FogBus : End User Tutorial

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1 Introduction

This tutorial or step-by-step guide shows you how to setup your own Fog-Computing Environment using Raspberry Pi's or similar edge node devices used for IoT applications. This specific tutorial is to setup a "Sleep Apnea Analyzer" which provides a user with Sleep Apnea disease severity and other parameters for in depth analysis.

Using Apache server and HTTP REST APIs you will be able to setup communication between Fog devices having a Master/Slave architecture. A "Master" is the Fog node that distributes work between the "Slave" or "Worker" nodes. A Master can itself also act as a Worker.

2 Material Required

For the Fog-Computing setup the following would be required:

1. 2 or more Raspberry Pi's : Amazon Link
2. HDMI cable : Amazon Link
3. Keyboard-Mouse : Amazon Link
4. Micro SD cards (Atleast 8 GB) : Amazon Link
5. Micro SD to SD adapter : Amazon Link
6. Monitor with HDMI input
7. USB Pendrive (Atleast 1 GB)
8. 5V - 2.5A power supplies with Micro USB output (Either of the two options)
    - Power Adapter : Amazon Link
    - Power Bank : Amazon Link
9. A PC with SD Card, USB slots and WiFi

3 Circuit

Connect the devices as per following steps:

1. Connect the Raspberry-Pi with keyboard and mouse.
2. Connect the Monitor to the Pi using HDMI Cable.
3. Power on the Monitor
4. Provide power to the Pi through adapter or power bank.

The final circuit is shown below.

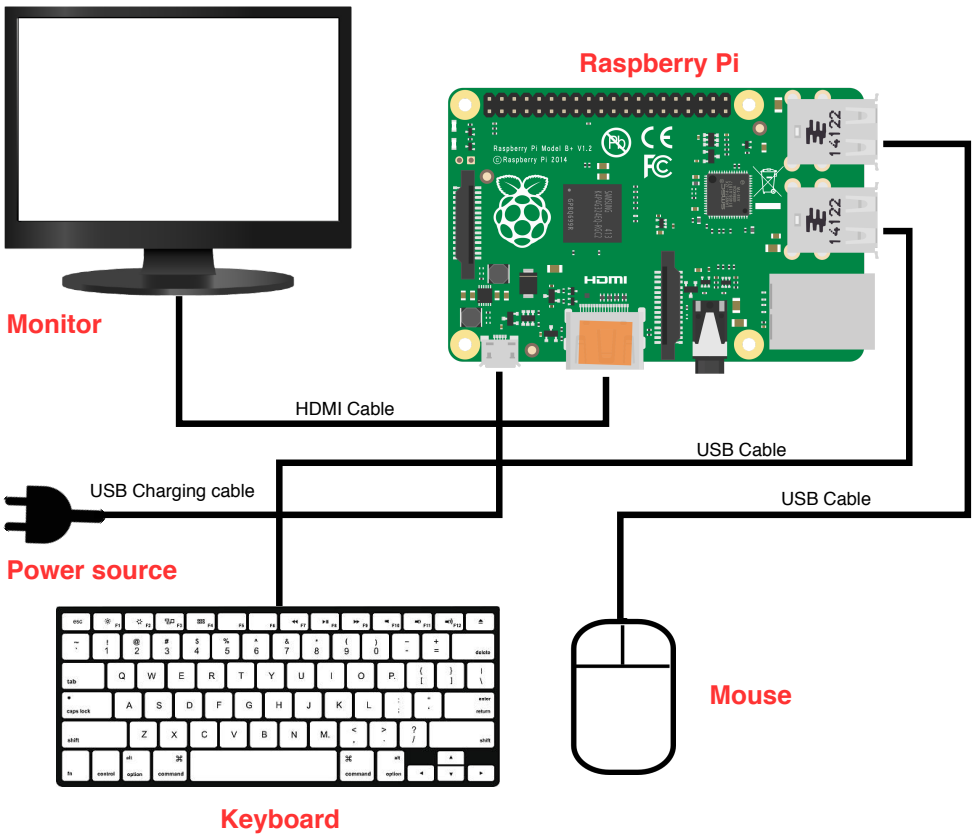

Figure 1: Circuit Diagram

4 Install OS

We will flash the Raspberry Pi operating systems on the SD Cards. Make sure that the SD Cards are formatted and partitioned. On PC follow the following steps:

