Context-sensitive Business Process Support Based on Emails

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ABSTRACT
In many companies, a majority of business processes take place via email communication. Large enterprises have the possibility to operate enterprise systems for a successful business process management. However, these systems are not appropriate for SMEs, which are the most common enterprise type in Europe. Thus, the European research project Commius addresses the special needs of SMEs and characteristics of email communication, namely highly flexibility and unstructuredness. Commius turns the existing email-system into a structured process management framework. Each incoming email is autonomously matched to the corresponding business process and enhanced by proactive annotations. These context-sensitive annotations include recommendations for the most suitable following process steps. An underlying, self-adjusting recommendation model ensures most appropriate recommendations by observing the actual user behavior. This implies that the proposed process course is in no way obligatory. To provide a high degree of flexibility, any deviation from the given process structure is allowed.

Categories and Subject Descriptors
H.4.1 [**Information Systems Applications**]: Office Automation – *Workflow management*; H.4.3 [**Information Systems Applications**]: Communications Applications – *Electronic mail*

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Algorithms, Documentation

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Email, Workflow, Business Process, Flexibility

1. INTRODUCTION
Email communication has become an integral part of our daily business activities, without which modern business would be unthinkable. On average, each employee spends 2.6 hours a day with sending and receiving 33 respectively 72 emails [1]. However, not only the time spent with emails as a means of communication, but also the knowledge that is bundled in an unstructured way within companies' email repositories is quite difficult to manage [2]. This becomes clear, if the number of 75 % is taken into mind representing the percentage of a company's knowledge saved in email messages [3].

As a direct consequence, there is a need for software solutions to effectively manage email messages representing an important resource for companies. If employees spend 1/3 of their time with email communication and 3/4 of a company's knowledge is stored in email inboxes, it can be concluded that in many companies a majority of business processes takes place via email communication. Large companies have the possibility to operate enterprise systems, for instance ERP systems, which contain features for a successful business process management. Nevertheless, these solutions are not appropriate for all types of companies. Small and medium-sized enterprises (SMEs)—that account for 99 % of the entire European enterprises with almost 70 % of all employees [4]—do not have the ability to spend money for purchasing, operating and maintaining such expensive systems [5].

Currently, none of the existing software solutions addresses the special needs for SMEs. Therefore, the development of a solution that is based on email communication focusing on SMEs seems promising. However, email-based business process solutions would have to address special characteristics of email communication, namely highly flexibility and unstructuredness. Traditional workflow engines lack the required flexibility for reacting to ad-hoc changes [6]. Their rigid underlying process model would need to foresee all possible variation, which becomes unfeasible even for simple processes. On the other hand, flexible workflow engines (for an exhaustive survey on flexible business process systems cf. [7]) expect user knowledge about the procedural structures of an enterprise and do not provide enough guidance. However, introducing more procedural structures would result in a decrease of a system's flexibility [8]. Due to these problems, none of the proposed solutions could be successfully established on the market [6].

The European research project Commius (acronym for COMMunity-based Interoperability Utility for Small and medium enterprises) addressed these problems (cf. [9]). The proposed concept manages email-based business processes and is tailored to the special needs for SMEs. Commius copes with the high flexibility as well as personal and company individual requirements of email communication. Consequently, Commius has the target to make email-based workflows easier, faster and more structured.

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2. COMMIUS FUNCTIONALITIES

The application of Commius is separated into build-time and run-time functionalities. For the purpose of initial process schema definitions at build-time, an easy to use web-interface is part of Commius. Patterns for the detection of process steps in incoming emails as well as process types being a sequence of process steps can be defined there via drag and drop. Since emphasis is laid upon process interoperability, collaborative business processes among multiple enterprises can also be defined here in particular. The designated annotations as well as system- and business-related modules for processing the mail can be defined individually for each process type and step. The configuration exhibits the system's flexibility paradigm by allowing changes to all settings and definitions at any point during run-time. Further, appropriate migration algorithms guarantee a correct handling of instances in case of an updated process definition at run-time.

Commius automatically hooks onto the existing email infrastructure and collaboration systems, such as Microsoft Exchange, and assigns incoming emails based on their content to new or already running processes. Users benefit most from the multitude of annotations within processed emails. At this, the system refrains from over-loading the mail and confusing the user. Instead, the mail is decently enhanced with interactive elements that only pop up on the user's intent like mouse-over actions or clicks. In a process bar which can be displayed at the right side of the mail window, the past, present and future steps of the current process instance are displayed. Therein, past steps also include the possibility of viewing the corresponding email message in a popup. One key feature of Commius are recommendations for the further proceeding. These take place in form of the future proposed steps in the process bar as well as in the form of direct support like predefined mail templates for the upcoming step. Context-sensitive web-links guide the user to relevant web resources that might be of interest for the current process. Inside the mail text, elements like item numbers are enhanced with popups displaying detailed information about the respective item. In the same vein, location statements inside the text include a Google Map of the location as a popup. Customer numbers are attached with a history of previous process instances of this particular customer. Additional modules performing special enhancements can be easily included into the system as required.

