Performance Rating of Routing Protocols in Wireless Sensor Networks

Boniface Kamala Mitume[1], Claude Takenga[1,2]
[1](*Faculty of Applied Sciences, Université Officielle de Ruwenzori, DRC)*
[2](*R&D,Infokom GmbH, Germany)*

ABSTRACT: *It has been witnessed in recent years, that an efficient design of Wireless Sensor Networks (WSN) has become one of the leading areas of research interest. This is due to the fact that, the WSN is a central component of the Wireless systems based on IoT (Internet of things). Wireless sensor networks face hardware constraints due to the fact that nodes used are limited in terms of capacity. This capacity include; the processing capacity, the storage capacity, and the communication capacity. This paper is trying to answer on some issues concerning routing in wireless sensor network. Our research will mainly focus on comparing two dynamic routing protocols of Wireless Sensor Network. The Ad-hoc On Demand Distance Vector (AODV) and the Dynamic Source Routing protocol (DSR) will be investigated based on nine performance metrics: Routing Overhead, Packet Delivery ratio, throughput, Control overhead, Delay, Jitter, Packet Dropping ratio, Packet sent and Packet received. The transport layer protocol for the experimentation is based on UDP (User Data Protocol). Different tests will be considered with different numbers of nodes and results are presented as comparing plots.*

KEYWORDS*-AODV,DSR, IoT, Network, NS2, WSN*

I. INTRODUCTION

The main purpose of sensor network is not only limited to monitoring certain environment phenomena but also forwarding collected data to specific destination. Since last years, wireless sensor network can be applied in different domains running from security, industrial, health and transport. In military domain, tracking and monitoring surveillance systems are based on this type network. In health domain, the necessity to monitor patients by doctors is a solution given with the help of a wireless sensor network [1-3].

Wireless Sensor Network architecture is divided into three main parts: the sensor field, the Gateway and the place where data need to be used. Sensing field: this is the area where different sensors are placed. It can be a forest, a town (collecting data on building) or any area where data need to be collected. Gateway: this is the antenna which receives data from the sensing field and conveys them to network where data can be processed. From the gateway to the place where data need to be processed, data can pass through Internet or can be in a Local Area Network.

The place where data need to be processed and visualized: after a gateway receives data, it conveys it to the destination of usage. This can consist of a processing center made of different hardware and software capable to process data so that it can be important to the user. The output, depending on the need can be different histograms, numbers or any other type to presenting data. The nodes are connected wirelessly but the connection between the gateway and the processing place can either be guided or unguided.

This article is investigating on two dynamic routing protocols of Wireless Sensor Network known as:

- AODV: Ad-hoc On Demand Distance Vector
- DSR: Dynamic Source Routing protocol

The transport layer protocol the experimentation is based on is UDP. Different tests will be considered with different numbers of nodes: the first one is based on 5 nodes, the second is based on 15 nodes, 25 and lastly 50 nodes.

To make decision about this topic, we have

been inspired by other works presented in the area of Wireless Sensor Network and other related areas. Here are some of the papers we have gone through and which make our research unique.

Analyzing the work in [1], we can mention the first point of discrepancy. It is true that, using different tools can provide different results. In this paper [1], the author used QualNet while we are using NS2 (Network Simulation version two).In addition to this, the authors have based their research on routing protocols such as AODV, DYMO, OLSR and IEPR, while in our research we focus on AODV and DSR. Further aspect, the authors made emphasis on mobile network while in our work we do research on a fix network. The final important aspect to highlight are the different performance metrics to be compared. In [1], the parameter considered are the thought, end-to-end delay, signal received with errors, average queue, length, packet to application layer, total packet received at the receiver. Some of the considered parameters are similar with the ones we tested in our work.

Work presented in [4] tackles the mobility based Performance analysis for wireless sensor network. As the topic explains, performance analysis of this work is measured on mobile nodes, this is totally different from our case where we are evaluating performance based on fixed nodes. The second element to mention is about the routing protocol used.AODV is the one used in this paper while we considered two protocols for comparison, AODV and DSR. We considered different parameters for comparison and the authors used QualNet to analyze performance.

The focus of the work [5] was on performance evaluation of routing protocols in Wireless Mesh Networks. Some of routing protocols of Wireless Multi-hop Networks can also be utilized in Wireless Mesh Network. But this paper has based evaluation on other routing protocols such as DYMO and BATMAN. In addition to this. The simulator tool used in this PhD thesis is OMNeT++ while the one used in our research is NS2.It is finally important to mention that this PhD thesis considered Throughput, Packet Delivery Ratio, Routing Overhead and end-to-end delay as evaluation criteria while in our research we have used these and other more.

