

**Robot basic architecture based on SSES Blueprint
Installation document**

V0.1 02/08/2022

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1 Introduction

The guide covers the installation details which are related to Robot basic architecture based on SSES Blueprint.

This guide covers detailed information of the various types of deployments, detailed steps and what are the various components it will install. In addition, the guide provides information on hardware requirements, prerequisite software and minimum hardware requirements. On successful deployment, IoT Gateway, PC/Server for robot control, Multi Sensor Module will be installed.

2 License

Apache License 2.0

2.1 How to use this document

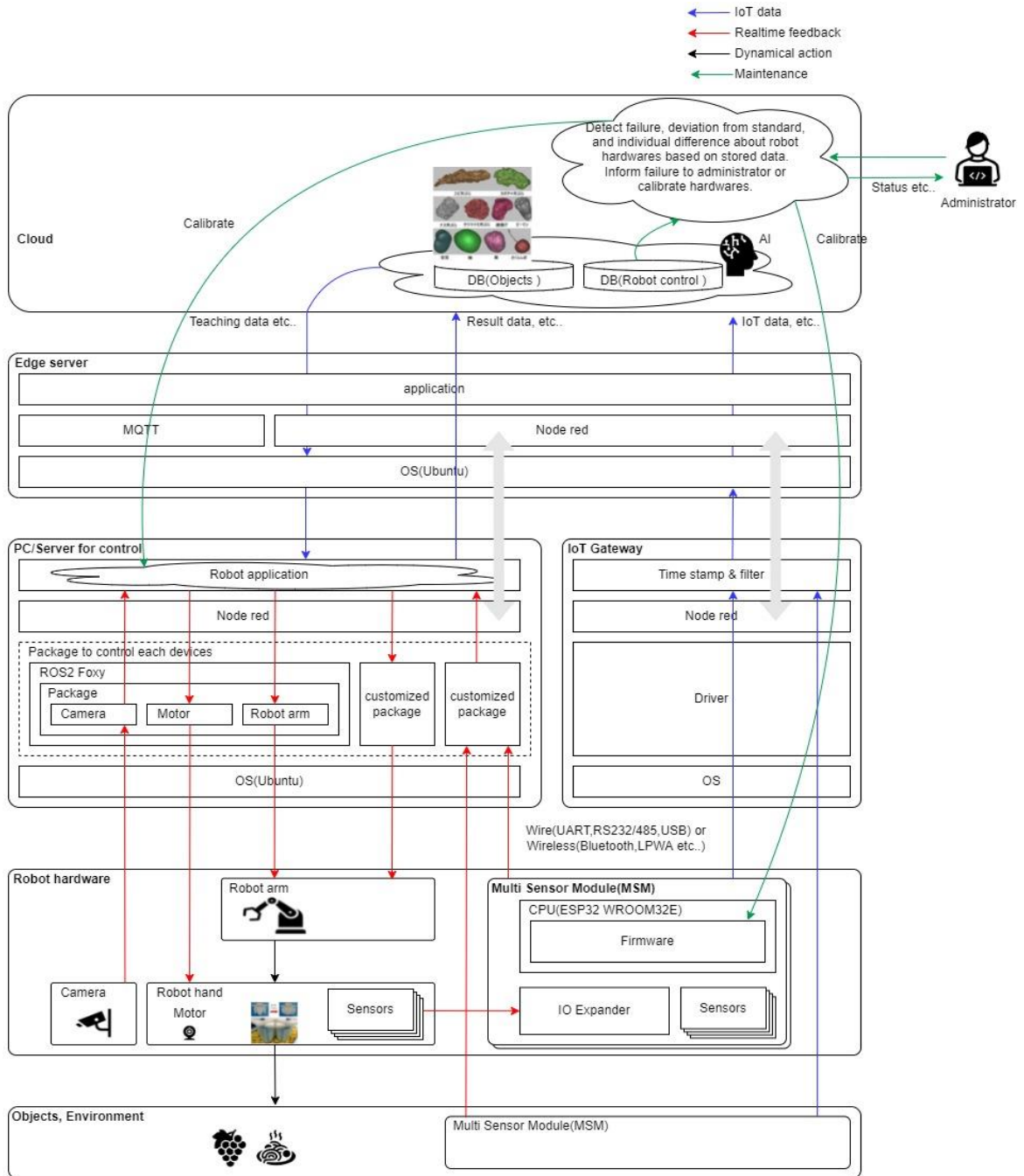
The document includes details of prerequisites, pre-installation and installation steps. The prerequisites and pre-installation software and hardware should be ready before executing the installation steps.

