Abstract—A base station (BS) in a traditional wireless sensor network (WSN) is a single stationary node, which makes a decision based on the collected data from the WSN. However, the institution of a mobile cloud BS gives way to much greater computational power than that of a single node BS through way of distributed computing, extends the lifetime of the network by moving each node to the optimal location, and the ability to physically restore the sensor motes of the network. Thus, in this paper we propose a mobile BS cloud.

Keywords—wireless sensor network; mobile; cloud; base station; optimization

I. INTRODUCTION

In a wireless sensor networks (WSN), a base station is essentially the brain of a network. It handles data aggregation and processing, intercommunication of sensor motes and the end user, as well as optimization strategies to extend the lifetime of the network.

The necessary numbers of hops required for message passing are decreased when instituting multiple base station node. A problem arises in this structure when focusing on network lifetime as a base station nodes closest mote takes on not only its own messages but also those of the motes in the near vicinity. The institution of a base station cloud that periodically moves to new locations based on an optimization problem solves this because the “routing” mote(s) continually change. Additionally, the institution of a WiTricity charging protocol will also greatly increase the network lifetime.

Another issue is the loss of sensor motes that can move or can be moved. A multiple node mobile base station can recover lost motes based on last known location and signals sent from the mote. Since each base station node is mobile it can move to the last known location of said mote and physically return it to the network and reestablish its connectivity.

Previously, a base station in a wireless sensor network has been a single, stationary machine with limited capabilities. However, the institution of a mobile cloud base station gives way to much greater computational power than that of a single node base station through way of distributed computing, extends the lifetime of the network by moving each node to the optimal location, and the ability to physically restore the sensor motes of the network. Thus, in this paper we propose a mobile base station cloud comprised of multiple Raspberry Pi powered Lego Mindstorms NXT robots.

II. BENEFITS OF BASE STATION CLOUD

There are many benefits to the institution of a base station cloud which include the following:

1. For Large Data Collection
2. For Decision Making Capabilities
3. To Solve Optimization Problems

These benefits cannot be easily implemented without the formation of a cloud. Figure 1 shows the proposed cloud network and the communication of its nodes. The benefits of this are better defined below:

II.1. For Large Data Collection

Data collection is the cornerstone of a WSN. The institution of a cloud base station makes data collection much easier as the large computations required can be distributed across the cloud to the many nodes for quicker, more efficient work. For this purpose we have proposed the incorporation of Hadoop/MapReduce.

II.2. For Decision Making Capabilities

The base station cloud allows for the ability of decision-making distributed across the multiple nodes. For instance, in a wireless sensor network, when large amounts of data are gathered from motes by the base station cloud it takes a large amount of computational power to sort and become useable. Distributing this work across the cloud, again, fulfills this need. For this purpose we have proposed the incorporation of Hadoop/MapReduce.

II.3. To Solve Optimization Problems

Decision-making can be done by solving an optimization problem. Again, solving optimization problems needs a large amount of computational power. The base station cloud again solves this issue. Solving an optimization problem, such as the most efficient path when a mote shouts for help (in need of power), is solved much more efficiently through distributed computing across the cloud.

II.4. Related Work

According to Gandham et al., by employing multiple base stations “we have effectively either reduced or
retained the hop count of each sensor node in the network” [1].

This is most important from the standpoint of energy consumption since the energy expenditure of a message from its sensor node to its nearest base station is directly proportional to the number of hops it must travel. Thus, the institution of multiple base stations reduces the energy consumption per message.

III. Benefits Of A Mobile Base Station

There are many benefits of a mobile base station in a mobile or non-mobile wireless sensor network. The following three are most pertinent to this research: (1) communication; (2) to build a mobile cloud; and (3) for decision making capabilities

The addition of a mobile base station gives way to the ability of the nodes of the base station to physically move to different areas throughout the network. These benefits are better defined below:

III.1. Communication

Communication between motes and the base station(s) is essential in a WSN. The proposed mobile base stations increases the communication due to the ability to physically move to the most beneficial position.

For instance, when a mote gets disconnected from the network and the network recognizes this, a node of the base station can move to the motes last known location (as determined by the network) and search – based on a signal emitted by the mote – and physically bring the mote back in range of the network and reestablish the connection.

III.2. To Build A Mobile Cloud

With the introduction of multiple mobile nodes comes the ability of a mobile cloud. In the case of a Mobile Wireless Sensor Network (MWSN) where the motes of the network can move it is necessary for the base station, in this case the network of mobile nodes that creates a cloud, to also be mobile.

As the motes of the MWSN move the mobile cloud base station would move with it. Also, the cloud base station could move to the more beneficial position (in terms of efficiency).

For instance, it might be more beneficial for more nodes of the cloud base station to be in one area of the network for more efficient data collection.

III.3. For Decision Making Capabilities

The institution of a mobile cloud base station can increase the network lifetime by making decisions based on the location of the base station nodes and their ability to move. By determining the location of each node we can determine the most efficient path of movement to assist throughout the network.

We have proposed the institution of nodes that will work in conjunction with a WiTricity charging protocol to solve an optimization strategy to extend the lifetime of the network.

III.4. Related Work

It has been show by [2] that sensor nodes that are only one hop away from a base station consume more energy as they essentially become the main routing node – forwarding not only their own messages but also those of the others belonging to that base station. This depletion of energy renders the node and others like it in the network in operational that in turn does the same to the network.

[1] suggests two strategies for periodically changing the locations of the base station nodes to increase the lifetime of the sensor network.

IV. How To

Each node of the mobile base station cloud is most significantly comprised of one Raspberry Pi and one Lego Mindstorms NXT robot connected through the NXT’s provided USB A-to-B cord.

We first set up the Raspberry Pi with a fresh distribution of Raspbian and install the Java Development Kit. We then begin developing the cloud network by installing and setting up hostapd and isc-dhcp-server. We then assign a static IP address to the Wi-Fi adapter. Next we configure the Access Point and configure Network Address Translation. Finally, we set these up as daemons to run automatically on boot.

We also flash the Lego Mindstorms NXT brick so that we can program it in Java. The NXT is connected to the Raspberry Pi through USB that allows us to control it from the Pi.

V. Conclusions

In this paper, we proposed a mobile base station cloud and developed it with multiple Raspberry Pi powered Lego Mindstorms NXT robots.

As a next step, we will institute Hadoop and MapReduce to let the mobile BS cloud solve a linear problem, which will be useful to find out an optimal solution on its decision making.

REFERENCES
