Technology
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NGN Project SoSe 2021
Evaluation of ThingsBoard Implementation in the Context of an IoT Based Home Network

Project by:

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Impact of IoT

By **2018**, there was an estimated **22 billion** IoT connected devices in use globally.

According to Statista, this number will be **38.6 billion** by **2025**

Impact of IoT

Fuel to the Fire

- **Low-cost, & low-power sensor technology.** E.g.: Temperature, pressure, photoelectric etc.

- **Cloud computing platforms.** E.g. aws Azure etc. salesforce

- **Machine learning and analytics** E.g.: Business analytics like Hotjar website heat mapping

- **Conversational artificial intelligence (AI)** E.g.: amazon alexa and Cortana

- **Custom Connectivity Protocols.** E.g.: MQTT AP, Zigbee zigbee

IoT Supporting Protocols

Parameters	HTTP	MQTT	CoAP
Abbreviation	*Hyper Text Transfer Protocol*	*Message Queuing Telemetry Transport*	*Constrained Application protocol*
Architecture	Request-response model	Publish-subscribe model	Request-response model or Publish-subscribe model
Interaction Model	Device-to-Cloud Cloud-to-Cloud	Device-to-Cloud Cloud-to-Cloud	Device-to-Device
Transport Layer	TCP	TCP	UDP
Network Layer	IPv4 or IPv6	IPv6	IPv6
Port Number	80 or 443	1883 or 8883	5683
Header Size	8 bytes	2 bytes	4 bytes
Protocol Design	Document Centric	Data Centric	Document Centric
Encoding	ASCII text	UTF-8 Binary	RESTful Binary
Reliability Mechanism	1 level	3 levels	Confirmable messages, Non-confirmable messages, Acknowledgements and retransmissions
Security	SSL/TLS	SSL/TLS	DTLS or IPSEC
QoS	N/A	Limited	Limited

The Project

Evaluate the performance of ThingsBoard via IoT based home device management application, HomeNetwork

- Devices connected to HomeNetwork :
  - o Raspberry Pi based lighting device
  - o ESP8266 based temperature and humidity measurement system

- Project application run in community edition (ThingsBoard also offers cloud and Professional edition) hosted on private virtual server.

- Operation and monitoring of application via ThingsBoard dashboard using MQTT protocol.

- Tests, based on connectivity, functionality, usability and robustness of the system was carried out to gauge parameters such as latency of real time data, accuracy, responsiveness etc.

- Short analysis of some popular IoT supporting communication protocols like MQTT, CoAP and HTTP.

HomeNetwork Architecture

IP enabled Lighting device and Temperature & Humidity measurement device controlled via ThingsBoard using the MQTT protocol

Notifications to end users will be communicated via third party mailing service such as Gmail.

All signaling and telemetry data will be stored in ThingsBoard's inbuilt NoSQL database, Cassandra

Provides API for transport protocols, shown. Each transport component pushes data to the rule engine.