2.2 Deployment Architecture

The Deployment Architecture consists of the following nodes

- IoT Gateway
- PC/Server for robot control
- Multi Sensor Module

Note: Other Nodes in the figure will be released from the next major release.



3 Pre-Installation Requirements

3.1 Hardware Requirements

The number of hardware required depends mainly on the use case and the size of the enterprise. A use case may include one or more IoT Gateways, one or more PC/Server for robot controls, and one or more Multi Sensor Modules.

3.1.1 Minimum Hardware Requirements

N/A

3.1.2 Recommended Hardware Requirements

IoT Gateway

Raspberry Pi 4 Model B / 4GB が推奨されます

CPU	Broadcom BCM2711
Architecture	ARM
RAM	4GB
Disk	16GB

PC/Server for robot control

CPU	4 core
Architecture	x64_AMD
RAM	4GB
Disk	500GB

3.2 Software Prerequisites

- The IoT Gateway has raspbian pre-installed.
- PC/Server for robot control has Ubuntu pre-installed.

3.3 Database Prerequisites

N/A

3.4 Other Installation Requirements

N/A

4 Installation High-Level Overview

4.1 Bare Metal Deployment Guide

4.1.1 Install Bare Metal Jump Host

4.1.1.1 IoT Gateway

4.1.1.1.1 Add hardware

Create and install an LED indicator to monitor the communication status. As shown in the photo, it is crafted using a universal board. A push switch is provided for safe power off.

Normally, the gateway is accessed via the network and shut down, but by pressing this push switch, the equivalent action (shutdown) is performed. To turn the power back on, turn the power off and then back on again.



4.1.1.1.2 Modify the system configuration

4.1.1.1.2.1 Update the OS to the latest version.

```
$ sudo apt update  
$ sudo apt upgrade
```

4.1.1.1.2.2 Display setting

During normal operation, the system operates with only the main unit and no display/keyboard/mouse is connected. It is basically a remote connection. When the power is turned on without the display connected, make the following settings so that the screen is displayed properly via VNC connection.

Edit `/boot/config.txt` to enable the following configuration items and remove the leading.

```
#hdmi_force_hotplug=1
```

4.1.1.1.2.3 Starting Node-RED automatically

Configure Node-RED to start automatically when power is turned on. Run the following command to allow Node-RED to start automatically when power is turned on.

```
$ sudo systemctl enable nodered.service
```

To stop the automatic startup when the power is turned on, execute the following command.

```
$ sudo systemctl disable nodered.service
```

The following is the default file that will be automatically started when power is turned on.

~/.node-red/flow_\$(hostname).json

Example: If hostname is raspberrypi,

~/.node-red/flow_raspberrypi.json .

4.1.1.1.2.4 Allowing VNC and SSH

Maintenance of the gateway will be done via the network. Therefore, we need to allow access to VNC and SSH. There are two ways to allow access: using the OS GUI or from the terminal screen.

4.1.1.1.2.4.1 Using GUI

Click on the raspberry symbol in the upper left corner of the screen to bring up the menu. Hover your cursor over "Settings" at the bottom of the menu. This will bring up the lower menu on the right. Select "Raspberry Pi Settings" from the menu and click on it.



This will bring up the Raspberry Pi configuration screen as shown on the left. Select the "Interface" tab, select the SSH and VNC enable buttons, and press OK to complete the configuration.

