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An Efficient Data Collection and Data Diffusion using Less Power Consuming Approach for Wireless Sensor Networks

M. Giri* and S. Jyothi**

Abstract : Day to day the usage of wireless devices are increased. A lot of research is conducted on wireless sensor networks to provide data communication over sensor nodes. Especially in some of the critical application like medical field, sensor nodes are deployed into patient body to closely monitor patient health condition and sensed sample data to be forwarded to physician to protect patient health conditions. In this paper we propose new novel security based multi hop routing algorithm. First, we fix sink node with maximum battery, next we fix relay node and then try to collect maximum data from sensor nodes. Proposed method is simulated using network simulator tool NS2 software. We evaluate our proposed research method and existing method using network performance evaluation parameters like delay, packet delivery ratio, power consumption, route overhead, and packet drop rate. At the end we conclude that proposed method performance is better when compared to existing method.

Keywords: Authentication; Data Transmission; End-to Intermediate Communication; Secure Routing; Relay Sensor Node; Wireless Sensor Networks.

1. INTRODUCTION

The day to day development in data communication system has chance of using new modern devices for network communication. The size of Wireless Sensor Network (WSN) is very small and due to its size it can be easily deployed in different remote locations. In wireless network almost all nodes are distributed and are logically inter connected with each other. Logically inter connected nodes are useful to increase reliability and fault tolerance of wireless sensor network. Implementation cost of WSN is not expensive one. The nodes which are present in WSN can be easily controlled and monitored from different remote locations [4].

Each sensor node in wireless Sensor Network periodically updates data and communicates with neighbor sink node. It is also acting as an interface media between network and its user. It is also treated as base station of sensor nodes in wireless networks. The main role of sink node is to collect data from sensor and forward to server and vice versa. In distributed computing environment the same sink node is called as coordinating server and its role is to retain or moving data and reply to user queries. In most of the situations sink node is not in the range of sensor node, therefore data from sensor node to sink node or sink node to sensor node is passed through intermediate sensor nodes by establishing routing [5].

Kim et al [6] proposed intelligent agent based routing algorithm to transfer data over wireless networks. They addressed and focused on route overhead problem in wireless sensor networks. In their method they first choose one node as agent node, from that node data is collected from all other nodes and

* Associate Professor, Department of Computer Science and Engineering, VEL TECH HIGH TECH Dr.Rangarajan Dr.Sakunthala Engineering College, Avadi, Chennai, Tamilanadu, India. *prof.m.giri@gmail.com*

** Professor, Department of Computer Science, SPMVV University, Tirupathi, Andhra Pradesh, India. *jyothi.spmvv@gmail.com*

then data is transferred to sink node. Sink node forward data to destination node. Here all source nodes temporarily communicate using agents. Kim et al is showing better results if they choose correct node as agent node. If the agent node is not selected properly or selected less power backup node as agent then there is a chance to lose sensed data in some crucial applications.

In this paper, we propose new novel reliable secure routing algorithm to transmit data to destination node. In our method, we propose new routing algorithm based on two factors. One is selection of rendezvous point and another is selection of relay node. We compare our method with Kim et al and our method. The proposed method shows better results when compared with existing methods. This paper is organized as in section II we discuss about related work, in section III proposed work is presented, in Section IV simulated results, and in section V brief about conclusion.

2. RELATED WORK

Mateo et al. proposed two methods NORA and NORIA for WSN. In NORA method, assignment of task to node is based on localization and nearest node concept and create path to base station[3]. First step is to find out condition of neighboring node before assigning job to that node. Assigning jobs to node or cluster of nodes are based on neighborhood concept which will help to enhance the performance of WSN. The complete process starts at base station and ends at sensor node. The nodes which are intermediate will simply forward sensed information to best neighboring node within its radio frequency range. In NORIA method they use fuzzy logic technique to enhance quality of assigning task problem. Like humans, fuzzy logic is useful to take good decision. The method which is proposed by the authors are producing good results but it is limited and not possible to apply to big networks.

Naranjo et al., proposed access control mechanism for wireless services over a network in internet of things development [1]. In their method they mainly focus on two aspects in sensor nodes, one is memory and other one is battery. They proposed key exchange mechanism as and when required and key is exchanged in the network media. Here the users are authenticated based on time gap. In their model main component are base station, sensors and user smart devices. They restrict users from unauthorized access of data by encrypting & key exchange methods but there is a chance of forcing man in the middle attack, user impersonate attack, and server masquerade attack [7].

Yang et al., discussed multiple radios and multiple channel wireless mesh networks which offer broadband internet in smart mobile devices. Assignment of jobs is one of the major problems due to less number of network channels and overlapping of signals. They consider this problem and proposed heuristic max cut method to find overlap network channel. They resolved the problem by choosing only odd number channels to produce good results. Their method was outperformed good results but they focus only on overlapping assignment problem and there is a chance to waste network bandwidth by choosing only odd number channel [9].

Xiaoding et al., addressed fault in routing nodes in wireless mesh networks and they focus on fault tolerance problem [8]. Suppose in wireless mesh networks more number of edges are added between nodes for better connection leads to a big problem in this type of wireless networks. The authors proposed a new algorithm to identify faulty nodes in the routing and faulty nodes are resolved by considering three factors. They are degree of the node, size of the network, and the number of operations. Their method outperformed good simulation results and still some of the issues need to be solved to provide better communication.

Truong et al., introduced adaptable routing method for wireless sensor networks for different climatic conditions like fire accident in smart building constructions [2]. In their method they assumed that base station is fixed at one centralized location, each and every sensor node will send data to base station using multi hop routing path. The mobile station must know its position, and mobile stations are roaming in uncontrolled manner. They also consider sensor networks which are suitable for fire accident applications, in this case sensors are used for sensing and reporting fire conditions will destroy because of fire. They introduced new fire fighter equipment that will be acting as sink nodes and provide sensed data without interruption. Their method has four stages like stationary phase, movement phase, reservation, and connection. If mobile station changes its position immediately it provides route information to base station through multi hop routing. Each sensor node will decide itself to send the message through mobile station in its own path. To maintain route information they created temporary tree which will lead to overhead in constructing trees. If the node changes its position then hop count is increased and keep on increasing hop value which may be lead to confusion stage.

3. PROPOSED METHODOLOGY

In this paper, we propose new novel reliable secure routing algorithm to transmit data to destination node. In our method we propose new routing algorithm based on two factors, one is selection of rendezvous point and another is selection of relay node. Some of the notations used in our proposed routing algorithm are listed below.

