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Always Best Connected Mobile Sensor Network to Support High Accuracy Internet of Farming

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ABSTRACT

The Internet of Farming be dependent on data gathered from sensor of Wireless Sensor Network (WSN). The WSN requires a reliable connectivity to provide accurate prediction data of the farming system. This paper introduces a mechanism that gives always best connectivity (ABC). The mechanism considers all stakeholders (mobile node, corresponding node and users) attributes. An empirical simulation shows that the proposed mechanism provides an acceptable ABC to the mobile sensors in the WSN.

Keywords: Internet of Farming (IoF), mobile sensor network, always best connected, smart farming system.

1. INTRODUCTION

Internet of Things (IoT)-related connected sensors that collect data and send information back to a central location became one of the biggest innovations in the agricultural space over the past few years. In the past farmers had to go out into the field and perform soil tests to make sure crops were getting all of the nutrients they needed, moisture was sufficient, and many other factors were on track. Farmers would either have to hope that the information they gathered was true across every field or perform multiple tests and take up a lot of time doing so. With newer technologies, farmers can now set down a sensor and have a constant source of data to return to whenever they need using web browser or their smartphones. They always have access to the data they need. They can also access climate forecasts to predict weather patterns in the coming days and weeks.

Farmers can use their smartphones to remotely monitor their equipment, crops, and livestock, as well as obtain statistics on their livestock feeding and produce. They can even use this technology to run statistical predictions for their crops and livestock.

The IoT and WSN technologies are used to observe and record data in order to make up precision agriculture, to achieve production output improvement while minimizing cost as well as preserving resources. The precision agriculture needs robust network that minimizes packet drops in the wireless network. Thus, this paper introduces a mechanism to provide an always best connection (ABC) for the sensors and gateways to communicate with the processing server with the aim to support accuracy in data processing.

2. RELATED WORK

The emerging Internet of Things (IoT) technique provides a new method for access to farmland information technique [1]. IoT is the expansion of communication network and internet application, which is a technique to sense the physical world by sensing technology and the intelligent devices through the interconnection, calculation, processing and knowledge mining to achieve the information exchange and seamless links among the persons and devices or among the things and to achieve real-time control of the physical world, accurate management and scientific decision-making [2-5].

O'Droma et al. [6] presents a proposal for a type of reference terminal architecture and the essential elements of re-configurability involved in the communication layers for ABC. They aslo a proposal for the development of the physical layer support for ABC, as well as outlining state-of-the art and research challenges in the components of various layer entities. Furthermore, they highlighted the inherent QoS inadequacies associated with "all-IP" wireless networking, and the implication for ABC offerings.

Passas et al. [7] presents a considerable set of the technologies that are expected to play a key role towards the ABC vision. The authors describe a reference architecture, the required enhancements at certain levels of a traditional protocol stack, and technologies for mobility and end-to-end Quality of Service (QoS) support. The paper concludes with a case study that reveals the advantages of the ABC concept. Mabrouk et al. [8] propose two approaches to provide multiple access networks simultaneous for mobile users moving in heterogeneous access network environment called graph theory-based approach, and signaling game-based approach. The first approach is based on graph theory while the second one based on signaling game theory to compute the suitable path which provides Always-Best-Connected service for a smart vehicle moving in vehicular networks.

Network selection problems have been a major research area for some time [9, 10]. The problems go to show that ubiquitous, seamless and Always Best Connected (ABC) network connections are highly sought. Moreover, providing all this for user that can easily go from moving at pedestrian speed to high speed (while in a vehicle) is expected. Mobile Nodes (MNs) with multiple interfaces are currently the norm. This means a MN can connect to different types of access networks. Typically, network selection occurs when handover is imminent. Traditionally, target network to handover to, is chosen based on single criteria such as Required Signal Strength (RSS). Bari & Leung [11] have shown that network selection based on single criteria is insufficient in serving the user's diverse and changing needs. Also, a context based network selection will better fulfil the ABC criteria as different users may have a different idea of what is ABC [12].

3. THE PROPOSED MECHANISM

In order to correctly identify the context on which the network selection occurs, attributes must be collected from all the stakeholders; the mobile node, the corresponding node, and user. The mobile node attributes include: velocity, travelling trajectory, active application and dwell time. The corresponding attributes

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include: coverage area, delay, packet loss ratio, jitter, throughput, security and cost. The user attributes include: user preference and user perceived quality (UPQ).

