Context-sensitive Collaboration in Service Processes through the Integration of Telecommunication Technology and Business Process Management

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Abstract

In this paper an approach will be presented which uses data from Business Process Management Systems (BPMS) to determine the communication context of individuals in corporations. It is intended to contribute to a closer alignment of the disciplines Business Process Management (BPM) and communication technology. Therefore, we provide a conceptual integration model for BPM and communication technology by deducing the potentials of BPMS to serve as data source for the identification of a business-related communication context. This is complemented by the system architecture and the prototype of a communication-integrated BPMS which has been implemented during a recently finished consortium research project.

1 Introduction

Competition on global markets, short product life-cycles and individual customer demands force companies to manage their resources efficiently and effectively. Among several management disciplines, Business Process Management (BPM) has evolved as a major approach to respond to the challenges companies currently face. The execution of processes is bound to target-oriented and efficient collaboration and information exchange between all stakeholders. The exchange of information has therefore been identified as one of the three major types of interactions in economic organizations, among the exchange of products and services, and the exchange of money [1]. Effective information exchange, in turn, relies on clear and effective communication between organizational units.

To increase the effectiveness of communication, current developments in telecommunication technology aim at taking the communication context of individuals into account. One example for the communication context is the location of an individual, being used in location-based services. Actual technological developments aim to integrate further context dimensions, like the task which is currently fulfilled, or the social relationship to the communication partner [2].

Although communication is an essential activity during the execution of business processes, today's Business Process Management Systems (BPMS) and communication systems are not coupled. It is still up to each employee to align the use of communication technology to the current activity in a business process. To counter this problem, an integration solution has to be developed, which provides communication integration into business processes.

The research focus of this paper is therefore to develop a conceptual approach for the determination of the communication context of collaborating individuals in business settings. In particular, the appropriateness of BPMS to serve as a source for the communication context shall be analyzed. This paper aims at investigating the collaboration support through a conceptual integration of telecommunication technology and BPM, driven from a BPM perspective.

A design-oriented research approach [3] has been chosen to achieve this objective. Our work aims at creating an innovative artifact for a closer alignment of telecommunication technology and BPM. At first, a deductive argumentative analysis of the potentials of BPMS to serve as data source for context identification is conducted. Then, this conceptual assessment is illustrated by an application scenario and evaluated by the prototypical implementation of a communication-integrated BPMS.

The paper is structured as follows: After this introduction, section 2 refers to the theoretical background of BPM, BPMS, and communication context. Section 3 is the major part of the paper and consists of a systematic analysis of the different components of a BPMS and their appropriateness to serve as data source for context identification. In section 4 the usefulness of this approach is illustrated by an application scenario. Section 5 presents the system architecture and the software prototype, whereas section 6 provides conclusions, and an outlook on further research.
2 Theoretical Background

2.1 Business Process Management

A business process can be defined as end-to-end work across an enterprise that creates customer value [4]. BPM is a customer-centered approach to organizational management. It comprises methods, techniques and tools to support the design, enactment, management and analysis of business processes [5]. The different phases of BPM are usually arranged in form of a lifecycle model, including at least a design phase, an execution phase and an analysis / controlling phase which provides input for the next iteration, starting with the strategy phase [6].

To support the management of business processes, a variety of tools and products has been established. Software tools that, a decade ago, would have been described as workflow tools, business intelligence tools, rules engines or enterprise application tools are now being integrated and spoken of BPMS [7]. BPMS have been defined as applications "that enable the modeling, execution, technical and operational monitoring, and user representation of business processes and rules, based on integration of both existing and new information systems functionality that is orchestrated and integrated via services" [8].

The different stages in the BPM lifecycle need to be supported by the components of a BPMS. A generic BPMS architecture comprises therefore components for strategy, design, execution, and controlling of business processes (figure 1). An established approach for a BPMS architecture is the “ARIS-House of Business Engineering Framework (HOBE)”, which was designed to holistically describe an information system supporting business processes [1].