N_{source} = Source Node;
N_{sink} = Sink Node;
P_{query} = Packet query
R_P = Rendezvous point;
N_{relay} = Relay Node;
$N_{neighbor}$ = Neighbouring node
P_{relay_n} = Relay path new;
P_{relay_o} = Relay path old
P_{relay_seq} = Relay path sequence number;
P_{relay_start} = Relay path start-up
P_{relay_close} = Relay path close;
D_{TX} = Distance of transmitter

Multi hop step by step route selection algorithm for data transmission is discussed below. Our idea is to fix centre node as sink to collect and transmit data to destination sink node.

Step 1: If any event rises immediately R_P is selected for communication. The complete process of selecting source node is shown below. In figure 1 shown how an event occurs in the environment, event is sensing by the neighboring nodes is shown in figure 2, signal alert from neighboring nodes is shown in figure 3, deciding node with maximum battery power as source node is shown in figure 4, and formation of network is shown in figure 5.

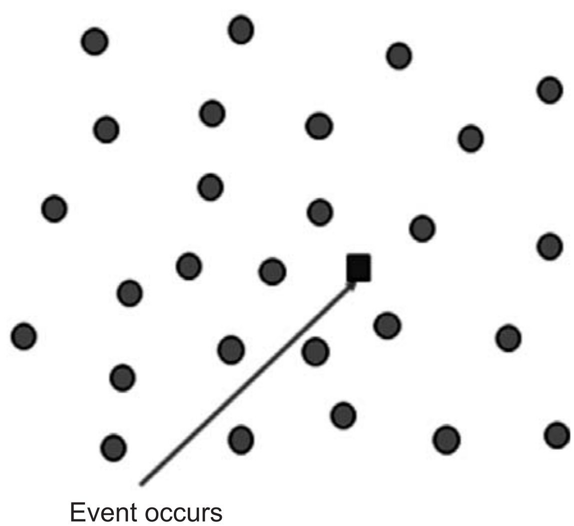

Figure 1: Event Occurs

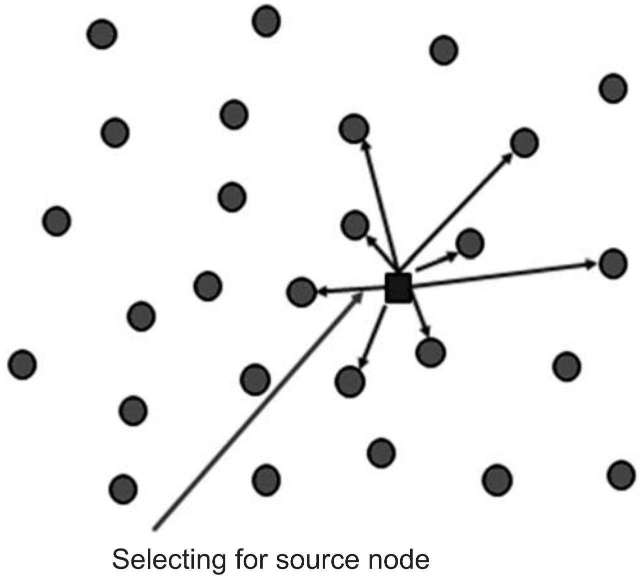

Figure 2: Event sensed by neighboring node

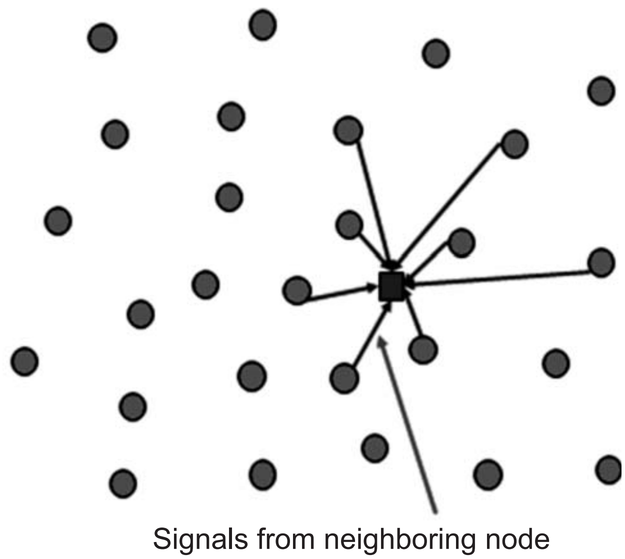

Figure 3: Signals from neighboring node

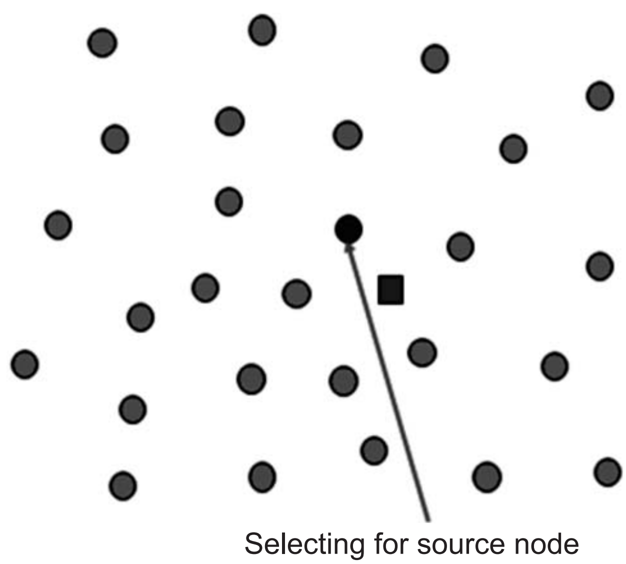

Figure 4: Deciding source node

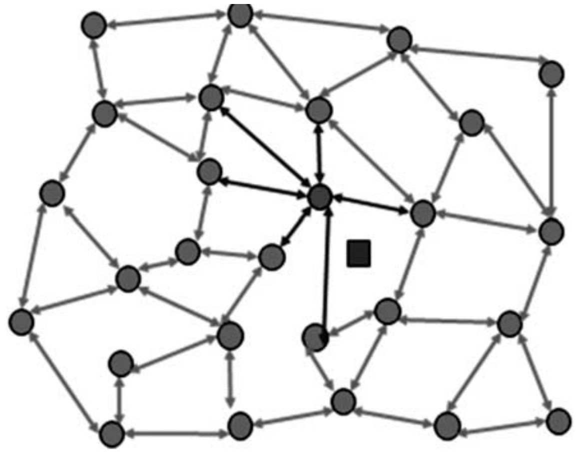

Figure 5: Network formation

Step 2: Sink node will send P_{query} to R_P with $ID_{sink} \| hop_{count} \| D_{TX}$

Step 3: R_P broadcasts P_{query} by setting its $hop_{count} = 0$

Step 4: if the node $N_{neighborreceives}$ query (P_{query}), simply it broadcast P_{query} to immediate neighboring nodes by incrementing hop count by 1.

