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Comparison of Wise Route and Flooding Network Type of Convergecast Routing in Wireless Sensor Network

Lovepreet Kaur and Jyoteesh Malhotra

CSE Dept.
GNDU Regional Campus, Jalandhar
lovebatala@gmail.com, jyoteesh@gmail.com

Abstract

Sensors are used to sense the data, collect and send to the base station for further processing it is known as wireless sensor network. Convergecast is a communication technique in which data flow from source nodes to sink node in many to one pattern. It is opposite of broadcasting which is one to many communication technique, every application of wireless sensor network comprised of both broadcasting and convergecasting. Due to its high usage in every application it gets attention of research scholars. In this paper simulative comparison is done between WISE route and Flood type of network, this paper simulate the convergecast routing on BER, SNIR, back-off duration, SNR and latency based parameters with the help of OMNET++ simulator.

Keywords: *Wireless Sensor Network, Convergecast routing, Routing protocols, Omnet++ Simulator, Back off, BER, latency, SNIR*

1. Introduction

Many applications of wireless sensor network require both broadcasting and convergecasting for the dissemination and collection of data. Convergecast is a communication pattern in which data flows from many source nodes to single sink node or base station. It is a routing protocol just opposite of broadcasting as shown in Figure 1. Broadcasting is followed by convergecasting in almost every application of WSNs. From Figure 1 it is clear that in case of broadcasting the message is disseminate from node S to a, b and c nodes, at first node a receive the packet from the sender node S and then node a send copy of received packet to node b and c, so bandwidth is uniformly used.

In case of convergecasting the data is forward to node S by node a, b and c but data relay by node a. Node a forward the data of node b and node c to node s, so congestion or data traffic is more near the sink node. Hence bandwidth in convergecast routing is not uniform.

It is proved that nodes require more power or energy to transmit data rather than sensing. The main concern is to save power to increase the life of sensor network. So in WSN energy efficient routing is essential due to limited power /battery. Routing protocols used in Sensor network are different from other network's routing protocols. Since the entire sensor nodes are battery powered devices, energy consumption of nodes during transmission or reception of packets affects the life-time of the entire network.

Convergecast routing differs from broadcasting, in broadcasting data flows from single node to multiple nodes as one to many(as shown in Figure 1 a) but as compared to convergecast in which data flows from many to one(as shown in Figure 1 b).

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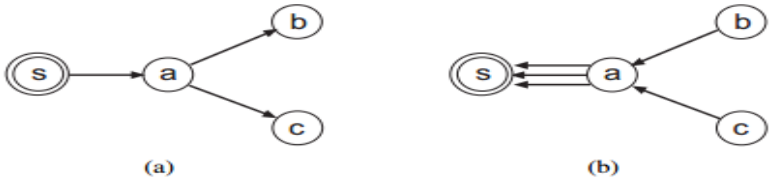

Figure 1. a) Broadcasting b) Convergecasting

Convergecast works on different network type but usually used with wise route network type. Wise route is a simple loop-free routing algorithm that builds a routing tree from a central network point. It is especially useful for wireless sensor networks and convergecast traffic, hence its name (Wireless Sensors Routing). The sink (the device at the center of the network) broadcasts a route building message. Each network node that receives it, selects the sink as parent in the routing tree, and rebroadcasts the route building message. This procedure maximizes the probability that all network nodes can join the network, and avoids loops [10].In this sink node first send route packet to the network and when sensor node receives this route flood packet from sink node it check the RSSI (Received Signal Strength Indication) value, if it is higher then the previously stored threshold value the node select sending node as its parent node and if duplicate route packet with low RSSI value is received then sensor node simply discards that route flood message. Considering the merits as reported in the literature, the work done in this paper is mainly based on convergecast routing. In doing so the Wise route and flood type network effect is compare in this paper on the basis of five QoS parameters like BER, SNIR, back-off duration, SNR and latency has been evaluated through extensive simulations. Rest of paper has been organized as follows:

In Section II problem definition is defined, next Section III gives brief simulation methodology followed by literature survey related to this work. Performance results have been given in the Section V before the paper is finally concluded in Section VI.

2. Literature Survey

This section discusses the state of the art research being done in this field.

