MULTITASKS-GENERIC PLATFORM VIA WSN

Mahmoud Mezghani, Raja Gatgout, Ghada Ellouze, Amal Grati, Imen Bouabidi and Mahmoud Abdellaoui

Wireless Intelligent and Multi-standard Communication Systems Research Team (WIMCS) ISECS, Sfax-University, Tunisia

mahmoud.mezghani@gmail.com, rajagat@gmail.com, ellouze.ghada@yahoo.fr, grati.amal@gmail.com, imenba1989@gmail.com, mahmoudabdellaoui4@gmail.com

ABSTRACT

In recent years, the use of wireless sensor network invade various areas (domotic/home automation fields, medical, industrial …), which sets up several applications such as control of energy consumption in the habitat, home entertainment system, security system of the intelligent home, health care, … Each application employed its own platform what restore the system very complex. For thus and in this paper, we proposed only one platform for all applications, that's qualified to generate endless tasks. It covers many commands developed with a generic remote control interface created by C# language. This generic interface is very adaptable & adjusts oneself to TinyOS operating system requirements and able to be accessed via Internet using 6LoWPAN protocol. Validate the proper operation of this generic platform multi-tasking is approved on several levels: at the implementation of a proposed solution to control energy consumption in the smart home which the suggested solution is based on the techniques of scheduling under constraints of resources; at the automation of habitat and in the overall context of the intelligent home and the other to improve the quality of life and make it more comfortable ;across of the practical assistance and to set monitoring of the patient and to keep track of his statement by the doctor and that, whether at home or in the route to the hospital or in the hospital.

KEYWORDS

Wireless sensor networks, multitasks generic platform, intelligent home automation, comfort, energy consumption, health care.

1. INTRODUCTION

The emergence of Wireless Sensors Networks (WSNs) opens the way for the deployment of new applications for monitoring and controlling of enormous systems. These applications pose new challenges in science and technology. WSNs are considered as a special type of ad hoc networks. The nodes of such networks consist of a large number of low-cost, low-power and multifunctional sensors devices [1-4]. The position of these devices is not necessarily predetermined. They are randomly dispersed throughout a geographic area called sensor field (Figure 1). These sensors can collect and transmit autonomously environmental data through a multi-hop routing to a node considered as a collection point called sink node. The latter may be connected to the monitoring central via the Internet or Satellite. A remote user can inject commands into the sensor network via the sink to assign data collection, processing and transfer tasks to the sensors and it can later receive the data sensed by the network through the sink [1, 5-7].

DOI : 10.5121/ijdps.2011.2406

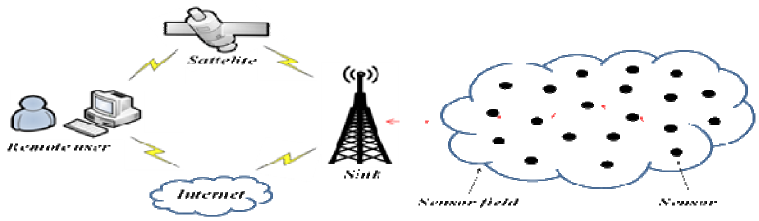

Figure 1. Basic architecture of a wireless sensor network.

There are three types of applications for WSNs and each has its corresponding data communication modes: event-driven, periodic, and on-demand reporting [8]. In the event-driven mode, sensors report the sensing data to the sink once a specified event has been detected. In the periodic reporting mode, sensor nodes gather information from the environment at predetermined times and periodically send the data to the sink. In the on-demand mode, users decide when to gather data. They send instructions to the WSN indicating that they wish to receive data and then wait for the required type of data to be sent in the requested format. The heterogeneous type of sensors has enabled potential enormous applications. These applications can be classified into two categories: monitoring and tracking [5]. Monitoring applications include indoor/outdoor environmental monitoring [9,10], health and wellness monitoring, power monitoring, inventory location monitoring, factory and process automation, and seismic and structural monitoring. Tracking applications include tracking objects, animals, humans, and vehicles. In [3-5,11-13] some of real applications are surveyed. While the study of home automation applications is limited to a brief review of some examples, despite that domotic is the way of our time. In fact, over and above health care part, the second main part in this paper was focused in the study of intelligent multi-tasks domotic applications which interests three main categories: control consumption energy & comfort, monitoring and security. These applications can be managed locally or remotely via a sophisticated interface. The interface provides a user-friendly environment and a set of functionalities that easies the interaction between the end-users and the WSN. The interface is characterized with modularity, which makes applications easily extensible.

The remainder of this paper is organized as follows: section 2 summarizes the related works; section 3 presents the basic characteristics and challenges of WSNs. The hardware and software systems are provided. Section 4 describes the multi-tasks platform and their applications such as our intelligent home automation "MyIHabitat", health care and management/administration of multi-tasking platform. Section 5 concludes this paper.

2. RELATED WORK

The majority of projects based on WSN, are specific to the type of application and desired needs. Several works have been accomplished in several areas such as Smart Dust, Sniper Detection, VigilNet in the military area, ZebraNet, Volcano Monitoring and CORIE in environmental area, Patient monitoring in the health care area, etc. [1,11-15]. In fact, each application is independent and has its proper platform. Moreover, a heterogeneous system means a painful management of a multitude of independent platforms. In addition, the extension to another application involves creating a new platform independent of the others.

Our research consists to design and to implement a generic, multitasking and extensible system managing some different applications through a modular interface which is easy to manipulate, at a reasonable cost that minimizes energy consumption and maximizing the lifetime of system.