![Diagram](image)

**Figure 1. ARIS-HOBE as generic BPMS architecture, based on [1]**

2.2 Communication context

The concept of context is subject of study in a variety of scientific disciplines, such as mobile application research [9] or artificial intelligence [10]. In literature, context is defined as information which can be used to describe the situation of an entity. Entities can be people, places or objects, which are considered relevant for the user, the application or the interaction between the user and the application [11]. Context can be decomposed into several dimensions, among others task context, social context, personal context, spatio-temporal context or environmental context [9]. For BPM, the consideration of the context of a business process has been discussed as a means for achieving better modeling quality and to achieve a better flexibility during execution [12]. The context of a business process can be defined as the minimum set of variables containing all relevant information that impact the design and execution of a business process [13].

In cooperative scenarios, individuals are usually not fully aware of the context of their communication partners. To increase the effectiveness of communication, they need to be able to attribute additional information to a statement which has been transmitted by the communication system. In business settings, this may be knowledge about the business process and all of its related parameters like customer, task difficulty, important people or deadlines.

In table 1 potential dimensions for the communication context in business settings and the characteristics of these dimensions are presented. The dimensions have been proposed in [2]. In fact, they represent only an excerpt of all imaginable dimensions of a business process context. Nevertheless, this proposition has been chosen as reference for the analysis in this paper. It shall demonstrate the general applicability of BPMS to serve as data source for context identification in collaborative business scenarios.

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Location</th>
<th>Presence</th>
<th>Task</th>
<th>Relation</th>
</tr>
</thead>
<tbody>
<tr>
<td>class [a]</td>
<td>workplace</td>
<td>available</td>
<td>writing</td>
<td>colleague</td>
</tr>
<tr>
<td>class [b]</td>
<td>canteen</td>
<td>away</td>
<td>break</td>
<td>private</td>
</tr>
<tr>
<td>...</td>
<td>car</td>
<td>busy</td>
<td>reading</td>
<td>customer</td>
</tr>
<tr>
<td>...</td>
<td>home</td>
<td>urgent case</td>
<td>talking</td>
<td>none</td>
</tr>
<tr>
<td>class [n]</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

Closely related to the concept of communication context is the use of sensor technology, which has proved useful to determine the context of an entity. A sensor can detect a physical attribute which is provided as the result of a measurement, transforming the value
of an attribute of its environment into a quantitative measurement value [14].

Sensors can be distinguished in software sensors and hardware sensors [15]. However, in most cases it is intended to use existing infrastructure or applications as data sources for sensors. In this case, existing knowledge merely needs to be interpreted in a different fashion, so that new knowledge can be created. For example, the keystrokes on the keyboard or the mouse moves, created by a user can be interpreted in such a way, that the user is busy working at his desk or reading a document [16].

In figure 2 an exemplary communication scenario is shown. In this scenario, a communication request from user A is received by a human assistant. This assistant needs to know the business-related context of the corresponding communication partners (user A and user B). To do so, the assistant relies on calendar information or direct communication with A and B. It is up to the assistant to decide, which communication request needs to be forwarded and which one can be delayed. However, this approach requires the existence of an assistant and that this assistant knows A’s and B’s communication context, as well as the business processes in which they are involved in.

It is intended, that in the future a BPMS-integrated communication system could support the identification of the communication context of all individuals who collaborate in a business process. In addition, such systems should also be able to use this context to align all communication activities to the business process, e.g. by selecting the best communication media (mobile phone, fixed line, email or others) or by forwarding calls to other persons with the same roles, if a required communication partner is currently not available.

![Figure 2. Context identification today and tomorrow [17]](image)

To identify the context of a communication partner in collaborative business settings, not only the already mentioned keystrokes and calendar entries can be used. There is the need to investigate new and more innovative data sources, like BPMS, for the deviation of a business-related communication context.

