Modeling Service-flow

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Abstract: As e-business is invading the service industry and the public sector, there is a need for a service-flow management of those processes, which consist of a sequence of interrelated sub-services. Making use of the potentials of internet applications, service-flow management aims at providing these service in an efficient manner, at improving customer relationship management in the field of tension between routine and situated/personalized service provision, and at providing flexible IT support for service providers and/or clients at each service point. Based on object oriented, workflow and user oriented modeling techniques, we model service-flow patterns by identifying sequences of service points, each capturing the specific service tasks and their respective pre- and post-conditions from the provider's point of view. This service-flow modeling approach may be supported by the modeling tools Visio® and Process@Work. We present some results from two cases of service-flow modeling, each with a short case description and a discussion of the models' application for technical and organizational development.

1. The e-Service Challenge

E-business is invading the service industry and the public sector. As in other e-business areas the e-Service challenge includes the relations Business-to-Customer (B2C) and Business-to-Business (B2B). Customers (e.g. patients in health care, students in an education program, tourists on a package holiday, etc.) increasingly experience complex services which consist of sequences of interrelated sub-services, each provided by different cooperating organizational units. Here, the B2B challenge is to cooperatively improve the efficiency and quality of service provision, and the B2C challenge is to conveniently provide information and (possibly) transaction to customers with internet access any place any time. Complex e-services may also consist of a number of service tasks, which consecutively center on the individual customer's concerns even if there is no direct communication (maybe with additional support tasks/processes not taking into account customers' concerns). Examples can be found within financial services, support for product use (e.g. software support) or travel reservation, but also within the whole range of e-government services (Authority-to-Citizen, A2C).
Both challenges (which, of course, may coincide) call for a cross-organizational process management of the sequence of service tasks. In the B2B case, internet technology is needed to support cooperation between service providers as the customers' concerns are

treated at one service point after another. In the B2C case, internet technology usually supports the customer's entry (portal) to the network of service providers who, in many cases, have to cooperate during service provision and/or continue interaction with the customer.
With service-flow management (SFM) we have introduced a general concept which we developed for supporting interrelated personalized and situated services carried out across different organizational units or provider firms ([Kl00], [KKW01]). SFM is centered around the specifics of service delivery and aims at

- improving *customer relations* during the delivery of services that consist of a sequence of interrelated sub-services,
- enabling *efficient provision* of these service and
- bringing the advantages of *internet applications* in service provision to both service provider and customer,
- providing *flexible IT support* for service providers and/or clients, addressing the field of tension between routine and situated/personalized service provision.

The SFM concept has been applied to domains such as e-government [KW01a] and e-health [KW01b], applying XML to exchange standardized process representations as well as a four-layered architecture to support service tasks within each provider organization (including Java components for handling the respective XML documents). As the exchange of XML documents is the only technical frame (allowing each service provider to independently manage his IT environment), aspects of shared knowledge and common organizational procedures become even more important success factors for cross-organizational process management. In particular, organizational development and technical support of SFM must rely on an agreed understanding the interrelation of separate service tasks.
In this article, we introduce the SFM modeling approach and address the specifics of the service domain as well as the challenges of cross-organizational process management based on internet technology. In the following, we briefly explain the notion of serviceflow, describe our concept of service-flow modeling, discuss appropriate IT support for modeling activities, and provide examples of how service-flow models can be applied to the development of IT support for SFM in different service domains.

2. Service-flow Modeling for Process Representation

Accepted definitions of the notion of service ([En94],[De98]) frequently emphasize – besides the satisfaction of needs – the substantial amount of work involved, the simultaneity of production and consumption and/or the lack of permanence (particularly in contrast to the provision of material goods). The person or organization requesting the service may be involved in the process personally (e.g., as a patient) or as the owner of the objects belonging to him (e.g., goods in transit).
As SFM focusses on sequences of service tasks and the respective process management, the client-provider relation is not simply an encounter, but a relationship (cf. [Gu95]). Therefore we consider services as unfolding social relations where the service provider's work is to (continuously) recognize and satisfy situated needs of an individual or collective client, based on an explicit or implicit agreement. Generally, form and content of services vary according to the domain, the service provider, and the unique situation

in which the relation unfolds, depending on the actual needs of the customer. Often, it is a matter of trust and/or past experience whether the client calls for a specific service, and in the end it is the client who decides whether his needs have been satisfied [Kl00]. Where the client naturally follows his individual concerns, the service provider applies a professional rationale. E.g., service is regarded as a piece of work or a performance by a business organization, the net value of which is based on the recognition and satisfaction of customer needs. To this end, standard processes are, wherever possible, adapted to the requirements of the respective service situation [KW00].

