

Fine Tuning of Wireless Sensor Networks for Enhanced Smart Farming

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Abstract— The efficient use of the wireless technology leads to the better implementation of security and data management in any domain of sector, but here implementing that kind of wireless technologies in agriculture to maintain crops and feedback efficiently through wireless sensor devices information which are being changed from time to time. To be precise, for data acquisition we need to know about the variables that need to be monitored and controlled. For example weather conditions like humidity, wind and rain are a few out of many to be considered as main constraints in agriculture. The objective of this work is to fine-tune IEEE 802.15.4 parameters to seamlessly integrate it in maintaining crops in different localities of the selected region. In any case, sensor hubs have restricted assets. Hence, it is important to adjust the expansion in inspecting recurrence for various products, under application limitations (unwavering quality, bundle postponement, and lifetime term). In this article, we are discussing the process to legitimately fine-tune IEEE 802.15.4 details and the examining recurrence of conveyed sensor hubs. A scientific model of system execution is determined and used to play out the tuning of these exchanges off parameters. Recreation examination demonstrates that our plan gives a proficient increment of testing recurrence of sensor hubs while fulfilling application prerequisites.

Keywords—WSN-Wireless Sensor Network, WirArb-Wireless Arbitration, MAC Protocol, IoT-Internet of Things

I. INTRODUCTION TO SMART FARMING

Smart Farming is a technique which allows sensing real time data and sending that information to base server. There are several techniques involved in Smart Farming for the effective data collection. Suitable algorithms and protocols have been implemented. The programmed data acquisition could be accomplished with Wireless Sensor Networks with sensor hubs obliged in vitality, set on farmland. [1]

The most part requires an extreme level of granularity of perceptions in spatial and worldly areas as a result of the yield fluctuation in space and time. A few checking zones require distinctive amounts of soil data over the whole span of yield season (around a year for a horticultural action, for example,

grape cultivation), i.e. at diverse examining frequencies. This could prompt heterogeneity of vitality utilization of observing zones; this altogether influences the application lifetime of a few observing zones. Henceforth, this raises the issue of vitality protection particularly if the application should be receptive. Indeed, even with outside vitality supply (e.g. by the sun based board), utilization and power administration in WSN may, in any case, be tricky. For instance, continuously checking applications, the vitality created by inexhaustible sources might be devoured more quickly than it is created, particularly in Northern Europe with low sun-powered radiation [2].

Likewise, in view of information transmission and memory repressions of remote sensor center points, a high looking at the repeat may cause high latencies and bundle incidents coming to fruition in low-level of nature organization Quality of Service (QoS). Along these lines, the analyzing repeat must be an arranging parameter that ought to be adjusted consistently to meet the agribusiness application necessities [3-20]. Not in any way like existing duties in WSN organization, where the testing repeat is a data, so the technique propose to control the augmentation of the investigating rehash of sensor focus required for the control of the level of nation wellsprings of data. The testing rehash will be properly fine tuned under the application necessities/estimations of structure lifetime, loyal quality and point to point delay. In addition, we propose a versatile tuning of enhanced IEEE 802.15.4 parameters to satisfy magnificent execution concerning control use, resolute quality, and deferral at the MAC layer [22-23].

II. OVERVIEW OF SMART FARMING

Cultivating in India is finished utilizing the unremarkable ways. The way that the greater part of our agriculturists needs legitimate learning makes it considerably more unpredictable. A vast segment of cultivating and rural exercises depend on the expectations, which now and again fall flat. Ranchers need to hold up under colossal misfortunes and now and again they wind up conferring suicide. Since we know the advantages of appropriate soil dampness and its quality, air quality and water system, in the development of products, such parameters can't be disregarded.

