PRONTO: EVENT RECOGNITION FOR PUBLIC TRANSPORT

Mr. Mika Varjola
Mattersoft Ltd.
Pinninkatu 45 A, FI-33100 Tampere, Finland
Tel:+358 10 322 5001, fax: +358 10 322 5009, e-mail: mika.varjola@mattersoft.fi

Mr. Jobst Löffler
Fraunhofer IAIS
Schloss Birlinghoven, 53757 Sankt Augustin, Germany
Tel: +49-2241-14-1956, fax: +49-2241-14-4-1956, e-mail: jobst.loeffler@iais.fraunhofer.de

ABSTRACT

The PRONTO project, partially funded by the European Commission, was launched in 2009 in order to explore the effects of real-time information based event recognition and decision making in operation control. The project focuses on the fields of emergency rescue operations and public transport, both of which typically involve vast amounts of information gathering in their operations. The project's aim is to demonstrate how organizations can fully utilize the collected data and the effects of this in their operations. This paper focuses mainly on the public transport scenario of the PRONTO project. The project's advantages for public transport are demonstrated in a pilot, where collected sensor data is analyzed and used to support decision making in various situations as well as operations control. The advantages for end users, operators and the environment are obvious, because fuel consumption is reduced and passenger comfort and traffic safety are increased at the same time as the drivers get feedback from their driving. As a result of this project more information regarding public transportation should be received and the significant events that need to be recognized are defined. Thus more specific information about ways to improve the operation can be received and increase the effectiveness and importance of public transport.

WHAT IS PRONTO?

PRONTO is a European Commission (EC) funded project that was launched in March 2009. The project is due to last for three years and during this time, the main emphasis of the project is to investigate the impacts of event recognition on intelligent resource management (IRM). This is done by gathering data from various sources, analyzing it to extract useful information

in the form of events and then delivering the resulting knowledge for decision making in emergency rescue operations and public transport. In order to achieve this objective, PRONTO uses techniques and expertise from the areas of data fusion, information extraction, temporal representation and reasoning, machine learning, and knowledge management systems [1]. PRONTO sets specific goals to its two main targets: real-time decision support for IRM in public transport and emergency rescue operations, both cases typically involving large volumes of various types of data. PRONTO is a follow-on project to the successful EC-funded project SHARE - Mobile Support for Rescue Forces, Integrating Multiple Modes of Interaction [2].

The need for a project like PRONTO derives from the fact that today's organizations are able to collect data in various structured and unstructured digital formats, but they do not have the capability or resources to fully utilize it in order to support and improve their resource management. Therefore, analysis and interpretation of the collected data needs to be automated and transformed into operation-related knowledge. To be able to do this, it is important to recognize different types of events in the area of IRM. PRONTO uses various techniques in recognition of events from the collected raw data that remain underutilized with current technologies. The extracted knowledge becomes available to the user organization, thus enabling the corresponding decision-making process based on event recognition. The decision making is done at the control center and therefore the extracted knowledge is received by these operators. Thus, studies will focus on proving the demand for technologies used and automated event recognition in resource management [3].

The PRONTO consortium consists of six partners from four European countries. Fraunhofer IAIS from Germany, coordinator of the project, and NCSR "Demokritos" from Greece are internationally renowned research institutes, University of Paderborn from Germany is a highly regarded research-led university, Mattersoft Ltd. from Finland and Noldus Information Technology BV from the Netherlands are leading industry corporations and the Fire Department of Dortmund in Germany is a major public emergency rescue operations organization.

ADVANTAGES OF EVENT RECOGNITION FOR PUBLIC TRANSPORT

In PRONTO, one of the two pilot cases is using real-time information in supporting decision making in public transport. The management of public transport system requires real-time, intelligent management with the help of available resources. During the project a pilot will be

done in the City of Helsinki, Finland, where public transport vehicles are equipped with on-board units that send sensor information to a central server. The central server offers information about the current status of the transport system (e.g., the location of the vehicles on a map) and about additional sensors data to measure conditions in the vehicles (e.g. noise level, temperature, 3D acceleration and technical vehicle data from CAN bus/FMS interface). Through real-time sensor data from vehicles and a mobile broadband connection in the vehicles, the management can detect exceptions regarding the operation and even possible threats in the vehicle, and thus effectively use these in analyzing the need for interaction with the driver or authorities in terms of stabilizing exceptional situation. In the pilot, the aim is to detect various high-level events that create a need for decision making.