1. Download the Raspberry Pi OS image : "Raspbian Stretch Desktop" from this link
2. Download and Install Disk Image flashing software like "Etcher" from here.
3. Insert the Micro SD card inside the Micro SD to SD adapter and then insert the adapter to the SD Card slot in the PC
4. Run "Etcher" Software. Select the downloaded Raspbian image file, the SD Card drive and click on "Flash".
5. When flashing and validation is over, eject the SD card adapter.
6. Repeat steps 3 to 5 for other Micro SD cards
7. Remove power cable from Raspberry Pi and insert the Micro SD Card. Re-insert the power cable into the Pi.

The Raspberry Pi would now boot up and is ready to install the required softwares for the Fog-Computing environment.

5 Installing FogBus : Worker

5.1 Raspberry Pi or other Linux machines

Connect Raspberry Pi to Wi-Fi by right clicking the Wi-Fi Buton on top right of the screen. Open Terminal by pressing simultaneously : Ctrl-Alt-T and type in the following commands:

```
sudo apt-get install git
sudo git clone https://shreshthtuli:Twins1998@github.com/shreshthtuli/FogBus.git
sudo chmod +x ./FogBus/Install-scripts/*
sudo ./FogBus/Install-scripts/fogbus-install-worker.sh
```

5.2 Windows Machines

Download XAMPP from the following link and Install XAMPP. Run XAMPP and start Apache and MySQL service.

Go to *C:/xampp/htdocs/* and create folder named "HealthKeeper". Download "HealthKeeper" data from this link and transfer files in the *FogBus/Browser-src/RPi/Worker/* folder to the HealthKeeper folder.

Go to the folder *C:/xampp/htdocs/HealthKeeper/* and open terminal. Run the following commands to run analyzer:

```
java -jar WorkerInterface.jar
```

Press ⊞ + R, type "cmd" and then press "Enter". On the command prompt type "ipconfig" and note the IPv4 address for future use.

6 Installing FogBus : Master

Connect all nodes to the same network and follow the further steps. For Linux machines follow the steps as for worker but instead of the last terminal command run:

```
sudo ./FogBus/Install-scripts/fogbus-install-master.sh
```

For Windows Machines follow the steps for Worker Installation, but instead of copying the Worker folder files, copy both RPi and Aneka folders in *FogBus/Broswer-src/* into the Healthkeeper folder.
Go to the folder *C:/xampp/htdocs/HealthKeeper/RPi/Master/* and open terminal. Run the following commands to run analyzer:

```
java -jar MasterInterface.jar
```

Press ⊞ + R, type "cmd" and then press "Enter". On the command prompt type "ipconfig" and note the IPv4 address for future use as the Master IP Address.

7 Configuring FogBus

On the master server, open browser and go to:

```
1  http://localhost/phpmyadmin/
```

Follow the following steps to configure database:

1. Create new database by clicking "New" in the left column. Enter name = "users" and click "create".
2. Add a table in this database named "registrations" having 3 columns.
3. Type the column names as "ID", "username" and "password". Keep "ID" column as primary key (option in the Index column) and of type INT. Keep others as VARCHAR. Click on "Save" to create table.
4. On the top tab, click on "Insert" to insert an entry. Type in 1 in ID, and "admin" in username and password.
5. To add other users, follow step 4 with username and password as required.

