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Modeling of B2B mobile commerce processes

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Abstract

Wireless network technologies, e.g. Bluetooth, enable the direct data exchange between mobile devices. When used in business-to-business processes, a new form of inter-organizational application integration becomes possible, which occurs ad hoc in mobile contexts, contrary to the presently dominating approaches, e.g. such as EDI, which connects centralized servers. Possible applications of this ''ad hoc application integration'' include fully digitized sales processes of goods, where all business documents are exchanged electronically at the point-of-sales via wireless data transmission technologies. This paper presents the technical aspects of ad hoc application integration and a notation for modeling and identifying ad hoc integration scenarios.

Keywords: Mobile commerce; E-commerce; B2B; Business process modeling; Application integration; EAI; CRM

1. Introduction

Wireless networks and the miniaturization of mobile devices (e.g. PDAs) now enable new application scenarios of (standard-) business applications in mobile contexts, referred as ''mobile applications'' in the following. While conventional integrated business applications were mainly used in-house via stationary PCs, mobile applications allow to enter and use data at arbitrary places on different mobile devices. Key aspired advantages are the direct entry and availability of relevant data and a mobile device in a mobile context (e.g. no manual re-entry of data) and as a consequence, quick and smooth digital information flow across the whole enterprise. Early well-known adopters of mobile applications are the logistic providers, such as DHL or FedEx, whose truck drivers use handheld devices as part of their delivery service. The handheld devices replaced previously used paper forms. Their use allow to electronically track delivery of the parcels almost in realtime. Further domains are now exploiting the benefits of mobile applications; examples include the deployment of PDA applications for the sales and service staff at Pepsi in the US (e.g. Brewin, 2002). ''Mobile Commerce'' in this context is the use of

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mobile applications by users at the organizational interface to the customer.

Taking the aspired advantages of mobile applications and integrated applications one step further, new application scenarios will also arise for inter-organizational data exchange: It is very likely that in the near term future standard mobile business processes in a company will be supported by business applications running on an appropriate electronic device (PDA, laptop, etc.). Non-electronic communication measures in these processes (e.g. paper forms) will be reduced to a minimum for efficiency reasons. Of special interest in this regard are process tasks, which require an interaction with other organizations (customers, suppliers, etc.): If both involved parties are using a (mobile) business application to accomplish their tasks, it is reasonable to assume, that both of them work at least partly with the same information in their applications. A typical example for such an information relevant to both parties is an invoice, which is required by the customer and the supplier. Accordingly the exchange of this common information via electronic measures opens up the opportunity to harvest all benefits of integration, such as avoiding re-entry of data and quick availability of the information. This paper shows, that the use of ad hoc network technologies is a suitable infrastructure to accomplish this. This offers new possibilities of application integration for business-to-business (B2B) commerce. In contrast to conventional application integration, such application integration occurs "ad hoc", i.e. at a not previously defined moment and place. A simple example scenario for ad hoc integration is the planning of a follow-up appointment among several meeting participants through the ad-hoc sharing of personal electronic calendars. An example scenario from the B2B sales domain is presented in Section 3.

Obvious use cases for ad hoc integration scenarios are the processes and business documents already discussed in the context of electronic data interchange (EDI) initiatives (e.g. Krcmar, 1995). In contrast to conventional EDI-based integration and currently discussed electronic market places, these could take place via means of decentralized technical interfaces on mobile devices. This is particularly relevant because despite all e-commerce potentials, industrial marketing consistently accentuates individual communication for a trustworthy cooperation (e.g. Leek et al., 2003). This especially holds true for the strongly expanding service industry, which depends on direct personal interactions.

Taking all of this into account, issues of identifying potential usages of mobile applications and ad hoc application integration are of interest.

This article presents a notation for business process modeling of B2B mobile commerce processes. First, technical aspects of ad hoc application integration using wireless network technologies are presented, by means of a basic ad hoc integration scenario. Building on this basic scenario the notation is presented. The article ends with an outlook and open issues.

2. Ad hoc application integration

2.1. Inter-organizational application integration

Industry requirements for IT-support of existing and new inter-organizational processes led to a constantly increasing demand for integrated application systems. Application integration has been known as complex and risky. E.g. the minimization of technical risks through interface minimization was identified as a critical success factor for the implementation of standard software (e.g. Parr and Shanks, 2000). The demand for application integration has led to the development of a new type of standard software, so-called "enterprise application integration" (EAI) systems (e.g. Lee et al., 2003).

