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Design and development of an Adaptive Zone Routing Protocol for Real-time Wireless Sensor Networks

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Abstract: The paper focuses on the task of handling traffic loads in mobility condition. We compared our simulated results in static and mobility conditions with low traffic and high traffic respectively. The results confirm the effectiveness of AZRP protocol. The AZRP protocol maintains all features and benefits of the ZRP protocol. At the same time it becomes obvious that AZRP protocol improves the behavior of ZRP protocol as it has the capability to be adapted at any time to the state of the network, i.e. to the current load and the mobility of the nodes. So, it improves the performance and the delay that introduced by the ZRP protocol.

***Index Terms* - Adaptive Zone Routing Protocol, Personal Digital Assistants, Wireless LAN.**

I. Introduction

Mobile computers, such as laptops (notebook computers) and PDA (Personal Digital Assistants) are the fastest developing sector of the computer industry. Many of the owners of these have desktops connected to a LAN or WAN in their office and they want to be connected to their base even when they are away or when they are on the road. If wired connection between cars and airplanes is not possible, there is a lot of interest in wireless networks. Wireless networks have many uses. A common use is portable office. Often, some people on the go want to use their laptop electronic equipment to make, send and receive telephone calls fax, email, access remote files and machines, etc. Wireless networks are valuable for vehicle fleets and various types of mobile units to be able to maintain contact with their base. Another use is for rescue teams in areas that disasters (fires, floods, earthquakes, accidents), making it possible to communication between groups. Finally, wireless networks are important for the military as well. In In general, wireless networks are applicable in any case that either does not exist no network infrastructure, or it has been damaged.

Although wireless networking and laptops are often related, they should not be however to be identified. There are cases where laptops are connected to wired network, such as a laptop connected to a telephone a hotel socket, as well as cases where a wireless network consists of desktops, e.g. in an old building without network wiring.

Wireless LANs are easy to set up (install a wireless LAN It may not require much more than buying a small box with some electronics and the installation of some antennas) and consequently cheap, however, have some disadvantages. They usually have a capacity of 1-2 Mbps, which is much lower than that wired LAN. Also the error rates are often much higher and the transmissions from different computers may interfere with each other.

II. Characteristics of an Ad Hoc Network

Ad hoc networks are self-organizing, wireless networks that consist of nodes that move randomly. The creation and development of networks of this category does not presuppose the existence of a stable and pre-existing infrastructure and does not require any preparation or installation process. Such networks can handle dynamic, random and sometimes very rapidly changing topologies which usually consist of short-range wireless connections and nodes whose operation is characterized by severe energy constraints. It is easily understood that in these networks due to their dynamic topology and special features their nodes are at the same time routers (hosts) and terminals (hosts) [9-10].

When studying and designing routing algorithms for ad hoc networks what to take seriously the characteristics of these networks, namely:

- . The size of the network (the number of network nodes).
- Network connectivity (the average of the number of adjacent nodes of a node) and the rate of occurrence of disconnected subnets.
- The mobility of the nodes and the form of their movement. The dependence of the protocol on the mobility of the nodes and in which cases the performance of the protocol is affected.
- The rate of change of topology (the speed at which the topology of a network varies).

- The bandwidth of the connections which is usually enough in wireless networks limited.
- The form of data traffic (the percentage of unidirectional connections that exist in the network topology).
- The percentage and frequency of power-save nodes (nodes which consume the least possible energy for their operation when they do not have data to send).