Several other works are anyhow related to the topic we chose for this paper [6-14].

II. METHOD

A. Performance rating parameters

Performance rating parameter is a method of verifying a proposed routing algorithm. According to the result of rating of parameter, a researcher can decide to clone a specific protocol or to develop a new one. This article is focused on two different protocols used in Wireless Sensor Network. The protocols considered are:

- AODV:Ad-hoc-On-Demand Distance Vector
- DSR: Dynamic Source Routing Protocol

Nine different parameters have been considered in this research: Routing Overhead, Packet Delivery ratio, throughput, Control overhead, Delay, Jitter, Packet Dropping ratio, Packet sent and Packet received.

- Packet Delivery Ratio(PDR)

This is the ratio of number of data packets received to number of data packets sent. Higher this ratio means better the result is and it expresses good reliability. Lower this ratio means more packet have been dropped.

- Packet Dropping Ratio

This is the ratio of data packets dropped to number of data packets sent. Higher this ratio means poor the results. Lower this ratio means more packets delivery ratio.

- Throughput

The throughput is the average number of bits transmitted per unit time. Higher the throughput means better the results, lower the throughput means more packets dropping ratio. It is important to mention that the throughput is directly proportional to the Packet Delivery Ratio. The throughput is usually measured in bits per second (bps) and sometimes in data packets per second or data packet per time unit.

- Normalized Routing Overhead

The ratio of number of routing packets to the total number of data packets received. Lower this ratio means better bandwidth utilization for actual data. Higher this ratio means routing consumes more bandwidth.

- Control Overhead

The control overhead is the number of routing packets required for data transmission.

Lower the control overhead means better results. Higher the control overhead means more exchange of control packets.

- Delay

The delay consists of the time taken by packet to reach to the destination from source. Lower the delay means better result. Higher the delays mean less quality of service.

- Jitter

The Jitter is the difference in packet delay. Lower the jitter means more stable the network is. Higher the jitter means there is instability in the network.

- Number of packets sent

This is total number of packets that the source has been able to send after establishment of the route. Higher this number means better the results.

- Number of packets received

the result. There is interoperability between the nine given parameters, the time one decrease/increase it directly affect some others.

B. Performance rating process

In this article, the use of NS2 is motivated by the fact that this tool provides substantial support to simulate bunch of protocols like TCP, FTP, UDP, https and routing protocols.In addition to this, NS2 uses a scripting language (TCL-Tool Command Language) which is easy to learn.

During simulation, there are some common parameters that have been considered, these parameters are as follow: the channel type, the radio propagation model, the network interface type, the mac type, the Interface queue type, the Link layer type, the antenna model, the time of simulation end and the transport layer protocol. What need to be highlighted is that the transport controlprotocol considered in UDP (User Datagram Protocol).

