Railway Infrastructure Maintenance Efficiency Improvement by Using Tablet PCs

Slobodan Mitrović[1], Svetlana Čičević[2], Slađana Janković[3], Norbert Pavlović[4], Slaviša Aćimović[5], Snežana Mladenović[6], Sanjin Milinković[7]

Abstract – **State of infrastructure of railway facilities affects safety and efficiency of railway traffic. Bearing this in mind, the usage of Tablet PC in wireless outdoor environment, as a support of infrastructure investigation activities of maintenance stuff is considered in this paper. The result of the investigation is recorded through data update process in the corresponding portal that is a part of the model for integration of traffic information systems in a cloud computing technological environment of Serbian Railways.**

Keywords – **Tablet PC, cloud computing, wireless, railways maintenance.**

I. Introduction

During railroad infrastructure inspection and/or investigation process Serbian railways personnel often spend a significant amount of time gathering and distributing information on paper documents.

Further, station stuff was about to perform tasks in several steps in order to convert paper-based data entry to electronic forms. Hence the necessity for technological improvement of this process arises.

Bearing in mind that the tablet PC provides a platform that combines data entry and retrieval with advanced communication and collaboration capabilities, in this paper the usage of such kind of device is considered. In this case the proposed solution is data updating process within the corresponding portal that is a part of the model for integration of traffic information systems in a cloud computing technological environment of Serbian Railways. This possibility is tested with a web interface that provides quick and easy way to access and update data, in order to provide the maximum in new mobile computing functionality that users can learn quickly with a minimum of training. Besides, the usage of such class of devices and personnel education for system and information management is not cost nor time consuming comparing to benefits.

[1]Slobodan Mitrović is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: s.mitrovic@sf.bg.ac.rs.

[2]Svetlana Čičević is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: s.cicevic@sf.bg.ac.rs.

[3]Slađana Janković is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: s.jankovic@sf.bg.ac.rs.

[4]Norbert Pavlović is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: n.pavlovic@sf.bg.ac.rs.

[5]Slaviša Aćimović is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: slavisa@sf.bg.ac.rs.

[6]Snežana Mladenović is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: s.mladenovic@sf.bg.ac.rs.

[7]Sanjin Milinković is with the Faculty of Transport and Traffic Engineering, University of Belgrade, Vojvode Stepe 305, 11000 Belgrade, Serbia, Email: s.milinkovic@sf.bg.ac.rs.

II. Proposed Infrastructure Model

Use of tablet PCs as a standard tool in railway infrastructure investigation activities requires presence of wireless infrastructure within railway stations and other facilities. Thus, standard WiFi outdoor engineering principles should be applied for facilities which lack this kind of equipment. In those environmental conditions the centrally controlled wireless mesh solution based on Lightweight Access Point Protocol (LWAPP) [1] is proposed (Fig.1). Stationary infrastructure could be created using Wireless LAN controllers and outdoor Root/Mesh Access Points (RAPs/MAPs). Position of RAP (WLC AP) and MAPs relies on the railway station/facility configuration and must be considered evenly, because a site survey reveals issues such as interference, Fresnel zone, or logistics problems.

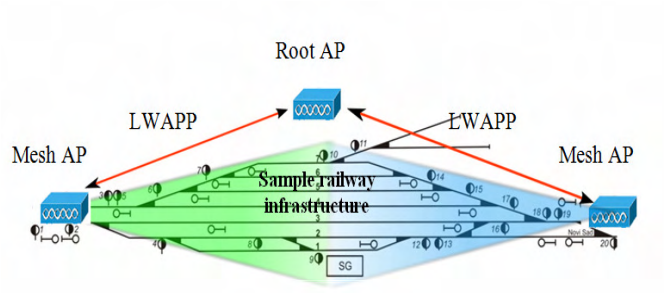

Fig. 1. Example of LWAPP based AP structure on a railway yard

The typical rail classification yard characteristics are [2]:

- 250 + acres of area covered
- 2+ linear kilometers end to end length
- Metropolitan and rural area environments
- Limited road access within the yard
- Very high levels of Radio Frequency Interference

Rail yard WiFi implementations often fail due to [2]:

1. Co-channel interference
2. Excessive Attenuation
3. Contention loss (too many clients converging on a single AP).
4. Inaccurate Signal strength mapping.