Push messages to external systems from ThingsBoard and to receive data in desired format via Rule Engine.
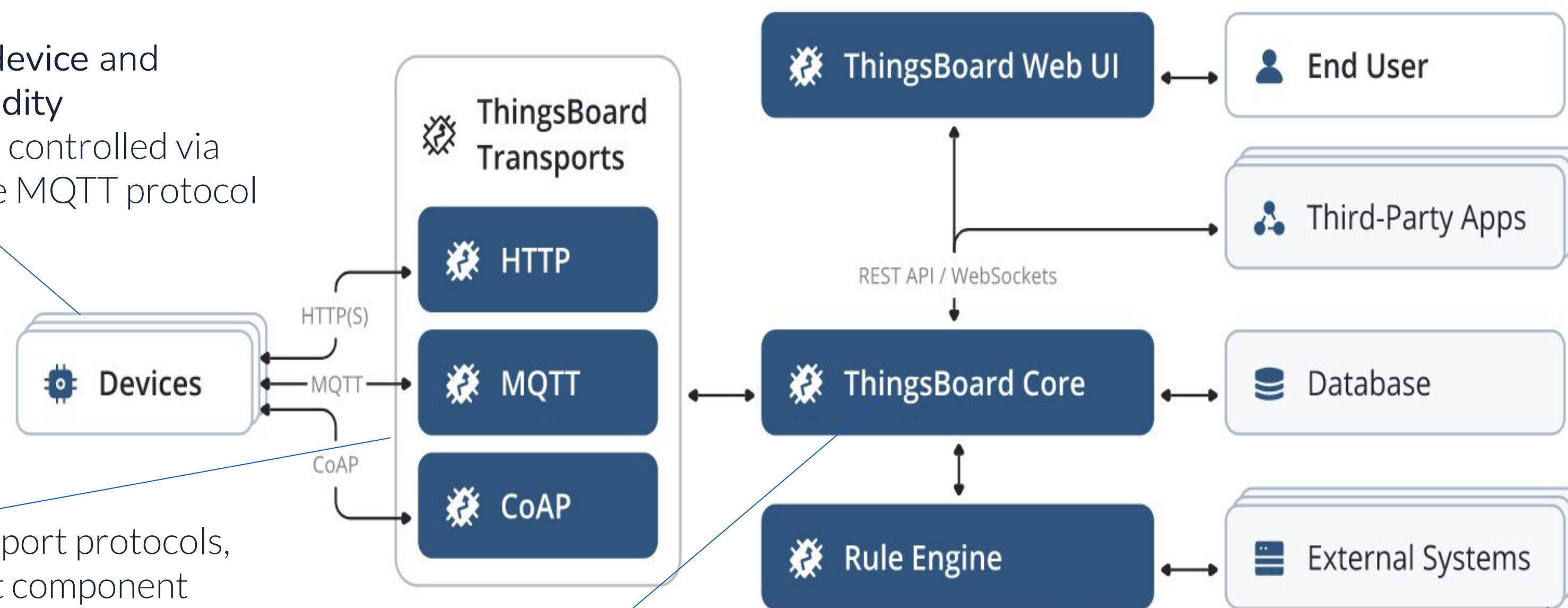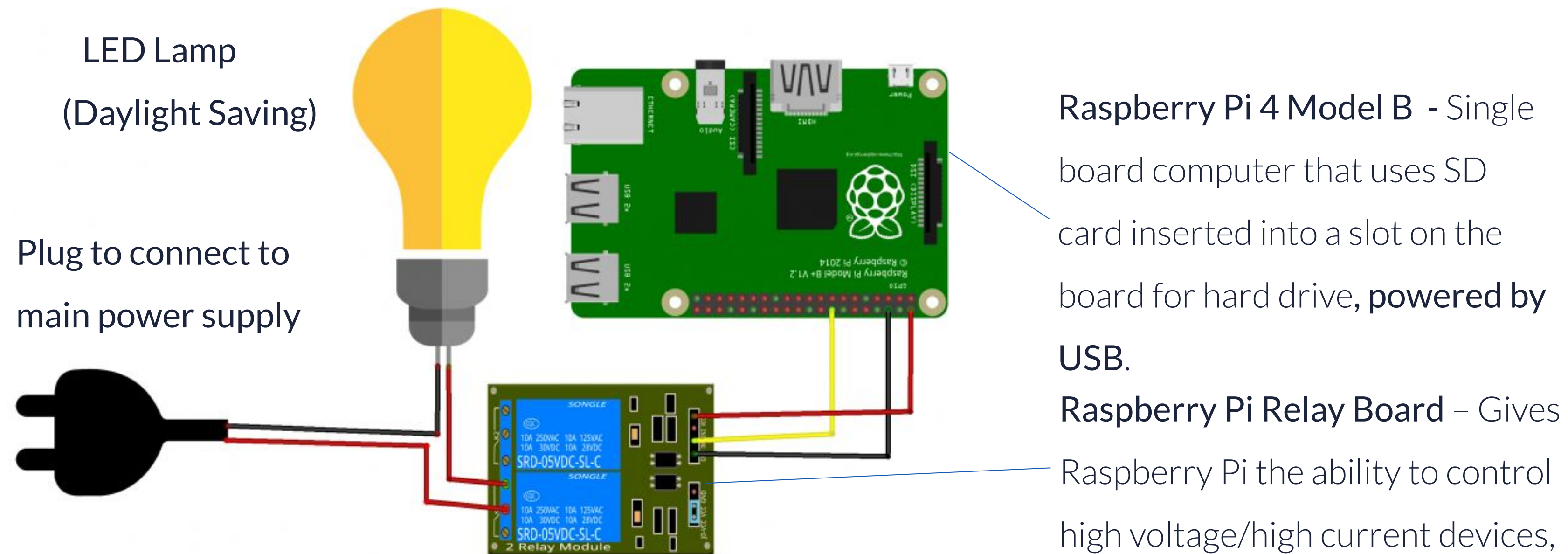
Manages all operational and management functions such as REST API calls, WebSocket subscriptions, Storing up to date information on device sessions and connectivity state

Incoming messages from connected devices is processed by user defined logic and flow set in the rule engine.

