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# $4^{th}$ Generation SCADA Implementation for Automation

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**Abstract:** SCADA [1] is the acronym that stands for Supervisory Control and Data Acquisition system [2]. Acquiring data in real-time, it can impose supervisory control over the module to monitor and manage states. It comprises of gathering data, exchanging it back to a centralized system, completing essential investigation and control, and after that showing this information on various administrator screens. This paper mainly focuses on the architecture to build a 4th generation SCADA Unit with voltage regulation for automation (Internet of Things) [3] which uses cloud topology to build a scalable and a reliable system. A cloud controlled [4] system which can be operated remotely by using internet which provides maximum flexibility in operation of the unit as well as a solid platform in cloud based automation.

**Keywords:** IOT, Arduino, SCADA, $4^{th}$ Generation, Middleware, ESP.

## I. INTRODUCTION

The blend of telemetry and administrative control is known as SCADA [1]. The SCADA incorporates the gathering of data by means of RTU (Remote Terminal Unit) migrating it back to local site doing conclusive, repeat and control and afterward showing that data on various working screens. SCADA frameworks are exceedingly circulated frameworks used to control geologically scattered resources, regularly scattered over many square kilometers, where brought together information procurement and control are basics to framework operation. They are utilized as a part of circulation frameworks, for example, water appropriation and wastewater gathering frameworks, oil and gas pipelines, electrical force networks, and railroad transportation frameworks. The motive of providing a vast geographical compatibility with unified control system brings us to the $4^{th}$Generation SCADA RTU's which is wireless and controlled using coded signals over the internet [5].

## II. EVOLUTION OF SCADA SYSTEMS [10]

### A. Monolithic

Independent systems operated individually without common network for communication which used proprietary communication protocols form minicomputers [5] which controlled these ancient systems also used a turnkey method instead of push switches.

### B. Distributed

Near real time communication which was possible with the introduction of LAN across multiple stations for command processing using a non standardized protocol which lacked security. [6] This decentralized method helped in wide spread usage of these PLC's in industries and in home automation. [5]

### C. Networked

Mimicking the distributed architecture, complex systems were broken down to individual operating units which could be controlled [5] over the network (LAN - PCN) reduced costs and also provided for stable platform for scalability even though geographically separated.

### D. Internet of Things

Combined with wireless technology [7] and use of cloud infrastructures, PLC's has come a long way into IOT market as they can be broken down into micro modules whilst achieving maximum control over the RTU and also provide a great deal of data acquisition system information which can be combined to form a stable, secure and a robust system for SCADA. [8]

## III. LITERATURE SURVEY

Analytical processing was not possible in SCADA systems as they did not work in a database environment [3]. To overcome these shortcomings, M2M was introduced to include a standardized environment for SCADA RTU's with database technology to preserve timely acquired data [3] as well as perform analysis on acquired data. Privacy is still a concern as Kuljeet Kaur et. al describes "we can say that IOT will provide a treasure of luxuries at the cost of privacy". But [9] Stankovic addresses these problems in a different way saying redundant systems which eliminates point of failure and also additional security which already exists in usable stack can be implemented to overcome these shortcomings.

## IV. SYSTEM ANALYSIS

### A. Problem Description

Fourth generation SCADA is designed to overcome deficiencies in the previous generations of SCADA systems. With Internet of things to drive these control systems, it offers a robust and a highly reliable system for acquiring data from sensors as well as to control remote terminal units using wireless technology. Main challenges on $4^{th}$ Generation SCADA systems are [10] :

1. Provide near real-time control states
2. Access individual RTU's over the internet

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3. Security in terms of both data acquisition and control over the unit
4. A complete wireless architecture for ease of use.

B. **Proposed System Architecture**

This proposed architecture consists of 3 primary components:

5. IOT Module - Consists of a ESP/NRF (Wi-Fi) chipset along with a PLC controller module which is in tandem with relay units.
6. Middleware – Cloud based middleware server to access IOT modules.
7. Frontend – Web based/ Native software to be able to control and visualize SCADA units.