Common sense dictates explicit input from the user is the best way to determine user's preference. Not only that, each user has his or her own idea of what constitutes ABC for themselves. The challenge here is in the method of acquiring the user's preference. The method must be as simple as possible so that users can understand easily. Users can also change the preference anytime. And these changes can be adapted immediately into the network selection strategy. This paper follow the work by Mohanan et al. [13] that consider the Quality of Experience (QoE) and combine with the Quality of Service (QoS) in order to make the network selection policy more reflective of the context.

Figure 1 illustrates the components of the holistic policy framework for network selection. The figure shows that the selection policy does not differentiate between homogeneous and heterogeneous handover. A comprehensive network selection policy should be able to handle both types of handover.

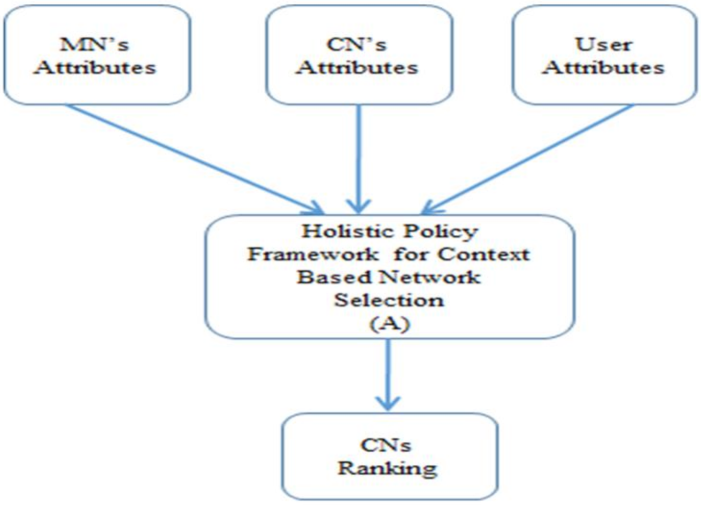

FIGURE 1. Holistic Network Selection Framework [13].

The algorithm to execute the component A from Figure 1 is shown in Figure 2. As shown in Figure 2, the selection policy is dynamic and adaptable to the changing context of the stakeholders. Instead of static weights [9, 14], dynamic weights are assigned to represent the importance of a particular attribute in finding the best target network.

1. Initial weights is decided with based on active applications
2. Identify prospective CNs
3. Calculate the mobile node's velocity V_{MN}
4. Do checking
   IF V_{MN} > VThreshold
      a) Remove the WLANs from CNs list
      b) Adjust weights fro Throughput and PLR
5. For each CN:
   i) Identify Dwell time DT_{CN}
   ii) IF $DT_{CN} < DT_{Threshold}$
      Remove the CN from the list
    ELSE
      Adjust QoS values collected from the CN
6. IF $UPQ_{User} < UPQ_{Threshold}$ for the active application
      Adjust the weights predefined for the said type of application
7. Choose appropriate GRA formula based on user preference
8. Rank the CNs

FIGURE 2. Algorithm for the context-based network selection [12].

4. EXPEREMINTAL SET UP, RESULTS AND ANALSYSIS

4.1 EXPERIMENTAL SET UP

FIGURE 3. Nodes and gateway used in the experiment.

Figure 3 shows the sensors and gateway used in the experiment. A sensor node has 4 communication slots (WLAN, Ethernet, GSM, and WiMAX) as shown in Figure 4. Each sensor is put in a remotely controlled toy tractor to keep the sensor nodes moving with different speeds. The QoS mapping used is adopted from [13] and the routing protocol is adopted from [15].

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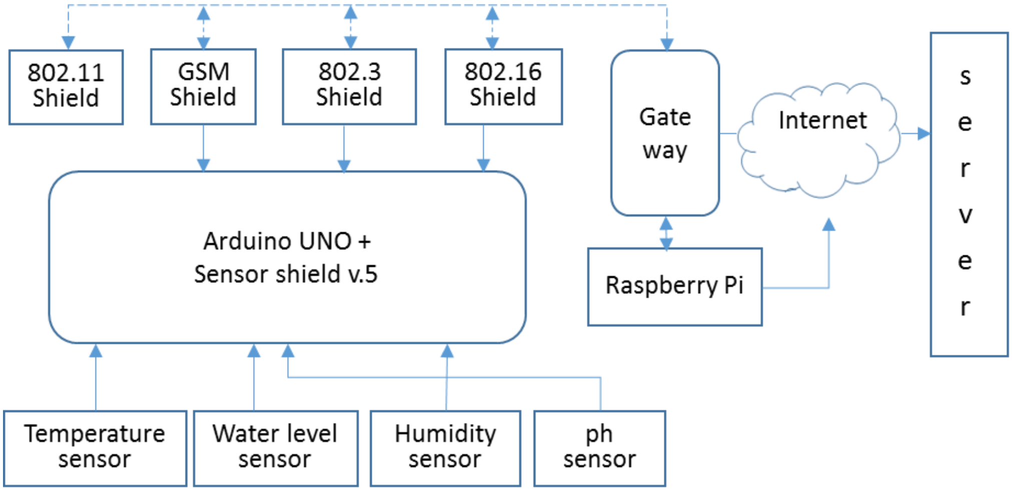

FIGURE 4. Architecture diagram of a sensor node.