3 Identification of context dimensions using BPMS data

3.1 Introduction and initial example

In this section, the appropriateness of each BPMS component (figure 1) to serve as a data source for the context dimensions in table 1 will be investigated systematically, based on a deductive argumentation. To give an example, the execution component of a BPMS is appropriate to identify the context dimension location. In this component the process instances are created and executed, so the execution path of the process can be traced. Assumed that the execution of a certain activity is always bound to a certain location, the location can be determined by observing the executed activity. The information about the executed activity can be extracted from the monitoring components of the workflow system. Enterprise Resource Planning (ERP) systems can tell the currently performed transaction, which is nothing less than a special kind of monitoring. In any case, it becomes possible to pass this execution information to a context-aware communication system. Further information can also be retrieved from Supply Chain Management (SCM) or Customer Relationship Management (CRM) systems which may provide the information that an employee is currently visiting his customer, according to data which has been fixed and stored in the calendar part of the CRM software.

In the following, an individual assessment for the appropriateness of each BPMS component in relation to a given context dimension will be derived, using one of the three categories useful for context identification (+), useful in some cases (o) and not useful for context identification (-).

3.2 Location

The context dimension location has been introduced consisting of classes like workplace, canteen, car, or home (table 1).

**Design:** The workplace can be identified using process models. The model of a process usually includes events and actions to be taken. Furthermore, there is a link to organizational units which are executing the foreseen activities. Considering that every activity requires a certain location where it needs to be executed, the kind of activity helps to determine the physical location of the employee. So it would usually be expected that all kinds of calculations, writing or processing documents will have to be done at the computer in an office location. This deduction still lets room for uncertainties as the computer may be located in different offices, or at home. Nevertheless, the activity
specifies a kind of location, which can be assigned to this activity. To give another example, the quality checking of a product has to be done in the production site. The reception of goods requires that a person has to go to the area where shipments are usually delivered to. Overall, the design component offers information about the location of a person, but also lets room for some uncertainties (which is due to the static nature of process models). Its appropriateness will nevertheless be classified as useful for context identification (+).

Execution: As presented, process models can indicate the location of an employee, assumed that the execution of an activity must be related to a certain location. As long as the modeling part is considered, the information is bound to uncertainties, as it is static and does not take the real flow in the process into account. The execution component offers real-time data for all process instances, which is retrieved from Workflow-, ERP-, SCM-, or CRM systems (details have already been provided in the initial example of this section). It includes all execution-related information (e.g. if the process model foresees alternative execution paths, only the execution components can tell which path has been selected). The execution component will therefore be classified as useful for context identification (+).

Controlling: Based on historic information about executed processes the controlling component offers the same information granularity as the execution component. As it processes historic data it has the disadvantage of being not real-time but in turn provides access to a large amount of data, enabling the deviation of statistical correlations. It offers the possibility to discover new relationships between executed activities and the locations from which the corresponding activities were performed. The discovered dependencies can then be stored in the BPMS or the context identification system in order to achieve better identification results for future process executions. The predefined (static) model-related information will be improved. Although this does not replace the real-time data delivered from execution components, the appropriateness of this BPMS component will be classified as useful for context identification (+).

Strategy: Strategic planning is focused on the definition of strategies, products, markets and organizational structures as well as on the business processes which are necessary to support the strategic objectives of a company. All measures are characterized by a long-term time horizon. Data concerning the current location of a person or an entity may hardly be available in such systems, as the level of detail is not sufficient (and not intended). The appropriateness of the strategy component of a BPMS for the identification of the dimension location can therefore be classified as not useful for context identification (-).

3.3 Presence

Concerning the context dimension presence the classes available, away, busy and urgent case have been proposed in table 1 as exemplary parameters for the use in current telecommunication systems.

Design: Concerning the presence of an individual, the process and data models can offer useful information to identify the corresponding class. In the process model it can be defined that a person should have the status of being busy if the person is foreseen to execute an important activity or, in case that no activity will be assigned, that he/she should be available. Although the final status may only be extracted during or after the execution of a process instance, the design phase offers a good level of information to derive the presence of a user. Therefore, the appropriateness of process models for the identification of the context dimension presence can be classified as useful for context identification (+).