Ozlem Durmaz *et al.*, [1] analyzed two techniques like aggregated convergecast (where data is aggregated at each node) and raw data convergecast to collect the summarized information as a maximum sensors reading. Analyze the impact of different parameters like by using multiple frequencies; test the impact on packet loss and interference. This paper is about convergecast routing in wireless sensor network and by using TDMA(different time slots for each node to send data to the sink node) avoid number of collisions and avoid retransmission under heavy data. Various TDMA based scheduling algorithms are used in convergecast routing like minimize schedule length for faster data rate by reusing time slots again and again *i.e.*, to decrease the number of slots per frame. Mrs. Aditi. P. Khadilkar *et al.*, [2] this research paper use the omnet++ and mixim framework to analyze the mobility based sensor networks and consider the MAC protocol to analyze various parameters like collision, loss of packets *etc.*, and concluded with the help of omnet++ simulator that average energy consumption increases as the mobility of nodes increases because node are not stationary. Andras Varga *et al.*, [3] omnet++ working environment is explained, the design of omnet++, history or background of simulator, understanding the architecture of omnet++, different types of files, how to use those files?, how the result stored in the result files?, how to change and compare different parameters in any network concluded with the overview of omnet++ simulator environment. Nikolaos

A. Pantazis *et al.*, [4] energy efficient routing protocols are classified into four main schemes: Network Structure, Communication Model, Topology Based and Reliable Routing. It is an analytical survey on energy efficient routing protocols for WSNs is provided. M.Thangaraj *et al.*, [5] Routing basically flooding technique is discussed with the help of OMNET++ and MIXIM framework. In this paper various types of modules under the simulator are define like NED (Network Description Language) and .ini file. Various Flooding parameters are explained with the help of simulator like routing table, deployment of nodes, residual energy in wireless sensor network under the simulation environment and concluded how we change the already existing protocols accordingly and analyze the performance with the help of different parameters and also concluded that availability of research in omnet++ simulator is high because less expertise developers for codding. A. Gogic *et al.*, [6] impacts of routing techniques on wireless sensor network using omnet++ simulator MAC layer protocols are discussed. Flooding, gossiping, convergecast are analyzed by the battery charge or discharge value of capacitor. Battery level decreases as the number of nodes are increases, Packet delay is estimated using omnet ++ simulator. Delay for different algorithms is calculated for WSN. Lai *et al.*, [14] use the greedy graph coloring technique is used to assign time slots to the sender to overcome the frequency interference problem in convergecast routing and find the shortest path to send data to the sink node so that throughput should increased.

3. Problem Definition

In wireless sensor network broadcasting is followed by convergecasting process. Only few researchers work on issues of convergecast routing like latency improvement to get data faster and for reliable communication to decrease the bit error rate. This paper will compare the wise route and flood network type effect in convergecast routing with the help of omnet++ simulator. In wise route network type sink node create a loop free tree to send data on that tree but in case of flood simply broadcasting of data is done all nodes get the same packet of data from the sink node if that data already exist in their memory they will discard the data else they will save the data. This simulative work shows which network type perform better in the given scenario.

4. Simulation Methodology

To understand the various issues in WSN networks simulation environment is necessary, for this system new simulator based on discrete event simulation known as Objective Modular Network Test bed in C++ version4.4.1 (OMNET++) has been used. Performance of various nodes and networks are checked with the help of this simulator on the basis of different parameters in different scenario .Omnet++ is an extensible, modular, component based C++ simulation library and framework, primarily for building network simulations. It is C++ programming based communication model with GUI support. Due to its flexible architecture its application areas are high like simulation is used in various communication networks. Omnet++ is eclipse based IDE. It has text editor, C++ based simulation launcher which helps in running simulation. Results for different scenario are stored in result files and plotted with the help of analyzer tool.

The convergecast routing protocol is modeled with the help of simulator indexed with mixim framework. The experiment is included on 9 sensor nodes with playground size 600m*600m.

In Figure 2.Initial deployment of nodes is shown as in running IDE.

Omnet++ is hierarchical based simulation model used for wired or wireless communication network. Nodes communicate with each other with the help of messages. The system contains the Network Definition File (NED File) which describes the module structure with parameters, gates *etc*.