III. SELECTION OF ROUTING ALGORITHM

It is obvious that despite the rather large variety of protocols there is no one that can gather those features that could enable it to meet the requirements of all the conditions and features of a wireless sensor network. Also the need for many protocols human intervention in their case-by-case arrangements to achieve optimal performance makes them unsuitable for wireless self-organizing sensor networks. We conclude that the proposal of a new routing protocol that will support self-organization of the network, will be able to respond dynamically to changes in network topology and status and should also be able to adapts its behavior dynamically in relation to the current state of the network in terms of mobility and volume of data transmission is important and necessary for meeting the needs of sensor networks. From the study of wireless routing algorithms self-organizing networks it is obvious that there is no protocol that can satisfy all the scenarios of movement of the moving nodes in the context of their applications above networks. Thus a hybrid routing protocol is proposed which was developed to fill the gaps created by use statically initialized protocols, thus unable to cope with dynamic conditions existing in moving sensor networks. This protocol is called AZRP (Adaptive Zone Routing Protocol) [1-4] and can be adapt to any network situation using a new technique to maximize performance and reduce end-to-end latency. The protocol this was created after a thorough study of the characteristics of MANETs and existing routing algorithms for this category of networks. As it happens as its name implies, AZRP is based on the ZRP described but also in many publications that have been made in the past [4-8]. The AZRP protocol seeks to improve and extend the mechanisms of ZRP so that it can be adapted to any network state at any time. The proposed protocol takes advantage of the information provided by the IARP and IERP protocols to improve the performance of the ZRP protocol using a variable radius for the routing zone. In order to make a quantitative evaluation of the proposed algorithm, it is necessary to implementation of the proposed structure in an acceptable simulation tool in order to investigate its behavior and identify any further critical parameters operation. In addition, the quantitative evaluation of the proposed protocol requires detailed simulation of it and a series of simulations for optimal adjustment of parameters (eg for ThrH and ThrL threshold values).

IV. PROPOSED ARCHITECTURE

Specifically in AZRP the BRP protocol used by ZRP is modified routing algorithm to make it even more efficient in the event that the zone Routing is variable and varies depending on its mobility and load network in a limited area around each node. So choosing a small zone can be achieved by reducing the additional traffic introduced by IARP during low node mobility or for periods with low load. Unlike in the case of high mobility of the nodes or for periods with high load, the AZRP will increase the routing band to provide the required knowledge for network topology around the station and a fast route to routing Route Requests at peripheral nodes. The mechanism which uses AZRP to decide when to increase and when to decrease the routing zone for each station and allows it to adapt to any situation network to maximize performance and reduce end-to-end delay. AZRP consists of an IERP protocol such as DSR or AODV and from an IARP protocol such as DSDV or OLSR, respectively modified so that they can use the idea of a variable zone routing. Although the idea of a variable routing zone has been proposed in the past in some publications [38] to determine its optimal value for a network, only in In the case of AZRP, this idea is used to adapt the network to current load and movement conditions of the nodes changing its behavior protocol to more proactive or reactive depending on the occasion. The AZRP uses a variable routing zone with a unique value for each node, which is controlled by the rate of occurrence of route failures in its neighborhood node zone but also by the density and number of nodes located inside in the belt. The proposed mechanism takes into account the previous occurrence rates erroneous routes that occurred for a period of time T and uses tires thresholds (soft bounded area) to decide if it needs to increase or decrease the radius of the band of a node by 1. Thus, if we consider that at some point in time the radius of the routing band for a node is R, then the next routing band R (t + T) that will result from the algorithm will move to the limits of R (t + T) = R (t) .1. The decision on zone change is based on an estimated threshold for the incidence rate wrong routes. Given the number of nodes within the zone (the number this is known as within the zone there is a proactive algorithm) can estimate the number of nodes in the nearby neighborhood outside the zone and thus become one forecast for the upcoming occurrence rate of erroneous routes measured in route failures / node. Watching, therefore, the rate of occurrence of incorrect routes, algorithm is able to increase or decrease the radius of the routing band in case where a large or small number of incorrect routes are recorded respectively. Suppose R is the radius of the routing band for a node, Szone is the area of the area covered by the zone, Nzone is the number of nodes located within the zone and Dzone is the density of nodes within the zone.

Table 1 shows a qualitative comparison of AZRP with ZRP. In this table we present the quality features of AZRP that make it design superior to ZRP. Specifically, the ability to adapt to each case Network conditions and dynamic bandwidth add great flexibility to AZRP.

Table 1. Qualitative Comparison of AZRP and ZRP Protocols

AZRP	Reactive/ Proactive	Variable zones	Update period is Adaptive	Adaptive to Network	Info is stored within zone topology	• Hop by Hop Routing is IARP • Source Routing is IERP
ZRP	Reactive/ Proactive	Defined zones	Update period is not Adaptive	Not Adaptive to Network	Info is stored within zone topology	• Hop by Hop Routing is IARP • Source Routing is IERP

At the same time from the above table it appears that the AZRP protocol maintains all features and benefits of the ZRP protocol. At the same time it becomes obvious that AZRP protocol improves the behavior of ZRP protocol as it has the capability to be adapted at any time to the state of the network, ie to the current load and the mobility of the nodes. So, it improves the performance and the delay that introduces the ZRP protocol.

