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Study the variation of the energy and packet size in new model of AODV protocol in mobile environment

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Abstract. A mobile ad-hoc network or MANET is a very hot topic at the moment and is already expanding greatly in use. It has a lot of applications and many good reasons for its popularity.
The obvious problem with ad-hoc networking is how to send a message from one node to another with no direct link.
This is the problem of routing. Because the nodes in the network are moving around unpredictably, after adapting a known routing protocol AODV, and studying its scalability, we would like in this paper to study the energy consumption with varying the size of the packet data and the number of node.

Keywords: Mobile node, ad-hoc, AODV, energy, packet size.

1. Introduction

Wireless communications is the fastest growing segment of the communications in these last years. Many new applications, including wireless sensor networks, are emerging from research ideas to concrete systems. The Wireless Sensor Network (WSN) is consist of a large number of autonomous nodes equipped with sensing capabilities, wireless communication interfaces, and limited processing and energy resources.
In Wireless Sensor Networks, WSNs, nodes are unattended. They are distributed across an area of interest and communicate among themselves in multiple hops, building an ad-hoc network. Nodes have limited and non-replenishable energy resources. There are special nodes named sink (or gateway) nodes, which are responsible for processing and storing the information collected by the network [4].
Energy is a factor of outmost importance in WSNs. To increase network lifetime, energy must be saved in every hardware and software solution composing the network architecture.
This article develops a model for the multi-hop communication in a linear array of nodes. Energy consumption in the various multi-hops scenarios has been proposed, simulated and analyzed.

2. Wireless Sensor Network

2.1. Introduction and Definition

The WSNs are under development because of their flexibility in interface, which makes possible to a user to easily change place in its company.

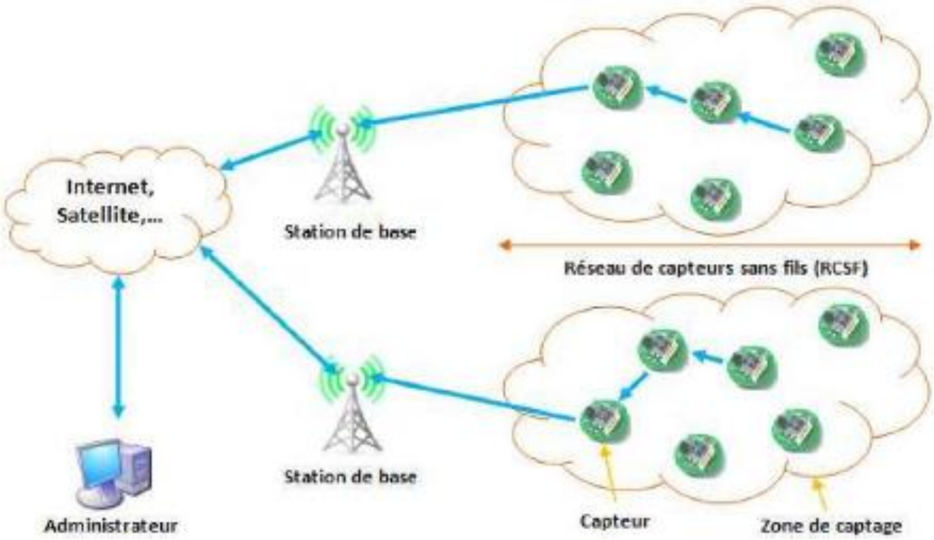


Fig.1 Wireless Sensor Network

The communications between final equipment can be carried out directly or not by the base station.
A Wireless Sensor Network [1] (fig.1) (WSN) is an ad hoc network with a great number of nodes which are micro-sensors and able to collect and to transmit environmental data in an autonomous way. The position of these nodes is not obligatorily predetermined. They can be dispersed in a geographical area. The objectives of the WSNs are multiple according to the treated applications, such as:

1) Determinate the values of some parameters according to a given situation. For example, in an environmental network, we can know the temperature, the atmospheric pressure, the quantity of the sunlight, and the relative humidity in a number of sites, etc.
2) Detect the occurrence of the events and estimate their parameters.