3. WIRELESS SENSOR NETWORK AND CHALLENGES

WSNs are composed of individual embedded systems that are capable of interacting with their environment through various sensors, processing information locally, and communicating this information wirelessly with their neighbours. However, the design of a multi-tasks WSN consists to use enormous different sensors depending on manufacturers or the nature of the sensor itself such as in home automation application. In fact, this makes a challenge of the concept for a multi-tasks WSN platform supporting a wide range of sensors. In the following subsections, we present and provide the hardware and software constraints, also the challenges of design and deployment of WSNs.

3.1. Hardware part

The WSNs are usually composed of a large number of intelligent sensors communicating with each other via radio links for information sharing and cooperative processing [14,15]. A sensor node is made up of four basic components (Figure 2): a sensing unit, a processing unit, a transceiver unit and a power unit [1,2,16]. For application requirements, other additional units can be installed on the sensor, such as a location finding system, a power generator and a mobilizer.

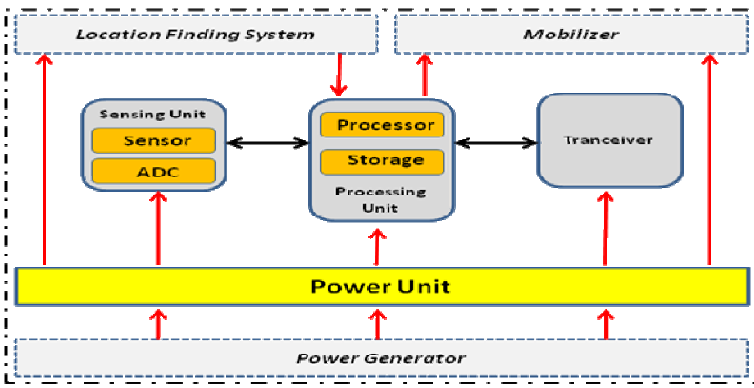

Figure 2. Basic physical architecture of an intelligent sensor

Sensing units are usually composed of two subunits: sensors and analogue to digital converters (ADC). The processing unit, which is generally associated with a small storage unit, manages the procedures that make the sensor node collaborate with the other nodes to carry out the assigned sensing tasks. A transceiver unit connects the node to the network. One of the most important components of a sensor node is the power unit. However, because the sensor nodes are often inaccessible, the lifetime of a sensor network depends on the lifetime of the power resources of the nodes. In [2,3,16] some of developed hardware platforms are reviewed and compared such as Mica2, Cricket, MicaZ, Iris, Telos, SunSPOT, and Imote2. For instance, the processing unit of Mica family nodes is Atmel AVR microcontrollers with a speed of 4–16MHz and 128–256 kB of programmable flash. The Mica node includes a 916 or 433MHz transceiver at 40 kbps, while the Mica2 platform is equipped with a 433/868/916MHz transceiver at 40 kbps. The MicaZ and IRIS nodes are equipped with IEEE 802.15.4 compliant transceivers, which operate at 2.4GHz with 250 kbps data rate. Each platform has limited memory in terms of RAM (4–8 kB) and data memory (512 kB).

3.2. Software part

In addition to hardware platforms, several software platforms have also been developed specifically for WSNs. In [4,11,16] some of these software platforms are explored and reviewed such as TinyOS, LiteOS, Contiki, EYES OS, BTnodes, etc. The most popular platform is the TinyOS. One of the main reasons for this popularity is the vast code space built throughout the development of WSNs solutions. TinyOS is an open-source operating system. It uses NesC language. It incorporates a component-based architecture, which minimizes the code size and provides a flexible platform for implementing new communication protocols. His component library includes network protocols, distributed services, sensor drivers, and data acquisition tools, which can be further modified or improved based on the specific application requirements. TinyOS is based on an event-driven execution model that enables fine-grained power management strategies. It has a FIFO (First In First Out) scheduler that organizes tasks in a queue while respecting the priority of interrupt events that have more priority. If the queue is full, task victim is the one that holds the tail of the queue.

3.3. Design challenges

When designing an application based on WSNs, the fundamental issues are the cost of production, reliability and lifetime. However, any application design involves consideration of the following problems: (a) Minimize network traffic by optimizing the number of packet transmission. This minimization leads to minimal energy consumption and long lifetime of the network; (b) Offer support to be able to perform reliable multi-hop communications; (c) Ensure optimal routing; (d) Self organizing network - this may be necessary in many cases. A network comprising a large number of nodes placed in harsh environments where manual configuration is not feasible. Another case is when a node is inserted or removed due to lack of energy or physical destruction. So, the network must be able to reconfigure itself to continue its operation.

4. MULTI-TASKS PLATFORM AND THEIR APPLICATIONS

A multi-tasking platform hardware and software was created when we realized the configuration and remote control of home automation equipment. Home automation is not a simple automation of habitat, but rather a task that specifically deals with the problem of control and supervision of smart home for control of energy consumption, user comfort and security of habitat at lower cost.

Deployment platform that multitasking was recommended by the requirements and objectives: (a) implementation of a strategy to control and diagnostic equipment complying with the requirements of the smart home. (b) Insure service continuity of the system by minimizing the energy consumption of embedded sensors by optimizing communication and management of information collected based on a multi-agent approach. (c) Specify the reconfigurability of WSN: actuators allow to optimize quality of service in real time. (d) This platform is based on the TinyOS operating system version2.1 using the access protocol 6LoWPAN of the standard IEEE 802.15.4 wireless sensor network.