7.1 Configuring Worker

Open browser and go to:

```
1  http://localhost/HealthKeeper/manager.php
```

Enter Master IP address as noted earlier. Once a worker node is configured, all connections other than power can be removed.

7.2 Configuring Master

Open browser and go to:

```
1  http://localhost/HealthKeeper/RPi/Master/manager.php
```

Add the IP addresses of the worker nodes noted earlier. To again get IP address of worker run "*hostname -I*" on terminal. Choose the "Enable Master as Worker" as per requirement. Edit the conf.xml file in HealthKeeper/Aneka/ folder as per Aneka Container parameters.
Then go to:

```
1  http://localhost/HealthKeeper/RPi/Master/
```

Login with username : "admin" and password : "admin". Enter data for analysis and press "Enter". Then click "Analyze" to get results.

Android devices can also be synchronized with Master using the steps shown in next section, by which data need not be entered manually but by connecting the android device to a Bluetooth Oximeter.

8 Configuring Aneka Cloud

Configure Microsoft Azure VM network using the following steps:

1. Create a Virtual Network
   - Named - VNET-01
   - Address Space - 10.10.0.0/16
   - Subnet - 10.10.10.0/24
2. Create a GatewaySubnet within the Virtual Network
   - GatewaySubnet - 10.10.1.0/24
3. Create a Virtual Network Gateway
   - Associate to Virtual Network VNET-01
   - This takes Azure 45 minutes to complete
4. Create a VM within the Virtual Network VNET-01, Windows Server 2016 Data center
5. Create the Root VPN Certificate
   - Download Windows SDK if neccessary from this link.
   - Go to Directory - $C:\backslash Program Files(x86)\backslash Windows Kits\backslash 10\backslash bin\ x86$
   - Run Command - makecert -sky exchange -r -n “CN=AzureVpnRootCert” -pe -a sha1 -len 2048 -ss My “AzureVpnRootCert.cer”
   - Find Cert in $Personal\backslash Certificates$ and Export to BASE64 without Password
   - Open Base64 Cert in Text Editor, put in one line and paste into Azure Root Cert Settings
6. Create the Client Certificate
   - Command - makecert.exe -n “CN=AzureVpnClientCert” -pe -sky exchange -m 96 -ss My -in “AzureVpnRootCert” -is my -a sha1
   - Run CertMgr to Convert to PFX file - certmgr.msc
   - Find Cert in $Personal\backslash Certificates$ and Export to BASE64 with Password
   - This pfx file must be installed and distributed to users with VPN Software
7. Get up Gateway Point to Site Setting
   - Address Space - 172.20.20.0/24
   - Set up Root Certificate

- Name - AzureVPN
- Cert as the key in the certificate's base64 file

8. Download VPN Software and install it
9. Install Client and Root Certs
10. Connect VPN via Network Connections

Now we need to Install Aneka in the Azure Virtual Machine for which follow the steps:

1. Install .NET framework
   (a) Open Server Manager
   (b) Click on "Add Roles and Features"
   (c) Install .NET 3.5
   (d) Restart VM
2. Disable firewall and antivirus
   (a) Open Settings
   (b) Go to Security and Update settings
   (c) Turn off real time scanning in Windows Defender
   (d) Search for Windows Firewall Settings
   (e) Click on "Turn Firewall On or Off"
   (f) Turn off firewall for both public and private networks
   (g) Restart VM
3. Install Aneka
   (a) Open Web browser - Internet Explorer
   (b) Go to Settings > Internet Settings > Security
   (c) Click on "Custom Settings"
   (d) Enable Downloads
   (e) Click Apply and close window
   (f) Go to Manjrasoft website and download Aneka Installer
   (g) Install and configure Aneka

9 Running FogBus

FogBus starts automatically after installation. If the node is rebooted or disconnected from network, you can run the FogBus software using the following instructions:

9.1 Linux Machines

To run FogBus in Linux Machines open terminal and run the following commands to start worker:

```
cd ~
sudo ./FogBus/Run/FogBus-Worker.sh
```

