

Parking Reservation – application dedicated for car users based on telecommunications APIs

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Abstract—The main objective of this paper is proposition simple, easy to implementation and low cost solution dedicated for parking lots reservation. The presented application uses Unstructured Supplementary Service Data (USSD) as a communication channel between driver and parking system. USSD communication proposed in this paper is more efficient and comfortable for the end user in comparison with SMS used in many existing parking solutions. System is integrated with communication service provider infrastructure using Service Delivery Platform exposed APIs for telecommunication network in Internet. Application can be launched on every phone and does not require Internet access on mobile phone side.

I. INTRODUCTION

THE parking place is costly and sometimes very limited resource in the cities. Every day thousands of car drivers spend a lot of the time to find an empty parking space. The result of this situation is the air pollution in urban areas, increasing traffic congestion and frustration of drivers. In large cities the traffic generated by drivers searching free parking places can achieve about 40 % of total traffic [1]. In order to solve this problem, the implementation of dedicated reservation based parking system in cities for managing parking places is mandatory.

A. Existing solutions

In last years many researchers proposed architecture of advanced parking systems supporting citizen in free parking spaces allocation. In this chapter are described some of them.

The first solution is Smart Parking Reservation System proposed by researches from University Teknologi PETRONAS in Malaysia [2]. Using this system car driver can reserve parking lot using Short Message Services (SMS). SMS messages are read and interpreted by GSM modem installed in micro-RTU (Remote Terminal Unit). Micro-RTU also sends to the car driver informa-

tion about reserved lot number and password which is dedicated for opening barrier gate.

Another solution Automated Parking Slot Allocation System [3] proposes using RFID technology for allocation free parking slot. In this system the driver is informed about free parking place using SMS communication channel. The driver can use this channel to reserve his parking slot as well.

Another solution SmartParking described in [4] is dedicated for NOTICE. It is a secure and privacy-aware architecture for the notification of traffic incidents. In this system car driver uses dedicated mobile application for PDAs, smartphones, vehicle display and laptops which can read the information from SmartParking based on Internet access (data) to the system.

Smart Parking System developed by University of Nebraska-Lincoln [5] uses Internet (by Wi-Fi or GSM) for communication with end user using Web Application.

Another solution, Wireless Mobile-based Shopping Mall Car Parking System (WMCPS) [6] uses SMS for interaction with the driver. End user of the system can request for reservation car parking spaces using their mobile phone. WMCPS have got implemented GSM modem for integration with mobile network.

B. Description of the problem

Presented above parking systems uses dedicated hardware (modems) for communication with end users. This solution generates additional costs (hardware) and can be not effective in large scale usage (due to performance issues of GSM/UMTS modems). Proposed and implemented SMS communication results need to send an SMS with the specific content and potential mistakes in SMS content results errors in application usage. Another solution for car drivers dedicated or web application for mobile devices uses data connection and generates costs for user. This paper proposes usage of another communication channel available in mobile network - Unstructured Supplementary Service Data and provides an alternative to existing solutions.

C. Telecommunication APIs and Service Delivery Platforms

In last few years we can observe the process of opening communication service provider networks for external developers. For many years the network operators were closed to external companies and programmers and only operator was able to develop innovative telecommunication services.

Telecom operators seeing changes in Internet and competing with Internet companies (Over The Top – OTT players) such as Google, Facebook or Skype, were implementing business models based on API (Application Programming Interfaces) exposure.

Using API telecommunication service providers can expose large sets of functionalities in Internet for external developers. Telecommunication functions such as call management, SMS and MMS communication, USSD, payment or locating terminals can be offered third parties as Web Services. Based of them is possible to create new innovative applications connected Internet assets, telecommunication area and IT functionalities such as [7], [8], [9]. From technical point of view – presented above enablers are exposed in Internet using dedicated system- Service Delivery Platform (SDP). SDP is additional layer between Internet and communication network. South interfaces of SDP are connected with network elements such as SMS Center, MMS Center or GMLC (Gateway Mobile Location Centre) using binary telecommunication protocols based on Signaling No 7 stack (SS7). North interfaces are connected to the Internet and expose APIs using SOA model or RESTful architectural style. The architecture of the API exposition using SDP is presented in Fig. 1.