Execution: During the execution of a business process the user is bound to a process instance, according to the roles the user can perform. Data which is necessary for process execution is available, corresponding decisions concerning the handling of logical connectors can be taken. Therefore, it can be decided, if the user is available, away, busy, or occupied with an urgent case. If the user is not performing any action his status will probably be away. If the user is involved in a process-related activity, doing transactions in an ERP system or accepting activities from a workflow system, the user can at least be classified as busy. The number of and the time between executed transactions in enterprise applications or workflow systems indicate that an employee is actively working in the system. To identify an urgent case, additional information should be considered, which can be found in other components of BPMS like the accounting or sales data in ERP systems or the customer information in a CRM system. If these data sources include data about potential order entry, realized revenue with a certain customer or deadlines which have been agreed on, all activities related to this customer can be classified as urgent. The appropriateness of the execution component for the context dimension presence will therefore be classified as useful for context identification (+).

Controlling: The controlling component delivers ex post information about executed activities and can tell from a historic point of view, if a person was present, available, busy or occupied with an urgent case. Here again, it is possible to analyze the patterns of these context dimensions in relation to other parameters, like deadlines, customers, suppliers or certain parts in the process models. As already pointed out, this supports the predefinition of expected states in static mod-
els during the design phase which can serve as prognosis for later, real-time data. Controlling is therefore suitable for all classes, taken its general limitation for context identification into account (no real-time data). Its appropriateness for context identification will be classified as useful for context identification (+).

Strategy: The context dimension presence can be influenced by strategy. Nevertheless, the current state of a user like busy or away cannot be derived from strategic planning systems. Here again, the level of detail provided by strategic components of a BPMS is not sufficient. So the appropriateness of the strategy components for the identification of the dimension presence can be regarded as not useful (-).

3.4 Task

The tasks writing, break, reading or talking are describing a very general kind of an activity without referring to the concept of business processes. The most appealing sources are the already mentioned keystrokes or mouse moves, which can be identified by software sensors. Using BPMS as data source seems possible, but is possible to some extent.

Design: The process models can reveal information about the tasks which are to be performed. An activity in a process may require writing or reading. Nevertheless, the current state of a user depends on the actual instance of the process model. This is even more the case for the classes break and talking which cannot (or in seldom cases) be already implemented in the process models. The appropriateness of the design component will therefore be classified as useful in some cases (o).

Execution: Concerning the context dimension task it is obvious that some activities in a process require writing, reading or talking. Monitoring transactions in ERP or workflow systems therefore provides useful information for the identification of these tasks. Nevertheless, it must be stated, that the process definitions themselves are usually not designed in the required granularity. It is therefore necessary to rely on direct measurement of keystrokes or other activities which are independent from the application software. So, the appropriateness of the execution components of a BPMS to extract the context dimension task is limited and will be classified as useful in some cases (o).

Controlling: As pointed out for the execution components, a BPMS only offers limited support to determine the task a person was involved in. The level of granularity in business processes is often not detailed enough to relate every activity to the specified tasks like writing or reading. The historical data stored in the controlling component does not offer any advantage to identify the task. The appropriateness of the controlling components of a BPMS to identify this context dimension can also be classified as useful in some cases (o).

Strategy: The strategy component cannot be taken into account for identifying the current task a user is performing. Data in strategic systems hardly gives a hint whether a user is currently writing, reading or having a break. Once again, the information is focused on companywide dimensions with long time horizon and is not intended to provide operational data. So for the context dimension task, the strategy component can be classified as not useful for context identification (-).

3.5 Relation

The context dimension relation refers to relationships within a company (colleague), relationships between companies (customer), non-commercial relationships (private) and unknown (none) relationships.

Design: BPMS can contribute to the identification of these relationships by providing data from the design component, especially data models (entities and their relationships) and process models (organization units which are responsible to execute certain activities). Concerning the relation of individuals, departments or company units, the design component offers good data to extract the corresponding relations. Especially the data models and organizational models offer all information about the relations of people to company departments, reveal hierarchies of roles or identify roles which need to work closely together. As relation is more static in its nature, the appropriateness of this (static) data source will be classified as useful for context identification (+).

