

# Exploitation of the EDF Scheduling in the Wireless Sensors Networks

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## ABSTRACT

*Today, due to recent advances in wireless technology, new products using wireless sensor networks are being employed. However, despite the excitement surrounding wireless sensor networks, it is not immune to the problem of energy consumption. To overcome this deficiency and enhance the real time aspect, a growing interest lies in the implementation of an “Earliest Deadline First” (EDF) scheduler. Thus, in this paper, the authors establish a management policy of periodic tasks that is preemptive, multiprocessor, and dynamic. The authors implement a real-time scheduling policy as a part of a user-level threads package under the Linux operating system as Linux does not support EDF. Furthermore, this paper describes the technique of the EDF scheduler and how it can yield to significant power savings.*

*Keywords: Earliest Deadline First (EDF), Energy Consumption, Linux Scheduler, Real Time Scheduling, Wireless Sensor Networks (WSN)*

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## INTRODUCTION

The network technologies of wireless sensors have become a global trend in communication, mobility and research of flexible implementation. With these advantages, these networks are undoubtedly among the principal vectors of development of embedded real time systems (Chéour, Lahmar, & Abid, 2011). Because they control or monitor real time processes, they must be able to respond to requests within a certain time limit. Confined essentially to

autonomous applications and small networks where man could hardly intervenes, the energy supply appears to be, therefore, the highest priority in the design and development of sensor networks (Chéour, Bilavarn, & Abid, 2010). In fact, it poses several challenges that the real-time scheduling seems to take up (Chéour, Bilavarn, & Abid, 2010). In the other hand, sensors networks are commonly used in environments where the guarantee of the response time is vital. The system must be flexible enough to cope with a dynamic and changing environment and to be able to meet its deadlines and to detect temporal conflicts,

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caused by different resources. Besides, meeting temporal deadlines leads to many problems that real-time scheduling can solve (Chéour, Bilavarn, & Abid, 2010). Once confined to a limited role and thanks to its impact on minimizing the consumption of energy, especially for sensor networks, scheduling is now a basic entity of the development of real time systems. Currently, the use of multiprocessor solutions for sensor networks is not obvious. However, as perspective in our work we aim to manage complex applications (video processing and others). A scheduling algorithm is perceived as a set of rules that select the task to run at any time during the life of a system (Liu & Layland, 1973). Therefore, we can consider scheduling as an algorithm that allocates the basic units of time called time quantum. A strict real-time system is essential to ensure the respect of deadlines for each task. The deadlines consist of run-ability constraints (each task must be completed before the next request) (Liu & Layland, 1973). Thus, a scheduling policy is applied to check the deadline of each task, the material constraints and the dependencies among data. In this paper, the EDF scheduler aims at evaluating a task set with given properties in terms of schedulability and compliance with given execution time constraints. It exactly consists in implementing and estimating such policy in an operating system, such as Linux.

The remainder of this paper is organized as follows. In the first section, we introduce Linux's most important abstraction, the process or the task model for basic process management including the scheduling (Love, 2007). Then, we discuss an issue related to the specific policies of energy's management in the sensors networks. The following section deals with the fundamentals of the EDF. Next, we will give a concise overview of the Linux process scheduler, its scheduling algorithm and its API. Furthermore, we outline the experimentation and the results observed within the scheduler. Also, we compare the performances of our scheduler developed on Linux with the results obtained with the simulation tool for multiprocessor scheduling STORM (2011).

## 1. STATE OF ART

The majority of scheduling strategies uses the concept of task. Several models of recurring real-time tasks have been defined. Belonging to one of these families influences strongly how the system will operate and particularly the type of the algorithm to use. We will try to give a glance about the task models and an overview of different techniques that reduce energy consumption.

### 1.1. Tasks Models

Tasks can be grouped into three families: periodic, aperiodic and sporadic. The simplest and the most fundamental model is provided by the periodic task model of Liu and Layland (1973). The periodic tasks are those which processing is repeated on a regular basis such as the regular monitoring of the state of a physical sensor or sampling of the serial communication line.

$T_i$  a periodic task is characterized by the quadruplet  $(O_i, T_i, D_i, C_i)$  (Burns & Welling, 2009) where:

- The date of arrival  $O_i$ , is the moment of the first activation of the task  $\tau_i$
- Time of execution  $C_i$  specifies an upper limit of the time of execution of each task  $\tau_i$ .
- The relative deadline  $D_i$  denotes the separation between the arrival of the task and the deadline (a task that arrives at time  $t$  has a deadline at  $t+D_i$ );
- A period  $T_i$  denoting the duration between two successive activations of the same task.

### 1.2. Power Consumption

The CMOS (Complementary Metal Oxide Semiconductor) is the dominant technology in electronic circuit. So, the power consumed is divided into two parts which are the static and the dynamic power. In CMOS, the dynamic power presents 80-85% of the whole consumption (Chéour, Bilavarn, & Abid, 2010). Most of the times, we consider that the static power of the core is negligible (Castagnetti, Belleudy,

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