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Multiprotocol Rule Based Monitoring Framework on Wireless Sensor Network

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ABSTRACT

As various fields are processing towards smarter systems with rapid adaptations towards sensor network to collect precious data, a common framework accommodating multiple protocols to communicate each other acting as a M to N gateway with user-controlled logic and middleware addition feature would ease the interoperability issues and pave a way towards better integration of sensor nodes into the ecosystem leading to much efficient communication across systems. The stronger infrastructure with lower cost of wireless devices and sensors have made economical for any sized industry to adapt but due to the monopoly of certain vendors with proprietary system, smaller scale industries aren't able to invest capital due to interoperability issues with home grown products. Thus, we are focusing on creating a generic multi-protocol support framework for interoperability across the devices with data centric approach. The framework is designed in such a way that it is able to work across presence enabled devices along with backward compatibility such as HTTP for polling methods. Every data unit is processed across the different layers of the system and passed to the processor thread which applies the rules defined at prior and dispatches the notification or alerts to the respective destination as defined in the data packet.

Keywords: MQTT, SocketIO, WebSocket, Middleware Mechanism, Aedes Broker, Client, MQTT, publish, subscribe.

I. INTRODUCTION

Every network has presence and non-presence-based devices, triggering a need for implementation of multi-protocol collaboration approach making the development time prolonged. Communication across multi-protocol system is a tedious process due to non-standardization of data interchange format and packetization carried out in the protocol with varied security implementations. Always on devices such as chat applications, action oriented listening devices, actuators requiring considerable quality of service occasionally need API like calling mechanism for certain task such as background maintenance making process of communication non-standardizedleading to security hazards, thus making a team of developers meticulously design the communications and architecture.

II. DESCRIPTION

With rising requirement for smart sensors and artificially intelligent system, data is one of the most crucial parameter to be fetched, understood and converted into useful information to build an intuitive user experience. Due to the varied protocols used based on the situation such as deployment,

legacy support considerations it is hard to design multiprotocol gateway. In current market there exist many internet of things or WSN gateways, but most of them support n to 1 communication, thus we propose with the following innovations

1) Multiprotocol message passing for inter things communication
2) Low Cost bridge between M2M and Internet of things.
3) High Level packet routing using data packets itself.
4) M to N communication channel with singleton middleware.

A. System Objectives and Considerations

In this framework, we are considering data agonistic message queue telemetry transport (MQTT) for decoupled publish-subscribe model, SocketIO considering XHR long polling mechanism having protocol upgradation for web sockets, Universal Asynchronous Receiver Transmitter (UART) for hardware communications such as Zigbee, BLE etc., and HTTP, considering request-response model coveringprotocols used in different use cases. The architecture is to be designed to accommodate middleware support for all supported protocols for authentication, user defined rule matching and dynamic addition of nodes to the network. System wide adaptation of data interchange format such as JSON for inter things data compatibility. In Memory key value datastores such as REDIS, MongoDB to be used for data storage along with persistence support.

B. Architecture Overview

In this framework, as a request passes via one of the end points, it is processed using the middleware at the first stage, then the data unit is being fed into the common queue for processing where worker processes contend for the queue for the data to be processed. The data is matched against the rule specified in the in-memory database in order to quickly serve the requests. The database contains the settings of the type of data packet as decided on prior for standardization, the threshold of certain types of data for notifications or alerts. The destination address is retrieved either via data packet or via database depending on whether the request is a fresh packet or not. If the destination address is not defined, it will be placed in the cache queue until the system defined timeout crosses. If within the timeout period if the source enquires for packets, the info is being passed to retrieve the destination or it will be discarded.