In case of a wrongly identified process step, the user can perform a rollback and correct the process step allocation. Therefore, the process-bar displays a set of sensible alternatives applicable for the current step. Upon clicking on the desired new allocation, the email is processed again by the system according to the definitions of the new step representing the message. Moreover, the user is free to skip, insert and switch steps within the course of the process. No explicit change of the process path is necessary therefore, the user can simply perform the action he wishes to do next and the system will integrate this step into the process course autonomously. Besides such ad-hoc changes in the current process instance, also permanent changes affected by evolution of the process schema and an appropriate instance migration are supported. The system will keep track of all changes and adapt the underlying models correspondingly, keeping separate recommendation principles for each user to correspond to individual work behavior. This self-learning mechanism operates at two stages. Recurring changes of a process step identification triggered by explicit rollbacks performed by the user result in changes to the process step matching engine. Following mails in the same context will then automatically be matched to the new process step as indicated by the users' rollbacks. Next to it, implicit user behavior like inserting and switching steps is considered. If such deviations are performed over a longer term, the underlying process schemata are adjusted to comply with the observed process flow. To counteract inefficient individual process behavior, best practices extracted from collective process knowledge are equally considered when adjusting process schemata.

Companies of any sector can benefit from Commius since email is an omnipresent business medium. Large enterprises can utilize the ERP-connectivity of the system to transfer email-inherent knowledge to ERP as well as incorporating information from ERP into incoming emails automatically. Still, Commius is most favorable for SMEs. Considering the low costs, the simple configuration and usage as well as the high flexibility, the special characteristics of SMEs are comprehensively addressed by the Commius approach. The frequently occurring collaborations among SMEs are taken into account by the possibility of easily defining business-spanning process chains.

Scientific extensions of the Commius prototype demonstrate the power and variety of the approach. As one add-on, social networks can be derived from the mails processed by Commius (cf. [10]). This extension allows the identification of communication patterns and can extract contact information in order to recommend e.g. appropriate business partners. A different extension supports the process of customs clearance for exporting goods. Thereby it shows the extensibility of the modular structured system since a connector to the EDIFACT-based customs system is included here. Furthermore, a recently developed RFID-extension demonstrates an automated triggering of email sending and process step initialization by RFID-chips, which offers numerous interesting fields of application.

3. COMMIUS ARCHITECTURE

The usage of the system is divided into two phases, build-time and run-time. During build-time, the basic system configuration is accomplished in a first step. Therefore, the IMAP-account and e-mail addresses to be observed are specified. Afterwards, the process types to be supported are defined in the configuration tool. Commius will contain process templates for a diversity of common SME standard processes to choose from. These standard processes may be customized or new processes may be defined. Therefore, parser elements to be identified in future e-mails are specified. These elements may include keywords or patterns of a definable structure. A set of certain parser elements constitutes a certain process step. After defining such process steps, they can be combined to process types. The desired annotation and processing treatment can be determined individually for each process step. All of these specifications can be performed using the easy-to-use drag and drop web interface.

Having defined the customized process settings, the Commius system can be employed. During this run-time phase, all e-mail movements of the given e-mail accounts are observed with respect to potential business e-mails. In case of a successful identification of such a mail, it runs through the Commius enhancing treatment. From a more technical perspective, Commius is divided into three main layers that are introduced in the following:

- On the level of the system layer each received email of an enterprise will be intercepted by the Commius system and subsequently be analyzed, archived, decoded and decomposed. Each part of an email, i.e. headers, body or attachments, will be transformed into plain text and merged into a single XML document to allow other Commius components to directly access the information for further processing. In addition, the system layer will provide system connectors usable to interface external as well as legacy systems, required to be accessible by Commius throughout a task.
- The semantic layer signifies meaningful communication of the enterprise. As such, it also underpins the interoperability between collaborating enterprises. Outgoing from pattern based information extraction, using e.g. regular expressions, notifications, invoices, payments, orders and other communication, can be identified and relevant information in this regard will be extracted.
- The process layer concerns process interoperability and constitutes the main part of this paper because user interactions take place mainly with this layer. Thus, it must be addressed more detailed in this section regarding the evaluation of an end-user prototype within this paper. The layer is subdivided into four run-time components and one build-time (configuration) component. This essential layer is described in the following subsections in more detail.

