

## City Alerts: Smart City Notification Platform Based on Public Open Data

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**Abstract** – Multiple efforts are being made nowadays to transform crowded, polluted and dormant urban communities into smart cities. As part of this endeavor, citizens rely on efficient and predictable public services to help them to smoothly run their busy lives and public agencies need to work synchronously to deliver performant services to the citizens. When things do not work as expected, as it frequently happens, the solution is to communicate openly and timely these issues, using information systems capable of adapting to the diversity and dynamics of modern cities. In this paper, we show how a platform called City Alerts, that we developed, notifies citizens about the various situations that can cause discomfort and short-notice change of plans, like gas cutoffs or changes of public transport routes. The strength and novelty of the platform lies in the ability to integrate into a single database heterogeneous data, both in terms of content and format, from various public agencies which provide it as public open data, and to expose it afterwards through open protocols.

**Keywords:** smart city, open data, database technology, information systems application, personalized alerts.

### I. INTRODUCTION

Today, more than two thirds of the European population lives in cities. These increasingly crowded urban communities face multiple challenges, such as unemployment, poverty, pollution or demographic decline [1]. Such pressing issues need innovative actions that are game-changing, work fast and do not require heavy economic expenses. Therefore, citizens, local governments and urban service providers need to work together to fulfill the smart city vision: “the city that works with what it has, and makes it better, faster and more efficient” [2].

One of the pillars of the smart city approach is leveraging the information and communication technologies to make the city more digital and intelligent [3], through delivering helpful urban services which result in a comfortable environment for the citizens. Such services should include, amongst others, some sort of automated notification system that can alert the citizens about unexpected, non-emergency issues, which lead to last-minute change of plans and discomfort: water, gas or electricity cutoffs, changing of the schedule of public institutions, change of public transport routes and others.

Developing such an electronic platform is not an easy endeavor, due to the need of integrating heterogeneous open data published by various public agencies, without forcing

them to spend resources to comply with a strict template of the data or to manually and frequently insert new data into the system.

To showcase how to approach such a project, we present the architecture and the functionalities developed so far for a platform called City Alerts. City Alerts was one of the projects developed during the HackTM event [4], the biggest hackathon in SSE Europe that took place in 17-19 October 2014. The hackathon featured a section dedicated to city applications and open data, where more than 50 participants worked on 10 projects. Proposed by the Smart City Association and endorsed by the City Hall as a useful application for Timisoara, the City Alerts platform was developed by a team composed of students and mentors from the Multimedia Centre, Politehnica University of Timisoara. The collaboration between the 3 entities (University, City Hall and Association) was the result of a successful commitment which these entities assumed within the framework of the European Innovation Partnership on Smart Cities and Communities, an initiative of the European Commission [5]. Timisoara is the first city in Romania – and, until now, the only one – to publish an open government dataset on the National Open Data Portal in 2014 [6] and to actively involve the local community, students and civil servants for powering the smart city revolution.

This paper is organized as follows. The first chapter presents the context in which the application was developed. The second chapter highlights the design principles that are the foundation of the project. The third chapter is an overview of the architecture of the system, while the fourth chapter lists the implemented functionalities of the prototype. The fifth chapter is a discussion around the challenges and advantages of the implementation while the last chapter concludes the paper.

### II. DESIGN PRINCIPLES

To be able to develop a useful and efficient application, we considered the following design principles:

1. Flexible integration of open data and nearly zero-effort for the public agencies to publish such data
2. Openly exposing the data to other applications

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3. Notification for citizens based on their preferences and location
4. Easy administration of the platform from a central point (e.g. the city hall)

The first design principle shows that open data is an important pillar of the philosophy of the proposed system. This is because open data is an important factor in building a smart governance environment [7], [8]. According to the Open Definition, a piece of data or content is open if anyone is free to use, reuse and redistribute it, for any purpose [9]. According to a 2014 study on Big and Open Data in Europe, publishing open data “means providing data in ways that can be conveniently accessed by any interested party without additional barriers such as costs (price should include only reproduction costs, and in the case of dissemination by the Internet data access should be free), bureaucracy (no registration required), technological (data should be provided in open format) or usage restrictions (all forms of use and reuse, including commercial, should be allowed)” [10].

