BusStop – Telco 2.0 application supporting public transport in agglomerations

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Abstract — **This paper presents possibility to use Telco 2.0 architecture interfaces to realize a service supporting public transport in agglomerations. Such systems are expected to be easily accessible for everyone and to be available in any location. Such expectations may only be met by a system using the latest achievements in the scope of telecommunication, which are API based on telecommunication operator's networks.**

I. Introduction

THE data presented in [1] shows that the number of passengers using public transportation in 2010 exceeded 3,9 million. That shows how crucial is public transport in the everyday activities of the agglomeration inhabitants. Public transport is related to a series of information which concern it: timetables, stops' locations, communication routes, etc. Nowadays, the passengers wish to have free access to such information from any location at any time. Additionally, access to such information should be as quick as possible.

A. Existing solutions

Using existing solutions, passengers may look for information regarding public transport in the following ways:

- going to a chosen stop where they will learn about the timetables for lines corresponding to that stop and the routes of these lines,
- checking information placed on the Internet website of the public transport operating in a particular city,
- using smartphones, in this case access is made through the Internet or by use of applications created for such purposes, such as e.g. Transportoid [2],
- using a hotline.

All of the above solutions have limitations. The largest possibilities are given by using smartphone applications. Such may operate in two modes: online and offline. The offline ones use data stored in the appliance memory delivered with the application. The online applications use information provided by Web Services. This solution requires the use of smartphone with dedicated application.

B. Concept of open data access

Development of applications delivering communication data to passengers is strictly related to the access to data that are held by the Public Transport Authority. These data may be available in the open data model. The concept of open data access is an very popular mainstream of sharing information in the Western Europe. Open data is part of a larger mainstream called e-administration which relies upon providing citizens methods for contact with state administration through electronic channels. Open data relate to the idea of open-government which offers citizens a large amount of public data, in form of raw and processed data. An example of such which should be widely accessible is public transport information:

- Location of stops
- Routes of lines
- Timetables

Open data related to transport is already being used in England, e.g. the British Fix My Street [3] portal containing information about street damage or the Fix My Transport [4] portal containing remarks by citizens regarding the functioning of public transport.

An example of an open-government application is a software developed in Holland – the Bridge [5] program designed for Android operating system phones. This application shares public data which is information about the state of drawbridges in Rotterdam (open/closed) and predicted times of their opening, making travelling through the city easier.

C. Description of the problem

Public Transport Authorities operate in Polish cities,

usually do not provide APIs allowing free access to information regarding public transport. They usually present such data on their websites as in the case of Warsaw Public Transport Authority [6]. For some cities those websites contain communication data in a compressed file.

Limited access to public transport data makes the development of applications and systems supporting public transport more difficult. The result is that there is still no solution which, while being simultaneously widely accessible, would also satisfy all the passengers' expectations.

D. Telco 2.0

Currently, telecommunication operator networks evaluates from Telco 1.0 to Telco 2.0. The main assumption of this process is to allow practically anyone to create added telecommunication services [7].

In the Telco 1.0 approach only the operator was allowed to create and distribute added telecommunication services. This resulted from the fact that such services were launched on intelligent network platforms. Only the operator could access them using special tools for management and configuration.

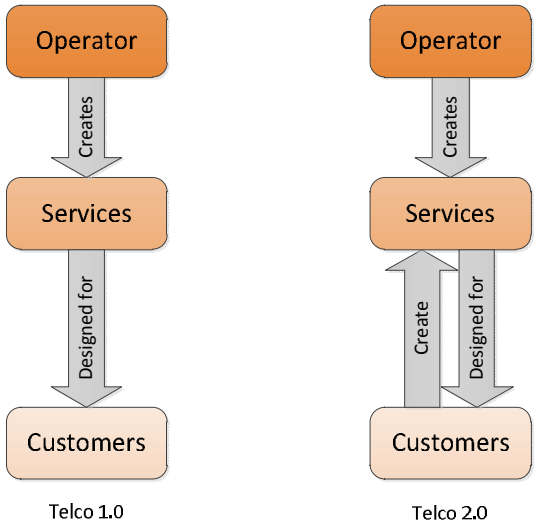

Fig 1. Telco 1.0 vs. Telco 2.0 concepts

The Telco 2.0 concept (Fig.1) assumes the existence of an additional layer in the intelligent network architecture responsible for communication of service platforms with user applications. The additional layer is realized in the form of websites. They allow access to basic telecommunication services such as assortment of phone calls, sending and receiving SMS and USSD messages and locating terminals, etc. Communication with such websites is possible using the SOAP and REST [8] protocols. The architecture of the Telco 2.0 solution is presented in Fig. 2.