Execution: As relation consists of static information, there seems to be no special advantage that the execution component can provide, compared to the design components. Nevertheless, it provides the same detail of information, as all executed processes are based on the predefined process models. Besides that, additional information can be retrieved if new relations are established during runtime. For example new customers can be added or new suppliers can be identified. Furthermore, in human resources (HR) applications the assignment of employees to their organizational unit as well as their direct colleagues and superiors are defined. It is therefore possible to match individuals to the organizational units and to the activities which are currently being executed in the workflow component of a BPMS. Furthermore, relationships to suppliers and customers can be extracted from the databases in CRM or SCM systems as well as suppliers can be identified using the purchasing component of an enterprise software (supplier directory). The same is true for changes in the HR databases. Overall, the execution component can be regarded as useful for context identification (+).
**Controlling:** The controlling component can be applied to analyze post the relations, which have been used to execute a certain activity in a business process. It therefore serves to identify relations which are often or less often used. It also reveals new relations, which have not been foreseen or which have been established during the execution. In any case, because of the large amount of data available, the controlling component assists in determining the relevant relations. This becomes useful during further iterations through the business process lifecycle. Its appropriateness to identify relations will therefore be considered as useful for context identification (+).

**Strategy:** As strategic planning also affects the organizational structure of a company, it can be considered to retrieve relevant information about the relationships of company divisions and departments. It may also reveal the importance of certain customers and suppliers if they are classified as key customers / suppliers or acting on markets which are of high importance from a strategic point of view. Although the details of these relationships are also modeled in the design component of the BPMS, it seems appropriate to say, that concerning the context dimension relation, the strategy component can be regarded as useful for context identification (+).

### 3.6 Synthesis of findings

In table 2 the individual context dimensions are reflected against the different components of a BPMS which have been analyzed in this paper.

**Table 2. Usefulness of BPMS components for communication context identification**

<table>
<thead>
<tr>
<th>Location</th>
<th>Design</th>
<th>Execution</th>
<th>Controlling</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Presence</td>
<td>-</td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>Task</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Relation</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

The design component is suited for most of the context dimensions with some limitations for the dimension task. Information like organizational relationships or possible locations can be attributed to the business processes. These serve afterwards for the identification of the corresponding communication context. In some cases (like private) the design component does not offer many possibilities for context identification, although it must be stated, that this is not a weakness of the design components but a general limitation of BPMS themselves. The design component includes static information and provides a sufficient level of detail in most cases. Due to its nature, it lacks the actual data which is created when the process instances are running. The overall assessment results in the conclusion, that the design component can be classified as useful for context identification (+).

The execution component can also be considered appropriate for context identification. The execution part offers dynamic information and provides a sufficient level of detail. It has the advantage to have the same character as has communication between individuals: it is bound to a certain situation. During execution, all necessary parameters are known, including the decisions, which parts of the process model will be executed, the different customers and the individual employee who performs a certain activity. The overall appropriateness of the execution component will therefore be classified as useful for context identification (+).

The controlling component offers a good level of detail and provides historic data. This is based on the analysis of a large number of executed processes which allow for the identification of patterns. Based on these patterns it is possible to calculate probabilities for locations, tasks, the presence or the relation which is most possibly attributed during the next execution of the related business process. Controlling lacks the real-time aspect but it supports the predefinition of useful static information for context identification. It has therefore been assessed as useful for context identification (+).

The usefulness of the strategy component is limited. As the character of strategy is static, with a low level of detail due to its long time horizon, it is evident that the identification of operational context dimensions like writing, busy or location cannot be derived. Nevertheless, strategy can be useful to identify context dimensions which are related to general decisions. Examples are key customers or relations of strategic impact (e.g. business units or departments). The overall assessment results in useful in some cases (ω).

Regarding the context dimensions from table 1, it can be stated, that every dimension profits from the use of a BPMS as data source, although the extent is different. It is obvious that relation profits most, as it is static information (besides new relations which are created during runtime) and most of the BPMS components offer static information. The dimension which profits less is task. Although some of the corresponding classes like writing or reading can be derived from the activities in the process, the granularity of data in BPMS is not detailed enough. For the dimensions location and presence it depends on the actual class, if BPMS offer appropriate data to identify them.
4 Application scenario

The conceptual findings which have been presented in the previous sections will now be explicated in an application scenario, which will also serve for the prototypical implementation. Therefore, a customer service process is provided in Figure 3.

