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Student Information Delivery Platform Using Telecommunications Open Middleware APIs

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***Abstract*—The paper describes architecture of a prototype networked student information delivery system. Main system functionalities include interactive access to lecture room timetables and group messaging. The system exploits modern mobile technologies to allow flexible usage scenarios. The use of open APIs of telecommunications service delivery platforms in combination with e-mail messaging provides diverse ways of system information delivery. The perceived application scenario of the system is to provide ubiquitous access to up-to-date lecture room timetables and reliable ways of notifying the affected users about changes.**

***Index Terms*—student information systems, web services, mobile applications**

I. Introduction

NOWADAYS, universities worldwide offer a variety of complex campus services addressed to different groups of users: academics, administration staff, and students. Among the information systems facilitating the management of these services we can find systems supporting various fields related to the educations process, like student information database systems [1], [2], [3], [4], systems facilitating students and staff mobility and general cooperation between education institutions [5], [6], [7], learning management systems [8], and many more.

In this paper we propose a system enabling ubiquitous access to up-to-date lecture room timetables and reliable ways of notifying the affected users about unexpected changes. The proposed system exploits modern mobile technologies (mobile phones, tablets) to allow flexible usage scenarios. The use of open APIs of telecommunications service delivery platforms [9] provides reliable and fast way of delivery of system messages to the users.

The remainder of the paper is organized as follows. Section II presents overall architecture of the prototype system and provides details on the system modules. Section III describes user system interactions as well as user interfaces of the system modules. Section IV summarizes the paper.

II. System architecture

Proposed system has a distributed heterogeneous network architecture. In particular the complex solution might be divided in two independent but yet complementary branches. The first one consists of modern interactive lecture room timetable delivery platform that provides the users with the most actual timetables for the auditoriums. The other part of the solution consists of group messaging platform utilizing telecommunications open APIs [9] to deliver messages to the mobile phones.

Both parts were developed separately with the use of different open source and proprietary technologies. The joint use of interactive timetables and group messaging offers possibility to notify system users on the temporary timetable modifications. Moreover, the ability to provide user with additional information makes it possible to offer group messaging in order to improve the communications between students and academic teachers.

The remainder of the section provides detailed description of the aforementioned system modules.

A. Interactive Lecture Room Timetable Delivery Subsystem

As mentioned before in many universities among the world contemporary printed schedule boards are still in use. This way of information delivery has strong advantages among which low usage cost and effectiveness of delivery are the most important. On the other hand, the possibility of live interaction with printed timetables is impossible. Thus, any unusual situations and events require manual updates of the timetables and in urgent cases engagement of additional communication channels to pass the notification of the changes to affected groups of students and academics.

Electronic boards can present information in a similar way to the printed ones but additionally may offer an interaction channel to provide the possibility of on-line data modifications. That was the main idea that led us to design and implement the timetable delivery subsystem.

Proposed system architecture consists of four main elements as presented in Fig. 1. Central application server is responsible for controlling input data, in particular it provides timetable conflicts resolver. It is also responsible for preparing data for each lecture room display. It is also the only element that interacts with incorporated Relational Database Management System (RDBMS). Database server is used to store all the timetable data.

The management of the system is also possible with independent WebGUI service that allows authorized users to enter timetable data for supported lecture rooms. It includes state-of-the-art calendar interface which permits to define events of

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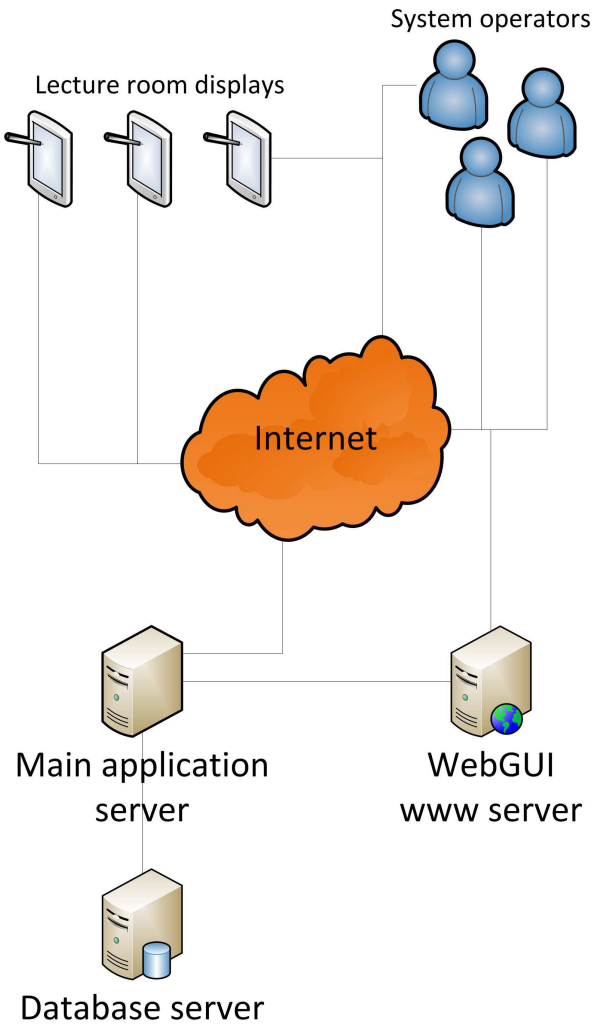