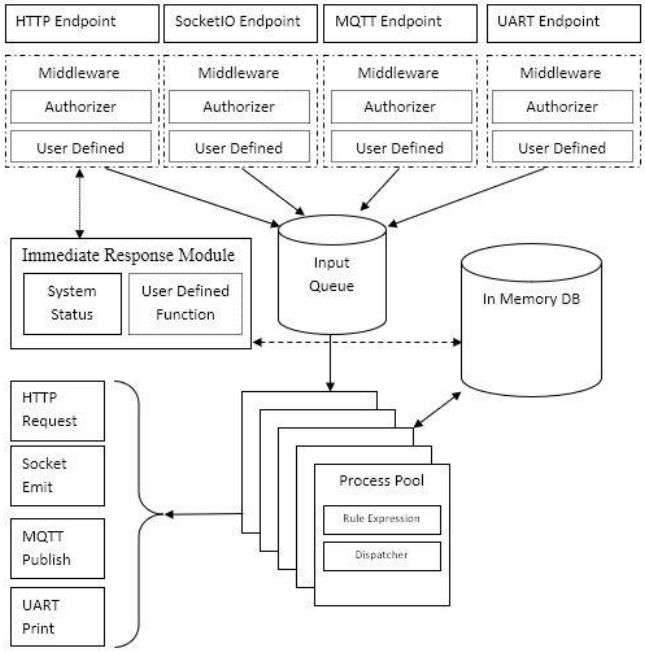

Figure 1.0 Architecture

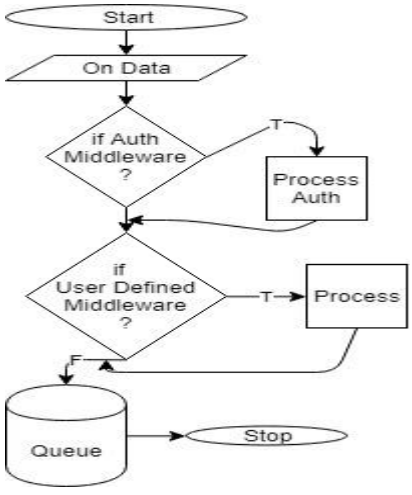

Figure 1.1 Processor Flow

DESIGN SPECIFICATION

The system uses various highly contributed opensource frameworks to allow multisource communication.

A) Message Queue Telemetry Transport:

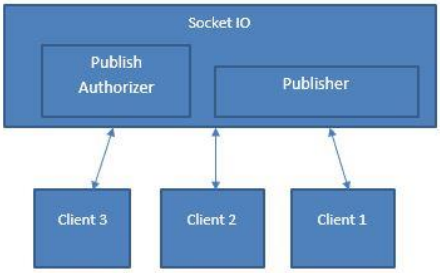

Figure 1.3. Request Section

In this design, as an instance of publish-subscribe low weight protocoli.e. MQTT. we are utilizing Aedes as a MQTT Broker which is written on highly scalable language i.e. NodeJS with Paho MQTT Client Library available for multiple platforms adhering to OASIS MQTT 3.1 Standards with backward compatibility as shown in the figure 1.5

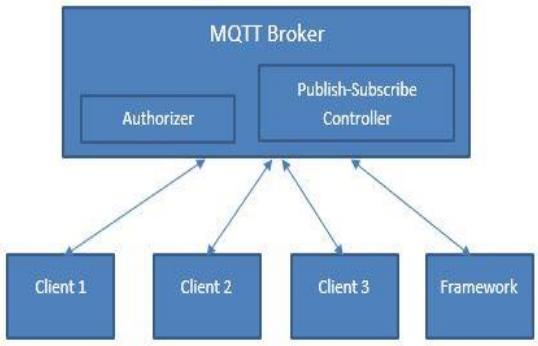

Figure 1.4. SocketIO Architecture

The broker contains authorizer which shares the credential of the framework database for client communication, it is also able to blacklist the client on either publishing and subscribing as needed.

B) SocketIO with WebSocket Support

Another widely popular protocol specifically used as a multi-platform chat application as shown in fig 1.4 is used as push notification agent in the framework named SocketIO which uses long polling mechanism on legacy system and upgrades automatically to WebSocket as available. The major benefit of SocketIO and MQTT is that, these are integrable in both Web Technologies and Application programming.

C) Immediate response module

As shown in the fig 1.0, is an administrator backend and a system application programming interface for changing settings and visualizing the logs.

D) UART Endpoint

Embedded systems are predominantly concentrated on UART since these signals can be easily be obtained by convertors available. E.g.: SPI to UART, USB to UART

E) Middleware Unit:

The Middleware unit is an addition module used mainly for authentication but is designed in such a way that users can also make a middleware wherein they get access to the raw data to be modified for further processing in the nodes. The flow chart in the fig 1.3 defines the process of acceptance of data, authorization via middleware if activated, user defined process if any, then it is placed inside the queue for further processing.

F) Rule Processor

The complete processing of data, decision making and dispatching to respective channels are carried out in this module. The rules are stored in database depending on the sensor type or data unit used. For e.g. Considering a sensor such as humidity and temperature, we give a universal ID which would be sent with the sensor to the processing node. The ID will be matched against the database for actions to be performed upon value received. The schema of the database in JSON would be as follows

```
{
  "ID": "12",
  "value_node": ["value1","value2"],
  "action": [
                {
                    "destination" : {
```

```
        "protocol_name":"mqtt",
                        "pub" : "xyz",

        "QOS" : 2
                                                }
                        }
                ],
        "condition" : [
                        {"value":"value1","
        threshold_g":23," threshold_l":18},

        {"value":"value2","threshold_g":100,"threshol
        d_l":50}
                ]
}
```

The attributes value_node, action, condition, ID are framework defined unit which are mandatory for any operations. The functionality is extendable using middleware attachment technique.

III. APPLICATIONS

The proposed framework can be applied to different industries and applications such as

- ✓ Industrial Automation and monitoring system with real-time analysis and notifications
- ✓ Hospital equipment connectivity manager to combine machines of different standards into one channel.
- ✓ Internet of things-based M to N gateway device

IV. CONCLUSION AND FUTURE SCOPE

In the recent years due to the rapid adaptations of smart systems, the use of smart sensors has flourished into the ecosystem due to the Bill of materials and better manufacturing capabilities. Inter communication of devices is the need of the hour for better integration into the ecosystem. Thus, our system fulfills these requirements to a satisfiable extent and machine learning to predict the possible sensor data if missing parameter would be future work.

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