Step 5: if next node hop value > 1 then every node compare packet arrived time stamp (TS_a) and next node is selected with earlier timestamp value (TS_a).

Step 6: if an event occurs immediately nodes jointly process and one node will be acting as source node.

Step 7: Data is send when source data is matches with P_{query}.

Step 8: when next hop node battery is low then immediately select next neighbor node is next hop node.

$$N_{Source} \rightarrow N_{neighbor} \& N_{neighbor} \rightarrow N_{Source}$$

Step 9: If N_{sink} within radio range of R_P then N_{sink} will receive data from R_P otherwise N_{sink} will select N_{relay} to receive packet from R_P.

Step 10: Identification of relay node:

Step 10.1: N_{sink} will send relay node request to its neighbor nodes.

$$N_{Sink} \xrightarrow{R_{req}} N_{neighbor}$$

Step 10.2: $N_{neighbor}$ can be send relay message R_{rply} to sink node.

$$N_{neighbor} \xrightarrow{R_{rply}} N_{sink}$$

Step 10.3: N_{sink} will select close nearest node as relay node.

Step 10.4: Sink send P_{relay_start} to R_P through chosen relay node.

$$N_{Sink} \xrightarrow{P_{relay\_start}} N_{relay} \xrightarrow{P_{relay\_start}} R_P$$

Step 11: If N_{sink}, moves out of coverage of N_{relay} and then new N_{relay} node is selected by following previous step.

Step 12: If R_P received P_{relay_start} then

Step 12.1: If already P_{relay_o} exists for the same N_{sink} then R_P send P_{relay_close} to P_{relay_o}.

$$R_P \xrightarrow{P_{relay\_close}} P_{relay\_o}$$

Step 12.2: P_{relay_o} is maintained as alternative path until getting P_{relay_start} message.

4. PROPOSED METHODOLOGY

Proposed method is simulated using Network Simulator (NS2) and results are discussed in the following sections.

A. End to end transmission delay

End to end transmission delay is a time difference between packet generation time at source node and packet receiving time at destination node. It is one of the performance evaluation parameter of a network. Depending on reliable energy efficient methods, there exist overhead and hand-off in terms of delay. End to end transmission delay of proposed method and Kim et al is calculated by varying increasing data transmission rate as 100, 200, 300, 400, and 500 KBPS. A graph is plotted based on the results produced by both schemes and it is shown in figure 6. With experimental results we come to know that our method shows less transmission delay when compared with Kim et al method.

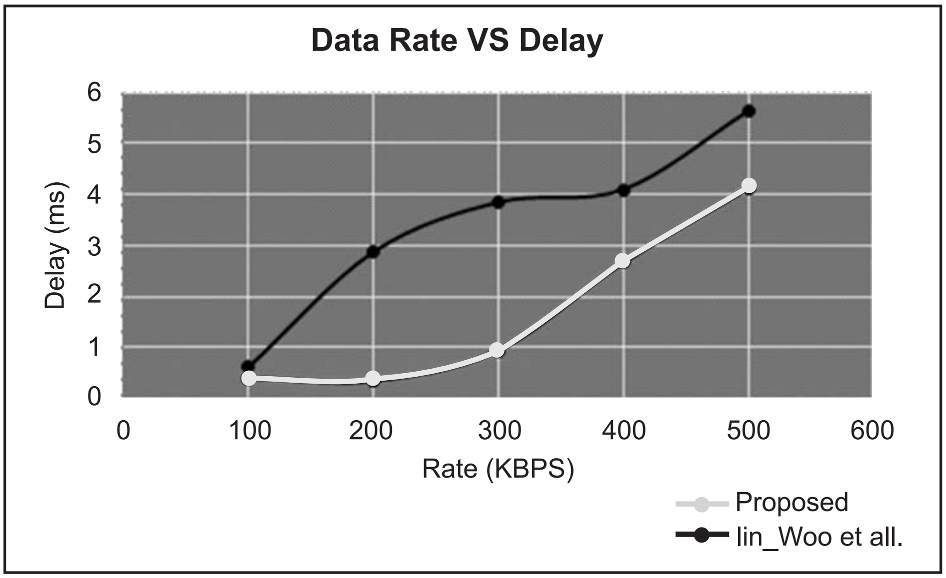

Figure 6: Data Rate Vs Delay

End to end transmission delay of proposed method and Kim et al is calculated by varying number of nodes in WSN as 20, 40, 60, 80, and 100 nodes. A graph is plotted based on the results produced by both schemes and it is shown in figure 7. With experimental results we come to know that our method shows less transmission delay when compared with Kim et al method.

