Assignment #5

Report- Group A

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GROUP A - "A Cooperative Learning Scheme for Energy Efficient Routing in Wireless Networks" and "An Intelligent Routing Approach for Wireless Sensor Networks"

Summary Review for "A Cooperative Learning Scheme for Energy Efficient Routing in WSN" also “CEERA”

"A Cooperative Learning Scheme for Energy Efficient Routing in WSN", also “CEERA”, proposed by Dr Sami AlWakeel and Dr Najla AlNabhan is an interesting approach for the development of energy-efficient WSNs that is crucial for sustainable and progressive growth and usability of the Internet of Things (IoT) in the real world.

The paper addresses the primary problem, that is currently being actively researched that is, energy-efficiency in Wireless sensor networks. As the researchers rightly pointed out, Network lifetime and efficiency are the most considered issues in Wireless sensor networks (WSNs) based systems. The scarcest resource being energy.

It is common knowledge in the field of Wireless sensor communication that, the most energy spent on Communication is on two things Route discovery and data transfer.

This Paper then presents a novel design of a cooperative nodes learning scheme called CEERA (Cooperative Energy-Efficient Routing Algorithm) in WSNs. The algorithm efficiently avoids the energy consumption problem as it does not require any prior configuration or routing discovery operations.

The paper describes the underlying network model and other related models, including: deployment, traffic, and energy models. A Network Model where all nodes transmit to control centre or a Base Station (BS). A Deployment Model where Deployment is either random or deterministic. The Traffic Model decides the inter-arrival time between messages and the Energy Model to divide energy requirements for sensing, computation, and communication.

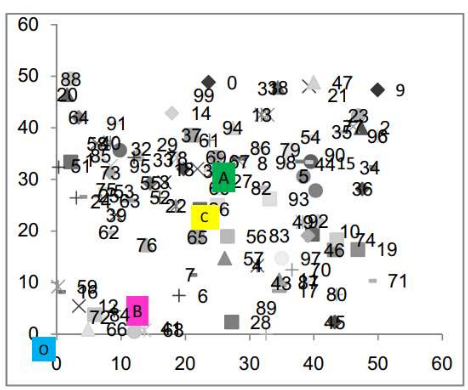

Fig. 2. The random network topology and multiple locations of the BS are shown.

The performance is measured in terms of Throughput, Delay, Delay time jitter, total energy dissipations, no of dead nodes, FND-First node to Die lifetime, Beta pf nodes to die lifetime, and duplicates.

CEERA authors say, nodes cooperate in learning from each other in order to have an efficient delivery of data to the base station. Also, data message is flagged to be transmitted in either source-route mode or cooperative mode. Based on its energy level, a node may not participate in data transmission if its current energy is less than a predefined energy threshold.

The CEERA Algorithm:

The following is the researchers' algorithm design for CEERA. Each transient node 't' that receives the packet will carry out the following steps:

1) Calculates the ID difference

2) Starts a timer counter

3) Listens to BS's ACK, and periodically decrements its timer.

If the BS acknowledgment is not received within the timer value, the transient node retransmit message and appends its address to the address list of transient nodes. Upon receiving the ACK, all nodes clear the call and reset their counters.

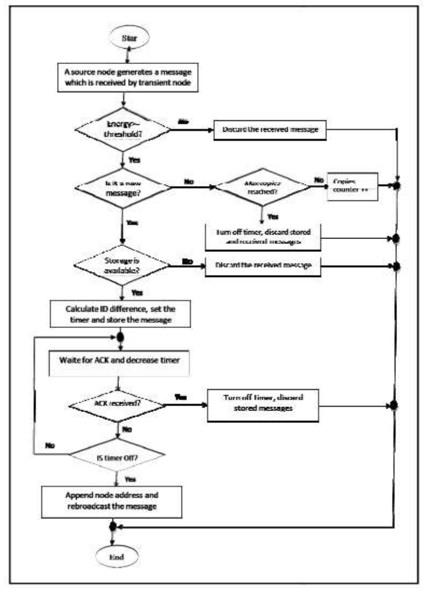

Fig. 3. A flowchart representing the design of CEERA.

The researchers implemented their own event-driven simulation written in C++, aimed at studying the impact of varying the scalar factor, Dmax, buffer size, and duplication factor over the collected performance measures. Researchers mention that these included Throughput delay, DTJ, memory occupation per node, energy dissipation, per initial energy, no. of died nodes, FND, BND, HNA, LND, Hop count, congestion/overhead, and duplicated arrivals.