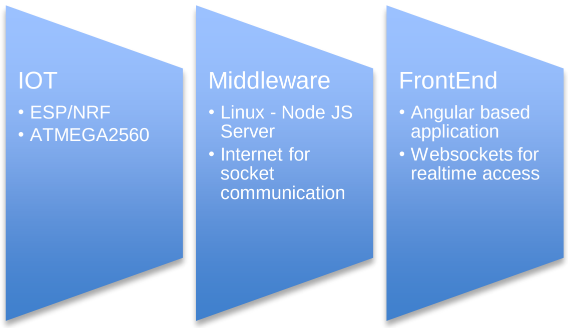


Fig1. Overview architecture of the $4^{th}$ Generation system

C. **System Design**

**I. IOT (Internet of Things)**

IOT module is divided into two major components which provides maximum scalability for remote terminal units.

1. ESP/NRF Module: ESP/NRF modules are self contained SOC with integrated TCP/IP protocol stack which works on 2.4 GHz WI-Fi protocol.
2. ATMEGA2560: Manufactured by ATMEL Corporation, it consists of 54 digital I/O pins of which 14 can be used as PWM outputs, 16 analog inputs (Used for analog sensors) and 4 UART and a 16Mhz crystal oscillator.
3. ACS712: The Allegrz ACS712 provides economical and precise solutions for AC or DC current sensing in industrial, commercial, and communications systems.

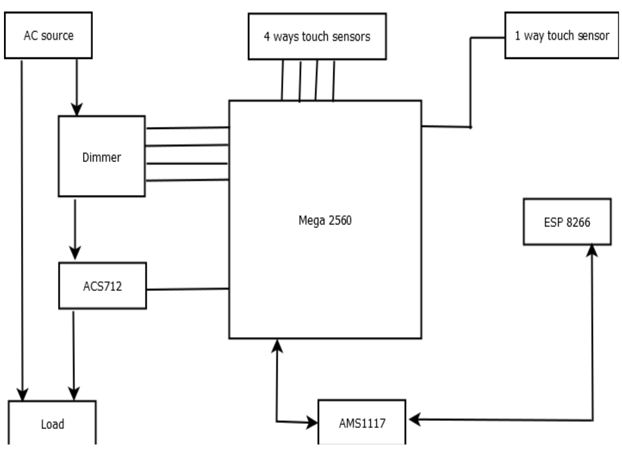


Fig 2. IOT Module Architecture

The device consists of a precise, low-offset, linear Hall circuit with a copper conduction path located near the surface of the die. Applied current flowing through this copper conduction path generates a magnetic field which the Hall IC converts into a proportional voltage.

**II. Middleware**

Consists of a Linux/Windows/Mac operating system with Node JS based server with open socket connections to listen to IOT messages and to relay messages from front end to the IOT module for concurrent control of multiple RTU's.

**III. Front-end**

Angular JS application which connects to the middleware using socket connection for near real-time SCADA unit access to retrieve real-time status update and and to control RTU states along with it.

**Working State:**

- Power up IOT device
- Configure IOT device for available AP (access point) with internet using web interface.
- IOT device automatically contacts the middle ware depending on the configuration given by the user.
- Middleware authorizes the IOT devices and establishes a bi-directional Layer 4 pipeline.
- IOT device updates its state for every 4 seconds
- Front the front end, user opens up the control page.
- The state of the module id displayed, user enters the control panel to control the SCADA system IOT device responds accordingly.