![Customer service process diagram]

**Figure 3. Customer service process**

The service process is modeled using Event-Driven Process Chain (EPC)-Notation. It is triggered by automatic error detection. The service process consists of the activities inform customer, analyze error, fix remote or fix onsite, and finally create documentation. In the process model, three roles are foreseen to collabo-
rate during the execution of the process, a sales representative (account manager), the customer center and an (onsite) technician. Table 3 shows the context dimensions which can be derived from the current activity in this business process. In the example it is assumed, that the customer to be served is a key customer of the company. The strategy component is useful in this example to assess the dimensions presence and relation (important customer and the service event itself trigger urgent case). During the design of the process it was foreseen, that the location for the activity inform customer would usually be the office location (nevertheless a sales representative may be on road and inform the customer on mobile phone). For the customer center it is assumed that a back office specialist is performing his work in the office. The onsite technician, on the other hand, will need to go to the customer site in order to repair a broken machine. So in dependence on the actual kind of repair (remote, onsite), the location may be office or customer site. Besides that, the process design offers good information for the dimension relation, as it predefines the (static) organizational relationships (e.g. technician and customer center are colleagues).

The execution component offers well-suited information to discover all context dimensions. Workflow and CRM systems support in identifying the corresponding step in the repair process. Furthermore, all customer-related information can be retrieved from the CRM system. In addition, it might be necessary to check inventory data in the ERP system, e.g. required spare parts. Execution supports in identifying the context dimensions location, presence, task and relation.

The controlling component also offers detailed information with the limitation that this information is historic, which nevertheless serves for the prediction of different context dimensions. If, for example, a certain role has proved to be useful to speed up repairs for a key customer, it will be an advantage to integrate this role in the communication context of the customer center or the onsite technician.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Account Manager</th>
<th>Customer Center</th>
<th>Technician</th>
</tr>
</thead>
<tbody>
<tr>
<td>inform customer</td>
<td>office urgent case</td>
<td>customer office available</td>
<td>office available</td>
</tr>
<tr>
<td>analyze error</td>
<td>office busy reading/talking customer office urgent case reading/writing customer/colleague office busy talking colleague</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fix remote</td>
<td>office busy reading/talking customer office urgent case talking/writing customer/colleague office available</td>
<td></td>
<td></td>
</tr>
<tr>
<td>fix onsite</td>
<td>office busy reading/talking customer office available</td>
<td>customer site urgent case repair customer/colleague</td>
<td></td>
</tr>
<tr>
<td>create documentation</td>
<td>office available</td>
<td>office busy writing colleague office available</td>
<td></td>
</tr>
</tbody>
</table>
In this example it becomes obvious, that the appropriateness of BPMS for the identification of the context dimension task depends on the granularity of the process model. It is not clear if the notification of the customer requires talking or writing or, most probably, a combination of all of them. Nevertheless it depends on the kind and the granularity of the process design, if the task can be identified properly.

As soon as the communication context has been identified, it can be used to improve the execution of the business processes and the collaboration of users during the execution of the business process. In situations where agility is needed, information about the communication context can speed up the solution of problems. The process-related communication context needs to be interpreted by an intelligent communication system, which should be integrated in the BPMS. This process-aware communication system should support the identification of the right experts or support the choice of the suitable communication device (e.g. mobile if a communication partner is not in his office). This integration potentially results in faster reaction times, lower downtimes and higher customer satisfaction for service processes.

Figure 4 refers to the initial example for context identification (figure 2), but is now complemented by a BPMS as data source for context identification. As outlined in this paper, BPMS data will be transferred by sensors to a context generator in order to align the collaborative communication activities to the execution of the related business processes.

**Figure 4. BPMS as data source for context identification in corporations [17]**

For example, if the execution component provides the information, that a role is currently performing the activity fix onsite it can be concluded, that the relation has been identified as customer, the location can be identified as customer site and the presence is urgent case. The employee is therefore not available, so that incoming communication requests should automatically be forwarded to a colleague in the customer center, who is probably in the state available and at the location office. This supports a better alignment of communication and process execution.

