Poster Abstract: AMRITA Remote Triggered Wireless Sensor Network Laboratory Framework

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ABSTRACT
In this paper, we present a real time remote triggered laboratory which has multi-set, multi-group of wireless sensor network experimental setup which is envisioned to provide a practical experience of designing and implementing wireless sensor networks' algorithms in both indoor and outdoor conditions. The architecture provides a remote code editing mechanism using deluge protocol that offers the user a flexible environment for the experimentation. Central and local authentication agents serve a two level security mechanism which makes the system robust to security threats. The lab is accessible for all the students in the world through internet and it will provide an intuitive web-based interface, where registered users can access the code and do code editing.

Categories and Subject Descriptors
C.3.3 **Computer systems organization~Real-time system architecture**

General Terms
Design, Documentation, Experimentation, Measurement, Performance, Reliability, Security, Theory

Keywords
Remote triggered lab, Remote panel, Remote code editing

1. INTRODUCTION
As wireless sensor networks (WSN) are emerging worldwide, the lack of e-learning facilities degrades the availability and usage of WSN applications, mainly in universities. The remote triggered lab aims in providing an easy, efficient, interactive and user friendly environment to the students, researchers etc., which can trigger their inquisitiveness and give them the equipments and materials needed for the lab experiments which are shared to them in a virtual manner wherein they can conduct the experiments online and observe the outputs as in a real lab through an effective visualisation tool.

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Our remote triggered lab provides an intuitive web-based interface, where educators and learners can learn theoretical concepts in Wireless Sensor Networks (WSN), Wireless Communication, Propagation Effects, Low power sensing, processing and transmission, Wireless Sensor Network Algorithms etc. Our system offers a code editing tool for the users to practice and understand the sensor node programming. The management and maintenance of the sensor nodes are done using reprogramming schemes.

2. REMOTE TRIGGERED LABORATORY FRAMEWORK
Our system is developed for achieving the following capabilities such as real-time access for management and maintenance of the WSN, developing multiple testbeds for conducting multiple WSN experiments, increasing the flexibility, scalability, reliability and robustness of the wireless sensor network etc.

In our system, the Central Server, as shown in Figure 1, verifies the authentication of a client who accesses the RT Lab resources such as the theory contents, animation, simulation etc. and a second level security is provided using Local Authentication Agent. The Media Server is used to stream the live video. The Remote Backend Server uses a Web layer for accessing the remote panel of an experiment, which provides the visualization of the physical setup - a User input panel for getting the input parameters from students, a Physical Representation panel for demonstrating the graphical representation or the topology of motes deployed in the WSN Testbed, a Chart panel for the real time data plotting, a Video panel which shows a live streaming video of the deployed sensor nodes and a Code editing panel for students to edit the programming codes for each experiment. For getting the sensor values to Remote Panel from the sensor node, a LabView service is used, which acts as a communication medium in between the Remote Panel and WSN Test bed.

3. REMOTE CODE EDITING MECHANISM FOR RT LAB
Our system offers a remote code editing mechanism, shown in Figure 2, for registered users, which allows them to have hands on experience with programming the sensor nodes. The central aim is to provide an efficient and effective high level interaction between users and wireless sensor nodes with the help of a code editing panel which includes options for editing, saving, compilation and burning of the source code. The compilation result is displayed in the web page. The final result after burning includes the video of the setup which is streamed using Media Server and the chart which shows the plotted data from the sensor node.

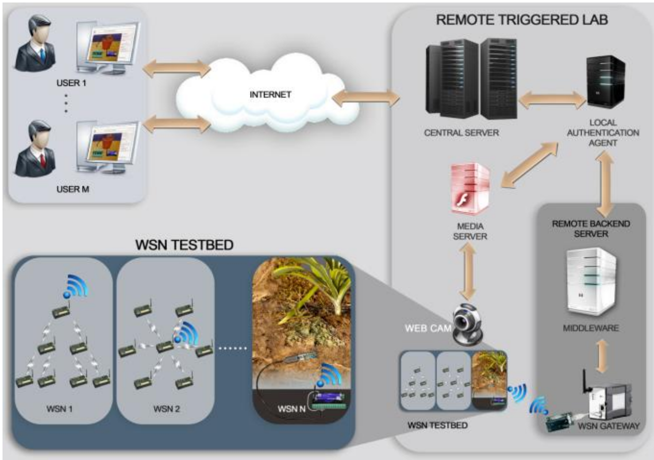

Figure 1. Architecture of the AMRITA remote triggered wireless sensor network laboratory

