Reduce the Energy Consumption of Connected Objects

Mohammed Moutaib[1][a], Tarik Ahajjam[2][b] , Mohammed Fattah [1][c] , Youssef Farhaoui [2][d] and Badraddine Aghoutane[3][e]

[1]*EST, My Ismail University, Meknes, Morocco*
[2]*FST, My Ismail University, Meknes, Morocco*
[3]*FS, My Ismail University, Meknes, Morocco*

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Abstract: The Internet of Things, also known as IoT, is a new concept that has changed information technology. It is a new and growing technology envisioned as a global network. This new technology is becoming more and more essential and covers all areas. However, this phenomenon helps us communicate objects without human intervention, which proves a significant energy consumption. In this manuscript, we propose a solution to reduce the energy consumption of IoTs, through a general study of the solutions already used to deal with this problem, starting with a data flow design. These solutions are implemented in architecture to test efficiency.

1 INTRODUCTION

Today, the application of the Internet of Things (IoT) affects all computing domains (F. Firouzi, K. Chakrabarty, and S. Nassif, 2020). A phenomenon has developed computing (M. Weiser, 1991). This technology is gradually appearing in our world and is naturally integrated into everyday objects.

However, the IoT is applied to many new applications, for example, smart parking lots, smart homes, healthcare, and efficient energy management in smart homes (L. Atzori, A. Iera, and G. Morabito , 2010) are producing huge returns. Economic (E. Fleisch , 2010). Several researchers believe that the IoTs or connected objects are one of the civilian technologies that can affect international forces (National Intelligence Council, 2008).

Indeed, the Internet of Things is currently dedicated to many connected objects, devices with their own identities, and increasingly complex computing and communication capacities: telephones, watches, household appliances, and other devices increasingly equipped. Therefore, in terms of architecture, Internet of Things concept, protocol stacks, applications, and conceptual vision, recent research has started (M. R. Palattella, N. Accettura, X. Vilajosana, et al., 2013)(S. Tozlu, M. Senel, W. Mao, and A. Keshavarzian, 2012). The intelligent grid is considered to be one of the main applications of the Internet of Things. It has generated significant interest in recent years(L. Atzori, A. Iera, and G. Morabito, 2010) (N. Bui, A. P. Castellani, P. Casari, and M. Zorzi, 2012) (X. Fang, S. Misra, G. Xue, and D. Yang, 2012).

Connected objects can communicate with the external world independently without any human intervention. However, it has certain limitations which slow down their growth, such as data storage or energy consumption which plays a critical role in their operation (Mohammed Moutaib, Mohammed Fattah, Youssef Farhaoui,2020), which can receive and transmit data using onboard sensors (ROXIN, I., BOUCHEREAU A.,2017). Related objects add value when linked to other objects and software, for example, smartwatches.

[a] https://orcid.org/0000-0002-6376-6746
[b] https://orcid.org/0000-0002-6217-6795
[c] https://orcid.org/0000-0001-6128-9715
[d] https://orcid.org/0000-0003-0870-6262
[e] https://orcid.org/0000-0002-9555-6786

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Furthermore, the European Intelligent Systems Integration (EPoSS) technology platform defines the IoT as a global network with connected objects uniquely addressable according to a standard communication protocol (INFSO D.4 Networked Enterprise & RFID, 2008).

Some researchers have spoken of their extraordinary abilities (MAVROMMATI I., KAMEAS A., 2003), which can concentrate resources to perform different tasks and dynamics, they are linked to each other by links in the same network. In this case, some researchers like (WEISER M., 1993) have considered computer science, among which "the most profound technologies are those which have become invisible. These closely related things constitute our part of daily life so much so that they are inseparable. "(Mohammed Moutaib, Mohammed Fattah, Youssef Farhaoui, 2020).

The IoTs pose several problems due to their large scale, dynamic nature, heterogeneity of the data and its constituent systems (powerful devices/energy consumption, fixed/mobile devices, batteries/DC power supplies, ETC.). These functionalities require tools and methods adapted to implement powerful applications to extract helpful information and numerous data sources to store them in heterogeneous databases.

The major problem with connected objects is the energy costs which are distributed between battery devices which must be recharged regularly each time for each object, constant power devices (refrigerators, televisions, washing machines, thermostats, ...), and the servers and routers needed to provide connectivity of objects and consume a significant amount.

As for connected battery-powered objects, it is evident that a sharp drop in autonomy accompanies their technological progress. Performance can be improved, but the need to maintain a connection to the Internet or the local network is a drain on energy.

This is why our article aims to reduce the energy consumption of connected objects by offering a solution divided into two essential parts: design and implementation.

In this context, our article is organized as follows. Section 2 presents work related to our study. In section 3, we give our proposed solution. In section 4, the implementation of our solution along with the results and a description of the architecture. Finally, the conclusion.