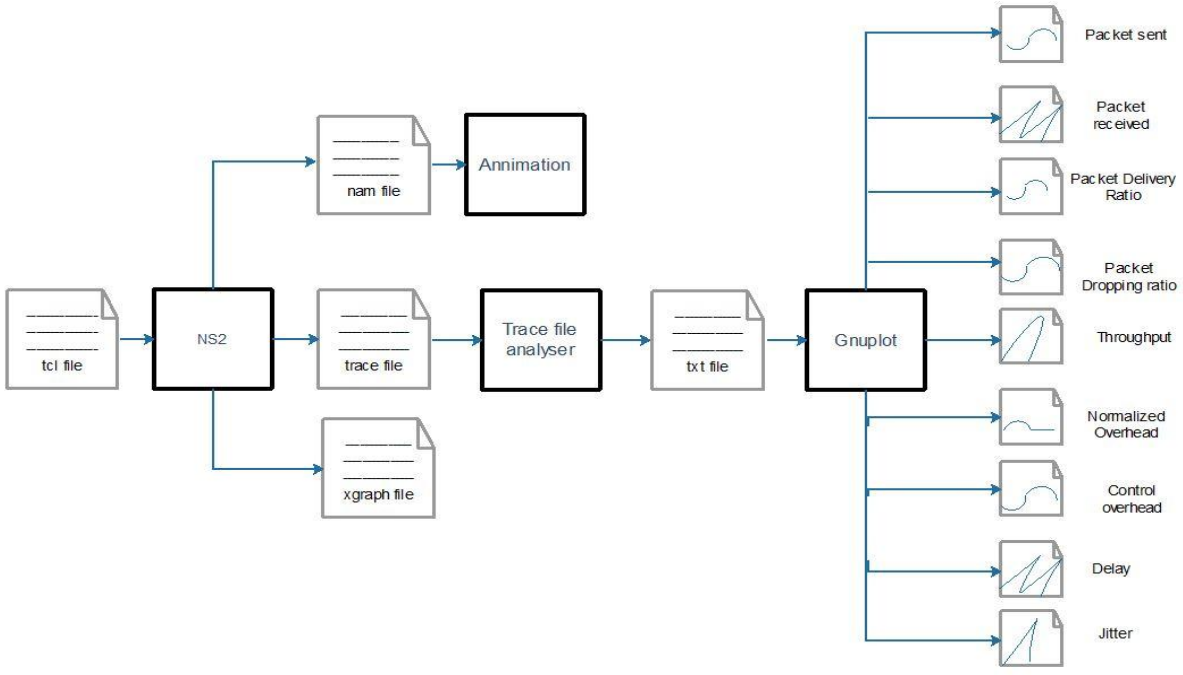

Figure 1: Performance rating process

III. RESULTS AND DISCUSSION

The two routing protocols have been separately analyzed and the graphics bellow will be plotting the results for both the routing protocols according to different parameter. A discussion is given so that the grid can be more understandable. More information is helpful in making choice about a specific routing protocol.

A point to highlight is that, these results can be impacted by the parameters considered and the simulation tool used.

A. Number of packets sent

This is total number of packets that the source has been able to send after establishment of the route. Higher this number means better the results. This consists the first parameter that need to be considered because most of the other parameters depend on it. The packets start being sent after the source node has decided about the route to take (route discovery). The router discovery phase has two major steps: router request and the route reply. The route request is done by the source router when selecting the best path. The source reply signal confirms the availability the route

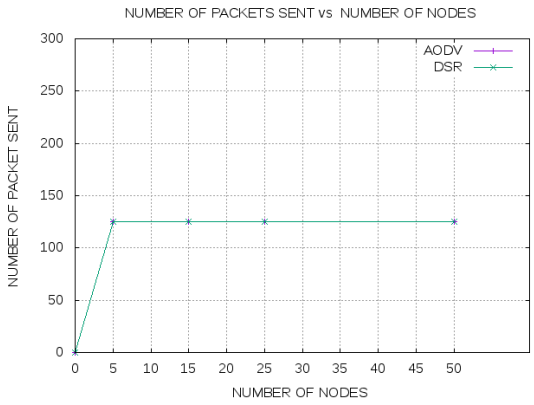

Figure 2: Number of packets sent vs number of nodes

As it can be seen, for the two routing protocols, the number of packets sent does not depend on the number of nodes. Even though the number of nodes is varying, the total packet sent remains the same. In addition to this, the two routing protocols have been able to send the same number of packets.

B. Number of packet received

This is the number of packets which have reached the destination node. Higher this number means better the result

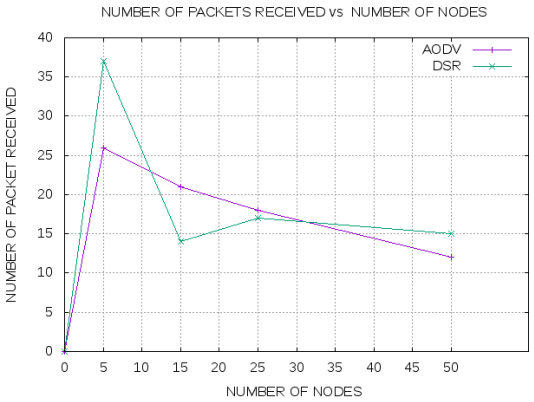

Figure 3: Number of packets received vs number ofnodes

For the two protocols, the number of nodes has impact on the number of packets. While increasing the number of nodes, the number of packets is decreasing. But also, the number of received packets for DSR is higher for 5 nodes and 50 nodes comparing to AODV.

C. Packet Dropping Ratio

The packet delivery ratio expresses the packets dropped comparing to the number of packets sent. If this ratio is higher, then the result need improvement.