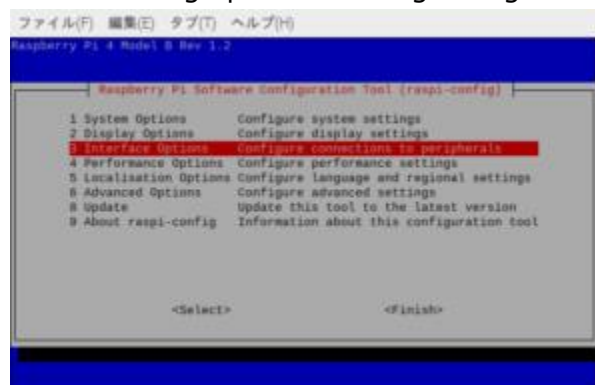


4.1.1.1.2.4.2 Using terminal

To do this from a terminal screen, open a terminal screen and enter the following command

```
$ sudo raspi-config
```

This will bring up the following configuration screen.

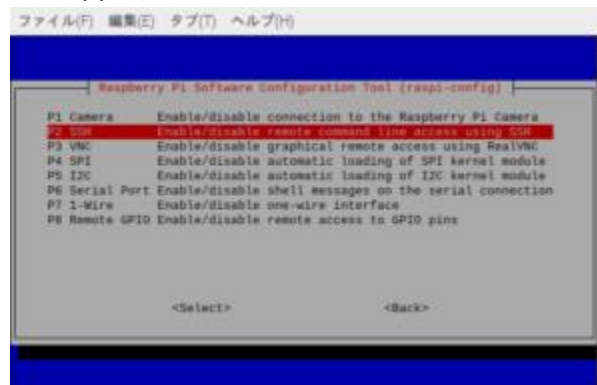


Use the cursor keys to move the red band to "3 Interface Options", and press the Enter key to move to the next screen. To move to <Select> and <Finish>, press the Tab key to move the red band down. To exit, use the left and right cursor keys to move the red band to <Finish>, and press the Enter key. You will be returned to the original terminal screen.

On the next screen, you will see the Enable/Disable menu for SSH and VNC, so use the cursor keys to move the red band there as well, and press Enter.

To move to <Select> and <Back> below, press the Tab key, and the red strip will move down. To return to the previous

screen, use the left and right cursor keys to move the red band to <Back>, and press the Enter key. You will return to the upper selection menu.



You will then see a screen asking, "Do you want to allow?" screen will be displayed.

The figure shows the SSH permission screen.

The "Yes" mark is red, so press the Enter key. The screen will change to "Permission granted". To select "No", use the cursor keys to move to the right. To select "No", move to the right with the cursor keys. The red band will move to "No".

To select "No," move the cursor key to the right. You will be taken back to the initial settings screen, so please allow VNC in the same way.



4.1.1.1.2.5 Setting time server

Set the time server of the upper network to synchronize the gateway with the time.

How to change the NTP server of the gateway

This section describes how to change the NTP server of the gateway. Please check the URL you want to connect to as an NTP server beforehand. As an example, we will access the address (ntp.nict.jp) of the NTP service provided by the National Institute of Information and Communications Technology (NICT), which determines and maintains Japan's standard time.

4.1.1.1.2.5.1 Modify setting file

Write the address of the NTP service in the timesyncd.conf file.

First, back up the original file by copying it.

```
$ cd /etc/system
$ sudo cp timesyncd.conf timesyncd.conf.bak
```

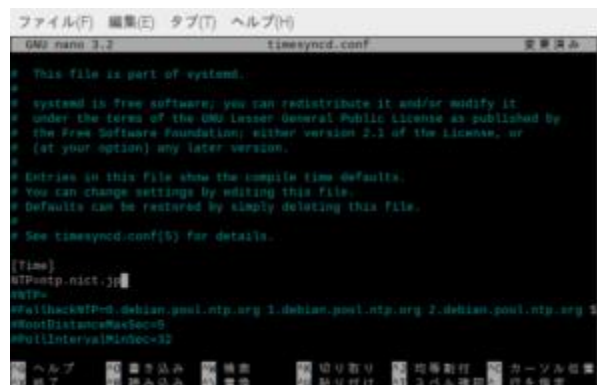
Modify file through editor.

```
$ sudo nano timesyncd.conf
```

After [Time], write following

```
NTP=ntp.nict.jp
```

If there are multiple connections, put them in a row with a space as a separator. If it fails to connect to the first one, it will try to connect to the second one, and if it fails to connect to the second one, it will try to connect to the third one, and so on. It will not go beyond the first connection, so it is recommended to arrange them in the order you want to connect.