2.2. WSNs Applications

WSN have found application in a vast range of different domains, scenarios and disciplines [2]:

1) Environmental/Earth monitoring: The term Environmental Sensor Networks, has evolved to cover many applications of WSN to earth science research. This includes sensing volcanoes, oceans, glaciers, forests, etc.
2) Data logging: Wireless sensor networks are also used for the collection of data for monitoring of environmental information; this can be as simple as the monitoring of the temperature in a fridge to the level of water in overflow tanks in nuclear power plants. The statistical information can then be used to show how systems have been working. The advantage of WSN over conventional loggers is the "live" data feed that is possible.
3) Agriculture: Using wireless sensor networks within the agricultural industry are increasingly common; using a wireless network frees the farmer from the maintenance of wiring in a difficult environment. Gravity feed water systems can be monitored using pressure transmitters to monitor water tank levels, pumps can be controlled using wireless I/O devices and water use can be measured and wirelessly transmitted back to a central control for billing.
4) Water/Wastewater Monitoring: There are many opportunities for using wireless sensor networks within the water/wastewater industries. Facilities not wired for power or data transmission can be monitored using industrial wireless I/O devices and sensors powered using solar panels or battery packs. As part of the American Recovery and Reinvestment Act (ARRA), funding is available for some water and wastewater projects in most states.

3. « Prefetching » data in mobile environment: Routing and Storage [13] in WSNs [3]

Routing in a MANET is fundamentally different from traditional routing found on infrastructure networks. Routing in a MANET depends on many factors including topology, selection of routers, and initiation of request and specific underlying characteristic that could serve as a heuristic in finding the path quickly and efficiently.
One of the major challenges in designing a routing protocol for Ad Hoc networks system from the fact that, on one hand, a node needs to know at least the reach ability information to its neighbors for determining a packet route and, on other hand, the network topology can change quite often in an Ad Hoc network. Some ad hoc network routing protocols: DSR [4], DSDV [5], AODV [5].
Ad Hoc routing protocols can be broadly classified as being Proactive (Table-Driven) or Reactive (On-Demand).

Proactive and Reactive Routing Protocols [Table 1]:

In a **Proactive routing protocol**, all the routes to each destination are kept in an up-to-date table. Changes in the network topology are continually updated as they occur.

Reactive routing protocol [Table 1]:

In the **Reactive routing protocol**, a connection between two nodes is only created when it is asked for by a source. When a route is found, it is kept by a route maintenance procedure until the destination no longer exists or is indeed.
The following Table1 presents a comparison between proactive and reactive routing protocols.

Table1. Comparison between proactive and reactive routing protocols

Protocol	**Proactive**	**Reactive**
Advantages	A route can be selected immediately without delay	Lower bandwidth is used for maintaining routing tables. More energy-efficient Effective route maintenance
Disadvantages	Produces more control traffic Takes a lot more bandwidth Produces network congestion	Have higher latencies when it comes to route discovery

3.1. *AODV (Ad hoc On-Demand Distance Vector Routing)*

AODV is an improvement of DSDV. Since it is on demand routing information between nodes that never communicate will not be considered. When one node is to communicate with another and it doesn't know of a route, it broadcasts a route request RREQ to all neighbors. The RREQ is forwarded until it reaches its destination or it finds a node with a fresh enough route to the destination.
AODV (fig.2) uses destination sequence numbers to make sure all routes are loop-free and contain the most recent routing information. Each node keeps track of its own sequence number and a broadcast ID which is incremented every time a RREQ is sent. The RREQ contains information of the source IP address, the source sequence number, the broadcast ID and the most recent sequence number known for the destination address. When an intermediate node receives a RREQ it can respond with a route reply RREP if it has a route to the destination with a sequence number that is greater of equal to the sequence number of the RREQ. Since the RREQ propagates by nodes passing it forward to its neighbors, an intermediate node will receive the same RREQ from many neighbors. Only the first copy of the RREQ is treated all others are discarded.

