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Abstract- Wireless Sensor Networks (WSNs) are charac-terized by multi-hop wireless connectivity, frequently changing network topology and need for efficient routing protocols. The purpose of this paper is to evaluate performance of routing protocol DSDV in wireless sensor network (WSN) scales regarding the End-to-End delay and throughput PDR with mobility factor .Routing protocols are a critical aspect to performance in mobile wireless networks and play crucial role in determining network performance in terms of packet delivery fraction, end-to-end delay and packet loss. Destination-sequenced distance vector (DSDV) protocol is a proactive protocol depending on routing tables which are maintained at each node. The routing protocol should detect and maintain optimal route(s) between source and destination nodes. In this paper, we present application of DSDV in WSN as extend to our pervious study to the design and impleme-ntation the details of the DSDV routing protocol in MANET using the ns-2 network simulator.

Keywords: DSDV; MANET, IEEE802, packet delivery, endtoend delay, packet loss, scalability, WSN wireless sensor network, NS2.34, LR-WPAN.

GJCST-E Classification: F.2.2, C.2.2

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Mohammed Zaid Ghawy [α] & Dr. Maher Ali AL - Sanabani [σ]

Abstract- Wireless Sensor Networks (WSNs) are characterized by multi-hop wireless connectivity, frequently changing network topology and need for efficient routing protocols. The purpose of this paper is to evaluate performance of routing protocol DSDV in wireless sensor network (WSN) scales regarding the End-to-End delay and throughput PDR with mobility factor .Routing protocols are a critical aspect to performance in mobile wireless networks and play crucial role in determining network performance in terms of packet delivery fraction, end-to-end delay and packet loss. Destination-sequenced distance vector (DSDV) protocol is a proactive protocol depending on routing tables which are maintained at each node. The routing protocol should detect and maintain optimal route(s) between source and destination nodes. In this paper, we present application of DSDV in WSN as extend to our pervious study to the design and implementation the details of the DSDV routing protocol in MANET using the ns-2 network simulator. also, the performance of DSDV protocol in sensor network of randomly distributed mobile nodes with mobile source and sink nodes is investigated for MAC IEEE802.15.4 network by ns-2 simulator.

Keywords: DSDV; MANET, IEEE802, packet delivery, end-to-end delay, packet loss, scalability, WSN wireless sensor network, NS2.34, LR-WPAN.

I. Introduction

Wireless Sensor Network (WSN) thus consists of tiny sensor nodes communicating with each other, and deployed from small to large scales. The existing wireless technology is based at the point-to -point technology. This kind of network is used in areas such as environmental monitoring or in rescue operatio ns. Wireless systems, both mobile and fixed, have become an indispensable part of communication infrastructure. Their applications range from simple wireless low data rate transmitting sensors to high data rate real-time systems such as those used for monitoring large retail outlets[1].

The destination-sequenced distance vector (DS DV) routing protocol is a proactive routing protocol which adds a new attribute, sequence number, to each route table entry at each node. Routing table is maintained at each node and with this table; node transmits the packets to other nodes in the network. This protocol was motivated for the use of data exchange along changing and arbitrary paths of interconnection which may not be close to any base station. The motivation for choosing a DSDV routing protocol for our research comes from the fact that many routing protocols are based on DSDV such as AODV [3]. In addition, several routing protocols have been proposed [4], [5], [6], [7], [8], [9], [10], [11], [12] to improve the performance of DSDV. DSDV routing protocols are considered more reliable and robust. Furthermore, in DSDV protocol, whenever a link failure is detected in a primary route, the source node can select the best route. This mechanism enhances route availability and consequently reduces control overhead, saves energy, enhances data transmission rate, and increases the network throughput .

For these reasons, proactive DSDV routing protocol is useful for the use to many applications in MANETs of data exchange along changing and arbitrary paths of interconnection without need to any base station and achieve high quality of service (QoS) in terms of packet delivery ratio and end-to-end (E2E) delay to support multimedia applications over MANETs, such as real-time traffic as visitor tracking sensor, load balancing. Some real time applications required DSDV protocol behavior such as Follow me, Multimedia guide book, Visitor tracking, Sensor network IEEE 802.15.4 LR-WPAN.

The primary objective of this article are: Firstly, evaluating the performance of DSDV in WSN as extend to our pervious study that it analyses performance , design and implementation in details of the DSDV routing protocol in MANET as in [2] using the ns-2 network simulator. Where what are we presenting in this paper it was not applied in [2]. So, The performance metrics evaluated in terms diffe- rent network metrics such as, number of nodes and network dynamicity in terms of node speed and pause time. Secondly, the application of DSDV we envisaged is called the monitor sensor system – involved tracking the approximate location of several mobile nodes in a small building, and feed information on location and direction of each node to a single central sink. It was required that the user at the central sink receive alerts if any mobile node approached restricted areas within the building. However, the DSDV protocol is a

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proactive protocol, and for this reason, the DSDV routing protocol was used to communicate nodes location information to the sink node. Thirdly, the application's performance achieved by analyzes and evaluate of DSDV protocol in terms of throughput, delay and packet delivery ratio. The problems that DSDV faced in this application presented.