4.1. Intelligent home automation

4.1.1. Consumption control of energy and user comfort

Recently, home automation has been dreaming since it is not limited to a mere improvement of user comfort, but it contributes to better energy management in order to limit such consumption peaks and that increasing the comfort to the detriment of the energy cost, so that equal comfort, energy consumption can decrease. In addition, the conjunction of intelligences, distributed embedded in different equipments home automation and communication systems (WSN), leads to an intelligent home and energy efficient. By providing the home automation equipment to sophisticated algorithm and powerful means of communication, it is possible not only to have a better control of energy consumption in the intelligent home, but also to introduce new services including enrolling in supervision through the development of control laws, supervision and reconfiguration. We are interested in both the modelling problems: problems related to implementation synthesized laws and the problems of responsiveness and that in terms time, security, environment and quality of service. In the automation field, the contributions are organized around mechanisms to synthesize online technology (PLC technology) control laws and supervision (control, recovery, emergency, maintenance, supervision ...) suitable for the production environment: normal or abnormal. Thus, it is to calculate and to set online all decisions to be taken, both in normal (Operating degrees of freedom required by the decisional flexibility: real-time scheduling, optimization, selection of control laws) and abnormal (select an alternative healing, local reordering; calculate an optimal reconfiguration of law...). The energy efficiency in home automation covers two areas: control of total consumption and control of instantaneous consumption. The solutions to the first part relive the monitoring of consumption where each component or components of aggregate home automation has a chip capable of recording the results of consumption and to set make statistics on demand. Against, the control of instantaneous consumption should be apprehended by a prediction mechanism or by estimated scheduling which will be complemented by a system of real-time scheduling [17,18].

The role of the mechanism of prediction or forecast scheduling is to find the schedules in the medium to long term based on estimated consumption of each component or components of the aggregate of home automation, able to avoid through an instantaneous management of the conflict of energy demand. Each automation component considers its future energy needs, while specifying its degree of latitude, and then forwards its forecast scheduling system (Figure 3) that will estimate the role of building an organization of consumption during a day. In case of conflicting demand of energy source, real-time scheduling mechanism will have the task of choosing a quick solution satisfying constraints criticality including aspects of security and user comfort (Figure 4). The cooperative nature of such a system naturally leads to multi-agent paradigm and technologies that result, especially since they allow apprehend the structures of the variables systems (addition, removal) [19-21].

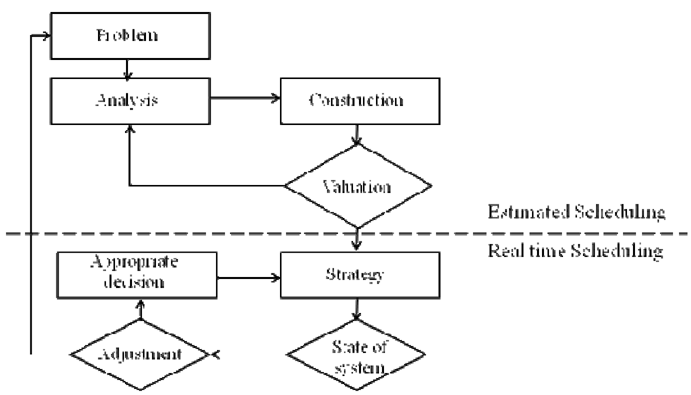

Figure 3. Scheduling system method

An agent is an autonomous system, still active, able to listen and act on its environment. It belongs a society of agents (multi-agents system) and contributes to seek, through its expertise in search of solutions to a problem. However, multi-agents system is primarily a generic approach to solving the problem requires algorithms, spatial distribution and structural adjustment. Secondly, an organization of inter-agent interactions that led to the emergence of mechanisms where interactions self-organize in whole or partially. The proposed scheduling method takes into account the dynamic and unpredictable nature of the workshop [22,23]. The operation of real-time system was based on the party estimated scheduling, cost of interruption, the needs comfort of users and the cost of subscription set. Its role is to resolve existing conflicts in the day. So, the real-time scheduling is introduced to solve this conflict and in the following way :(α) modelling of devices and unpredictable or half-predictable when it introduced the scheduler that organizes the day's activities. It is connected with all the other devices. (β) Exchange of information: when the user launches one of semi-unpredictable devices, it sends an application of energy equal to the power consumed, but we do not yet know his duration. The scheduler will estimate its duration. If the device ends before that time, it sends a message to indicate that it has released the resource. If it exceeds this time, it sends a message to ask for more energy. The phases of real-time scheduling are carried out as follows: normal operation, the task delay, reorder unpredictable and warning devices (see figure4).