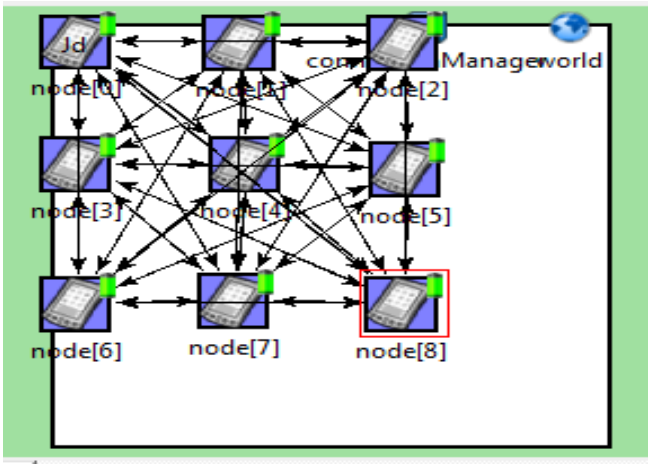

Figure 2. Deployment of Nodes

NED files can be written using any text editor or the GNED graphical editor. Message files (.msg files) defines various message types and add data fields to them. OMNeT++ will translate message definitions into full-fledged C++ classes. Omnet.ini file is the main file in the simulator; whenever program starts it reads the configuration file known as Omnet.ini. This file controls how the executions of simulator run, what are the parameters to be set and assign their values *etc*. The NED file is added in this configuration to import the structure of the network.

Mixim is known as "mixed simulator" developed for wireless and mobile based simulations. This framework contains the detailed model for wireless networks and various communication protocols like MAC (Medium Access Control). Mixim has a powerful and feature rich tool box because of which the user can simulate and study the performance analysis of wireless networks. The specialty of Mixim is such that is tries to hide the complexity of such simulations and user gets a clean and easy user interface. Most of the simulators provide single frequency and single antenna systems, Mixim has rich library of protocols and modules also it has supporting infrastructure. Mixim can support simulation of networks consisting up to 1000 nodes [3].

Table 1. Simulation Parameters

Sr.no	Simulation Parameters	
	Parameter	***Value***
1	Number of sensor nodes	9
2	Carrier Frequency	2.4 GHZ
3	Thermal Noise	-100 dBm
4	Header Length	24 bit
5	Mobility	Constant Speed
6	PMax(sending power)	1.1 mW
7	Route floods interval	600 s
8	Network type	Wise route, Flood type
9	RSSI	-50 dBm
10	Simulation time	10 min

5. Result and Discussion

Wise route is a simple loop-free routing algorithm that builds a routing tree from a central network point. It is especially useful for wireless sensor networks and convergecast traffic, hence its name (Wireless Sensors Routing). The sink (the device at the center of the network) broadcasts a route building message. Each network node that receives it selects the sink as parent in the routing tree, and rebroadcasts the route building message. This procedure maximizes the probability that all network nodes can join the network, and avoids loops. This is defined as route flood interval in simulator when the sink node sends the route packet to all the other nodes in the network.

5.1 Comparison on Back Off Duration in Wise Route and Flood Type Network

Result for this project in Figure 3 shows that back off duration increases in case of flood type of network structure in which data packets forward to all nodes without any route construction as in case of wise route tree is constructed to send data.

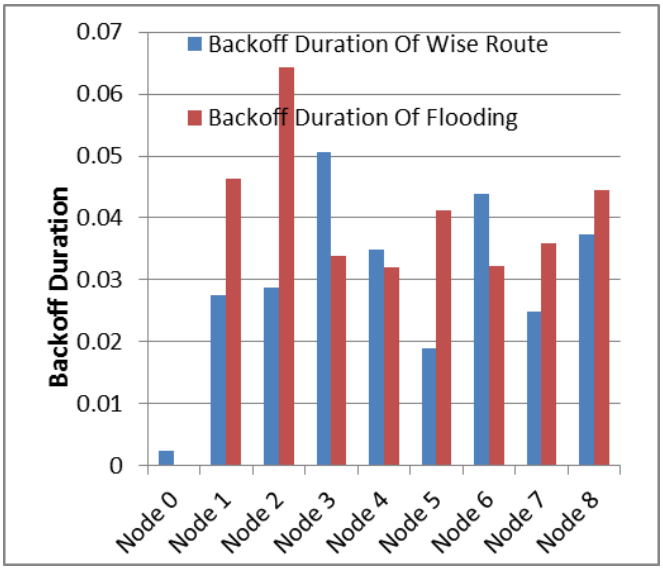

Figure 3. Back Off Duration at Different RSSI

From the simulative environment it is clear that more retransmission of data or more wastage of energy in case of flood type network instead wise route network.

