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A Comprehensive Study on Power Consumption in IOT

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ABSTRACT

IOT refers to a tightly tangled web of devices, such as sensors, software, actuators and normal items are not considered as computers, to extent the network connectivity and computing capability without any human intervention. Estimates by experts shows that by 2020, 30 billion objects would be a part of this network across the globe. IOT has brought about a tremendous change among the lives of the people-has made the radio frequency identification (RFID) a ubiquity and created a "smart world" by giving rise to intelligent business, smart cities, improved quality and much more. However, it has raised certain challenges, which cannot be ignored while realizing it is potential. One of the most disadvantageous facts about IOT devices is their tight requirements for power in order to keep themselves alive for interconnection. This paper talks about the need for an optimized energy consumption and some methods to avail it.

Keywords: IOT, Actuators, RFID, Smart World, Intelligent Business, Tight Power Requirements, Optimized Energy Consumption

I. INTRODUCTION

The term IOT, K. Ashton, first introduced the acronym for Internet of Things or Internet of Everything, to the globe in 1996. Its emergence transformed the global world into a local village where communication could be established in the blink of an eye. It is a continuous growing field and rapidly improving. A survey made by HP (Hewlett Packard) estimated 3 million devices were connected in the IOT by 1990, which increased to a hype of 90 million in just a span of 5 years. By 2010, 5 billion such devices were connected and in 2013 the estimation further increased to 9 billion. They predicted an interconnectivity of 1 trillion IOT devices by the year of 2025. IOT network has proved to be highly profitable for industries across the world. GSMA (Group Special Mobile Association) stated that IOT has the capability to generate revenue of $14 trillion for industries over the coming decades.

II. CHALLENGES

There are many challenges related to IOT. Some of them are protocols and standards, low power consumption, data to process, privacy and security, design complexity, connectivity, technological compatibility, system integration, end-user sophistication and many more are in the line. The biggest challenge is to design effective solutions to these problems.

Among these issues three major issues have been discussed i.e. security, privacy and low power

consumption. The former two have been discussed a little bit as the discussion revolves around the power management.

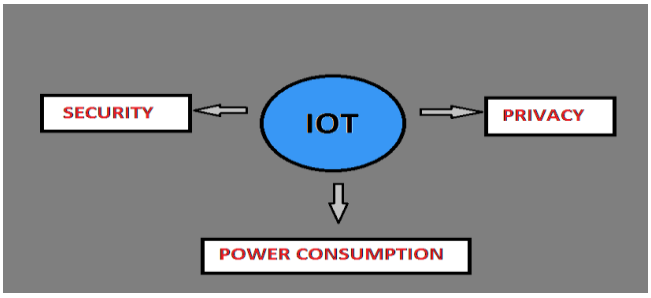

Figure 1. Major challenges in IOT

A. Security

With IOT becoming more integrated and pervasive in every nook and corner of the world, maintaining a secure network becomes a challenge since IOT makes devices connected to it vulnerable to some unique threats such as cipher attacks. Due to the interconnected nature of the IOT devices, even a single fault can lead to major cipher threat and theft of data. This issue is aggravated by exposing these devices to insecure environments, the automated interconnectivity between devices and mass- scale deployment of homogenous devices. Thus, the developers and users are bound to devise a system where all these issues get nullified or at least optimized enough to get ignored.

B. Privacy

The need for keeping the private information of individuals connected to IOT discrete and consistent is major. IOT challenges privacy by exposing data for online surveillance and tracking, predicting trends etc. A viable IOT network needs to protect the privacy rights and expectation of the uses to ensure confidence and trust in internet, connected devices and related services. Also, the user integrity should be maintained with utmost care.

C. Power Consumption

Every device connected to the IOT fights incessantly for the same power supply resources to maintain a running battery life. With the increase in making devices IOT ready, the power demand rises from that of an ordinary device. A smart connected device aim at achieving greater battery lifetime to stay feasible and working. While IOT certainly improves the human lifestyle- making it a piece of cake, designers and developers need to meet the demand for power each device requires ensuring a reliable and flexible interconnection. Almost every IOT device comes with a sensor which elevates the need for consuming power for its design as well as the resilience of EMI (electromagnetic interface).Since IOT is a wide network, its operation in vast climate conditions of the globe requires greater power consumption.

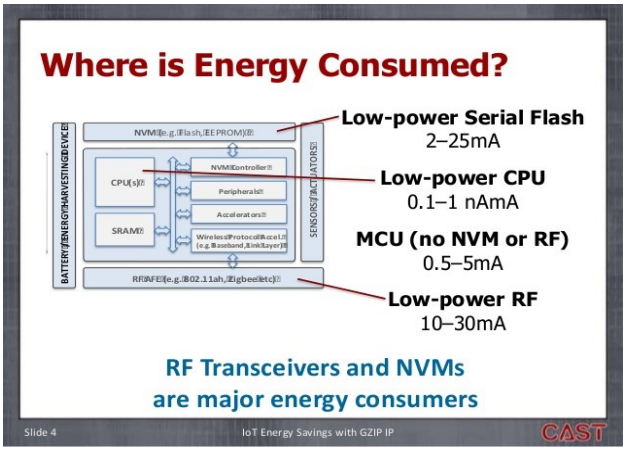

Figure 2. Energy consumption in devices, Source [12]

III. NEED FOR AN OPTIMIZED POWER CONSUMPTION

Majority devices of the 'internet of things' depend on cellular networks and demand a low latency rate (the amount of time in which data is send from a device to the time it is received back by the same device).But low latency rates often come at the cost of a high power usage. Moreover, the need for a faster exchange of data within the IOT framework demands for huge amounts of energy. Since, the rate at which energy gets produced falls short of the rate at which it is demanded and used up, a heavy depletion of power leads the way. According to a survey, 70% of the world depends on power to get things working- thus, power is a necessity for every span of life. Heavy consumption of power endangers the future of

extinction of energy producing resources. The rate for availing power in future is expected to become highly unaffordable for the common man. This poses a major threat for the future generations. Thus, a need to devise a smart and reliable mechanism while conserving power arises.

