Serviceflow management for health provider networks

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Keywords

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Abstract

Exploding expenditure in health care has led to new reimbursement regulations forcing health care providers to conduct their organisations as business concerns. In order to be competitive providers have started to build networks that allow the delivery of interrelated health services in a well-adjusted and uniform manner. However, besides strategic agreement, successful networking requires the support of information systems for efficient cooperation and process management in order to deliver efficient day to day service. With serviceflow management we provide a general concept that answers these needs. Based on modelling process patterns and the exchange of XML-representations of process knowledge and data between service providers, serviceflow management supports organisations in jointly delivering services that cross provider boundaries. Furthermore, it enables flexible handling of processes, which is indispensable in health care. Based on a health care example, we explore the possibilities of serviceflow management and present a Web-based prototype on the basis of our generic, four-layered architecture.

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Introduction: the challenge of supporting health care processes

Today, health care providers of all kinds face extreme pressure. Owing to demographic reasons and the availability of better medical facilities and therapy forms, expenses in the health care sector are exploding. Consequently, cost reduction is of prime importance. As a response, drastic changes in reimbursement procedures cause health care providers to act as firms with a business orientation. The ensuing competition compels health care providers either to specialize or merge, or both. A promising alternative is to build networks that enable providers to act in a corporate way *vis-à-vis* business partners (insurance companies or suppliers) as well as clients (patients). This situation only mirrors developments that already exist in the USA, such as health management organizations (HMOs). The question is whether new Web-based technology can improve the situation. Out of the great number of possibilities in online health provision (cf. Rippen, 2000; Rodrigues, 2000; Tambouris *et al.*, 2000) we are interested in the design and impact of e-business at the joint between networks and patients. Our intention is to support health providers in both a cost effective provision of cross-organizational service processes and a substantial improvement in their quality.

Many authors agree in that improving cooperation and coordination among different providers is of critical importance in the health care sector (e.g. Schroeter, 2001; Gordon, 2001; Healy, 2001; Browne, 2001; IHE, 2002). Unwanted situations need to be overcome in which, for example, patients have to repeatedly fill out identical forms at

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each visited provider site, tests are redone unnecessarily as their performance is less an effort than locating the required results within a different organization, or errors occur due missing integration causing re-keying results between systems (Schroeter, 2001). Improving integration and cooperation in health care - a "woefully uneconomic industry when it comes to information management" (Schroeter, 2001) - is still considered to be an extremely difficult endeavor. Health care IT projects often fail due to a lack of end-user involvement, executive support, and/or re-engineering of current processes (Healy, 2001). However, the main source of problems is seen in the complexity and the specifics of health care work (Strauss *et. al.*, 1997). Project such as the Esther Project in Sweden (Gordon, 2001) try to interrelate several subgoals, e.g. to develop flexible organization with patient value in focus, to improve efficiency in medication routines, to allow for adaptation of documentation and communication to the next link on the care chain, etc. To achieve the overall goal "to improve the way patients flow through the system of care by strengthening coordination and communication among providers" (Gordon, 2001), they call for integrated IT support for such health care processes. Yet, when it comes to realization the means are still divided. Despite the progress and availability of established standards that improve interoperability (e.g. HL7 and DICOM) the gap between these standards and the actual implementation of integrated systems is a major concern, as pointed out by IHE (2002).

At this point, workflow systems may be considered as a possible solution. However, among others, Browne (2002) speaks clearly of domain specific hurdles that needs to be solved first in order to make workflow systems useful to the domain. Topics are the need for distributed interinstitutional workflow systems with the ability for introspection, instance-adapted workflows that may alter throughout performance, non-deterministic outcomes with state changes not related to activities or events. In addition, workflows are based on intent rather than results; they are highly complex due to the number of activities, the number and uncertainty of attributes, long-lasting events, *ad hoc* roles, the patient as an object to be considered, and heterogeneous actors that need to be defined. Furthermore, by referring to the paper of Wang *et al.* (2001) in which the authors studied representations of clinical practice guidelines, Browne (2001) identifies complex state descriptions (by distinguishing internal, external and workflow states) which are important in health care but are "underconsidered" in workflow literature in general. Hence, Browne asks how, if the notion of state is so extremely complex (possibly including the patient's record), workflow systems can be designed in order to cope with them adequately. His final conclusion is rather pessimistic: "Far more research needs to occur before WfMS systems can play more than a facile role in Health Information Systems".