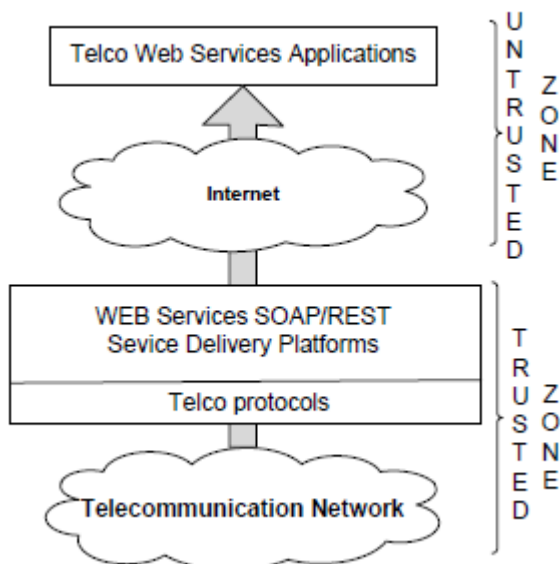


Fig 1. API exposition architecture [7]

Web services were implemented in SDP were standardized using two models: Parlay X specification [10] defined by ETSI and the Parlay Group - based on

Service Oriented Architecture [11] and SOAP protocol [12]. Second standard OneAPI [13] was defined by GSMA and the newest version of this specification is based on Representational State Transfer architectural style (RESTful) [14] de facto standard in Web 2.0 and Social Media world.

II. THE PARKING RESERVATION SYSTEM

The Parking Reservation System is an application prototype based on API for operator's network. Presented in this paper system is dedicated for supporting and managing parking places reservation process. The system allows to make reservation or if reservation has been made to cancel it. Application recognizes two types of end users. One is the end mobile user - making the request, the other one is parking security - handling the request using Web based user interface. The mobile users can store in their mobile phone address book two records. The first record is responsible for parking reservation and contains *665*0015*0# USSD request, the second address book position cancel reservation and is coded as *665*0015*1#. To make or cancel reservation the end user must call stored in book number (USSD code) and therefore send specific USSD request.

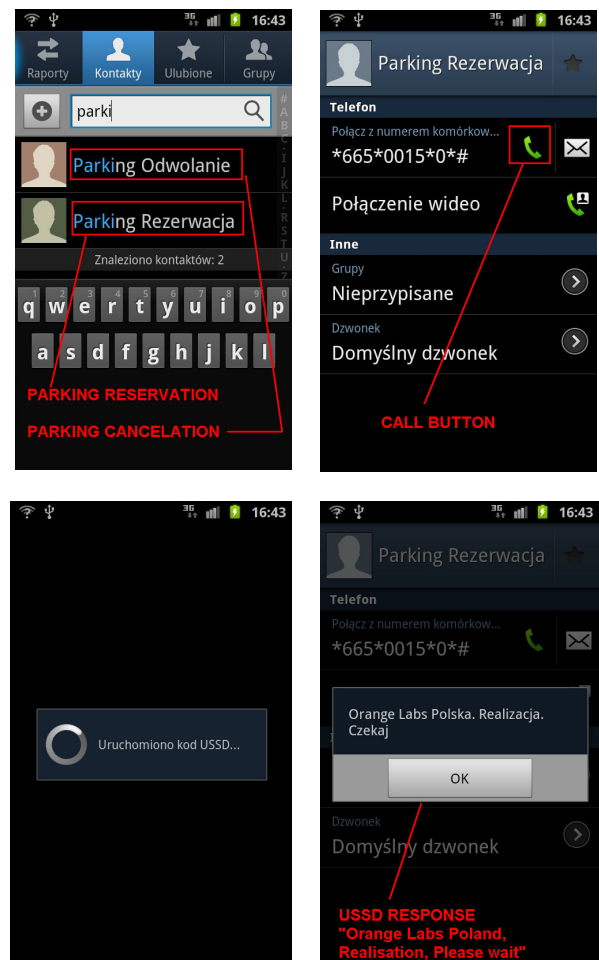


Fig 2. Parking system mobile end user interface

In current version system recognizes only these two described above USSD messages. The request from mobile user in web application is presented to the person responsible for parking place reservation. To handle the request the parking security user selects in web application free parking lot and sends mobile user response using one of the method: USSD or SMS. In a similar way (using another USSD code) is realized parking place reservation cancellation. In case of no free parking places the parking security user can send to the mobile user dedicated message predefined in application (Fig. 3).

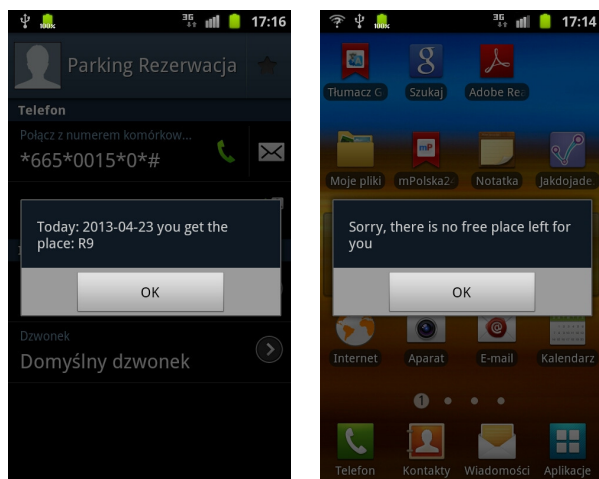


Fig 3. Parking system - example messages

III. SYSTEM ARCHITECTURE

A. Functionality of the solution

Using their mobile phone mobile end users sends USSD request to the system. The parking system notifies parking security end user in web application using AJAX request. In the next step the parking security end user using web application (Fig 4.) sends response to the system and application forward it to the mobile phone end user through appropriate SDP's Web Service. The functionality of the system is shown in Fig.4 and Fig 5.