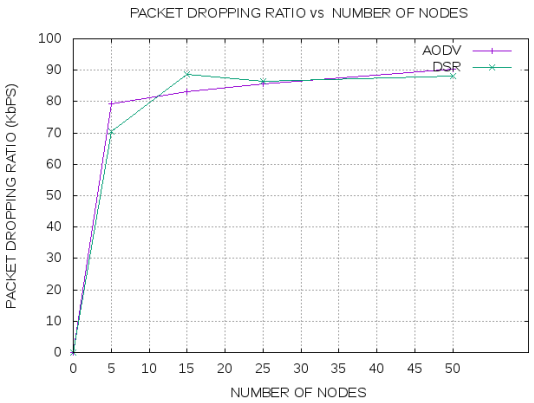

Figure 4: Packet dropping ratio vs number of nodes

For 5 nodes, the ratio is higher for AODV but for 15 nodes, the ratio is higher for DSR. For 25 nodes, the difference for two protocols decreases. Finally, for 50 nodes, the ratio is higher for AODV routing protocols.

D. Packet Delivery Ratio

This is the number of data packets received to the number of data packets sent. If the packet delivery ratio is higher it expresses that the

result is good and the network is reliable.

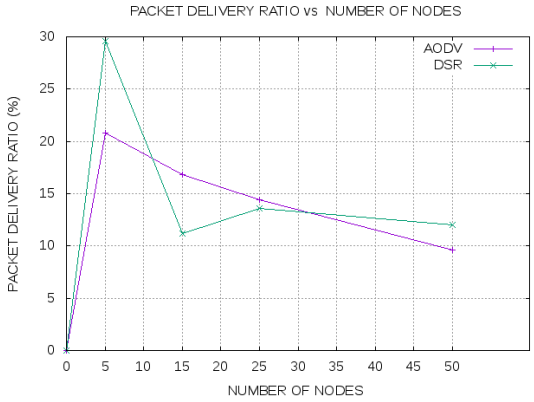

Figure 5: Packet delivery ratio vs number of nodes

The packet delivery ratio is higher for both the protocol AODV and DSR for the 5 nodes network. But, DSR for 5 nodes give a higher packet delivery ratio than the one for ADOV.

E. Normalized Routing Overhead

This is the ratio of number of routing packets to the total number of data packets received. Higher this ratio means routing consumes more bandwidth.

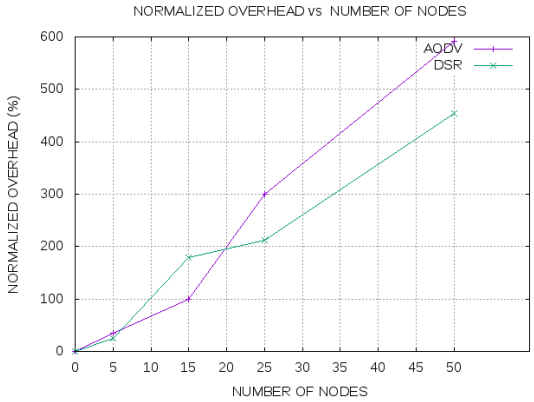

Figure 6: Normalized overhead vs number of nodes

The Normalized routing Overhead is lower for both protocols for 5 nodes network than for 50 nodes network. But there is still difference, for 5 nodes, 50 nodes and 25 the normalized Routing Overhead is higher for AODV. But for 15 nodes, it is higher for DSR.

F. Throughput

This is the average number of bits transmitted per unit time. If the throughput is higher, the result is better.

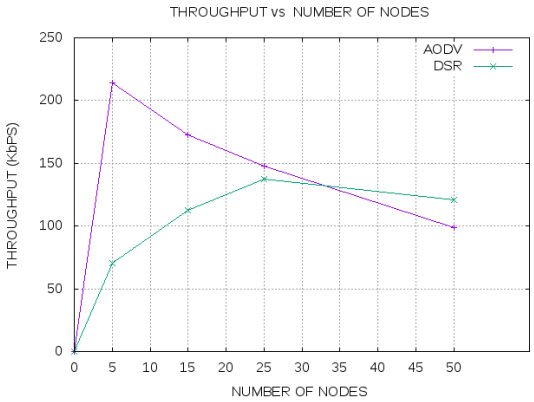

Figure 7: Throughput vs number of nodes

The throughput is higher for 5 nodes network for bother protocols, it decreases when the number of nodes increases. AODV provides good result for small network (5 nodes network) and DSR provides good result for big network (50 nodes).

H. Delay

This is the time taken by packet to reach the destination from source. If the delay is lower, then the result is better.

