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Evaluation and implementation of cluster head selection in WSN using Contiki/Cooja simulator

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Abstract

Remote Sensor Systems are these days turning into a normal segment in our everyday life for simplicity of numerous tasks. It is already seen that they are currently conveyed in

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almost every field of wireless sensor network research. Numerous territories in research and innovation are adjusting to utilize remote sensor systems for investigation of information. Contiki is another working framework when contrasted with a large portion of the other working frameworks in this field. Because of the utilization of C language for its improvement, many progressed and light segments are currently winding up some portion of it. Despite the fact that the speed of improvement in Contiki is fast and exceptional, however regardless it does not have the utilization of security natives for secure correspondence between sensor hubs. Right, now there is just a single Security engineering "ContikiSec" proposed for this working framework. Cooja is a test system given by Contiki, which not like most test systems additionally, enables genuine equipment stages to be imitated. In this instructional exercise you will figure out how to utilize the Cooja Simulator to arrange an essential RPL network.

Subject Classification: *68M99*

Keywords: *Wireless Sensor Networks, Cooja*

1. Introduction

Remote sensor systems comprise of little hubs of sensor nodes that examine physical conditions around them, for example, temperature, sound, vibration and so on, through remote connections. A remote sensor set-up (WSN) for the most part comprises of a base station, which holds the capacity to speak with various remote sensors present nearby by utilization of a radio connection. When the information is gathered by concerned node, it is then packed, and transmitted to the portal straightforwardly or, on the off chance that not legitimately associated, at that point utilizes different remote sensor hubs to advance information to the sink.

Contiki is created in C and is as of now utilized in numerous microcontrollers. While Cooja tool has been demonstrated to be a perfect device for the reproduction of RPL in wireless network environment, there are difficulties associated with its utilization. The Contiki site might be a first for bringing concerning Cooja, and gives a picture of Moment Contiki which would then be able to be utilized with the virtualization apparatus VMware.

When Contiki is effectively begun, the Contiki site would then be able to be alluded to no end more than brief directions with respect to a basic system arrangement on Cooja. By using this, the whole of any official documentation in regards to Cooja, with most of help is given inside web discourse sheets.

Features of Contiki-Cooja

- Open Source Platform
- Back-End C language Code
- Contiki Supports Integration with Hardware
- Event-Driven Programming

2. Review of literature

In [1], authors have evaluated an Contiki proving ground to explore the presentation of IPv6 RPL. This presentation measurements containing two bits, Zolertia Z1 bit and WiSMote are broke down for different conditions that determine executions of RPL. Zolertia Z1 bit is a low-control WSN module that fills in as a universally useful advancement stage for WSN engineers to test and convey various features with the best exchange off between time of improvement and equipment adaptability.

In [2], authors proposed a RPL routing metric that work on minimization of the delay towards the DAG root and proposed how various nodes run with very low duty cycles at the MAC layer. They referred the RPL metric as Averaged Delay (AVG_DEL) metric. They proposed AVG_DEL metric with Cooja, with WSN simulator for Contiki, and then compare it with the performance of ETX.

In [3], authors made an inside and out examination on a famous execution of the RPL (directing convention for low power and lossy system) to give bits of knowledge and rules to the selection of IPv6 measures. In particular, they utilized the Contiki working framework and COOJA test system to assess the conduct of the Contiki RPL usage. They dissected the presentation for various systems administration settings.

In [4], authors proposed the IETF 6LoWPAN innovation that encourages the utilization of IPv6 interchanges in WSN systems, which tackles the various issue of interoperability, empowering low power, minimal effort miniaturized scale controllers to be all inclusive associated with the web. The Contiki operating system, touted as the open source operating system for IoT, gives low power IPv6 correspondences and supports the 6LoWPAN and CoAP conventions, alongside work steering utilizing RPL.

In [5], authors proposed a new clustering routing method based on Predictive Energy Consumption known as PECE for WSN. In this authors have proposed an energy efficient clustering algorithm which is based on various parameters.