V. SIMULATION SCENARIOS

At this point we quote the results of the simulations to determine if and whether the operation of the proposed algorithm ensures better behavior. In order to isolate the results of the proposed structure, we performed 2 identical simulation sets with a unique differentiation feature the activation of the proposed control structure. In the first set we have used the "static" and in the second set we have used the "mobility" scenarios.

The metrics used to quantify its behavior routing algorithm, are the Packet Delivery Ratio (PDR), Throughput (Th), Time Consumption (Tc), Energy Consumption (Ec) and End-End Delay (EED) on the network.

The detailed characteristics of the network we simulated are shown below:

Nodes --------------- 30
Area ----------------1700m * 1700m
Range of transmission ---------250m
Size of packets ------1024 bits

Static nodes

Speed 0

Time of Execution 3 sec

Mobility nodes

Speed 3 m / sec

Time of Execution 0.1 sec

Figure 1. Characteristics of a set of simulations

Static

In this set, we have used scenes in a pair of series communications between a pair of nodes. We evaluated the performance of AZRP and compared the results with the ZRP algorithm. The results are shown in Figure 2 to Figure 6. The film depicts the existence of poor performance in AZRP. But with the increasing number of nodes, the traffic load of the ZRP algorithm increases. Similarly, if we observe that the increasing traffic load has affected the packet delay of communications. The higher peaks of the maps caused a greater EED in ZRP's than in AZRP. The PDR is significantly reduced by increasing the number of nodes for ZRP over AZRP by reducing packet loss due to higher load imposed. This shows that our proposed algorithm is better at delivering performance compared to ZRP. Performance decreases with the number of nodes that are apparently true on the network, but the performance reduction is less than the ZRP algorithm. The interesting factor of the results is that our proposed algorithm significantly reduces energy and time consumption compared to the ZRP algorithm.

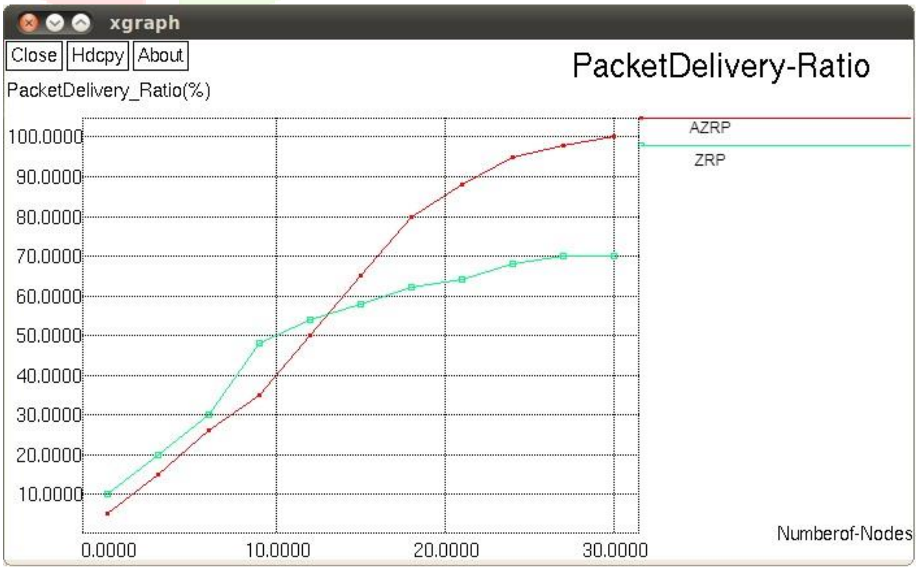

Figure 2 Packet delay of AZRP (static)