9.2 Windows Machine

To run FogBus on Windows machines as Master go to:
http://localhost/HealthKeeper/RPi/Master/.
In web browser and open terminal at *C:/xampp/htdocs/HealthKeeper/RPi/Master/* and run the following command:

```
java -jar MasterInterface.jar
```

Configure Aneka container in the Master node and Aneka Worker container in the Azure Virtual Machine. Make sure that the Master node is connected to the Azure virtual network through VPN. Start Aneka software by running:

```
FogBus/AnekaHealthKeeper/AnekaHealthKeeper/bin/Debug/AnekaHealthKeeper.exe
```

10 Configuring Android Device

To configure an android device to send data collected through a Bluetooth Oximeter, download the android app from this link. Install the app in android device and follow the following steps:

1. Turn on device's Bluetooth and then open the HealthKeeper app
2. You would be greeted by a welcome screen. Click on the "Pair Sensor" button and choose the oximeter device from the list.

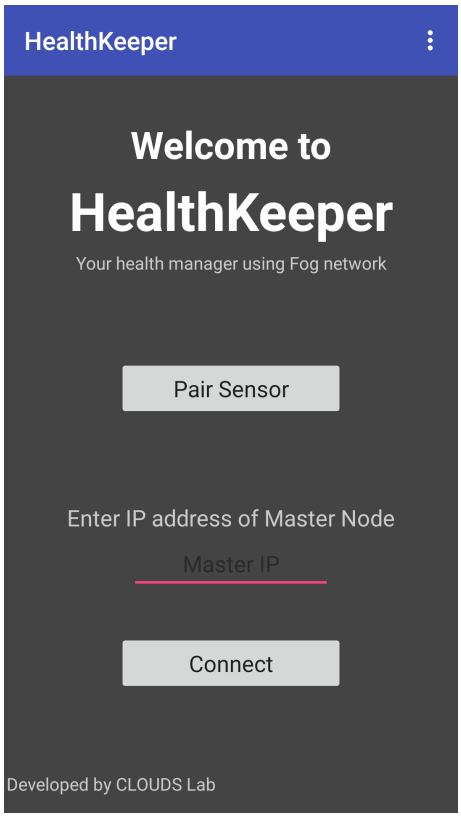

Figure 2: Welcome screen

3. Enter the IP address of the master node and click on "Connect".

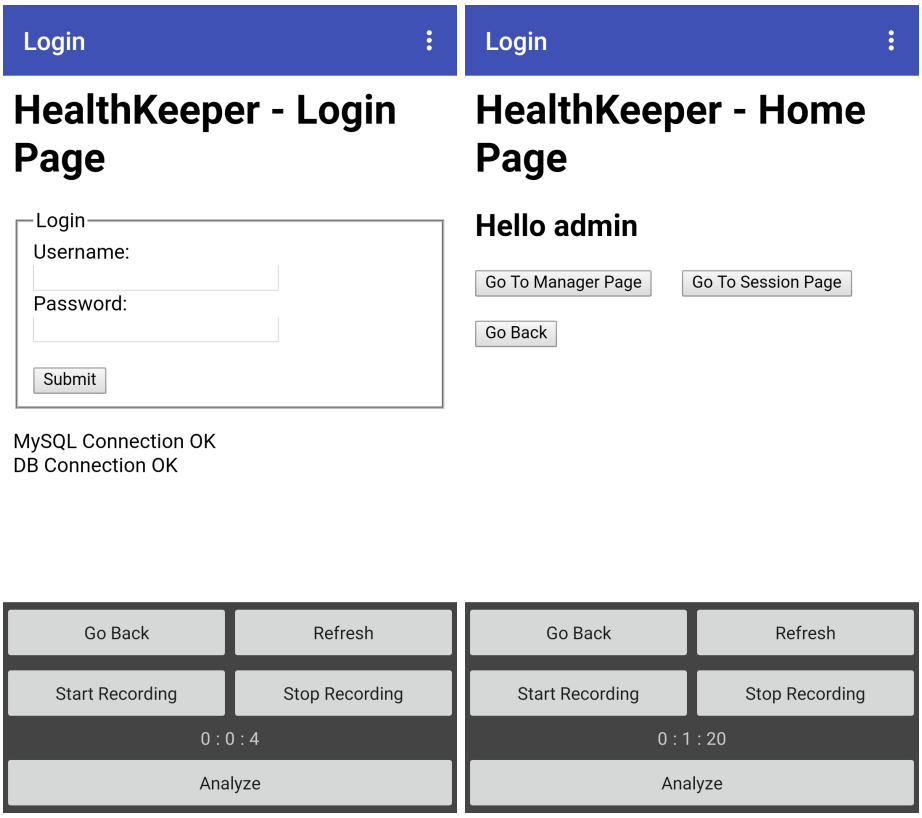

Figure 3: Login Page and Home Page

4. A login page would be visible, enter username and password and click on submit

5. On the Home Page, click on "Go To Manager Page" to setup worker nodes and enable/disable master as worker.

