Implementation of Mesh Network Topology using ESP8266

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ABSTRACT

Here in this work efforts were made to design, develop and establish a Wireless-Local-Area-Network (WLAN) between different nodes connected in a Mesh network topology specifically for IoT applications. Here a hardware-based demonstration was made for the implementation of mesh network topology to establish connectivity between multiple Wi-Fi enabled NodeMCU devices for the transfer of sensors data without using the internet and without using any router in between. Here as this system was connected in a mesh network topology, there was no central node or parent node in this system instead here each node communicates with every other node available. It was observed that the system was capable of establishing connectivity between each node automatically by making use of same ssid, password and port address for each node just like a wireless ad-hoc network.

Keywords: IoT, Web server, NodeMCU, Home Automation

INTRODUCTION

A mesh network is a local network topology in which the infrastructure nodes connect directly, dynamically and non-hierarchically to as many other nodes as possible and cooperate with one another to efficiently route data from/to clients. This lack of dependency on one node allows for every node to participate in the relay of information. In a traditional infrastructure Wi-Fi network there is a point-to-multipoint network where a single central node known as the access point (AP) is directly connected to all other nodes known as stations. The AP is responsible for arbitrating and forwarding transmissions between the stations. Some APs also relay transmissions to/from an external IP network via a router. But there are certain limitations associated with it like it has a limited coverage area due to the requirement that every station must be in range to directly connect with the AP. Also it is susceptible to overloading as the maximum number of stations permitted in the network is limited by the capacity of the AP. Therefore, to overcome these limitations there is another infrastructure known as ESP-MESH network where nodes are not required to connect to a central node. Instead, nodes are permitted to connect with neighboring nodes. Nodes are mutually responsible for relaying each other's transmissions. This network topology provides a much greater coverage area as nodes can still achieve interconnectivity without needing to be in range of the central node. Also it is less susceptible to overloading as the number of nodes permitted on the network is no longer limited by a single central node. Wireless Local Area Network (WLAN) includes protocols like Bluetooth, BLE, Thread, Wi-Fi, Zigbee, etc. ESP8266 chip is capable of Wi-Fi Mesh networking. In a mesh network, nodes can self organize and dynamically talk to each other. Any node in that network is able to transmit data packets to any other node, within range, which can then forward data packets through the network to the final destination. Each NodeMCU module that has an ESP8266 chip embedded can act as a node in the Mesh Network. The internet of things, or IoT, is a system of connected equipment, machines, commodities, animals, or persons having unique identities and the capacity to exchange information across a

network without necessitating human-to-human or human-to-computer contact. A point in the IoT technology can sometimes be a person ingrained with a breathing tube, a farm carnivore embedded with a nanoparticle-based guidance system, and any other instinctual or personal component that can then be assigned a Transmission Control protocol/internet (IP) email and transfer data. An IoT ecosystem consists of browser programmable controllers' systems and devices such as phones.

AIM & OBJECTIVE OF RESEARCH

The aim was to demonstrate the mesh network topology implemented between some Wi-Fi enabled devices for the transfer of data without using internet and without using any router in between. It was expected that the system should be able to automatically establish connectivity between each node by using the same ssid, password and port address for each node just like a wireless ad hoc network. Elaborating the above statement, a versatile system was required to establish communication between the different nodes using mesh network topology. Here each node was expected to enable the user to remotely access the status of other two nodes in real-time without using internet or a router. The whole system will be built around NodeMCU development board for IoT.

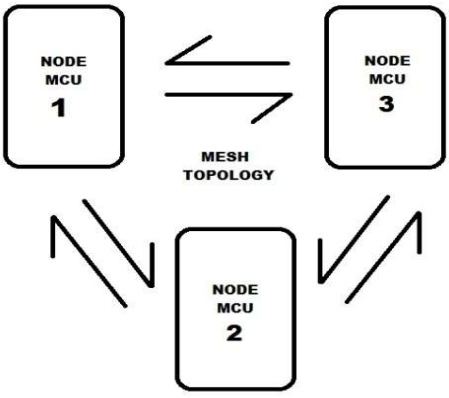

Figure-1 A Simple Mesh Network Architecture

PROBLEM FORMULATION

A high-performance, low-cost microcontroller platform with Wi-Fi protocol integrated was required. After referring to the datasheets and application notes for some devices like ESP01, ESP-12, ESP-32, etc., finally ESP-12 based NodeMCU module was selected for this work. The detailed knowledge was gathered about the sensor specifications, their availability in market, operating principles, working procedures, driver circuits and also about their interfacing with the NodeMCU. Performed studies about establishing the wireless mesh network connections between multiple nodes deploying sensors, push-buttons, display and relays. Prepared the Bill-of-Material and make procurement for the required components from local sources. Designed algorithm and written firmware for each individual node and tested it. Tested the system over a bread-board and finally implement it over a self-designed PCB in a CAD tool and finally perform multiple iterations to test it and calibrate it.

EXPERIMENTAL RESULTS

The experimental set-up was developed for the implementation of proposed work as shown below. There were three sub-systems deployed to get connected through wireless local area network in a mesh topology. For the transfer of data between different NodeMCUs, each sub-system was powered up separately means there were three different power sources used here for three sub-systems. Three batteries could be used to power up these nodes. The system was operated on a 5V/ 1Ampere dc power source. The first node was connected with push buttons and OLED display module. It accepted inputs from the push buttons and sent the updated status remotely to other two nodes individually each time a dedicated push button got pressed. Similarly, this node displayed the outputs obtained remotely from other two nodes individually over an OLED display screen as shown.

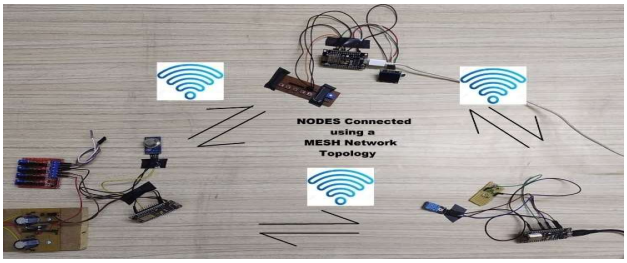

Figure-2 A Simple Mesh Network Architecture

CONCLUSION

Here it could be easily observed and verified that to establish communication between multiple nodes in a wireless network could be through a router if it were a traditional Wi-Fi network which has its own set of limitations or it could be attained without using any router in between via a mesh network topology which has its own set of benefits. Here it was successfully demonstrated that a local wireless local area network could be established between multiple nodes without even using the internet. The number of nodes could increase to a significant level using this mesh network topology as here the nodes are mutually responsible for relaying each other's transmissions and these interconnected nodes resulted in a much larger coverage area.

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