The technique involves in yield checking and shrewd cultivating utilizing IoT. So the idea will be a benchmark in the agribusiness because of its unwavering quality and remote checking. The idea of this study is to digitize cultivating and horticultural exercises so the agriculturists can keep an eye on the prerequisites of the yields and precisely foresee their development. This idea will most likely quicken their business to achieve new statures and furthermore be more beneficial. The execution of our venture to a great extent relies on the mindfulness among ranchers, which, we accept will be effortlessly made because of its various points of interest. The point of this venture is to bring the most recent innovation into the horticulture business and better yield creation by gathering constant status of harvest and educating the agriculturists about it.

Some of the objectives of the proposed work are as follows:

- 1) SMS Notifications
- 2) Valuable information collection.
- 3) Detailed Data analysis
- 4) Cost-effectiveness
- 5) Easy of implementation

The main global problem is with an increase in population we need to get an increase in production of food. As per the statistics of Food and Agriculture Organization of UN, the current population on the planet is around 7 billion and that may reach a record mark of 8 billion by 2025. In future the population would increase and the production of the agriculture must be 70% more than the present cultivation. The below architecture explains about the data gathering for smart farming which is the future technology for farming which will estimate the climate indifferent localities for better farming in those regions.

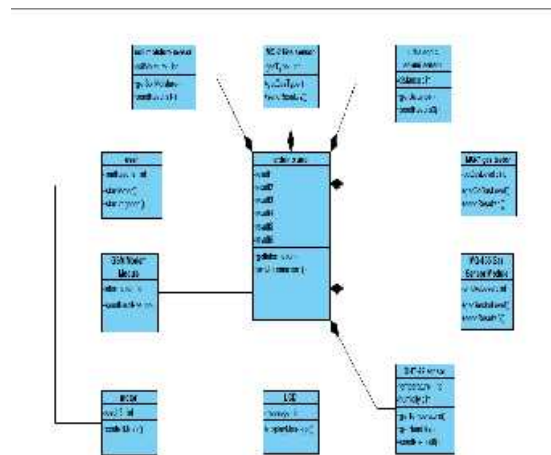


Figure 1: Class diagram to implement Smart Farming
The diagram gives an overall picture of the various aspects of farming and the variables that influence the whole process

farming. The different parameters that need to be collected apart from weather report are as follows:

- Soil moisture ratio
- Soil report
- Ultra sonic soil details report
- Water content nearer to the farm place
- Resistance to natural calamities
- Soil power

These are the few things required to be considered as variables while designing smart farming architecture using any IEEE standards.

III. LIMITATIONS OF SMART FARMING

In any case, various difficulties in this process must be reduced. Among the real issues to be tended to: Who possesses the information? ICT that records the contribution of assets and the yield of items raises inquiries of property rights furthermore, utilization of information. Plans of action may make included esteem by changing over spatially unequivocal enormous information into data, what's more, guidance for agriculturists as well as for administrative specialists who may utilize the information for observation furthermore, control. Governments must set up an administrative engineering that ensures high caliber information while in the meantime encouraging trust among all performing artists included. The potential abuse of information makes extra legitimate and moral difficulties for control furthermore, checking [24]. Moreover, ICT will escalate the difficulties of duty furthermore, the responsibility of new innovations.

There must be responsible for botch or mistakes prompting monetary and ecological outcomes. For instance, who is in charge of follows of fungicides deserted on reaped natural products when that fungicide has been connected past the point of no return? Such situations are a long way from the existence direct, as of late symbolized by automatic driving cars [25].

High expenses to embrace innovation for singular ranches, what's more, restricted learning and aptitudes can be critical selection obstacles[26,27], particularly in creating nations. In this way, the entrance to the most recent innovation may stay limited to enormous and industrialized ranches. The advantages of ICT may be restricted to industrialized nations and concentrated on the generation of surely understood what's more, generally developed products, for example, rice, corn, brown wheat [28]. This additionally builds the danger of unsustainable strengthening hones. In an industrialized setting, infection episodes might be postponed by pesticides and fungicides, yet this accompanies an expanded danger of producing safe parasitic strains that would then be able to act considerably more devastatingly when they have conquered counteractive action measures. The change to industrialized social orders has prompted quick abatements in cultivating inhabitance rates to values of 2% and less of the populace in North America and North Europe. Digitalization of

horticulture may impact work openings and employment profiles of agriculturists also, cultivating related experts considerably further.