Public agencies can provide data to the City Alerts platform by manually inserting it via a web form or can interact automatically with the platform. In the latter case, the City Alerts platform is able to consume data published in the following ways:

1. Via a web interface
  2. Via a web API
  3. By downloading files (CSV, XLS or XML)
- What is innovative is the concept that allows the integration of existing documents from data providers without creating additional costs that arise from converting data to a specific format. Many institutions store data in XLS, CSV or XML file formats. For this, we implemented an interface that allows one to upload a document, for example a XLS or CSV, associate the columns of the XLS or CSV to the columns of the *alert* table in the application database and save the document location (URL) to the server and the column associations in the database. This way the platform offers the possibility to import data and process information easily by using a server-side scheduled task which parses each document, based on the already-saved associated settings. If it detects changes in the document, it reimports the data and updates it into the platform database.

The second design principle is addressed through the implementation of open gateways. Once data is stored in the database, it can be consumed in JSON format and is easy to be accessed through a REST API by other applications. This gives the possibility for third-parties to develop other innovative applications, on top of the already published data, a fact which is desirable for a true smart city [11]. Also, the public agencies are encouraged to publish their data, as this data does not end up in a closed system, but it is further offered as open data, in even better technical conditions. As

such, the platform also acts as a powerful open data management system, similar to CKAN [12].

The third design principle refers to the communication with the citizens. The system was designed in such a way that citizens can subscribe to alerts that belong to certain public agencies or that are relevant only for some geographic areas. As such, the platform can notify the citizens through easy methods such as website, email or SMS about the “exceptions” that happen in the life of the city.

The fourth design principle is addressed through the development of an administration dashboard that allows a central institution, e.g. the City Hall, to edit the global settings of the platform, to add and edit the public agencies that can publish on the platform, to add and edit users, to manage the alert types and the files that can be consumed.

### III. SYSTEM ARCHITECTURE

The City Alerts application is based on the following three main components (Figure 1):

1. **A web-based backend with MySQL database** where data from different institutions is collected through a form or by uploading documents in open data formats: CSV, XLS or XML. For example, an institution has an account on City Alerts. An administrator from that institution uploads an XLS document, selects the desired fields to be stored in database and saves the document with the associated settings. After that, data is imported into the database where it can be edited, verified and published. Another option is to manually add the alerts using a simple form where relevant information can be inserted.
2. **A web-based frontend with a responsive interface** – here data is shown to the users, either logged in or not. An authenticated user has possibility to filter the information and to save the filters so next time it comes back, only the desired information is shown. The user can also choose to receive alerts through email or SMS whenever a new relevant alert is issued. Users that are not logged in can also filter the information, but the filter settings will be deleted once the browser is closed.
3. **REST API** – this component collects data from the database and provides it in JSON format as base for new applications. This format was preferred because it is flexible, more compact and in many cases easier to use than, for example, XML [13] (especially when working with JavaScript).

### IV. IMPLEMENTED PROTOTYPE

Built using latest programming paradigms and based on a custom platform using technologies like PHP and MYSQL for backend, Bootstrap Framework and custom responsive layout (HTML 5, Javascript / JQuery, CSS) for frontend, City Alerts provide a scalable solution, adaptive and easy to maintain.