TABLE 1. Parameter Mapping Table [13].

802.21	802.11	802.16	3GPP
Max bit rate	Peak data rate	Max. sustained traffic rate	Max bit rate
Min bit rate	Min data rate	Min reserved traffic rate	Guaranteed bit rate
Packet error rate	Packet error rate	Packet error rate	SDU error ratio
Delay	Delay bound	Max latency	Transfer delay
Jitter	Jitter	Tolerated jitter	Delay variation
Priority	User priority	Traffic priority	Traffic handling priority

4.1 Experimental Results & Analysis

Figure 5 and Figure 6 show the simulation results run for about one hour.

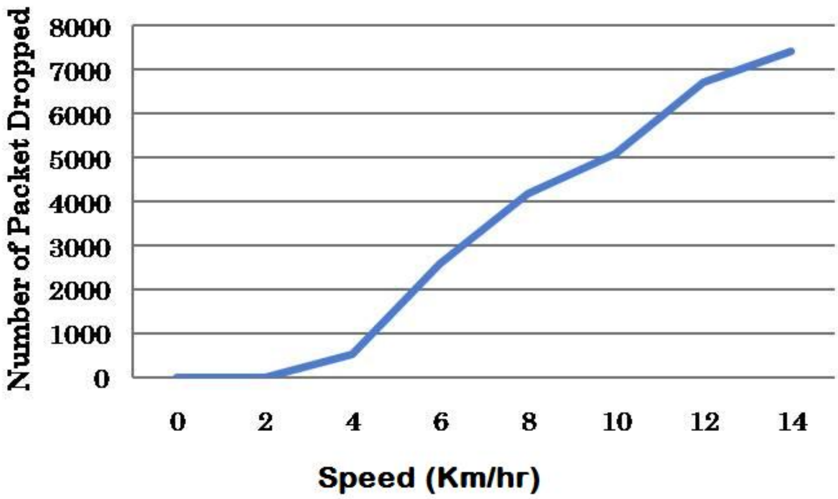

FIGURE 5. Packet drop of overall WSN.

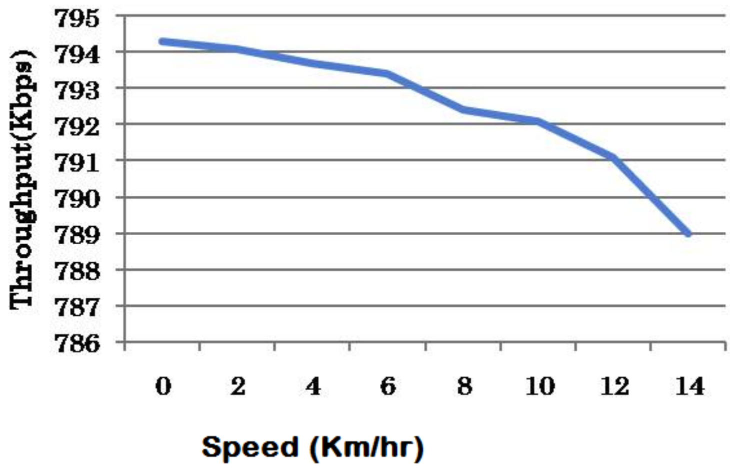

FIGURE 6. Throughput of the overall WSN.

The Always Best Connection for the sensor nodes is guaranteed by the adopted mechanism during the experiment. The packet drop shown in Figure 5 tends to increase almost linearly when the mobile sensor nodes moving faster. Meanwhile the throughput of overall WSN decreases when the speed is increased.

5. CONCLUSION

This paper adopted the Always Best Connection mechanism from [14] with the aims to provide a high accuracy farming monitoring system. The adopted mechanism successfully provide the ABC by considering its QoS. Nevertheless, the experimental results showed that the throughput of the overall network decrease and the packet drop increase when the mobile sensor network moving faster. An improvement and adjusting parameter are needed for the future work.

We are also thinking of considering the power/energy used by sensor node with regards to providing the ABC.

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