Here we need to follow connectivity like shown in Figure 3 in smart farming. Technology related to the kind of architecture we are following to get and use the data, Diversity relates to the kind of data we are expecting and performing operations, Networks related to telecommunication system, Institutions like corporate which will operate this kind of research work. Everything is interrelated to each other in this process.

IV. PERFORMANCE OF IEEE 802.15.4 MAC PROTOCOLS

The smart future is the main reason for the implementation of smart farming and there is a rapid requirement in IoT platform related applications which are being connected with the servers and the respected people who are maintaining the device.

Let's consider a drone which can carry yield throughout the crop in different places and to yield the crop we need to get the weather report to that drone and if the drone is connected with IEEE 802.15.4 wireless sensing technology or any other sensing technology it will be useful to get the data regarding weather and that data is also used to identify which crop we need to start for that year or month. So that crops will not have vanished with rains or floods.

The usage of the smart-farming using some IEEE standards is shown in the pictorial representation below which is in the process of betterment.

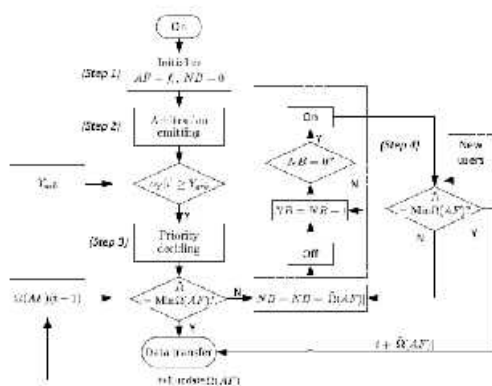


Figure 4: Flow chart of initializing and maintaining of WirArb

The WirArb medium access convention utilizes a discretion cycle (additionally called the assertion stage). A discretion stage comprises of two sections, which are discretion choice period and discretion execution period. The assertion choice period is the initial phase in a discretion stage. This is to process channel get to demands and decide a deterministic

channel get to arrange. At that point, the mediation execution period happens at the point when the real information is transmitted. In particular, contingent upon its need, the client with the most elevated need can instantly get to a channel to exchange information, while the rest of the clients with bringing down need can't get to the channel. The percent that an assertion stage spends in the choice time frame is a small amount of the aggregate intervention cycle, and ought to be little enough to guarantee that the gadget with the most elevated need will have enough time to finish its information transmission. This can be accomplished in light of the fact that it is workable for a gadget to utilize a flag sufficiently short to convey the discretion demand to the entryway. We characterize a reshaping period T_s as the settled discretion interim.