In-house integration problems can be reduced by means of appropriate IT procurement strategies (e.g. use of an integrated solution exclusively from one vendor) and central EAI tools. The trend to integrate inter-organizational business processes increases the demand for inter EAI solutions. The mainsprings for this are e-commerce processes, particularly with the implementation of optimized procurement strategies within supply chain management (SCM) strategies. According to Scheer and Borowsky (1999), SCM is characterized by

Table 1
Differences between current EAI approaches and mobile ad hoc integration

	Current EAI approaches	Mobile ad hoc integration
Integration software	Singular instances on central servers (1:1 communication)	Multiple instance on mobile devices (n:m communication)
Communication format	Previously defined	Negotiation of format at the time of integration
Data transmission	Previously defined over fixed lines	Ad hoc using mobile data communication

information transparency within the whole network, in contrast to data exchange between directly preceding and succeeding process partners. Therefore inter-organizational application integration particularly becomes necessary for supplier networks in the production industry; e.g. such as the automotive industry.

Different standards have been developed for the implementation of inter-organizational application integration; the latest of these are based on XML-standards (e.g. Erasala et al., 2003 or Shim et al., 2000). These focus on questions of syntax and parts of the semantics of the messages to be transferred. Technical implementations based on these standards mostly rely on centrally installed application instances, which are running on central servers at the communicating organizations. The server applications perform the required conversions between the standard formats and the desired internal formats. In contrast to this, ad hoc integration scenarios require decentralized solutions, which provide format conversions in mobile contexts, as shown in the following. Table 1 summarizes the differences between conventional EAI approaches and mobile ad hoc integration.

2.2. *Mobile applications*

Essential drivers for mobile applications are suitable infrastructures for wireless data communication. These can be presently divided in two main groups: on the one hand technologies for data traffic optimized mobile radio networks (3rd generation networks ("3G"), e.g. UMTS) and their precursors ("2.5G" networks, e.g. GPRS, EDGE) and on the other hand standards for local wireless networks (e.g. Wireless LAN (WLAN), Wireless Personal Area Networks (WPAN)). An overview of these technologies is given in Herzig (2001), Garber (2002) and Hännikäinen et al. (2002).

From the user's point of view, these technologies can be characterized as follows:

- Heterogeneous bandwidth: While modern standards for local wireless networks (e.g. IEEE 802.11a) are designed for transmission rates of up to 54 Mbit/s, UMTS is introduced in Europe in the first stage only with commercially available transmission rates of up to 384 kbit/s, despite theoretical transmission rates of 2 Mbit/s. Present 2.5G networks and current mobile devices offer transmission rates of approximately 40 kbit/s.
- Heterogeneous local availability: 3G networks require new infrastructure components, which will not be deployed everywhere (e.g. in sparsely populated areas). In contrast to this, 2.5G networks can be built on top of existing infrastructures and are therefore already available. WLAN/WPAN networks can be established according to users' individual demand with standard components. WPAN technologies, e.g. Bluetooth, allow the immediate establishment of high-speed (up to 1 Mbit/s) ad hoc networks directly between devices in any places.
- Homogenization of the devices: While present devices are (still) adjusted to one of the different network technologies, prototypes for the homogeneous network access to different 2.5G/3G/WPAN/WLAN technologies exist. Particularly low hardware costs for the required network components allow to expect cheap devices with flexible access possibilities (e.g. Hännikäinen et al., 2002).
- Homogeneous protocol layer: All network technologies are based on package-oriented

transmission protocols (TCP/IP). Thus, from an application point of view, the network layer behaves transparently, independent of the applied network infrastructure. Essential differences at protocol level arise in the future by configurable quality of service attributes (e.g. with IP version 6).

On the basis of the available technologies, different kinds of mobile applications can be identified as follows:

- Locally limited mobile applications via WLAN/WPAN: Within defined areas, users can freely move with access devices and access the information in enterprise software. New forms of office organization are technologically supported, e.g. non-territorial office concepts, and physical wiring is not necessary for (PC-) clients. Few changes are required within the applications, due to the high available bandwidth and the typically low mobility of clients once they are checked into the network, so that familiar software architectures with centralized data storage can be used.
- Distributed mobile applications via 2.5G/3G networks: Up until now, new information created in a mobile context (e.g. an order at a customer site) had to be transferred from the place of its "production" to a place of data entry into a business application (typically a PC). With the new network technologies information can be directly collected by appropriate devices ubiquitously. By the use of mobile radio networks, this can occur in defined, locally limited areas (e.g. an office building), but the expansion is as well conceivable on whole regions (e.g. City of London). Herewith particularly the support of different, user-oriented processes on spot is available. Due to the bandwidth limitations, the type and size of the data to be transferred needs to be optimized. Particularly temporary interruptions of the network connection need to be taken into account, e.g. with the change of the network cell, as well as variations of the available bandwidth. Centralized data storage strategies are suitable here only under certain circumstances, so that replication and synchronization functions are required.
- Hybrid mobile applications via 2.5G/3G/WLAN/WPAN networks: The homogenization of devices enables mobile applications to dynamically decide whether they can work directly on the central system or whether they must work locally in an autonomous mode.