IV. COMPREHENSIVE APPROACHES

Devices consume energy in two forms:

- Static power Consumption: that power consumption, which devices require even when the devices are sleep.
- Dynamic power consumption: which is when the IOT devices are awake and operational the energy consumption they have is termed as the dynamic power Consumption.

Presently many approaches have been devised to cater the increasing power requirement of IOT devices and are proposed to minimize the power consumption.

A. Optimizing Hardware:

- Microcontrollers are considered the main energy consumers in IOT sensors. Variable sizes for these microcontrollers are available out of which 32-bit ARM (Advanced RISC Machine) reduced instruction set computing (RISC) is the most suitable for IOT devices. While its energy efficient but replacing it with the Cortex-Mo+ family of microcontrollers becomes more fruit able, yielding excellent energy conserving results. It is said that most Cortex-Mo+ parts consume only a mere 1μA power in the deepest sleep modes. Some sensors require greater I/O (input/output) ports and demand a larger RAM (Random Access Memory). Using STM32L031K6T7 micro controller for them is the best option. Choosing the best alternative for an energy efficient microcontroller requires the following considerations:

Lesser number of I/O pins, reduced internal peripherals, a low power timer included with internal parts and DMA (Direct Memory Access) Controller

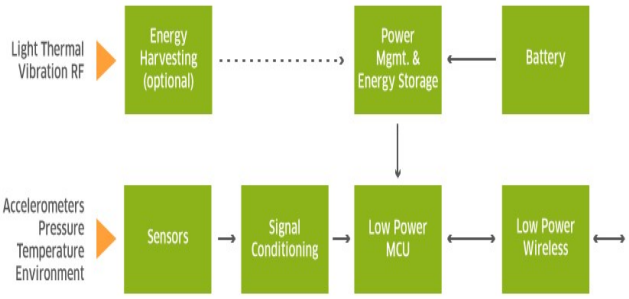

Figure 3. Power management techniques, Source [13]

- While designing a minimal power consuming system, we need to consider even the smallest part involved in the energy consumption. There by designing efficient memory and passives becomes a part of this action. Using the newer FRAM (Ferroelectric RAM) chips with microprocessors consuming power as low as 200 μA (1 MHz) saves almost 3mA for loading external memory. Also, replacing aluminum capacitors and reducing the leakage currents goes a long way in making devices more power efficient.

B. Optimizing Software:

- Efficient software's can be build by centers realizing their electrical limitations. Developers have devised low power mode systems by including reduced power timers for their wakeup timers, written event driven software's and using autonomous peripherals . Monitoring power with the IAR I-Jet I-Scope determines the lines of code consuming energy in the system. Using it together within an in-circuit debugging code for ARM, helps attain the major of voltage and current points around the system.
- Optimizing the transmission power for sensors is directly analogous to a decreased level of power consumption. Scientists have made a lot of efforts to effectively optimize the utilization of energy by making the MAC (Medium Access Control) layer better and improvised since transmission in wireless networks uses a many power based factors that consume up a higher amount of

energy. Thus, a reduced transmission power helps in efficient energy consumption by the sensor nodes.

C. Surveillance Of Energy Consumption

- Tracking energy take-ins of each device attached to a system, such as compressors, and continuously evaluating their energy requirements is a necessary for saving huge energy losses. This reduces the energy waste in real time consumption and brings down any charges on the maintenance. Eliminating the energy wastes are directly linked to reduced power consumption and help yield larger profits. This is achieved by using RT-ZVC (multi-channel power probe) along with CMWrun (sequencer software tool) and CMW500. This solution was given by Rohde and Schwarz and enables effective measurements of voltage and current. It provides visual graph of power consumption in various signaling states and estimates the average power requirements for a device's lifetime given its battery capacity.

D. Improvising The Network Topology

- The most effective topologies known to be consuming the least power is a mesh configuration using the Zigbee protocol. This attaches a biggest drain on the sensor node battery and consequently increases its feasibility. Thus making nodes highly reliable and the overall network cost effective.

E. Use of BLE (Bluetooth Low Energy)

Combining the wireless standards with BLE using a hybrid topology in the IOT based WSN (Wireless Sensor Network) called IOTWSN reduces the power wastage in addition to making it more energy efficient.

V. CONCLUSION

While the interconnection of sensors, networks, and computers has been the talk of decades, use of improvised and effective technologies has given a birth to a new reality for IOT. The Internet of Things has ushered a revolutionary, fully interconnected 'smart' world where each and every device is intertwined together into an endless loophole. While these potential benefits are significant, some unavoidable challenges may play a major role in making it lose its sheen!- particularly, the drawbacks of its power consumption. Because IOT is like a hot cake for the present world, a need to bring down these limitations is key for its success. We need to cater to these challenges locally and act globally to set up a flexible and reliable IOT network.

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