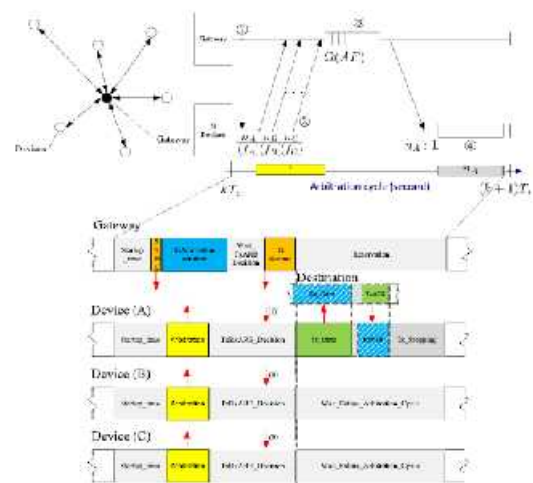


Figure 5: Smart Mechanism using MAC protocol considered for WirArb

Maintaining the Integrity of the Specifications

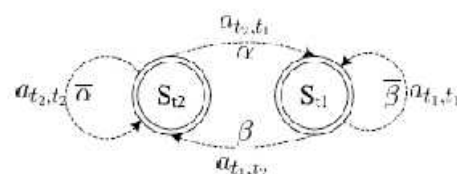
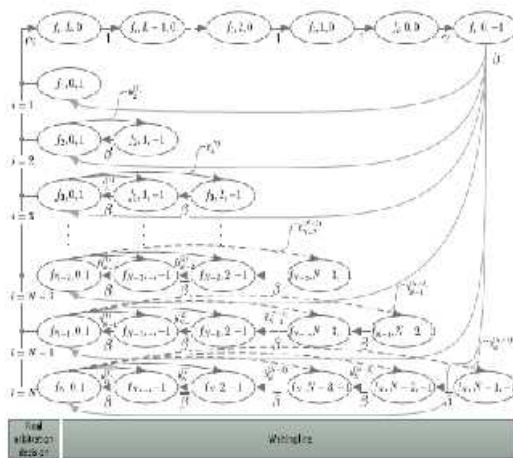


Figure 6: Two State Markov Representation



V. CHALLENGES AND ISSUES IN IEEE 802.15.4 MAC PROTOCOLS

As discussed earlier in the disadvantages of smart farming the main challenge and issue which is being raised so many times is the receiver of the data is genuine or not. There must be some literature idea on the concept of getting and handling data using the smart farming devices. Some of the issues may arise with not having the relevant data regarding maintenance of the device and the process of smart farming.

Data must be collected in a relevant manner and MAC protocols must be used to process the data and first, we need to identify the weather condition and have to process that information to the devices which are connected with the smart farming device.

A. Impact of these issues:

There are few impacts identified because of the existing approach:

1. Data security
2. Data maintenance
3. Size of the data and processing techniques
4. Handling Interruptions in data transfers.
5. Mode of data transfer
6. Changing the mode of data transfer or type of data. Like text to CSV or image to some readings
7. Storing and manipulation of Data.

These are the issues we are facing with the current scenario of smart farming using MAC protocols and other IEEE protocols.

B. Existing Approach:

In the existing method, the technique implements the wireless sensor network (WSN) lifetime; all the more particularly, they proposed a sink movement technique and a versatile transmission extend alteration conspire in light of the

remaining battery vitality of sensor hubs. For that the paper proposed 802.15.4 MAC (Medium Access Control) parameters and sampling rate of sensors [29].

In the next paper, an innovative MAC-(medium access control) protocol is used, which enables the individual users to access the channel based on their priority levels [30].

C. Disadvantage

In sink relocation method, sensor nodes have limited resources In MAC protocol require high idleness and high vitality utilization

D. Proposed system

In this article on research work, we propose to appropriately tune IEEE 802.15.4 MAC (Medium Access Control) parameters and the inspecting recurrence of sent sensor hubs. An expository model of system execution is inferred and used to play out the fine tuning of this exchange off parameters. The study proposes a versatile tuning of IEEE 802.15.4 Medium Access Control (MAC) parameters to accomplish great execution as far as power utilization, unwavering quality, and postponement at the MAC layer are concerned.

E. Advantage

- Increase the sampling rate of sensor nodes
- Low energy consumption

VI. CONCLUSION AND FUTURE WORKS

Smart farming is going to be a revolution in the country which is going to implement the system in full scale. In this article we discussed various types of pros and cons of the previous operations and findings in smart farming and how we can use IEEE standards to fulfill the concept for smart farming. All we need is a best technology tracker and data analysis technology which will gather the useful information for the process of smart farming instead of considering the unwanted data. In this kind of architecture we need to consider soil nature, have to test soil first and consider any natural calamities may occur or not in that location. High level IEEE standards are required to verify this and operate.