2 LITERATURE REVIEW

Recently, new technological applications allow us to measure various parameters. Thus obtained various daily parameters and facilitated tasks without human intervention. These applications are developed thanks to the advantage of the IoTs and the innovation of new devices.

In this section, we describe recent research related to methods of reducing IoT energy consumption.

Several recent research has been carried out to optimize connected objects, such as (Benjamin Billet,2015) (Gang Sun, Victor Chang, Muthu Ramachandran, Zhili Sun, Gangmin Li, Hongfang Yu and Dan Liao ,2016). To manage large amounts of data and at the same time have reasonable power consumption, the most effective solution comes from L. Mottola and GP Picco; they came up with an application method that focuses on process management l IoT service. This solution focuses on the use of object centralization, in which the node sends all measurement results to the base. The latter generally stores them in a database and allows users to retrieve and process this information in the posterior part (L. Mottola and G. P. Picco, 2011). This single-jump mode can be used in case the sensors are close to the base. However, for sensor networks, it is necessary to adopt multi-hop communication. The nodes are linked directly to the base, which increases the possibility of link problems when all nodes are connected in real-time. This architecture adopts two-way communication for adaptation, which means that consumption has doubled.

Previous work on scheduling algorithms has mainly focused on reducing scheduling time (X.H. Xu, X.Y. Li; X. Mao, et al.,2011) (S. Wang and Z. Chen,2013) or distributed implementation (S. Wang and Z. Chen,2013) (M. Martalo, C. Buratti, G. Ferrari, et al.,2013]. A heuristic algorithm has been proposed in (S. Gandham, Y. Zhang, and Q. Huang, 2008] to the program as many independent segments as possible to increase the degree of parallel transmission. In (L. Shi and A.O. Fapojuwo, 2010), a cross-optimization protocol supporting energy efficiency and minimum delay in WSN networks is proposed. Furthermore, other technologies that have been implemented have been introduced in the previous chapter to minimize consumption.

To our knowledge, no research has succeeded in reducing the number of nodes in the IoT architecture to reduce consumption, which is one of this article's objectives.

3 ARCHITECTURAL DESIGN

There are varieties of solutions to reduce connected objects' energy consumption: To achieve hyper-connectivity, people choose continuous data transmission. However, in many cases, devices should only be inadvertently connected to the network, exclusively when all devices are operating in an automated fashion. Usually, the connected object is structured around two large families of devices that interact with each other:

Nodes: These are the most common devices on the network. They are generally equipped with low-power processors, wireless communication interfaces, and limited memory. They are the ones who use the sensors they carry to take measurements in the field (Boumaiz M., and all ,2019).

The basics:They are generally limited in number in the network. They are used as a centralized collection point for the receiving node's measurement values, used as an intermediary between two networks of sensors or as an intermediary or interaction with another network (D. Daghouj, and al,2020)..

However, after analyzing the existing models (Mawloud Omar, Yacine Challal, Abdelmadjid Bouabdallah, 2012), (M. Omar, Y. Challal, A. Bouabdallah, 2009), we propose a fully distributed trust model. We have not yet applied the rule of direct connection with the base, but we have introduced a new rule by which nodes can communicate with each other and exchange data: "Nodes A and B send to C, then C and D and E also send to F Immediately go to "Down" (Figure 2).

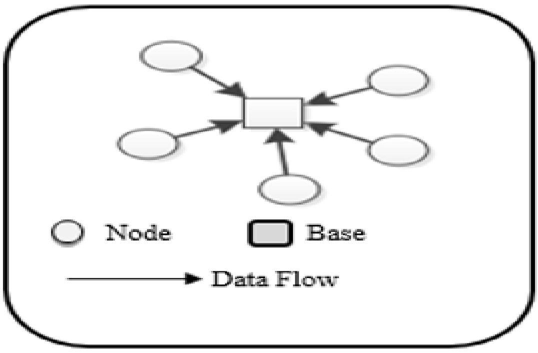

Figure 1: Centralized collection

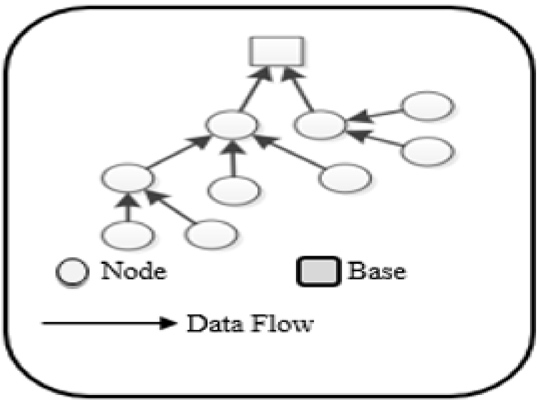

Figure 2: Distributed collection

The problem with data transmission: a single bit sent sometimes consumes as much energy as the processor executes a thousand instructions(A. Maroua , and all ,2019). To reduce energy consumption, several methods exist to reduce energy consumption such as:

•Time slots: In this solution, nodes are only allowed to communicate at regular intervals, while the network interface is disabled the rest of the time, which is helpful in some cases, but in most cases (the sensitive data) is not available (M. FATTAH, and al,2019).