Table 1
Getting Contiki-Cooja Platform for Simulation

Link-www.contiki-os.org/download.html	
Download Contiki/Home/Instant contiki	
Name	Modified
Parent Folder	
Instant Contiki 3.0	2015-08-25
Instant Contiki 2.7	2013-11-15
Instant Contiki 2.6.1	2013-08-16
Instant Contiki 2.6	2012-07-17
Instant Contiki 2.5	2012-05-14
Instant Contiki 2.5-rc-1	2010-11-06
Instant Contiki 2.4	2010-02-16
Instant Contiki 2.3	2009-06-26
Instant Contiki 2.21	2008-09-13
Instant Contiki 1.0a	2008-05-30

In [6-8], authors proposed an algorithm for data transmission based upon multi hop mechanism from sender to the user .In this residual energy is the prerequisite for CH selection which further helps in saving the energy to be consumed in selection. Also, the mobile motes balance is considered keeping under view various metric like reliability of the network etc.

3. Contiki-cooja simulation environment aspect

IPv6 based implementations are possible with the higher degree of performance in Contiki Cooja and thereby the assorted features of IoT can be used using these tools. Using Contiki and Cooja platform, any number of sensor nodes or motes can be included without any complexities or compatibility towards the environment. In addition, there are enormous features in this platform for the customization of code and updating the behavior of the network environment.

Assorted Flavors of Contiki as in Table 1

- 3.0
- 2.7
- 2.5 rc and so on

Start-up and Initial Settings

We will initially visit the Contiki site so as to download Moment Contiki. When this Moment Contiki picture has been downloaded and

Figure 1

Creating Simulation

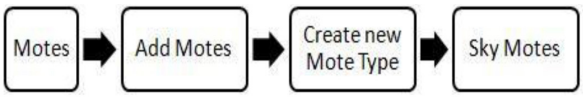


Figure 2

Adding Sensor Nodes

unfastened it very well may be opened utilizing VMware. Moment Contiki is an Ubuntu based working framework with Cooja effectively inherent to utilize. To begin the recreation programming, open a window and enter the accompanying directions:

cd contiki/tools/cooja ant run

The Contiki site presently shows how to set up a straightforward 'Hi World' reenactment. Be that as it may, we see how to set up a basic RPL system using a UDP receiver and a few UDP Sender motes. Cooja environment contains four windows namely Network Window (Motes), Simulation Control Window, Mote Output Window and Timeline window for all communication.

Figure 1 presents the simulation environment to create the simulation and working panel. It will open a window named create new simulation, where we need to set simulation name and advanced setting. After clicking create tab we get a running environment of cooja.

Figure 2 gives the view of adding the sensors and motes for the implementation. The Create tab would now be able to be clicked. Its outcomes in the underlying recreation screen as appeared in Figure 3. The Sky mote is the least difficult of motes for use inside a WSN and perfect for starting designs inside a Cooja reenactment.

Network Options

The Timeline window at the base of Figure 3 shows occasions over some stretch of time such as layer two correspondences to motes to arouse

