ENTRY-LEVEL SOLUTIONS FOR SMALL AND MEDIUM-SIZE ENTERPRISES IN SUPPLY CHAINS

Elisabeth ILIE-ZUDOR[1], Zsolt KEMÉNY[2], Marcell SZATHMÁRY[3],Jan NYMAN[4], Kary FRÄMLING[5], Ville HINKKA[6], Béla PÁTKAI[7]

[1,2,3]Computer and Automation Research Institute, Hungarian Academy of Sciences
Kende u. 13-17, 1111, Budapest, Hungary
{ilie, kemeny, szatmary}@sztaki.hu
[4,5,6,7]Helsinki University of Technology,
Otaniementie 17, POB 5500, FI-02015 TKK, Espoo Finland
{jan.nyman, kary.framling, ville.hinkka, bela.patkai}@hut.fi

Abstract:

The increasing need for customization, more efficient quality feedback, better supply chain coordination, etc. are all factors which demand for implementation of item-level tracking and tracing services across company borders. A platform enabling such operations has been developed under the acronym of TraSer (http://www.traser-project.eu/). The fundamentals of the TraSer solutions, as well as the implementations done in different application areas form the base of the present paper.

Keywords:

RFID-based tracking and tracing, supply-chains, pilot implementations, SME, middleware

1. INTRODUCTION

Today's product development and industrial production are marked by a number of changes which point towards the *need for item-level tracking and tracing* across company borders (as opposed to account-oriented material handling). Some of the most common drivers for such solutions are: *demand for customization, more efficient quality feedback, less deadheading in logistics, better supply chain coordination, fast development with better integration of prototype procurement*, and *flexible collaboration* in changing production networks.

Many currently offered business and enterprise integration platforms already include the option of establishing tracking and tracing functionalities, and some of them already include medium-size enterprises in their targeted spectrum of users. However, these commercially offered solutions rarely focus on the specific circumstances of—possibly constantly changing—production networks of small and medium-sized enterprises which are frequently marked by small production volumes, high variation among products, and custom-tailored communication with retailers, customers or other members of the supply chain. The 6th Framework EU project TraSer (Identity-Based Tracking and Web-Services for SMEs) intends to provide a solution platform fitting into this niche of entry-level tracking and tracing solutions for small-scale users [2].

Started in June 2006, the TraSer project has already brought forth test releases of the solution platform, which are now undergoing field tests in a variety of pilot applications. Several industrial project partners participate in these implementation trials which span a complete range from closed-circuit tracking to supply chain applications, as well as tracking of electronic documents.

The pilots presented in this paper have a higher than usual importance, as the planning, design and development of the TraSer software is based on more than just the *existing* requirements widely explored at the beginning of the project. TraSer is intensively and proactively working with real SMEs and other targeted organizations by suggesting potential application scenarios not considered or invented by end users due to their relative unfamiliarity of tracking and tracing technology.

The structure and order of the following sections represent this *agile development method,* introduce preliminary requirements, state-of-the-art, the basics of the TraSer architecture and lessons learned during the pilot projects.

2. REQUIREMENTS FOR OPERATING TRACKING AND TRACING SERVICES

In order to operate an integrated tracking and tracing solution—with transparency across organizational or architectural borders—several preconditions must be met at different functionality levels:

i) Unique identifiers must be used for unambiguous distinction of instances within the range of concern (where instances may be separate items, larger packaging units or batches, depending on the needs of the given application). When a given solution is planned, identification standards already in use, as well as expected future needs, may have to be observed [1].

ii) Databases must be set up for consistent and secure storage and retrieval of item-related information, containing both static features related to the instances (e.g., links to data sheets, handling instructions etc.), as well as properties which will be subject to change during production and delivery.

iii) Item-related events (e.g., departure/arrival during shipment, changes during assembly) have to be mapped to identifier readings (e.g., the given item passing a specified checkpoint), so that time, location and nature of operation steps can be entered into the tracking and tracing system without active human assistance.

iv) Sharing of events with proper transparency and security (access control, communication encryption, consistency guarantees etc.) must be facilitated among all parties concerned in the supply chain or production network.

3. TECHNOLOGY PENETRATION LEVEL AT SMES

The degree to which enterprise integration solutions are used varies in a wide range as far as SMEs are concerned. This is influenced by the size of the given company, the branch of industry they are working in, their status in a value chain, and their relations with larger companies which are—and will always be—early adopters of new integration technologies, forcing a given degree of inclusion on their smaller business partners. In order to summarize the findings gathered at various industrial partners let us observe the two ends of the enterprise spectrum in concern.

