IMPLEMENTATION OF CENTRALIZED MONITORING SYSTEM USING TRAP AGENT

Major Project Report

Submitted in partial fulfillment of the requirements

for the degree of

Master of Technology

 \mathbf{in}

Electronics & Communication Engineering

(Embedded Systems)

Jay Dabhi

(14MECE03)



Electronics & Communication Engineering Branch Electrical Engineering Department Institute of Technology Nirma University Ahmedabad-382 481 May 2016

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Declaration

This is to certify that

- a. The thesis comprises my original work towards the degree of Master of Technology in Embedded Systems at Nirma University and has not been submitted elsewhere for a degree.
- b. Due acknowledgment has been made in the text to all other material used.

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Certificate

This is to certify that the Major Project entitled "IMPLEMENTATION OF CENTRALIZED MONITORING SYSTEM USING TRAP AGENT" submitted by Dabhi Jay K. (14MECE03), towards the partial fulfillment of the requirements for the degree of Master of Technology in Embedded Systems, Nirma University, Ahmedabad is the record of work carried out by him under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination. The results embodied in this major project, to the best of our knowledge, haven't been submitted to any other university or institution for award of any degree or diploma.

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This is to certify that the Major Project entitled "IMPLEMENTATION OF CENTRALIZED MONITORING SYSTEM USING TRAP AGENT " submitted by **Dabhi Jay K.(14MECE03)**, towards the partial fulfillment of the requirements for the degree of Master of Technology in Embedded Systems, Nirma University, Ahmedabad is the record of work carried out by him under our supervision and guidance. In our opinion, the submitted work has reached a level required for being accepted for examination.

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Abstract

The embedded systems like X86 (linux based system), Router (Panda board running with openwrt) and embedded devices (R-Pi) running on the same network can be monitored by central server. The user can configure the list of parameters to be monitored on each devices in the network. Also the user can configure the threshold values on few parameters (like CPU, Memory, etc.), so when the parameter on the system exceeds the configured value / threshold, the event would trigger to the central server. User can enable or disable the TRAPs, can assign the priority to the TRAPs, can assign the Threshold value of the TRAP. The TRAP AGENT library running at the client side monitors the various parameters of the client. And it notifies to server as per the configuration parameter. At the server side simple GUI will be made to display the TRAPS .Admin can configure the system using the GUI. The TRAP AGENT library is designed in a such way that it can work on any Linux distribution. The TRAP AGENT library will be tested in three major platforms.

- Desktop computing
- Embedded system
- Router system

Contents

D	eclar	tion	iii
D	isclai	ner	iv
С	ertifi	ate	v
С	ertifi	ate	vi
A	ckno	ledgements	vii
A	bstra	t	viii
Li	ist of	Figures	xiii
1	Intr	oduction	1
	1.1	Centralized Monitoring System	1
	1.2	Trap agent library	3
	1.3	System overview	4
2	Wo	king of system	6
	2.1	Basic Working	6
	2.2	Working at server side	7
		2.2.1 Main menu of server	7
		2.2.2 Submenu after pressing config button	8
		2.2.3 Displaying and changing the configuration value of client	8

		2.2.4	Configuration file	9
	2.3	Worki	ng at client side	10
	2.4	Block	Diagram	11
		2.4.1	Block Diagram of server	11
		2.4.2	Block Diagram of client	12
3	SYS	STEM	ARCHITECTURE	14
	3.1	Whole	e System Architecture	14
	3.2	Client	architecture	15
	3.3	Server	System architecture	16
	3.4	USE (CASES	17
		3.4.1	Actors	17
		3.4.2	List of use cases for admin	17
		3.4.3	Use Cases Discription	17
4	Boa	rd bri	ng up and installation of library	20
	4.1	Board	bring up for pandaboard	20
	4.2	Board	bring up for raspberry pi	23
	4.3	Install	ing TRAP LIBRARY at client device	23
5	Fina	al Resi	ults	25
	5.1			
		GUI(C	Graphical User Interface) of server	25
	5.2	Config	Graphical User Interface) of server	25 27
	$5.2 \\ 5.3$	GUI(C Config Startin	Graphical User Interface) of server	25 27 29
	5.2 5.3 5.4	Config Startin Displa	Graphical User Interface) of server	25272930
	5.2 5.3 5.4	Config Startin Displa 5.4.1	Graphical User Interface) of server	 25 27 29 30 30
	5.2 5.3 5.4	Config Startin Displa 5.4.1 5.4.2	Graphical User Interface) of server	 25 27 29 30 30 31
	5.25.35.4	GUI(C Config Startin Displa 5.4.1 5.4.2 5.4.3	Graphical User Interface) of server	 25 27 29 30 30 31 32
	5.25.35.4	GUI(C Config Startin Displa 5.4.1 5.4.2 5.4.3 5.4.4	Graphical User Interface) of server	 25 27 29 30 30 31 32 33

