

# Electronic engineer essay



**ASSIGN  
BUSTER**

Wows are composed of small sensors equipped with lopper devices, and have limited battery power supply. The main concern in existing architectural and optimization studies is to prolong the network lifetime. The lifetime of the sensor nodes is affected by different components such as the microprocessor, the sensing module and the wireless transmitter/ receiver. The existing works mainly consider these components to decide on best deployment, topology, protocols and so on. Recent studies have also considered the monitoring and evaluation of the path loss caused by environmental factors.

Path loss is always considered in isolation from the higher layers such as application and network. It is necessary to combine path loss computations used in physical layer, with information from upper layers such as application layer for a more realistic evaluation. In this paper, a simulation-based study is presented that uses path-loss model and application layer information in order to predict the network lifetime. Physical environment is considered as well. We show that when path-loss is introduced, increasing the transmission power is needed to reduce the amount of packets lost.

This presents a tradeoff between the residual energy and the successful transmission rate when more realistic settings are employed for simulation. It is a challenging task to optimize the transmission power of Wows, in presence of path loss, because although increasing the transmission power reduces the residual energy, it also reduces the number of retransmissions required. Index Terms? attenuation; path loss; wireless sensor networks; energy consumed; life time Evaluation tools Analytical modeling Simulators Test Beds Fig. 1. Performance evaluation methods I.

I INTRODUCTION Recent advances in wireless communications and electronics have enabled the development of wireless sensor networks (Wows), which comprise many low cost, low power, and multifunctional sensor nodes to accomplish certain sensing tasks in an intelligent manner. A sensor network is a special type of network which generally consists of a data acquisition system and a data distribution system. The unique characteristics of Wows in terms of data collection and energy constrains, separate them from other communication networks.

In Figure 1 we show the most common techniques for performance evaluation that are analytical modeling, simulation and benchmarking. The existing studies consider benchmarking in form of test beds and measurements for real deployment. The energy constrains of Wows, limits their processing capabilities and communication. Therefore, using one of these performance evaluation methods, and analysis of deployment and management of such complex systems is a challenging task [1]. Due to inherent complexity and diverse nature of Wows (dynamic topology, wireless channel characteristics, mobility, 978-0-7695-4682-7/12 \$26. 0 2012 IEEE DOI 10. 1109/skin-n. 2012. 87 569 density of the nodes etc. ), analytical methods may become inappropriate as they quire certain simplifications to model and predict the performance of the system. The simplifications may lead to inaccurate results in case of unrealistic assumptions Experimental studies such as are not always practical for evaluation of systems with different architectures and under various conditions, mainly because of the difficulties in deployment of real systems.

Potential difficulties associated may be deploying tens or hundreds of sensor nodes in the physical environment, program the nodes and monitor their behavior, the high costs involved in obtaining the instrumentation and other aspects such as fault tolerance, ND scalability. It is well known that when it comes to benchmarking, the results in many cases cannot be extrapolated to suit the changes in the system or environment. Hence, testing and performance evaluation of Wows through analytical modeling, real deployment and test beds can become complex, inaccurate, time consuming and/or costly.

Simulation is currently the most widely adopted method for analyzing Wows. Simulation studies provide quicker evaluation, optimization and modifications of the proposed algorithms and protocols at design, development and implementation stages. A number of simulation tools are available with different features, models, architectures and characteristics for performance evaluation in Wows. Packet level simulators offer various optimization methods for free space scenarios and avoid the effects of path loss 1 that may be caused by different obstacles.

The existing studies considering path loss for Wows on the other hand are together with details in upper layers such as network and application. In this paper, a new approach is considered to combine 1 Path loss is the attenuation in power density of an electromagnetic wave as it propagates through space. He path loss related issues with packet level simulation. A case study is presented which uses path-loss as well as network and application layer data in order to predict the network lifetime.