Fig. 1. Timetable delivery system architecture diagram.

different kinds, in particular single-time and periodic events are supported. The last part consists of interactive displays to be mounted at entrances to the lecture rooms.

As the result of conducted market research it was decided to use modern Android OS based tablet devices as the interactive displays. Therefore, dedicated application for Android operating system was developed. The main goal of the application is to display schedule timetable in convenient and accessible way. It is designed to be constantly active and refresh the data for up-to-date timetable delivering. Moreover, after each user interaction application returns to it default state (i.e. displays the timetable for current week).

As extensive user-timetable interaction is expected, it was also decided to develop dedicated pointing device to navigate over schedule application in order to reduce the use of touch screen of the device. The prototype device uses Bluetooth protocol to communicate with tablet device and is equipped with seven buttons. Four of them are used as the four-directional joystick, two are used to change the week view and the last one allows to display additional subject related information in a new window.

B. Student Massive Messaging Subsystem (SMMS)

The ability to send notification to a group of students is the main feature exposed by Student Massive Messaging Subsystem (SMMS). Contemporary messaging services at the university usually use university electronic mail systems as the only way to contact students. However secure and reliable, the effectiveness of information delivery is strongly affected by the necessity of user initiated mailbox checking in order to retrieve new messages. This might be insufficient in the case of unusual changes to timetable caused for example by lecture room equipment failures.

Aforementioned limitations might be omitted by incorporating the use of mobile phones and Public Land Mobile Network (PLMN) messaging services like Short Message Service (SMS) and Unstructured Supplementary Service Data (USSD). In particular these protocols are the most suitable for sending short messages that should be delivered shortly and reliably. Therefore, the proposed service involves SMS and USSD messaging services exposed by Telco 2.0 APIs of Service Delivery Platform WebGateway. The overall SMMS system architecture is presented in Fig. 2.

The main application server exposes a set of SOAP-based stateless web services that allows the following actions:

- It allows to send notifications on exceptional changes in the timetable (i.e. caused by equipment failure or important special event) to previously assigned users (both students and academics),
- It simplifies the communication between academics and groups of students by allowing academic teachers to send short notifications to selected groups of students registered in the system,
- It provides fast and reliable communication channel between university administration and students which improves the quality of administration services.
- It allows end users to sign-in for receiving the messages on selected topic. The user might sign-in in three ways: by sending a USSD code, SMS message or using Web Interface (which communicates with the main server).

This part of system was developed with the use of Windows Communication Foundation (WCF) technology. SOAP protocol was implemented in the northbound interface of the service, although RESTful web services are planned to be developed for final revision of the software.

User interacts with the system using web-based GUI offered by Web Interface server. This web portal was developed in PHP and communicates with SOAP web services from application server. The tool set also allows to manage database of users and news groups. Sensitive data, in particular user personal data and passwords are processed in accordance to widely accepted rules. Fraud detection mechanisms were also considered to prevent unauthorized use of users e-mail addresses and mobile phone numbers. In particular, verification