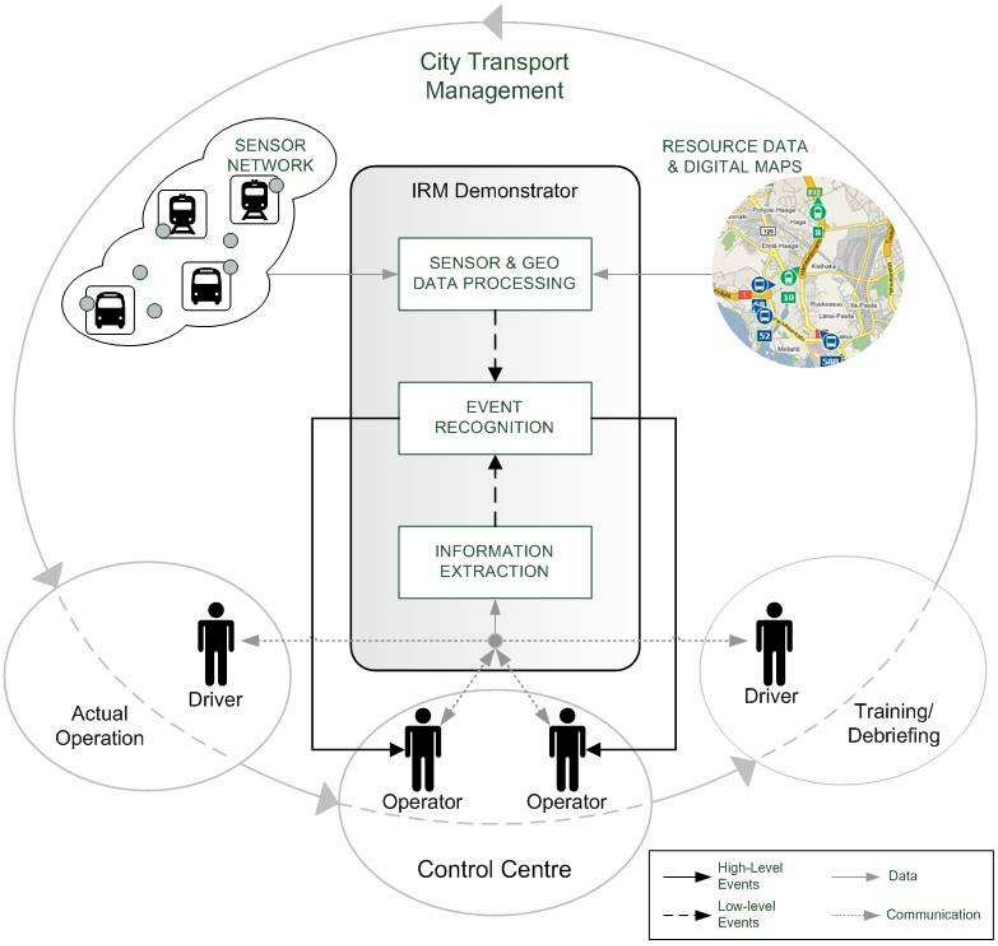

Figure 1 PRONTO data flow

In terms of city traffic management (CTM) the study focuses on aggregation and analysis of the gathered sensor data, defining different types of events that need to be recognized and then detecting the events.

In PRONTO, IRM consists of the following phases: collecting data from sensors, analyzing the collected data and applying event recognition techniques in order to detect, particularly in

real-time, high-level events, which are derived from low-level events in sensor data. PRONTO focuses on the difficult task of real-time, accurate recognition of complex events defined by various sources of information, including different sensors and modes of actor interaction.

The control center can also use the sensor data for back office analysis, which helps to detect possible continuing problems on specific routes or drivers. For drivers the sensor data enables also more effective training because analyzing past event data will help them to notice major problems in their own driving style as well as general matters, thus leading to improvement of individual knowledge, reduction of stress and the risk of mismanagement.