The rest of the paper is organized as follows: Section 2 begins with knowledge information about some the applications of DSDV in different approach. Section 3 presents the following methodology and procedures of previous and current our study. Section 4 discusses of tools and the simulation environment. Section 5 describes Network Topology and Device Architecture in a LR-WPAN and scenarios. Section 6 and Section 7 describes the simulation parameter used to analysis and running of program in ns2. Section 8 discuss the results, evaluates the performance of DSDV protocol. The paper is concluded along with future works directions in section 9.

II. Application of DSDV Protocol in WSN

Potential WSN applications include security, traffic control, industrial and manufacturing automation, medical or animal monitoring [13]. The WSN nodes can also be used to monitor dangerous or inaccessible environments, such as volcanoes, toxic regions, the deep ocean or the lunar surface. These small nodes can be fixed, mobile or move together with the observed phenomenon (e.g. sensing animal movements or hurricanes).

The purpose of this paper is to evaluate DSDV routing protocol in wireless sensor network (WSN) as Wireless Personal Area Networks (WPAN) scales regarding the packet delivery ratio , the average end-to end delay and throughput and other parameter is will presented as list as will we see. However, many Ad hoc routing protocols are proposed for WSNs due to their quick and economically less demanding deployment. DSDV and AODV are good examples of Ad hoc protocols that are proposed and implemented in WSNs [14].

a) *Applications DSDV routing protocol in MANET*

There are however sensor applications that are designed with mobile ad-hoc routing protocols. Destination Sequenced Distance Vector (DSDV) is a candidate routing algorithm for many sensor applications like the "Follow me" application that guides visitors to the location of a building or an application to assist workers in finding conference rooms [15].

Both applications could be also used in outdoor sites such as archaeological sites, where no infrastructure exists. Another application of DSDV protocol is the Multimedia Guidebook [16], which is based on sensors communicating through an Ethernet to provide multimedia information via Bluetooth to the user's mobile device. If the Ethernet is substituted with a wireless 802.11b network then the application can be deployed to outdoor archaeological and tourist sites, especially when the sites are expanding for areas of many km^2.

b) *DSDV applications in Visitor Tracking System (VTS)*

The application we envisaged-called the Visitor Tracking System-involved tracking the approximate location of several mobile nodes in a small building personal area, and feed information on location and direction of each node to a single central sinks. It was required that the user at the central sink receive alerts if any mobile node approached restricted areas within the building, from [17].

c) *Sensor network IEEE.802.15.4 RL-WPAN*

The IEEE 802.15.4 standard [18] defines the physical layer (PHY) and medium access control (MAC) sub-layer specifications for Low Rate - Wireless Personal Area Networks (LR-WPANs), low power consumption and low cost applications. The standard MAC protocol supports two operational modes, either beacon enabled or non beacon-enabled. When using a beacon, the transmitssion is based on super frames slotted CSMA-CA. For the non beacon mode, the messages will be directly transmitted in an unspotted CSMA-CA, from [19]. The IEEE 802.15.4 standard is being designed to be used in a wide variety of applications which require simple wireless communications over short-range distances with limited power and relaxed throughput needs. IEEE 802.15.4 facilitates Wireless Sensor Networks (WSNs) with the goal of reducing the installation cost of sensors and actuators while enabling sensor-rich environments.

III. Methodology

To achieve primary objectives, the following tasks must be done: Firstly, get a general understanding of MANETs, simulation environment that could be used for analyzing, evaluating and implementing MANETs' protocols, understanding DSDV source code to know how DSDV protocol mechanism. Then, analyze the protocol theoretically and through simulation based on above mentioned performance and network metrics. The research methodology used is simulation-based prototyping. That is, designed and implemented the routing protocol that extends the well-studied DSDV protocol. Then evaluation of protocol in life as WSN application. We revise the protocol based on these performance metrics to produce the final protocol DSDV. As in Fig 1, shows the research methodology used in this research and it taken from initial previous our study by Gawiy in [2].

Simulation in general and the NS2 simulator in particular are widely used to evaluate network protocols. They have significant advantages over other methodologies such as direct experiments and mathematical modeling. A computer simulation is an application designed to mimic a real-life situation .

One of the advantages of simulators is that they are able to provide our with practical feedback when designning real world systems. Consequently, we as designners can determine the correctness and efficiency of a design before the system is actually constructed. The simulators permit our to study a problem at several different levels of abstraction. By approaching a system at a high level of abstraction, we can understand the behavior and interactions of all components of this protocol, and is therefore better equipped to counter the system's complexity. One of the disadvantages of using a network simulator for testing a distributed application system from the fact that there is no real network involved in the simulation [2].

Indeed industry standard tools like NS2 have emerged to meet this need. This study follows this practice.