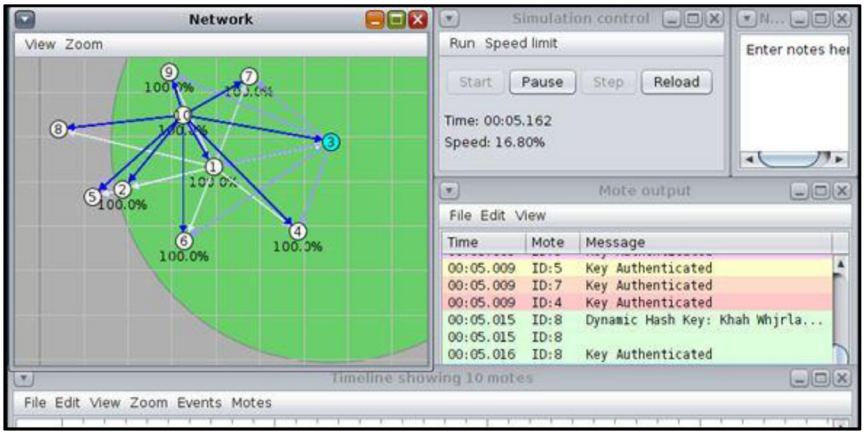


Figure 3

View Radio Range

them high. This environment can be shifted by utilizing the drop-down menu and the yield can be spared to a record as per requirement.

The Mote Output window demonstrates the yield window that will show any results from the motes. It can be amazingly helpful in increasingly highly complex systems which require all the more improves results, as the real source code of the motes can be adjusted for different levels, with delivery of messages which can be seen in this window.

The Simulation Control window is where the simulation is started, paused and stopped.

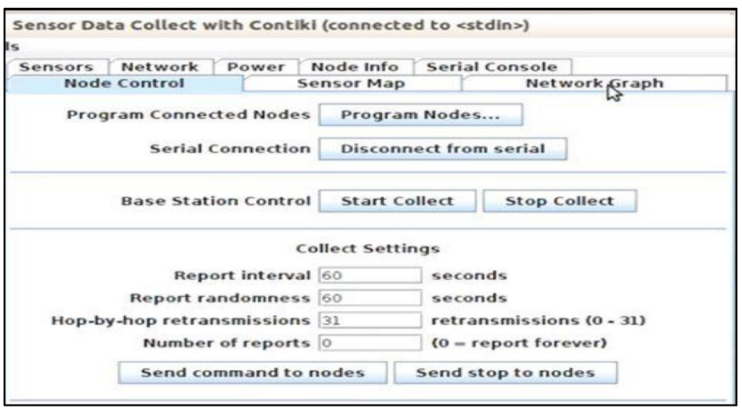


Figure 4

Setup of Serial Connections and Sync

The Network window shows the design of the system motes and can be incredibly adjusted so as to all the more effectively show different elements of the system, just as network traffic.

Cooja has complex apparatuses for gathering information from motes; be that as it may, it isn't quickly clear how to empower this in a reenactment. For information accumulation in a system with a receiver and a few senders that gathering ought to be performed from the perspective of the receiver. To empower the Sensor Information the outcome is a window as appeared in Figure 4. Gathering for a Cooja Reproduction essentially click 'Start Collect'.

Figure 5 and 6 gives the view of mote associations and their impact.