As many others, Schroeter (2001) sees XML as a "compelling" interchange format which, while put at the center of systems, may overcome some of the above given hurdles. XML may serve as a basis for intelligent patient records. "Although not being a panacea for the woes of the world's health care systems", it provides a standardized mechanism for presenting data in a self-describing way. This may even support the legal obligations in order to store and find documents over decades. In this contribution we also argue for the use of XML, but more far reaching to represent and exchange case knowledge which in turn will allow for flexible and distributed flow of service in a network of health care providers.

Our line of argument is as follows: first, we introduce our methodology of analyzing clinical problems and of modeling service processes; second, we examine a typical cross-provider health care service process and conclude with specific requirements for online support. Based on these insights, we describe how the serviceflow modeling approach leads an IT architecture for process support, discuss a suitable IT infrastructure, and present a prototype for the given example. Finally, a summary highlights the main potentials of applying serviceflow management in health care provider networks and how it may contribute to new e-health scenarios.

Methodology of understanding and supporting health care processes

Our work is based on previous experience in health care projects (Krabbel *et al.*, 1996, Krabbel and Wetzel, 2000; Wetzel, 2001). Like many others, we consider the difficulties in implementing information systems into hospitals as being rooted in the specifics of the domain, such as situated cooperation of high complexity (Wolf and Karat, 1997), work "on" human beings (Strauss *et al.*, 1997), hospitals as representatives of special organizational types (Mintzberg, 1979) and relatively low investments and IT knowledge compared to business organizations of similar complexity. We assume these factors will similarly affect efforts in improving cross-organizational processes.

In this research, we use serviceflow modeling (Klischewski and Wetzel, 2000; Klischewski *et al.*, 2001; Wetzel and Klischewski, 2002) to bring out the different perspectives and problems to establish a health care provider network around a specialized hospital in northern Germany. With serviceflow modeling as a part of serviceflow management (SFM), we introduced a general concept which was developed for supporting interrelated personalized and situated services carried out across different organizational units or provider firms. Above all, SFM is based on services understood as relationships, since this is more comprehensive than just focussing on services as encounters (Gutek, 1995). Services are social relations to recognize and satisfy situated needs of an individual or collective actor, based on an explicit or implicit agreement. It is often a matter of trust (e.g. in a physician) whether the client calls for a specific service, and in the end it is only the client who decides about successful satisfaction of his needs. However, this personal dimension has to be enhanced by a dimension of professional performance. From the perspective of the professional provider, service must be defined in economic terms: a service is an act of labor 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, where possible, adapted to the requirements of the individual service situation.

With the notion of serviceflow we apply this twofold understanding of services - their relationship and efficiency aspects - to interrelated services which consist of sequences of sub-services which are delivered by different service providers. The success of these services (in terms of business revenue) is crucially dependent on the customer/client experiencing all sub-services as coherent and continuous and as part of a comprehensive overall serviceflow. From the customer's perspective, a serviceflow gives customers the feeling of being embedded in a coherent "flow of services" taken care of by the service. 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.

To simplify matters, we define serviceflow in terms of service points. A service always creates some social situation, it needs "places" (Harrison and Dourish, 1996) which frame the situation where service tasks are carried out. These places we call service points, and the successive interrelation of a number of service points is a serviceflow. Based on object oriented, workflow and user oriented modeling techniques, we model serviceflow patterns by identifying sequences of service points, each capturing the specific service tasks and their respective pre- and postconditions from the provider's point of view. The pre- and postconditions represent the contract for interrelating the service points. Service tasks are modeled as UML use cases, with each use case being further linked to a rich description (a scenarios and use case picture). Cooperation pictures can augment the serviceflow representation to further illustrate cooperation among the involved actors. In contrast to workflow approaches, serviceflow modeling implies that each work-place is a place of service (i.e. a service point), flowing data represent customer relations (not the products to work on), all process models are resources for personalization, and process governance is decentralized (no central flow engine).