CONTENTS	xi
7 Future Work	35
Bibliography	36

List of Figures

1.1	Syslog working ^[1] \ldots \ldots \ldots \ldots \ldots \ldots \ldots	2
1.2	UDP in syslog	3
1.3	System working	4
1.4	System working with priority, threshold, enable options	5
2.1	Main menu of server	7
2.2	Displayin all the online users(clients)	8
2.3	Displaying the configuration file	9
2.4	Configuration file structure	10
2.5	Structure of client configuration file	10
2.6	Block diagram of server	11
2.7	Block diagram of client	12
3.1	Whole System Architecture	14
3.2	Client system architecture	15
3.3	Server system architecture	16
3.4	Use Case Diagram	18
4.1	Pandaboard ES	20
4.2	Openwrt toolchain	21
4.3	Boot up process	22
4.4	Login page of Openwrt	22
4.5	Raspberry pi B	23

LIST OF FIGURES

4.6	Installing TRAP LIBRARY at client device	23
5.1	GUI(Graphical User Interface) of server	25
5.2	List of connected users	27
5.3	Configuration file	27
5.4	Starting of the Server	29
5.5	New User added and deleted in pandaboard server view	30
5.6	New User added and deleted client in panda board	30
5.7	CPU usage increased in raspberry pi	31
5.8	Pandaboard is disconnected from network	32
5.9	Login to raspberry pi using ssh (Trap genrated at server	33
5.10	Login to raspberry pi using ssh (New user is login to raspberry pi	
	using ssh)	33
7.1	Centralized system using Cloud Computing	35

xiii

Chapter 1

Introduction

1.1 Centralized Monitoring System

In a network there are many systems connected to each other. In this system we can have desktop computer, embedded systems or any other industrial instruments. These systems are connected to the server. In the offices, organization or in industries all these clients are connected to the external network via server. This server is interface between the LAN and external network. In the centralized monitoring system the admin at server can monitor the client system information. The system information includes the current memory usage, current cpu usage , network information, system performance etc. The program(TRAP AGENT or TRAP LI-BRARY) running on the client system informs status of the client to server. So person at server side can monitor all the clients centrally. This entire system is known as the centralized monitoring system.

CHAPTER 1. INTRODUCTION

Currently syslog is a way to send event message to logging server. syslog uses UDP as a transport. UDP is connectionless and not guaranteed so it could be possible to lose log messages due to network congestion or packet loss.



Figure 1.1: Syslog working^[1]

Since syslog is using UDP there is no acknowledge back from server to client. If some event is generated at client side then client transmits message to server. If message is lost in channel then server will not get the event information from client. And client cant know that message is lost because there is no acknowledge back from server to client.



Figure 1.2: UDP in syslog

To overcome above problem we can make the use of TCP communication.

1.2 Trap agent library

As discussed in the centralized system client can be monitored by the server. This task is carried out by the library (software) installed in the client. This library will monitor the system parameters. If the status of system parameter is changed then this library will notify the status of that parameter to server. Notifying the system parameter value to server is known as TRAP. So Trap agent library will monitor the system parameter and it will send trap (parameter value) to server.

1.3 System overview



Figure 1.3: System working

Admin at server side can set the Threshold value of system parameter for each client, can disable or enable TRAP, can set priority to TRAP.

- Threshold value: When the system parameter value changed beyond threshold value then that particular trap will be notified to server.
- Enable: When TRAP is enabled then client will notify that particular TRAP to server. If TRAP is disabled it will not be notified to server.
- Priority:Priority can be assigned to TRAP. The priorities are warning,debug,error,critical and alert.Error(E),critical(C) and Alert(A) are high priority.Debug(D),warning(W) are low priority. High priority trap is notified to server within 1 second and low priority trap is notified to server within 5 seconds.