At the high end of the spectrum are medium-sized companies which already employ some type of a comprehensive enterprise integration solution. It is expected that the latter is fully functional at the level of ERP, and SCM solutions may already be in use to some degree [6], especially for collaboration with larger companies they are suppliers of [3], [4], or retail networks distributing the company's products. In such cases, process and data models, naming conventions, storage and retrieval of product data and communication interfaces are already existing, and a TraSer-based solution would mainly serve as an add-on for enhancing interoperability with other networks. This also implies that a minimal amount of data is to be stored directly in the TraSer system (since most data are already managed by the existing enterprise integration solution), and the focus of system adaptation is shifted towards the correct definition and use of interfaces whose definition depends on the data models used by components and collaborating parties in the given case. Little can be generalized in terms of data model definition, as models largely vary in different branches of industry and there is even much variability depending on the specific solution used. Even though standardization approaches do exist (such as Core Components [5]), it is still absolutely necessary to analyze the existing data models, plan the extensions and configure the interfaces case by case.

The lower end of the spectrum comprises small enterprises where small production volumes, small product variability at a given time, and a low number of production and business processes did, so far, not urge the company to invest in integration or introduction of comprehensive enterprise IT solutions. Typical, in such cases, is the use of spreadsheets or comparable low-end solutions (sometimes even purely paper-based) handled manually by a human operator who is often in charge of bridging the gaps between different interfaces or data models—in other words, what enterprise integration solutions do automatically in larger companies is performed here through human intervention. This bears substantial risks which may, until a given point, not surface frequently enough to signalize the need for integration by an IT solution but are, nevertheless, present as potential problem sources:

1. Compared to automated handling, human operators introduce higher risks of error which may further increase at higher work-load.
2. Human operators may be less consequent in keeping data models and communication protocols. This may receive little attention if the other end of the communication channel is likewise occupied by a human whose intuitive understanding can correct the error (or recognize it as a data model change, supporting the initial evolution of data models and protocols before formalization), but it bears serious risks of misinterpretation and hinders transparency.

3. A potential bottle-neck is made by entrusting only one given specialist with certain operations (such as receiving of goods) without requiring transparency of the data processed by the person. This bears the risk that a number of processes cannot be carried out if the specialist is unavailable, and since no transparency is given, data processed so far cannot be accessed by others.

4. FUNDAMENTALS OF THE TRASER SOLUTION

TraSer has key features such as: it stores data associated with items historically, it can integrate information from more than one source, and it can connect systems using different numbering schemes to identify their items.

In order to be able to provide these features, a few preconditions must be met though. First, a separate governing entity such as the owning organization must be extractable from the used numbering scheme in order to map the identifier to the internal ID@URI representation used by TraSer. Second, co-operating parties wanting to share information must agree on a common schema of data stored, as servers only store the data and don't interpret it.

The general TraSer implementation consists of 5 parts that are called the TraSer library: the core, a server, a client stub, a persistent client and an AutoID reader framework. The core application can be used to track item data and maintain numbering scheme mapping rules. It can also be used as an embedded program to enhance standalone programs with tracking functionalities.

The server offers the services provided by the core application over a network connection. Since these services can be accessed by other parties as well and the network itself is possibly not secured, the server uses secure enhancements of the web-services protocol stack to offer the services and applies authorization rules to updates and queries. The server augments the services of the core application with management tasks needed to maintain the configuration used by the above mentioned functionalities. The client stub offers a library to initiate a connection to a server, while the persistent client maintains locally duplicated data and meta-information about the network of servers. The AutoID framework provides access to automatic identification devices using a plug-in architecture. The AutoID framework can be extended to support other devices later on, and can be embedded into applications to extend their functionalities with vendor neutral automatic identification.

In addition to the general implementation, TraSer will deliver a set of applications that can be used out-of-the-box to launch tracking in businesses. The provided server application is always needed to start tracking as item information is stored in servers. It is thus most feasible to be operated by the organization owning the items. This server application uses both the persistent client and the server part to give access to the services of an embedded core application and form a conglomerate of servers that can spread public and useful information among its members, like numbering scheme mapping rules.