The clinical insights presented here are based on an inquiry into a health provider network in northern Germany. The research followed the methodology for systems development as elaborated and applied in a number of projects before (Heybrock *et al.*, 1997; Krabbel and Wetzel, 1998, 2000; Wetzel *et al.*, 1998; Wetzel, 2001). The aims are:

(1) to improve the communication processes and consensus among the providers involved;

(2) to nurture the communication between network providers and IT system designers; and
(3) to provide a Web space linking analysis and design documents to support the above.

From October 2000 until February 2001 the following activities were carried out:

- Interviews had been conducted with professionals for admission, medical documentation, IT management in a clinic specialized in bone surgery and endoprothetic, and a family doctor and a specialist both with working relations with the clinic.
- Based on the interviews, a series of scenarios were written for each of the functional roles related to the professionals interviewed. Those scenarios identified the main tasks of the functional role and described each of the tasks by using plain text. Specific terms (utilized within the domain or the organization) were defined within a glossary and linked its usage in the scenarios.
- In a next step, the cooperation models were elaborated to structure and visualize the cooperation between the functional roles as well as the patient involvement while carrying out the tasks identified. The serviceflow model (as described above) focused on the process, i.e. the service points involved and their interrelations. Additionally, cooperation pictures were modeled in order to capture details of cooperation between the providers such as the frequent usage of the telephone and the exchange of documents and other materials. This comprehensive picture of the existing cooperation was then discussed again with the professionals interviewed. The revised version is the starting point for design.
- The (re-)design of the serviceflow within the network may include the redesign of service points (e.g. a service point may become Internet-mediated, tasks may be shifted from one service point to another) along with the improvement of the underlying cooperation which may call for (additional) IT support. In this case suggested changes were captured in a second set of cooperation models and some future scenarios.
- All models and related design documents were linked and uploaded for Web access. This Web space along, with some interface prototypes, served to inform provider representatives and/or decision-makers of the network and to demonstrate the potentials of future systems support use. The Web space has been used individually as well as for meeting presentations. As in other settings before, the contrast of different models helped everybody involved to comprehend what is at stake in the network development and to discuss the specific requirements for IT support.

All in all, the serviceflow modeling (including use cases, use case pictures, cooperation pictures and scenarios) has served the analysis of the clinical context as well as the development of IT support from different perspectives. And the comprehensive Web-space has provided a means for sharing perspectives, improving participation and decision making for all actors involved.

Cross-organizational health care service processes

Apart from cost reduction, the nature of health service itself gives grounds for networking. In the case of a more severe disease, a close cooperation among specialized health care providers is required in order to enable a comprehensive diagnostic, curative and care process.

The case: preparation, performance and aftercare of an inpatient surgical operation

Based on our analysis in cooperation with a German clinic specialized in bone surgery and endoprothetic, the presented scenario describes a standard procedure for hip replacements. In this process, the patient usually moves back and forth between different physicians/specialists and a clinic to receive an in-depth diagnosis as well as appropriate medical care and treatment. A patient typically starts with consulting a family doctor, is directed to a specialist, chooses a hospital, goes through consultation and registration at the hospital with a schedule for further preparation, passes through all preparations, stays in the hospital where the operation is performed, followed by aftercare treatment at specialists, (see Figure 1). In the course of this process, various documents have to be exchanged, some of which are delivered by the patient while others are sent by mail or fax.

Problems and different perspectives

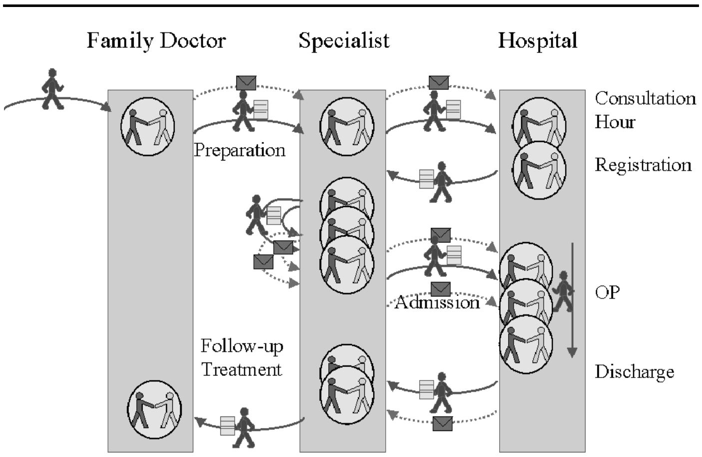
The performance of this sample process is affected by a number of problems inherent in the nature of health care services in general:

- *Process responsibility*. There is no overall responsibility for the process or its planning. Rather, the process seems to rely on the ability of individual providers to shape the service according to their special insights about the patient's case, including the calling in of additional providers.
- *Monitoring process status*. Involved providers fall short of a complete picture of the process, its current status and development. Often, they lack information about deviations from tacitly assumed ways to proceed, or are unable to retrace this knowledge.
- *Timely exchange of documents*. A further problem relates to the exchange of documents. Today, there are no clear rules. It is neither obvious in which way documents are to be delivered nor is it fixed which kind of documents should be exchanged at all.

Apart from these problems inherent to the process, a further set of obstructions is caused by the patient's multiple crossing of two different "realms" of funding (different procedures for reimbursing physicians and hospitals). While trying to enforce more efficient cooperation among the "separated" providers, the new reimbursement laws seem to fall short of providing the necessary incentive for the resulting increasing coordination. Considering the different perspectives of the two provider groups makes this clear.

- *Specialist's perspective*. Without any kind of extra reimbursement, the specialist might be unwilling/uninterested to spend time on improving the hospital's knowledge about the patient's overall condition more than absolutely necessary. On the other hand, the specialist is eager for information about the patient's treatment in the hospital or at least at the time of discharge so that he/she is able to attend the patient in a circumspect and professional manner.
- *Hospital's perspective*. According to the new reimbursement laws, where the patient's overall condition affects payment (e.g. a hip replacement for a patient with a heart condition will be more expensive than for an otherwise healthy patient), the hospital needs to receive this basic, and from a medical perspective desirable, information. Furthermore, the capacity utilization of the operating theatre forms a critical profit factor. For this reason, the hospital is highly interested in the patient's status of preparation prior to admission. If a lack of preparation is discovered only then, the probability of the operating theatre staying idle the next day is high.

Figure 1 Service example: preparation, performance and aftercare of an operation



General requirements for service delivery in health care provider networks

The case presented here, just like many other cases, calls for a better support of cross-organizational health care service processes. However, the requirements for support are far from trivial. The actors involved must define and agree details of routine procedures (goals and steps of cooperative processes, responsibility and division of labor, exchange of relevant information, etc.) prior to setting up organizational and technical systems. At the same time, flexibility is required in order to enable individual treatments which may differ significantly from the predefined process patterns and clinical practice guidelines. In addition, different kinds of

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overviews (over the process status of one patient, of all patients of a certain provider in a certain status, etc.) have to be provided.

Up to now, the ambitions to support cross-organizational service processes are only poorly supported by standards in the health care sector (e.g. for exchanging information and interfacing IT systems), and many of the actors involved only reluctantly adopt new technologies. Hence, technical solutions for cross-organizational support must be simple in terms of usability as well as installation and maintenance (at providers' sites). Nonetheless, all providers and their patients expect availability, reliability and security of the technical support to be ensured.

Networking health care providers

This approach to serviceflow management does not presuppose any kind of IT infrastructure except the processing and exchange of XML documents. Thus, any provider can easily join the cooperative serviceflow management and may independently care for its own IT support as long as it keeps up with the mutual agreement. However, we are interested in a generic layered architecture supporting service points at providers' sites, which will be introduced below. On this basis, we discuss contrary aspects underlying possible technical network infrastructures for health providers and, finally, present a prototype to support our case example.

XML-based serviceflow management

With SFM we had introduced a general concept which was developed for supporting interrelated, personalized and situated services carried out across different organizational units or provider firms. In prinicple, SFM enables any process to continue individually according to the accumulated postconditions as well as the requested preconditions and situated process planning at each service point. Thus, each service provider must decide to what extent the respective work organization and IT support will allow for variations of or deviations from the predefined standard processes.

Focussing on service providers, the challenge is to look for recurrent serviceflow patterns. For defining these patterns, both the sequence of service points and the service at each service point have to be modeled. The sequence of service points for our example is shown in Figure 2.