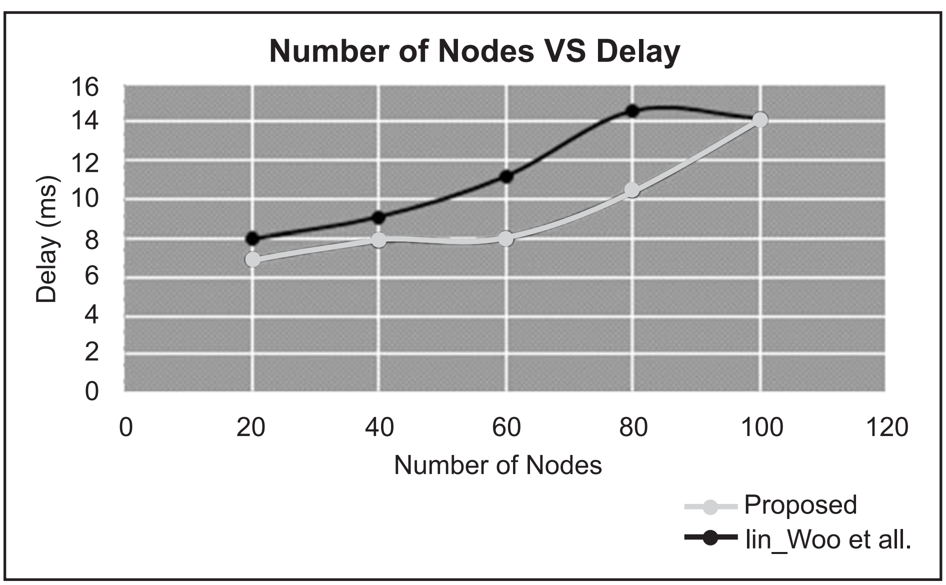

Figure 7: Number of Nodes Vs Delay

End to end transmission delay of proposed method and Kim et al is calculated by varying number of sources in WSN as 5, 10, 15, 20, and 25 sources. A graph is plotted based on the results produced by both schemes and it is shown in figure 8. With experimental results we come to know that our method shows less transmission delay when compared with Kim et al method.

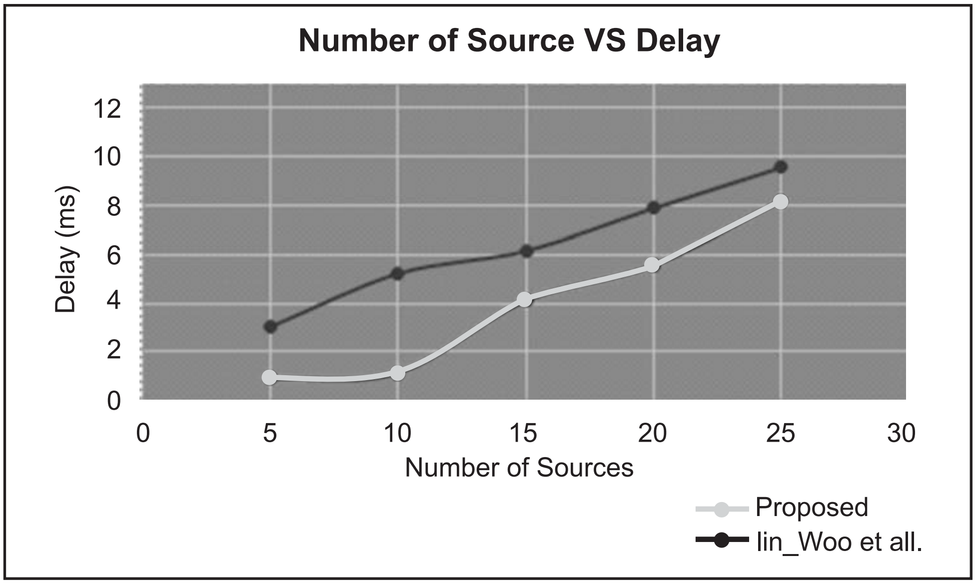

Figure 8: Number of Sources Vs Delay

B. Power Consumption

Total power consumption for data transmission. Power consumption of proposed method and Kim et al is calculated by varying data transmission rate as 100, 200, 300, 400, and 500 KBPS. A graph is plotted based on the results produced by both schemes and it is shown in figure 9. With experimental results we come to know that our method consuming less power when compared with Kim et al method.

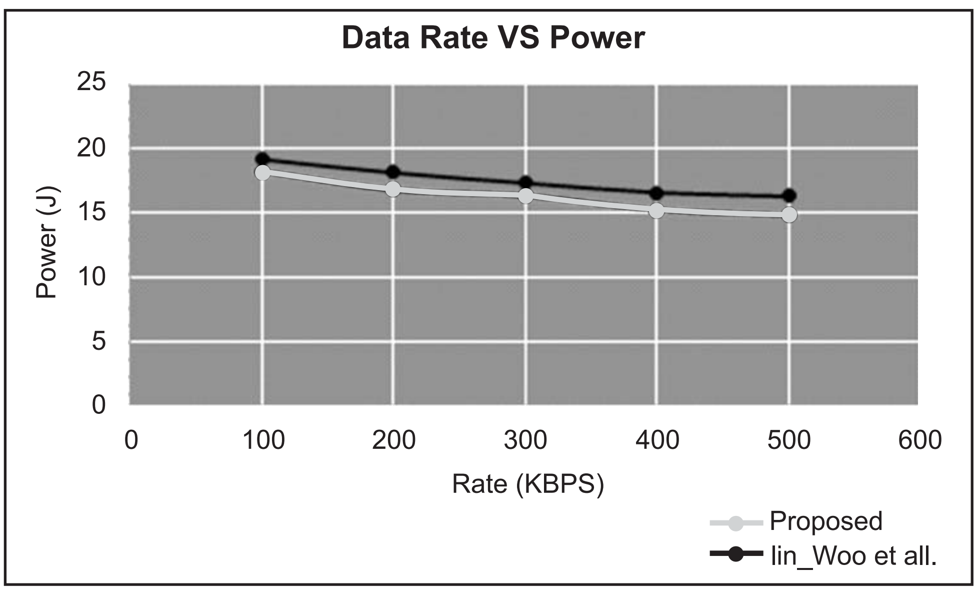

Figure 9: Data Rate Vs Power

Power consumption of proposed method and Kim et al is calculated by varying number of nodes in WSN as 20, 40, 60, 80, and 100 nodes. A graph is plotted based on the Results produced by both schemes and it is shown in figure 10. With experimental results we come to know that our method consuming less power when compared with Kim et al method.