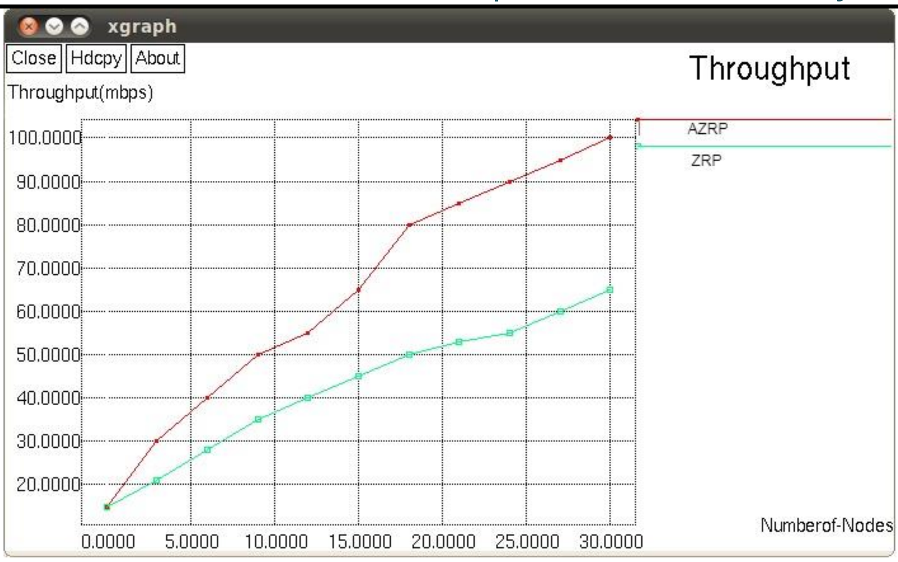

Figure 3 Throughput of AZRP (static)

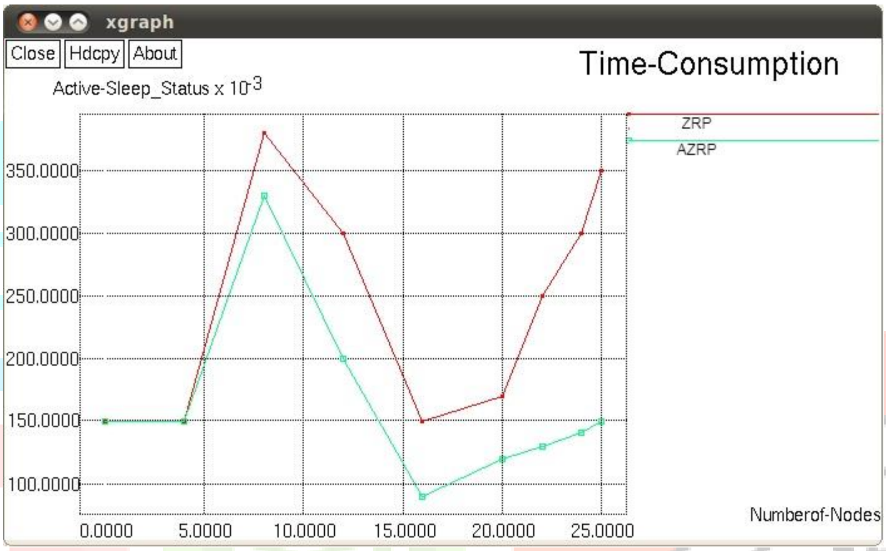

Figure 4 Comparison of PDR (static)