Well known path loss computation models are adopted to use with a new tool, which allows the users to deploy sensors in a two dimensional abstraction of the physical environment, and to introduce obstacles. The new tool in turn communicates with well-known Statistical package and MOMENT simulation environment. The energy consumption of the nodes considering the impact of path loss for different transmission powers is presented, the tradeoff between traditional performance measures such as packet loss and residual energy is illustrated.

The approach presented lends itself as a flexible and efficient tool which provides a more realistic approach for analyzing Wows and evaluating the performance in terms of energy efficiency. The flexibility of abstraction provided for the physical environment, also makes it possible to use various path loss models (even experimental ones). The rest of the paper is organized as follows: Section II considers various types of simulators. In section III, our approach is presented. Section IV provides the details of home automation application which is chosen as a case study. Section V shows the numerical results obtained.

The impact of path loss on energy consumption of the nodes in a WAS is shown as well as the behavior of nodes for different transmission powers in presence of path losses. In section VI, conclusion and future studies are presented.

II. RELATED WORK In this section, we consider existing simulators. They can be classified based on their level of complexity in to three main categories: Instruction, algorithm and packet level.

A. Instruction level simulators Instruction level simulators are often regarded as emulators.

They model the CPU execution at the level of instructions. TOSSES [8], Attempt [9], Vapor [10] are well known emulators.

TOSSES is the most commonly used emulator. However, compared to other emulators, it is not the most precise one. TOSSES, is a platform specific simulator (a Tiny mote simulator) which can compile any code written for Tiny to an executable file. Tiny, is the basic GUI for TOSSES which can visualize and interact with the running simulations. TOSSES is specific for Tiny applications on Mica motes sensors and do not include power models. Favor, is a Japanese emulator used for programs specifically written for AVER microelectronics produced by Motel and the Mica sensor modes.

Attempt provides low-level emulation of the operation of individual sensor nodes. A unique feature of Attempt is its ability to simulate a heterogeneous sensor network. It is scalable and its high fidelity platform is used as a presentment tool for sensor networks. B. Algorithm level simulators Shawn [1 1], Alleghenies [1 2], and Signals [1 3], are well known algorithm level simulators with emphasis on the logic, ATA structure and presentation of the algorithms. They rely on some form of graphical data structure to demonstrate the communication between the nodes. Point of view. It supports distributed protocols and generic high level algorithms.

Alleghenies focuses on network specific analysis of algorithms like localization, distributed routing, and flooding. Alleghenies mainly facilitates the implementation and quality analysis of new algorithms. Signals focuses on the verification of network algorithms and abstracts from the underlying layers. It also offers a message passing view of the network. Signals can be

employed for quick prototyping and verification in freely customizable network settings. C. Packet level simulators OPPONENT, Equaled, INS-2, Glooms, are some of the most commonly used packet level simulators.

They implement the data link and physical layers in the OSI network layers. Hence, radio models, 802.11b or newer MAC protocols, fading, collisions, noise and wave diffractions are commonly implemented. Network Simulator (INS) is a discrete event simulator written in combination of C++ and TCL. TCL is an object oriented scripting language, developed mainly for networking research. It provides extensive support for simulation of TCP, multicast protocols, and routing for wired and wireless networks. With protocol implementations being widely produced and developed, the extensibility of INS-2 has been a major contributor to its success.

It has an object-oriented design which allows for easy creation of new protocols. The key features for Wows include battery models, hybrid simulation support, sensor channels, scenario generation tools and a visualization tool [14]. Scalability, lack of application model and the lack of customization are few limitations of INS-2 along with lacking an application model [3]. OPPONENT [15] and Equaled [16] are commercialese network simulator software with powerful standard modules and they provide good simulation environment.

OPPONENT is an excellent choice to simulate Gibe based networks with the implementation of Gibe protocol and IEEE 802.15.4 MAC protocol. Equaled performs well in simulating large scale sensor networks due to its scalability in wireless simulation, but OPPONENT simulation requires a long time when

the number of sensors considered is large. The above mentioned simulators use rather simple radio/channel models [17]. Also, the simulators are still platform specific and attracted scalable, making them unsuitable for protocol [algorithm design and testing.