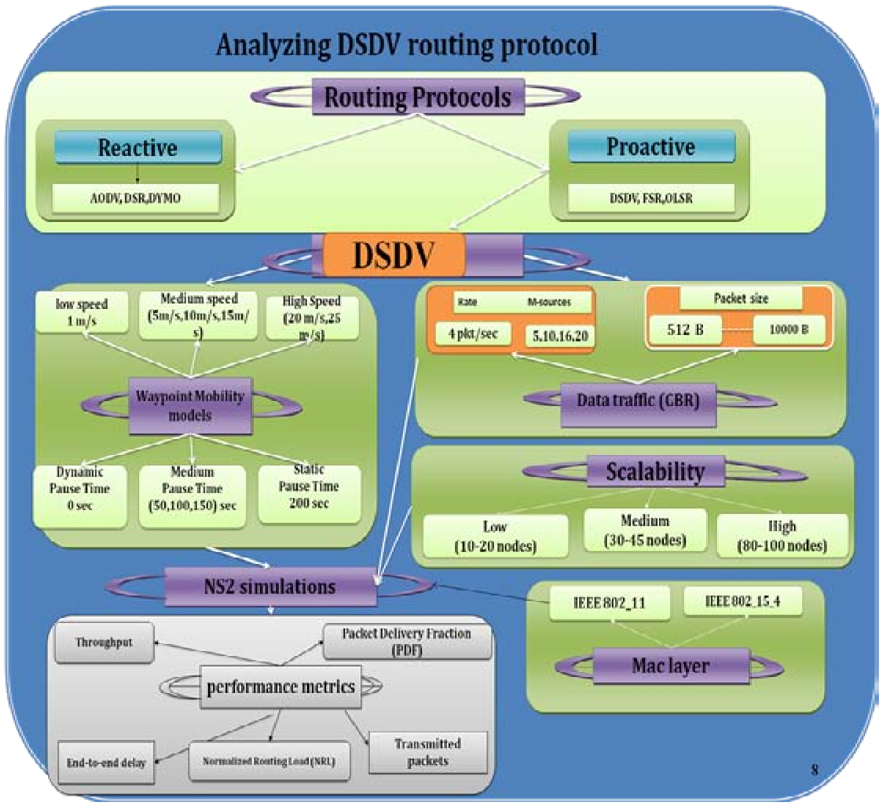

Figure 1: The analysis study and implementation study of DSDV in brief

IV. Simulation Environment

NS2.34 network simulator [20] is used to evaluate the proposed DSDV. The simulation scenario topology consisting of number of nodes and their connectivity and was created by topology generators GT-ITM [21].

The goal of our simulations in this paper is study and evaluation and measure the ability of DSDV routing protocol to react to multi-hop ad-hoc network topology changes with. IEEE 802.15.4 standard and comparison of performance metric based on following network metrics, number of nodes, pause time of mobile nodes movement, speed of nodes mobility. To run the simulation experiments, our basic methodology is to define a set of movement scenarios and communication patterns and apply them to MANET. In fact, testing with each data packet originated by a sender mobile node, whether the DSDV routing protocol is able to route and deliver it to the destination node.

a) Working environment

- Operating System: Ubuntu10.10 (Linux).
- Patch used: Mannasim [24] Patch with ns-allinone-2.34[20] for WSN simulation.
- NS version: ns-allinone-2.34.
- Various packages and scripts: NAM 1.14, Awk 3.1.6, tcl8.4.18, Tracgraph 2.02,gnuplot 4.0.

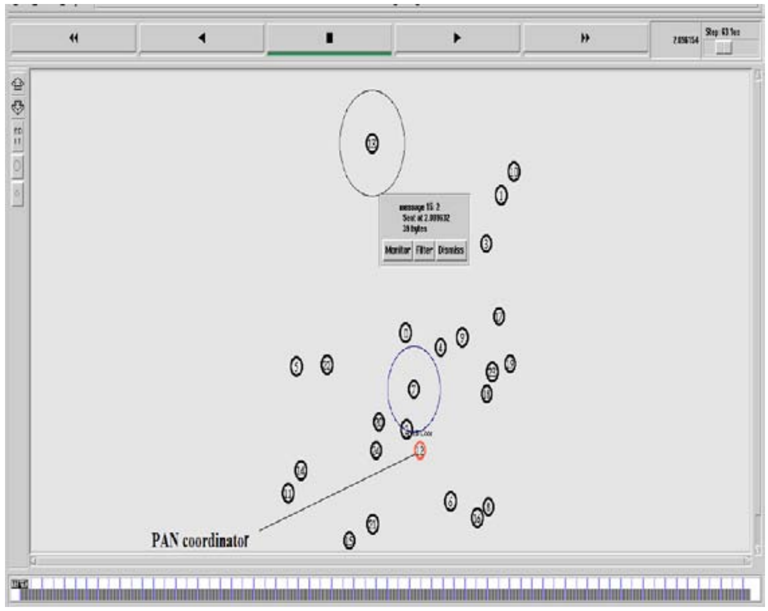

Figure 2: Initial modes movements before the nodes associates with its coordinator at time 2 sec

V. Network Topology and Device Architecture

Devices in a LR-WPAN scenario can be of 3 types, PAN Coordinator, full function device (FFD) or a reduced function device (RFD) [22]. Devices that participate are FFD or RFD. Each RFD can only associate with a single FFD at an instance whereas FFDs can communicate with other FFDs or RFDs. A FFD contains the complete set of MAC services and is able to operate as a network coordinator or a network device. On the contrary, a RFD is simply a network device with a reduced set of MAC services and usually used for simple applications. In fig. 2 with this topology, communication is established between devices by a single mobile controller known as the PAN coordinator (this is nod 12 shown in scenario fig 2). The PAN coordinator (which is a FFD) acts as a hub that forms direct links to other devices. These devices, consisting of FFDs or RFDs, from around the PAN coordinator and act as data terminal locations (sensors). This topology simplifies routing and reduces direct links at the expense of data traffic latency.