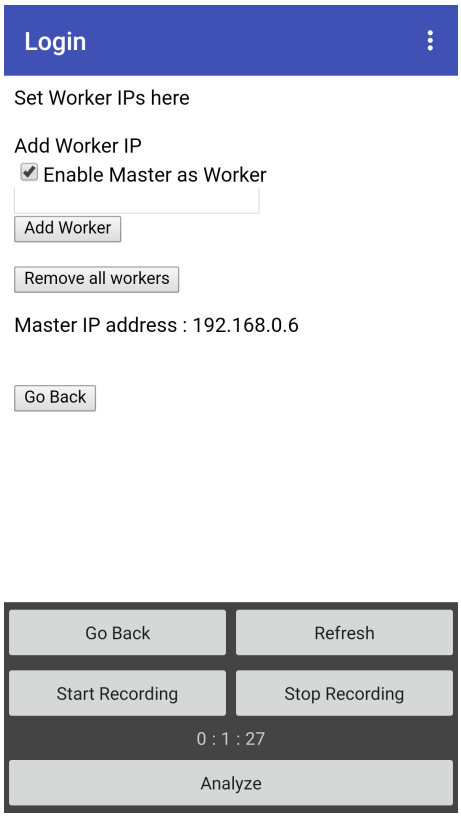

Figure 4: Manager page

6. Go back to Home Page and click on “Go to Session Page” to enter session.

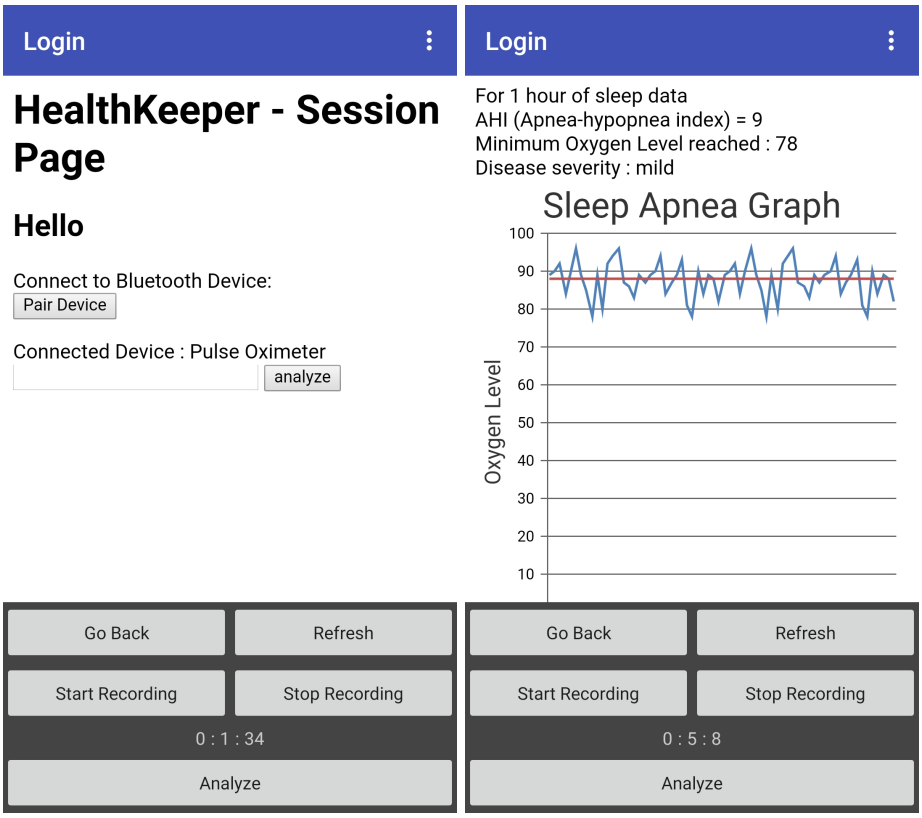

Figure 5: Session Page

7. Click “Start Recording” to start collecting data from Oximeter
8. Click “Stop Recording” to submit data to master node.
9. Click on “Analyze” button to submit data for analysis and view results on the current session.
10. Repeat steps 7 to 9 for analyzing more data.

11 Further Information

For further information and queries please contact:

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Appendix

Installation script : Worker

Install Java

```
sudo apt-get update
sudo apt-get upgrade
sudo apt-get install oracle-java8-jdk -y
sudo apt-get install ant git vim -y
```

Install Apache, PHP and MySQL

```
sudo apt-get install apache2 -y
sudo vim /etc/apache2/apache2.conf
```

Now on the bottom of the file type "i" to append document and add the following line:

```
ServerName 127.0.0.1
```

To test Apache, run:

```
sudo apache2ctl configtest
```

The output of this command should be : "Syntax OK". If yes, then Apache is installed and configured properly.
Now install PHP and MySQL using:

```
sudo apt-get install php libapache2-mod-php php-mcrypt php-mysql -y
sudo service apache2 restart
sudo apt-get install mysql-server -y
sudo mysql_secure_installation
```