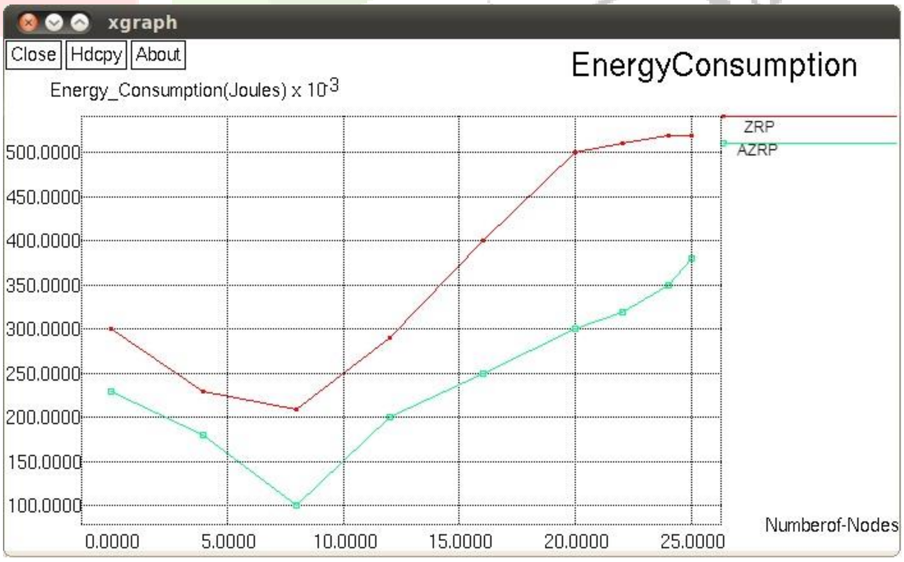

Figure 5 Comparison of Energy Consumption (static)

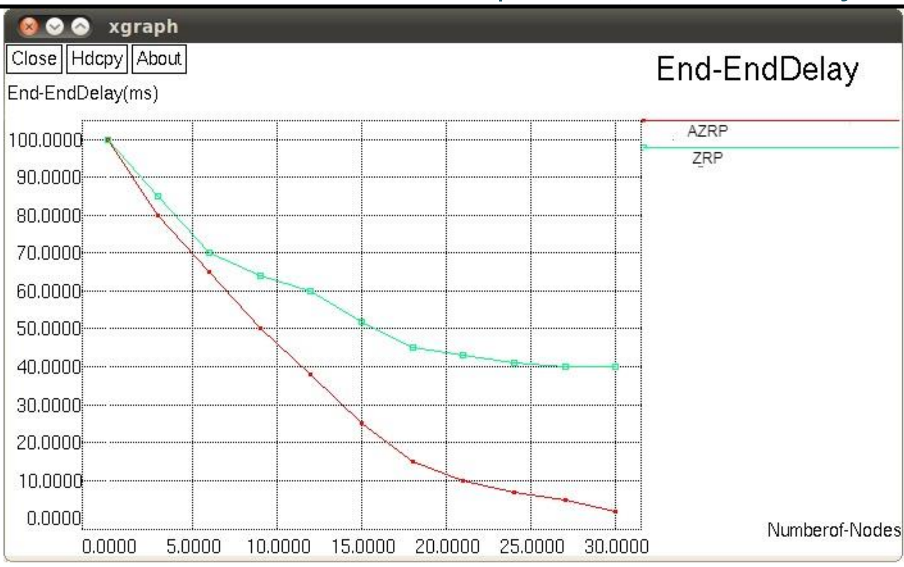

Figure 6 Comparison of End-End Delay (static)

VI. WITH MOBILITY

Mobility is a key factor in routing protocols. If it is linked to a routing protocol, it also creates the effect of high load, transmission delay, and more. Therefore, we need to measure the efficiency of the proposed algorithm compared to ZRP for all scenarios by differentiating the number of nodes. We graphically show the results from Figure-7 to Fig11. The mobility of our proposed algorithms has the best performance in the presence of increased number of nodes. Although both methods are affected by the degraded performance at the increased number of nodes, the proposed method will outperform the ZRP. The results of the final delay for the result for the simulated environment show that the proposed algorithm has less delay compared to ZRP. The average delay of the packets is 220 ms for the proposed algorithm, while the average delay of ZRP is 330 ms. It can be seen from the above conclusion that our proposed method shows the best performance in performance and the best delay of the EED in each transit. But if we test the PDR, we can understand that when the proposed algorithm starts with 30 nodes, it offers the best PDR compared to other scenarios.