So, our experiences are in accordance with the findings of other researchers [2]:

1. Successful WLAN design must incorporate RF engineering considerations such as attenuation loss in long antenna cable runs.
2. Co-channel interference will often occur due to the presence of multiple and rogue Access Points competing for bandwidth.
3. Existing tools for signal strength mapping are difficult to apply to large outdoor environments.
4. Security and encryption are essential requirements for most applications.

Security and encryption requirements are crucial for this proposed model. It has to be taken into account that different models of tablet PC with different platforms (Windows, Android, IOS, etc) could be the choice of one Railway Company. Thus, we need security and encryption method that will be platform independent as much as possible. In this particular case, the choice is on IEEE 802.1x standard [3], with use of RADIUS server (IETF RFC2865) [4], AAA and LDAP protocol [5] (Fig.2).

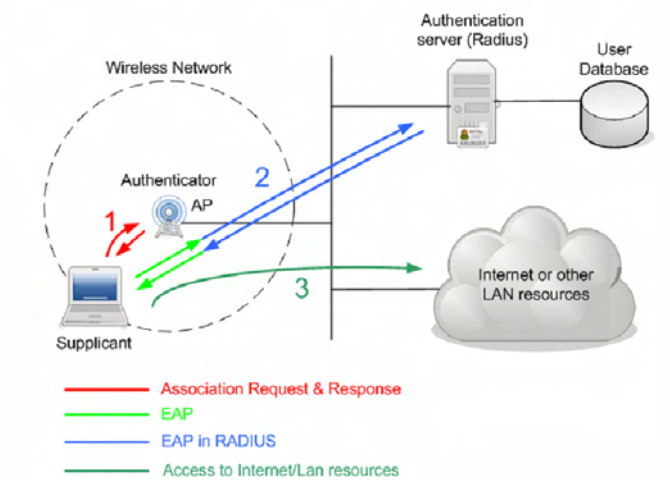

Fig. 2. Use of IEEE 802.1x standard

During the authentication process, only the client EAP messages could reach the NAS (e.g. WLC AP), which are forwarded to the appropriate RADIUS server. If the authentication is completed successfully, the user is allowed to access other network resources (such as DHCP, Internet).

User credentials protection is accomplished by using EAP-TTLS (Tunneled Transport Layer Security). These protocols are based on PKI (Public Key Infrastructure), which allows the client to authenticate communicating server, and also to send credentials through the protected tunnel. After connecting, client is ready to use Cloud resources.

III. USING THE CLOUD RESOURCES

The proposed integration model of the Serbian railways traffic Information System [6] involves the Community cloud delivery model, which means that only those computers which belong to Serbian Railways IP range should have right of access to a hosted service. This model involves the development of the classic n-tier application with the following layers:

- Database layer – SQL Azure database,
- Data access layer – Windows Azure Hosted Service, ADO.NET Entity Framework,
- Presentation layer – ASP.NET application.

In our case study Windows Azure application is implemented as an ASP.NET *Web role* application RAILROAD STATION INFRASTRUCTURE (RSI). *Web role* supports representation of user interface through IIS (Internet Information Services). RSI uses the ADO.NET Entity Framework - ADO.NET in a set of technologies that support the development of application-oriented data. *EntityDataSource* control enabled us to connect objects on a Web page with the data in our Entity Data Model. RSI Web client application allows users to view and/or update the contents of Azure SQL database Serbian railroad infrastructure. The main menu consists of following menus: stations, switches, lines and objects (Fig 3).