Diagram labels:

ThingsBoard Web UI → End User

Third-Party Apps

ThingsBoard Transports

HTTP

MQTT

CoAP

Devices

HTTP(S)

MQTT

CoAP

REST API / WebSockets

ThingsBoard Core

Database

Rule Engine

External Systems

Devices (Hardware)

Lighting Control Device

LED Lamp

(Daylight Saving)

Plug to connect to

main power supply

Raspberry Pi 4 Model B - Single board computer that uses SD card inserted into a slot on the board for hard drive, **powered by USB**.

Raspberry Pi Relay Board – Gives Raspberry Pi the ability to control high voltage/high current devices,
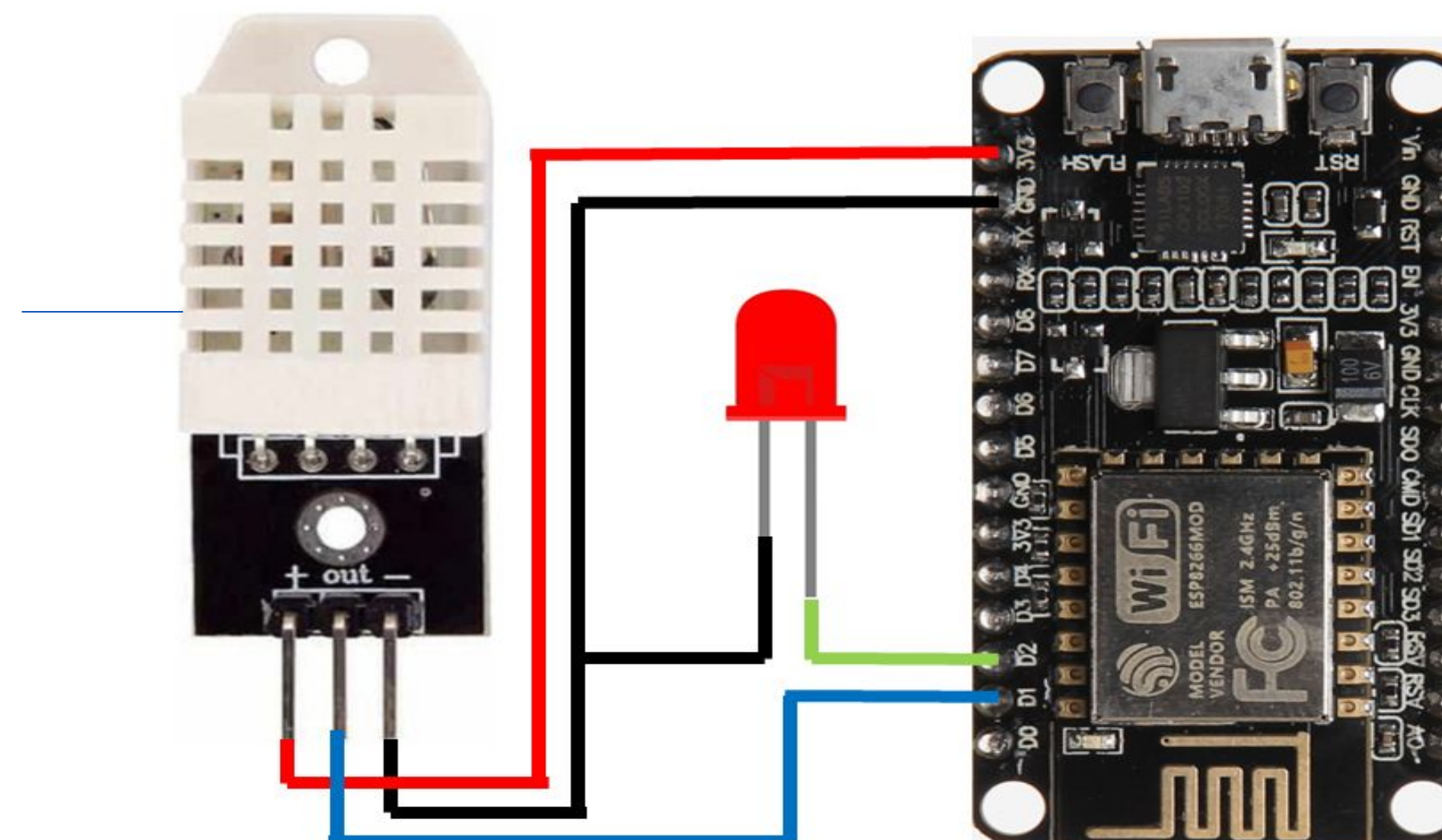
How it works

Functionality based on the code written to Raspberry Pi. It switches on every time it receives a voltage value (5V) associated with switch on state i.e.: True or False in case of 0V. This voltage is supplied as a signal from a application based user interface

Temperature & Humidity Device

DHT 22 - measures the humidity and temperature of the surrounding air with its capacitive humidity probe and thermistor and displays a digital signal output.