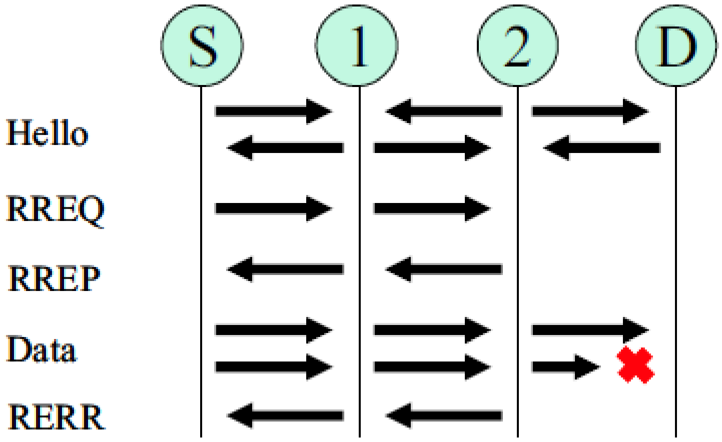


Fig. 2 AODV Protocol Messaging

An intermediate node receiving the first copy of a RREQ stores the information of which neighbor sent it. When the RREQ reaches the destination node or an intermediate node with a fresh enough route, the RREP message is sent back to the source by backtracking the RREQs path using the information of from where all intermediate nodes received their first RREQ. The nodes on the path of the RREP store the information of from which neighbor came, setting up an active forward route.
When the link between the source node and its next hop node is broken, the source node simply sends another RREQ to its remaining neighbors. If a link between two intermediate nodes is broken a message of this event is sent back to the source node which then can decide if it wants to send a RREQ to re establish the route to the destination or not.

3.2. Storage in Ad Hoc Networking:

Storage [6] in Ad Hoc Networking was the most important issues. We find 3 sort of storage: Local Storage, External Storage (Table2) and Data-Centric storage

Table2. Comparative study between local and external storage

Storage model	Routing algorithm	advantage	disadvantage	Related work	applications
External storage	multi-hop routing	Adapted to a large-scale deployment of network	No load balancing	[6]	Environmental Monitoring, …
Local storage	multi-hop routing	Adapted to a small-scale deployment of network	No load balancing	[6]	Environmental Monitoring, …

In data centric-storage (DCS) [7] [8], data is stored according to its event type at designed sensor net node. As a direct consequence, users can send queries for a particular data type directly to the node that stores data type rather than flooding the network with queries.

4. Related Work

In 2002 Andrew Howard et al. [9] considered the problem of deploying a mobile sensor network in an unknown environment. In the paper, a potential-field-based approach to deployment has been presented. The fields are

constructed such that each node is repelled by both obstacles and by other nodes, thereby forcing the network to spread itself throughout the environment. The approach is both distributed and scalable.
Chih-yung Chang et al., in 2006 [12], proposed an efficient node placement and topology control protocols to balance the power consumption of sensor nodes. Firstly, a virtual tree topology is constructed based on Grid-based WSNs. Then two node placement techniques, namely Distance-based and Density-based deployment schemes are proposed to balance the power consumption of sensor nodes.
Finally, extension of the proposed protocols is made from a Grid-based WSN to a randomly deployed WSN, making the developed energy-balanced schemes can be generally applied to randomly deployed WSNs. Simulation results reveal that the developed protocols can efficiently balance each sensor node's power consumption and prolong the network lifetime in both Grid-based and randomly deployed WSNs.

