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BUILDING A CENTRALIZED SMART CITY SYSTEM FOR URBAN MOBILITY MANAGEMENT AND SOLVING PROBLEMS RELATED TO PARKING AREAS, PUBLIC TRANSPORT AND ECO-TRANSPORT PART 1 - SMART CITY INTELLIGENT SYSTEM IN THE BLUE AND GREEN PARKING ZONE[26]

Eng. Ivan Kolev, PhD
Department of Telecommunications,
University of Ruse "Angel Kanchev", Bulgaria
Tel.: +359 899 075 092
E-mail: ikolev@uni-ruse.bg

Assoc. Prof. Georgi Hristov, PhD
Department of Telecommunications,
University of Ruse "Angel Kanchev", Bulgaria
Tel.: +359 82 888 353
E-mail: ghristov@uni-ruse.bg

Assoc. Prof. Plamen Zahariev, PhD
Department of Telecommunications,
University of Ruse "Angel Kanchev", Bulgaria
Tel.: +359 82 888 353
E-mail: pzahariev@uni-ruse.bg

Abstract: *The focus of the article is to consider the principles and ideas for building a unified centralized system for urban mobility management and finding intelligent solutions to solve well-known problems in highly urbanized environments, such as parking problems in highly congested areas with existing Blue and Green areas or the construction of new ones, as well as finding innovative smart solutions to modernize and improve efficiency. The basis of this article is the need to create such a centralized system, which consists of many different software applications that communicate with each other via API (Application Programming Interface), collecting data in a central database, performing the necessary computational actions on central servers. , such as fees, tariffs, subscriptions, fines, generation of QR codes for identification or validation, etc.*

Keywords*: Smart City, intelligent parking solutions, public parking lots, blue and green areas, public transport, eco transport, LoraWan network, API and central database, smartphone app, Android, iOS, Centralized system, Web applications, Servers, efficiency , GPS*

INTRODUCTION

In recent years, the concept of the Internet of Things has become increasingly popular and widely used in our daily lives, while making our lives in many respects easier and more convenient. The Internet of Things is a generalized concept for the practical application of LoRaWAN (Long Range Wide Area Network) technology in various fields of activity, which has been developing since 1999.

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Over the last 20 years, LoRaWAN technology, based on the LPWAN (Low Power Wide Area Network) protocol, has undergone many changes and a huge evolution. The main advantages of LoRaWAN are the transmission of small data packets over long distances (10 - 30 km), the low power consumption of the terminal devices (nodes), and according to different specifications and application the terminal can run with a cheap battery up to 5 or even up to 10 years, performing its functionality normally.

Last but not least, the relatively low cost devices such as nodes and gateways that make up the physical layer of the LoRaWAN network. In this way, they cover a large area with minimal costs (Parkhi, P., Thakur, S., Chauhan, S., Jia-Ning, L., Ming-Hour, Y., & Ming-Chien, Y. (2014)).

That is why LoRaWAN is gaining more and more applications in our lives, such as remote reading of water meters, electricity meters, heat meters, data collection from meteorological stations scattered over long distances, reading sensors in industry and automation and more.