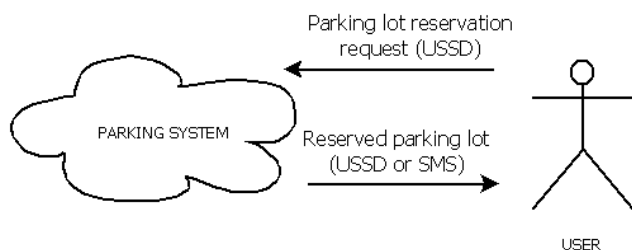


Fig 4. Functionality of the Parking System

B. Used API interfaces

The Parking System functionality is based on API provided by the cellular phone networks. The system is invoked with the USSD request. The response can be

send using two methods: USSD or SMS message. Both functionalities are realized by Orange Service Delivery Platform \using Web Services implemented in RESTful architectural style as Receive USSD, Send SMS and Send USSD APIs.

C. Structural architecture of Parking System

The Parking System service consists of three main functional parts based on the performed functions shown in Fig. 5.

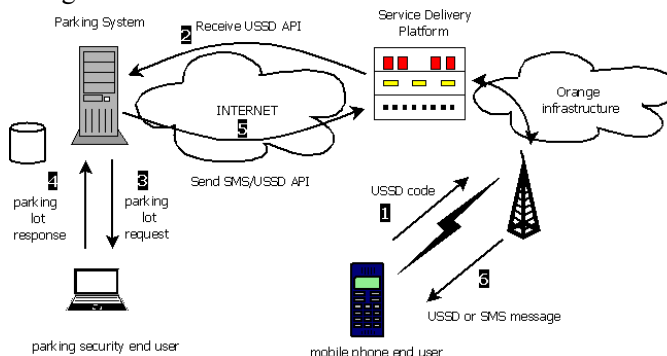


Fig 5. Structure of the developed service

- End Users – there are two types of end users: one communicates with the parking system using mobile phone through UTRAN/GERAN (mobile end user) and the second (parking security end user), which using Web Application maintains parking resources.
- Parking System – the application logic implemented as a Web Application, running on a server. System data is stored in XML files. Data consists of USSD requests, system end users and parking resources data. The system is using telecommunication APIs exposed by Orange for communication between end users.
- GSM/UMTS Operator – enables communication with the Parking System through exposed APIs interfaces.

D. Class Diagrams

Presented solution was developed in Model-View Controller (MVC) style. It consists of Controller, Model and Helper classes. All classes are presented in Fig. 6 and Fig 7. Views are simple dynamically generated HTML. The project consists of following classes:

- Controller classes – responsible for handling HTTP requests. GET and POST requests are mapped to appropriate method called action from the class. Diagram is presented in Fig. 6.
- Model classes – represents the data objects send within system. Each class consists of properties and the setter/getter methods for each.
- Helper classes – are responsible for parsing XML data, handling AJAX, sending response to mobile phone end user and are presented in Fig. 7.

IV. USER INTERFACE

The Parking system was developed using C# programming language and ASP.NET MVC 3 framework. The system has a simple, intuitive web interface. The user (parking security end user) logged in to the system, on the main page can see the map of the parking, three tabs on the right (home, make reservation, cancel reservation) and request notification messages on the bottom. On the map reserved parking places are marked with a car pictures. Home page of application is presented in Fig. 8.

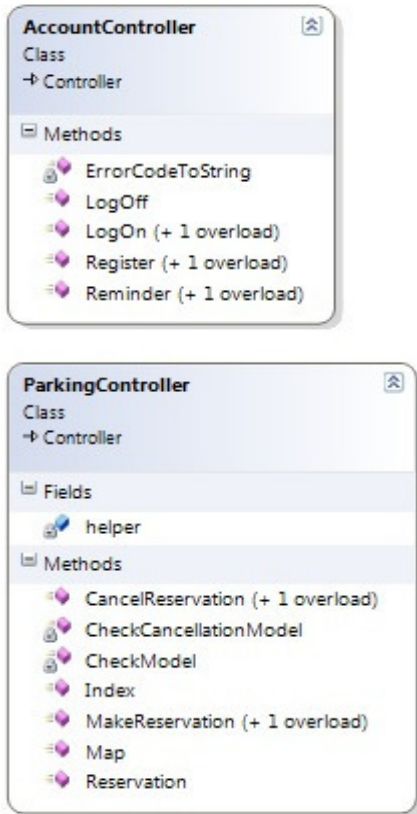


Fig. 6. Controller class diagram



Fig. 8. Parking system - home page

Application supports two types of notification messages. One for making reservation and second for canceling. Both types of notification are presented in Fig. 9.