4.1.1.1.2.5.2 Reload the daemon and restart the service.

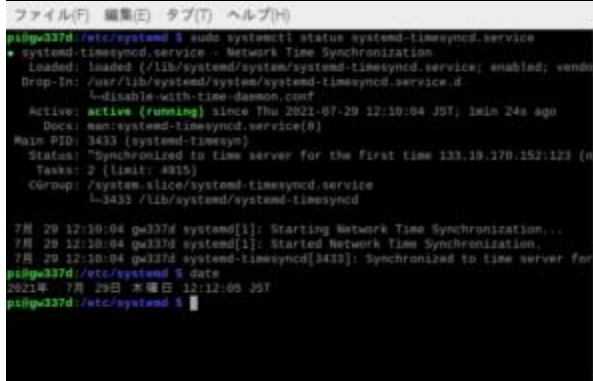
Execute the command to enable NTP. Next, reload the daemon, and finally restart the timesyncd service to complete the configuration.

```
$ sudo timedatectl set-ntp true
$ sudo systemctl daemon-reload
$ sudo systemctl restart systemd-timesyncd.service
```

4.1.1.1.2.5.3 Confirmation that the service is started and that the time is correct.

Confirm that the service is Active : active (running) by pressing the start confirmation command.

```
$ sudo systemctl status systemd-timesyncd.service
```



```
ファイル(F) 編集(E) タブ(T) ヘルプ(H)
pi@q337d /etc/systemd $ sudo systemctl status systemd-timesyncd.service
* systemd-timesyncd.service - Network Time Synchronization
   Loaded: loaded (/lib/systemd/system/systemd-timesyncd.service; enabled; vendor
   Drop-In: /usr/lib/systemd/system/systemd-timesyncd.service.d
           ↳-disable-with-time-daemon.conf
   Active: active (running) since Thu 2022-07-29 12:10:04 JST; 1min 24s ago
   Docs: man:systemd-timesyncd.service(8)
   Main PID: 3433 [systemd-timesyn]
   Status: "Synchronized to time server for the first time 133.19.178.152:123 (N
   Tasks: 2 (limit: 4915)
   CGroup: /system.slice/systemd-timesyncd.service
           ↳-3433 /lib/systemd/systemd-timesyncd

  7月 29 12:10:04 q337d systemd[1]: Starting Network Time Synchronization...
  7月 29 12:10:04 q337d systemd[1]: Started Network Time Synchronization.
  7月 29 12:10:04 q337d systemd-timesyncd[3433]: Synchronized to time server for
pi@q337d /etc/systemd $ date
2022年 7月 29日 水曜日 12:12:05 JST
pi@q337d /etc/systemd $
```

Type the following command to make sure that the OS time and the NTP service time match.

```
$ date
```

You can check the NTP service of the National Institute of Information and Communications Technology (NICT), which we used as an example, by accessing the following address. <https://www.nict.go.jp/JST/JST5.html>



4.1.1.1.3 Installing software

Install some of the application software needed to build the gateway.