In the article of Said El Garouani [10] which treats the efficient access to data when the technique used is "prefetching". It consists in putting in reserve the information before the users need it. This information is stored in the user's mobile device cache (PDA, handheld device, portable PC, etc.). This technique takes into account the user's location and allows to send the relevant data and to reject the non-relevant ones. The main goal is to allow the users to have access permanently -in the next displacement- to available information in an almost immediate way. Besides, the data prefetching permits it to improve the performances of the cache's use and allows an adaptation of the mobile devices having limited resources, and also to take into account the prediction of the possible and the most relevant way how users will request information.
So, we project following this work to propose a more general prefetching architecture. This architecture must take into account all the hierarchical proxies caches or collaborative distributed in the area covered by the system. That's why we are using WSNs architecture.
For our work, we can replace our problem in the Network Layer from WSN OSI Layer, because the major function of this layer is routing. This layer has a lot of challenges depending on the application but apparently, the major challenges are in the power saving, limited memory and buffers, sensor have to be self organized.
Adding a routing problem, we will treat also optimizing a network lifetime with saving an energy node.

4.1. Our approach and algorithms

We will test and explain in this paragraph the scenario of communication which we want to study.
We estimate that our WSN includes mobile nodes and they are able to manage data. Before each answer, the node must update its table of routing according the used protocol. The first part of the proposal algorithm treats the general way to send and receive an ACK from nodes (from 1 to 5). The answer of the request will be treating according haw much node had an answer, one or more than one (if we had a distributed request) (from 5 to the end of algorithm).

Algorithm 1 Prefetching data in mobile environment

Require: Node in mobile environment
Ensure: Data routed to a client

```
1- The nodes update their table of routing (following the roles of AODV Routing),
2- Client sends its request in multicast to its nodes close (those which belongs the table of routing), and awaits ACK
if NO ACK then
    3- Client updates its table of routing again and resend the request
    4- Go to 2
else
    5- Receivers treats the request and answer it
end if
if One node contains answer then
    6- It informe nodes Client updates its routing table again and resend the request
    5- Chek the best route from his table of routing to send the answer
else
    6- Create a cluster including these nodes
    7- Identify the Cluster Head
    8- Send the answer
end if
9- Update routing table to all nodes
```

Fig.3 New proposed model

After studying the energy consumption in the first case using 10 nodes, and comparing them with the static case [17], we can see the feasibility of our algorithm because we had a best result between those cases. And in the other hand, we studied the scalability of this algorithm [16], we study the energy consumption for the scalable case.

4.2. Simulation

The goal of this simulation is to optimize the number of transmission following the requests in the network. We are taking a network with adding tens of mobile nodes for each step of our analysis [15]. Initially, we suppose that the sensors can transmit without collisions and error. When a node transmits a package, it is sure that the package will arrive at destination. The goal is to have a simulation which makes it possible to represent a WSN on very broad scale.

They are many simulators for the WSN: NS2[11], GloMoSim[13], OMNeT++[14].

Our simulation was carried out in the following software environment:

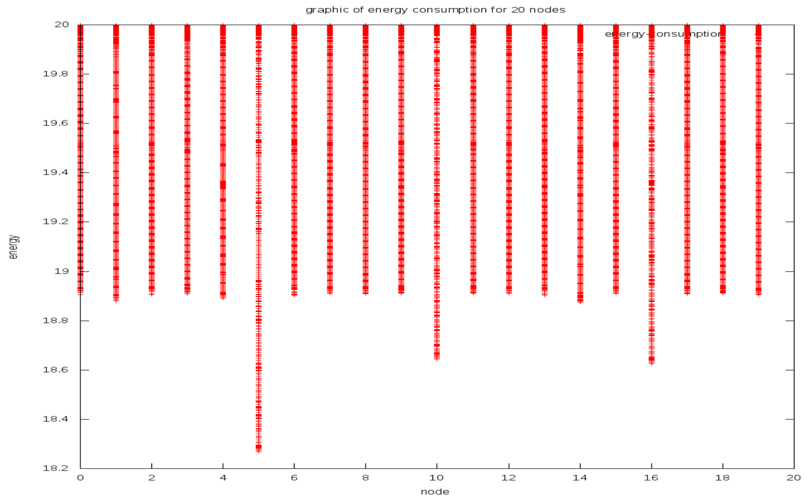
- Operating system UNIX: Ubuntu
- The simulator: NS2 [8]