Figure 1.4: System working with priority, threshold, enable options

As shown in the figure ,for client1 the CPU trap is disabled, for client2 threshold value is set for parameter memory usage and for client 3 the priority is given to the USB trap. So CPU usage trap for client 1 will not be notified to sever even if it is there. The memory usage at client2 is increased beyond 55 percentage so it will be notified to server and USB trap has been given critical priority, so it will be notified in the less time to server.

Chapter 2

Working of system

2.1 Basic Working

- The client library will start automatically when system starts.
- It will wait for server to start.
- If server starts then client library(the trap agent library) will connect to the server and it sends IP, user name and configuration parameter value to server.
- The trap agent library keeps the tracks of the various parameter of the client system.
- If the parameter of the client system changes above threshold then trap agent library at client side notifies to the server about that parameter.
- This mechanism allows admin at server to monitor the various parameter of the client system without any human effort.(Server and clients should be connected to same local network.)
- The parameters to be monitored are called the TRAP parameters.
- Admin at server side can view TRAPS using the simple GUI.

- Admin can change the value of different configuration parameter.
- If a configuration parameter is changed for perticular client then server will send the configuration value to that client and then system will work as the new configuration parameter.

2.2 Working at server side

2.2.1 Main menu of server

When the server is started following GUI will be opened. Here start, config. and



Figure 2.1: Main menu of server

clear are buttons. In port number user should specify the port number of server. The display will be made to show different TRAPS on display. When start button is clicked the server will be started on specify port. Clear button is used to clear display which will show traps. Now when server is started it will connect to client.(server does not wait for connection since client library will started at client side automatically.) Now when client will connect to server its ip address, user name and configuration value will be stored at server.

2.2.2 Submenu after pressing config button

When Config. Button is clicked following window will be opened which will show the ip and user name of the all the online user. So when user button(hyperlink) is



Figure 2.2: Displayin all the online users(clients)

pressed then the configuration file for particular client will be opened. User can edit that file. In the configuration file all the configuration parameter will be specified (like threshold, priority, enable).

2.2.3 Displaying and changing the configuration value of client

When the button of one particular client is clicked then sub window will be opened as shown in figure 2.3. From this window admin can change the configuration value of the TRAP parameter and can send this changed configuration value to particular



Figure 2.3: Displaying the configuration file

client. When open button is clicked then configuration file for that client will be displayed. User can edit that file. After editing that file if user presses save button then new configuration parameter will be sent to client and then client trap agent library will generate TRAP as per the new configuration value. When user will click on default button the edited configuration file will be replaced with default configuration.

2.2.4 Configuration file

The structure of the configuration file is as shown in below figure.

The TRAP NAME specifies the name of the TRAP. Enable will specify if TRAP is disabled(0) or enabled(1). Threshold value specifies the threshold value of the TRAP.(It may present or absent as per the TRAP characteristics.) The priority specifies warning(W), debug(D),error(E), critical(C).



Figure 2.4: Configuration file structure

2.3 Working at client side

The client TRAP agent library will automatically started when system boots up. Then this library will read the client configuration file in which the IP and port address of server is specified. Here trap agent will connect to server with IP address 192.168.1.13 and port number 9000. The structure of the client configuration file will be as followed.



Figure 2.5: Structure of client configuration file

2.4 Block Diagram

2.4.1 Block Diagram of server



Figure 2.6: Block diagram of server

As shown in the block diagram, Admin enters the port number on server GUI. The port number value should be greater than 1024. After that admin has to press the start button and server will wait for clients. Now the clients that are waiting for server will send the user name, IP address and configuration file to server. Server stores all this value in the database. Database at server side is maintained using the linked list. Now client library(TRAP AGENT) monitors the system at client side. If any trap is generated at the client side then it will be sent to server and server displays these TRAPs on GUI. Admin can change the configuration value by changing the configuration file for particular client. If configuration file is changed then it will be transmitted to that particular client and TRAP will be generated as per the new configuration. If the client system is halted then the information for that particular client will be removed from the database. If server halts then it will send the NULL to all the clients.

2.4.2 Block Diagram of client



Figure 2.7: Block diagram of client

Client reads the port number and IP from configuration file and then it creates the socket. It will wait for server to start. If the server is started then it will establish the connection to the server and library sends trap configuration, port and IP to server. Now client library monitors the system parameter value. If trap is generated then TRAP AGENT notifies to server. If new configuration value is received from the server then it will be written to trap configuration file and trap will be generated as per the new configuration value. If server is closed then client removes old connection and will wait for new connection from the server. TRAP AGENT sends NULL if the client system is halting.