4.1.1.1.3.1 Installing GTKTerm

Install GTKTerm, a serial port terminal software that can be used with Raspberry Pi OS and Linux systems such as Ubuntu. This is used to check the USB connection and Bluetooth connection of the sensor module.

```
$ sudo apt install gtkterm
```

4.1.1.1.3.2 Installing hostapd

Install hostapd, a software that provides services for wireless LAN access points. It is used to realize AP mode (Access Point Mode), which is used for the initial configuration of the gateway.

```
$ sudo apt install hostapd
```

4.1.1.1.3.3 Installing dnsmasq

Install dnsmasq, a software that provides DNS/DHCP server functions for small-scale networks. Assign an IP address using the DHCP server function in AP mode, which is used for initial configuration of the gateway.

```
$ sudo apt install dnsmasq
```

4.1.1.1.3.4 Installing blueman

Install Blueman, which is a Bluetooth manager tool that allows you to make Bluetooth connections with sensor modules via GUI.

```
$ sudo apt install blueman
```

4.1.1.1.4 Connecting sensor module

Refer to exhibit material.

4.1.1.1.5 transition between AP mode and CL mode

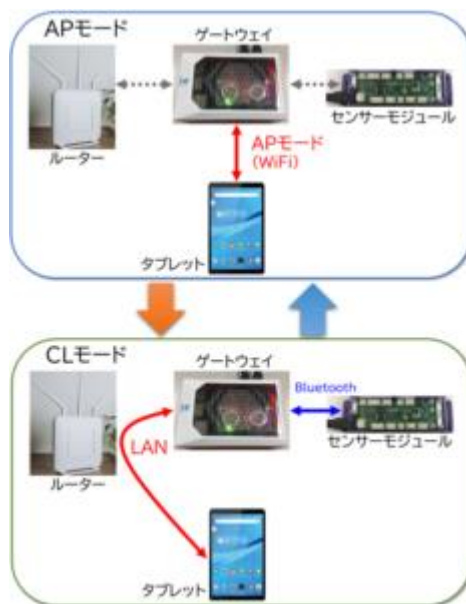
This section explains how to switch between using the gateway as an Access Point (AP) or as a Client (CL) of the network. Choose the appropriate method according to your environment.

4.1.1.1.5.1 Outline

In AP mode, the gateway uses DHCP to assign IP addresses to devices that connect to it, and the network is completed by the gateway and the devices.

In CL mode, the gateway acts as one of the devices and gets its IP address assigned using the DHCP function of the router just like any other device, and the network is configured among the devices hanging on the router.

Normally, the gateway is configured to work in CL mode.



4.1.1.1.5.2 Preparation for transition from CL mode to AP mode

Creating /etc/hostapd/hosapd.conf

Create a new file named hostapd.conf in the directory /etc/hostapd/ and add the following description.

```
interface=wlan0
driver=nl80211
hw_mode=g
ieee80211n=1
wmm_enabled=1
ht_capab=[HT40][SHORT-GI-20][DSSS_CCK-40]
macaddr_acl=0
auth_algs=1
ignore_broadcast_ssid=0
wpa=2
wpa_key_mgmt=WPA-PSK
rsn_pairwise=CCMP
channel=6
ssid=<SSID>
wpa_passphrase=<PASSWORD>
```

<SSID> and <PASSWORD> are the ID name and password for accessing the gateway in AP mode, so please write them by yourself.

Backing up /etc/dnsmasq.conf

We will change the /etc/dnsmasq.conf file, so make a backup.

```
$ sudo mv /etc/dnsmasq.conf /etc/dnsmasq.conf.org
```

Creating /etc/dnsmasq.conf

Create a new /etc/dnsmasq.conf and add the following description.

```
interface=wlan0  
dhcprange=192.168.50.100,192.168.50.255,255.255.255.0,24h
```

The value of dhcprange is the range of IP addresses and subnet mask that DHCP will assign in AP mode, and the last is the effective time. In this example, the address to be assigned in AP mode will be between 192.168.50.100 and 192.168.50.255. The subnet mask is 255.255.255.0, and the validity time is 24H. Set the IP address, etc. that you want to assign in AP mode.

First-time only configuration of hostapd

Run the following two commands on hostapd for the first time only.

```
$ sudo systemctl unmask hostapd  
$ sudo systemctl disable hostapd
```

The first command is to unmask hostapd in order to make it bootable; if it is masked, it cannot be started manually or automatically.