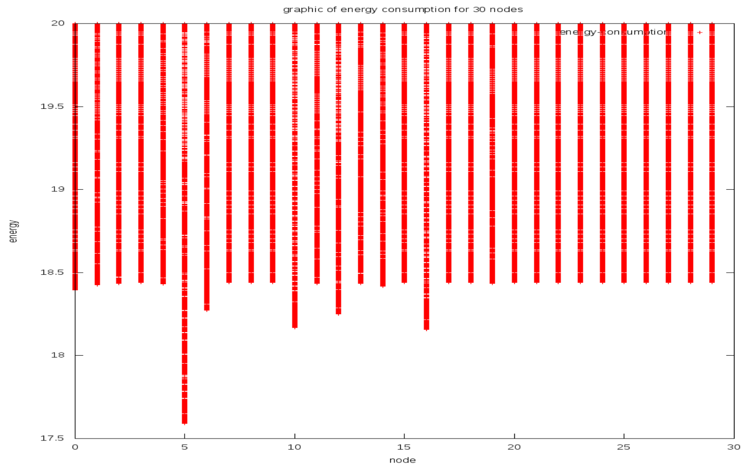
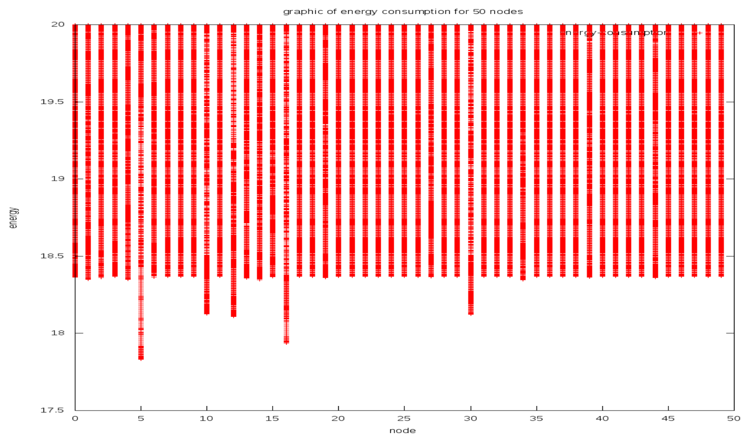
The rest of the simulations parameters are represented in the following table (Table 3):

Table3. The simulation Parameters.

Number of Nodes	10/20/30/40/50
Network Type	Mobile
Connection Type	UDP/CBR
Packet Size	Variable
Routing Protocol	AODV
Radio-Propagation Model	TwoRayGround
Interface Queue Type	DropTail
MAC Type	Mac/802_11
Antenna Model	Antenna/OmniAntenna
Link Layer Type	LL
Chanel Type	WirelessChannel
Max Packet in ifq	50
Zone of Deployment	Variable

Table4. Result of simulation

Number of node	Result of simulation with packet size:100
20	

30	
50	

In table3, we can see the energy consumed in several communications using multi-node.
We can see that the energy depend the number of time we used the node in each communication, but we didn't lose as much energy. Comparing with the case varying the packet size of data (10b to 500b), and the example with the same size of packet (1000b), we can see that the size affect the consumption of energy.
If the size is bigger, the energy consumption is important. (Fig 4)

To see the difference, we used network with 30 nodes.