Serviceflow management is now centered around the technical representations of the modeled process pattern (cf. Züllighoven *et al.*, 1999) that lead to the notion of service float and service point script. Service floats are sent from service point to service point and capture personalized, always up-to-date process knowledge, whereas service point scripts direct the standard activities at each service point (see Figure 3). This approach bears the following obligations and potentials:

- initializing a service float by copying (and possibly adapting) a standard serviceflow pattern guides each provider as to how to deliver the service;
- enabling providers to access and update the process representations (as a material) allows for flexibility and instant realization of changes;
- documenting the history enables a service provider to be informed about deviations from the standard and their reasons; and
- constant update of the current and next service points forms a basis for automating the delivery of service floats to the next provider.

All in all, SFM requires agreements on the content of the modeled serviceflow pattern and on the handling of these representations during exchange.

In order to exchange service floats between provider organizations, we represent them technically as XML documents. As the use of XML is just spreading and only a few domain specific solutions are available as yet (Lenz and Oberweis, 2001), we had to develop our own framework for an XML-based process representation for serviceflow management.

The framework requires network members to agree upon a set of XML DTD or schema for service floats and service point scripts and other shared data structures (e.g. forms, patient data, patient record), XML "master"-documents for service floats and service point scripts according to different serviceflow types, and a set of rules on how to manipulate and share those XML documents.

In detail, a service float's XML representation contains the following elements: an identifier for individual serviceflow, basic information on the

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Figure 2 Model of the case serviceflow

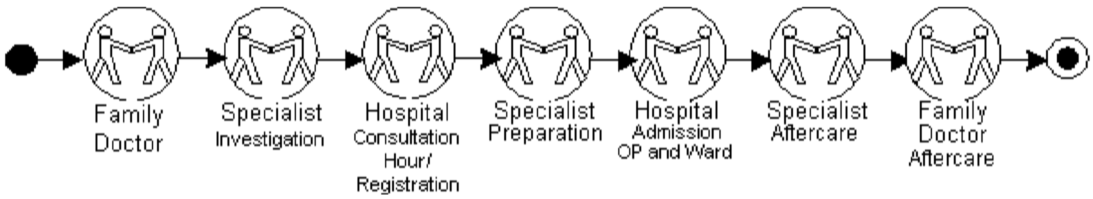
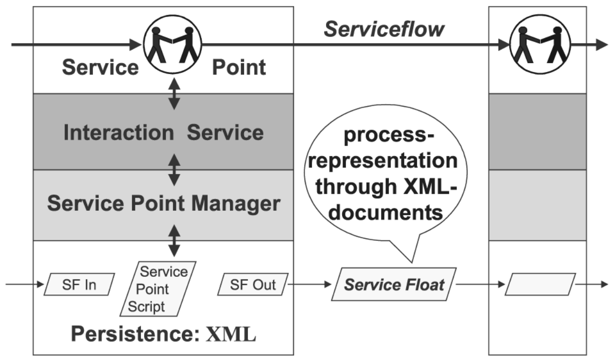


Figure 3 Service floats and service point scripts to represent the process activities



serviceflow client, the current service point (service points are described by identifier, name, type, provider, address), a list of scheduled service points, a list of service points passed, a list of accumulated postconditions, a list of documents, i.e. short message texts or references to full documents or document folders. At each service point, the service float is evaluated according to the respective service point script that prescribes the activities at the "current service point": an identifier for the individual service point, basic information on the service point provider, current activity (activities are described by identifier, name, type, task), a list of scheduled activities, a list of passed activities, a list of preconditions for the set of activities at this service point and a list of documents.

Service point architecture

There is no need to subscribe to a specific IT architecture to implement XML document handling at specific service points. However, we recommend a client-server architecture with three server layers:

- frontend - client to present the user interface;
- interaction - server layer to organize the user dialogue;
- serviceflow application - server layer to realize the XML document processing for process representation; and
- persistence - the server's file system or database for saving and retrieving XML documents.

