Next Generation Public Travel Information Systems

by Karl Rehrl, Harald Rieser and Siegfried Reich

The Sun Technology Research Excellence Center of Salzburg Research and the Ascom Center of Competence are jointly working on a next generation middleware that will allow the integration of mobile devices in Public Travel Information Systems.

Public Travel Information Systems (PTIS) are widely used in train, tramway and subway stations. However, the integration of mobile devices (such as PDAs for personalised traveller information or onboard displays in trains) is difficult due to the heterogeneity of these devices and the fact that the status of connectivity changes rapidly (from high availability of bandwidth to off-line mode). Moreover, configuration and management of these devices and the distribution and delivery of content - increasingly of a multimedia nature - are difficult issues.

During our work we have found a number of requirements for middleware systems dealing with stationary and mobile devices in public information systems. The most important of these are:

- *Heterogeneity of devices:* PTIS must cope with a multitude of devices, including personal computers, public information terminals, videowalls, LED displays and also mobile devices, such as PDAs (Personal Digital Assistants) and mobile phones.
- *Variability in connection modes - the off-line mode:* The use of mobile devices implies that not all devices will be available all the time; in mobile environments, devices are regularly off-line, and as a result, the off-line mode cannot be considered to be an exception. Consequently, the middleware infrastructure must be capable of caching data in the off-line mode and redistributing it upon reconnection through the use of sophisticated data synchronisation mechanisms.
- *Centralised configuration and 'Plug & Work' capability:* Another issue involves the accessibility of mobile devices in large systems for configuration and management purposes. For example, a huge number of information displays in train stations cannot be physically accessed. Consequently, the configuration data for these devices should be minimised, and in general they should be configured, maintained and monitored through a central management tool. Using a central management tool ('Control Center') with automatic data distribution allows the easy maintenance of a huge number of devices with similar configurations. This also allows the so-called 'Plug & Work', ie the dynamic configuration of devices during run-time.
- *Quality of information:* The quality as perceived by the customer, ie traveller, is measured by the quality of the information delivered. This requires information to be synchronised and updated regularly.

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Public Travel Information Systems in Graz.

Under consideration of the requirements and aims mentioned above, we have adopted the following technical solutions. The middleware infrastructure is based on an overlay network structure with a hierarchical, two-tier network scheme. This means that, despite the underlying physical network, mobile devices are dynamically assigned to logical sub-domains within one global domain, enabling efficient device management, message routing and allocation of the necessary infrastructure. In order to provide a simple and efficient programming model for developers, software infrastructure on devices had to be structured appropriately. The concept of a service-oriented architecture (SOA), defining services as coarse-grained functional units with well-known interfaces, was therefore adopted. Following the requirements for mobile devices, services are allowed to use different communication modes like synchronous RPC and asynchronous 'Store and Forward' messaging. Reliable data distributed to mostly off-line devices required the development of a data-distribution mechanism called Virtual Database (VDb). With Virtual Database it is possible to provide services with a virtual database connection without establishing a real connection. VDb

hides the necessary communication details from the developer and improves the efficiency of data distribution. Services ask the VDb for database fragments and get these either from the local cache or upon network connection directly from the database. VDb is used for the distribution of configuration data and management data, and is also well suited for multimedia content.

Another of our technical aims is the support of a broad variety of heterogeneous devices. This was achieved through the use of widely adopted standards such as Web Services, and through building upon platforms which are also available for embedded devices. While our first prototype was based on the Java 2 platform, requirement changes demanded that the current prototype be developed using the .net Framework. In the future, we are planning to support the .net Compact Framework on embedded Windows.CE devices as well.

In conclusion, we have argued for requirements for next-generation transport information systems and have outlined how we are addressing these issues with respect to the middleware layer. The concept of Service-Oriented Architecture was carefully chosen in order to overcome platform borders and to simplify the process of porting code to other platforms.

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Mobile Communication in Newspaper Distribution and Transport

by Olli Kuusisto and Janne Pajukanta

Newspaper distribution and transport are time-critical operations in which a large number of people are required to work in a coordinated manner. VTT has developed a pilot system based on mobile communication to solve production and communication problems in the newspaper distribution and transport process.

Even though this process is, in principle, repeated every night, varying disturbances and problems can occur each time. By utilising mobile communication, people working in different locations can be reached, and problems solved. It also enables reporting of up-to-the-minute information on the entire production process, and communication between supervision and employees as well aswithin a team. With the help of real-time control and tracking, the entire delivery process can be optimised and the quality of the process improved. Pilot systems and solutions were developed to enable work-related communication in newspaper distribution organisations, and experience was gained in practical field tests. The tests made clear what kind ofbenefits can be offered by the use of these new tools, as well as showing how currently available technology is able to meet the challenges of professional usage in a real working environment.

At present, the flow of electronic information in newspaper production ends at the post-press department. Tailoring of newspapers, new subscription alternatives, new products and predicted shortage of deliverers will increase the challenges for accurate and reliable distribution. In practice, distribution will evolve, and is predicted to function more and more through teamwork, where teams will be autonomous and the need for supervision will decrease. These challenges create a demand for new systems of communication and transmission of data.

The objective of the mobile communication pilots was to plan and implement mobile control and tracking in order to obtain empirical information on the suitability of the system and the portable wireless devices used. The pilot system included following functions:

- on-time and deviation reporting to the distribution organisation
- instant messaging to deliverers
- communication between and among the foreman and the deliverers.

The preliminary requirements specification was made based on interviews with deliverers, their foremen, van drivers and management from several distribution companies. In particular, opinions concerning portable devices and features of the system were gathered. Typical working methods and the need for bilateral communication were also examined. At the pilot stage, the operation of the pilot system was first presented to the pilot companies and deliverers, and feedback was gathered accordingly.

Web-application architecture was chosen since individual applications to different terminals, as well as the control of the state of the application, would have been troublesome, the latter resulting from at the time not so reliable GPRS-connection. The application can be run on any general Web browser. Typical layers in such architecture are client application, www-server and database. Web browsers served as the client application at the different terminals. HTML pages were created dynami-