Fig 4 (a)

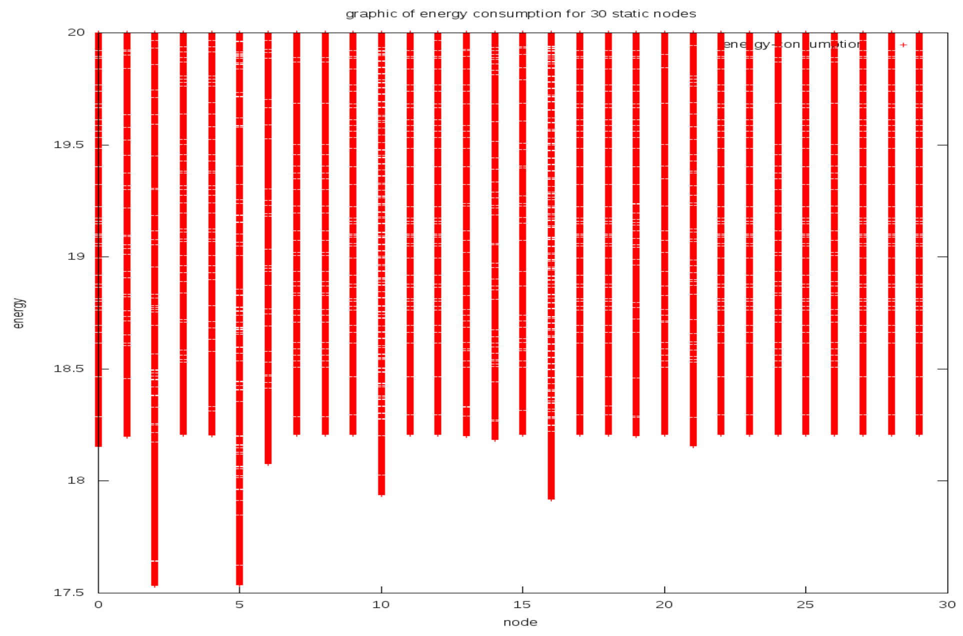


Fig 4 (b)

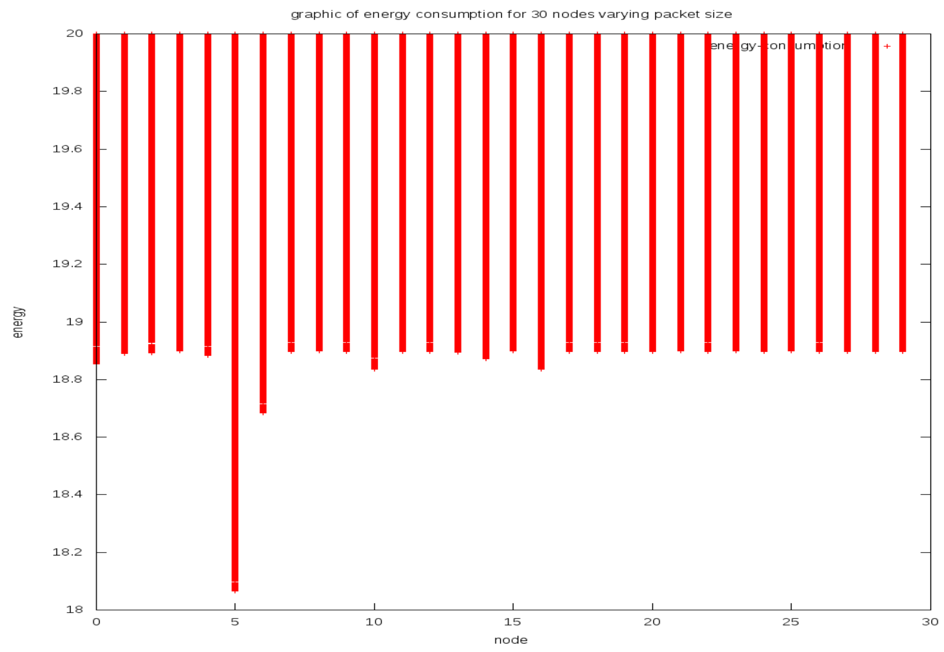


Fig 4. Studying static case (a), varying packet size (b) in network with 30 nodes

Comparing these graphics (fig 4 (a)-(b)), and those from the table 3, we can see the differences between result. But the most important information, that the movement of node following our model didn't consume energy bigger than the static case.