4.1.1.1.5.3 Processing of transition from CL mode to AP mode

```
$ sudo systemctl stop wpa_supplicant  
$ sudo systemctl stop dhcpcd  
$ sudo ip addr add 192.168.50.1/24 dev wlan0  
$ sudo ip route add default via 192.168.50.1  
$ sudo systemctl start dnsmasq  
$ sudo systemctl start hostapd
```


4.1.1.1.5.4 Remarks

As remarks, Describe how to shift from AP mode to CL mode.

4.1.1.1.5.4.1 Preparation for transition from AP mode to CL mode

Set the SSID and password for WiFi in CL mode.

There are two ways to do this. The first method is recommended because it encrypts the password, and the second method is to write the SSID and password in an editor. The second method is to write the SSID and password in an editor.

•Enter the following command on the command line

```
$ sudo sh -c 'wpa_passphrase {SSID} {PASSWORD} >> /ect/wpa_supplicant/wpa_supplicant.conf'
```

Please use the SSID and PASSWORD of your own environment.

•How to modify the file with an editor

Open the file /ect/wpa_supplicant/wpa_supplicant.conf with an editor and enter the following

```
country=JP
ctrl_interface=DIR=/var/run/wpa_supplicant
GROUP=netdev
update_config=1
network={
    ssid="SSID"
    psk="PASSWORD"
    key_mgmt=WPA-PSK
}
```

Adding network... Please use the SSID and PASSWORD of your own environment.

Configure WiFi IP address and router address in CL mode

If you want to specify the IP address and router address in the network environment without using DHCP IP address assignment when you return to CL mode, please change/add the following description.

Editing /ect/dhcpd.conf.

```
interface wlan0
static ip_address=<IP_Address/Netmask>
static routers=<IP_Address>
```

Please make changes according to your own environment.

This completes the preparation for returning from AP mode to CL mode. As described in the Quick Reference, this gateway allows you to enter the SSID, password, IP address, and router address for CL mode, and change the settings in CL mode according to the description. The above is accomplished by using Node-RED and shell scripts to change the files and then return to CL mode.

4.1.1.1.5.4.2 Processing of transition from AP mode to CL mode

```
$ sudo systemctl stop hostapd
$ sudo systemctl stop dnsmasq
$ sudo ip addr flush dev wlan0
$ sudo systemctl start wpa_supplicant
$ sudo systemctl start dhcpd
```

4.1.1.1.6 Setting mDNS(multicast Domain Name System)

Use a DNS service to map IP addresses to hostnames. This is not necessary for networks with static IP. Just specify the IP address directly.

If your Raspberry Pi 4 has been configured with a gateway up to this point, the DNS server should be up and running. This will confirm that the service is up and running.

```
$ systemctl status avahi-daemon.service
```

```
Active : active (running)
```

4.1.1.1.6.1 Creating /etc/avahi/services/ssh.service

Create a new /etc/avahi/services/ssh.service and include the following information.

```
<?xml version="1.0" standalone='no'?>
<!DOCTYPE service-group SYSTEM "avahi-service.dtd">

<service-group>
  <name replace-wildcards="yes">%h</name>

  <service>
    <type>_ssh._tcp</type>
    <port>22</port>
  </service>
</service-group>
```

4.1.1.1.6.2 Modifying hostname

The name in the DNS service will be \$(hostname).local. Normally, the hostname of the Raspberry Pi is raspberrypi, so if you leave the hostname unchanged, DNS will assign the name raspberrypi.local to the IP address. If you want to change the name to something else, you need to change the hostname.

If you do not want to change the hostname, please jump to "Restart DNS Service".

In order to change the hostname, you need to modify two files.

Modifying /etc/hostname

Use an editor to change /etc/hostname. Before the change, it is only listed as raspberrypi.

Adding /etc/hosts

Use an editor to change /etc/hosts.

```
172.0.1.1      raspberrypi
```

Adding following.

```
172.0.1.1      <NewHostName>
```

<NewHostNam> should contain the hostname you wish to change.