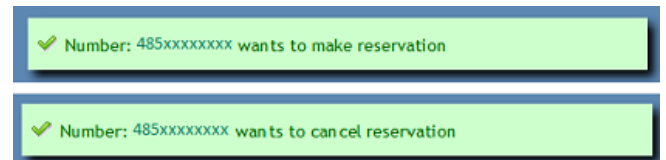


Fig. 9 Notification messages

To make or cancel reservation the parking security end user has to select the appropriate tab and fill up the form and select communication type (USSD or SMS). The forms are shown in Fig. 10 and Fig. 11.

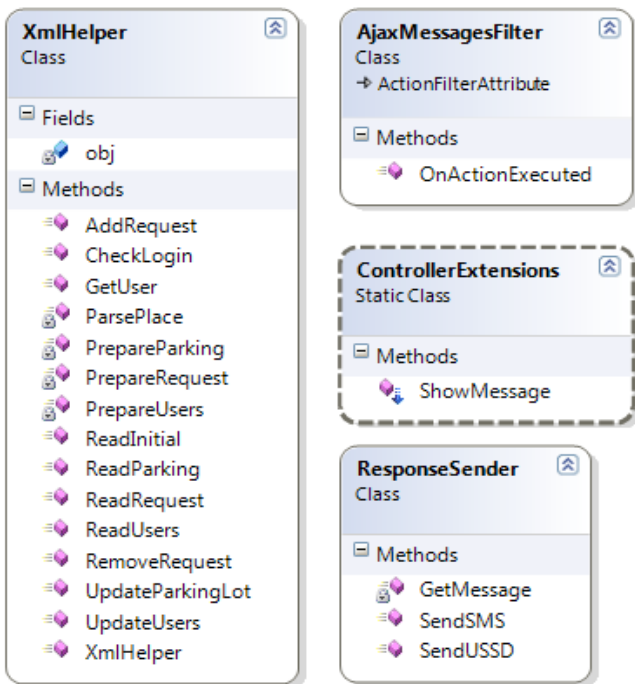


Fig. 7 Helper class diagram

The screenshot shows a form with the following fields: 'Phone Number' (text input with value 485xxxxxxx), 'Place ID' (dropdown menu with value 10), 'Send Method' (radio buttons for USSD and SMS, with USSD selected), and a 'Send' button.

Fig 10. Reservation form

Fig. 11 Cancellation form

After performing the operations the person responsible for parking place management is redirected to the home page with parking map.

AJAX, JSON, JavaScript. technologies were used to create the user interface, Microsoft Internet Information Server was used as an application container.

V. CHALLENGES

The presented in this paper application has some possible future enhancements. It is possible to add new communication channel via SMS for parking place reservation. In the further development of the system it is also possible to create a mobile application dedicated for smartphones. One of the future challenges will be function of navigation to the reserved parking place. This functionality requires a precise localization API (e.g. based on GPS or Wi-Fi) or usage of specific and expansive hardware (e.g. sensors) [3], [4], [5] and implementation of algorithms for parking management strategies [5], [6]. Another enhancement concerns on the functionality of the Parking System. The current system version supports only two mobile end user actions: make reservation and cancel them. There are few more options available such as: check reservation status, change status, extend reservation time, make reservation for some time in future, etc. Potentially interesting idea is automation of system functionality: allowing end user to triggers the application with a USSD or SMS channel without interaction with parking guardian. Based on this the system could automatically reserve the place, recognize the car or end user mobile phone and navigate the user to the reserved place. Parking navigation system would be very helpful, when the mobile end user wants to find the car on the parking.

VI. CONCLUSION

Presented in this paper the prototype of the Parking Reservation System is low cost and effective solution. Because system is based on web application can be

hosted in cloud computing environment and offered potential (companies, security agencies) as a service. Because no specific hardware requirements system can be used by everyone and need only mobile phone (smartphone are not necessary) for mobile end user and computer with Internet access for security end user. The implementation telecommunication APIs: Receive USSD, Send SMS and Send USSD in Web Services allowed creating application using standard programming tools in very short time. Using this system car driver can reserve a parking slot on the fly in very easy way by pressing call button on their mobile phone.

Prototype of Parking reservation System was developed under the program Open Middleware 2.0 Community by Orange Labs [15].

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