## V. ALGORITHMS

**1. IOT MODULE**

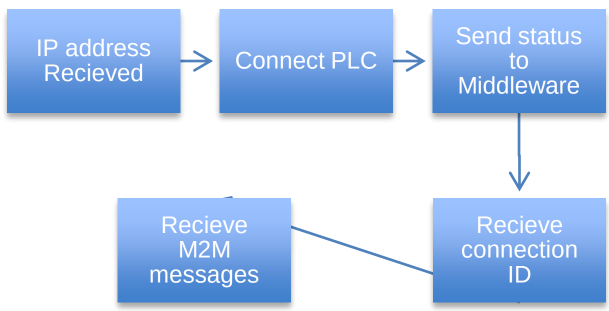


Fig3. IOT Algorithm

**2. MIDDLEWARE**

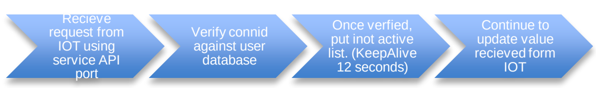


Fig4. Middleware Algorithm

### 3. FRONTEND

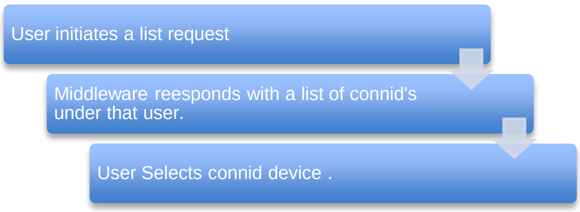


Fig5. Frontend Algorithm

## VI. EXPECTED RESULTS AND DISCUSSION

The web based graphical user interface shown in Fig 6 is used to control and monitor the PLC units. It can be accessed via internet which returns data from server and real-time data through web sockets.

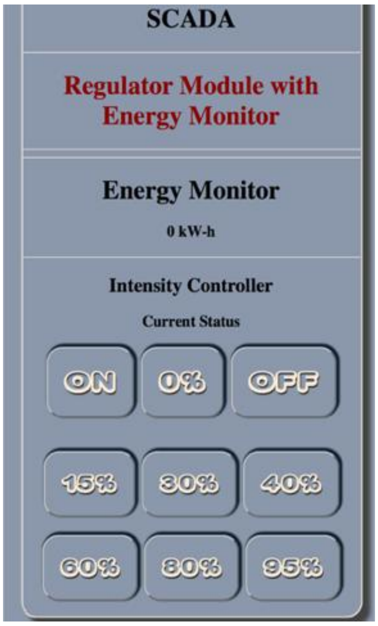


Fig6. Front end Interface

Fig 7 shows the working of the module in different voltage scales which was controlled via internet using the front end interface.

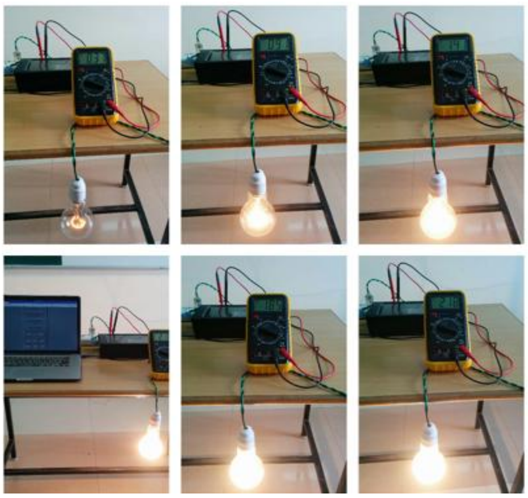

Fig7. Working states for regulated voltages

## VII. CONCLUSION AND FUTURE WORK

### A. CONCLUSION

Automation using IOT has been experimentally proven to work by the use of the above mentioned architecture which also captures values from sensors and to be used in a later point of time for analysis. This helps the user to analyze the conditions of various parameters in any system anywhere.

### B. FUTURE WORK

This framework can be expanded by inclusion of security protocols such as SSL/TLS layer and also provide real-time video feed for consistent access. Repetitive tasks such as global configurations for industries and provision of Wi-Fi access in remote locations using WSN (Wireless sensor networks) which eliminates the need for centralized access points. Also Electric grids and smart cities could be developed with such a middleware tier for massive scalability to make it open source so that it is available to everyone

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