4.1.1.1.6.3 Restarting DNS service

Restart DNS service.

```
$ sudo /ect/init.d/avahi-daemon restart
```

You can now access Node-RED at [http://\\$\(hostname\).local:1880/](http://$(hostname).local:1880/).

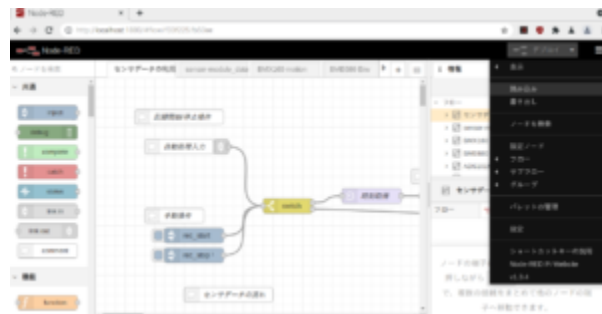
4.1.1.1.7 Installing the standard flow of Node-RED

Download and install the flow from the download page (https://sipses.net/download_list/). This is not necessary if you are creating the flow yourself.

Unzip the downloaded .zip file and prepare the .json file.

- If you want to return to the initial state completely, please delete all the flows before loading them.

Select "Load" from the three-line menu in the upper right corner.



The Import Flow window will open. Click "Select File to Import".





When the file selection window opens, select the flow (.json file) that you just downloaded and click the "Open" button.

The flow you are trying to load is now displayed. In this state, click the "Load" button.



If you load a flow from a previous flow that still exists, you may get the message "Some of the nodes you are trying to load already exist in the workspace."

In this case, please complete the loading as "Load a copy" and edit it to your desired process in the flow editing screen.



4.1.1.1.8 Setting password of Node-RED

When accessing the Node-RED flow screen, enter `http://<IP ADD>:1880`. In this case, the password is not managed by default. Follow the steps below to restrict the password.

4.1.1.1.8.1 Outline

The user name and password can be configured by writing them in `~/.node-red/settings.js`.

Passwords are hashed using the `bcrypt` algorithm for added security, so they must be hashed beforehand using a separate command.

4.1.1.1.8.2 Hashing password

Hashing a password is done with the following command.

When you enter the command, you will be prompted for a Password, enter it and hit the return key, and the hashed password will be returned to the screen. Copy this password and paste it into the `setting.js` file.

```
$node-red admin hash-pw [RET]
Password:XXXXXX[RET]
$2a$08$9tHg3MhtmRDRiBICOL.EiOR0qB3vNjP1eFF2VYouDWrrd
OzjwrHdy
```

4.1.1.1.8.3 Modifying settings.js

Use an editor to open the `~/.node-red/settings.js` file.

In the middle of the file, there is a description of the user name and password as shown below. Remove the commented-out `"/"` at the beginning of the line, change the description to the user name and the hashed password output above, and save the file. After saving the file, start Node-RED and your username and password will be valid.

<Before>

```
//adminAuth: {
```

```
// type: "credentials",
// users: [{
// username: "admin",
// password:
"$2a$08$zZWtXTja0fB1pzD4sHCMYz2Z6dNbM6tl8sJogEN
OMcxWV9DN.",
// permissions: "*"
// }]
//},
```

<After>

```
adminAuth: {
type: "credentials",
users: [{
username: "passwd",
password:
"$2a$08$9tHg3MhtmRDRiBICOL.EiOR0qB3vNjP1eFF2VYouDWrr
dOzjwrHdy",
permissions: "*"
}]
},
```

4.1.1.2 PC/Server for robot control

4.1.1.2.1 Installing GTKTerm

[See Gateway GTKTerm installation instructions.](#)

4.1.1.2.2 Installing Node-RED

4.1.1.2.3 Installing Node-RED.

```
$ bash <(curl -sL https://raw.githubusercontent.com/node-red/linux-installers/master/deb/update-nodejs-and-nodered)
```

4.1.1.2.4 Installing the standard flow of Node-RED

[See Gateway Installing the standard flow of Node-RED](#)

4.1.1.2.5 Clone source code

Clone source code.