Furthermore the environmental details and especially the effects of path loss has not been considered in any of the given simulation packages. III. OUR APPROACH Figure 2 outlines the main components of our approach. This has been implemented in a tool called Applicable. An environment editor allows the user to specify the physical environment by using a graphical editor. The environment can include different obstacles and different sensors. An obstacle can have different properties such as the material it is 570

Applicable other layers info Environment Editor Application Model Path loss Model Translation engine commonly used path loss models that defines the behavior of signal strength in an and the attenuation factor added by the objects. The attenuation can vary based on several factors such as the construction materials (e. G. , wood, glass and concrete) and the object size. In the Table I we show some attenuation values in db introduced by various materials. We provide a detailed discussion in the next Section. The dependent path loss model can be expressed as [21]:  $LAP = LO + \text{egg}(d) + \text{empty witty Statistical Moment}++$  Fig. 2.

Applicable where, LAP represents the path loss between two nodes, d is the distance between the two nodes, LO is the path loss in free space environment, empty refers to the number of objects of the same type and witty is the loss in decibels attributed to that particular object. B. The



translation engine The translation engine takes as an input the environment, application, and path loss models in order to produce simulation scripts. We use Statistical [22] as a simulation tool. Statistical is a WAS simulator used for initial testing of protocols and/or algorithms with a realistic node behavior, wireless channel and radio models.

Since Statistical is highly tunable and can simulate a wide range of platforms, it is used to evaluate different platform characteristics. Statistical features an accurate radio model based on the work of the authors in [23]. It also features physical process model, considering clock drift, sensor energy consumption, CPU energy consumption, sensor bias etc. Unpredictability of the wireless channel, energy spent in transmission/receiving packets, performance degradation experienced by duty cycles, collisions are usually overlooked by simple simulators.

However these details are well established in Statistical [17]. All main components that affect the energy consumption of sensor nodes are considered that are the micro-processor, the sensor module, wireless transmitter/receiver and the path loss. We emphasize that while Statistical provides a good low level simulation platform; it does not provide any means to specify the application behavior, the environment and the path loss models. The application behavior is needed to derive application level simulation parameters. The environment and the path loss models allow the calculation of the path loss.

In fact while Statistical assumes that the user provides path loss related parameters, our approach automatically derives those values from high level

models such as the environment and path loss. ' V. H MOM AUTOMATION Monitoring and automatic control of building environment is a case study considered quite often [24], [25], [26], [27]. Home automation can include the following functionalities: (I) heating, ventilation, and air conditioning (HAVE) systems; (ii) emergency control systems (fire alarms); (iii) centralized control lighting; and (v) other systems, to provide comfort, energy efficiency and security.

In order to validate made of and its size. The environment editor also allows the specification of the sensor position in the physical environment.

Obstacles and sensor position are used to compute the path loss. An application model defines the behavior of nodes. From this model various performance parameters such as transmission and sensing rates can be derived. Applicable considers information from other layers such as network, data and physical layers to have a more realistic approximation for the life time.

At network layer different protocols such as DVD [18] and ADS [19] can be specified but also static routing can be defined. This can be easily specified on the environment model. Although various data link layer access methods can be used, the Timeout MAC (T-MAC) has been chosen in this case study. T-MAC is a contention based MAC protocol that use synchronized sleep schedules between the nodes in a WAS to conserve energy [20]. Also T-MAC provides both collision avoidance and reliable transmission. A. Path loss Path loss is the attenuation in power density of an electromagnetic wave as it propagates.

Path loss is consequence of many effects such as free-space loss, refraction, diffraction, reflection, aperture-medium coupling loss, and absorption. Path loss is also affected by other factors such as propagation medium (dry or moist air), the distance between the transmitter and the receiver, and the frequency of the signal. When the effects of path loss are not considered, the evaluation of underlying structure can become optimistic, since the problems associated, retransmissions and the way this phenomena affects the energy consumption are not taken into account.