The notion of *service-flow* is meant to pick up both of these perspectives:

> From the *customer's perspective*, a service-flow gives a customer the feeling of being embedded in a coherent "flow of service" taken care of by the service organization(s) where the service provided "follows", "accompanies" or "precedes" the customers as she/he moves through time and space.
>
> From the *service provider's perspective*, the emphasis is on the integration and coherence of all situated sub-services across temporal, spatial and team boundaries, which are combined to form a continuous and complex overall service to the "moving" customer (based on standard processes).

On the one hand, supporting cross-organizational process management in the service domain challenge requires new modeling approaches. On the other hand, any new approach must relate to the modeling ideas already implemented in existing organizations and technology. To meet the technical and organizational aspects of the e-service challenge, we may draw on two modeling backgrounds:

- *Workflow management* originally focuses on the flow of the work item, usually worked-on documents, as well as on the interrelation of workplaces. The "workflow" metaphor conjures up the image of a factory where the assembly line effectively and efficiently supports cooperation among the workers in the mass-production process. It delegates process control to a workflow management system "that completely defines, manages and executes 'workflows' through the execution of software whose order of execution is driven by a computer representation of the workflow logic" ([La97], p. 244) Meanwhile, flexibility (e.g. in terms of ad-hoc workflows) and cross-border process management have become an issue, but with workflow management primarily seeking to organize the internal division and coordination of labor, there usually is no focus on customer relation management or quality of related services.
- *Business networking* (e.g. [÷F00]), based on business process analysis/engineering, is a rather comprehensive approach meant to identify and support processes for increasing accountable value in business cooperation and/or for external clients. It provides a guiding vision and a strategy framework for the cross-organizational integration in e-commerce, supply chain management, or customer relationship management through the extensive use of internet applications (e.g. customer process portals). But this top level approach focuses primarily on the interrelation of business units, not on the workplace or personal interaction level. It may lead to a comprehensive IT strategy, but does not include concepts detailed enough to bring out new application modeling and respective IT architectures.

In the following, we will draw on these approaches, but we need to go beyond them to address the specifics of the service domain. Service-flow modeling takes up on modeling techniques and approaches which have evolved through the 90's in the area of process modeling (workflow, business processes) and object modeling (mainly UML). We try to

incorporate these approaches as much as possible, striving for integration and trying to keep specific supplements to a minimum. Our modeling approach has also been inspired by recent work in the field of computer supported cooperative work (CSCW). Being concerned with social relations and interactions (service, work cooperation), we try to introduce modeling as a tool to bring out the different actors' perspectives and keep them involved while envisioning change and deciding about design and use of information technology within the service performance.

The notion service-flow indicates the interrelation of all subservices whereas what actually flows is (1) the customer's concern (which may evolve over time) related to a service agreement and his/her accumulated service experience (often supported by the customer's physical or virtual presence) as well as (2) the documented plan and history of each individual sequence of service tasks. The *aim of service-flow modeling is to provide a process representation,* which may serve as a basis for

cooperation agreements between the service providers involved in a service-flow (process patterns for standardized serviceflows)

service agreements between client and customer (personalized process pattern)

individual process documentations to be passed on between the service providers

Also, modeling must allow for flexibility and decentralized control of what service tasks are to be carried out and what should be the schedule for service tasks to follow.

To simplify matters and to enable structuring from the provider's point of view, we define service-flow in terms of service points. A service always creates some social situation, it needs a "place" [HD96] which frames the situation where service tasks are carried out, e.g.