About the energy consumption between mobile case, varying packet size, we see the difference in the case when the packet size is smaller than 1000b.

we conclude, following our proposed model, we have also a good result even we used a lot of communications in the same time.

5. Conclusion

In this paper, packet size optimization based on the energy efficiency has been analyzed, following the proposed model to adapt the AODV routing protocol to a mobile area, with increasing the number of node till 50 with. We saw that the energy consumption depend the communication in our network.

We will improve this consumption by using the clustering in WSN, with proposing a new model. We will also study the power of node and comparing them with this work.

References

[1] J. Yick, B. Mukherjee, and D. Ghosal, "Wireless sensor network survey," Computer Networks, vol. 52, no. 12, pp. 2292-2330, 2008

[2] D. Bri, M. Garcia, J. Lloret, and P. Dini, "Real deployments of wireless sensor networks," Proc. Of the 3rd int. conf. on Sensor Technologies and Applications, pp. 415-423, 2009

[3] ADJIDO Idjiwa, BENAMARA Radhouane, BENZIMRA Rebecca, GIRAUD Laurent « Protocole de routage ad hoc sécurisé dans une architecture clusterisée », étude réalisée dans le cadre du module de routage de M2-RES de l'UPMC du 7 au 28 octobre

[4] David B. Johnson, David A. Maltz and Josh Broch "DSR: The DYNAMIC Source Routing Protocol for Multi-Hop Wireless Ad Hoc Networks"

[5] Adel.S.El ashheb "Performance Evaluation of AODV and DSDV Routing Protocol in wireless sensor network Environment" International conference on Computer Networks and Communication Systems (CNCS 2012), IPCSIT vol.35(2012), IACSIT Press, Singapore

[6] Hung-Cuong LE : Optimisation d'accès au médium et stockage de données distribuées dans les réseaux de capteurs

[7] Sylvia Ratnasamy, Brad Karp: Data-Centric Storage in Sensornets with GHT, A Geographic Hash Table 2003.

[8] Hung-Cuong Le. A Clustered Data-Centric Storage for Wireless Sensor Networks.

[9] Andrew Howard, Maja J Matari´c, and Gaurav S Sukhatme. 2002. Mobile Sensor Network Deployment using Potential Fields: A Distributed, Scalable Solution to the AreaCoverage Problem. Submitted to the 6th International Symposium on Distributed Autonomous Robotics System (DARS02).

[10] El Garouani Said, El Beqqali Omar and Laurini Robert : "Data Prefetching Algorithm in Mobile Environments" European Journal of Scientific Research Vol.28 No.3 having ISSN 1450-216X (2009), pp.478-491.

[11] Kevin Fall and Kannan Vardhan "The ns Manuel (formerly ns Notes and Documentation)", The VINT Project

[12] Chih-Yung Chang, Kuei-Ping Shih, Hsu-Ruey Chang, Hsiao-Jung Liu. 2006. Energy- Balanced Deployment and Topology Control for Wireless Sensor Networks. In IEEE GLOBECOM proceedings.

[13] Global Mobile Information Systems Simulation Library (GloMoSim).[Online]. Available : http://pcl.cs.ucla.edu/projectes/glomosim/

[14] OMNET++ discrete event simulator.[online]. Available:http//www.omnetpp/org

[15] Teixeira, I., de Rezende, J. F., and Pedroza, A.C.P. - "Wireless Sensor Network: Improving the Network Energy Consumption", in XXI Simpõsio Brasileiro de Telecomunicações -SBT'2004, Belém Brazil, September 2004.

[16]Sanae EL OUKKAL and Omar EL BEQQALI:" Study of the Scalability on Routing Data in Mobile Network Using the Architecture of Wireless Sensor Network (WSN)"Journal of Networking Technology, Volume 4, Issue 2, June, 2013, Pages 94-101

[17]Sanae EL OUKKAL and Omar EL BEQQALI:"Analysis of energy consumption in network data Routing: Mobile Wireless Sensor Network". WOTIC, Morocco, 2013