The resultant analysis reiterated a significant improvement in energy usage in routing with CEERA. CEERA outperforms Flooding 15, 27, and 41 times. Also, CEERA achieves over a factor of 1.34 and 1.26 reduction in energy dissipation.

Methodology of the Research

The research has been done following the quantitative methodology approach. The research paper presents a model that was developed to address a problem and the results were analysed to determine the efficiency of the proposed improvements.

Quantitatively, the research measured various metrics and compared it with current standards and presented the data using tables, graphs and charts.

Results concluded by the article

The paper evaluated and discussed the results, WSN performance of CEERA with various values of transmission range, Dmax. the WSN throughput in terms of number of messages as a function of Dmax. As shown, the highest recorded throughput is for BS at (A) which has the highest nodes density around BS. Increasing Dmax increases throughput to a certain degree, minimizes delay, delay time jitter and hop count but it maximizes no. of duplicated arrivals. For buffer size, it is expected that buffer size is proportional to throughput, and inversely proportional to delay, conjunction, and duplicated arrival. Maximizing buffer size allows more messages to be stored and routed later. We extracted results for buffer size values: 5, 10, 15, and 20.

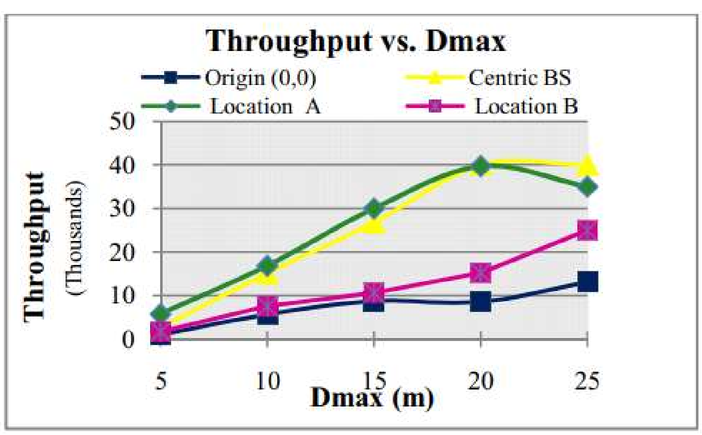

Fig. 4. Throughput vs. D_{max} (in meter) for different BS locations.

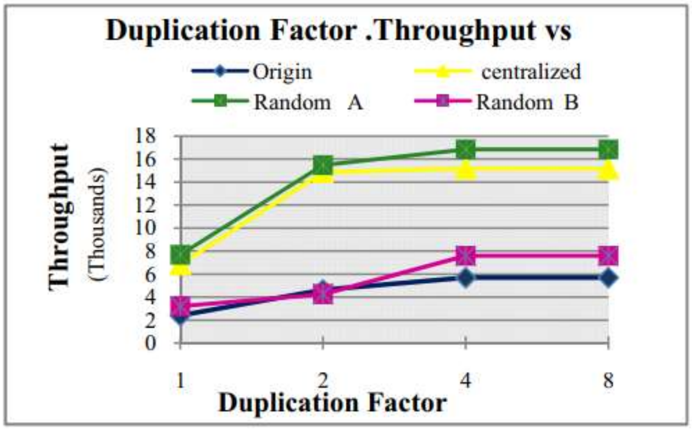

Fig. 5. Throughput vs. duplication factor for different BS locations.

TABLE I
Performance results of varying scalar factor

The BS Location	Performance Factors	Scalar Factor						
		0	0.1	0.5	1	2	5	10
C	Throughput	4703	15151	15147	15149	15115	14911	14795
O		2849	5677	5677	5691	5700	5709	5709
A		4608	16829	16828	16824	16740	16600	16551
B		4144	7567	7567	7568	7569	7564	7560
C	Delay	0.00023	2.81936	14.0662	28.2405	60.2757	179.097	338.65
O		0.000271	2.86646	16.8269	30.4126	55.9837	89.3468	123.502
A		0.00	2.53	12.60	25.34	53.87	160.13	313.35
B		0.000192	1.84439	11.3982	19.1129	35.2904	54.8282	75.9604
C	Delay Time Jitter	0.000117	3.82722	19.1394	38.3072	82.3954	275.467	529.082
O		0.000263	6.10709	37.7896	73.5379	142.987	247.34	360.592
A		0.00	3.87	19.30	39.07	82.48	257.99	514.29
B		0.000203	5.17728	32.673	61.2812	118.92	211.417	337.255
C	Hop count /message	10	2	2	2	2	2	2
O		6	2	2	2	2	1	1
A		13	2	2	2	2	2	2
B		5	1	1	1	1	1	1
C	Duplicated Arrival	11007	21	24	22	34	88	80
O		2958	29	28	17	8	4	2
A		12939	0	0	2	63	89	45
B		3633	0	0	0	0	0	0

The location O is at (25,25), C is at (0,0), A is at (22.97, 31.79), and B at (8.92, 4.57). For a given D_{max}=10, No. neighbor nodes to the BS equals 18, 7, 20, and 9 for locations C, O, A, and B respectively.