When asked for password, enter "raspberry". For all other questions except the last question answer "n", and for last "y".
Now, configure MySQL and add database named "data" using:

```
sudo mysql -u root -p
CREATE DATABASE data;
show databases;
GRANT ALL PRIVILEGES ON data.* TO 'root'@'localhost' IDENTIFIED BY 'raspberry';
FLUSH PRIVILEGES;
exit;
```

Install PHPMyAdmin using:

```
sudo apt-get install phpmyadmin -y
```

When prompted to choose server : select “Apache2”. In the Configure PHP-MyAdmin, select “No”.
Now add PHPMyAdmin configuration to Apache2 using:

```
sudo vim /etc/apache2/apache2.conf
```

In the end of file, select “i” to insert and add the following line:

```
Include /etc/phpmyadmin/apache.conf
```

Restart apache service using:

```
sudo service apache2 restart
```

Now, go to the html folder and add “HealthKeeper” scripts using following commands:

```
cd /var/www/html/
sudo mkdir HealthKeeper/
sudo chmod -R 777 HealthKeeper/
```

Download “HealthKeeper” data from this link and transfer files in the “Worker” folder to the, just created, HealthKeeper folder. in the */var/www/html/* path.
On terminal run the following commands to run the Analyzer:

```
cd /var/www/html/HealthKeeper
sudo chmod 777 *
javac ./analyzer.java
java analyzer
```

In another tab of terminal run:

```
hostname -I
```

It will show the IPv4 address of the machine. Note it for future use.