Sometimes the reply time of sensor node gets delay due to traffic. In order to provide proper real time information without any data loss, the system should be carried out by implementing effective protocols to avoid the tradeoff between time delay and energy efficiency between nodes.

REFERENCES

- [1] I. F. Akyildiz, W. Su, Y. Sankarasubramaniam, and E. Cayirci, "Wireless sensor networks: a survey," *Computer Network*, vol. 38, no. 4, pp. 393-422, Mar. 2002.
- [2] Y. Sukamongkol, S. Chungpaibulpatana, W. Ongsakul, "A simulation model for predicting the performance of a solar photovoltaic system with alternating current loads," *Renewable energy*, vol. 27, no. 2, pp. 237-258, Oct. 2002.

- [3] C.-F. Wang, J.-D. Shih, B.-H. Pan, and T.-Y. Wu, "A Network Lifetime Enhancement method for Sink Relocation and Its Analysis in Wireless Sensor Networks," *IEEE Sens. J.*, vol. 14, no. 6, pp. 1932-1943, June 2014.
- [4] M. Keshtgary and A. Deljoo, "An efficient wireless sensor network for precision agriculture," *Canadian Journal on Multimedia and Wireless Networks*, vol. 3, no. 1, pp. 1-5, Jan. 2012.
- [5] M. Mafuta, M. Zennaro, A. Bagula, G. Ault, H. Gombachika, and T. Chadza, "Successful Deployment of a Wireless Sensor Network for Precision Agriculture in Malawi," *Int. J. Distrib. Sens. N.*, Article ID 150703, 13 pages, 2013.
- [6] P. Levis, S. Madden, J. Polastre, R. Szewczyk, K. Whitehouse, A. Woo, D. Gay, J. Hill, M. Welsh, E. Brewer, and D. Culler, "TinyOS: An Operating System for Sensor Networks," *Ambient Intelligence*, Springer Berlin Heidelberg, pp. 115-148, 2005.
- [7] A. Dunkels, B. Gronvall, and T. Voigt, "Contiki a Lightweight and Flexible Operating System for Tiny Networked Sensors," in *Proc. IEEE LCN*, Washington, DC, USA, 2004, pp. 455-462.
- [8] M. Eslaminejad and S.A. Razak, "Fundamental Lifetime Mechanisms in Routing Protocols for Wireless Sensor Networks: A Survey and OpenIssues," *Sensors*, vol. 12, no. 10, pp. 13508-13544, Oct. 2012.
- [9] C.T. Kone, M. David, and F. Lepage, "Multi-channel clustering algorithm for improving the performance of large-scale wireless multi-sink sensor networks," in *Proc. IWCMC*, Caen, France, 2010, pp. 691-695.
- [10] N. Al-Nabhan, M. Al-Rodham, and A. Al-Dylan, "Cooperative Approaches to Construction and Maintenance of Networks' Virtual Backbones for Extreme Wireless Sensor Applications," *IEEE Sens. J.*, vol. 14, no. 11, pp. 3782-3790, Nov. 2014.
- [11] M. Soul, A. Bouabdallah, and A. E. Kamal, "Efficient QoS Provisioning at the MAC Layer in Heterogeneous Wireless Sensor Networks. *Computer Communications*, vol. 43, no. 0, pp. 16-30, Mar. 2014.
- [12] H. Sahota, R. Kumar, and A. Kamal, "A wireless sensor network for precision agriculture and its performance," *Wirel. Commun. Mob. Comput.*, vol. 11, no. 12, pp. 1628-1645, Dec. 2011.
- [13] IEEE Standard for Information technology-- Part 15.4: Wireless Medium Access Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANS), *IEEE Std 802.15.4-2006* (Revision of IEEE Std 802.15.4-2003), pp. 1-320, 2006.
- [14] M.O. Farooq and T. Kunz, "Operating Systems for Wireless Sensor Networks: A Survey," *Sensors*, vol. 11, no. 6, pp. 5900-5930, May 2011.