Based on these technical requirements, different scenarios of an ad hoc-integration of mobile applications are possible. In the following, at first an application scenario will be presented for illustration, from which possible architectures for hybrid mobile applications are derived. Based on this, a method for business process modeling in mobile commerce will be presented.

2.3. Exemplary basic scenarios of an ad hoc application integration

The basic scenario for ad hoc application integration is as follows: Two representatives of two different organizations meet at an arbitrary place. Within this meeting, data is used, created or edited which is stored at least partly in a central enterprise application (e.g. an ERP system) of both parties. The representatives of both parties have a mobile device, which provides them access to the data in their respective central system.

Fig. 1 depicts the following assumed technical basic constellation of this scenario. Party 1 operates an application system on Server 1 (e.g. a merchandise information system (MIS)). Data on Server 1 should be modified within a business transaction with Party 2 by means of the mobile client 1. Party 2 operates an application system on

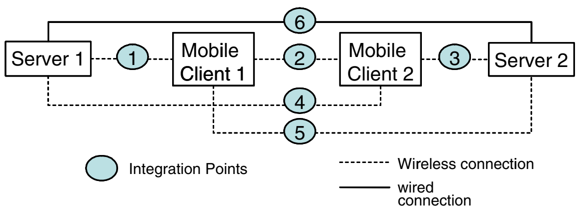

Fig. 1. Technical components in an ad hoc application integration scenario.

Server 2 (e.g. an ERP system). At the place of the meeting of Party 1 and 2, a mobile client 2, which modifies data on Server 2, is used.

Altogether six different communication ways are possible between these four systems $\left(\binom{4}{2}=6\right)$, from which five can occur via wireless network technologies.

2.4. Morphology of mobile integration architectures

The available network connections (network connection No. 1 or 3) at the place of system use are obviously of primary importance regarding the software architecture: If a network connection is available at all times, the mobile device can be used as a rather "dumb" input/output device (often referred to as "Thin Client"), which does not store transaction data locally. For an overview on the consequences and challenges for database applications in such architecture see e.g. Madria et al. (2002). If a network connection does not exist at all times, the system must be usable autonomously, e.g. with replicated data. With regard to an inter-organizational ad hoc application integration, the available network connections between Party 1 and 2 are of relevance (physical interfaces No. 2, 4, 5, 6): e.g. by means of a WPAN it is possible that clients on mobile devices exchange data directly (client–client communication, interface No. 2). Alternatively, hybrid solutions are also conceivable with which the clients of one party call central functions of the other party (client–server communication, interfaces No. 4, 5).

The combination of possible network connections defines a solution space in technical constellations, which can occur in a mobile commerce scenario. These can be displayed as a morphologic table, which describes $2^6=64$ alternatives (cf. Table 2). These have direct consequences for a possible technical organization of the ad hoc application integration. Two main architectural variants are compared in Table 3: one is an architecture, where all application logic and data reside on the central servers ("server centered architecture" model). The other is a decentralized architecture ("peer-to-peer" architecture), where application logic and data is stored on the mobile devices and replicated to the central servers. Table 4 specifies exemplary advantages and disadvantages of these architecture variants.

3. Modeling of mobile commerce processes

Apart from the technical feasibility of ad hoc integration, the issue of identifying economically meaningful application scenarios is of relevance. A notation based on the method "service blueprinting" (e.g. Shostack, 1982) is presented in the following. Service blueprinting is a method established in the field of service development, which models interactions between suppliers and consumers of services. The extension of service blueprinting presented here, integrates modeling of business process steps, available technical resources as well as the location of the actors in one notation. This eases the identification ad hoc

Table 2
Morphology of technical settings in an ad hoc application integration scenario

Attribute	Attribute values	
Operation procedure MC 1 (implies if necessary connection No. 1)	Autonomous usable	Pure input/output device (Thin Client)
Operation procedure MC 2 (implies if necessary connection No. 3)	Autonomous usable	Pure input/output device (Thin Client)
Network connection No. 2 (between MC 1 and MC 2)	Available (e.g. via WPAN)	None
Network connection No. 4 (between MC 2 and servers 1)	None	Available (e.g. via WPAN)
Network connection No. 5 (between MC 1 and server 2)	None	Available (e.g. via WPAN)
Network connection No. 6 (between server 1 and 2)	None	Available (e.g. via Internet)

MC 1 = Mobile Client 1, MC 2 = Mobile Client 2.