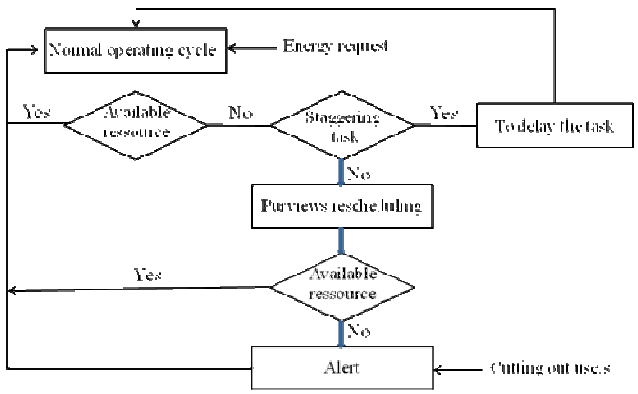

Figure 4. Real time scheduling algorithm

To validate the proper functioning of the platform for multitasking and quantify the opportunities of this system, we give the bulk of the task (application) of the platform multitasking processing the energy management within the habitat, and we proposed a novel approach of adapting and applying the techniques of scheduling under resource constraint to better manage energy consumption. This approach was first proposed an adaptation of the scheduling problem in home automation (scheduling problem where single-resource electricity constitute renewable resource type and disjunctive, and where the criterion to be minimized is no longer a maximal consumption C_{max}, but a maximal power P_{max}). Secondly, we showed the relevance of the proposed classification (predictable devices, half-predictable and unpredictable) that helped define an estimated scheduling. The remaining power margin has to accept real-time triggering devices unpredictable. In case of conflict, a real-time scheduling is required. Thirdly, the type components “ConnectME” have been used to manage all the equipments of "MyIHabitat" over Ethernet. A methodological approach to research on the ability of such a system has been circulated and considered. A distribution of intelligence in various domotic appliances has enabled these products to automatically adapt them (modelling), but also the needs of the user (learning). Finally, the scheduling solution has been obtained by a process of negotiation between agents (agent-based concept).

4.1.2. Monitoring and security

This application is intended to provide a level of safety in an intelligent manner to habitat. The tasks to be undertaken are as follows: provide habitat security against thefts and intrusions: the detection of any event generates some scenarios of surveillance such as reactions lighting evolutionary starting by the garden; then, lighting indoor and finally triggering the alarm. To deceive the attackers and thieves with presence simulation by controlling the lighting in different parts of the habitat and combined with some household appliances like TV that is a considered solution possibly when the user is outside the habitat. Surveillance cameras accessible locally and remotely can save any attack action and alerts the user that is the capabilities to remote control his habitat. Provide secure habitat against fires: the use of sensors to detect gas leaks, smoke or elevated temperature in excess of the normal threshold, alert the user and control the appropriate reaction such as stop the gas valve and open the windows for exhaust gas leakage from the habitat; detection of structural abnormalities causes alert the user to act appropriately before the disaster.

4.2. Health care

The use of WSN technology in the medical field has allowed the monitoring of patients, the diagnosis of their statements, and their assistance and monitoring via mobile sensor nodes. In the following, we present the proper functioning of the multitasks-generic platform with mobile sensor nodes. Subsequently, you find the source code of zone-based hierarchical routing protocol used to : network partition in virtual zone; trunk zones table construction set (inter-zone routing table at chief border nodes when node n receives a packet p; inter-zone routing table at border nodes when source node n wants to sent data to destination node n';...).

Zone-based Hierarchical Routing Protocol

I- A network Algorithm Partitioning into Virtual Zones:

```
INPUT : R
PART A :
IF (n is an inviting node) THEN
    Send a packet P (n.NodeId, ANY, n.ZONEID, INVITATION, NORMAL, R-1)[only once]
ENDIF
PART B :
IF (n receives a packet P) THEN
    PART B.1 :
IF (P.Subject = INVITATION) THEN
    IF (n.ZoneId is undefined) THEN
        Join the zone [n.ZONEID := P.ZONEID]
        IF (P.TTL = 0) THEN
            n.NodeType := BORDER
            Send a P'(n.NodeId, ANY, n.ZONEID, BORDER, n.NodeType, 1)
        ELSE
            Send a packet P'(n.NodeId, ANY, n.ZONEID, INVITATION, n.NodeType, P.TTL -1)
        ENDIF
    ELSE
        IF (n.ZONEID ≠ P.ZONEID) THEN
            n.NodeType := BORDER
            Send a packet P'(n.NodeId, ANY, n.ZONEID, DISAGREEMENT, n.NodeType, 1)
            n.BorderTable.add(P.ZONEID, P.SrcId)
ENDIF  ENDIF ENDIF
PART B.2 :
IF (P.Subject = BORDER OR P.Subject = DISAGREEMENT) THEN
    IF (n.ZONEID ≠ P.ZONEID) THEN
        n.NodeType := BORDER
        n.BorderTable.add(P.ZONEID, P.SrcId)
        IF (BorderTable is modified) THEN
            Send a packet P'(n.NodeId, ANY, n.ZONEID, BORDER, n.NodeType, 1)
ENDIF ENDIF ENDIF
PART C :
IF (P.Subject = NEW_NODE) THEN
    Send a packet P'(n.NodeId, P.SrcId, n.ZONEID, INVITATION, n.NodeType, 1)
ENDIF ENDIF
OUTPUT : BorderTable, ZoneID, NodeType at node n
```

II- Algorithm for Sending the Inter-Zone Table by the Head Node:

```
IF (n.NodeType = CHIEF-BORDER) THEN
PART A :
TempZones := Ø
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
    For each zone in entryRT.ZoneIds | zone ∉ TempZones DO
        Send a packet P (n.NodeId, entryRT.NextHopId, entryRT.DestNodeId, n.ZoneId,
        UPDATE_TABLE, n.InterZoneRoutingTable)
    Save zone in TempZones
```

```
ENDDO ENDDO
PART B :
For each entryBT in BorderTable DO
For each node in entryBT.BorderNodesIds DO
        Choose randomly node from entryBT.BorderNodesIds
        Send a packet P' (n.NodeId, node, NULL, n.ZoneId, UPDATE_TABLE,
        n.InterZoneRoutingTable)
ENDDO ENDDO ENDIF
```

III- Algorithm for Constructing the Inter-Zone Table:

INPUT : InterZoneRoutingTable at CHIEF-BORDER nodes

When node n receives a packet P

```
PART A :
IF (n.NodeType = NORMAL) THEN
    Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = P.FinalDestId
    Send a packet P'(n.NodeId, entryRT.NextHopId, P.FinalDestId n.ZoneId,P.Subject, P.ZoneT)
ELSE
PART B :
IF (n.NodeType = CHIEF-BORDER) THEN
    UPDATE n.InterZoneRoutingTable
    IF (InterZoneRoutingTable is not complet) THEN
        TempZones := Ø
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
For each zone in entryRT.ZoneIds | zone ∉ TempZones DO
        Send a packet P'(n.NodeId, entryRT.NextHopId, entryRT.DestNodeId, n.ZoneId,
        UPDATE_TABLE, n.InterZoneRoutingTable)
        Save zone in TempZones
ENDDO ENDDO
For each entryBT in BorderTable DO
    Choose randomly node from entryBT.BorderNodesIds
    Send a packet P' (n.NodeId, node, NULL, n.ZoneId, UPDATE_TABLE,
    n.InterZoneRoutingTable)
ENDDO
ELSE
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
        Send a packet P'(n.NodeId, entryRT.NextHopId, entryRT.DestNodeId, n.ZoneId,
        COMPLET_TABLE, n.InterZoneRoutingTable)
ENDDO ENDIF
ELSE
PART C :
IF (n.ZoneId ≠ P.ZoneId) THEN
     Find entryRT in IntraZoneRoutingTable | entryRT.NodeType = CHIEF-BORDER
     Send a packet P'(n.NodeId, entryRT.NextHopId, entryRT.DestNodeId, n.ZoneId, P.Subject,
     P.InterZoneRoutingTable)
ELSE
IF (n.NodeId = P.FinalDestId) THEN
IF (P.Subject = UPDATE_TABLE) THEN
    For each entryBT in BorderTable DO
          Choose randomly node from entryBT.BorderNodesIds
          Send a packet P' (n.NodeId, node, NULL, n.ZoneId, P.Subject, P.ZoneT)
     ENDDO
ELSE
      Save P.ZoneT in n.InterZoneRoutingTable
ENDIF
ELSE
    Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = P.FinalDestId
    Send a packet P'(n.NodeId, entryRT.NextHopId, P.DestNodeId, n.ZoneId,P.Subject, P.ZoneT)
ENDIF ENDIF ENDIF ENDIF
```

OUTPUT : InterZoneRoutingTable at BORDER nodes

IV- Applied Algorithm by the Source Node when Sending a Data Packet:

When source node n wants to send DATA to destination node n'

```
PART A :
IF (n.ZoneId = n'.ZoneId) THEN
     Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = n'.NodeId
     Send a packet P (n.NodeId, n'.NodeId, entryRT.NextHopId, n'.NodeId, n'.ZoneId, DATA)
```

```
ELSE
PART B :
IF (n.NodeType = NORMAL) THEN
     TempNodes := Ø
     For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
     For each zone in entryRT.ZoneIds DO
IF (zone = n'.ZoneId) THEN
    Save entryRT.DestNodeId in TempNodes
  ENDIF ENDDO  ENDDO
IF (TempNodes ≠ Ø) THEN
      Choose randomly destNode from TempNodes
      Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = destNode
      Send a packet P (n.NodeId, destNode, entryRT.NextHopId, n'.NodeId, n'.ZoneId, DATA)
ELSE
      Find randomly entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER
      Send P (n.NodeId, entryRT.DestNodeId, entryRT.NextHopId, n'.NodeId, n'.ZoneId, DATA)
ENDIF
ELSE
PART C :
IF (∃entryBT in BorderTable | n'.ZoneId = entryBT.neighZoneId) THEN
     Choose randomly node from entryBT.borderNodesIds
     Send P (n.NodeId, node, node, n'.NodeId, n'.ZoneId, DATA)
ELSE
     Find entryZone in InterZoneRoutingTable | entryZone.DestZoneId = n'.ZoneId
     IF (∃ entryBT in BorderTable | entryZone.NextZoneId = entryBT.neighZoneId) THEN
     Choose randomly node from entryBT.borderNodesIds
     Send P (n.NodeId, node, node, n'.NodeId, n'.ZoneId, DATA)
ELSE
       TempNodes := Ø
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
For each zone in entryRT.ZoneIds DO
IF (zone = entryZone.NextZoneId) THEN
      Save entryRT.DestNodeId in TempNodes
ENDIF ENDDO ENDDO
Choose randomly destNode from TempNodes
Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = destNode
Send a packet P (n.NodeId, destNode, entryRT.NextHopId, n'.NodeId, n'.ZoneId, DATA)
ENDIF ENDIF ENDIF ENDIF
```

V- Applied Algorithm when Receiving a Data Packet:

When a node n receives a data packet P

```
PART A :
IF (n.NodeId = P.FinalDestId) THEN
      Process P.data
ELSE
PART B :
IF (n.ZoneId = P.DestZoneId) THEN
      Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = P.FinalDestId
     Send a packet P' (n.NodeId, P.FinalDestId, entryRT.NextHopId, P.FinalDestId,
      P.DestZoneId, P.data)
ELSE
PART C :
PART C.1 :
IF (n.NodeType = NORMAL) THEN
       Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = P.LocallDestId
       Send a packet P' (n.NodeId,P.localDestId,entryRT.NextHopId,P.FinalDestId,
       P.DestZoneId,P.data)
ELSE
PART C.2 :
IF (∃ entryBT in BorderTable | entryBT.neighZoneId = P.DestZoneId) THEN
      Choose randomly node from entryBT.borderNodesIds
      Send P'(n.NodeId, node, node, P.FinalDestId, P.DestZoneId, P.data)
ELSE
PART C.3 :
     TempNodes := Ø
```

```
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
For each zone in entryRT.ZoneIds DO
IF (zone = P.DestZoneId) THEN
      Save entryRT.DestNodeId in TempNodes
ENDIF ENDDO ENDDO
IF (TempNodes ≠ Ø) THEN
Choose randomly destNode from TempNodes
Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = destNode
Send P'(n.NodeId, destnode, entryRT.NextHopId, P.FinalDestId, P.DestZoneId, P.data)
ELSE
PART C.4 :
Find entryZone in InterZoneRoutingTable | entryZone.DestZoneId = P.DestZoneId
IF (∃ entryBT in BorderTable |entryBT.neighZoneId = entryZone.NextZoneId) THEN
      Choose randomly node from entryBT.borderNodesIds
      Send P'(n.NodeId, node, node, P.FinalDestId, P.DestZoneId, P.data)
ELSE
PART C.5 :
TempNodes := Ø
For each entryRT in IntraZoneRoutingTable | entryRT.NodeType = BORDER DO
For each zone in entryRT.ZoneIds DO
IF (zone = entryZone.NextZoneId) THEN
            Save entryRT.DestNodeId in TempNodes
ENDIF ENDDO ENDDO
Choose randomly destNode from TempNodes
Find entryRT in IntraZoneRoutingTable | entryRT.DestNodeId = destNode
Send a packet P' (n.NodeId, destnode, entryRT.NextHopId, P.FinalDestId, P.DestZoneId, P.data)
ENDIF ENDIF ENDIF ENDIF ENDIF ENDIF
```

4.3. Management and administration of multi-tasking platform

A smart home energy efficient and secure requires not only the implementation and installation of a multitude of electronic devices and sensor nodes but also the design and development of a software platform that hides material entities manipulation complexity. This platform will be equipped with a graphical user interface (GUI) that creates a virtual environment easier to use by users. However, our platform provides an interface automation multitasking modular, scalable and easy to operate. Our platform enables the management, monitoring and control equipment simultaneously each application on the one hand, and secondly the wireless sensor nodes installed. In addition, users can remotely monitor and manage their habitats through a dedicated Web interface. The physical structure of our platform is composed of three layers: physical layer, management layer and application layer. (a) The application layer consists of GUI, which provides the user with the services of monitoring, management and control of each task. (b) the control layer consists of a set of modules allow for the collection and recording of sensor data in the database, analyzing data and implementing an appropriate scenario, the control and management of equipment and sensor nodes and the configuration of the control interface of the application to the user. (c) The physical layer contains the sensor nodes responsible for collecting such data in our application of intelligent home (temperature, humidity, gas) and nodes (sink) for transferring data to the treatment station. It also includes actuators that control equipment (air conditioners, fans, cameras ...) installed in our smart houses. The Web server allows the user to control and monitor its application remotely via a Web interface.

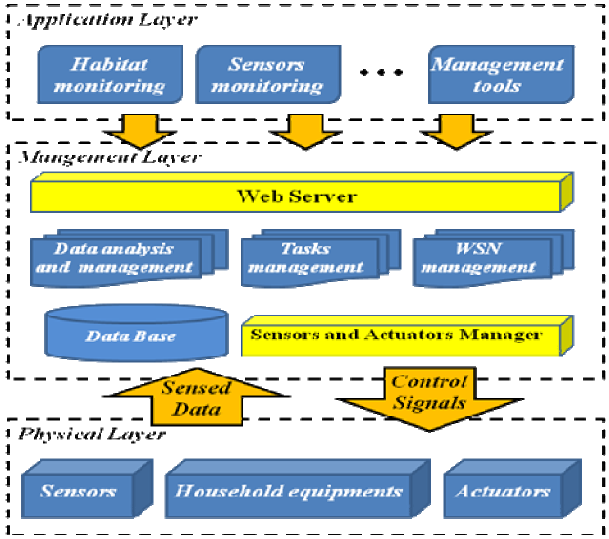

Figure 5. Physical structure of our platform

Our platform provides an intelligent behaviour in the environment such as habitat or for any other application. Instead of a group of sophisticated equipment, it creates an integrated environment in which the system can infer and react appropriately in response to changing conditions and events, and if necessary alert the occupants of the house. This environment uses an XML (eXtensible Markup Language) database. On this basis, there exists: the data collected by the sensors, the events triggered, programmed scenarios, users with their access rights and configuration of the platform (available applications, sensor nodes, GUI, architecture of habitat ...). Among the most important steps in the process of implementation of the generic interface dedicated for multi-tasking is the design using UML (Unified Modelling Language). To validate the proper operating of our generic interface multitasking, we run on our application of "MyIHabitat (Figure 6).