TRAP NO.	TRAP PARAMETER NAME
1	USB DEVICE ADDED OR DELETED
2	NEW USER ADDED OR DELETED
3	NEW SOFTWARE INSTALLED
3	NEW USER LOGIN
6	NEW ALIAS IS ADDED
7	PCI TRAP
8	USER NAME CHANGED
9	RUN LEVEL
10	SOUND LEVEL EXCEEDS BEYOND THRESHOLD
11	CPU FREQ. USAGE EXCEEDS BEYOND THRESHOLD
12	CPU USAGE EXCEEDS BEYOND THRESHOLD
13	RAM USAGE EXCEEDS BEYOND THRESHOLD
14	SWAP MEMORY USAGE EXCEEDS BEYOND THRESHOLD
15	ZOMBIE PROCESS EXCEEDS BEYOND THRESHOLD
16	SSH LOGIN
17	SECONDARY MEMORY USAGE
18	NEW FILE SYSTEM MOUNTED
19	SYSTEM REBOOTS
22	DEVICE DISCONNECTED
23	CONFIG FILE CHANGED
24	IF SOUND LEVEL RISES
25	ETHERNET DISCONNECTED

Table 2.1: TRAP PARAMETER LIST

Chapter 3

SYSTEM ARCHITECTURE

3.1 Whole System Architecture



Figure 3.1: Whole System Architecture

The clients and server are connected to each other by socket. They will communicate on the specified port. When system starts the TRAP will be generated as per the configuration parameter value. The configuration parameters are: Threshold value, TRAP enable or disable, TRAP priority. Admin at server side can change this configuration parameter value for particular client. Once this parameter value is changed it will be transmitted to to that client with the help of the socket. Then client (Trap agent) library will generate the TRAP as per the new specified configuration parameter.



3.2 Client architecture

Figure 3.2: Client system architecture

Client system has three modules.

- Main thread will receive the configuration parameter from server.
- Low priority thread monitors low priority TRAPs and sends low priority trap to server.
- High priority thread monitors high priority TRAPs and sends high priority trap to server.

The high priority and low priority threads will running at a time .They will monitor system parameter value simultaneously. High priority thread monitors system parameter value within 1 second and low priority thread monitors system parameter value within 5 seconds. ALERT, CRITICAL, ERROR TRAPs are monitored in the high priority threads and DEBUG, WARNING TRAPs are monitored in the low priority threads.



3.3 Server System architecture

Figure 3.3: Server system architecture

- GUI(Graphical user interface): It provides the graphical user interface. User can use the GUI to monitor entire system.
- Networking: It is responsible for connection between server and clients. It is responsible for connecting, disconnecting, writing and reading data from client.
- Database: It stores the client system information like IP address, user name of the client system and configuration file for client system

The server GUI is created in the QT creator. Various widgets like buttons, slider are used to create GUI at the server side. The networking among the server and clients are carried out with the help of the socket. When new client connects to server then unique socket descriptor will be generated for that client and further communication to that client will be carried out with the help of the socket descriptor. The database part is maintained with the help of the linked list. Whenever new clients are connected then new node will be crated and added in the linked list. If client is disconnected then the node for that particular client will be deleted from the linked list.

3.4 USE CASES

3.4.1 Actors

• Admin: admin is responsible to monitor entire system.

3.4.2 List of use cases for admin

The use case diagram is shown above, The use cases are as follow:

- Start server, Close server
- Set threshold for TRAP parameter
- Set priority to TRAP parameter
- Enable, disable TRAP parameter

3.4.3 Use Cases Discription

- a. Start Server
 - In this use case admin can start the server.
 - After starting the server, server should connect to the clients.
- b. Set threshold to TRAP parameter



Figure 3.4: Use Case Diagram

- In this use case admin can set the threshold value to TRAP parameter.
- If the TRAP parameter value exceeds beyond threshold then TRAP agent library at client side notifies to server.
- c. Enable, disable TRAP parameter.
 - Enable, disable TRAP parameter.
 - In this use case admin can enable and disable TRAP parameter. The TRAP parameter will be displayed only if they are enabled.
- d. Set priority to TRAP parameter.
 - In this use case, admin can set the priority of the TRAP parameter.
 - As per the priority TRAP will be sent. It means that high priority TRAP will be sent first and low priority TRAP will be sent last.