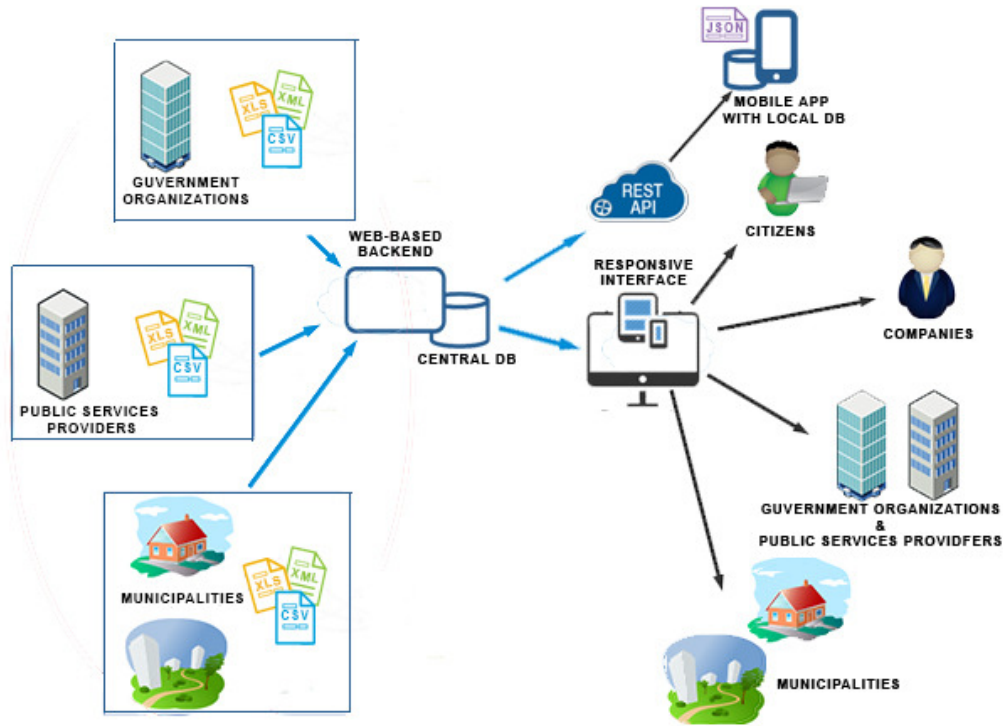


Figure 1 City Alerts Architecture

We used these technologies for the following reasons:

- The need of an online solution accessible from any device with an internet connection;
- Availability of different libraries that allows us to process open data document formats;
- Costs for implementation and maintenance;
- Technical background of development team.

For the interface we used the technologies mentioned earlier because they provide a cheap and scalable solution that can be transformed in the future in native applications for mobile devices without much effort.

For the document processing we used PHPEXcel [14], a library written in PHP which provides a set of classes that allows us to write to and read from different spreadsheet file formats. The library is actively developed and maintained and is built around Microsoft's OpenXML standard and PHP, things that make it compatible with the technologies we are using as base for the platform. Once the document processing is done, the next step is to save its location (URL) in the database, save the document metadata and reparse it based on the saved settings on regular intervals with a scheduled task or when a new document is updated.

Several functionalities have been developed so far and are available online at <http://www.cityalerts.info/>. As mentioned earlier in this paper, the citizens can use the platform either anonymous or logged in, with the latter option having the

advantage that they can save their preferences. Citizens can view the alerts posted by the public agencies, can filter them based on specific criteria, can visualize them on a map and can comment on them, as shown in Figure 2.

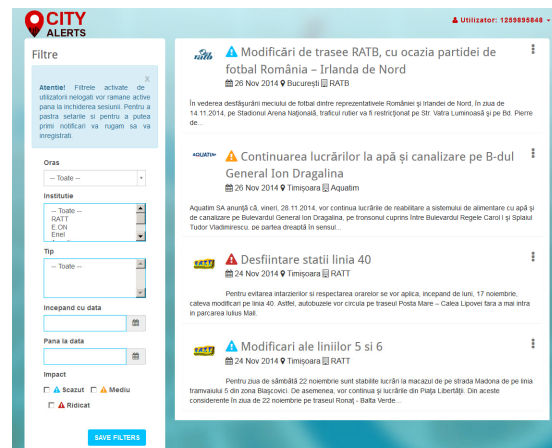


Figure 2 Alert viewing and filtering

The platform offers an administration dashboard that allows the management of users, public agencies, alerts and files. Alerts can be added manually to the platform, using a detailed web form (Figure 3) or can be imported automatically, based on the format of the file that holds the dataset (Figure 4).