Our system uses over the air programming mechanism to manage our large WSN. To support over the air programming, we used Deluge [1], a reliable data dissemination protocol for propagating large data objects from one or more source nodes to many other nodes over a multihop WSN. However this remote code editing setup allows the students to experience all the changes happened to WSN in real time.

4. IMPLEMENTATION AND RESULTS

Our WSN Testbed provides 11 wireless sensor networks which uses memsic micaz motes, where we deployed 9 sensor networks with more than 100 sensor nodes in indoor and 2 sensor networks with more than 15 motes in outdoor.

Using Flash Media Server, the videos of the WSN test bed are getting streamed. A minimum of 11 parallel webcams to be streamed simultaneously for our 11 deployed experiments. For giving an overall view of the entire-laboratory-setup, a minimum of 3 webcams are used.

The main experiments implemented are “nesC Programming” for learning the nesC programming basics through Blink program, “Send and Receive” for learning how to send and receive a packet wirelessly, “Range & Connectivity vs. Antenna Power” to show how we can select different transmission ranges with respect to the available power levels, “Duty Cycle vs. Power Consumption” for showing the implementation of duty cycle in WSN and the analysis of power consumption in different states viz. sleep, sensing, transmission and processing, “Sensor Data Acquisition” to acquire sensor data from the wireless sensor board and also from external sensors such as dielectric moisture sensor, rain gauge, temperature sensor, humidity sensor etc, “Data Collection Frequency and Transmission vs. Power Consumption” to analyze the power consumption of wireless sensor node under different sampling intervals of sensing and different transmission rates, “Wireless Propagation” for implementing WSN at different environmental, terrain, and vegetation conditions, “Wireless Sensor Network” for remotely design WSN and experiment the data sending and reception at various power levels, and “WSN Data Acquisition, Transmission, and Aggregation” for implementing WSN to acquire sensor data, transmit it to the nearby node and aggregate the data in intermediate nodes.

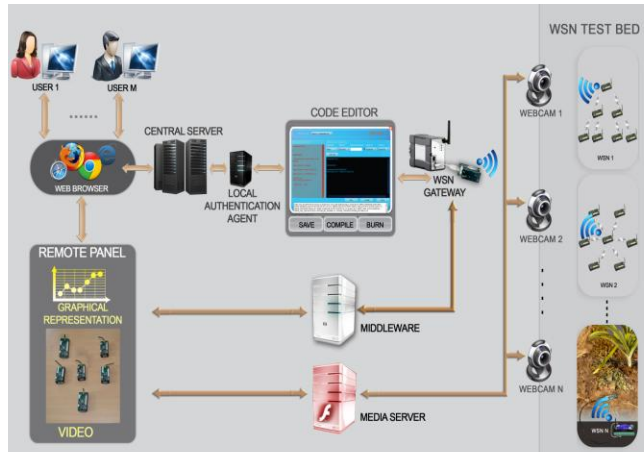

Figure 2. Remote Code Editing Architecture

Figure 3. The remote panel of a WSN experiment which shows the video, chart and physical representation

5. CONCLUSIONS

In general, our complete system incorporates the concepts of virtual laboratory and remote triggered laboratory, thus providing an effective and efficient learning experience to remote users. In future we will focus on enhancing this test bed by adding more experiments, optimizing the network based on bandwidth utilization, and developing better medium access protocol to enhance the scalability of the complete system.

6. REFERENCES

[1] Hui, J. W., and Culler, D. 2004. *The dynamic behavior of a data dissemination protocol for network programming at scale.* DOI=http://doi.acm.org/10.1145/1031495.1031506