Table 3
Morphology of technical settings in an ad hoc application integration scenario

Characteristics	Architecture variant	
	Peer to peer architecture	Server based architecture
Operation procedure MC 1 (implies if necessary network connection No. 1)	Autonomous usable	Pure input/output equipment (Thin Client)
Operation procedure MC 2 (implies if necessary network connection No. 3)	Autonomous usable	Pure input/output equipment (Thin Client)
Network connection No. 2 (between MC 1 and MC 2)	Required (e.g. via WPAN)	Irrelevant (not used)
Network connection No. 4 (between MC 2 and servers 1)	Irrelevant (not used)	
Network connection No. 5 (between MC 1 and server 2)		
Network connection No. 6 (between server 1 and 2)	Irrelevant (not used)	Required (e.g. via Internet)

MC 1 = Mobile Client 1, MC 2 = Mobile Client 2.

Table 4
Advantages and disadvantages of a centralized vs. a peer-to-peer architecture

Centralized solution "server centered architecture"	Decentralized solution "peer-to-peer architecture"
Advantages	
Optimal data integrity, e.g. simple data protection, highest data update on server systems	Optimal reliability; devices are usable independent of central server and network components
No replication mechanism is required	High local data communication rates are usable
Low development expenditure; software development for the client can be limited to the presentation (user interface) level	Software client optimized for mobile devices
	Data security; data are transferred via few network nodes, therefore the communication is less vulnerable
Disadvantages	
Lower reliability; clients only usable during network connectivity	Complex data security
Limited display possibilities on the client because of the limited bandwidths	Higher application expenditure; replication mechanism necessary for the server
Data security; cryptographic measure required for the communication protection	Higher development expenditure for a complete software client
Complex transaction management	Complex transaction management

integration scenarios. The notation is introduced with the following sample use case.

Example (version 1). The sales employee *V* visits his customer *K* in order to present sales samples. *K* is entitled to special purchasing conditions (discounts) from *V*. The sales process is as follows:

1. *V* presents the sales sample to *K*.
2. *K* formulates his requirements to *V*.
3. *V* records the preferences of *K*.
4. *V* creates a quotation for *K* in his office and sends it to *K*.
5. *K* receives the quotation from *V*. *K* initializes an order for *V* in his MIS. *K* notices shortcomings in the received quotation and sends a request for adjustments to *V* via fax.
6. *V* creates a modified quotation 2 and sends it to *K*.
7. *K* updates the changed quotation 2 in his ERP; the order is authorized by *K*.
8. *V* prepares the delivery of goods to *K*.

9. The order is delivered to *K*.
10. *K* receives the delivery documents from *V* and updates his MIS accordingly.
11. *V* issues the bill and sends it to *K*.

It is assumed in the following that business process models exist for the outlined process, which describe the process steps and the involved IT systems and applications. The suggested method orders the process steps in chronological order from left to right in a process graph. The vertical arrangement provides information about the place of execution (cf. Fig. 2).

Every specified process step is assigned to an actor (here *V* and *K*). The process steps are arranged vertically in six levels, *L*1–*L*6: *L*1–*L*3 contain the activities of *V*, *L*4–*L*6 the activities of *K*. *L*1 contains the process steps, which occur at *V*'s premises (and therefore within the technical infrastructure controlled by *V*). Process steps in *L*2 run outside *V*'s central IT infrastructure. Process steps assigned to *L*3 are executed by *V* beyond his own infrastructure, which are physically visible for *K*. Correspondingly process steps of *K* are assigned to the levels *L*6–*L*4. The available network resources (for instance LAN, WLAN, etc) are associated with the levels. For every modeled process step, available devices are recorded in conjunction with their network capabilities (cf. Fig. 3).

The process steps are formalized to $PS_i = (Name_i, \{(Dev, Nets)\}$. The process model itself is

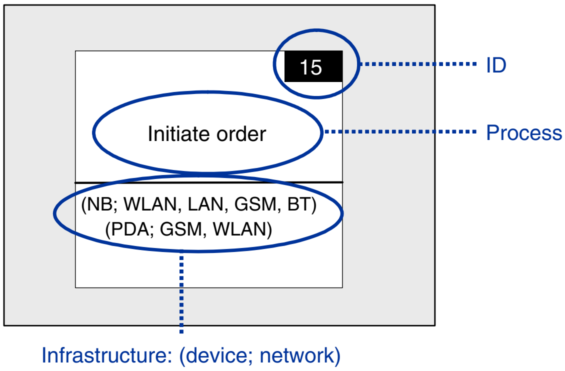

Fig. 3. Notation of a process step.