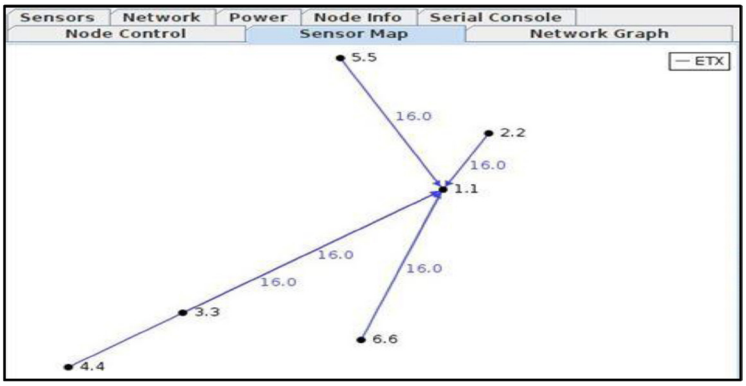


Figure 5

View Mobility of Nodes

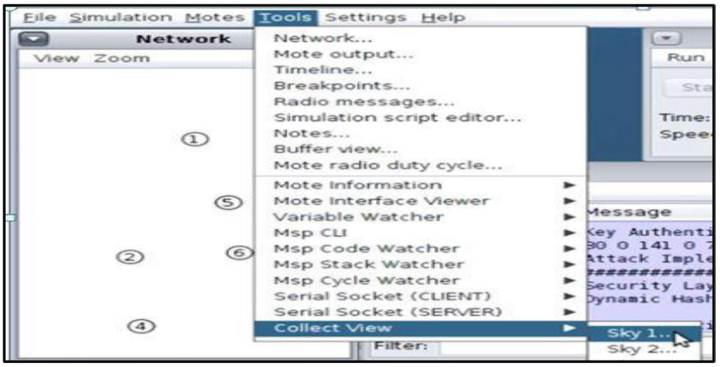
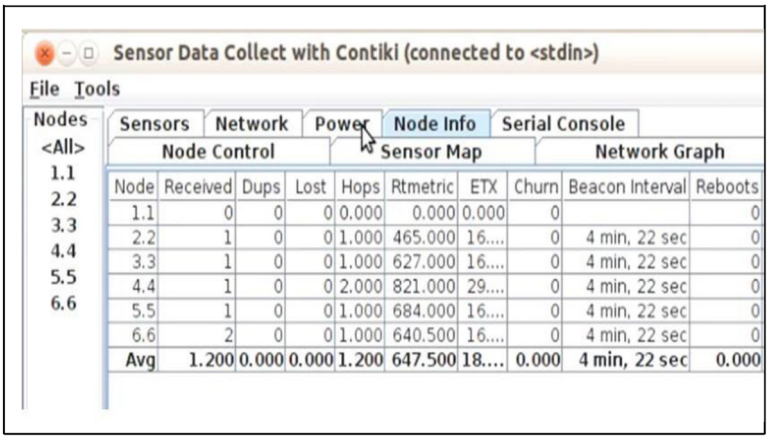


Figure 6

Collect Views in Cooja



Node	Received	Dups	Lost	Hops	Rtmetric	ETX	Churn	Beacon Interval	Reboots
1.1	0	0	0	0.000	0.000	0.000	0		0
2.2	1	0	0	1.000	465.000	16....	0	4 min, 22 sec	0
3.3	1	0	0	1.000	627.000	16....	0	4 min, 22 sec	0
4.4	1	0	0	2.000	821.000	29....	0	4 min, 22 sec	0
5.5	1	0	0	1.000	684.000	16....	0	4 min, 22 sec	0
6.6	2	0	0	1.000	640.500	16....	0	4 min, 22 sec	0
Avg	1.200	0.000	0.000	1.200	647.500	18....	0.000	4 min, 22 sec	0.000

Figure 7

Details of Nodes

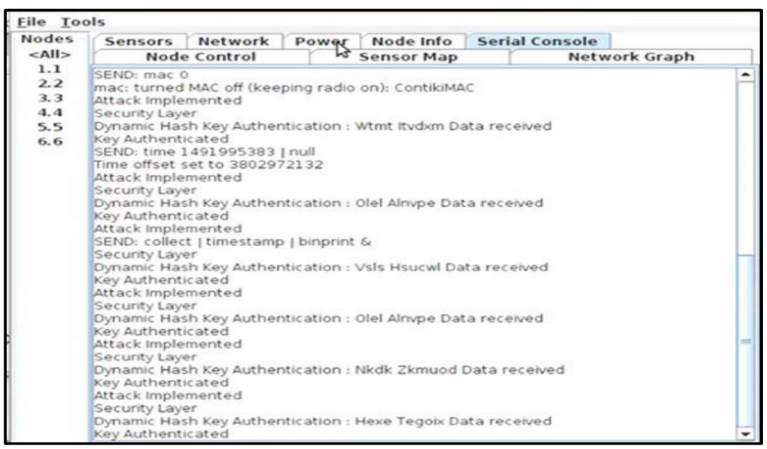


Figure 8

Serial Console Based View

Figure 7 demonstrates the outcomes and parameter- based investigation of various motes in simulation environment.