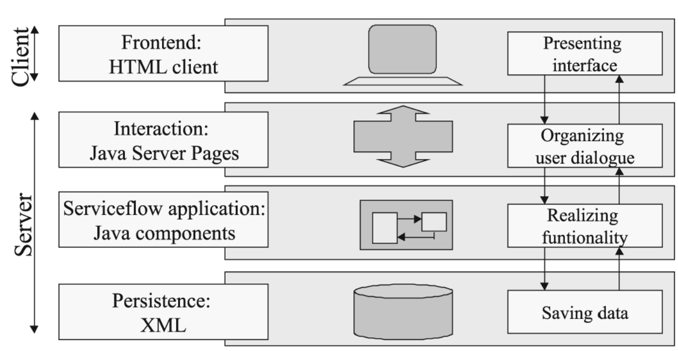
The IT architecture for a Web-based service point as applied in our e-health prototype is shown in Figure 4. The user dialogue is organized on the basis of Java server pages. Alternatively, a set of templates created in a Web content management system could be used. The user dialogue implementation includes Java method calls addressing the public interface of the serviceflow application layer implemented in Java.

The components of the serviceflow application layer encapsulate the processing of the XML documents related to serviceflow management:

- the service point manager includes methods for retrieving the relevant XML files, creating document object models (DOM) of service float and service point script for a specific customer, saving the manipulated DOMs in XML files and preparing the service float for dispatch;
- service float and service point script both include a variety of get- and set-methods (according to the usage of serviceflow process representation) to be called on through the public interface for manipulating the respective XML DOM.

The described architecture is used in the prototypical implementation for e-health

Figure 4 IT architecture for a Web-based service point



services presented in the next section. The same architecture has been applied in a project to enable an e-Government process portal, where the first service to be offered was the postal vote application in the city state of Hamburg through www.hamburg.de (Klischewski and Wetzel, 2001).

Information flow vs. information system

Returning to the general requirements for health service discussed above, we note two contrary aspects in regard to suitable infrastructures in this domain. Interrelated services are delivered by sending the patient from one service point to the other. At each service point specific tasks are performed and documents exchanged. Flexibility can be achieved through the exchange of updated process knowledge along the service chain. Thus, the information flow seems to accompany the patient's move through the service provider network. However, depending on the kind of examination performed, service work might last longer than the patient's presence at a service point. Accordingly, providers have to be able to add documents to a patient's case although the service float has already left the service point. Furthermore, as patients often revisit the same provider during a serviceflow (though at different service points) providers try to be kept informed about the patient's course at other sites throughout the whole serviceflow period.

It seems that the nature of interrelated health services requires a balanced solution somewhere in between an information flow and information systems approach. Whereas the information flow approach emphasizes flexibility and autonomy without assuming any central technical infrastructure, the information systems approach highlights provision of information at any time for any provider while requiring some sort of central solution. Additionally, we have to consider the existing IT infrastructure in the health sector ranging from not seldom "poorly" IT equipped physicians to large hospitals using sophisticated IT landscapes including Web servers. So far, different alternatives are on the horizon and will be discussed in the next subsection.

The prototype

For our prototype we combined both directions discussed. We assume a central server for serviceflow management, i.e. service floats and service point scripts are used according to the rules but managed centrally instead of being exchanged between providers. The huge advantage lies in the resulting low requirements on technical and software equipment: providers will need nothing more than an Internet browser which matches the requirements stated above. Nevertheless, more sophisticated scenarios are on the horizon. Structurally, the patient record has to be separated from the process knowledge. Infrastructurally, an appropriate distribution of servers across a network of commercial and health care technical providers with different responsibilities has to be worked out.

Concerning the use of the system, the Web-based user interface at a service point provides access to the underlying process information as well as to exchanged data. It has four main sections, as indicated in Figure 5. Section 1 represents the provider/network leaving space for its corporate identity. Section 2 visualizes the actual serviceflow for the patient in question. Section 3 provides the list of activities to be carried out at a chosen service point. Section 4 captures the patient record represented as a folder including forms and documents about the patient's treatment in the serviceflow. When selecting a service point rather than a patient's case, this area presents an overview over all patients served at this service point.