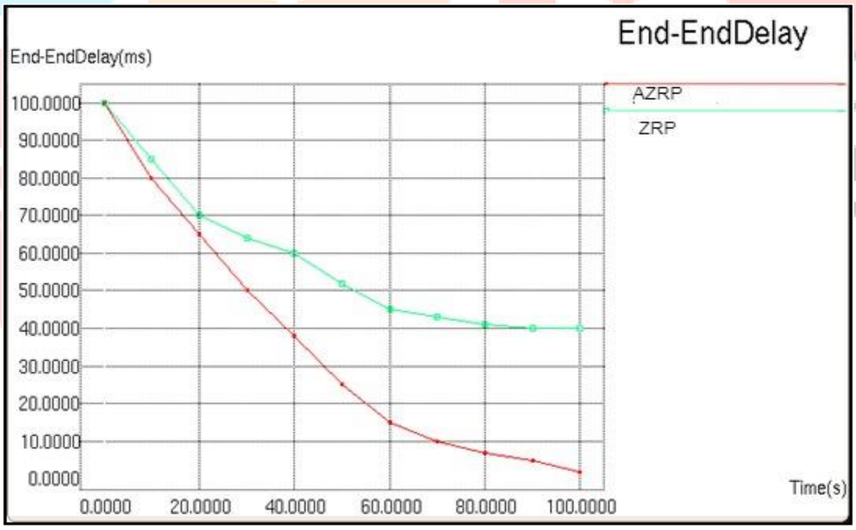

Figure 7 Comparison of End-End Delay (mobility)

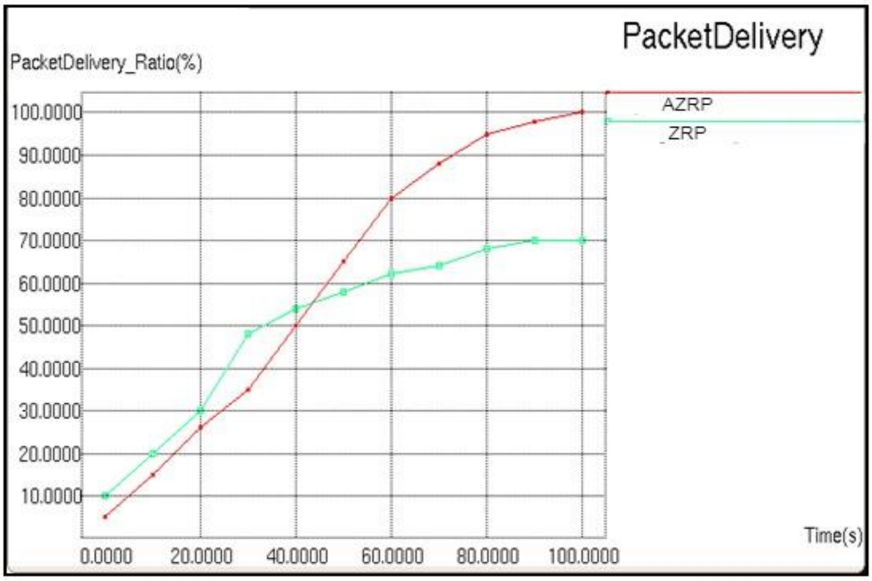

Figure 8 Comparison of Packet Delivery (mobility)

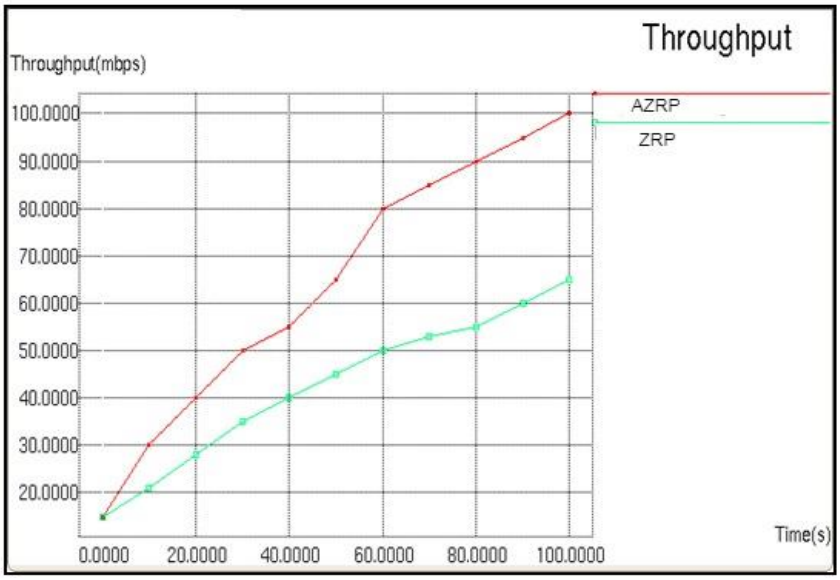

Figure 9 Comparison of Throuput (mobility)