- [15] J. Hiltunen, M. Ala-Louko, and M. Taumberger, "Experimental performance evaluation of POBICOS middleware for wireless sensor networks," *ISRN Communications and Networking*, Article ID 180369, vol. 2012, 10 pages, Jan. 2012.
- [16] STREP/FP7-ICT: Platform for Opportunistic Behaviour in Incompletely Specified, Heterogeneous Object Communities (POBICOS), http://cordis.europa.eu/project/rcn/87268_en.html
- [17] Crossbow motes and Stargate-Xscale, <http://www.xbow.com>.
- [18] A. Koubaa, M. Alves, B. Nefzi, and Y.-Q. Song, "Improving the IEEE 802.15.4 slotted CSMA/CA mac for time-critical events in wireless sensor networks," in *Proc. RTN*, Dresden, Germany, July 2006.
- [19] G. Anastasi, M. Conti, and M. Di Francesco, "A comprehensive analysis of the mac unreliability problem in IEEE 802.15.4 wireless sensor networks," *IEEE T. Ind. Inform.*, vol. 7, no. 1, pp. 52-65, Feb. 2011.
- [20] P. Pangun, P. Di Marco, C. Fischione, and K.H. Johansson, "Modeling and Optimization of the IEEE 802.15.4 Protocol for Reliable and Timely Communications," *IEEE T. Parall. Distr.*, vol. 24, no. 3, pp. 550-564, Mar. 2013.
- [21] P. Pangun, P. Di Marco, P. Soldati, C. Fischione, and K.H. Johansson, "A generalized Markov chain model for effective analysis of slotted IEEE 802.15.4," in *Proc. MASS*, Macau, Oct. 2009, pp. 130-139.
- [22] S. Pollin, M. Ergen, S. Ergen, B. Bougard, L. Der Perre, I. Moerman, A. Bahai, P. Varaiya, and F. Catthoor, "Performance analysis of slotted carrier sense IEEE 802.15.4 medium access layer," *IEEE T. Wirel. Commun.*, vol. 7, no. 9, pp. 3359-3371, Sept. 2008.
- [23] C.T. Kone, G. De Sousa, J.-D. Mathias. (2015). "Energy-network performance trade-off in a slotted IEEE 802.15.4 network with acknowledged uplink transmissions. *Int. J. Sensor Networks*, vol. 17, no. 4, pp. 263-277, May 2015.
- [24] IEEE Standard for Information Technology- Part 11: Wireless LAN medium access control (MAC) and physical layer (PHY) Specifications, *ANSI/IEEE Std 802.11, 1999 Edition (R2003)*, pp. i-513, 2003.
- [25] Iozzio C (2016), "Who's responsible when a car controls the wheel?" *Scientific American* 314:12-13.
- [26] Kutter T, Tiemann S, Siebert R, Fountas S (2011) "The role of communication and co-operation in the adoption of precision farming". *Precis Agric* 12:2-17.
- [27] Baumgart-Getz A, Prokopy LS, Floress K (2012) "Why farmers adopt best management practice in the United States: A meta-analysis of the adoption literature". *J Environ Manage* 96:17-25.
- [28] Tilman D, Cassman KG, Matson PA, Naylor R, Polasky S (2002) "Agricultural sustainability and intensive production practices". *Nature* 418:671-677.
- [29] Cheick Tidjane Kone, Abdelhakim Hafid, and Mustapha Boushaba (2015), "Performance management of IEEE 802.15.4 wireless sensor network for precision agriculture", *IEEE Sensor Journal*, Volume : 15, Issue: 10, Oct. 2015.
- [30] Tao Zheng, Mikael Gidlund, and Johan Åkerberg (2016), "WirArb: A New MAC Protocol for Time Critical Industrial Wireless Sensor Network Applications", *IEEE SENSORS JOURNAL*, VOL. 16, NO. 7, APRIL 1, 2016