A typical work scenario could be as follows. A specialist starts the system and chooses the serviceflow "preparation, performance and aftercare of an inpatient surgical operation". A window then opens with the serviceflow in question and an overview over his/her patients active in the serviceflow, out of which the specialist chooses a certain patient. As soon as this happens, the patient record with details about the patient's case appears, see Figure 6. Depending on the point of service the patient is in, a task list with standard tasks at this point is provided. Clicking on tasks will open the patient's record at the right place, when tasks are accomplished they are automatically marked (or by hand). Even though possible in the underlying serviceflow representation and implementation, the interface still lacks supporting changes in the task list or in providing pre- and postconditions.

As a modification of the original SFM concept and owing to the "one server

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Figure 5 Overview over patients

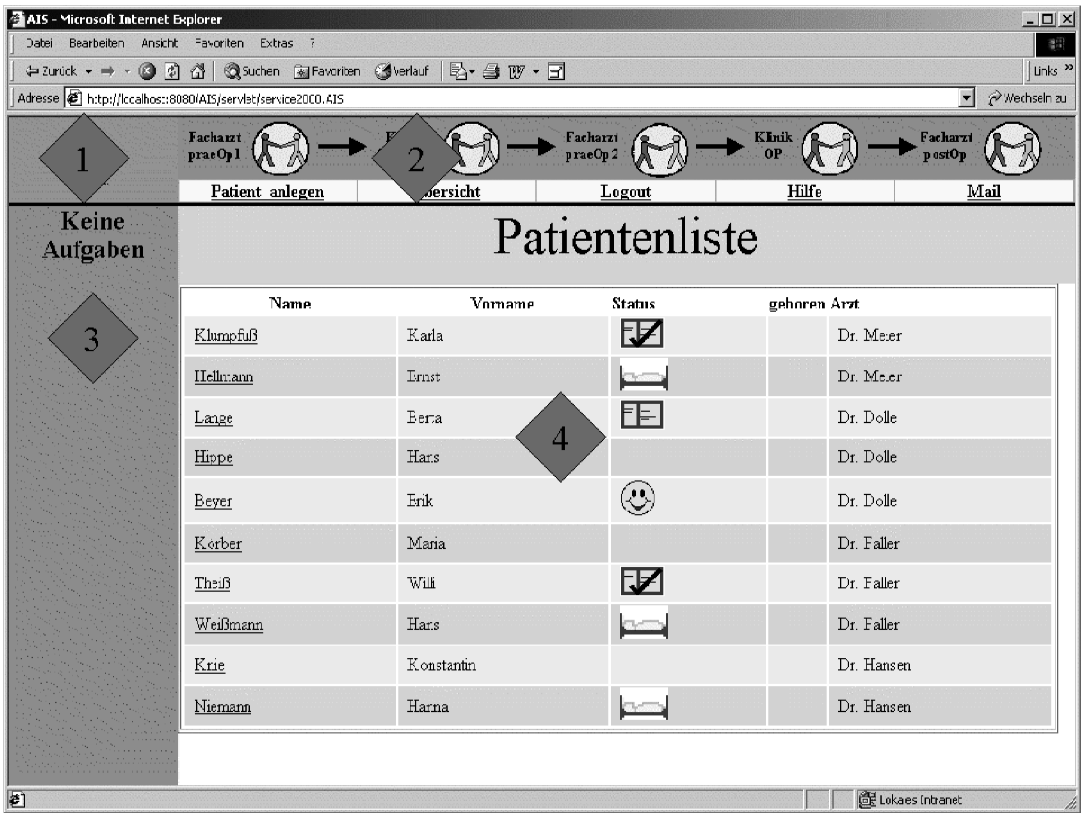
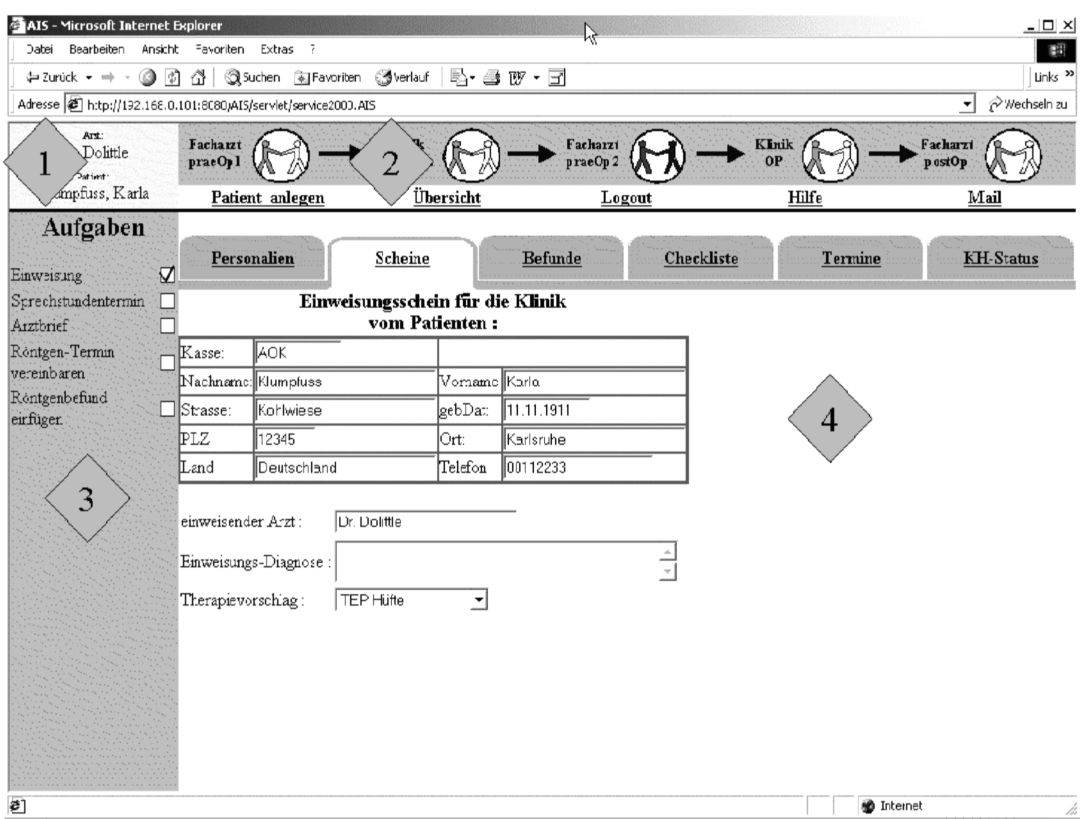