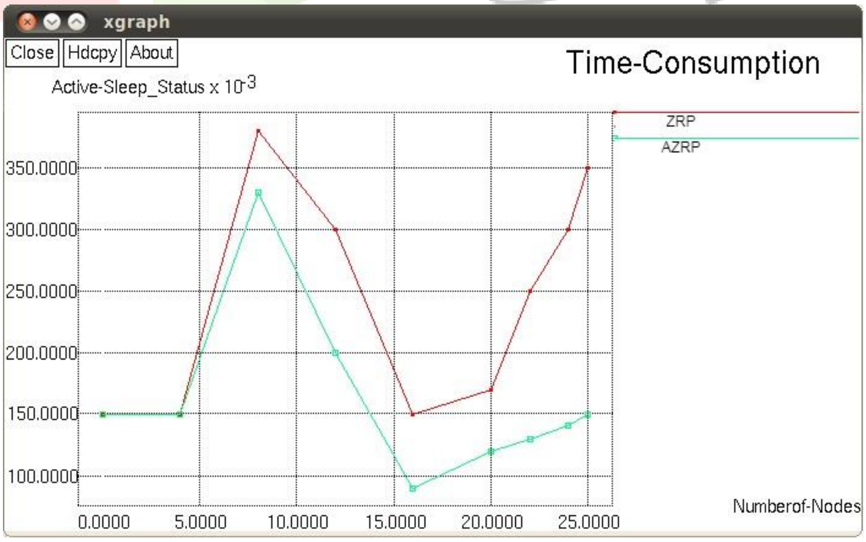

Figure 10 Comparison of Time consumption (mobility)

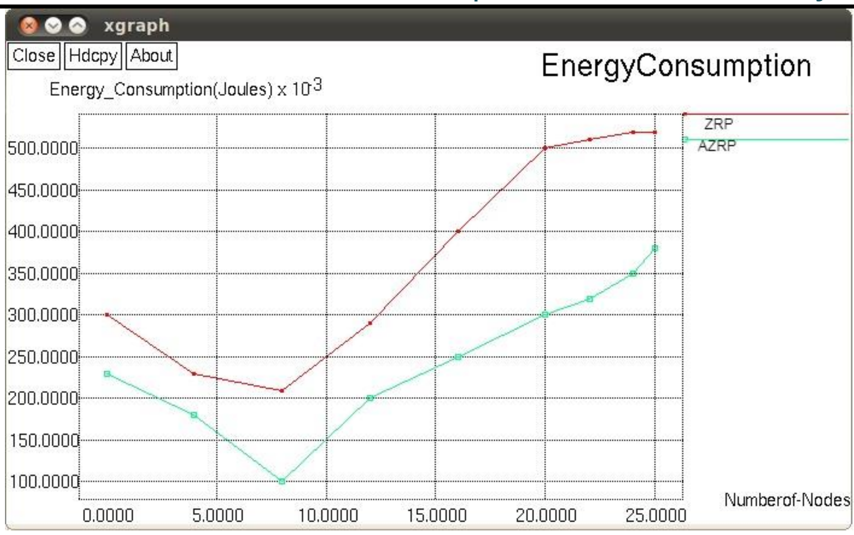

Figure 11 Comparison of Energy Consumption (mobility)

Observing the above results we come to the conclusion that in this scenario we achieve a marginal reduction of delay while at the same time the extra load imposed on the network by the routing protocol. In addition they are reduced packets that failed to be routed within the IARP area attributed to the dynamic regulation of the zone but also to the better knowledge of the topology, resulting in packets being sent to the border zone stations arriving with success. Increasing mobility at the level of human gait we observe how with use of the AZRP control algorithm we achieve a 15% -25% reduction of packet latency while maintaining the same number of packets transmitted successfully to their destination. In addition, the additional load of protocol packages is reduced about 25%. Finally, excellent behavior is achieved in its operation routing protocol to border nodes within the zone.

VII. CONCLUSIONS

The paper focuses on the task of handling traffic loads in mobility condition. We compared our simulated results in static and mobility conditions with low traffic and high traffic respectively. The results confirm the effectiveness of our proposed method. As we have seen, despite the complexity of AZRP, it is entirely possible to transfer it to an integrated system with whatever it entails for the offered RAM and ROM that this argues. Using it on an embedded platform will bring about necessary dynamic behavior of the routing protocol in relation to the dynamic state of the wireless sensor network.

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