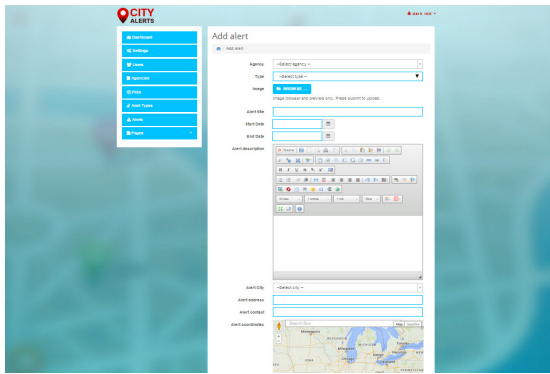


Figure 3 Manual alert management interface



Figure 4 Automated file import options

Other features include integration with social networking platforms, REST API to access alerts from other applications and a responsive interface (for desktop and mobile).

In Figure 5 it is easy to observe the main components of the City Alerts application database. This structure allows creating multiple types of users, connecting specific users to an agency, sharing on social networks, saving documents for each agency along with settings per each document, etc.

This database structure provides a solution which can be reused by other systems. Therefore, by replacing the alerts table with the desired open data “collector” table, the City Alerts CMS becomes the underlying foundation for a series of projects and new solutions that can bring a real advantage to the local community.

## V. RELATED WORK

We reviewed the research literature to analyze some projects that have already tackled the issue of alerts in smart city scenarios.

Seddigh et al. report in 2006 [15] on a public emergency alert system that is Internet-based, a medium that has some distinct

peculiarities, as opposed to those of traditional means of communicating emergency messages to the public. The system is based on a publish-subscribe architecture, which we also employed in our work, but is focused only on emergency alerts, which pose slightly different challenges. In [16], Montanari et al. present the design and implementation of an automatic customized warning system based on an open architecture and which was tested in an emulated scenario.

Banerjee et al. propose in [17] a smart public alert system that is based on stream reasoning. The knowledge-based system is personalized, context-aware and near real-time. For the prototype implementation, static data is generated from user-curated web portals such as OpenStreetMap and dynamic data is gathered from various RSS feeds belonging to official or non-official sources of information. The information is stored and processed using semantic web standards.

In Santander, Spain, a large Internet of Things experimentation facility was deployed, a project that is a Future Internet Research and Experimentation initiative of the European Commission. The paper mentions that the proposed architecture includes the possibility for the users to subscribe to alerts that are generated based on the issues that affect “the pace of the city”, but no more details are given. [18].

Our work differs from the prior ones as it focuses on integrating open data from various public institutions, each one publishing data in its own format and style. We also emphasize the ability of the platform to offer the data, using open standards, to third party applications, thus acting as a technical enabler for mass consumption of open data.

## VI. CONCLUSION

Urban communities are slowly but surely transitioning to genuine smart cities and IT&C tools play an important role in this upgrowth. The permanent race between keeping expenses low, delivering on sustainability goals and keeping the citizens engaged and informed can be alleviated by focusing on open data-based IT tools for citizens.

In this paper we present City Alerts, a solution to communicate openly and timely different issues in delivering public services or to notify citizens about the various situations that can cause discomfort and short-notice change of plans, like gas cutoffs or changes of public transport routes. City Alerts is also a general system that can be used as foundation for other open data applications that wish to be able to collect data from different public institutions without requiring them to deliver it in a specific style or format. This results in lower costs and a scalable and efficient application for the management of open data documents.