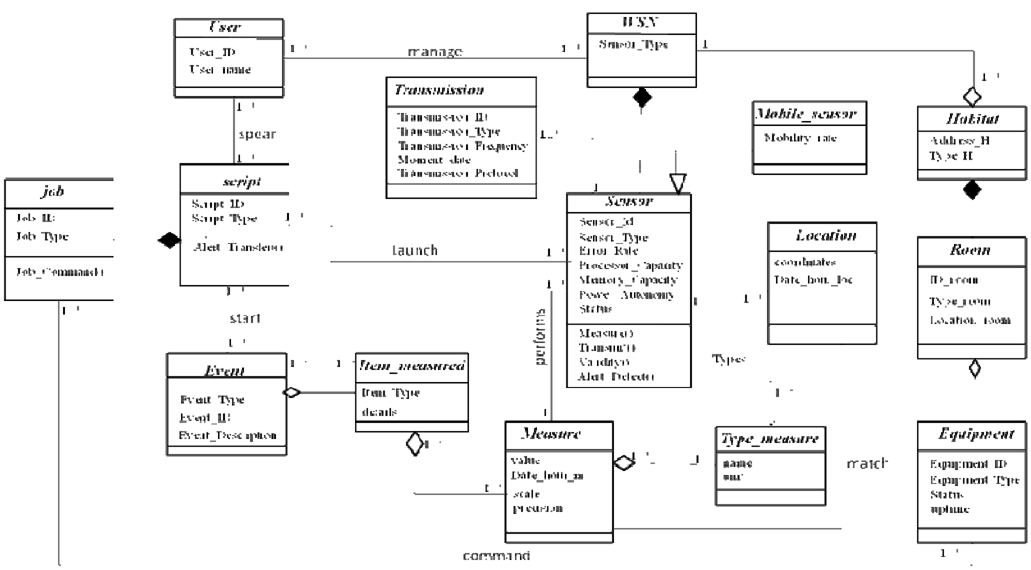

Figure 6. Class diagram of the platform "MyIHabitat"

Through our platform, users can easily manage all components of its habitat, for example: electrical equipment, doors, shutters, security cameras, the sensor nodes and the same GUI command provided by the platform (buttons, panels...). Indeed, using a dynamic interface - modular and scalable proposed, the user can adapt the sensor nodes for other new applications in the platform (extensible platform). The interface of the platform, in the case of "MyIHabitat", consists of a main menu allowing access to different topics: (α) habitat architecture configuring interface: the user must define the rooms of habitat types and to control and order them separately. (β) deployment-control and sensor remote: In this interface, users can manage their matching WSN as tree containing all sensors with their statements. Possibly the control, activation or deactivation of a sensor will be in this category. A simple click on a sensor can view the newspaper operation, frames sent, error rate, type, status... (γ) User Configuration: In this interface, the administrator adds or deletes users and attributes access rights. A task not permitted to a user, it does not appear after authentication. (δ) Configuration of various applications: This step is very important for the large number of sensors that can be deployed and the large mass of collected data and scenarios / events that are configured for user comfort and habitat monitoring.

5. CONCLUSION

In this paper, we have been proposed and analysed an optimal-generic-multitasking platform using WSN and its operation. The proposed solution improved the significant performance to the WSN applied in the intelligent home automation fields, medical area ... and overcome several disadvantages of the conventional platform. The multitasks-generic platform has been solved two problems concerning the complexity of the system and the performance. The effectiveness of the multi-tasks platform has showed and approved viewpoint of management, simpleness, robustness, preciseness, and particularly when the interface number of the proposed system is decreased by 1/N compared with the conventional system, taken into account N tasks. The improvements in the execution, concerning the time and the speed of the proposed system have made rapid progress with Jen 5139 module.

REFERENCES

[1] I. F. Akyilidiz, W. Su, Y. Sankarasubramaniam, E. Cayirci, (2002),“Wireless sensor networks: a survey”, Computer Networks, 38 (2002), pp. 393-422.

[2] P. Baronti, P. Pillai, V. W.C. Chook, S. Chessa, A. Gotta, Y. Fun Hu,(2007),“Wireless sensor networks: A survey on the state of the art and the 802.15.4 and ZigBee standards”, Computer Communications, 30 (2007), pp. 1655-1695.

[3] I. F. Akyilidiz, M. C. Vuran, (2010), “Wireless sensor networks”, WILEY series on communications and networking, chapter 1 & 2, pp. 1-49, ISBN : 978-0-470-03601-3.

[4] W. Dargie,C. Poellabauer, (2010),“Fundamentals for wireless sensor networks”, WILEY series on Wireless communications and mobile computing, part one, chapter 1 & 2 & 3 & 4, pp. 3-91.

[5] J. Yick, B. Mukherjee, D. Ghosal, (2008), “Wireless sensor network survey”, Computer Networks, 52 (2008), pp. 2292-2330.

[6] V. R. Syrotiuk, B. Li, A. M. Mielke, (2009),“Heterogeneous Wireless Sensor Networks”, Algorithms And Protocols For Wireless Sensor Networks, WILEY series on parallel and distributed computing, chapter 2, pp. 21-50.

[7] N. Vlajic, D. Stevanovic, G. Spanogiannopoulos, (2011),“Strategies for improving performance of IEEE 802.15.4 / ZigBee WSNs with path-constrained mobile sink(s)”, Computer Communications, vol. 34, n°6, pp. 743-757. http://dx.doi.org/10.1016/j.comcom.2010.09.012.

[8] A. Nayak, I. Stojmenovic, (2010)," Wireless Sensor and Actuator Networks: algorithms and protocols for scalable coordination and data communication", WILEY series, chapter 1, pp. 1-32.

[9] J. Polastre, R. Szewczyk1, A. Mainwaring, D. Culler, J. Anderson, (2004),"Analysis of wireless sensor networks for habitat monitoring", Wireless sensor networks, VI, pp.399-423. DOI: 10.1007/978-1-4020-7884-2_18. Springer Link.

[10] S. Wu, Derek C. Croome,(2007),"Understanding the indoor environment through mining sensory data—A case study", Energy and Buildings, 39, pp. 1183–1191.

[11] M. Kuorilehto, M. Hännikäinen, T. D. Hämäläinen,(2005),"A survey of application Distribution in wireless sensor networks", EURASIP Journal on Wireless Communications and Networking, 5 (2005), pp.774-788.

[12] Th. Arampatzis, J. Lygeros, S. Manesis, (2005), "A survey of applications of wireless sensors and wireless sensor networks", Proceedings of the13th Mediterranean Conference on Control and Automation, Limassol, Cyprus, June 27-29, pp. 27-29.