5 System architecture and software prototype

In the related consortium research project PROWl, a service-oriented BPMS prototype has been developed as a proof-of-concept implementation. It is composed of a set of so-called Portlets, developed for Liferay Enterprise Portal [18] using jBPM 4.4 as a workflow engine, with process models defined in jPDL. The architecture of the prototype is provided in figure 5.

**Figure 5. Architecture of the prototype**

The prototype is based on a Model-View-Controller (MVC) architecture pattern. The application realizes loose coupling of components, thus the underlying Model or Viewer plus Controller set can easily be exchanged with other components. Every Portlet in the application consists of a Portlet class (e.g. ProcessInstanceManager Portlet), serving as Controller, and a corresponding View. Controller classes extend the ExtendedMVCPortlet class which in turn extends Liferay’s MVCPortlet class. The ExtendedMVCPortlet communicates with the underlying BPMS components, which serve as Model.

In case a communication context needs to be identified, the ExtendedMVCPortlet delegates its creation to ContextAssembler, which uses an appropriate class, inherited from ContextGenerator, to compute the context contents based on data obtained from sensor services (Sensors & Manipulators). The ContextGenerator may call ContextAssembler to recursively generate other contexts (called sub-contexts), which are required for
the generation of a target context. The ContextGenerator detects e.g. the location of a user. After detection, it adds that location to the user’s location communication context dimension. It detects if a currently assigned activity has a relation to the customer. If so, it adds the current process instance’s client name to the assignee’s communication context. In addition, the ContextGenerator deduces a communication priority for every user. This parameter supports process-aware communication connections and is based on parameters like EPC activity attributes, and process instance execution parameters.

The CommunicationPortlet enables an IP-based communication between users by providing integrated telephony functionality. For each call, the users’ communication priorities are taken into account and the resulting call is allowed or denied, complemented by a detailed visualization of the calculated communication priorities.

In the Process Abstraction Layer, various Portlets for the management of the business process are provided. The ProcessInstanceManager provides workflow-related functionalities, like the ability to assign users to activities or the ability to stop activities in the workflow. It displays data like the list of currently executed EPC activities for a given process instance, or the name, required roles, and the currently assigned user for each activity. For the given service process a screenshot for the activity fix onsite is presented in figure 6.

The screenshot shows how the system supports the execution of the business process by providing a workflow engine which leads the user through the different activities. Different employees can be assigned to an activity which is to be executed, as long as they match the required role. In this case, the user Alexander, who has the role Fleet Service Technician, has been assigned to the activity fix the problem onsite. The prototype detects the context of the user depending on his current activity in the business process and derives further information, like the client site, the relation to the customer or the task, with its integrated sensors. This information is visualized in the Portlet Communication Context. In the current scenario, the context dimensions location, presence, task and relation have been identified by the prototype and have been assigned the values which match the current instance of the service process. This information is passed to the communication component. This component now uses the context of the employees who are involved in the business process and proposes communication partners in the organization, whose roles match the actual requirements. Furthermore, it is possible to establish communication connections to these communication partners, using the integrated IP-based telephony functionality. In the CommunicationPortlet of the prototype numerical values are derived from the context information which are used for the calculation of the communication priority of each user.

Figure 6. Screenshot of the corresponding prototype
6 Conclusions and outlook

The objective of this paper was to contribute to a conceptual integration of BPM and communication technology, to support collaboration in business settings. It was found, that BPMS can serve as data source for the identification of the communication context and can therefore be used to support collaboration. This finding is based on the analytical deduction as well as on the realized software prototype which demonstrates the usefulness of the alignment between communication and business processes.

As the communication context is related to a certain situation, the best data source in a BPMS is the component which can deliver situation-specific information. This is the reason why a matching between the desired context and the abilities of each BPMS component to deliver the required information should be done. For example, it should be distinguished between BPMS data sources which deliver static information and data sources which deliver real-time information.

Although their usefulness for context identification has been shown, and a proof-of-concept implementation has been realized, the system effects in real-world scenarios need to be investigated in more depth. This includes the coupling with well established BPMS or workflow management systems, as well as the development of new application scenarios for integrated context-aware telecommunication systems and BPMS. This needs to be supplemented by the further development and evaluation of the software prototype.

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7 References