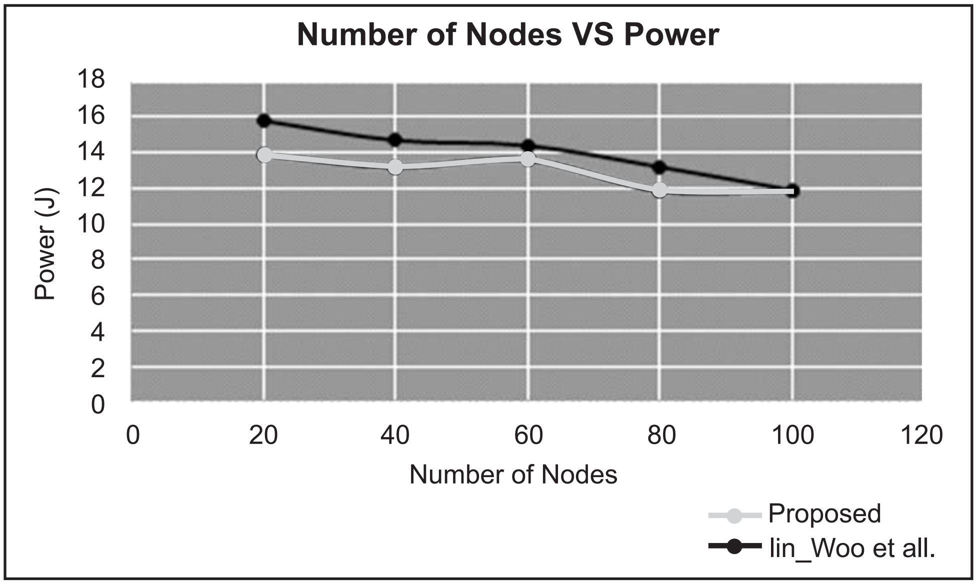

Figure 10: Number of Nodes Vs Power

Power consumption of proposed method and Kim et al is calculated by varying number of sources in WSN as 5, 10, 15, 20, and 25 sources. A graph is plotted based on the Results produced by both schemes and it is shown in figure 11. With experimental results we come to know that our method consuming less power when compared with Kim et al. method.

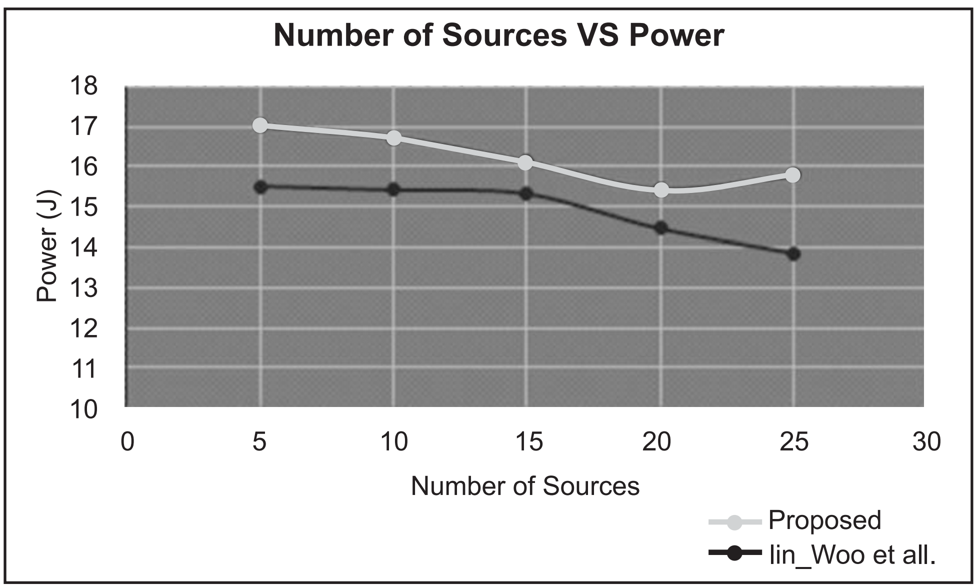

Figure 11: Number of Sources Vs Power

C. Overhead

Overhead is defined as the total number of routing control packets normalized by the total number of received data packets. Overhead of proposed method and Kim et al is calculated by varying data transmission rate as 100, 200, 300, 400, and 500 KBPS. A graph is plotted based on the results produced by both schemes and it is shown in figure 12. With experimental results we come to know that our method showing less overhead when compared with Kim et al method.

Overhead of proposed method and Kim et al is calculated by varying number of nodes in WSN as 20, 40, 60, 80, and 100 nodes. A graph is plotted based on the Results produced by both schemes and it is shown in figure 13. With experimental results we come to know that our method showing less overhead when compared with Kim et al method.