NODEMCU ESP8266 - Development kit based on the ESP8266 for programming of Wireless LAN controlled projects with open source firmware

How it works

Power is supplied over a USB-Cable to ESP8266 which in turn supplies power to the DHT22 with its internal regulator.
In Addition to these modules the IoT Sensor also has an indicator LED. It is switched on every time a measurement is undertaken and data is transmitted to the dashboard.

The IoT Platform:

ThingsBoard

Installing Thingsboard

- Installation on Ubuntu 18.04, other OS' like CentOS7/8 are possible

- Prerequisite: Java 11

- Consists of 3 Steps:

    - Thingsboard Service itself

    - Thingsboard Database:

        - Cassandra 4.x beta

        - PostgreSQL

    - Thingsboard Queue Service

        - In memory queue implementation (default)

        - Alternative: e.g. Kafka

- Optional: Installation script. Creates sample users, devices, and rulechains

Device Integrations

- Integration or connection of devices is done on a token base.
- Each device has its own entry in Thingsboard and a unique token
- In case of Raspberry Pi: maho-mqtt is used
- In case of ESP8266: Thingsboard-library for the Arduino IDE are available

THINGSBOARD_HOST = '45.146.254.245'
ACCESS_TOKEN = ' access_token'

Configuration of Devices
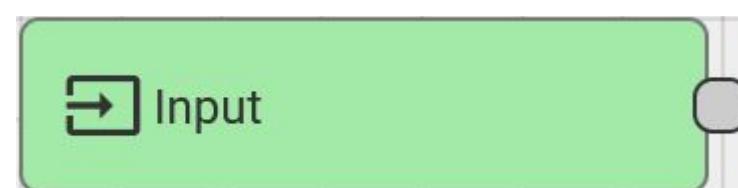

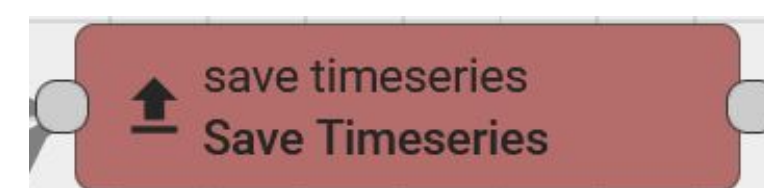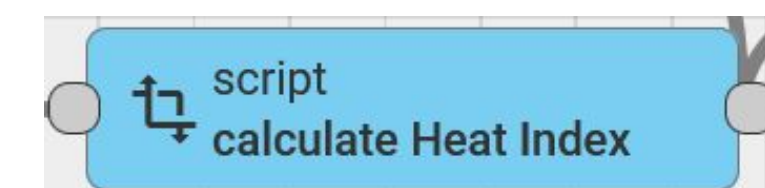Device Page with access token

Rulechain Setup

- The Rulechain drives the Workflow of the System.

- Messages are used between nodes in a rule chain.