In the scenario showed as in fig. 3, each node connected with the central coordinator considered secondary Coordinator for node farther out as well as this node if it succeeds in sync link with the secondary coordinator is like the farthest coordinator of the central coordinator. If node works in contact, they transmit information owned by other nodes and so are transfers information between the wish to reach even the central coordinator, which is regarded as the sink or destination for the entire network and the rest of the nodes is the source for the transfer of information

Because DSDV protocol is proactive any it cares greatly providing availability and keep topology of network exposed to all node. All node have information about the location nodes other in network so this protocol does not require a delay is needed to rediscover the path to the target as long as it always update routing table .for This that DSDV useful so in such applications.

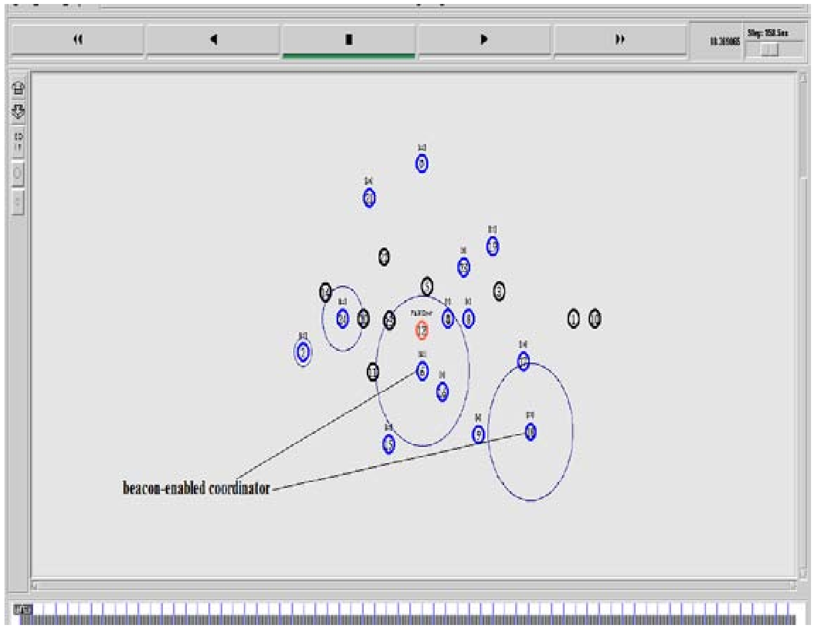

Figure 3: Movement after the node associates with its coordinator

The implementation of non beacon-enabled mode in mobile ad-hoc sensor networks is not suitable because the non beacon enabled mode does not send a beacon periodically, thus the node (node 11 as in fig 4) will assume it's association is always preserved although it may have moved away from the coordinator and lost the link. If this happens, the moving node stops

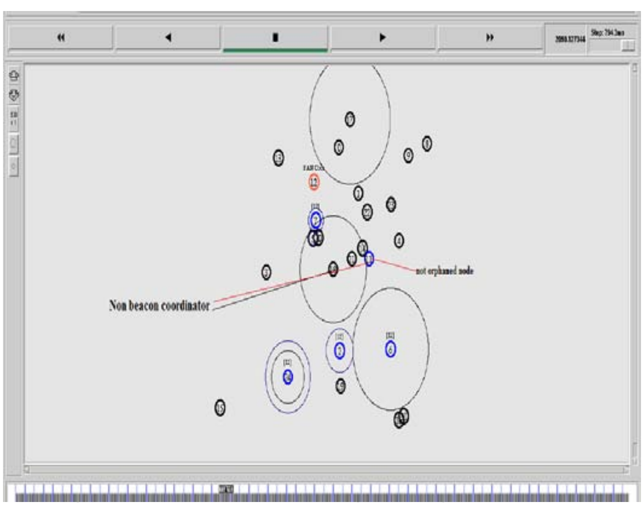

Figure 4: Fast moving lost synchronization

its attempt to associate with other coordinators because it does not consider itself an orphan node. Thus, it will be difficult for the nearest coordinator to detect this node. In this network the DSDV protocol in very good way periodically or incremental updates messages is transmitting between the nodes to maintain network topology as it theses the node moving in network area.

The flow of node association and synchronization is given in Fig. 5. The node starts association with an active scan procedure that scans all listed channels by sending beacon requests to all nearby coordinators. All the information received in a beacon frame will be recorded in a PAN descriptor.

The results of the channel scan will be used to choose a suitable PAN. The node then sends a request to associate with the chosen coordinator. The node updates its current channel and PAN id while waiting for an acknowledgement from the coordinator. Upon receiving an acknowledgement, the node then waits for the association results. The coordinator will determine whether the current resources are available on the PAN in order to allow the node to associate. If sufficient resources are available, the coordinator then allocates a short address to the node and sends an association response command containing a new address and a status indicating a successful association[19]. If there are not sufficient resources, the node will receive an association response command with a failure status.

VI. Performance Analysis

In practice, node movements in the PAN will result in the network having to re-learn new routes. Several experiments are conducted to analyze and evaluation the behavioral response of DSDV in the Mac/IEEE 802.15.4 network. The DSDV protocol presents a stability at the power consumption as it has a mechanism of finding a valid route be using a technical which exchanges routing messages between nearby mobile nodes. Essentially, the influence of mobility, dropped packets by node and network loading on the network will be considered. In particular, the network's packet delivery ratio, delay and data throughput performance are measured with specific transmission rates. The performances resulting from the metrics are presented with moving scenarios. To increase then confidence level of the results, a set of simulation parameters are performed with various random seeds for the data transmission.