In our approach a path loss model can be specified by the user. This model is used together with the physical environmental model in order to define the path loss between two nodes. In this paper we consider indoor environment and the dependent path loss model [21]. This is one of the most 571 T SMS SP SPASMS T -r Asp SMS SMS T Sp = sprinkler T = temperature SMS SMS SP Fig. 4. Fig. 3. Home automation = smoke BBS = base station concrete wood glass Energy consumed by each node with and without path loss alarm system is composed of different temperature sensors and smoke detectors that are distributed inside the building.

There are also sprinkler actuators used to enable the water flow in case of fire. All the temperature sensors monitor the temperature at regular intervals (every 30 seconds). When a temperature sensor dads a value that exceeds a specified threshold; it sends an alert message to the smoke detector. The smoke detector receives the alert and checks for smoke. An alarm is raised when the smoke is detected. In this case the smoke sensor also activates all the sprinklers. The automatic heating application is composed of different temperature sensors, a base station and various heaters.

The temperature sensors send readings every 30 seconds to the base station. This is placed at the center forming a star topology. The base station averages the readings and decides whether or not the central heating system should be on. More specifically the base station works in the following way: if the heating is turned on and the average temperature is greater than the minimum threshold, the central heating system turns off. If the average temperature is less than the minimum threshold, the central heating system turns on. We consider the scenario of Figure 3. A flat composed of five rooms (AY-AS).

We also consider different obstacles such as wooden doors, walls and glass partition. V. N NUMERICAL RESULTS AND DISCUSSIONS In order to show the usefulness and effectiveness of our approach and to analyse various actors affecting the performance in terms of energy consumption of Wows, the numerical results are presented in this section. The simulation parameters are as follows: COCCYX radio defined by the Texas instruments is used, the output power of the different transmission levels in dam are varied from 0 to -Dobb. Energy consumption for each transmission level varies.

For instance for 0 dam power consumed for listening (receiving) is 62 maw and for transmission is 57. 42 maw. Packet rate is kept at 250 Kbps, the radio bandwidth is 20 Much and the simulation runs for 9000 sec. T-MAC is used as a MAC rotator, and this makes the length of each frame period for all nodes 610 milliseconds, and the duration of listen time out 61 milliseconds. For our case study, we calculated the path-loss due to the material and explicitly set our path loss map [21], [28]. Refer to Figure 3 and Table I [21] for each type of obstacle and for its contribution to path loss.

For the sake of the presentation we use numbers to represent sensors. Node 0 represents the base station. Nodes 1, 4, 5, 7, and 9 monitor temperature in areas AY, AY, AY, AY, and AY respectively. Nodes 2 and 8 monitor smoke in the areas AY and AY respectively. Table II and Table III show the energy consumed by the nodes for the application scenario considering the path-loss phenomenon and ignoring the path loss respectively. Similarly, Figure 4 shows the difference in energy consumed by each node for two different cases. In case one path loss is ignored, and for the next set of results the path loss is present.

Transmission power is varied from -25 dBm to 0 dBm, the energy consumption of the nodes is increased as we increase the transmission power. For node 7, as the transmission power is increased from -25 dBm to 0 dBm, the energy consumed by the node also increases from 80.1 Joules to 88.9 Joules. The trade-off between traditional performance measures such as packet loss and residual energy is presented in Figure 6. The dotted lines represent the packets lost and the straight lines represent the energy consumed by each node. As the transmission power is decreased from 0 dBm to -25 dBm, there is a gradual increase in amount of packets lost.

For node 0, as the transmission power is decreased from 0 dBm to -25 dBm, the number of packets lost increases to 370, from 206 and the energy consumed increases to 100 Joules, from 88 Joules. Because of the retransmissions, more energy is consumed by the nodes. But the increase in transmission power does not necessarily mean increase in the life time as there are no retransmissions. When the tradeoff between the packet loss and the energy consumed is analysed, it can be seen that the optimum

transmission power should be between -15 to -5 dBm where the energy consumption is less than 95 Joules and packet loss is less than 200 packets.