PROJECT ACHIEVEMENTS SO FAR

Since the beginning of March 2009 the project has been progressing steadily through regular meetings and planning. Most of the required specifications are done and implementation has begun at the end of 2009.

In the public transport scenario, the PRONTO system utilizes two existing information systems which are Mattersoft Live! and Noldus Observer XT. Mattersoft Live! collects real-time position data of the Helsinki City Transport vehicles and sends the information via mobile broadband connection to the server in order to calculate real-time timetables for passengers. As the Live! system has been in use in Helsinki since 2007, it provides an easy platform for enhanced data gathering. The Live! System is integrated into the distributed event-based PRONTO system. The Observer XT, which is currently used as stand-alone component, then analyzes the gathered data and shows a variety of information in the user interface. This product has also been added with enhanced functionality in order to provide results needed in PRONTO.

With the Live! system, all trams and some of the buses within the City of Helsinki can be used as sensors in order to provide GPS data for the PRONTO system. This data, gathered by 150 vehicles, can then be utilized in some of the use cases in the public transport scenario. Moreover, two vehicles have so far been installed with additional sensors, including acceleration in three dimensions, noise level sensor and in-vehicle temperature sensor. One of the vehicles is a tram, and another one a bus, both in regular city public transport service. The additional sensor kit in the bus is presented in Figure 2.

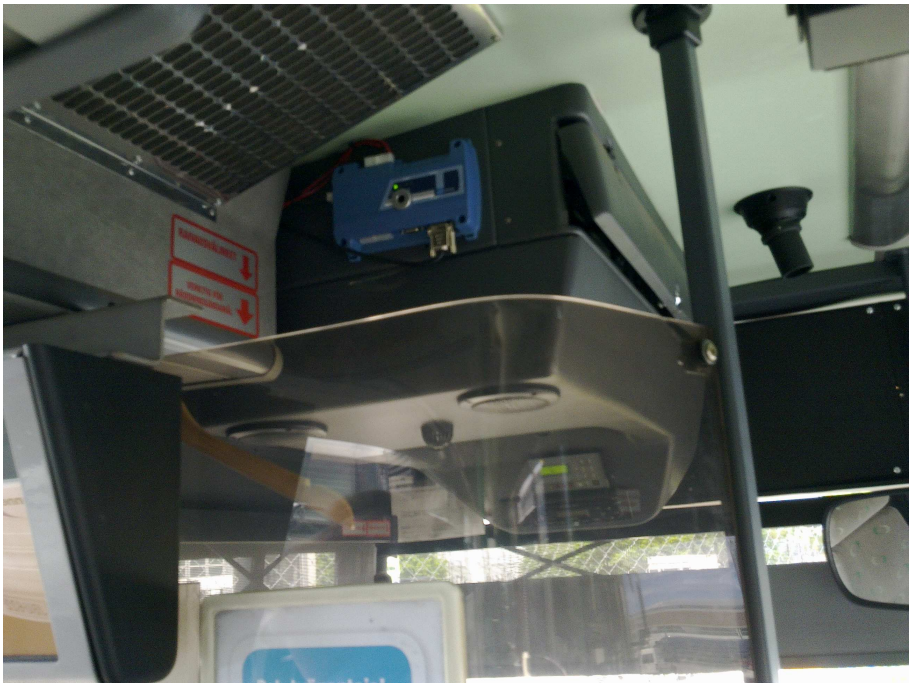

Figure 2 Additional sensor kit installed in a bus in Helsinki

The bus is also equipped with an interface to the FMS/CAN-bus interface for gathering the vehicle data such as fuel consumption, engine speed and engine temperature. Moreover, as the mobile broadband connection utilized in the City of Helsinki uses a special network which is available in Finland only, also GPRS communication is tested in order to get internationally applicable results.

The architecture of the PRONTO system is based on a message-oriented middleware (MoM) approach [4]. Open source software HornetQ is used as MoM solution. HornetQ is an open source project to build a multi-protocol, embeddable, high performance, clustered, asynchronous messaging system. All modules act either as producer or consumer or both of event messages which are sent to the MoM using the messaging standard JMS (Java Message Service) API. The main modules of the current PRONTO prototype are the Mattersoft Live! system, the complex event processing module (CEP), the GPS event detection module and, finally, the application module which provide a Browser-based map service to the end-user. The application module will be extended in the near future with additional resource management functionality.