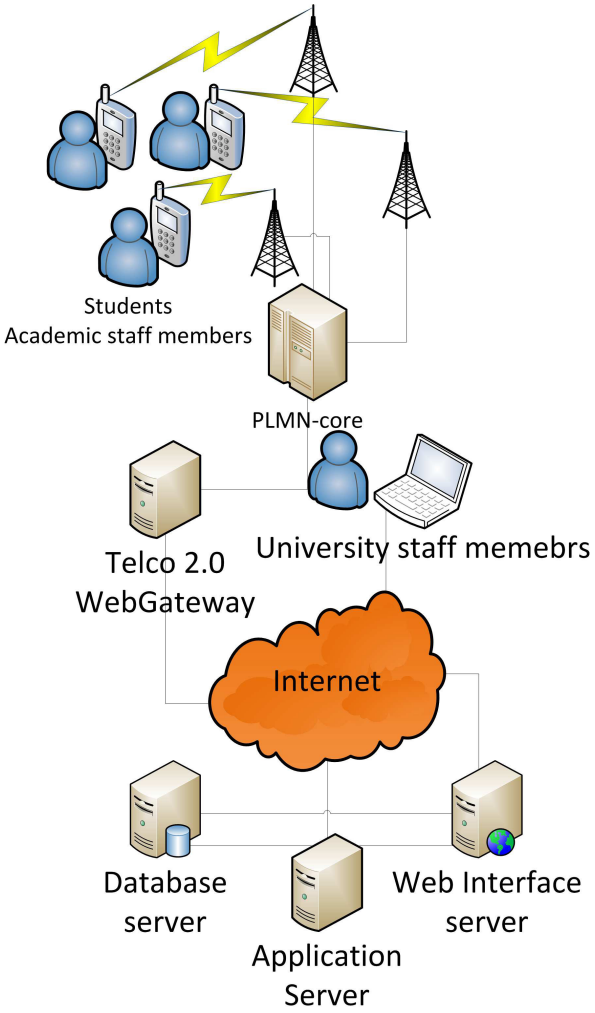

Fig. 2. Architecture diagram of the massive messaging system.

mechanisms are invoked every time the user wants to join the system or messaging group.

All the internal data, as well as user account information are stored in incorporated RDBMS which is accessible for both the application and WebGUI servers.

III. USER SYSTEM INTERACTION

Despite the capabilities of the developed solution user interaction models are the key factors of the deployment success. Thus four complementary user interfaces were proposed:

- Web-based ical User interface for timetable management. This interface allows to easily create and manage timetable for a given lecture room. The access is restricted only to previously defined users. It is also planned to offer students personalized timetables. Sample GUI view is presented in Fig. 3.
- Electronic interactive timetables (EIT) mounted at the entrance to the lecture rooms equipped with wireless 7-buttons pointing device. The primary objective of the EIT is to provide the most up-to-date contemporary timetable

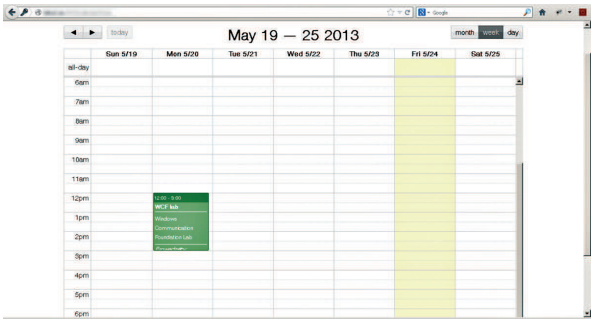

Fig. 3. Example of the timetable manager GUI.

but it is possible to obtain additional information on the selected entry thus EIT strongly extends the timetable capabilities.
- Web based GUI for management of group messaging subsystem. This interface is intended to be used by both academics and students. Staff members might create topic groups (editor role) or join existing ones (notification recipient role). Student may only join the existing groups. As mentioned in section II, to avoid frauds or improper use, e-mail addresses and mobile phone numbers submitted to the system are subjects of verification procedures.
- User might join the messaging group by sending a USSD code. This method is intended for combined use with the capabilities of the EIT in order to minimize the effort needed to join the desired messaging group. It is worth to notice that in this case there no necessity for phone number verification as the action has to be initiated on the target device.

The use of the system includes notifying affected users on changes in the timetables. Nevertheless of the change type, whether it is planned or emergency situation the system allows to improve the communications between building management team and students or teachers. It is especially useful in the case of emergency situations when all the users of the lecture room might be informed on the unexpected changes.

The latter use case scenario involves the academic teachers or administration staff (e.g. dean office). Nowadays they usually communicate with the selected student using emails. Then the leader of the student's group is obligated to pass the information received to the rest of the group. Although emails are reliable and secure mean of communications, in the case of urgency this approach might be ineffective. SMS or USSD messages provide similar level of security and reliability but due to immediate delivery are the most appropriate for such situations. The use of proposed solution creates the possibility to inform all the interested students at once just by creating notification to the target messaging group.

Aforementioned examples only show the base system functionalities and application possibilities. Due to open and distributed architecture the proposed solution might be easily adopted to new application scenarios.

IV. SUMMARY

In the paper we presented a prototype Student Information Delivery Platform. Proposed system architecture consists of two joined independent modules:

- Interactive Lecture Room Timetable Delivery Subsystem which allows to create, manage and display interactive timetables at the entrances to the lecture rooms,
- Student Massive Messaging Subsystem (SMMS) which makes it possible to send notifications to predefined groups of students or academics. The system incorporates SMS, USSD and email messaging in order to suit various delivery time and reliability needs.

Joint use of the proposed subsystems allows instant notification of the users on unexpected changes to the timetables as well as facilitates communications between academics and student groups. Future system development plans include implementation of RESTful northbound interfaces in all the key components as well as implementation of interfaces enabling integration with already deployed campus systems.

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