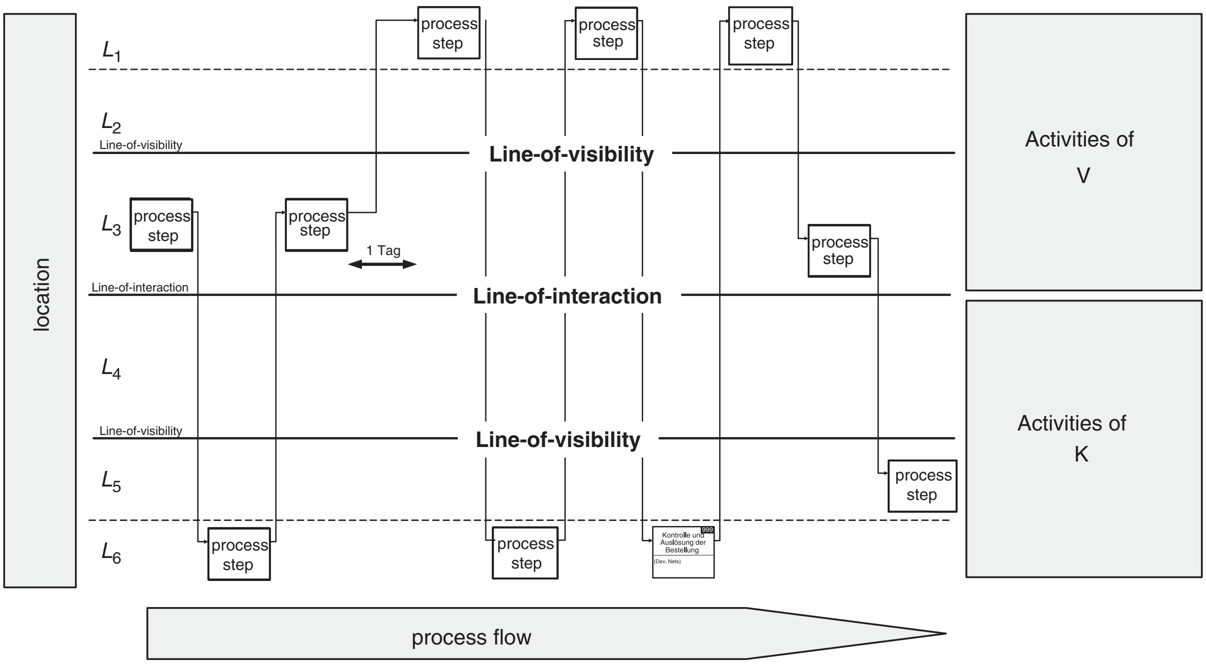

Fig. 2. Integrated modeling of process flow and execution location.

considered a directed graph ("process graph"). In order to formalize the arrangement of the process steps in the described levels, a location-function is introduced:

$$\text{loc}(\text{PS}_i) = j \Leftrightarrow \text{PS}_i \in L_j.$$

The location function enables the identification of scenarios in which the employee (e.g. V) is outside of his infrastructure and is therefore considered "mobile" in terms of the given definition of mobile applications. These are exactly the process steps of V, where

$$\text{loc}(PS_i) > 1$$

holds true (for K, this corresponds to $\text{loc}(\text{PS}_i) < 6$). For the identification of inter-organizational integration scenarios such process steps are interesting, where V and K interact. These are the ones, where the "line-of-interaction" is crossed. Formally this can be modeled as

$$\exists(\text{PS}_i, \text{PS}_j) \in E \vee \exists(\text{PS}_j, \text{PS}_i) \in E:$$
$$\text{loc}(\text{PS}_i) \leqslant 3 \wedge \text{loc}(\text{PS}_j) \geqslant 4,$$

where $E = \{(\text{PS}_i, \text{PS}_j)\}$ is the set of edges in the process graph.

Three typical configurations are selected from the theoretical amount of possible interactions for the following observations (cf. Fig. 4):

1. At-site-K (similar to at-site-V): Interaction between V and K, where V's activities are visible for K and process steps are conducted at K's premises. This situation is given for:

   $$\text{loc}(\text{PS}_i) = 3 \wedge \text{loc}(\text{PS}_j) = 6.$$

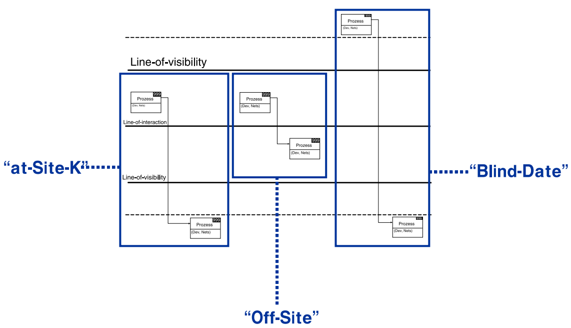

Fig. 4. Configuration of inter-organizational interaction.

