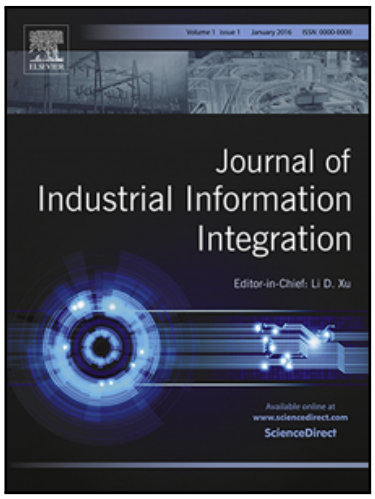

Engineering Friendly Tool to Estimate Battery Life of a Wireless Sensor Node

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***Abstract*—Battery life of low power devices is a major concern for the users of such devices. Existing research focuses on using different power management techniques and power consumption models to predict the battery life. However most of the exiting power consumption models and simulators assume a high degree of technical expertise of the users such as user of a home automation system. This paper proposes a power consumption model that can be used as an easy to use engineering tool by the end user or system integrators to estimate the battery life of the device by just estimating the levels related to expected traffic that network will support and the possible interference level depending on the number of interference sources. The tool can also be used by the device manufacturer to compare/select chipsets, batteries or alternatively optimize the some parameters of the communication protocols for a selected hardware to get the desired battery life. The model also provides insights to the major components that contributes to the power consumption under different number of operations and different traffic conditions. Finally the paper provides strategies to mitigate the effect of the different components contributing to the power consumption.**

Keywords—wireless sensor network; Internet of Things; battery life; power consumption model

I. INTRODUCTION

In the time of Internet of Things (IoT), wireless sensor and actuators finds usage in different domains such as building automation, process automations, factory automation, power automation etc. Most of them are based on the three "Lows"; the Lows are identified as low cost, low resources and low power. Mostly these devices are battery powered and are expected to be operating on batteries for at least a couple of years. Maximization of the battery life is widely researched area with numerous work such as [1] that has studied the different battery models and their discharge behavior. Different power management techniques [2] are also proposed in the literature.

Thus a user purchasing such a device or a system integrator deploying a device in a location would ideally want to get an estimate how long the device will last given the actual deployment conditions. The actual deployment conditions can be related to number of operations that will be performed in the device, the severity of the traffic flows in the network, the type of the environment the nodes will be deployed in which will in turn influence the Packet Error Rate (PER) or Bit Error Rate (BER). There can also be some configuration parameters that can be chosen by the system integrators/users at the time of deployment which can affect the battery life. These include the type of batteries, the total charge of the battery, its sleep current etc. In general the system integrators have much more information to guess that battery life of the devices he/she is installing. This requires that a tool is needed by the system integrators or the users which is easy to use and will be able to provide an estimate without requiring very deep technical input from him/her as this may not be his/her expertise.

There are numerous existing work that has tried to model the power consumption of a wireless sensors or actuator nodes. For example authors in [3] present a simulation framework to estimate power consumption of sensor network applications for arbitrary hardware (HW) platforms. It enables simulation of behavior of different hardware components such as central processing unit (CPU), timers etc. Similarly [4] express the relation of the battery lifetime with the imposed load and capacity for a common AA alkaline battery. In general it considers the current drawn for different operations by different hardware modules. Authors in [5] model the energy consumption of clustered wireless sensor networks (WSN). [6] explores different method to enhance the battery life of Zigbee modules by techniques such as using different packet lengths. Focusing on more IoT devices, authors in [7] present energy consumption measurement of networked embedded applications for Contiki Operating System based HTTP web server by both a simulation based method and a real world software based measurement method. Considering the different states of device such as transmission, idle etc. and transition between states, authors in [8] propose an energy consumption model of WSN devices based on their actual hardware architecture. Taking more of a system-level perspective to account for all energy expenditures: communications, acquisition and processing, authors in [9] proposes a power consumption model. An overview of the currently existing simulators and simulation methods for fast system simulation with respect to power consumption is given in [10]. Authors in [11] have proposed an energy consumption model that models the energy consumption in successfully transmitting one bit of data and takes into media access protocol to access the channel, length of the packets, transceiver functionality etc. However it