- Nodes can alter and process a message and can trigger events

- Nodes are connected with each other by relations which are node dependent

Input-node: start of every rulechain

Action-Node: e.g. saving of data
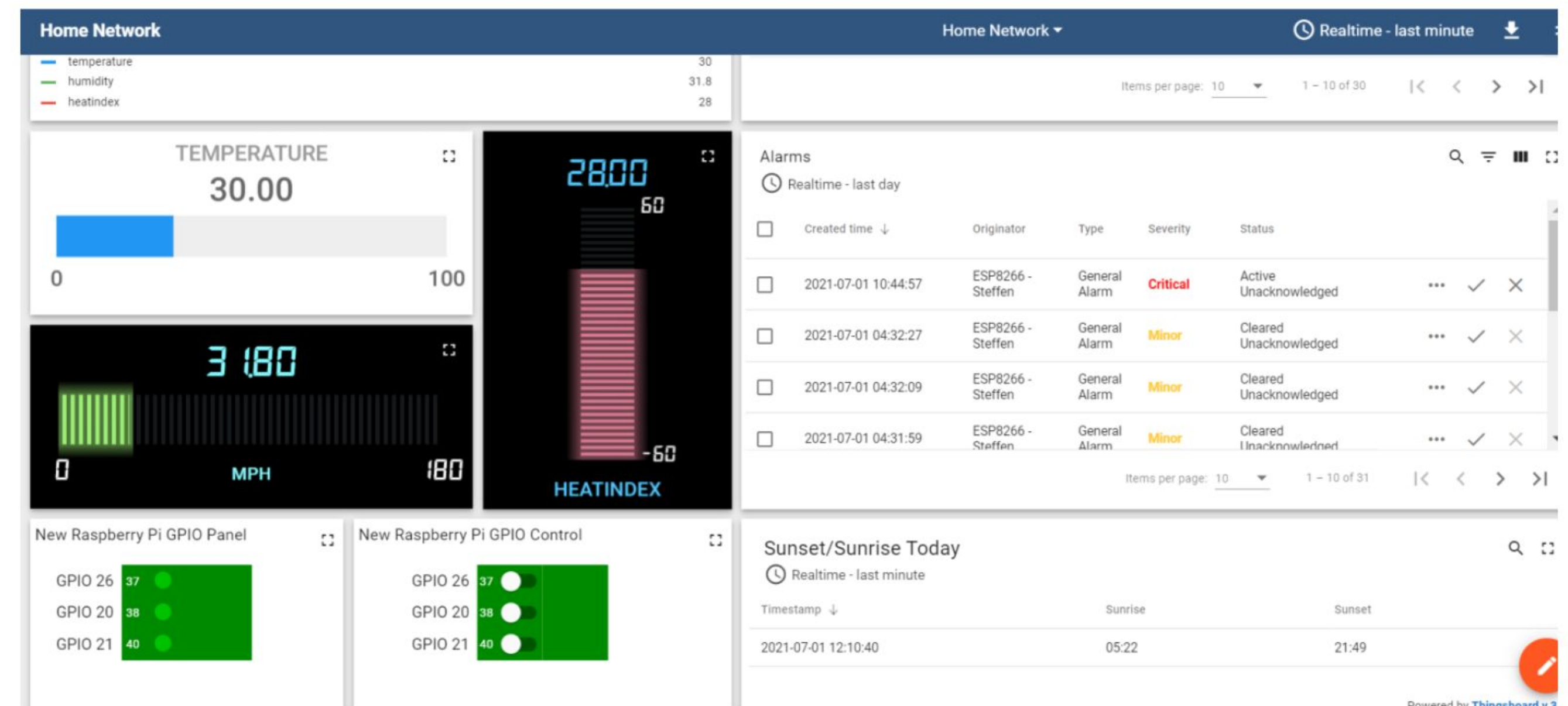

Transformation-Node: modifies message

Dashboard Setup & Visualization

- A dashboard corresponds to a rulechain
- Needs to be connected to a customer
- Is made up out of widgets
  - Each widget has its own set of keys and attributes which needs to be considered
- Displays data saved in timeseries – table form rulechain

Dashboard with multiple Widgets

Testing the System

Connectivity Testing

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered. The medium, however, provides little to no value to the end-user without the information and experiences that make

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Functionality Testing

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered. The medium, however, provides little to no value to the end-user without the information and experiences that make

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Protocol Testing

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Regression Testing

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered. The medium, however, provides little to no value to the end-user without the information and experiences that make

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Usability Testing

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered. The medium, however, provides little to no value to the end-user without the information and experiences that make

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Testing Afterthoughts

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered. The medium, however, provides little to no value to the end-user without the information and experiences that make

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Conclusions

Backup templates

- Write here a list of features

- Here you can write more

- More about the project

Content itself is what the end-user derives value from also can refer to the information provided.

YOUR
SLIDE
TITLE

CONTENT IN TWO COLUMNS

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Content A

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered.

Content B

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered.

Content C

Content itself is what the end-user derives value from also can refer to the information provided through the medium, the way in which the information was presented, as well as the added features included in the medium in which that information was delivered.

TABLES TO COMPARE DATA

	A	B	C
Content A	100	200	400
Content B	$67,000	$56,000	$78,000
Content C	4500	60000	$8,000
Content D	34000	$400	$600
Content E	$90	$800	$1,000