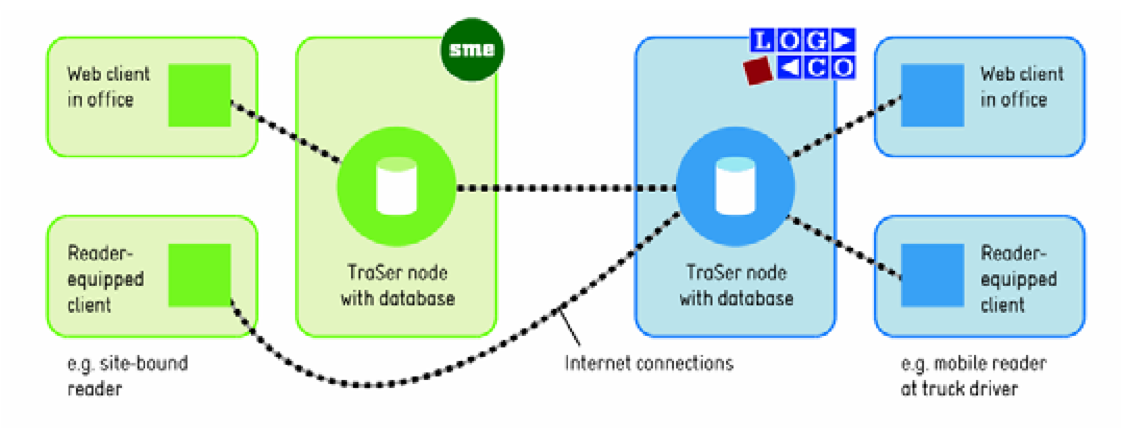

Figure 1: TraSer simple solution setup example

5. IMPLEMENTATION TYPES

TraSer makes possible both implementations for **product tracking** (and tracing) and implementations for **tracking of data** related to physical or virtual products.

5.1. Products tracking

The product tracking solution is based on collecting and managing shipment and product individual specific information for tracking-based logistics service solutions to be effective and valuable in temporary and changing participant networks. TraSer proposes product centric applications, rather than provider specific. The reason is that product centric applications facilitate solutions that can be used at different stages of the product life cycle and by actors that are not needed to be specified in advance. The research also goes beyond the state of the art by proposing that the user, not the service provider, should define where and how tracking information is collected. Furthermore, it proposes that the primary responsibility for the service provider is identifying, activating and using the identity based applications defined by the user. In respect of identification processes, TraSer supports both bar-code and RFID based applications.

5.2. Product-data tracking

The increasingly complex supplier networks and the growing demand that information about products has to be easily accessible during the product's entire lifetime increase the need to exchange product information between organisations. Increasing product customisations make it necessary to handle product information in the product item level rather than on the product type level, which greatly increases the amount of product information. Therefore vast amounts of product and component information are potentially pushed forward in the product design network so that all information can be associated with the final product. This easily leads downstream in the design network to an information overflow. As shown by current STEP implementations, setting up information links is costly and time-consuming for all participating companies. Even though information links exist, handling changes in products and in the information about them is not an easy task. The challenge is to know where the information should be updated if there are multiple copies of it in different companies [7].

6. DESCRIPTION OF PILOTS

6.1. Healthcare Asset Tracking

Healthcare is an application area with great potential for TraSer, because workforce shortage in the EU, the aging population and budget restrictions provide high motivation for automation and efficient use of resources. Teletalo is a Finnish company developing tracking systems for hospitals and implementing now a pilot of TraSer in this environment. The prospective end user of the TraSer integrated system shown in Figure 2 is an equipment vendor or owner in a multi-facility scenario.

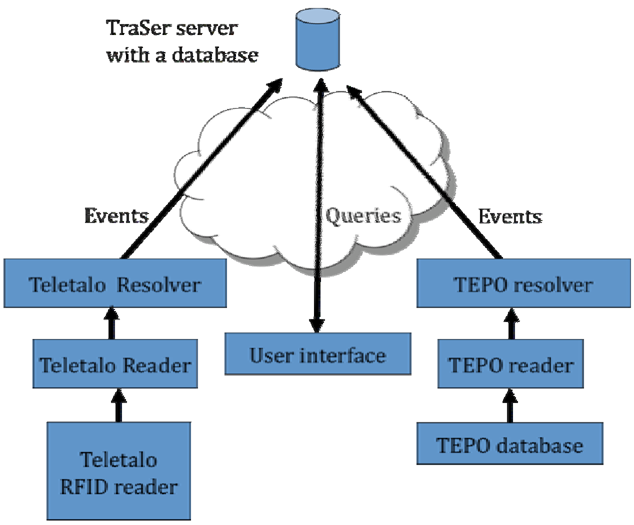

Figure 2: Healthcare asset tracking system "Tepo" integration with TraSer

Instead of observing patients, the pilot was planned to monitor the movement and place of healthcare equipment by adding TraSer tracking system to Teletalo's TEPO multiservice system. It offers the following practical applications:

- Location information of the equipment
    - Quick location information about vital equipment in the case of an emergency
    - Preventing theft by alarming, if the equipment is moved from building
- Monitoring utilization rate of the equipment
- Controlling service and maintenance information

6.2. Tracking and Tracing of Conveyor Shuttle Load

RedBite has integrated TraSer with their RedBox product, that is a standalone, self-contained box designed to streamline the collection of RFID data and its conversion into meaningful business information. RedBox is equipped with simple interfaces to both RFID hardware and network systems. Internally, RedBox is equipped with data filtering, logging, data management and business logics modules, designed for easy configuration and readily customized for specific applications.