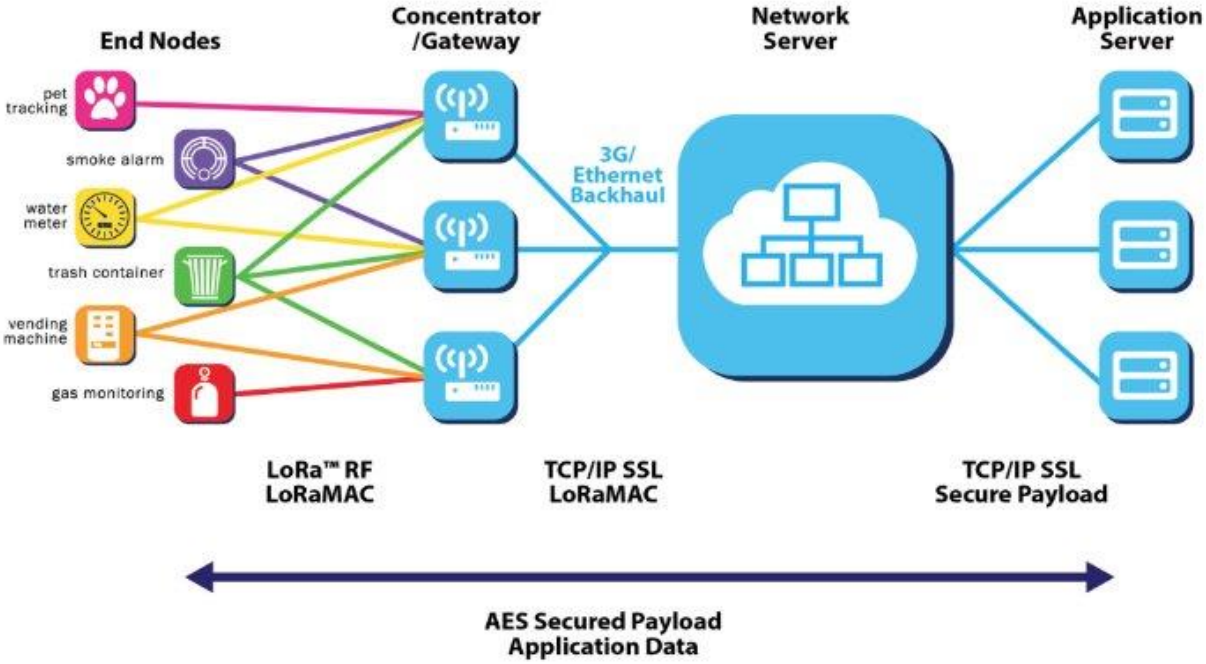

Fig.1 LoRaWAN architecture

In today's fast-paced world, we all more or less use different technologies, often with the word Smart in their name. Thirty years ago, perhaps none of us even imagined that we would carry the phone in our pocket. Today we all use smartphones, smart TVs, smart watches, etc. This reminds us that technology itself is smart, intelligent and innovative and is becoming an integral part of our lives.

THESIS

We have already noted some of the advantages of LoRaWAN, which would be extremely valuable in building an intelligent parking system in a highly urbanized urban environment, in order to solve well-known problems with parking cars in blue and green areas Bonde, D. J., Shende, R. S., Kedari, A. S., Gaikwad, K. S., & Bhokre, A. U. (2014, January). The main ideas in the design and construction of SMART CITY system are to improve the collection of parking fees, to maximize control over each parking space in the Blue and Green Zone, automating this process and reducing the number of employees for control, improving their efficiency. On the other hand, the aim is to facilitate the users of the paid parking services in the Blue and Green Zone, use of public

transport, use of Ecological transport with personal vehicles such as bicycles or electric scooters for rent. All these services are combined in one centralized software management system SMART CITY, consisting of many separate hardware and software components. Such a system provides its users for convenience and a variety of payment methods for the services they consume, through a single software application installed on their own smartphones (Hans, V., Sethi, P. S., & Kinra, J. (2015, October)).

Imagine that you are driving in an urban environment and looking for a parking space on a busy boulevard, along which there are separate parking areas on the sidewalk from the so-called Blue and Green Zone. You are a user of the system and you have installed a Smart City client application on your personal smartphone, which according to your current GPS coordinates directs you to the nearest free parking space on this boulevard.

Fig.2 Smart city - process 1

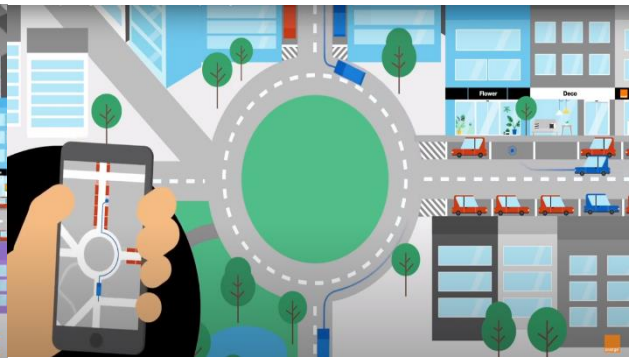

Fig.3 Fig.2 Smart city - process 2

You find this parking space and park. Each such place is marked with a peg, on which there is a sign with a large QR code, in which it is coded, the number of the settlement, the number of the parking lot and the number of the parking place.