Figure 3 shows the Browser-based map application of the first prototype. Event messages coming from the vehicles in Helsinki are displayed on the right side of the GUI. The map is annotated with a section (red color) and a vehicle is entering the section causing an event message which is displayed directly on the map. The application is built on open source technology and uses OpenStreetMap as source for map data.

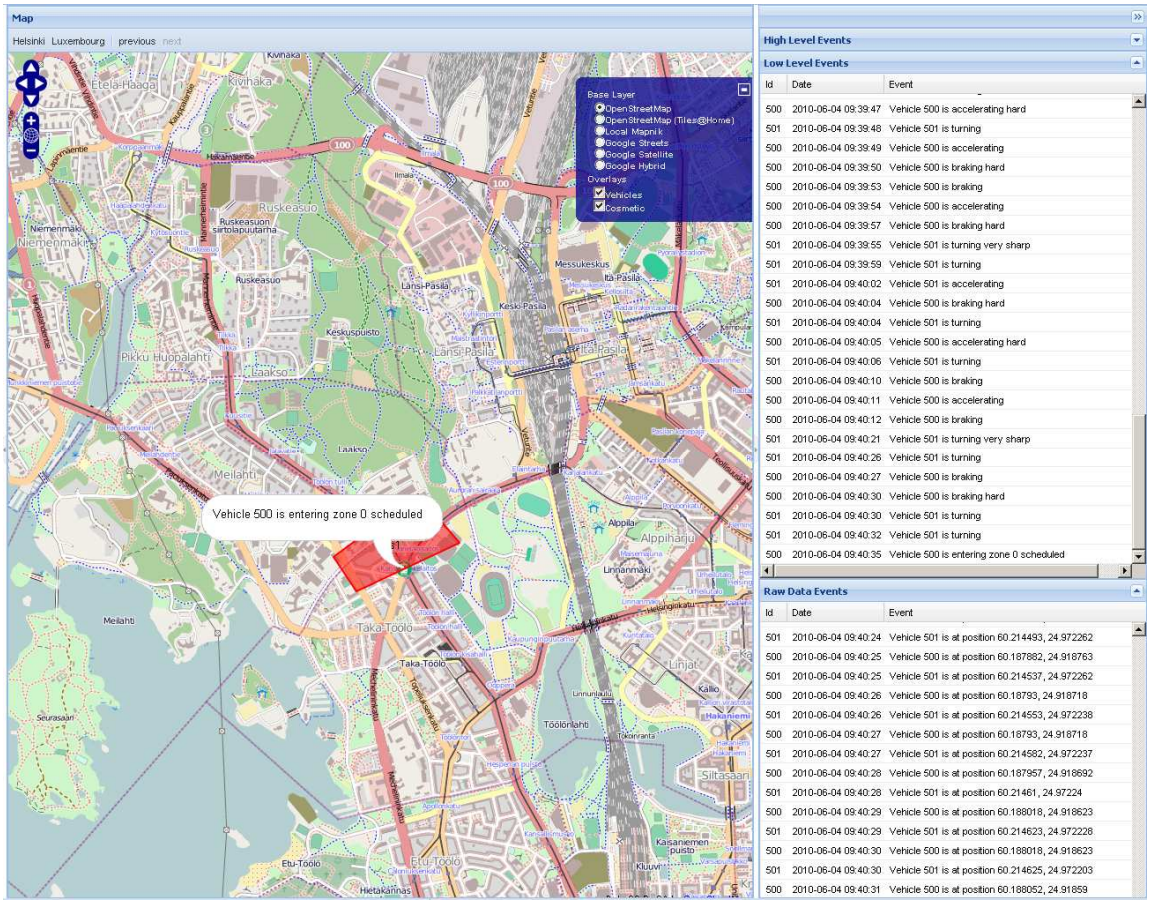

Figure 3 Browser-based map application showing user annotations and event messages

Figure 4 shows the extended version of The Observer XT of Noldus Information Technology. The Oberver XT is used to analyze and visualize logged event data off-line in a synchronized fashion. Moving the slider of the video player or selecting another event in the event list will cause a synchronized display of related data in all display windows. The Observer XT will be the main tool used in training and debriefing activities of PRONTO usage scenarios.