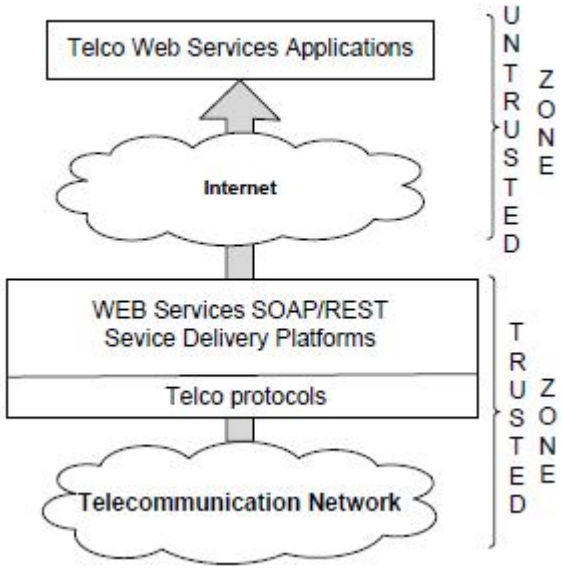

Fig 2. Telco Web Services architecture

E. Profits of using Telco 2.0 to solve the presented problem

Telco 2.0 allows the creation of added telecommunication services. Access to those will be possible for all mobile phone users which is based on the information presented in [9] for over 95% of the citizens of Poland. It will be possible to launch the service from any location covered by the radio access network of the native cellphone operator.

II. THE BUSSTOP SERVICE

The BusStop service is a proposition of a system which is aimed to support public transport in agglomerations. One of the main functions of the system is to provide users information about the timetables of chosen lines, routes of particular lines and numbers of lines operating near a user location. An implemented prototype of the service supplies with the mentioned above information within the Warsaw agglomeration.

The aim of the prototype is to show the advantages of using Telco 2.0 interfaces to develop services aimed at a large number of recipients, and to present the basic function of the BusStop service.

III. SYSTEM ARCHITECTURE

A. Functional schematic of the solution

The BusStop service is responsible for accumulating and storing data about public transport and for providing this information to users. The functionality of the BusStop service is shown in Fig. 3.

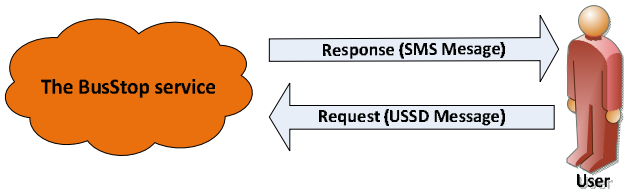

Fig 3. Functional schematic of the BusStop service

A. Used Telco 2.0 interfaces

The BusStop service is based on the functionalities offered by cellular phone networks. The BusStop uses USSD messages to invoke the service. Then, when it is needed, the service locates the subscriber, and generate the response related to subscriber location. In the final stage, a response is sent to the user using SMS message. Described above functionality is possible, only using Telco 2.0 interfaces exposed by the operator.

B. Structural architecture of the BusStop

The BusStop service consists of three parts based on the performed functions shown in Fig. 4.

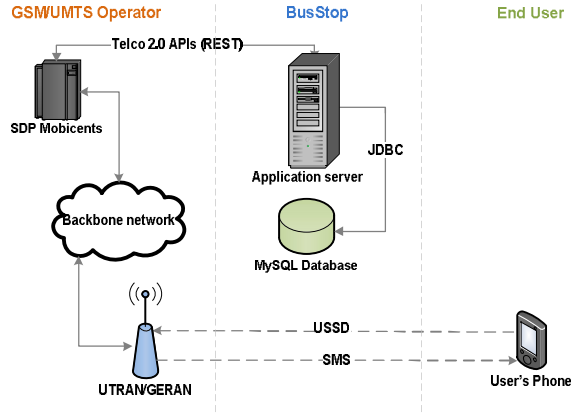

Fig 4. Structure of the developed service

- End User – communicate with the service via UTRAN/GERAN access network using mobile phone.
- BusStop – the logic of the service is performed within a Web application, launched on an application server. Communication between application and database uses a JDBC library. The database stores information about public transport. The Web application uses Telco 2.0 interfaces, in order to assure communication between the service and the user and to locate users.
- GMS/UMTS Operator – provides communication of the end user with the BusStop service using exposed in Internet Telco 2.0 interfaces.

IV. MEASUREMENTS

In next step a series of 100 tests were performed (50 in GSM and 50 in UMTS network). A single test consisted of calling BusStop service, where input argument was a number of public transport line. The result was received in SMS timetable. Service calls were made from different places in Warsaw for the various public transport lines.

A. Accuracy and usability tests

Table 1 Test results for the GSM network

Parameter description	Result
average response delay	8,7s
successful service calls	98 %
unsuccessful service calls	2%
received answer was the nearest bus stop	76%
received the answer is a neighboring bus stop	20%
received the answer is a neighboring second bus stop	2%
received the answer is a neighboring third or more bus stop	0%

Table 2 Test results for the UMTS network

Parameter description	Result
average response delay	5,9s
successful service calls	98 %
unsuccessful service calls	2%
received answer was the nearest bus stop	48%
received the answer is a neighboring bus stop	40%
received the answer is a neighboring second bus stop	8%
received the answer is a neighboring third or more bus stop	2%

The results of test for the 2G network are satisfied. More than 75% of the received responses pointed the nearest of public transport stop. Location of 3G subscribers in less accurate, which means that about 40 % of received responses pointed the neighboring bus stop. There was also a situation when the location error was so large that indicated by the service public transport stop was the third in order from closest. Results of test are presented above in Table 1 and Table 2.