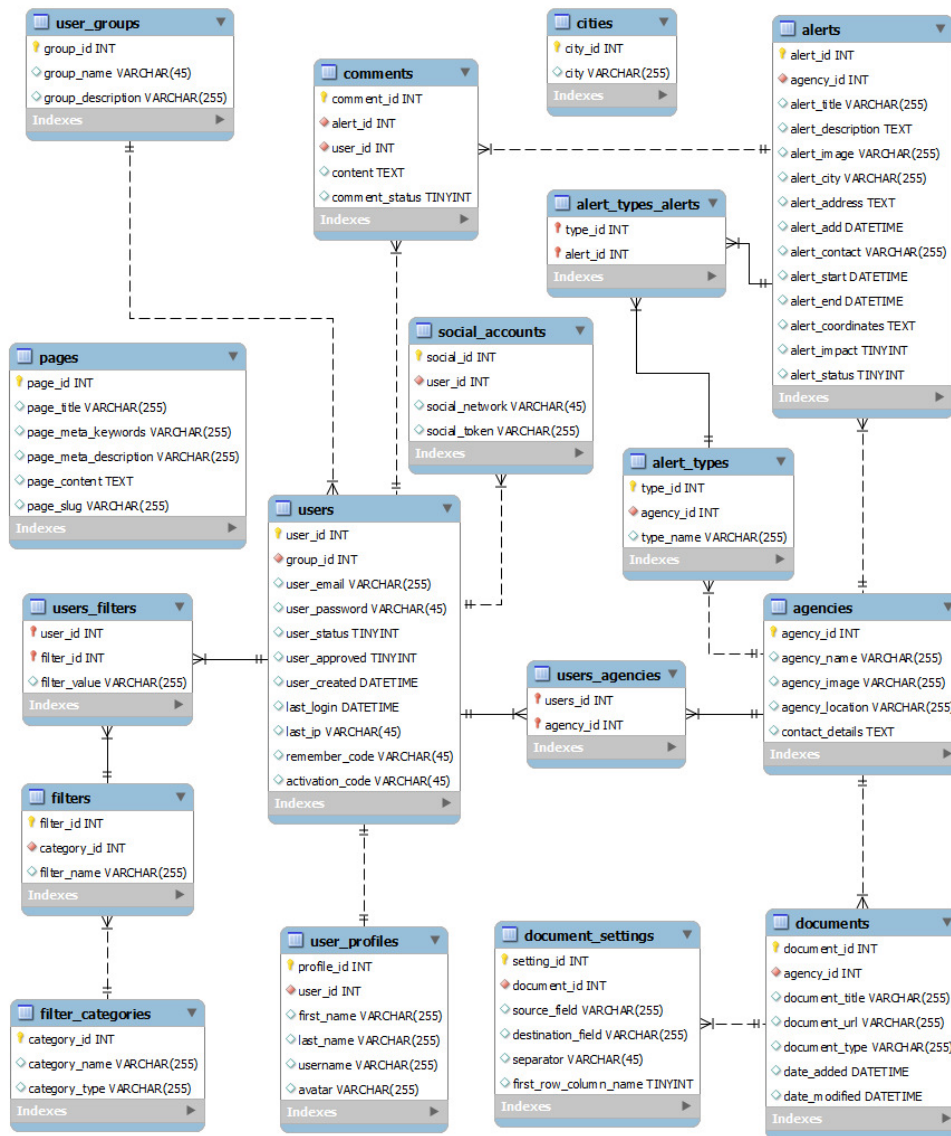


Figure 5 City Alerts database architecture

Based on the developed prototype, we plan to start discussions with some public agencies, such as Colterm or Aquatim, under the coordination of the Timisoara City Hall.

The first steps have already been made through this application which provides:

1. Benefits for institutions and citizens
2. Support for open standards: JSON and REST API
3. Flexible integration with various data sources (CSV, XML, XLS)

The next steps involve a tight cooperation between the stakeholders and some decisions about procedures. More concretely, we need to identify all the relevant sources of data in the city, to analyze the data structures and how they are produced and to establish

work procedures for entering data manually or automatically.

City Alerts is part of a wider range of Smart City applications that we think will bring several advantages to the city, such as transparency of the administrative process, monitoring and adjustment of the urban traffic, interconnecting the public institutions, increased involvement and support of the citizens for the local governing process and better management of the resources of the city [19].

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