- service staff evaluating the client's concern and serving his/her needs (in these situations the client's presence may vary from being present, being present through telecommunication, or being virtually present through one of his objects or through a representation of the concerns)
- client is served by some autooperational device (e.g. a web portal) on behalf of the service provider

These places we call service points, and the subsequent interrelation of a number of service points is a service-flow (figure 1).

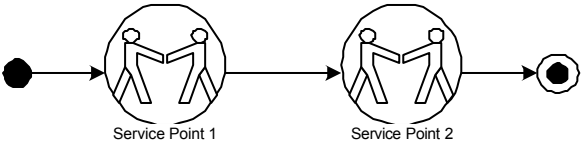

Fig. 1. Service-flow pattern with two service points (meta model)

Each service point captures specific service tasks to be carried out and their respective pre- and postconditions from the provider's point of view (figure 2). The service tasks are modeled as use cases are in UML. Jacobsen ([Ja92], p. 129) defines a use case as a "behaviorally related sequence of transactions in a dialogue with the system." Within service-flow modeling, these service tasks either refer to a set of activities carried out by service staff with support from an IT system (indicated in the model by connecting tasks and service staff) or to a set of operations carried out by the IT system, possibly in dialogue with the client (indicated in the model by connecting tasks and the client).

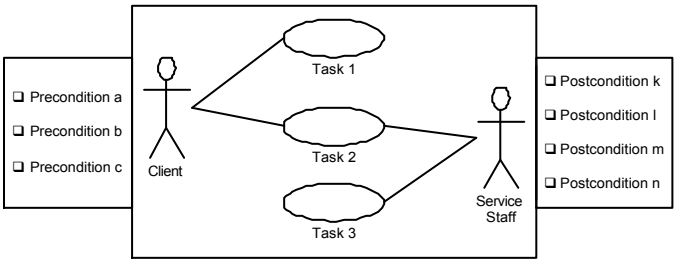

Fig. 2. Servicepoint with three service tasks (with alignments to client service staff) and respective pre- and postconditions (meta model)

The pre- and postconditions represent the contract for interrelating the service points. Note: there is no centralized service-flow control assumed. During service-flow implementation the service-flow model is only a process pattern, i.e. the flow logic may or may not be executed (automatically). Based on the service-flow modeling appropriate IT support can allow for flexible performance at each servicepoint: e.g. tasks may be carried out although some preconditions are not true, tasks may differ from the pattern although all preconditions are true, or postconditions may not be achieved although tasks have been carried out according to the pattern (or the other way around). The interrelation of service points is subject to possible changes: whereas the service-flow history (the sequence of service points passed) is, of course, not changeable, the service-flow schedule, i.e. the part of the service-flow pattern with service points not visited yet, may be manipulated by deleting or adding service points or changing their order.
However, based on the service-flow pattern, a documentation of the individual service-flow can be initiated and updated at each service point. This documentation, i.e. the process representation, includes the individual schedule, the service-flow history (especially the accumulated postconditions). At the next service point, this process representation can be (automatically) interpreted based on the general service-flow pattern shared by all actors involved.
For modeling purposes, each service point activity should be linked to a rich description (e.g. scenario) and a glossary. Cooperation pictures ([KWR96], [KrW00]) can also augment the service-flow representation to explicate recurrent cooperation relations among the actors involved. To construct an enriched service-flow model the resulting documents of all these techniques should be related for display, e.g. by interlinking HTML versions of the different documents.
Applying the modeling approach above has led us to two different concerns: (1) how to support the modeling process by appropriate use of information technology, and (2) how to evaluate potentials and limits of this approach in different service domains. Hence, we now discuss technical support for service-flow modeling and provide some examples.