2. Off-site: The participants meet outside their infrastructure (for instance on a fair). This corresponds to

   $$\text{loc}(\text{PS}_i) = 3 \wedge \text{loc}(\text{PS}_j) = 4.$$

3. Blind-date: An interaction between V and K takes place without visual contact. This is

   $$\text{loc}(\text{PS}_i) \neq 3 \wedge \text{loc}(\text{PS}_j) \neq 4.$$

In Fig. 3, process steps 1, 2 and 3 are implemented in "at-site-K" configuration. In the following it is assumed, that process steps 1, 2 and 3, the technical infrastructure is available to establish a WPAN (e.g. via Bluetooth). In addition, K is within his technical infrastructure. It should be noted at this point, that the set up assumptions could be derived from the notation. By applying a WPAN the mobile devices of V and K could be directly connected in order to exchange the quotation and the order. Thus a process flow as described in Example (version 2) becomes possible.

Example (version 2). Since the quotation generation and order placement can occur at the customer's place as presented in the following, V takes the product along with him and leaves it after receiving the order from K.

1. Presentation of the sample by V.
2. Formulation of the requirements by K.
3. V creates an quotation for the products demanded by K on his PDA and transmits the offer via WPAN to K.
4. K verifies the offer automatically with regard to supplier information and pricing conditions. The price verification occurs against the stored purchase conditions in the MIS of K. The offer is transmitted to the MIS of K via the available WLAN. The MIS of K checks the offer conditions and the authorization of K.
5. The MIS creates an order with its own order id and transmits it to K.
6. K confirms the order and transmits it via WPAN to V.
7. V leaves the product to K; the delivery note is transferred to K via WPAN.

8. *K* confirms the delivery with an electronic signature. The electronically signed document "delivery note" is transmitted to *V*.
9. *V* transmits the delivery note signed by *K* to his central ERP system.

The ad hoc application integration between *V* and *K* in process step 2–8 under the utilization of the "at-site-*K*" configuration eliminates any follow-up work for quotation adaptation as in version 1 of the example (Fig. 5). Furthermore, through the integrated transmission of delivery documents an integration of material and information flow was obtained (cf. Fig. 6) and the previous paper-based information flow was replaced with a continuous digital information flow.

Further optimization can be realized by online accessibility of central information systems running at *V*'s premises during the offer generation (process step 3), to recall most recent customer information, e.g. such as relevant discounts.

The practical applicability of the derived scenario was tested in a prototype. The prototype includes a mobile client (cf. Fig. 7), which provides functionality to prepare a quotation and sent this quotation directly via Bluetooth to the customer. For the customer an application was implemented for a Tablet PC, to receive the quotation, validate the quotation and store it in an ERP system. The prototype was developed applying Microsoft's. NET architecture. Web services were developed to encapsulate basic functions of the involved ERP system. The mobile PDA client was developed using the Microsoft.NET compact framework. All client applications presented in this paper were developed with Microsoft's programming language Visual Basic. The prototypes were tested under lab conditions. The test persons commented that the technical solution presented makes the