5.2 Comparison on Signal to Noise and Interference Ratio between Wise Route and Flood Type Network

Result for this project in Figure 4 shows SNIR is high in case of wise route instead of flood type network, which shows high strength of signal at wise route.

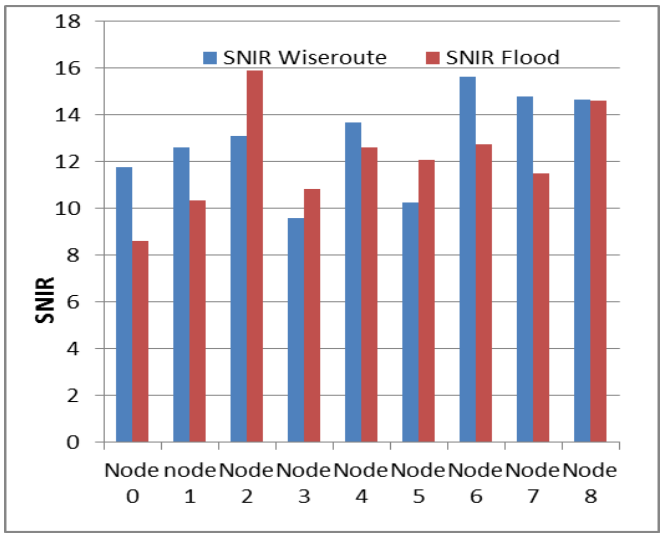

Figure 4. SNIR during WISE Route and FLOOD Type Network

5.3 Comparison on Signal to Noise and Interference Ratio between Wise Route and Flood Type Network.

From the simulative results it is shown SNR (Signal to noise) ratio is high in case of wise route. Better QoS in case of wise route.

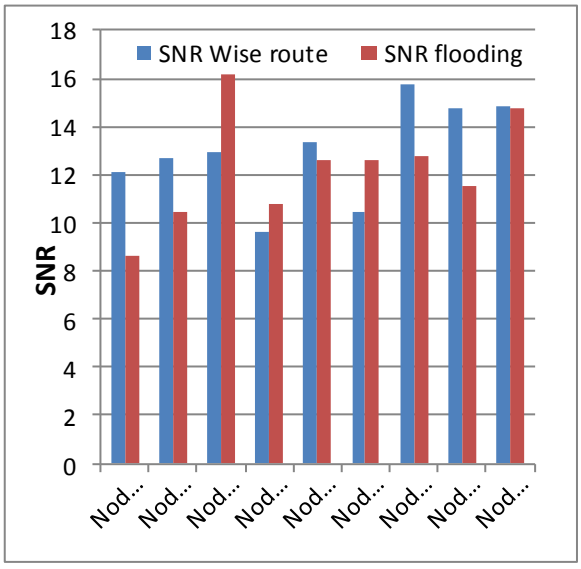

Figure 5. SNR during WISE Route and Flood Type Network

5.4 Comparison on Signal to Noise and Interference Ratio between Wise Route and Flood Type Network

From the simulative results it is shown that in case of simple flood method more collisions occur and more bit error rate than wise route tree construction method which exhibits less bit error rate.