4. MAIL ENHANCEMENT PROCESS

4.1 Detecting

The first step along the execution of the process layer is the detecting component. Here, the Commius system uses the system-inherent Enterprise Process Repository to determine whether the incoming email concerns an already running process or a new process instance has to be initiated. Based on a semantic analysis performed in the prior semantic layer, the email can either be assigned to an existing process—where it constitutes the next step—or the email is considered as a starting event and triggers out a new process. In this case, a new process instance with its specific process ID (cf. Figure 1, F) will be created outgoing from the corresponding reference model template from the Enterprise Process Repository. Further, the information whether the incoming email is part of an already instantiated process or a completely new one, is being displayed to the user (cf. Figure 1, F). Future incoming emails concerning this particular process will be assigned to this initial process instance henceforth. As mentioned before, the correct assignment of the actual process step to the correct template is being realized by an analysis of process characteristics done by the semantic layer. If the detection component assigns an incoming email to a wrong process (step) based due to an incorrect semantic analysis, the user still has the possibility the manually reassign the email to another process step (cf. Figure 1, H). To assist the user, the system provides information about the semantic matching of the email to a process step based on a percentage basis.

4.2 Tracking

As the second step along the process layer's execution, the tracking component monitors all incidents occurring within a running process and stores every performed step in context of the related process. This component utilizes the Enterprise Process Repository as well as the semantic information gathered from the original incoming email, to track, which process is triggered by this email. Additionally, it updates the assigned process instance within the Enterprise Process Repository with all important data that can be useful or applicable for future process analysis. Each performed step concerns two occurrences, actions and events. Actions signify human or application triggered activities, whereas events on the other hand have no active part. In the context of

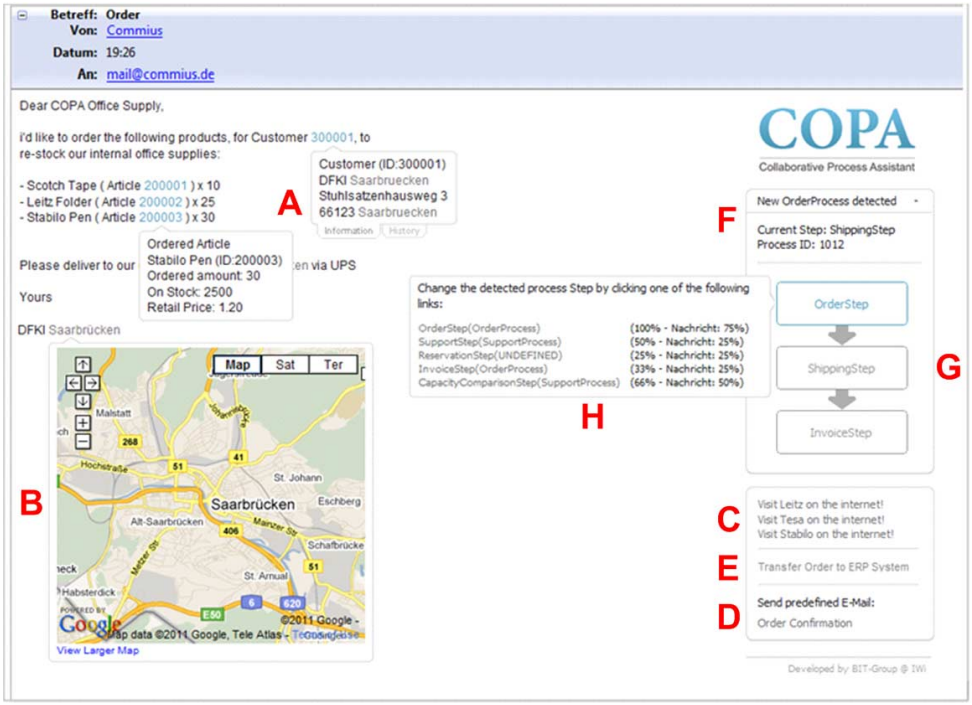

Figure 1. An enhanced email in the COPA prototype of the Commius system.