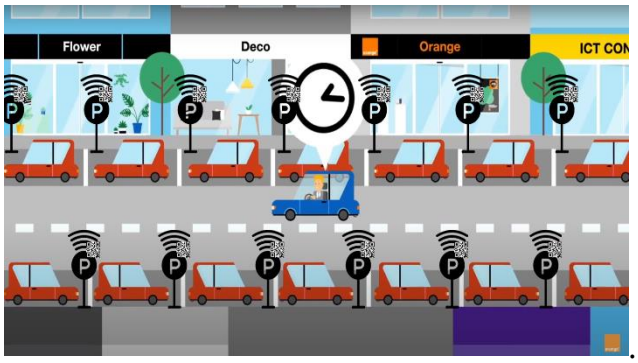

Fig.4 Smart city - process 3

Fig.5 Smart city - process 4

The identification peg of each parking lot, in addition to the QR code printed on it, also has a built-in LORA unit and an ultrasonic sensor to detect the presence of a parked car or the absence of one. Once you have parked, scan this QR code through the app and thus start a parking session in the system for that parking space and your car. As a user of the system, you are registered with your personal data and car number, and your unique identifier is the serial number of your smartphone.

You have the following options on how you will be charged. You can be on a prepaid subscription and depending on the type of the selected subscription plan you may have the right to park in 1 or more car parks in this area or in more than 1 settlements. You can be on a tariff plan with deferred payment, which takes into account the time of stay of all parking sessions and at the end of the month an invoice is paid for all of them. Another option is to pay for your current parking after the end of your parking session, just before you leave, directly through the app on

your phone. Of course, with this option, if for some reason you do not pay for your stay, you will be charged all the time until the opening of a new parking session by someone else for this parking space plus a penalty. The scenarios for paid parking used in the Blue and Green service by a client / user of the SMART CITY application are the following:

1. The client / user of the service has a valid prepaid monthly subscription, for unlimited time and number of use of the service. He needs to scan through his smartphone the QR code from the peg adjacent to the parking lot where he has already parked with the pre-installed SMART CITY application. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that he has a valid prepaid subscription for unlimited time and number of use of the service, he returns a reply to his smartphone with the validity parameters of the current parking. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

2. The client / user of the service has a valid prepaid monthly subscription for a limited number / time of use of the service, for example 40 credits (40 hours), and for each started hour when using the service 1 credit is deducted from the prepaid ones. He needs to scan the QR code from the peg adjacent to the parking lot where he has already parked with the pre-installed SMART CITY app. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that there is a valid prepaid subscription for limited number / time use of the service, reduces the number of credits by 1, returns a response to his smartphone with the validity parameters of the current parking. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

3. The client / user of the service does not have a prepaid monthly subscription but has indicated through the application that he wishes to be on a tariff plan with deferred payment. He needs to scan the QR code from the peg adjacent to the parking lot where he has already parked with the pre-installed SMART CITY app. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that for this client in the database there is a tariff plan with deferred payment, the system starts a new parking session for him with hourly charge and returns an answer to his smartphone with the validity parameters of the current parking. In this case, it is extremely important for the client to end his parking session through the application before leaving, as he will be charged until he opens a new session in another parking space or another user does not open a parking session for that parking space. Of course, the system will notify him at each starting hour, via Push Notifications, that the amount for hourly parking according to the tariff plan is added to it. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

4. The client / user of the service does not have a prepaid monthly subscription and has not chosen to be on a tariff plan with deferred payment. In this case, you must have an associated valid credit / debit card with the pre-installed SMART CITY application, then scan the QR code from the peg adjacent to the parking space where you have already parked. The system compares the parameters obtained during the scanning of the static QR - code with the information in the centralized system for this specific Client / user. Finding that for this client in the database there is a valid TOKEN for payment through the MyPOS system, a micro payment of BGN 1.00 is made and a response is returned to his smartphone with the validity parameters of the current parking. In this case, it is extremely important for the client to end his parking session through the application before leaving, as he will be charged until he opens a new session in another parking space or

another user does not open a parking session for that parking space. Of course, the system will notify him at each starting hour, via Push Notifications, that the amount for hourly parking according to the tariff plan is added to it. A QR code for verification is generated, which is displayed on the screen of the user's smartphone. This verification QR code can be scanned by control officers with another mobile application in the SMART CITY system, and information on the validity of the current use of the service is returned accordingly.