[13] H. Alemdar, C. Ersoy,(2010),"Wireless sensor networks for healthcare: A survey", Computer Communications, 54, pp. 2688-2710.

[14] I. F. Akyildiz, T. Melodia, K. R. Chowdhury,(2007),"A survey on wireless multimedia sensor networks", Computer Networks, 51, pp. 921–960.

[15] I. F. Akyildiz, E. P. Stuntebeck,(2006),"Wireless underground sensor networks: Research challenges", Ad-hoc Networks-ELSEVIER, 4, pp. 669–686.

[16] A-B. G. Hernando, J-F. M. Ortega, J-M. L. Navarro, A. Prayati, L. R. López, (2008), "Problem solving for wireless sensor networks", Computer Communications and Networks, Springer-Verlag London Limited, chapter 3 & 4, pp. 17-99, ISBN: 978-1-84800-202-9, DOI : 10.1007/978-1-84800-203-6.

[17] J.Blazewicz, K. H. Ecker, G. Schmidt, J. Weglarz, (1996), "Scheduling in computer and manufacturing systems", second revised edition, Springer-Verlag, chapter 2, pp. 59-73.

[18] C. Artigues,(1997),"Ordonnancement en temps réel d'ateliers avec temps de préparation des ressources", Thèse de doctorat, Laboratoire d'analyse et d'architecture des systèmes, CNRS.

[19] S. Demassey, C. Artigues, P. Michelon,(2001),"Coopération entre programmation linéaire et programmation de contraintes pour l'ordonnancement de projet à moyens limités", Rapport interne LIA, Février 2001.

[20] J. T. M. Pirlot, (2002), "Optimisation approchée en recherche opérationnelle", Edition LAVOISIER, chapter2, pp. 37-46.

[21] Konnex-Association,(2003),"KNX the technology, which integrates all the applications in home & building", Konnex Journal, 3(2003), pp. 59-111.

[22] G. Knotts, M. D. Bruce, C. Hartman, (2000), "Agent based project scheduling", IIE on Transactions, 32 (2000), pp. 387-401.

[23] J. Holland, (1975), "Adaptation in natural and artificial systems", University of Michigan press, Ann Arbort, USA.

Authors

Mahmoud Mezghani, received Master diplomated in 2005 from the Higher Institute of Computer and Multimedia of sfax-Tunisia, and the master's degree Research in Safety and Security of Industrial Systems, specializing in Real Time Computer and Electronics since 2007 from the Higher Institute of Applied Sciences and Technology of Sousse-Tunisia (ISSATSousse). Since 2011, he was student doctoral in Electrical Engineering**.** Her current research interests focus on the intelligent cooperative Wireless sensor networks based on multi-agent approach for effective control of the flooding and optimal management of information.

Ghada Ellouze, borned on 04-09-1989 in Sfax. She received her Bachelor's in 2008. She was diplomated from the Higher Institute of Electronics and Communication in 2011. During her academic

years three following stages: in Tunisia Telecom (June2009), in The Tunisian Post (Jully2009) and the third was in the company Cynapsys in July 2010. Her research interests focus on the achievement of an embedded plateform multitasking based on Zigbee.

Amal Grati, borned on 18-09-1989 in Sfax. She received her Bachelor's in 2008. She was diplomated from the Higher Institute of Electronics and Communication in 2011. During her academic years three following stages: in Communication Center of Tunisia (Programming a dynamic Web Site with PHP and JavaScript) in 2009, in the Tunisia Telecom (2009) and the third was in the Mahida Center (Management application with C#) in July 2010. Her research interests focus on the WSN in health care area.

Imen Bouabidi, borned on 17-03-1989 in Mednine. She received her Bachelor's in 2008. She was diplomated from the Higher Institute of Electronics and Communication in 2011. During her academic years two following stages: in Tunisia Telecom in 2009 and 2010, in the Tunisia Telecom (2009). Her research interests focus on the WSN in health care area.

Raja Gatgout, borned on 16-11-1987 in Jerba. She received her Bachelor's in 2006. She was diplomated from the Higher Institute of Informatics and Mathematics in 2009.She received Master diplomated in 2010. Her research interests focus on the control of energy consumption with WSN.

Pr. Mahmoud ABDELLAOUI, received the B.S. degree in Electronic Engineering from High National Engineering School of Electronics and their Applications (ENSEA), Cergy, france, in 1988, and the M.S. degree from Lille University, france, in 1989. He received his Ph.D. degree in Electronic Engineering from Ecole Centrale de Paris, in 1991. He received his Habilitation degree in Electrical Engineering from National Engineering School of Sfax, Tunisia, in 2007.

From October 1991 to September 1995, he was a Post doctor with Electronics & Telecommunications Research group in ENSEA-Cergy University, france. From September 1996, he has been an Assistant Professor at INSAT & ISECS, Tunisia. In October 2007, he was promoted to the rank of Associate Professor at High National Institute of Electronics and Communications, Sfax, Tunisia. His current research interests include wireless communications like Link and System capacity, Multistandards MIMO-OFDM systems; Mobile Networking (mobile IP networks, VoIP, networking wireless networks based on ISPDPLL); Wireless Sensor Network (WSN). He's the author of many published articles in: International Journal on Wireless Personal Communication (Springer); International Journal of Computer Sciences; American Journal of Engineering and Applied Sciences; International Journal of Electronics & Communications (AEŮ)-ELSEVIER; IEE Electronics letters; IEEE-MTT,… etc.

Dr. Abdellaoui has been invited as a reviewer of IEEE communications letters, International Journal of Electronics and Communications (ELSEVIER), Wireless Personal Communication (Springer)… etc.