email communication, actions mainly correspond to the activity of sending an email and events to incoming emails. Since every performed step is related to its unique process instance, it can be tracked and on this basis recommendations for further steps can be obtained and provided to the user (cf. Figure 1, G). In case the Commius system is applied in a collaborative scenario, it may be possible, that the incoming email belongs to an overall process, which previous steps have been executed by other Commius instances. In this case, the tracking component offers a synchronization functionality, which offers the possibility of synchronizing already executed steps of an overall process throughout several Commius instances. Hereby, the tracking component determines which information has to be gathered from other known Commius instances. Thus, collected information will subsequently be added to the local database and utilized to further enhancement of the generated output. At this point other beneficial aspects of the tracking component and respectively the Commius project reveal. The gathered information provides a comprehensible documentation for further disposal. Due to the semantical extraction of process information, e.g. customer information and quantity of ordered goods, the system enables a (mostly) automated build-up of a company's unique customer database. Moreover, the tracking component gives SMEs raise to business supporting functionalities only accessible by large scale enterprises. Gathered information, for example about the consumer behavior of customers, could be used by SMEs to send out individual offers to customers, to support other marketing activities, etc. The email contains two sets of data informing the user of the present state of the actual process, as well as the visualization of the preceding process steps. The first data set contains key information about the email and the process at hand and informs the user about the present status of the process instance the email belongs to (cf. Figure 1, G). The second data set shows an overview over all preceding steps in the actual process including the corresponding emails.

4.3 Assisting

As the correct process step has already been identified by the detection component and the semantic layer, the assisting functionality is now deployed in two ways. First, the assisting component exploits the Enterprise Process Repository in order to gather relevant process data. Secondly, the assisting functionality supplies the user with this case related information about the particular process step. On the one hand, this data consists of internal information like customer history or article information from an own database (cf. Figure 1, A). On the other hand, additional external information are offered context-based either in form of a gateway to useful web links (cf. Figure 1, C) or email-integrated travel details to a location provided by Google Maps (cf. Figure 1, B). Besides the context-sensitive enrichment of incoming emails with internal and external information, the assisting component provides the possibility to send email drafts that are context-based selected and recommended to the user (cf. Figure 1, D). Furthermore, if other software systems are used within the enterprise, e.g. ERP systems, components can be integrated that transfer information out of the email to these systems (cf. Figure 1, E). Depending on the context, different information can be useful or required for a particular process. For that reason, the type and level of detail of the information to be displayed can be adjusted using the customization tool (cf. section 2.1).

4.4 Advising

Due to prior process instances and according user actions, there is already knowledge about the underlying process available, which forms the input for the advising functionality. Using the Enterprise Process Repository, the advising component—as the fourth step in the processing of an incoming email—offers suggestions and recommendations for the further proceedings in a particular process (cf. Figure 1, G; for detailed information on the recommendation process, it is referred to [11]). A second functionality of the advising component is to provide advice in actually executing the next process step once the user has chosen one of the provided actions. This more interactive part is not directly invoked while processing an incoming email, but later via the embedded hyperlinks, which redirect the respective user to the Commius integrated web-interface where they will be provided with more specific information on the further proceedings.

5. USABILITY EVALUATION

The prototype COPA (acronym for COllaborative Process Assistant), developed by the German Research Center for Artificial Intelligence (DFKI), implements all concepts and functionalities of the Commius approach. An empirical evaluation of this prototype with the objective to clarify whether it is beneficial in practice or not has been conducted in [12]. The objectively measured processing time of the workflow execution with COPA and without COPA as well as the subjectively rated satisfaction with the processing time served as the basis to prove the hypothesis "COPA makes a workflow significantly faster". A dependent Student's t-test for paired samples showed a significantly faster processing of the workflow execution with COPA compared to an execution without COPA. In contrast to the previous hypothesis, the hypothesis "COPA makes a workflow significantly easier" could not be proved based on objectively measured variables. Therefore, this test of the hypothesis relied on the subjectively rated satisfaction of each test person. A conducted sign ranks test showed that the test persons judged the workflow execution significantly easier if it was supported by COPA. The last hypothesis that was tested within this evaluation is whether a significantly higher satisfaction—regarding the achieved workflow result—can be guaranteed by a COPA-supported workflow execution. A conducted sign rank test showed a significantly higher satisfaction with the workflow result, as hypothesized, if the test persons were supported in their work by COPA. Furthermore, test persons agreed with general statements on COPA and judged the integration into the existing email landscape as a very useful feature. Consequently, Commius seems to be a feasible approach to manage email-based business processes.

6. CONCLUSION

In this paper, we have presented Commius as a prototype to support enterprise interoperability based on e-mail technologies which fits the special needs of SMEs. It enables SMEs to use and maintain the system without major financial efforts and changes in their technological landscape. The most innovative aspects of Commius include the extensive capabilities for flexible adaptation to changed environmental needs while still providing process guidance, the platform and software independence while still offering interfaces to ERP-systems and the easy and clear structure next to a high range of functionalities.

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