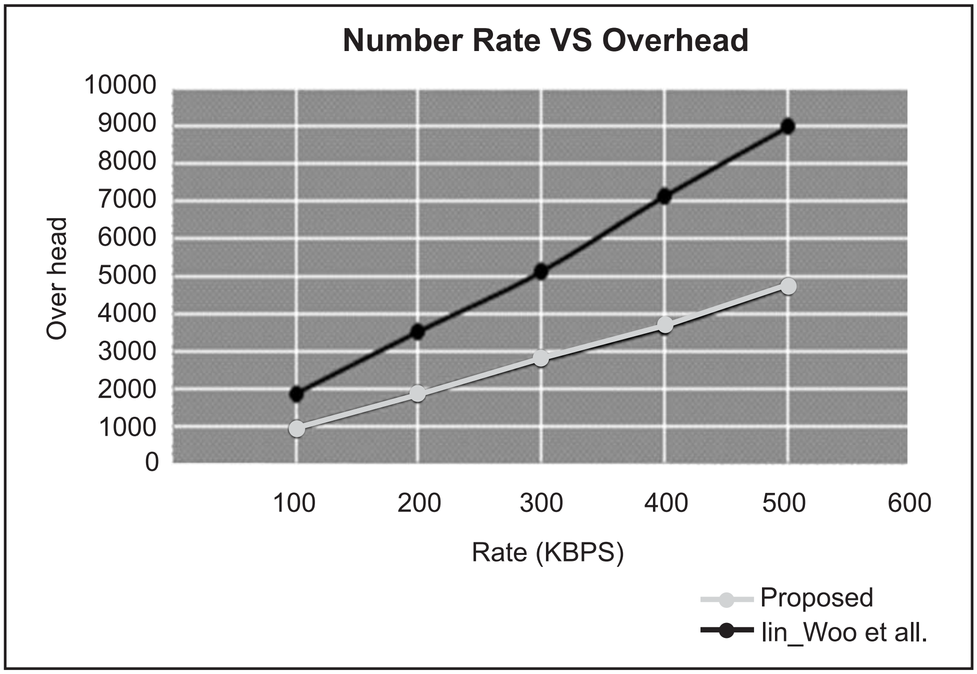

Figure 12: Data Rate Vs Overhead

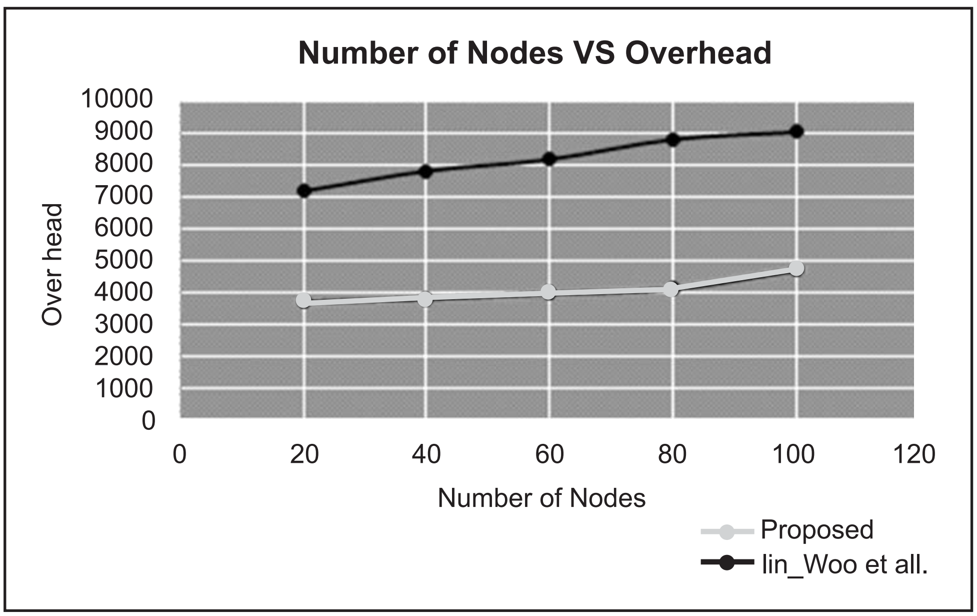

Figure 13: Number of Nodes Vs Overhead

Overhead of proposed method and Kim et al is calculated by varying number of sources in WSN as 5, 10, 15, 20, and 25 sources. A graph is plotted based on the Results produced by both schemes and it is shown in figure 14. With experimental results we come to know that our method showing less overhead when compared with Kim et al method.

D. Packet Drop

Data is transmitted from source to destination using sink nodes. Packet drop is defined as number of packets missing or dropping during transit. Number of packets drop during transmission is estimated for both proposed method and Kim et al by varying data transmission rate as 100, 200, 300, 400, and 500 KBPS. A graph is plotted based on the results produced by both schemes and it is shown in figure 15. With experimental results we come to know that in our method number of packets drop during transit is low when compared with Kim et al method.

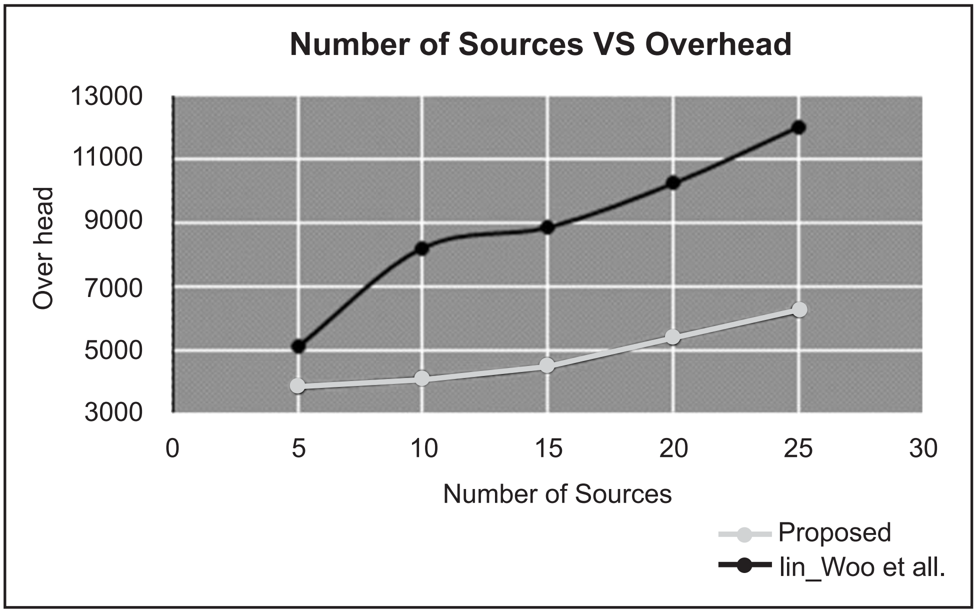

Figure 14: Number of Sources Vs Overhead

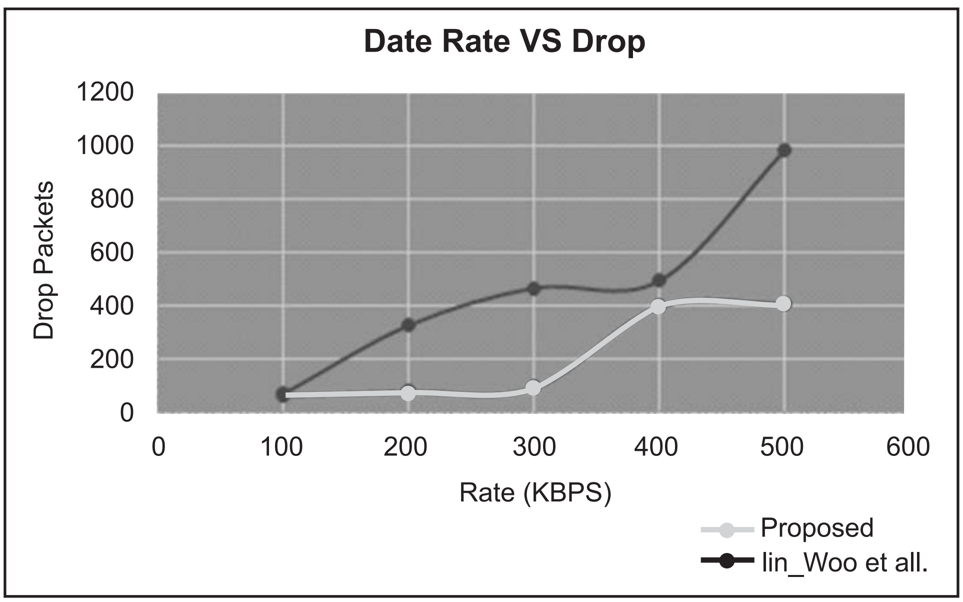

Figure 15: Data Rate Vs Drop

Number of packets drop during transmission is estimated for both proposed method and Kim et al by varying number of nodes in WSN as 20, 40, 60, 80, and 100 nodes. A graph is plotted based on the Results produced by both schemes and it is shown in figure 16. With experimental results we come to know that in our method number of packets drop during transit is low when compared with Kim et al. method.