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VII. Simulation Setup and Parameters

Depending on the WSN operating requirements nd environment, there has to be compromises between the node transmission range, operational lifespan and device cost. The transmission range can be determined from two-ray ground reflection models which relates the maximum range to the antenna gain, transmit power and receiver sensitivity. The data traffic type is CBR with the application agent sending at a rate of 4 data packets per second continuously. The nodes

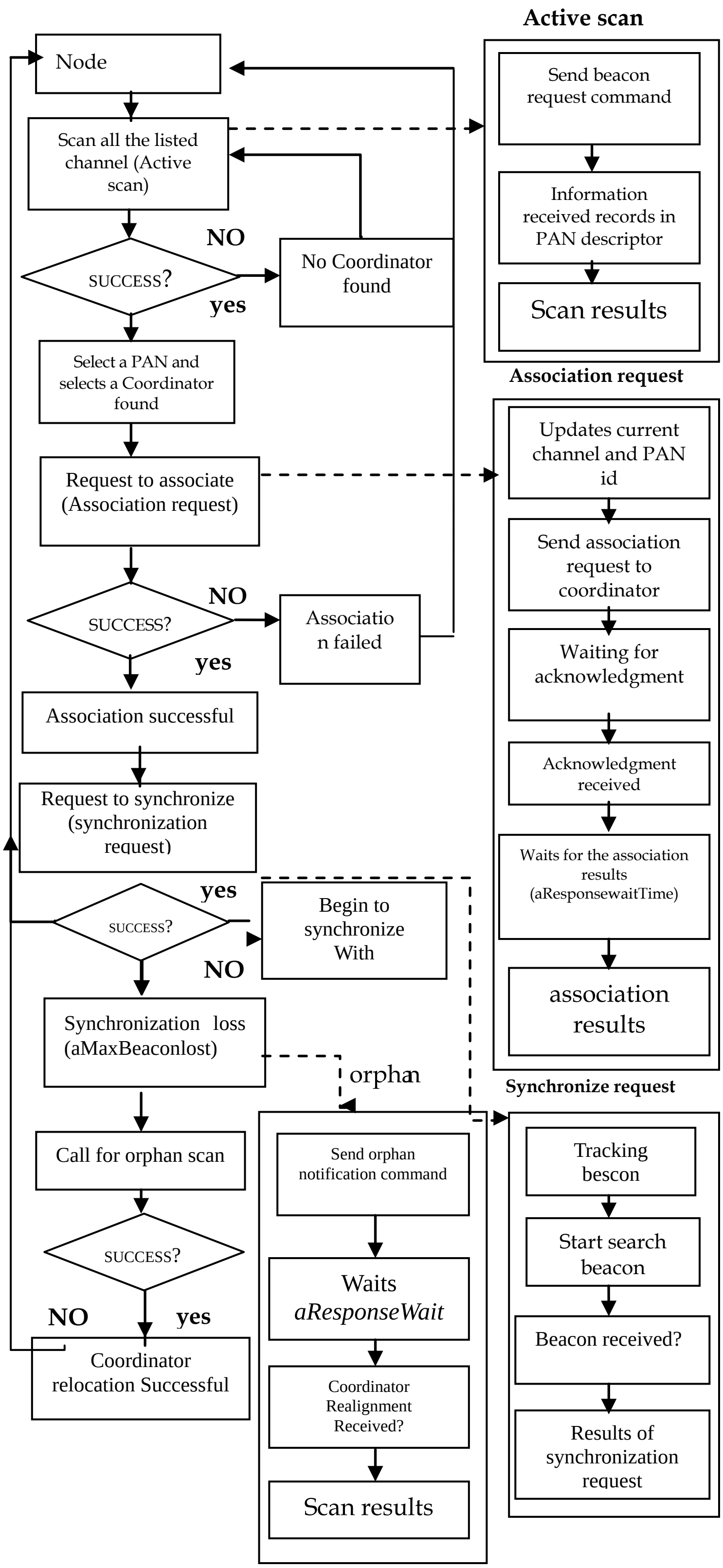

Figure 5: Flow of node association and synchronization(19)

used in the simulation will movement and placed at random position generated by setdest in ns-2.

The centre node is designated the PAN coordinator with all other nodes randomly transmitting data packets to the PAN coordinator. The speed and heading of each node will vary according to the generated movement scenario with a maximum simulation runs of one hour. The simulations are

During the simulation, certain behaviors are exhibited by the nodes if communication cannot be established with the coordinator. When a node losses synchronization, orphan-scanning is performed to relocate the coordinator. When coordinator relocation is successful, communication will resume. If relocation of the coordinator fails, node will subsequently perform active channel scan to send association request to the PAN coordinator. Upon successful association, the node begins to transmit beacons and start data transmission. Else, non-beacon mode is enabled for that node.