4. IT support for service-flow modeling

Up to now, all of our service-flow model production has been based on Visio® Professional. To have all the necessary symbols, shapes and connectors ready to hand for service-flow modeling, we have included a set of “simple shapes” (files with .vss). Since

Visio® version 5.0 it has been possible to export all drawings directly to HTML (including links between drawings or links to other HTML files, e.g. scenario text). For users familiar with Visio this part of the modeling does not pose new problems.
Whilst this rather simple way of supporting the modeling is already of great help, it is not sufficient to support large projects with a larger number of actors related to many different serviceflows and service points. The modeling process needs to be organized on a (cross-) organizational level where IT support is needed to provide options for, among others, the construction of complex models, on-site service-flow analysis, general model access, reuse of models and model parts, service-flow simulation. Up to date, the most promising IT support for service-flow modeling is provided by Process@Work, developed by Ali Bahrami in 1999, based on an experimental version of the tool designed and developed by the same author in 1997. The aim was to design an easy to use and yet very comprehensive UML based business process modeling tool which is capable of performing dynamic analysis of business processes via simulation of the business processes.[1]
Process@Work is written in Java and integrates a number of commercial off-the-shelf software tools (COTS) in a single comprehensive tool by utilizing the open architecture of all the components involved. The heart of the tool is a sharable repository (any ODBC/OLE DB database such as Microsoft jet engine™, SQL Server™, or other suitable information repository) for storing process models and various process information, such as class diagrams, activity diagrams, use cases and serviceflows as well as their associated data and modeling objects and attributes. Furthermore, the modeling system allows for reusability and creation of common process libraries via "Process Component." The repository makes it possible to perform search and query on the processes. For data entry and reporting, the system can interface with Microsoft productivity tools such as Excel™.
The web publishing capability of the tool provides an easy way of publishing and viewing the process information on the web. Furthermore the tool is capable of exporting the contents of the repository into an XML document. For simulating the activity diagrams, Process@Work uses the Arena Business Edition (ABE)™ from System Modeling. The simulation capability of the tool allows users to perform a dynamic simulation of the business processes in order to collect process performance statistics, to validate the processes and to analyze "what-if" scenarios.
Modeling in Process@Work is also done by using the Visio™ engine for creating and editing graphic models. These models are a collection of customized Process@Work modeling objects. Users can define static views of processes using the extended UML activity diagram. Given some additional information (e.g., resources, duration, or distribution probability, etc.), one can use the same model also for a dynamic simulation study of the processes.
The Process@Work representation language is based on the three UML diagrams:

1. **UML Class Diagram** for modeling objects defined within processes as well as data modeling

[1] The earlier version of the tool called (MS)^2 - **M**odeling and **S**imulation **M**anagement **S**ystem has been used (and is still being used) in a number of projects at the Boeing Company mainly for customer support services [BH00], to define documentation and engineering, and for work support information systems [Bu00] as well as in several other process management, workflow and simulation projects.

2. **UML Use-Case Diagram** for expressing how actors (e.g. people, departments) and systems interact to accomplish a portion of the business (or system)
3. **UML Activity Diagram** for modeling workflows, business process definitions, simulation, and workflow execution

Using these basic concepts further modeling is possible to meet specialized needs. For service-flow modeling, the following extensions have been implemented:

4. **Service-flow Picture** for depicting sequences of interrelated service points (additionally, a service point is always related to an organizational unit)
5. **Cooperation Picture** for depicting organizational units (here: service points), the use of media for communication and information flow and the material exchanged between the units
6. **Use Case Picture** for depicting actors, their interaction and their use of shared material within a use case

Thus, the modeler is supported on different levels by the same integrated modeling tool which allows her/him to capture cross-organizational processes with zooming functionality into each single activity and its attributes and objects. A double click on any model element allows for specifying properties, including references to other diagrams or related documents such as scenarios. For instance (see example in figure 3), the cooperation between organizational units is further specified by objects exchanged and the roles and tasks involved (relating to the respective use cases). In a similar way, a double click on a service point within a service-flow picture allows for specifying the pre- and post-conditions as well as the service tasks (relating the concepts of figure 1 and 2).

