph of Network Admin Node
- ▶ Admin information display of Network Admin Node
- ▶ Filtering function for each level of Network Admin Node
- ▶ Filtering function for bandwidth use rate of Network Admin Node
- ▶ Network Weather Report Map editing function
- ▶ Network Weather Report offer function

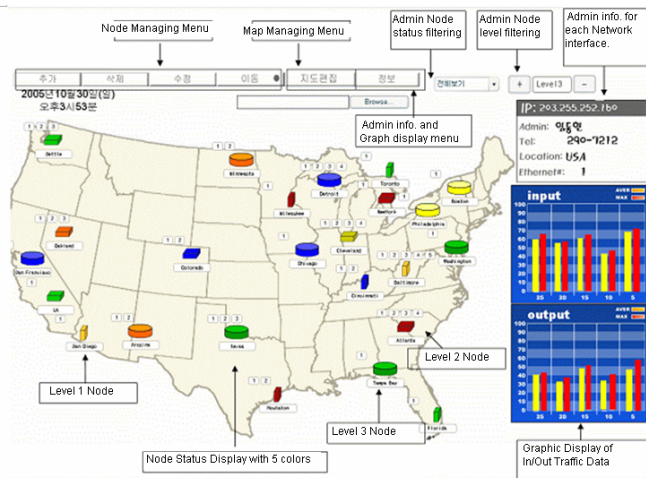


Fig. 8 Network Weather Map GUI

4.2 Measured DB System Summary

Measured DB system saves traffic information collected from Admin server and manages information of Admin server. CGI of Admin server is positioned between the administrator's GUI and Measured DB and saves the administrator's request in DB or displays data obtained from DB on the administrator's GUI.

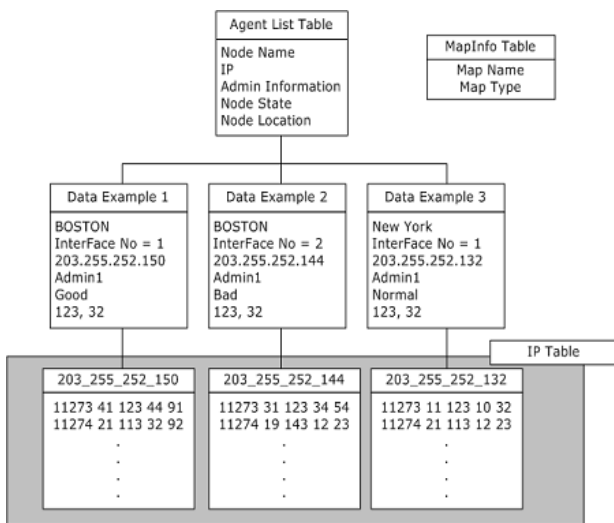


Fig. 9 A measurement DB system

Measured DB consists of AgentList table, IP table and MapInfo table and the relationship among these tables is as the showed figure. AgentList table manages all information about Admin Node, supports IP information to logs saving module of Admin server and helps create IP tables. So the number of IP table is the same as the number of AgentList table. MapInfo provides Map file information

when the initialization map is loaded. Map file information is updated by a Map editing function.

5. Conclusion

This paper pursues to notify the floating situations changes of the whole network of an administrator immediately, to accumulate the network data, to enhance the efficiency of the future network operation and to develop the system which prevents the abnormal situations.

The result of this paper can make the general status of a certain Network display. The traffic information of Admin Node collected via SNMP Agent is gathered in Admin server and provided to the administrator in more convenient and easy-to-see via web browsers. With long-term data accumulated, it is possible to forecast when the network traffic rapidly increases and read the average bandwidth use of certain network sections. So in case of the network resources lacked, it's possible to deal with the situation such as to install additional network equipment or to add the extra circuits.



Donghyun Lim received the B.S. degrees in information and communication engineering from Sungkyunkwan University, Korea in 2005. He is currently working toward the M.S degree in computer engineering with the School of Information and Communications Engineering, Sungkyunkwan University, Korea.



Hyeakro Lee received the M.S degree in education information from Kongju University, Korea in 2004. Since 1990 he has been a researcher of Korea Institute of Science and Technology Information. He is currently working toward the Ph.D. degree in the curriculum of education with Sungkyunkwan University, Korea.



Byungyeon Park received the M.S degree in education information from Kongju University, Korea in 2004. Since 1990 he has been a researcher of Korea Institute of Science and Technology Information. He is currently working toward the Ph.D. degree in Bio informatics with Kongju University, Korea.



Haenggon Lee received the M.S degree in statistical informatics with Chonbuk University, Korea in 2000. Since 2000 he has been a researcher of Korea Institute of Science and Technology Information.



Seongjin Ahn received the B.S., M.S., and Ph.D. degrees in information engineering from Sungkyunkwan University, Korea in 1988, 1990 and 1998. He is currently a professor department of computer education, Sungkyunkwan University, Korea.



Jinwook Chung received the B.S. and M.S. degrees in Electric engineering from Sungkyunkwan University in 1974 and 1979, And he received the Ph.D. degree in computer science, from Seoul National University, Korea in 1991. He is currently a professor department of information and communication engineering, Sungkyunkwan University, Korea.