The first demonstration was made in June 2010 at the European Commission in Luxembourg, where the project reviewers and the project officer of EC were shown an online demonstration of the developed system. This included the presentation of real-time public transport information from the City of Helsinki, and a real-time demonstration vehicle runs around the EC surroundings in Luxembourg. The gathered data was analyzed in real-time and some events regarding vehicles entering or leaving a specific area, passenger comfort and passenger safety were found and presented in real-time on the graphic user interface. The demonstration was successful, and the PRONTO system will be developed further according to project plan.

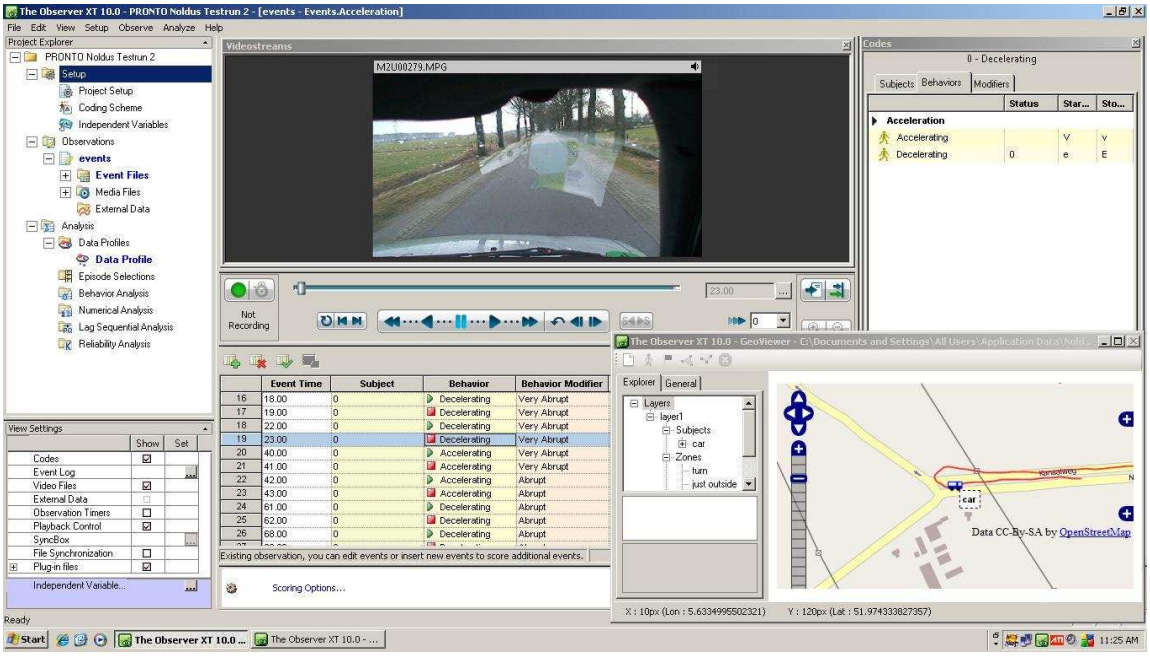

Figure 4 The Observer XT (© Noldus Information Technology) with PRONTO extensions

NEXT STEPS FORWARD

The next steps in the project and especially the public transport scenario include further test data gathering, further sensor evaluation and possible implementation, new sensor data gathering, software development, system integration and further requirements analysis (focusing mainly in post-operational use cases like analysis of operations). The new sensors could also include cameras with automatic video recognition processing units in the vehicles. Naturally privacy issues have to be taken into account. Another option is to have cameras pointing forward in order to get the driver view. With the live view from the vehicle more information about events in an outside the vehicle can be detected and thus evaluate their impact on other events in the operation on a wider perspective.

CONCLUSION

PRONTO offers a significant chance to prove the importance of real-time information in public transport operations. The project members have high expectations regarding the results of the upcoming pilot and are assured that through the results, a higher understanding of decision making support is formed, thus enabling the public transport operators to fully utilize all the existing information they have and thus improve their operations. Naturally, increased passenger safety and positive effects on the environment due to more fluent city traffic are also important results expected from the PRONTO project.

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