Number of packets drop during transmission is estimated for both proposed method and Kim et al by varying number of sources in WSN as 5, 10, 15, 20, and 25 sources. A graph is plotted based on the Results produced by both schemes and it is shown in figure 17. With experimental results we come to know that in our method number of packets drop during transit is low when compared with Kim et al method.

E. Delivery Ratio

Delivery ratio defined as a ratio of total number of data packets received by the receiver successfully and total number of data packets transmitted at sender side. Packet delivery of proposed method and Kim et al is calculated by varying data transmission rate as 100, 200, 300, 400, and 500 KBPS. A graph is plotted based on the results produced by both schemes and it is shown in figure 18. With experimental results we come to know that in our method packet delivery ratio is high when compared with Kim et al method.

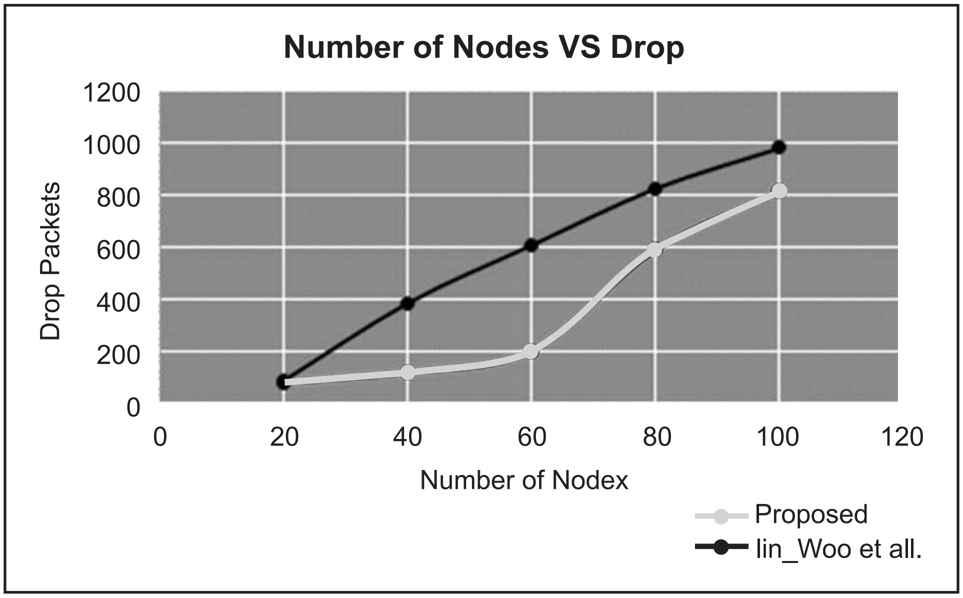

Figure 16: Number of Nodes Vs Drop

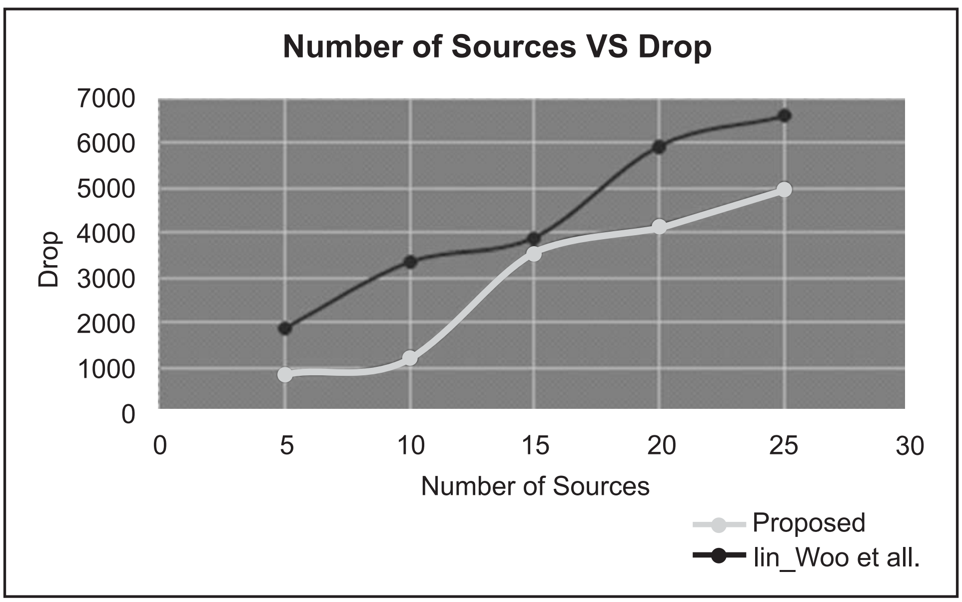

Figure 17: Number of Sources Vs Drop

Packet delivery of proposed method and Kim et al is calculated by varying number of nodes in WSN as 20, 40, 60, 80, and 100 nodes. A graph is plotted based on the Results produced by both schemes and it is shown in figure 19. With experimental results we come to know that in our method packet delivery ratio is high when compared with Kim et al method.

Packet delivery of proposed method and Kim et al is calculated by varying number of sources in WSN as 5, 10, 15, 20, and 25 sources. A graph is plotted based on the Results produced by both schemes and it is shown in figure 20. With experimental results we come to know that in our method packet delivery ratio is high when compared with Kim et al method.

5. CONCLUSION

Usage of wireless sensor networks is rapidly increasing day by day and now a day we are using sensor networks in some critical applications like health care wireless body area networks. In this paper we proposed secure reliable data collection and data transmission technique. We simulated proposed method using network simulator 2 and results are compared with Kim et al using performance evaluation metrics like packet delivery ratio, delay, power consumption, overhead, and packet drop. Network delay of proposed method is 18% less than Kim et al, power consumption is 11% is less than Kim et al, overhead of proposed is 49% less than Kim et al, packet drop of proposed method is 45% less than Kim et al, and packet delivery ratio of proposed method is 27% higher than Kim et al. At the end, we come to know that our method shows better results when compared with Kim et al.