Figure 6 Support at a service point



solution", the prototype permits information retrieval at any time about the patient's actual case as well as addition of documents to the process, which requires further change indicators (awareness information) at the overview and patient record level.

Summary

Typical service processes in health care allow and force the patient to move between different specialized service providers. The patient has the chance to receive optimal comprehensive therapy and care, provided the necessary cooperation and coordination among the service providers works. With serviceflow management the paper presents an approach that claims to be suitable for supporting flexible interrelated services as required in health care. SFM is oriented around services understood as relations between provider and customer and defines interrelated services in terms of chains of service points. As pointed out, the exchange of service floats representing individualized current process knowledge enables situated changes. Furthermore, by cutting up processes into manageable parts (serviceflow and service points), the modeling features provided nurture the necessary agreement process among network partners. A realization is presented using XML representations of process knowledge based on XML DTDs for service floats and service point scripts. Additionally, domain specific XML standards for exchange of patient information can be integrated if existent.

In our case, the deployment of IT support for the provider will need perseverance. Although the results regarding the analysis and future scenario were highly appraised from all the representatives involved (especially the clinic), the realization of the proposed design ideas is still lacking. From our point of view, the main factors causing delay are: first, the hospital information systems vendors still being busy with inner-hospital solutions; second, the lack of a determined actor to strengthen the ties of the network; and third, the distrust in return of investment in cross-organizational service applications.

From the technical point of view, process networking in the health care sector needs a still more comprehensive solution than the peer-to-peer approach introduced here. There are three main aspects to be considered. First, some health care providers need to be in charge over a longer period of time than the time frame of a single service point would allow. Second, the exchanged diagnoses-related data are sophisticated and of a possible high data volume. Third, the IT infrastructure in health care is not too promising at the moment. Consequently, a combination of both an information flow and information systems approach seems appropriate. With our prototype for the considered case we provide a first solution which combines serviceflow management flexibility using XML based process representations and generic components with a one-site server solution providing access to patient records at each point in time. For the future, we expect infrastructures based on a mixture of commercial application service providers and selected health care providers for equipping health care networks with appropriate IT support.

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