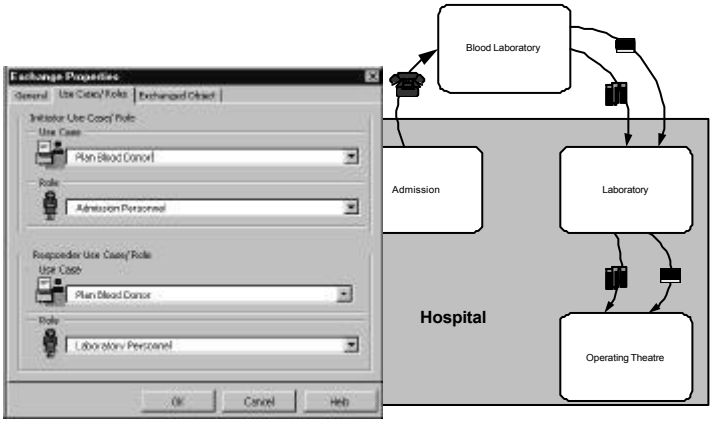

Fig. 3. Property specification of an exchange relation between admission and blood laboratory within a cooperation picture (modeled with Process@Work; see also case in section 5.1)

Based on UML, service-flow modeling can relate to established software development and system design by drawing on existing models and feeding back models incorporating familiar modeling elements. The web functionality of Process@Work supports especially the cooperative modeling as well as the cooperative use of models across organizational boundaries. Research is being done to make extending Process@Work easier by allowing users to perform meta-modeling or extending the tool modeling objects. We believe this will be a very powerful capability which will enable the tool to be very adaptable for various organizational environments and modeling activities.

5. Modeling Service-flow in Practice

In the following we present some results from two cases of service-flow modeling, each with a short case description and a discussion of the models' use in technical and organizational development.

5.1 Case: Preparation, Performance and Aftercare of an Inpatient Operation

Service-flow modeling has been applied to the preparation, performance and aftercare of a inpatient surgical operation. Within this sequence, the patient usually moves back and forth between different physicians/specialists and a clinic to receive a profound diagnosis and as well as appropriate medical and care treatment. In such a process, a patient typically starts with consulting a family doctor, is directed to a specialist, chooses a hospital, receives consultation and registration at the hospital with a plan for further preparation, passes through all preparations, stays in the hospital where the operation is performed, followed by aftercare treatment at specialists (see figure 4).

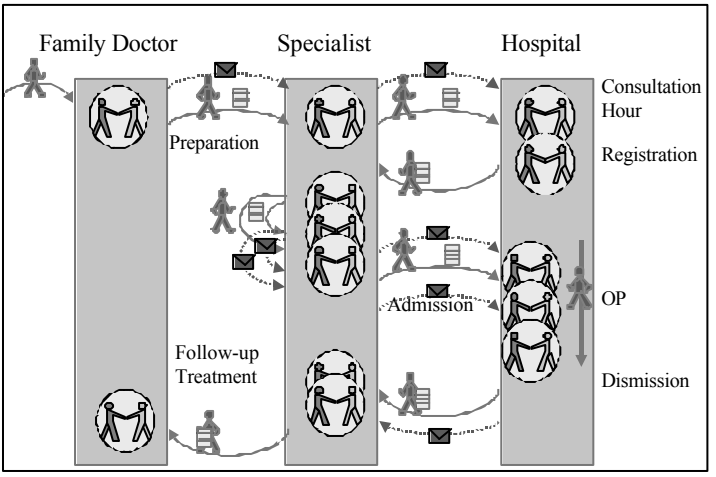

Fig. 4. Cooperation picture for service providers within a service-flow pattern of the preparation, performance and aftercare of an inpatient operation.

This complex service is characterized by a high process variability, based on a service-flow pattern. New service tasks (possibly related to new service providers) might appear on the agenda at any time or place as the case unfolds. However, despite all flexibility the process must meet certain requirements, e.g. the preparation has to be carried out as planned and legal and medical documents have to be available before an operation takes place. The fulfillment of these divergent requirements is complicated by different interests among providers and the lack of a process ownership and/or centralized process control. Thus, service-flow management seems promising as it enables a 'just-in-time' exchange of process knowledge (along with legal and medical documents) while preserving the provider's autonomy for altering process plans.