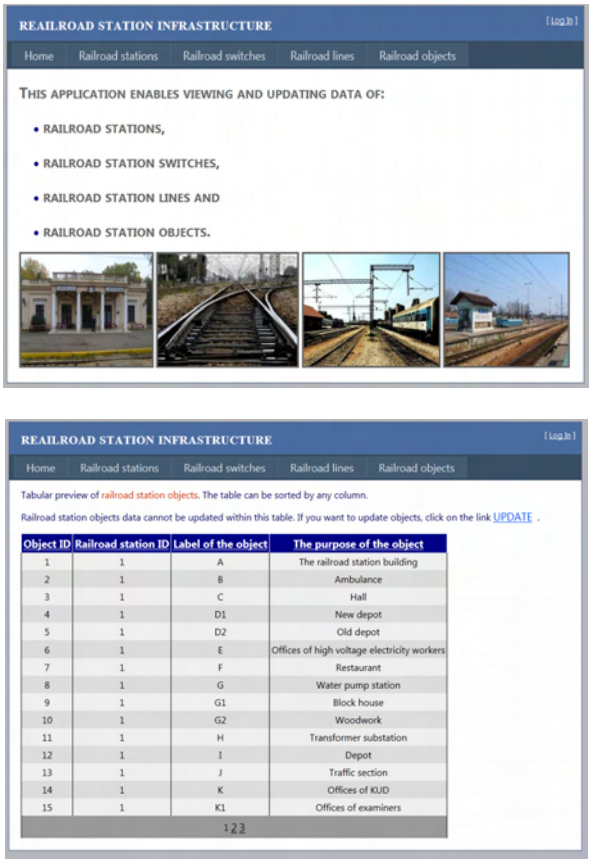

Fig. 3. RSI Portal, main menu and objects data table

IV. TESTING PHASE

The usage of tablet PC has been tested in real conditions. For testing purposes, a secured 802.1x environment has been created for access to the Cloud IS. The 8.4" tablet PC Prestigio MultiPad PMP3384B has been chosen, because the size of its display was estimated as to be suitable for optimal operation from the ergonomics point of view. This tablet works in the Android operating system, which has been successfully configured to access the Cloud IS (Fig. 4). Tablets that work in MS Windows operating system were not selected for this test because, according to previous experience, we assumed that they will work without problems. On the other hand, various tablet PC models based on the Android OS are available at prices that are affordable for purchasing.

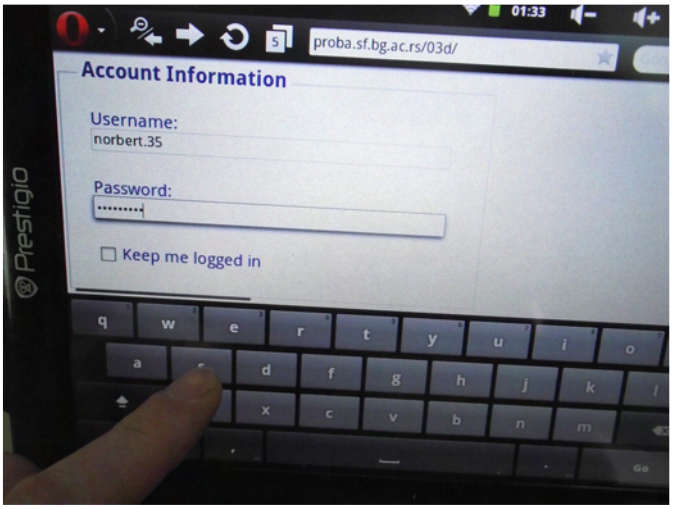

Fig 4. Cloud IS login sequence

Test web application was set up in the way that it contained two frames, one for railway station infrastructure schematic diagrams and another for tabular data (loaded from the Cloud) or satellite maps. The purpose of those satellite maps was to help railway personnel in finding objects from diagrams more easily (e.g. to perform the inspection tasks on site more successfully) (Fig. 5).

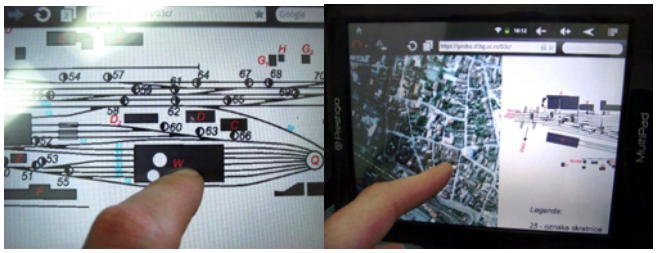

Fig 5. Usage of schematic diagram frame and satellite maps

On the other hand, the idea was to show whether the proposed web interface architecture was suitable for operation within certain type of web browser.

On the very beginning of test, it was encountered that the default Android web client (html reader), did not met required criteria. Therefore, The Opera mini browser was additionally installed, providing the satisfied level of functionality (Fig. 6).