•Single-hop: Each device only exchanges information with devices that are close enough to communicate. However, to minimize power consumption, the range of these links has been dramatically reduced (Tarik A., and all ,2019).

•Multi-hops: Each node can act as a functioning intermediary of the routing for other nodes, self-organizing to build a route through which a message passes.

The scheme typically uses a centralized approach (Figure 1), where the node sends all information to the base. These usually store it in a database and allow users to retrieve and process this information. In our solution, we want to create a distributed schema (Figure 2), where each node communicates with another node and passes data to the base node.

4 ARCHITECTURE IMPLEMENTATION

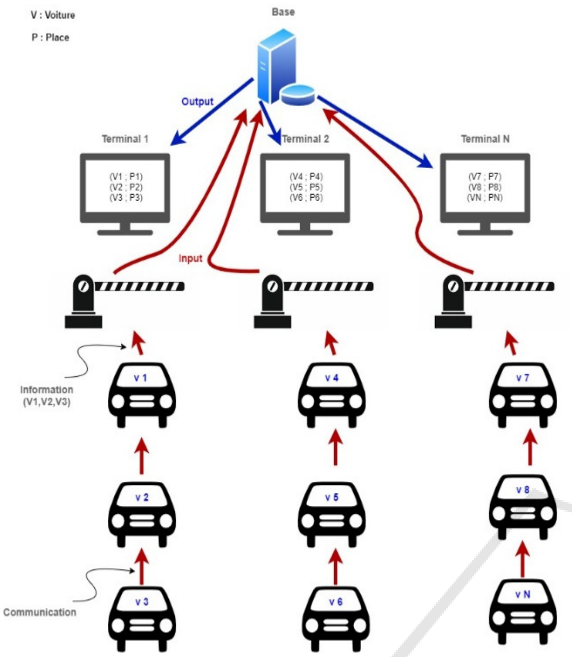

Figure 3: Application architecture of the solution.

After describing and deriving the working solution through the diagram in figure 2 of this chapter, we implement our solution in an intelligent parking lot. With this in mind, we explain below the different components of the application architecture, which divide our work into three parts:

Part A: (Car / Car)

In this part, we are based on the direct communication between the cars hierarchically so that the last car sends the information to the next car up to the first car in one direction only.

Example: (the first row of cars)

Car 3 sends its identifier to Car 2, and the latter carries the two pieces of information and sends it to Car 3.

$$V3 \rightarrow V2 \rightarrow V1 \quad (1)$$

It knows that each car is equipped with a chip that takes on a node/base to communicate with the other cars.

Part B: (Car / Barrier)

This second part has the role of opening the barrier through the communication between the first car and the barrier.

The purpose of the barrier is to process information.

Example:

Car 1 contains the following information (V1, V2, and V3); this information sent to the barrier, and the latter processes this information if it belongs to the identity of cars in the parking lot:

If the Exact case:

Opening within a defined period depends on the number of cars.

If not:

Do not open the barrier by indicating a message on the notice board.

Other cases:

If the information sent is:

$$(V1, V2, V3) \rightarrow \text{Barrier } 1 \quad (2)$$

Moreover, the second car does not correspond to the parking lot, and the opening only is for V1 and V3.

Part C :(Barrier / Base)

The last part of our solution is to make communication between the barrier and the base. After processing the cars' data on the barrier, this information is transferred to the base to be stored in the cloud and analysed to make long-term predictions and display conditions.

A message is displayed on the terminals for each entry line, which guides the cars to their parking lot places.

The contribution of our solution compared to others is that our solution aims to minimize the complex link between the nodes and the base and replaces it with a strategy that aims to make each node and base object at the same time to facilitate transmission

5 CONCLUSIONS

The technology market is attacked by a new phenomenon: "connected objects." These technologies' object is the object that uses the Internet to improve its function.

In the first part of this article, we were able to identify these areas and explain the progress they are undergoing.

This technology must be treated and protected on the one hand, as well as adapting the appropriate protocol to verify the identity of connected objects properly.

Our article has designed an architecture that contains a mechanism to minimize power consumption across the link between nodes. This mechanism is light, fast and robust. It facilitates communication between objects. In our first part, we were able to identify the fields of application as well as the progress they undergo. Finally, we have applied our approach in an intelligent parking lot and it has proven that this solution is applicable on other infrastructure such as houses, cities.

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