In this case, we use service-flow modeling to bring out the different perspectives and problems to establish a health care provider network around a specialized hospital in Northern Germany (cf.[KW01b]). Besides discussing the overall process and its flexibility by using service-flow and cooperation pictures (as in figures 3 and 4), we use additional modeling facilities for capturing details concerning necessary inter- and intra-organizational cooperation. E.g., the use case picture of figure 5 expresses the interaction between patient and admission personnel (talking and exchange of documents) during planning and scheduling of the operation. It models the process representation (the folder) as shared material and only indicates cross departmental cooperation during the use case (phone calls, e-mails) and access to organization wide shared information spaces within the hospital (like the schedule of the operation theatre or the roster).

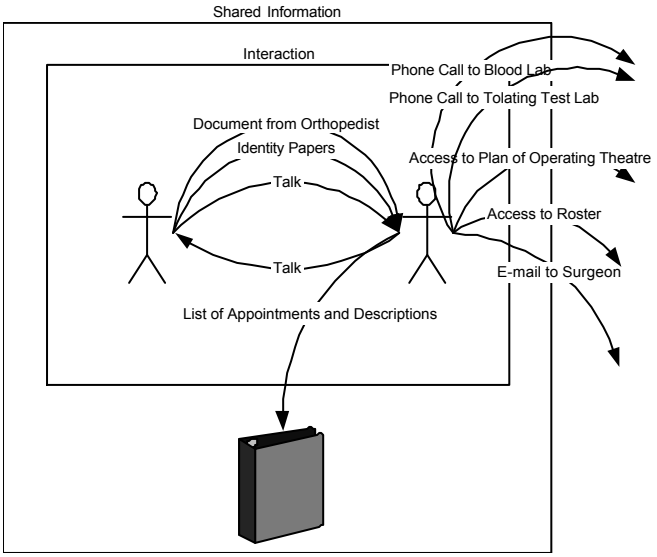

Fig. 5. Use case picture for making a reservation and scheduling an operation.

Owing to the nature of interrelated health services, there is a tension between an information flow versus information systems approach for architectural realization. Moreover, an information flow approach emphasizes the exchange of process knowledge and data among different service providers in relation to the patient's movements while emphasizing flexibility and autonomy of the partners involved without any need to establish a joint technical infrastructure. Whereas the information systems approach emphasizes a central provision of information and task support requiring, at least in the past, integrated technical infrastructures.

For a balanced solution, we have to face the fact that the IT infrastructure of the service providers involved in the health sector is highly heterogeneous, it ranges from very poorly IT equipped physicians to large hospitals using highly sophisticated IT land-scapes with hospital information systems integrating a huge variety of different specific systems and web servers. In this situation, service-flow modeling provides a sound basis to discuss the issues at stake and to provide suitable IT support for the service providers involved and for the health care network as a whole.

5.2 Case: Postal Vote Application at www.hamburg.de

Within an e-government project (started in fall 2000) cf. [KW01a]), we have modeled the future process of citizens applying for postal vote through the web portal of the city state of Hamburg (Germany). Based on interviews with administration staff we developed a service-flow picture (figure 6) as well as service point pictures for the first three service points, each with lists of pre- and postconditions and of service tasks to be carried out. All tasks are linked to text descriptions (scenarios, role descriptions) which also refer to a glossary. All documents were linked and exported into HTML which allowed for convenient reviewing by the interview partners.
Conceptualizing the citizens' application for postal vote through the web portal we identified four service points with respective tasks in parentheses (see figure 6):

1. providing application assistance for citizens visiting www.hamburg.de, the city's web portal (opening application, autooperational assistance in personalization, on-site evaluation, confirming receipt, service-flow preview, offering/registering personal reporting channel, optional: saving application)
2. inspecting the application at "Senatsamt für Bezirksangelegenheiten", the city's central administration for IT procedures (autooperational validity check including selecting the voting office in charge; or exception handling: selecting the voting office in charge if application processing seems possible – or moving directly to service point 4 in case of invalid application)
3. processing the application by the respective voting office (validity check with up to date preconditions, preparing personal postal ballot paper, notification for the electoral register, preparing postal ballot paper for delivery, personalized exception handling if necessary)
4. reporting on process through the web portal provider (delivering messages to inform the applicant about the state of the process, providing information about what to do next and/or whom to contact) through the channel the applicant has selected before (web page, email, SMS, etc.)