So far, we have considered the algorithm of response of the SMART CITY system to the user in terms of payment methods for the service. The user may have chosen to be on a prepaid subscription plan, and in the case of subscription plans the variations can be very different, for example unlimited in number, time or parking area, as well as a combination of restrictions on these same parameters. Accordingly, the price of the different subscription plans would be different according to the restrictions on the use of the parking service in the Blue and Green Zone. The user can pay for a subscription plan at the designated places, in which case the employee of the respective cash register uses the centralized software of the SMART CITY system to reflect the payment of a selected subscription plan for the specific customer already in the system with his smartphone. If the customer has an associated credit / debit card through the SMART CITY application or could from the application itself make a choice of a subscription plan and pay it directly online through the MyPOS system, without the need to visit the cash register. While for subscriptions the customer does not have to associate his credit / debit card with the SMART CITY application, as he can prepay at the checkout, in case the customer has chosen to use the service without a prepaid subscription, but on a one-time basis for each parking, then the customer must either be on a tariff plan with deferred payment, which again allows him to pay the amount charged at the cash register at the end of the reporting period or must have an associated credit / debit card to make an instant payment after a parking session. When choosing a tariff with deferred payment, the customer can pay the invoice issued to him at the end of the reporting period and through the SMART CITY application, where a complete history of invoices and payments will be displayed.

If we look at the reaction algorithm of the SMART CITY system from another aspect, namely from the feedback system with the LoRaWAN technology or in other words the network of LORA GATEWAYS and LORA NODES, respectively, which are integrated in the parking pegs themselves, marking each parking space. SMART CITY centralized system software monitors the information from each LORA NODE and responds as follows:

1. LORA NODE does not detect the presence of a car - this means that a parking space is available.

2. LORA NODE detects the presence of a car and the parking session is started in the system by a specific user of the system, who is on a prepaid subscription or is charged according to a selected tariff plan.

3. LORA NODE detects the presence of a car, but no parking session has started in the system - this means that we have an infringer who must be fined immediately.

The operation of the system in the third option is to notify the municipal employee, who is on shift and is responsible for the respective parking area. This municipal employee has a smart device (tablet or smartphone) on which another application (software) connected to the centralized system is installed. The system sends a notification through this application that a parking space is occupied illegally.

After reaching the respective parking number, the actions on the part of the municipal employee are the following:

Checks through the application from the Registration Number of the parked car, whether he is a user of SMART CITY.

- If a user is registered, the municipal employee takes photos by applying the front and rear number of the car and creates a penalty in the system for that user, attaching the relevant photos as evidence.

- If there is no registered user of the system, the municipal employee takes photos through the application of the front and rear number of the car. Creates a penalty in the system for an

unregistered user, attaches the relevant photos as evidence. The accrued penalty will be sought within the legal limits by the respective violator.

The information in the intelligent parking system, which comes from all Lora nodes, transmits the data to the Lora gateways and from there via the Internet to the centralized processing and storage servers is managed by centralized software. This centralized software is a complex ERP system of the SUPTO type, through which the subscription and tariff plans are managed. The separate parking zones are created, as well as virtual workplaces, customer subscriptions, reports and inquiries through sales and sanctions, monitoring of the entire system, etc.

CONCLUSION

LoRaWAN is used more and more and today we have considered another extremely useful application of this technology, which perhaps in the very near future we will see practically realized in the big cities and resorts of Bulgaria. The practical and financial benefits for the municipalities that will use the intelligent parking system in the respective settlements will undoubtedly improve the efficiency and will be proven to solve some of the known problems with parking. First of all, such a system will put an end to uncontrolled parking, with more and more blue and green areas for paid parking. Second, the collection of parking fees will be drastically increased. Sales of parking subscriptions will also be greatly enhanced, as will the effective collection of penalties from violators, as the system itself will detect such cases quickly and accurately and will inform the relevant staff immediately. Third, such a system will reduce the number of control officers in the Blue and Green zones, respectively, the cost of salaries and insurance, as 1 employee with a smart device and related software will be much more effective in detecting violators and imposing penalties, as and will be able to cover much larger areas than the Blue and Green Zones.

Fourth, payments through the client application will eliminate current payments via SMS and thus also minimize costs, as currently a significant percentage of revenue through SMS goes to the relevant operators through which this service is provided.

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