4.1.2 Creating a Node Inventory File

N/A

4.1.3 Creating the Settings Files

N/A

4.1.4 Running

N/A

4.2 Virtual Deployment Guide

Standard Deployment Overview

N/A

Snapshot Deployment Overview

N/A

Special Requirements for Virtual Deployments

Install Jump Host

N/A

Verifying the Setup - VMs

N/A

4.3 Upstream Deployment Guide

We will release next.

Upstream Deployment Key Features

N/A

Special Requirements for Upstream Deployments

N/A

Scenarios and Deploy Settings for Upstream Deployments

N/A

Including Upstream Patches with Deployment

N/A

Running

N/A

Interacting with Containerized Overcloud

N/A

5. Verifying the Setup as defined the Akraio validation feature project plus any additional testing specific to the blue print

Refer to test document.

6. Developer Guide and Troubleshooting

Utilization of Images

N/A

Post-deployment Configuration

N/A

Debugging Failures

N/A

Reporting a Bug

N/A

7. Uninstall Guide

8. Troubleshooting

Error Message Guide

9. Maintenance

Blue Print Package Maintenance

- Software maintenance
- Hardware maintenance

Blue Print Deployment Maintenance

10. Frequently Asked Questions

11. License

Component	Software name	Version	License
PC/Server for control	Ubuntu	20.04	GPL
	Node red	1.3.4	Apache License 2.0
	Robot arm package		Apache License 2.0
	gtkterm		GPL 3.0
IoT gateway	Raspbian	Raspbian GNU/Linux 10 (buster)	BSD-3-Clause,MIT,GP

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	Node red	1.3.4	Apache License 2.0
	Node.js	10.24.0	MIT
	node-red-dashboard	2.30.0	Apache License 2.0
	node-red-contribute-moment	4.0.0	Apache License 2.0
	gtkterm	0.99.7+git9d63182-2	GPL 3.0
	hostapd	2:2.7+git20190128+0c1e29f-6+deb10u3	GPL 2.0
	dnsmasq	2.80-1+rpt1+deb10u1	GPL 2.0 or 3.0
	blueman	2.0.8-1+deb10u1	GPL 3.0
MSM	arduino-esp32		LGPL 2.1
	Arduino IDE	1.8.15	AGPL 3.0
	Arduino ESP32	2.0.2	LGPL 2.1
	esp-idf	4.4	Apache License 2.0
	TaskScheduler	3.4.0	BSD-3-Clause
	Arduino_JSON	0.1.0	LGPL 2.1
	Adafruit Unified Sensor	1.1.4	Apache License 2.0

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	Adafruit GFX Library	1.10.13	BSD-2-Clause
	Adafruit BusIO	1.11.0	BSD-3-Clause
	Adafruit SSD1306	2.5.1	BSD
	Adafruit_BME680	2.0.1	BSD
	Adafruit_MCP4725	2.0.0	BSD-3-Clause
	Adafruit_ADS1X15	2.3.0	BSD-3-Clause
	Adafruit_MCP9600	2.0.0	MIT
	Adafruit_MCP2300 8	2.1.0	BSD
	Adafruit_MPR121	1.1.1	MIT
	DFRobot_BMX160	-	MIT
	RPR-0521RS	-	MIT
	U8g2lib	2.31.2	BSD-2-Clause
	preMSM firmware		Apache License 2.0

12. References

SIP: <https://sip-ses.net/>

Building gateway: <https://sip-ses.net/gateway/>

13. Definitions, acronyms and abbreviations

- SIP: The Cross-ministerial Strategic Innovation Promotion Program
SIP is a national program led by the Council for Science, Technology and Innovation (CSTI) of the Japanese Government with interdisciplinary management to realize scientific and technological innovation in our country.
[About SIP | SIP | JST](#)
- SSES: Sensor-rich Soft End effector System
[立命館大学 SSES Platform - Ritsumeikan Univ. \(sip-sses.net\)](#)

14. Revision history

Version	Date	Editor	Contents
0.1	02/08/2022	Inoue	Draft version