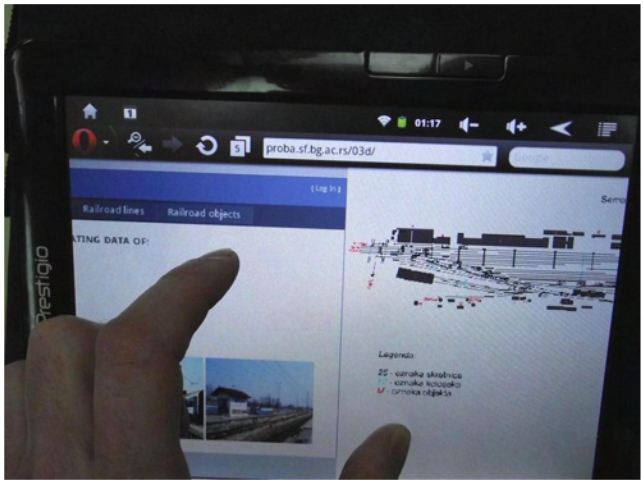

Fig 6. Frame structure of web application

Upon completion of inspection tasks the participants updated tabular data which were previously investigated (Fig. 7).

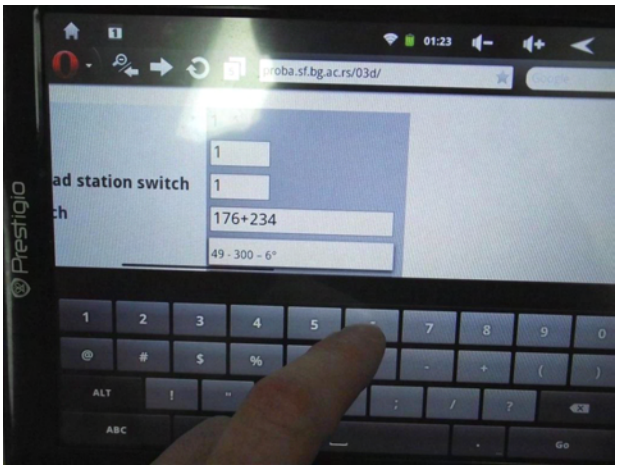

Fig 7. Updating tabular data

In addition the parallel testing with use of traditional forms of documentation (on paper) has been performed, but those are is beyond the scope of this paper.

The results of this experiment showed that the performances of inspection staff (represented by the time it took to perform tasks) were satisfactory. Furthermore, the number of errors that has been made was insignificant.

It was observed that the time needed for initial training in work with the Tablet PC device was very short, averaging less than 10 minutes. The participants were very satisfied working with this type of device as well as with the application.

V. CONCLUSIONS

The usage of Tablet PCs with the scope of railways infrastructure investigation process brings many advantages, comparing with use of traditional (paper) form of documentation. However, there are several types of difficulties in implementation such model of technological improvement. First, there are many issues that have to be considered during WLAN engineering process. Secondly, proper security measures have to be implemented in order to protect data that has to reviewed and updated.

Forasmuch as, there are several tasks that have to be accomplished in our future work.

- Railway infrastructure could be characterized as industrial environment and a part of our future work will be related to the development of general WLAN implementation model that could be particularly applied on Serbian Railways facilities.
- Some security measures have already been implemented. For example, RADIUS and LDAP server, as well as WLC APs are positioned to IP locations, defined by Serbian Railways Intranet (SRI) IP plan, so they are protected with firewall system from external attacks. Network segmentation to different VLANs, are also followed with standard security measures, according to facility position and importance within SRI. However, development of some security procedures related to usage of Tablet PCs and personal access to Cloud database, as well as accuracy of data entry and/or updating is highly recommended.
- As part of wider research, which is however, beyond the scope of this paper, a series of experiments have been conducted testing the possibility of applying tablet PCs with different types of touch screens that would be most suitable for usage in the above mentioned environment.

On the other hand, working with this kind of tablet PCs is helpful in making the state of information system more accurate. This leads to proper decision process, gaining the safety and efficiency of railway traffic, especially when the whole traffic picture is distributed to all important management elements through the Cloud environment.

ACKNOWLEDGEMENT

This work is partially supported by the Ministry of the Science and Technological development of the Republic of Serbia under No. 036012, No. 036022, and No. 036006.

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