- e. Close the server
 - In this use case, admin can close the server.
 - After closing the server the connection of the server with all the clients will be terminated.

Chapter 4

Board bring up and installation of library

4.1 Board bring up for pandaboard



Figure 4.1: Pandaboard ES

Pandaboard is used as the router platform. It is ported with openwrt which is router operating system. Openwrt is custom operating system. User has to compile the required packages from the tool chain and then the image and root file system



Figure 4.2: Openwrt toolchain

will be copied to SD card. In the figure 4.1 tool chain for openwrt is shown.User has to select appreciate Target system. For pandaboard TI OMAP4 should be selected. User can also select the different drivers and packages. To reduce the size of the final image one should only select and compile required packages.

After successful compilation of tool chain following files are generated:

- Root file systems
- MLO : first stage boot loader
- Uboot : Second stage boot loader
- dtb file : It has all hardware related information about target system
- Image file : It is Linux kernel

MLO,UBOOT and Image file should be placed in the bootable(FAT32) partition of SD card and root file systems should be placed on EXT4 partition. These partitions are created using Fdisk utility in Linux. After successful completion of boot



Figure 4.3: Boot up process

up process, one can open the web GUI of Openwrt by entering IP of pandaboard on web browser.

https://192.168.1.186/cgi-bin/lu	ci		
	OpenWrt		
	Authorization Re Please enter your usemame and	equired password.	
	Username	root	
	Password		l
	Decision Reset		
	Powered by LuCI 15.05-187-gfe2a	a27c Release (git-16.018.33482-32019	103) / OpenWrt Chaos Calmer 15.05

Figure 4.4: Login page of Openwrt

4.2 Board bring up for raspberry pi



Figure 4.5: Raspberry pi B

The raspberry pi is ported with raspbian OS. The image is easily available for raspbian OS. This image should be flashed in the SD card and after successful installation of the raspbian OS the raspberry pi will be started.

4.3 Installing TRAP LIBRARY at client device



Figure 4.6: Installing TRAP LIBRARY at client device

Trapmanager binary is put in home directory. Client related files are put in

/home/Trapconfig directory. Temporary data files are put in /home/trapdata directory.

To make traplibrary run at boot time following steps are needed to perform:

- Make trap.sh file in /etc/init.d directory.
- Put command /home/Trapmanager to trap.sh file.(This command will start library)
- The scripts in the /etc/init.d directory is started automatically when system boots up.

Chapter 5

Final Results

5.1 GUI(Graphical User Interface) of server

TIME	USERNAME AND IP	TYPE	MACHINE	PRIORITY	TRAP		USERNAME	1
11:42:25	pi@192.168.1.155	NETWORK	armvől	ALERT	Device has been connected su	1	pi	192.168.1.155
11:42:26	jay@192.168.2.112	NETWORK	x86_64	ALERT	Device has been connected su	2	jay	192.168.2.112
							Configure Clear Filter	

Figure 5.1: GUI(Graphical User Interface) of server

Following information is provided by GUI:

CHAPTER 5. FINAL RESULTS

- TIME:Specifies when the trap is generated.
- USERNAME AND IP:Specifies the username and IP address of client device.
- TYPE:Specifies the type of the trap.
- MACHINE :Specifies the architecture of the client device.
- TYPE Field:Specifies the type of the trap.(CPU,MEMORY,DEVICE,SYSTEM,NETWORK)
- PRIORITY:Specifies the priority of the trap
- TRAP:Describes the TRAP information.
- List of connected devices
- Configure: To change config parameter for particular client
- Clear:To clear the screen
- Filter:Filter outs the TRAPS
- Port:It is used to enter the port number.
- Start: To start the server.

5.2 Configuring the system

😑 回 List	Of Users	
19	2.168.2.112 jay No:1	
19)2.168.1.155 pi 140:2	

Figure 5.2: List of connected users

The configure button is used to change the configuration parameter value. Above submenu will open after pressing configure button which lists the connected client as shown above.By pressing the one of the button, the submenu will be opened which shows the configuration value for that particular client as shown below.



Figure 5.3: Configuration file

CHAPTER 5. FINAL RESULTS

- Open button: It is used to open configuration file for particular client
- Save button: To save the configuration value
- Default button: To save to default configuration value.