Table 1: Simulation Parameter

Parameter	Value
Topology	Random
Number of Nodes	25
PAN coordinator location	random
Area of simulation	500 m*500 m, wide
Simulation time	3600 second
No. of sink (destination)	One (Node 12)
No. of sources	20 sources (Node 0 to20 except node 12)
Speed	Varying from 0.006m/s 0.47m/s(ocean env)
Pause Time	300 second
Traffic Type	Constant Bit Rate (CBR)
Data packet length	70 bytes
Connection Rate	0.05 to 4 packets per second
Routing protocol	DSDV
Radio-propagation model	TwoRayGround
Interface queue type	DropTail/PriQueue
Maximum packet in Queue	150
Network interface type	Phy/WirelessPhy/802_15_4
MAC type	Mac/802_15_4
Antenna type	OmniAntenn
Transmitting Power(pt_)	0.001 Watts
receiver threshold (RXThresh_)	3.981e-13 Watts
capture power threshold(CPThresh_)	10 dB
carrier sensing threshold(CSThresh_)	3.981e-13 Watts
Operating Freq(freq_)	2.4e+9 GHz
System loss factor(L_)	1.0
Bandwidth	10 Mbps

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VIII. Simulation Results and Discussion

a) *The packet delivery ratio*

In DSDV, if it is not possible for the packets to be delivered, DSDV tries to drop them which means a lesser PDF as well as less delay Furthermore, DSDV is a table-driven protocol and updates its table periodi- cally which leads to an increase in the routing load in the network and less PDF in movement with high spe- ed, but in this simulation and as we seed in previous scenarios that DSDV protocol with low speed net work perform high throuput and PDF nearly to 100%. As ocean environment speed of sensor node slow ly movi- ng has 0.47 m/sec based ocean speed, then DSDV algorithm has better packet delivery rate as in fig 6. In contrast, pdf in DSDV is 50 % at time 5.47 sec and increases by approximately 98% at time between 5.5 to 70.46 sec. then pdr take in constant from at time between 80 to 125.11,so pdr at time 125.11sec become 99 % .

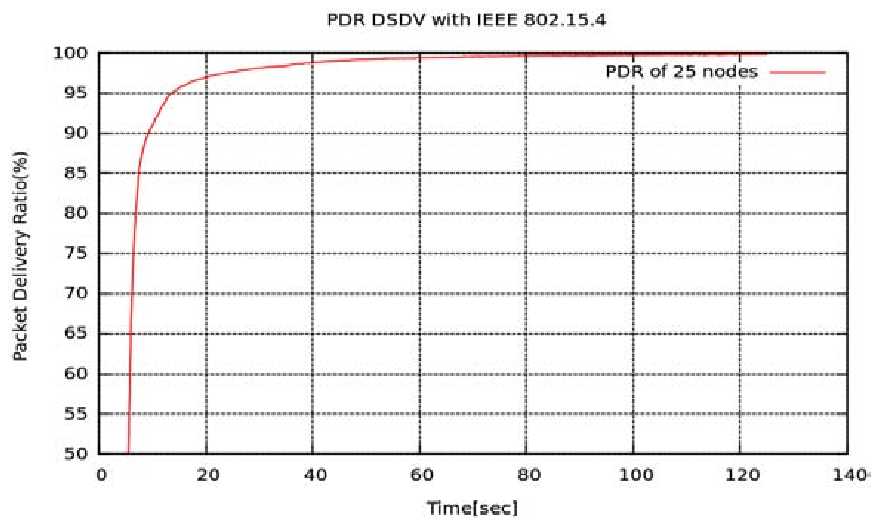

Figure 6: Packet delivery ratio vs simulation time

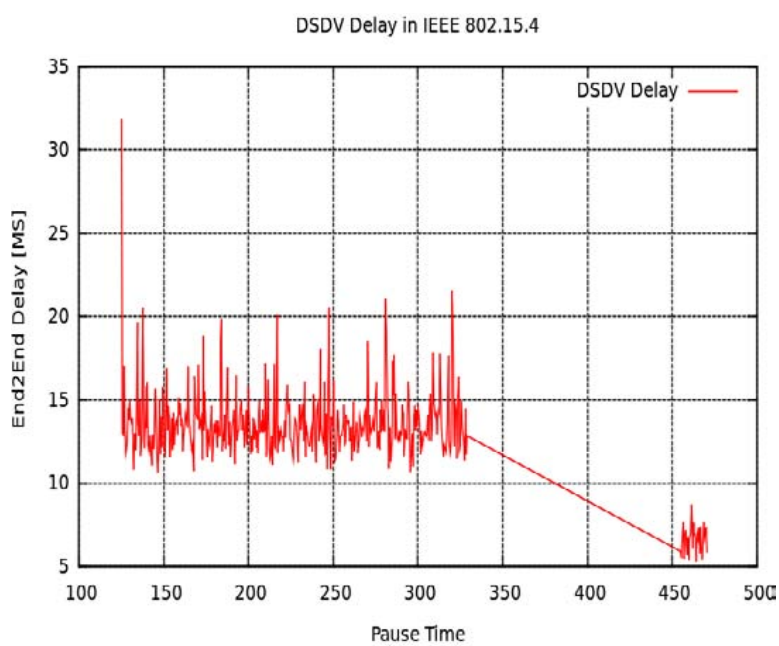

Figure 7: Ave End 2 End Delay vs Movement in Time

b) End-to-End delay

These graphical results from fig. 7 are measurement of Delay extremely powerful. It shows that End-to-End delay in IEEE 802.15.4 with DSDV is lowest as compared with the other routing protocols we are see them in several researches as in [23] .