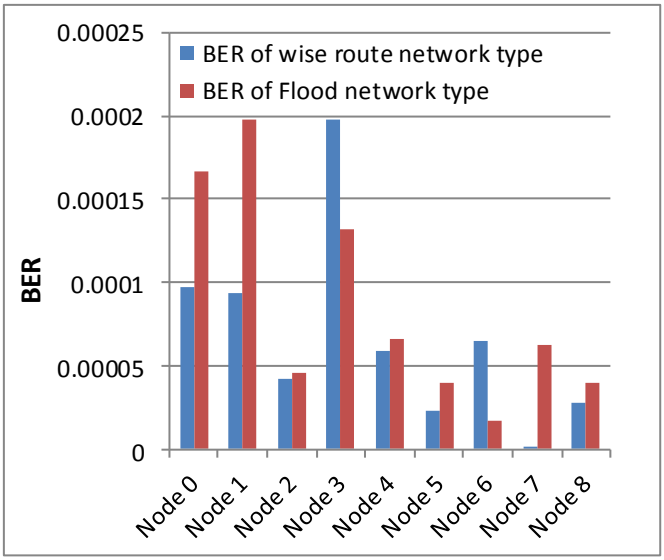

Figure 6. Bit Error Rate during WISE Route and FLOOD Type Network

5.5 Comparison on Signal to Noise and Interference Ratio between Wise Route and Flood Type Network

Latency is quite less in case of flood type network as compare to wise route because in wise route tree construction consume time to send packet which is saved in flood type network. So flood type is still used where quick response is required almost after every second. Simulation shows that latency in flood type is ¼ of wise route latency as shown in Figure 7.

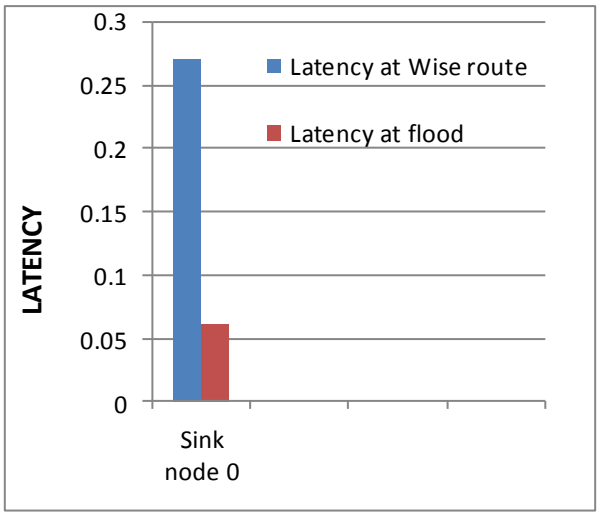

Figure 7. LATENCY at Different RSSI

Table 2. Result Table for RSSI Parameter

Sr. no	Simulation Results			
	Parameter	***WISE ROUTE.***	***FLOOD***	***RESULT DISCUSSION***
1	Back off	0.2691	0.3305	In case of wise route selection number of retransmissions decreases as compare to flood type network because in flooding collisions increase. .
2	SNIR	115.96	109.18	Signal to noise and interference ratio increases in wise route and lesser the chance for error. Signal strength increases.
3	BER	.00106	.00323	Bit error rate is high in case of flood as signal strength directly affects the error rate as shown with simulation results error rate become triple in case of flood type network .
4	SNR	116.55	110.10	In wise route the SNR increases and hence better signal strength lowers the chances of packet drop.
5	Latency	.27024	.06073	Latency decreases four times in case of flooding so data received in very short period of time in case of flooding. In wise route selection of parent node to form tree pattern takes time in the flow of data hence its latency time is quite high than flooding type.

6. Conclusion

Convergecast is used for supporting many wireless sensor network applications but its optimization is not studied extensively. In this paper simulative investigation is done on BER (bit error rate), SNIR (signal to noise and interference ratio), Back-off duration, SNR (signal to noise ratio) and latency. This paper use two network type WISE route and FLOOD type and comparison is done between these two network types. Simulative results shows that WISE route selection perform much better than flood type, wise route is much reliable than flood network type but latency of flood is ¼ of wise route latency so flood type network is used where information is required very frequently i.e. after some seconds application need current situation status. Wise route is selected in those applications which require correct information without any packet loss, it is always observed that congestion is quite high near the sink node in case of convergecast routing, so wise route selection decrease the congestion as compare to flood type because its signal strength is high than the signal strength of flood network. Only few researchers work on issues exist in convergecast routing so it still need attention to increase reliability, scalability and security.

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Author

Lovepreet Kaur, was born in Batala City, State Punjab in India during 9 November 1990. She completed Btech with Distinction from SSCET Badhani, Pathankot and M. Tech from Guru Nanak Dev Univeristy (GNDU) RC Jalandhar during 2013-2015. Her research interests are in the broad area of QoS aware convergecast routing in wireless sensor network. She has published papers in scientific journals and also presented in international conferences. Contact email: lovebatala@gmail.com