Figure 3 shows the conveyor system with shuttles, that was used for the integrated pilot. These shuttles can carry a load of parts, books or any other items with RFID tags. The figure also shows one of the Impinj readers registering events, while in Figure 4 the basic architecture of the RedBox-TraSer integration setup is shown. The pilot aimed at extending the RedBox product with external nodes that are easy to set up and operate for SMEs willing to share data with RedBox users but not using RedBox themselves. Integration was successful and RedBite Ltd has expressed interest in further collaboration with the project.

Figure 3: Tracking and tracing on automated shuttles with TraSer in the RedBite Ltd. pilot

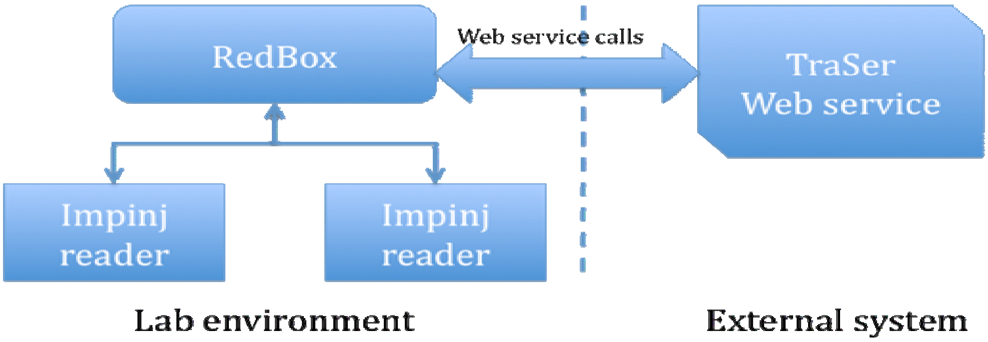

Figure 4: The RedBox-TraSer integration scenario

6.3. Closed-Circuit Asset Management

A **closed-circuit asset management** application is being tested at the Dutch research organization TNO—providing an alternative implementation of their proprietary inventory management system LIMS—where the TraSer-based tracking system is coupled with TNO's already existing user management and authorization system including user access interfaces.

6.4. Asset-Based Goods Tracking

The Finnish logistics company Itella is in the process of building up a series of asset tracking test applications where subsequent pilot stages are to realize an extended **vehicle authorization**, **tracking of returnable transportation assets** (primarily roll cages) across selected locations, and finally, offering tracking services for smaller business partners through **asset-based tracking of goods**.

6.5. Electronic Product Data Tracking

The Hungarian manufacturer Innotec Magyar Kft. is currently applying the TraSer platform in two sample cases. In the first layout, **tracking of physical products** within a "classical" supply chain is realized with all participating partners being small enterprises, focusing on individually tailored solutions of business-to-business interfaces. A second pilot will deal with **tracking of electronic product data**, i.e., blueprints produced by several collaborating industrial partners during product design. Operating in the fashion of distributed version control, the latter pilot will also explore possibilities of integrating product development with the procurement of prototypes over entire design–prototype–correction cycles.

7. CONCLUSIONS

The TraSer project has been developing entry-level, light weight tracking and tracing solutions with a holistic approach. TraSer is much more than middleware, for instance its nodes reveal properties which were, until now, not covered by AutoID middleware, especially i) long-term, organized storage of item-related data and the processing of queries regarding their access, and ii) communication of item-related messages within or across organizational borders. Instead, TraSer clients can very well rely on existing middleware, especially when it comes to the aggregated collection of item-related data from autonomous sensor/reader clusters. Furthermore, the TraSer solution makes possible tracking not only for items, but also for item-related data (e.g.: design files). TraSer goes beyond other approaches also with the agile development methodology that emphasizes the immediate consideration of available feedback from potential end users and especially pilot project participants. Even if such a methodology is more difficult to manage than more conventional approaches, in case of TraSer it proved to be a success.

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