Simulation shows an increase in delay and DTJ for network “B” and “O”, this is because more messages are able access BS after we increased storage of transient nodes. Simulation shows a minor change in throughput for increasing buffer size from 10 to 20, which implies that CEERA‘s efficiency is not restricted that the amount of memory. For all monitored networks, it is sufficient to include a realistic storage area and no need to extra storage.

The goal of introducing duplication factor in this research is to save memory by limiting long message storage while it stored by other neighbours. Duplication factor must be selected so that it avoids message loss and saves the available storage. When duplication factor equals r, it means that a message is discarded by a transient node when it received r times. A small value for duplication factor causes message loss, since message deleted quickly. Fig. 5 shows the impact of maximizing the value of duplication factor from 1 to 4 improves throughput for all networks. This significant improvement does not continue when duplication factor is increased to 8.

The paper studied the performance of CEERA extensively when compared to other algorithms. Simulation shows a significant improvement in energy usage in routing with CEERA. CEERA outperforms Flooding 15, 27, and 41 times.

Also, CEERA achieves over a factor of 1.34 and 1.26 reduction in energy dissipation compared to Minimum Transmission Energy (MTE) scheme for some BSs’ locations.

Summary Review for “An Intelligent Routing Approach for Wireless Sensor Networks”

The conference paper titled "An Intelligent Routing Approach for Wireless Sensor Networks"

presented by Dr Najla Al-Nabhan, and Dr Sami Al-Wakeel is an interesting read for Wireless

sensor networks and IoT researchers.

The paper brings to light how wireless sensing technology applications faces many challenges,

mainly caused by communication failures, storage and computational constraints and limited

power supply. In the five-section paper, they have presented the problem and a fitting solution

to counter the problem effectively.

Section 1 - INTRODUCTION:

In this section, we are introduced to the research topic- Wireless Sensor Networks (WSNs).

The writers rightly suggest that WSNs present a revolution in the field of wireless

communication and embedded systems as they allow new generations of applications in areas

such as environmental monitoring, military and security, health care, structural-health

monitoring, intelligent transportation systems, Internet of Things (IoT), and as a part of many

smart systems such as smart cities.

We know that in WSN, data transmission is performed in multi-hop fashion, however this form

of communication possibly floods the network with many data packets due the multiple broadcasts.

Further, reinstating that finding an intelligent routing approach with energy-efficiency and selforganizing property is an important research problem in wireless sensor networks.

Section 2 - INTELLIGENT ROUTING APPROACH WITH ENERGY EFFICIENCY

FOR WIRELESS SENSOR NETWORK

Then we move to section 2 of the paper that presents the detailed design of how researchers

approach the problem. We then see what are the contents of each data packet in network, Mbits source node address, M-bits address for every transient node (optional), K-bits data, and

X-bits packet ID. In total, the data packets contain [M+K+X] bits.

The paper details how this approach achieves energy efficiency by minimizing packet

retransmission caused by transient nodes. It does so, apparently, by allowing the transient

sensor nodes to response intelligently for receiving data packets from source nodes.

In their approach, they intent to maximizes the lifetime of sensor nodes by considering the

residual energy level as a major criteria for the participation in the cooperative packet routing.

Based on its energy level, a transient node may not participate in data transmission if its current

energy level is less than a predefined energy threshold (Emin).

Section 3 - PERFORMANCE EVALUATION AND RESULTS

In this section, the paper discusses the design of the simulation experiment. It consists of the

following:

A. Simulation Setup: To model and study the underlying network.

Their typical network characteristics includes

1) A fixed Base StaΘon (BS),

2) sensor nodes- homogeneous and energy constrained

3) sensors have no locaΘon informaΘon,

4) not all nodes are able to reach BS,

5) symmetric propagaΘon channel: that means the energy required to transmit a packet from

node A to node B is the same as the energy required for transmiţng a packet from node B to

node A.

Transmission range, Dmax, depends of number of nodes within this distance to the base station

and is a key parameter that has a significant impact on the network operational lifetime.

B. Performance Measures: The main performance measures are as follows: Throughput

(Thr), Delay(D), Delay Time Jitter (DTJ), the Total Energy dissipations(E), and number of dead

nodes.