Poster Abstract: A Global Resource Management Model (GRMM) for Wireless Sensor/Actuator Network

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Abstract - *Sensor networks represent a significant improvement over traditional sensors. Very advanced application can be designed on wireless sensor network if network resources are optimally managed. This critical issue advises to design a complex resource management plane (as a framework) composed by ad-hoc protocols to communicate, to reserve network resource, to optimize network resource.*

Key words - Resource Optimization, Resource Reservation, Wireless Communication, Wireless Sensor Network.

INTRODUCTION

RECENT advancement in wireless communications and electronics has enabled the development of low-cost, low-power, multifunctional sensor nodes that are small in size and communicate in (relatively) short distance. These tiny sensor nodes, which consist of sensing, data processing and communicating components, leverage the idea of sensor networks. Sensor networks represent a significant improvement over traditional sensors. Sensor networks can be used for various application areas (e.g., health, military, home). For different application area there are different technical issues that researchers are currently resolving.

Resource Optimization is a central and critical issue for Wireless Sensor/Actuator Network. Sensor hardware is rapidly improving and, as consequence, requests and computation level of applications that work on WSN are increasing too. If interest applications are really characterized by high level, a global and complex resource management plane is required; Global Resource Management Model (GRMM) is the proposed model.

GLOBAL RESOURCE MANAGEMENT MODEL

Figure 1 shows the proposed model. Different classes of protocols and planes, organized on various logical interdependent layers, are designed to support, in optimal way, high level applications. Critical research issues are the follows:

- Topology/Logic Organization
- Communication protocol
- Resource Reservation System
- Optimization Layer

Other important issue, directly related with the others, is the management plane. Optionally a Security Layer can be designed.

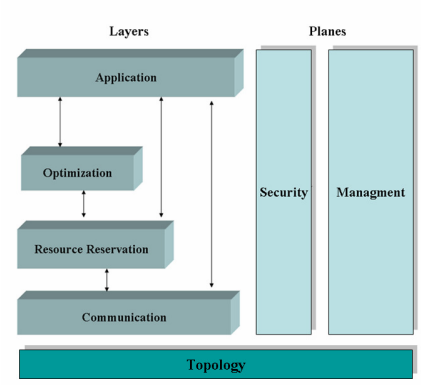

Figure 1: GRMM structure.

I. Topology/Logic Organization

Sensor/Actuator nodes are organized in logic areas and levels (Figure 2). This logic organization can be supposed 2D or 3D.

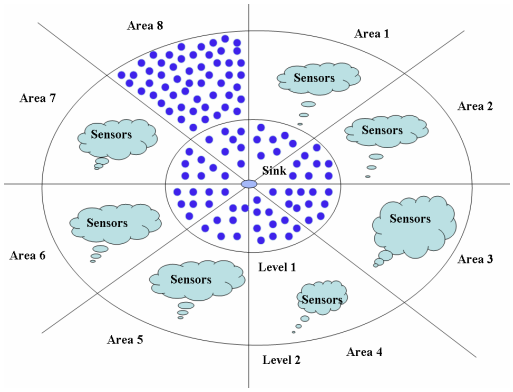

Figure 2: Logic Organization.

Some topologic parameters, as for example the number of areas and levels, the number of nodes in each sector, determine some network characteristics .In general way, a great number of nodes increases network scalability (and cost) decreasing network performance.

II. Communication protocol

Communication protocol provides, basically, a routing plane for the network. The interest characteristics are mainly performance (minimum number of hops) and scalability; so, independence of application field and application requests, communication protocols must be able to guarantee different communication planes. Typically, a wireless sensor network is a relatively centralized system for the presence of Sink. This means that communication protocols are related with convergence and divergence of information both. A good communication protocol, typically, guarantees an optimal communication in convergence mode. Scalability is a critical issue for the communication in divergence mode; so,

communication protocol is really integrated with Resource Reservation Protocol to optimize the divergence of information using particular structures (spanning tree, for example). A good example of communication protocol that guarantees performance and scalability and that can be integrated with resource reservation protocol is LRA (Logic Routing Algorithm) [1]. Using the configuration (and related connectivity diagram) that guarantees best performance and minimum scalability (Figure 4) showed in Figure 3, LRA simulation returns an average number of hops next to 4 hops.