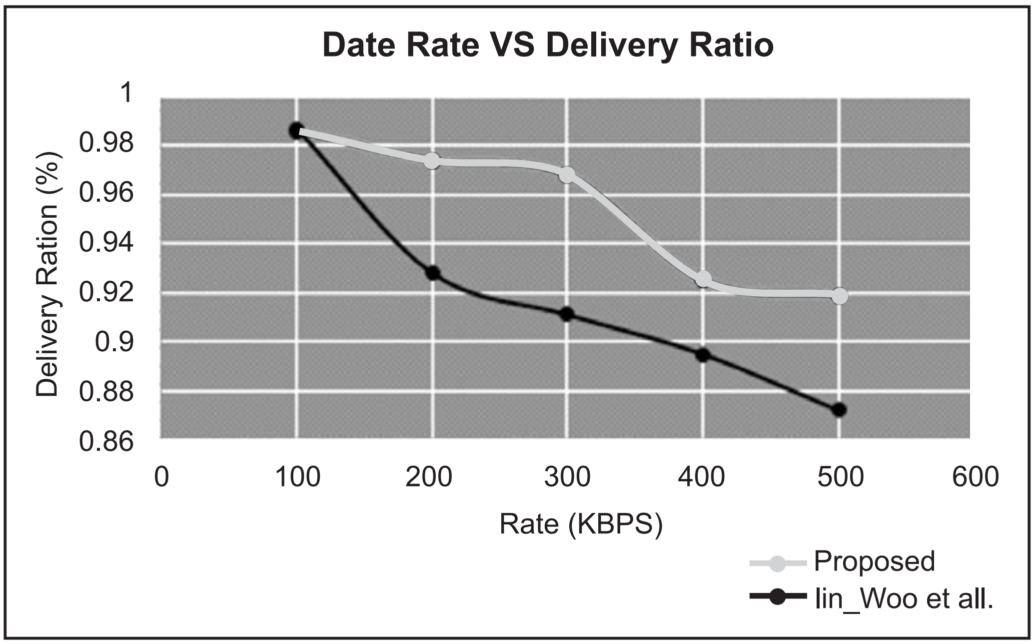

Figure 18: Data Rate Vs Delivery Ratio

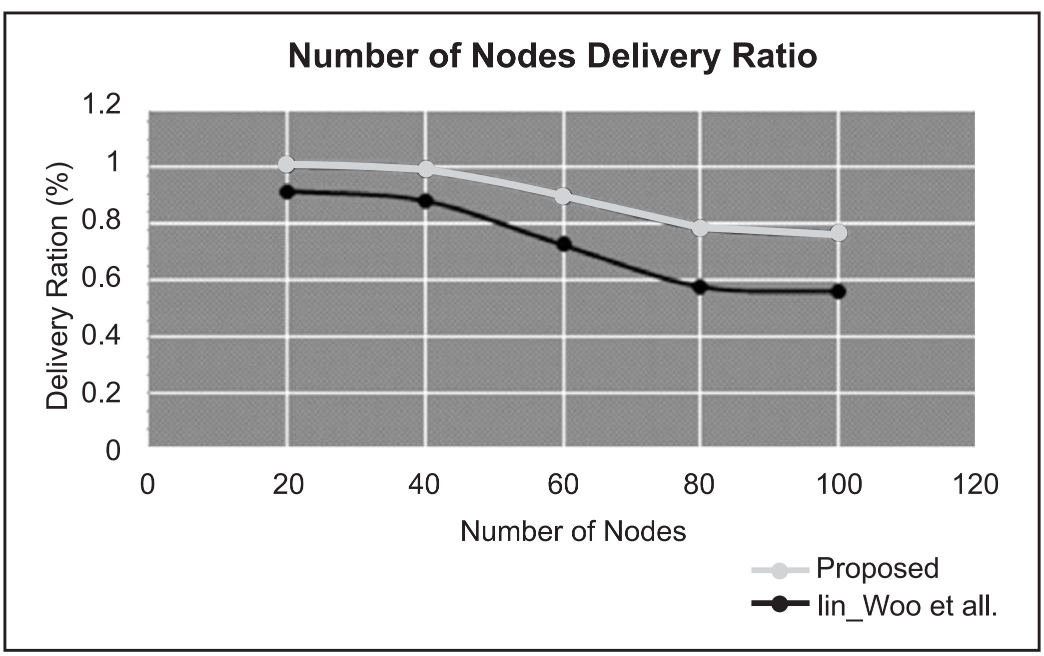

Figure 19: Number of Nodes Vs Delivery Ratio

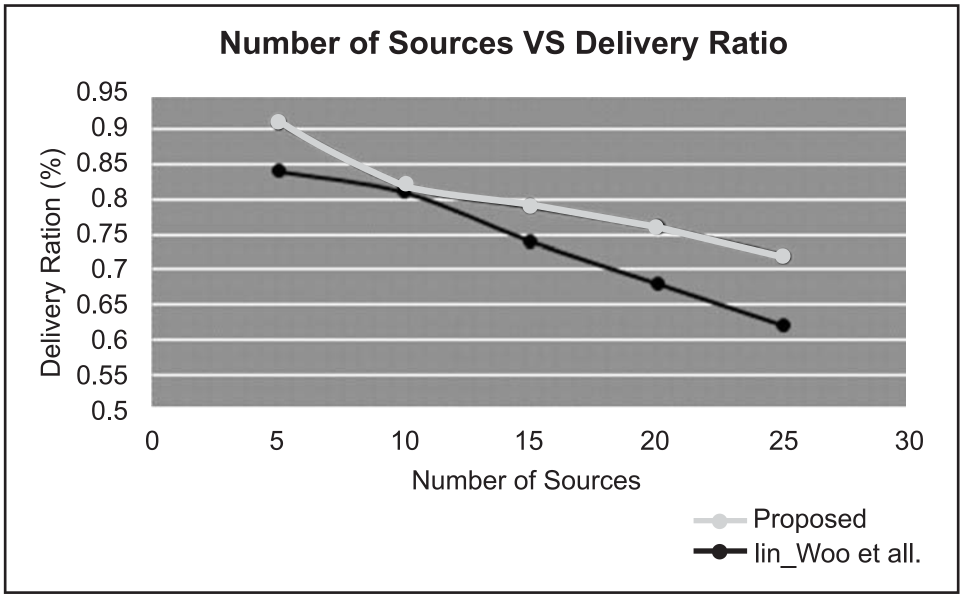

Figure 20: Number of Sources Vs Delivery Ratio

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