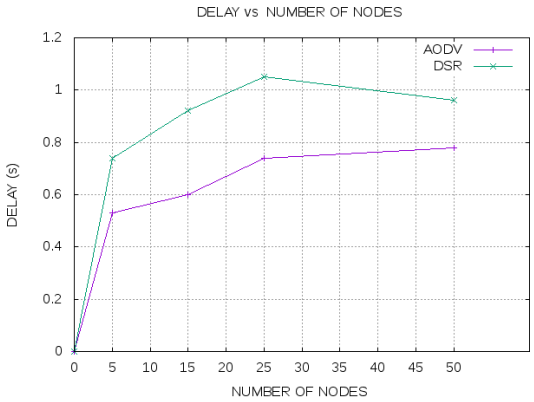

Figure 8: Delay vs number of nodes

The delay for AODV is lower than the one for DSR for all the different networks according to the different number of nodes. So, it can be seen that AODV helps packet to move quickly.

I. Control Overhead

This is the number of routing packets required for data transmission. If this number is lower, the result is better.

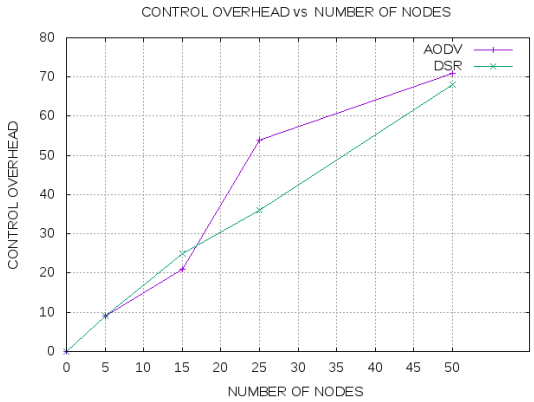

Figure 9: control overhead vs number of nodes

For 5 nodes, the two protocols have the same control overhead. But for 15 nodes network, AODV provides lower control overhead than DSR. AODV provides a higher control overhead for 25 nodes and 50 nodes network.

J. Jitter

This is the difference in packet delay. If the jitter is lower, then there is stability in the network.

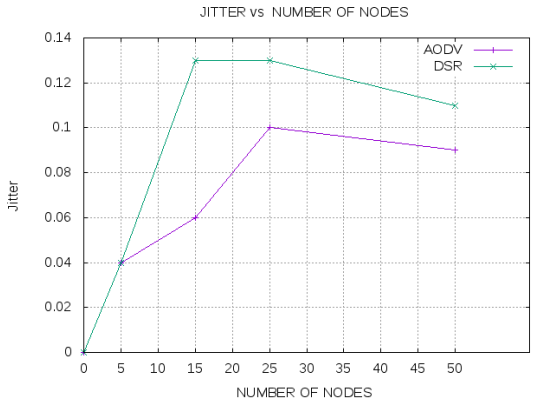

Figure 10: Jitter vs number of nodes

The jitter for DSR is always higher than the one for AODV except the 5 nodes network where the two protocols have the same jitter. So, form this result, AODV is stable compared to DSR.

IV. CONCLUSION

This article has presented an overview of wireless sensor network. The first point was focused on describing the different components of WSN. As a Wireless Sensor Network architecture is made up of nodes, in this part of the work the architecture of node is explained. In addition to this, different communication media used for WSN have been clearly described.

The second part concerns the routing protocols used in Wireless Sensor Network. Routing protocols in WSN can be classified according to different aspects, the one adopted in this article consist of a description based on the network structure. According to the network structure, three different families can be found:

- Location based routing protocol
- Hierarchical based routing protocols
- Data-centric routing protocols

This part has explained a number of protocols, each belonging to a specific family.

The third part of this work presents the performance rating of routing protocols, here two routing protocols of WSN have been considered: AODV and DSR. For performance rating, nine different parameters have been considered: the number of packets sent, the number of packets delivered, the packet dropping ratio, the normalized routing overhead, the packet delivery ratio, the throughput, the control overhead, the delay and the jitter.

For each routing protocol, the simulation has been done using 5 nodes, 15 nodes, 25 nodes and 50 nodes. Using different number of nodes has helped observe trend of a specific parameter depending on the number of nodes. This shows the behavior of specific routing protocol in small scale Wireless Sensor Network compared to the behavior the protocol in question in big scale network. This result is helpful not only for researcher but also for those who want to implement WSN in a specific area and are deciding about which routing protocol to use.

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