This shows that for delay-sensitive applications, DSDV protocol with IEEE 802.15.4 standards is remarkably well suitable. This attribute can be explainned by the fact that DSDV is a proactive routing protocol and in these types of protocols the path to a destination is immediately available. In other words, there is no delay caused by routing discovery. Furthermore, DSDV routing protocol tries to drop the packets, if it is not possible to deliver them which means less delay.

c) The Throughput

The network throughput in general, increases steadily over the entire simulation time. DSDV attains the highest throughput and shows efficient behavior in all mobility scenarios. The reasons for this good throughput include: firstly, when the first data packet arrives, it is kept until the best route is found for a particular destination. Secondly, a decision may delay to a decision may delay to advertise the routes which are about to change soon, thus damping fluctuations of the route tables. The re-broadcasts of the routes with the same sequence number are minimized by delaying the advertisement of unsterilized routes. This enhances the accuracy of valid routes resulting in the increased throughput of DSDV in 4 packet/sec of mobility rate, as depicted in Fig.8

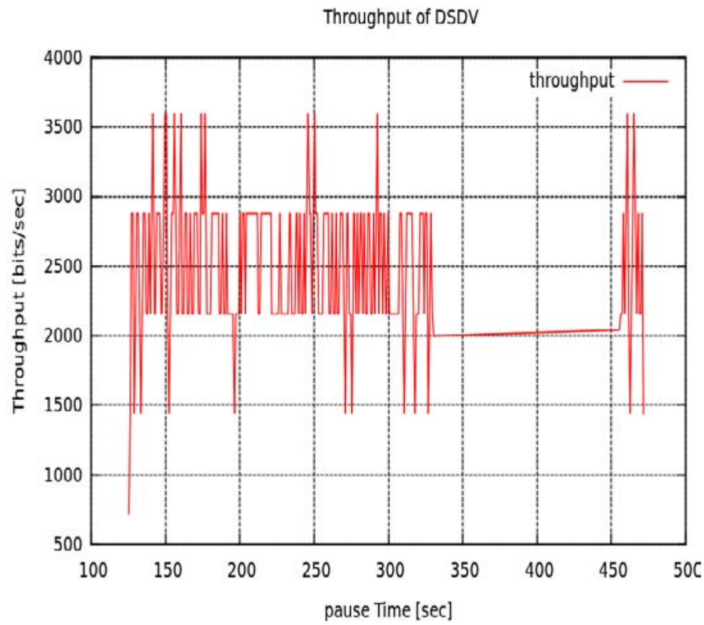

Figure 8: Results of Network Throughput with Node Movement of Time

Table 2: QoS parameter results of DSDV on IEEE.802.15.

NO.	Parameter	value
1.	No. of CBR Packets Generated	86314 packets
2.	No. of CBR Packets sent	83166 packets
3.	No. of CBR Packets received	84821 packets
4.	No. of routing packets	3104 packets
5.	Total No. of MAC Packets sent	36056 packets
6.	Total No. of Fwd packets	398 packets
7.	Total No. of Dropped (packets	259748 packets
8.	Packet Delivery Ratio (PDR %)	99.989996 %
9.	Network Throughput	1.536942 kbits/sec
10.	Average node Throughput	38.423553 kbits/sec
11.	Normalized routing load	3.659471 packets %
12.	Average end to end delay	13.065065 ms

IX. Conclusion and Future Woke

Since The IEEE 802.15.4 standard is being designed to be used in a wide variety of applications which require low send rates over short-range distances with limited power and relaxed throughput needs. This consider problem for routing protocols when need to transmitting of large routing packet especially in network that contain large number of mobile hosts. thus , Because full dump packets that generated by DSDV to routes update and by progress of simulation time in pervious sensor scenario then routing tables at each node become large to maintain all topology of network and this require large bandwidth to exchange these packets . As resulting of that much dropped packet will occur because The IEEE 802.15.4 not enabled large packets transmission.

To this cause PDF of DSDV with progress of simulation time take in decrease. So, the problems in this protocol will taken consideration and The performance comparison with other routing protocols can be done in different classes of parameters and operating conditions, which will be useful for actual deployment of sensor network in particular application of industrial control.and improvement of DSDV protocol to achieve high QoS in terms of packet delivery ratio and end-to-end delay to support multimedia applications by this protocol over WSNs.

References Références Referencias

1. Venetis Kanakaris, David Ndzi, and Kyriakos Ovaliadis." *Applications of MANET Routing Protocols in Sensor Network*" .Department of Electronic and Computer Engineering, University of Portsmouth,

Portsmouth, United Kingdom. International Journal of Research and Reviews in Ad hoc Networks (IJRRAN) Vol. 1, No. 4, December 2011, ISSN: 2046-5106 © Science Academy Publisher, United Kingdom, www.sciacademypublisher.com .