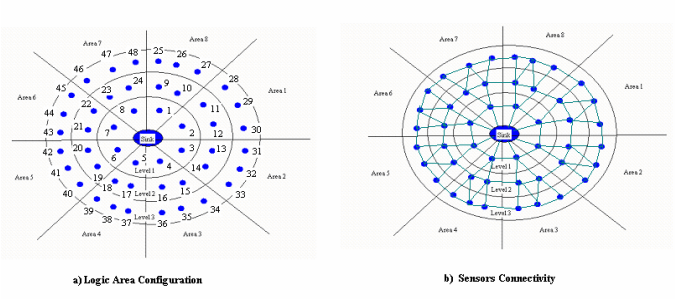

Figure 3: Logic Area Configuration and sensor Connectivity.

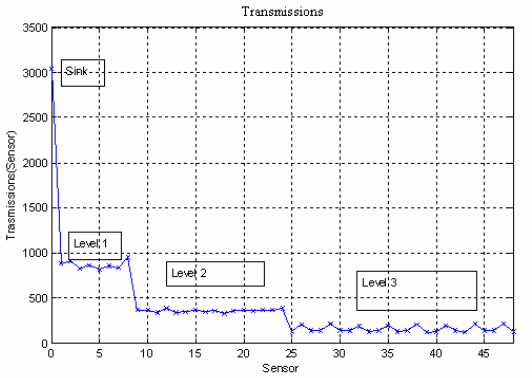

Figure 4: Load distribution.

III. Resource Reservation System and self re-configuration

Resource Reservation can be considered as an important research issue in a large number of context (wired, wireless) and for a large number of applications (multimedia, for example). Many applications can require some resources to work (minimum resource request) or a number of resources to guarantee a quality of service. Resource Reservation in Wireless Sensor Network means integrating other protocol layers to optimize their functions and provide interest application of nodes that can have special "roles" (leader area for example) or ad-hoc optimization structure (spanning tree for example). Different applications can so share the same WSN. The main characteristic of Resource Reservation Layer (self re-configuration) determines a higher dynamism for application.

IV. Optimization Layer

Resource Optimization is a central and critical issue for Wireless Sensor/Actuator Network. Sensor hardware is rapidly improving and, as consequence, requests and computation level of applications that work on WSN are increasing too. Resource Optimization layer has the main goal to optimize network resource in function of application characteristics. A power expense model by single sensor node point of view (PEM) is designed; PEM is used to design PEC (Power Expense Coefficient); PEC is a power expense model of a single sensor/actuator node but by network point of view. PEC is a "guide" to measure the "goodness" of network design in function of interest application. Finally a real resource reservation protocol, TROP (Timed Resource Optimization Protocol), is designed. The main goal of TROP is to minimize PEC. This layer is important by methodological point of view: different mathematical node models can be designed independence of hardware considered or general node characteristics, as well as different guide coefficients and finally different protocol/models for resource optimization. Figure 5 shows the simulated results independence of application characteristics (real time coefficient).

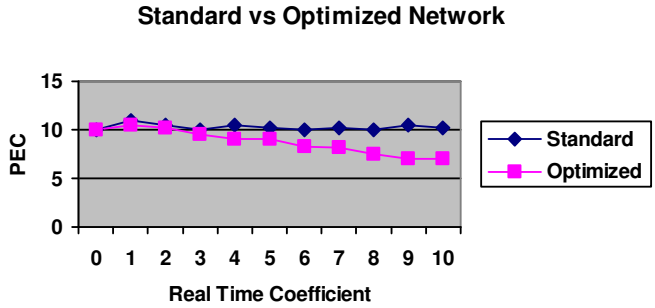

Figure 5: Standard vs Optimized Network.

CONCLUSIONS AND FUTURE WORKS

A framework (GRMM) to support the development of high level applications on WSN was designed; some mathematical models that can support the designer in resource optimization step were proposed too. Future works are mainly focused on the development of applications over proposed framework; interest application fields are related with:

- Reliable tourism
- Habitat monitoring
- Security and Alarm systems

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