5.3 Starting of the Server

	TIME	USERNAME AND IP	TYPE	MACHINE	PRIORITY	TRAP		USERNAME	
1	11:42:25	pi@192.168.1.155	NETWORK	armvól	ALERT	Device has been connected su	1	pi	192.168.1.155
2	11:42:26	jay@192.168.2.112	NETWORK	x86_64	ALERT	Device has been connected st	2	jay	192.168.2.112
								Configure Clear Filter	

Figure 5.4: Starting of the Server

After pressing the start button all the users will be connected to the server as shown above. The IP address and user name of the user will be stored in the server database.

5.4 Displaying the TRAPs

5.4.1 User added and deleted

1 13:38:01 root@192.168.1.186 SYSTEM armv7l WARNIN 2 13:38:11 root@192.168.1.186 SYSTEM armv7l WARNIN	Vew user is added	1	i jay 2 pi	192.168.2.112
2 13:38:11 root@192.168.1.186 SYSTEM armv7l WARNIN	User is deleted	2	2 pi	107 168 1 158
		3		192,108,1,153
			root	192.168.1.18
		0	()
			Configure	
			class	
			Clear	

Figure 5.5: New User added and deleted in pandaboard server view



Figure 5.6: New User added and deleted client in panda board

As shown in the figure at the client side new user is added. Now TRAP AGENT library sends the TRAP to server and at the server side new user is added TRAP is displayed. Now when the user is deleted at the client side TRAP AGENT library sends the User is deleted to server and that is displayed at server side.

5.4.2 CPU usage trap

	USERNAME AND IP	TYPE	MACHINE	PRIORITY	TRAP	Г	USERNAME	
1	pi@192.168.1.155	CPU	armv6l	ALERT	Cpu usage is exceeding above threshold	1	jay	192.168.2.112
2	pi@192.168.1.155	CPU	armv6l	ALERT	Cpu usage is exceeding above threshold	2	pi	192.168.1.15
3	pi@192.168.1.155	CPU	armv6l	ALERT	Cpu usage is exceeding above threshold			
					2		Configure)
							Clear Filter	

Figure 5.7: CPU usage increased in raspberry pi

As shown in the above figure, CPU usage is increased beyond the threshold in the raspberry pi. TRAP AGENT library notifies to sever as shown in the figure.

5.4.3 Device disconnected Trap

800	Ð	Server							
				VOL	ANS'	YS			
[USERNAME AND IP	TYPE	MACHINE	PRIORITY	TRAP		USERNAME	IP
	1	root@192.168.1.186	NETWORK	armv7l	ALERT	Device is unreacheble	1	root	192.168.1.186
							2	jay	192.168.2.112
							3	pi	192.168.1.155
								Configure Clear Filter)

Figure 5.8: Pandaboard is disconnected from network

The pandaboard is disconnected from network. Server pings to each device with the interval of 1 second. If client is disconnected from the network then ping response will be negative and at that time server notifies Device is unreachable as shown in the above figure.

5.4.4 SSH trap

90	Server							
			VOL	ANS)	YS			
	USERNAME AND IP	TYPE	MACHINE	PRIORITY	TRAP		USERNAME	IP
1	pi@192.168.1.155	NETWORK	armv6l	ALERT	Device is being tried to connect using ss		i jay	192.168.2.112
						2	2 pi	192.168.1.155
						-	s root	192.168.1.186
							()
							Configure	
							Clear	
							Filter	

Figure 5.9: Login to raspberry pi using ssh (Trap genrated at server



Figure 5.10: Login to raspberry pi using ssh (New user is login to raspberry pi using ssh)

As shown in the above figure, Raspberry pi is tried to connect using SSH. So TRAP AGENT library at raspberry pi notifies this thing to server and this TRAP is displayed at the server side.

Chapter 6

Conclusion

The Generalized TRAP AGENT library can be worked on the any Linux distributions. The TCP communication increases the reliability of the system. As per the requirement admin at server side can enable or disable the traps. Admin can also set the priority and the threshold value of the TRAP. The system will help to monitor the client systems in offices, organizations and colleges.

Chapter 7

Future Work



Figure 7.1: Centralized system using Cloud Computing

As shown in the figure clients and server will be connected by cloud platform. So server can monitor the client which is situated at the remote location. All the communication among clients and server will be passed through the cloud and it may possible that clients and server are located in the different country.

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