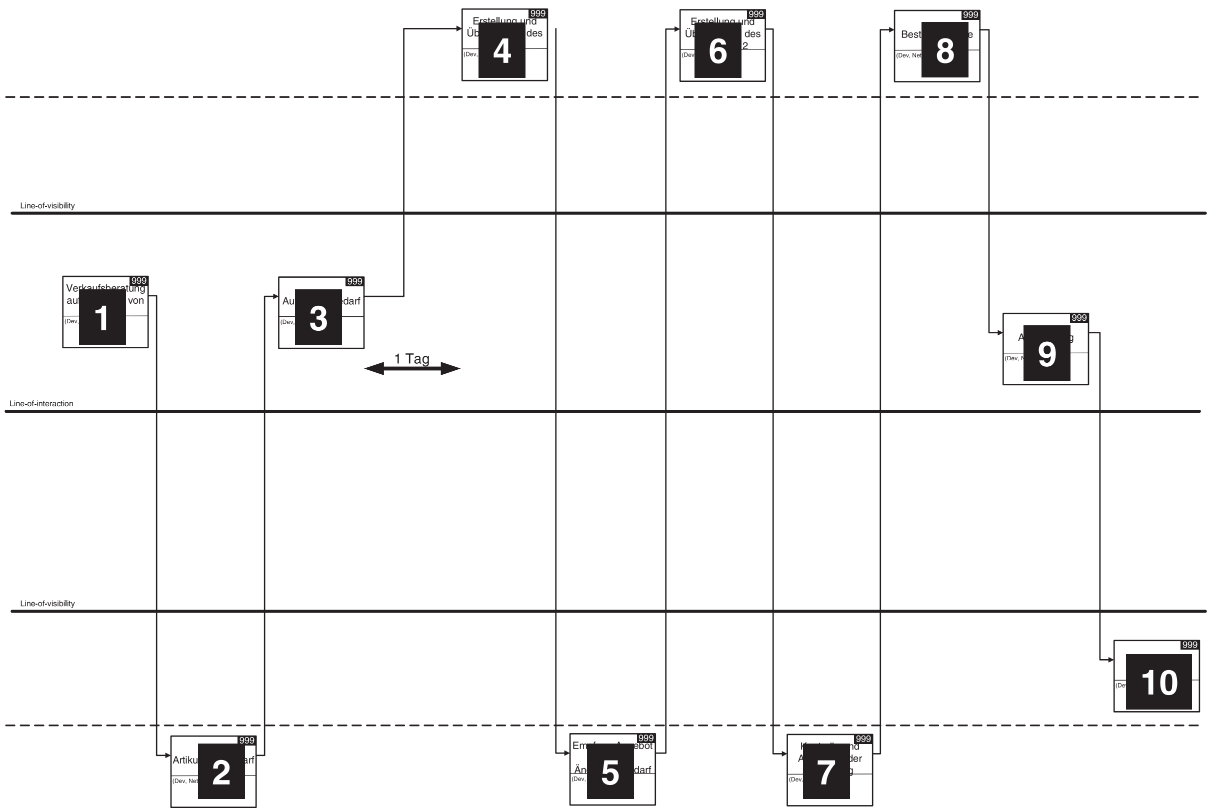

Fig. 5. Application of the method on the example scenario (numbers refer to the process steps in version 1).

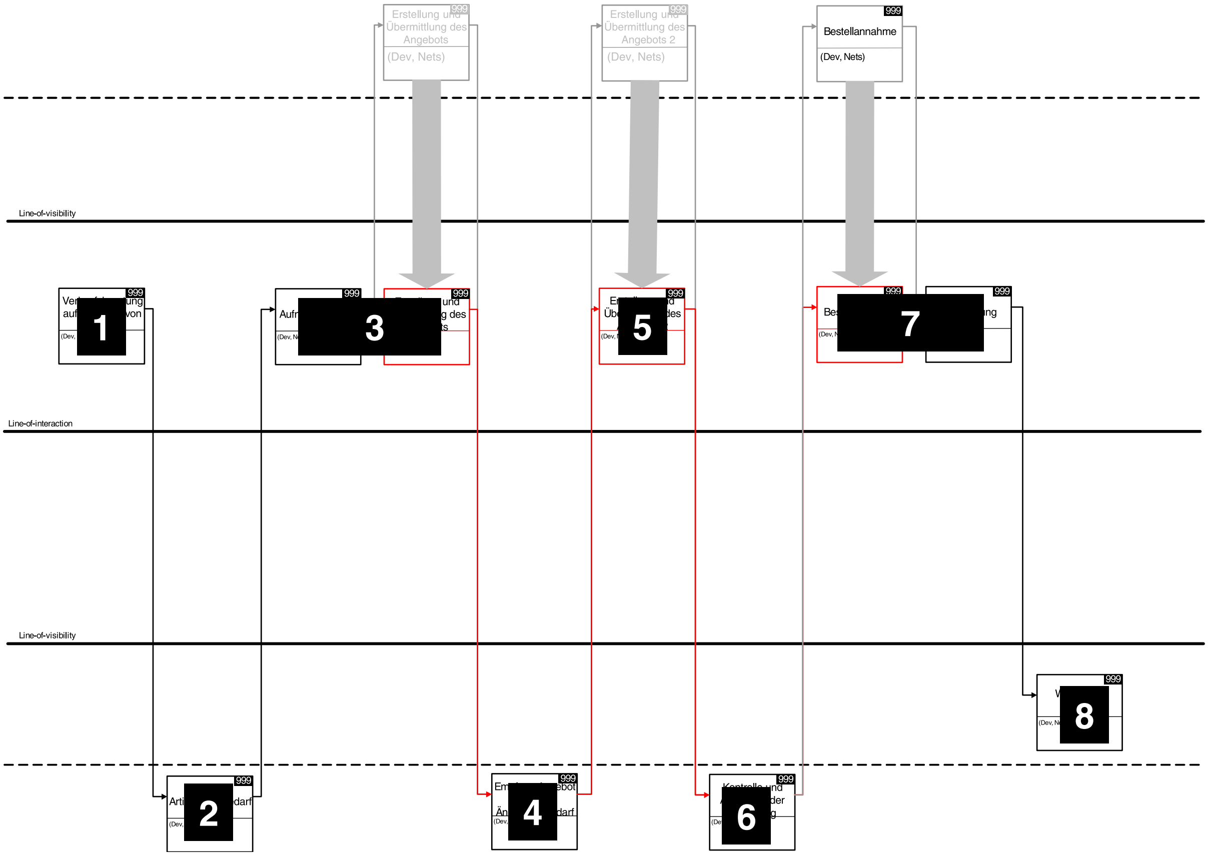

Fig. 6. Application of the method on the example scenario (numbers refer to the process steps in version 2).