B. Example accuracy test results

In Figures bellow are presented results of test cases. The maps presents selected points, in which the service was called and shows the location of bus stops which points the received response. If the response received was incorrect in Fig. 5 -8 is pointed the correct location of the stop. For results of test presentation Google maps were used.

 - location of service call

 - stop location pointed BusStop service

 - correct public transport stop location

Fig. 5. Example result of service - GSM network, the correct stop location

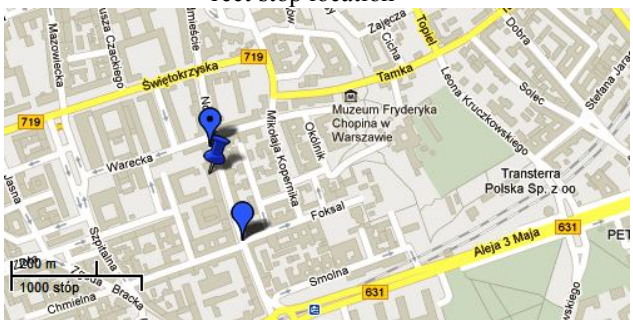

Fig. 6. Example result of service - GSM network, incorrect stop location

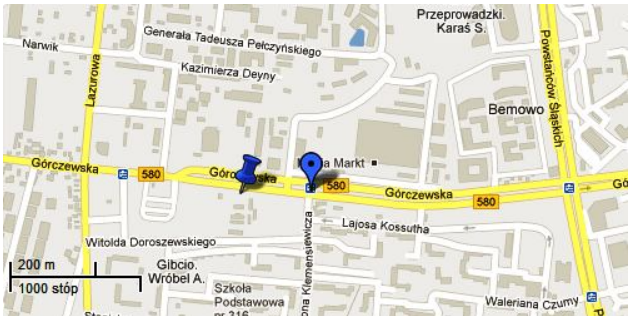

Fig. 7. Example result of service - UMTS network, incorrect stop location

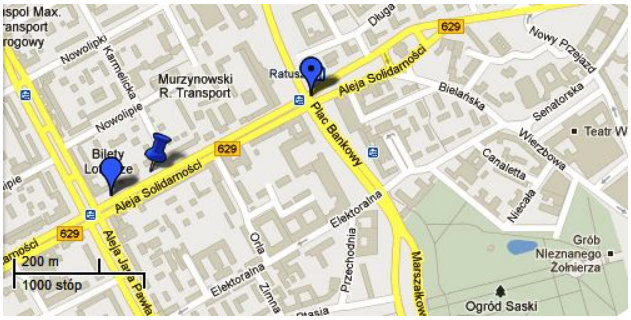

Fig. 8. Example result of service - GSM network, incorrect stop location

V. CHALLENGES

The presented architecture of the service is characterized by large elasticity. In this case it is based on the simplicity of implementing new functionalities. Additional functions may be created in the form of independent modules dedicated to performing new tasks and functionalities.

The BusStop service may be enhanced by a dedicated application for mobile devices. The application would be a layer of presentations for the acquired data. An additional advantage is the possibility to integrate the functions of a cellphone with the BusStop service to e.g. a better localization of the user using the GPS transceiver in the smartphone.

In its current state, the BusStop service does not offer a function of searching bus or tram connections. From the end user point of view this functionality is also very important. This problem may be solved in two ways. The first by creation a connection browser that could be used by BusStop. The other by integration the presented service with existing connection browsers which provide adequate API, e.g. with the "jakdojade" website [10]. The presented architecture of the service allows implementing such integration.

Another way to improvement the BusStop service is creation a module responsible for acquiring up-to-date information about timetables, which can take into consideration information about bus/tram delays. If any systems providing such information exist, they could be integrated with the BusStop service. In other cases, acquiring data from the users may be utilized (in user participation model).

VI. CONCLUSION

Presented in this paper the prototype of the BusStop service shows that the Telco 2.0 interfaces allow for development a system dedicated for supporting public transport in agglomerations. Such system is characterized by a high speed of operation. The BusStop service may be launched in all locations which are covered by the radio access network of the native mobile network operator.

The functionality of the service based on the accuracy of locating subscribers returned by the mobile network. In smaller cities or in some districts of larger cities it may be insufficient. The functionality of the BusStop service is strictly dependent on the information provided by the Public Transport Authority. Open, provided by standard API access to this data is crucial for correct operation and maintenance of BusStop service in the future.

Prototype of BusStop service was developed under the program Orange Labs Telco 2.0 University [11] as part of Kamil Litwiniuk' BSc Thesis .

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