Figure 8 shows the data transmission log along with the outcomes related to authentication of data transmitted. The implementation of authentication process with dynamic hash key is depicted which assist the data when it is transmitted. As shown in Figure 8, different keys are generated every iteration; it means data transmitted is secure in our scenario. This shows authentication process in real time scenario. As

depicted in Figure 9, there are enormous parameters including LPM, Radio Listen, CPU, and Radio Transmit during the Ubiquitous Computing simulation. The simulation results in mode with integrity mode.

4. Plotting results in form of graphs

Figure 9 sets the factors and parameters in the environment of simulation. The outcomes demonstrate that the temperature assessment and logging viewpoints are reliable and respectability mindful. The lowering of temperatures in the bits is fundamentally the same as and it demonstrates the consistency in the conduct of the algorithm in

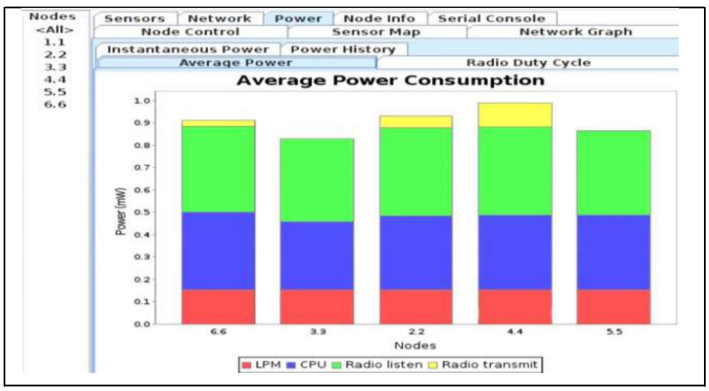


Figure 9

Power Evaluation in Network Execution

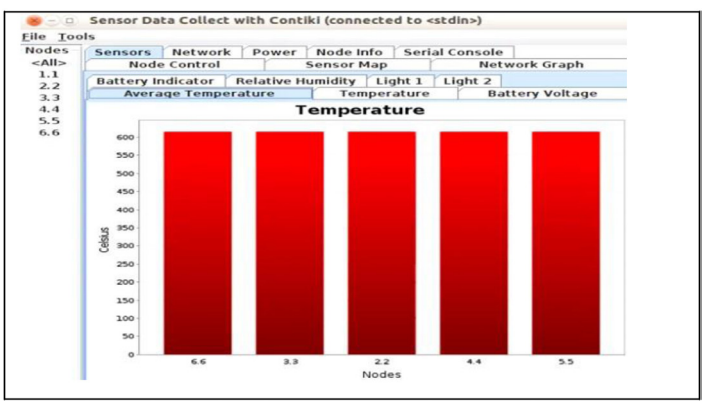


Figure 10

Analysis of Temperature for Lifetime of Network

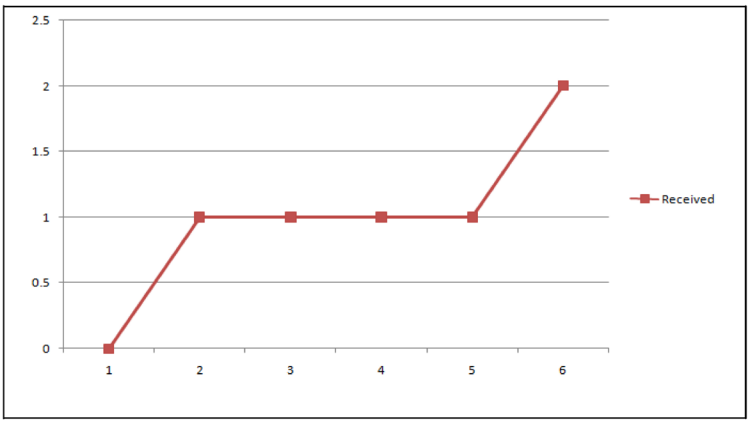


Figure 11

Checking Signals

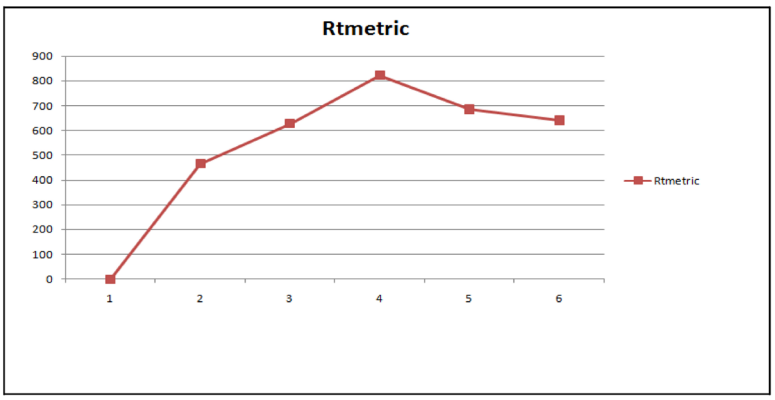


Figure 12

Rtmetric Analysis

Figure 10. Figure 11 below underlines that the logging of got flag by the bits is strong and raising in the system usage which demonstrates the general execution.

The router measurements portrayed in the above Figure 12.

5. Conclusion and future work

The execution done in Cooja stage portrays the important outcomes and the methodology is better as thought about than different variations of conventional methodologies. The execution done in Cooja stage portrays

the important outcomes which removes congestion problem arises during packet transfer in WSN.

- Analysis of the parts in enhancement for various parameters
- Node energy and Predictive elevation of energy.