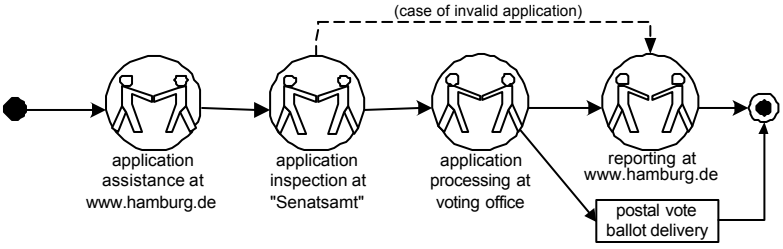

Fig. 6. Service-flow model for the postal vote application starting at www.hamburg.de

The delivery of the postal ballot paper by regular mail is regarded as a support process, i.e. it does not focus on or reflect the citizen's personal/situated need.
While the process described above seems pretty straightforward (at least simple enough for prototyping purposes), a number of variations, uncertainties, possible exceptions and failures may occur. Situated needs to be addressed include that a citizen

- moves to a new address before the voting offices starts processing his/her application
- has lost the postal ballot paper and needs a new one
- does not need to use the postal vote and wants to vote at the polling station

However, the administration expects that the majority of the personalized serviceflows will follow the designed pattern. The provider organizations at each service point will assign staff members to the task of looking after those applications where automatic procedures do not operate successfully.
In this case, the above service-flow model and the related XML specification are the most important basis for the technical and organizational cooperation between the service point providers involved: the commercial portal provider of www.hamburg.de, the city's central department for application programming, and the city's voting department responsible for the temporary voting offices. At the time of writing, systems architectures and IT solutions are being developed and deployed independently for each service point, aiming at supporting service tasks as well as processing XML documents as exchangeable process representations on the basis of the adopted service-flow model.
All parties involved have acknowledged that the underlying concept of service-flow management opens up a general perspective and that the case of postal vote application is only one first example of demonstrating the city's new capabilities and learning how to manage the organizational and technical aspects of e-government transaction services. Given the successful realization of the postal vote application service, the established team work will continue to pave the way for a number of future e-government services. Lately, negotiations have started with other administrative bodies in Northern Germany who also want to adopt this new approach. Whereas each citizens' process portal and the management of all accessible serviceflows need a negotiated organizational model with specific actors in charge, the IT architecture and technology to support service-flow management is of general purpose. This way, service-flow modeling supports the implementation of e-services specific to each city or state, and at the same time fosters the development of e-government concepts and technology for general use.

Conclusion

The key concept for modeling service-flow is the identification of service points, each of which captures the specific service tasks and their respective pre- and postconditions from the provider's point of view, and provides a frame for the interaction between the service client and provider as social actors, supported by IT systems and networks. As e-services expand the place and time of interaction – from "same place, same time" to computer mediated and asynchronous – we suggest to model complex services as a sequence of interrelated service points, where each of the related service tasks has its own place and time, allowing the service to unfold as a social relation.
Service-flow modeling supports the management of serviceflows from the providers' point of view and the related technical and organizational development. The decomposition of complex services into serviceflows with service points and related tasks including activities and/or operations permits a comprehensive analysis as well as the construction of a process representation which may serve as a basis for a cooperation agreement between the service providers involved, for a service agreement between client and customer (personalized process pattern), and for individual process documentation to be passed on between the service providers.
Economically, service-flow modeling provides concepts for analyzing and (re-)designing service chains across organizational boundaries, identifying and interrelating the

necessary performance of each service partner, and establishing a high performance service network based on standardization of service operations, process management and information exchange. From the work perspective, service-flow modeling identifies the recurrent service tasks and cooperation needs of service work and helps to design appropriate IT support for the work place as well as for the client using computer mediated service interfaces.
As e-business generally tends to reconstruct the "transpa rent customer", it is all the more important for service providers to exercise a degree of care and attention to avoid letting the customers "drown" in the service -flow as mere objects – not (only) because of ethical considerations, but because business success in the service domain strongly depends on the quality of the service as a social relationship.

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