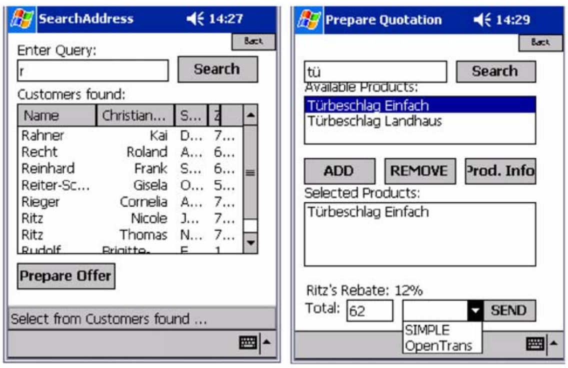

Fig. 7. Prototype of PDA client for mobile sales force.

process of selling goods smarter and more efficient. The major barrier for applying the solution in the field was a lack of reliability and usability regarding underlying basic technologies (especially Bluetooth on PDA) and some minor usability issues which were improved in the meantime.

4. Discussion and outlook

The introduced example presented a classical sales procedure supported by mobile applications and ad hoc application integration and demonstrated how process lead times can be shortened by applying ad-hoc integration technologies. Discussion of the technical aspects has shown that possible integration architectures can be server-centered, completely decentralized or follow hybrid approaches. The introduced notation helps in identifying suitable processes for inter-organizational ad hoc integration.

Mobile ad hoc application integration promises the most benefit in processes, which are conducted very often or which are extremely time-critical. Obvious candidates are any transactions, where currently paper based business documents are exchanged. An example is the procurement of maintenance, repair, operations (MRO) goods, which are not used directly in the production process. For these goods, the administrative costs for the procurement procedure are often higher than the commodity value.

Apart from the technological challenges, mobile ad hoc integration raises for buying procedures issues of necessary organizational adjustments; e.g. in the discussed example the customer representative K needs to be authorized to make orders, which need not to be authorized by a purchase department. Therefore, the authenticity of the customer must be unambiguously determinable, which raises questions of the implementation of a digital signature in the system. This goes beyond existing standards for wireless applications (e.g. Boncella, 2002) and can be based e.g. on public-key infrastructures.

An open issues is the automatic identification and location of integration functions to be called during an ad hoc integration. As a basic communication protocol, the different established mechanisms, such as COM, IIOP or recently SOAP and web services can be used. Standards for the general application integration address different semantic levels, which are meanwhile frequently based on XML (e.g. Shim et al., 2000). It remains to examine, to what extent, the combination from web services with a directory service like e.g. UDDI (universally description, discovery and integration, http://www.uddi.org) and XML process description languages, e.g. business process execution language for web services (BPEL4WS) (e.g. Peltz, 2003) might create a suitable solution.

Finally, it should be noted that the mobile clients foreseen in the ad hoc integration scenario are not restricted to devices used by humans. A very likely variant of the sample scenario is the replacement of the salesman V by a vending machine: an example for this case is a warehouse, in which sensors automatically note the removal of goods out of the warehouse (e.g. in a consignment warehouse). The customer initiates an order by the bare procedure of carrying the goods out of a warehouse through an electronic gate, which immediately sends a delivery note to the customer's ERP system. In such scenarios, the products must carry corresponding intelligent electronic identification tags, in order to make identification possible. Approaches for such systems with radio frequency identification (RFID) tags are already available (e.g. RFID, 2003).

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Glossary

B2B: business to business
BPEL4WS: business process execution language for web services
COM: component object model
CRM: customer relationship management
EAI: enterprise application integration
EDI: electronic data interchange
ERP: enterprise resource planning
GPRS: general pocket radio service
IIOP: internet inter-ORB protocol
LAN: local area network
MIS: merchandise information system
MRO: maintenance, repair, operations
PDA: personal digital assistant
RFID: radio frequency identification
SCM: supply chain management
SOAP: simple object access protocol
UDDI: universally description, discovery and integration
UMTS: universal mobile telecommunication system
WLAN: wireless LAN
WPAN: wireless personal area networks
XML: extensible markup language