2. Mohammed Gawiya, Abdullah Al-quha, Ali Al Iathaaa, Zaid Amrana andMohammed Al-Hubaishi. ;"*Performance Analysis of Destination Sequenced Distance Vector RoutingProtocol in MANET*". International Journal of Ad Hoc, Vehicular and Sensor Net works.
3. C. Perkins, E. Belding-Royer, and S. Das, "*RFC3561: Ad hoc ondemand distance vector (AODV) routing*". Available: http://www.ietf.org/rfc/rfc3561.," ed, July 2003.
4. S. Ahn and A. U. Shankar, "*Adapting to route-deman d and mobility in ad hoc network routing,*" Computer Networks, vol. 38, pp. 745–764, April 2002.
5. U. Lee, S. F. Midkiff, and J. S. Park, "*A proactive routing protocol for multichannel wireless ad-hoc net works (DSDV-MC),*" in IEEE International Conference on Information Technology: Coding and Computing (ITCC 2005) Las Vegas, NV, United states, April 2005.
6. Boukerche and S. K. Das, "*Congestion control performance of RDSDV protocol in multihop wireless ad hoc networks,*" Wireless Networks, vol. 9, pp. 261–270, 2003.
7. R. R. S. Kumar, and D. Pandey, *"OPR: DSDV Based New Proactive Routing Protocol for Ad-Hoc Networks,*" in International Association of Computer Science and Information Technology – Spring Confe rence (IACSIT-SC 2009), Singapore, April 2009, pp. 204–207.
8. R. U. Z. K.U.R. Khan, A.V. Reddy, K.A. Reddy, and T. Harsha, "*An Networks and its Performance Comparison,*" in The 2nd UKSIM European Symposium on Computer Modeling and Simulation, Liverpool, United kingdom, September 2008, pp. 506–511.
9. T. Liu and K. Liu, "*Improvements on DSDV in mobile ad hoc networks,*" in International Conference on Wireless Communications, Networking and Mobile Computing (WiCom 2007), Shanghai, China, September 2007, pp. 1637–1640.
10. T. T. Luong, B. S. Lee, and C. K. Yeo, "*Dual-interface multiple channels dsdv protocol,*" in 5th IEEE International Conference on Wireless and Mobile Computing Networking and Communication, WiMob 2009, Marrakech, Morocco, October 2009, pp. 104–109.
11. T. T. Luong, B. S. Lee, and C. K. Yeo, "*Channel allocation for multiple channels multiple interfaces communication in wireless ad hoc networks,*" in The 7th international IFIP-TC6 networking conference on AdHoc and sensor networks, Singapore, May 2008, pp. 87–98.
12. S. Chang, W. Ting, and J. Chen, "*Method for Reducing Routing Overhead for Mobile* Ad Hoc Network*,*" in IEEE International Conference on Wireless Communications and Signal Processing (WCSP 2010), Suzhou,China, October 2010.
13. IEEE Std 802.15.4TM " 2003, Part 15.4: *Wireless Medium AccessBControl (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)*, Institute of Electrical and Electronics Engineers, 2003.
14. Yadav,N. and Yadav ,R. (n.d). "*The Effects of Speed on the Performance of Routing Protocols in Mobile Ad-hoc Networks*". International Journal of Electronics, Circuits and Systems Volume 1 Number 2.
15. W. S. Conner, J. Heidemann, L. Krishnamurthy, Xi Wang, and M.Yarvis, "*Workplace Applications of Sensor Networks,*" In Wireless Sensor Networks: A Systems Perspective, Nirupama Bulusu and Sanjay Jha (eds.), Artech House, August 2005 (to appear).
16. M. Ros, M. D'Souza, M. Chan, K. Bialkowski, A. Postula, N. Bergmann, and A. Toth, *"Using Wireless Sensors as Selection Devices for a Multimedia Guidebook Scenario",* In Proc. RealWSN ,Workshop on Real-World Wireless Sensor Networks, Stockholm, Sweden, 20-21 June 2005.
17. Siddhu Warrier*," Characterisation and Applications of MANET Routing Algorithms in Wireless Sensor Networks"*, Master of Science School of Informatics,University of Edinburgh,2007.
18. IEEE Std 802.15.4TM " 2003, *Part 15.4: Wireless Medium Access B Control (MAC) and Physical Layer (PHY) Specifications for Low-Rate Wireless Personal Area Networks (LR-WPANs)*, Institute of Electrical and Electronics Engineers, 2003
19. Zen, K., Habibi, D., Rassau, A. M., & Ahmad, I." *Performance Evaluation of IEEE 802.15.4 for Mobile Sensor Network*". Proceedings of 5th IFIP International Conference on Wireless and Optical Communications Networks. WOCN '08. (pp. 1-5). Surabaya, East Java Indonesia. IEEE Press. (2008) http://ro.ecu.edu.au/ecuworks/1175.
20. NS2, "Network Simulator 2(Ns2) http://www.isi.Edu /nsnam/ns/," ed.
21. h. w. c. g. e. f. E. Z. g. h. "*Georgia Tech Internetwork Topology Models (GT-ITM) homepage*", ed.
22. K. Y. Lim*," a performance analysis of an ad-hoc ocean Sensor network".* Civilian, Singapore Technologies Dynamics Pte Ltd, University of Sheffield, United Kingdom, December 2006.
23. D.D.Chaudhary (Member IACSIT), Pranav Pawar, Dr. L.M. Waghmare*," Comparison and Performance Evaluation of Wireless Sensor Network with different Routing Protocols".* Aalborg University, Denmark. International Conference on Information and Electronics Engineering IPCSIT vol.6 (2011) © (2011) IACSIT Press,Singapor.
24. Mannasim Framework, a module for WSN simulation,http://www.mannasim.dcc.ufmg.br/