You can likewise utilize Cooja (System Test system) to examine a system. In Cooja use "Radio Message with a 6LoWPAN analyzer with pcap send out" to store the bundle catch in pcap group. Along these lines you would then be able to utilize Wireshark or Foren6 to envision the system and investigate it. Utilize different sniffers and test to imagine the constant progression of parcels in remote sensor systems.

References

[1] Gautham Krishna, Krishna, and Bhalaji. "Analysis of Routing Protocol for Low- power and Lossy Networks in IoT Real Time Applications." *Procedia Computer Science*, vol. 87, (2016):270-274.

[2] Pietro Gonizzi, Riccardo Monica and Gianluigi Ferrari."Design and evaluation of a delay-efficient RPL routing metric." 9th International Wireless Communications and Mobile Computing Conference, IWCMC (2013). 1573-1577.

[3] Tao Zhang and Xianfeng Li. "Evaluating and analyzing the performance of RPL in Contiki". Proceedings of the International Symposium on Mobile Ad Hoc Networking and Computing (MobiHoc). (2014).

[4] Summet Thombre ,Raihan Ul Islam, Karl Andersson , and Mohammad Shahdhat Hossain." IP based Wireless Sensor Networks: Performance Analysis using Simulations and Experiments". *Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications*, 53–76.

[5] De-gan Zhang, Xiang Wang, Xiao-dong Song, and Ya-nan Zhu. "A new clustering routing method based on PECE for WSN". *EURASIP Journal on Wireless Communication and Network* 162(2015).

[6] Sayed Mohammad Hossein Mirshahjafri and Behrouz Shahgholi Ghahfarokhi. "Sinkhole + Clone ID:A hybrid attack on RPL performance and detection method", *Information Security Journal: A Global Perspective* (2019), Volume 28,Pages 107-119.

[7] George Helmy Saad and Magdy Ahmed, "Power saving by incorporating mobile agents and clustering approach in Wireless Sensor Networks", *Journal of Discrete Mathematical Sciences and Cryptography*, (2012), vol.15, pp.135-147.

[8] Vijayashree and Suresh Ghana Dhas " Energy efficient data collection with multiple mobile sink using artificial bee colony algorithm in large-scale WSN", (2019), Automatika: 555-563.