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Infrastructure for an e-Government Process Portal

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In evaluating an ongoing project to realise transaction services in the city state of Hamburg (Germany), this paper identifies the essential elements of an infrastructure for an e-government process portal and discusses how the findings could be generalised. Besides pressing ahead with standardisation and out-of-the-box approaches, research can make use of actor-network theory to learn more about how technical and non-technical resources are selected, formed and used, how existing infrastructure elements prescribe the development of process portals, and how the social actors involved try to set up a new infrastructure suitable to their environment.

1. Introduction

Many authorities have started to use web sites to provide services based on transactions (e.g. tax returns). The guiding vision is often a process portal for citizens (i.e. a single entry point) that provides access to the innumerable variations of administrative processes (transactions). But connecting the portal's functionality with internal IT supported processes of the various administrative units is quite a challenge. We cannot, for example, assume an integrated technology infrastructure when the provider hosting the city's or state's web portal runs a secured IT environment that is significantly different from the main frame oriented IT landscape of the public administration.

However, as expectations towards complex online services rise, the actors involved are in desperate need of a practical basis for networking across their organisational and technical borders. Therefore, we need to find answers to the following questions

- what makes up an appropriate infrastructure for e-government process management?
- what needs to be done to set up this infrastructure?

In this paper, infrastructure is regarded as a network of technical and non-technical elements which provides a stable foundation for co-operation, including common resources and standards. In evaluating an ongoing project to realise transaction services in the city state of Hamburg (Germany), this paper identifies the essential elements of an infrastructure for an e-government process portal and discusses how the findings could be generalised.

2. Reflecting and Managing the Rise of Infrastructures

In common language, the general meaning of infrastructure refers to "the underlying foundation or basic framework" or "the resources (...) required for an activity" (Merriam-Webster 1999, 600). To make use of the term, it clearly needs a frame of reference (foundation/framework for what? what kind of activity?). As we are concerned with managing administrative processes utilising information technology and, in particular, an Internet front-end, we should focus on the IT infrastructure for Internet applications. But even in this context interpretations of the term are quite diverse, depending on the perspective applied. Research in this field points to different categories of interpretation:

- systems development: infrastructure as a platform, i.e. a product, for developing advanced web applications as sets of communicating, scalable, highly-available services. (e.g. Carey et al. 2001)
- collaborative systems: infrastructure as a relation (not a "thing"), sunk into other social arrangements, institutions, or technologies, invisible and transparent in supporting the execution of tasks (Star/Ruhleder 1996)
- corporate information: infrastructure consisting of IT components, human IT infrastructure (people, skills etc.), shared IT services, shared applications (Weill/Broadbent 1998)
- information society: the idea (as in, e.g., the Clinton administration programme for an "information highway") of infrastructure as a foundation underlying society, a stable structure, a common resource, a common standard – the idea now being challenged by the "nomadic society" with no need for infrastructure (Dahlbom 2000).

Infrastructure as a product, relation, networked components, attributes of society's foundation – none of these interpretations should be excluded when establishing an appropriate frame of reference for discussing the infrastructure for e-government process management. Reviewing the literature on electronic trading infrastructures, Damsgaard/Lyytinen (2001) point out that the technical issue of providing the means for electronic data interchange (EDI) is inherently connected to organisational, economic and political issues. Even more obviously, the same applies to corporate information infrastructures (cf. Ciborra et al. 2000).

Based on this analysis Monteiro (2000) suggest to apply actor-network theory (ANT) to untangle the involved socio-technical processes related to the development, introduction, and use of information infrastructures. In particular, ANT helps to make us sensitive to the aspects of inscription, translation and black-boxing as social action and technical agency intermingle during the growth of any infrastructure. Beyond introducing ANT to the discussion of information infrastructures, Monteiro aims his analysis at supporting the management of those infrastructures. This approach is in line with regarding systems development as networking (Klischewski 2000, 2001), where ANT assists the management of development projects by sensitising us to the need for the heterogeneous resources needed (e.g. public opinions, role assignments, management support, expertise, work effort, contracts, budgets, standards, accepted work routines, software, technical devices) which have to be co-ordinated to get a system eventually up and running.

In the following, based the on research discussion and approaches already introduced, infrastructure is regarded as a heterogeneous actor network of technical and non-technical elements, which social actors involved may/must use as resources to set up a computer-based application (here: a cross-organisational e-government process management). As ANT provides flexibility in the granularity of analysis, the issues in focus may vary between managing infrastructure as, e.g., a product, relation, networked components, attributes of society's foundation. Based on action research, we will now examine a case in order to discuss how an ANT-based approach can help actors in the e-government domain to proceed in setting up appropriate infrastructures.

3. Case: Starting Up an e-Government Process Portal

E-business "invading the public sector" (Wimmer et al. 2001) poses technical as well as organizational challenges. Governmental institutions must move on to catch up with the rise of the network society, but at the same time they cannot simply copy the concepts applied in commercial domains. From the numerous differences (see e.g. Wimmer et al. 2001) the most significant is that governments do not sell products to customers in a competitive

environment. Rather, they provide a vast variety of informational and document-oriented services where, in most cases, the client-citizen is forced (by laws and regulations) to demand a service from a monopolistic provider. Specifically, much of governmental administration consists of law-based, well-defined processes that take into account the citizens' concerns and personal situations and produce specific documents and records as well as a number of intended side effects.

In the case reported here, the city state of Hamburg (Germany) tries to meet these challenges: e-government for the citizens should be more than just providing information and contact through the web – the Internet-based supply should also include transaction services. Following the vision of a one-stop government, these transaction services should be accessible through one single entry point. This entry point was meant to be the city's web portal at www.hamburg.de, which since 1999 has been provided by the private company hamburg.de. Thus, given the outsourcing arrangement already established, process management has had to reach beyond the borders of the competent authority in charge, however without being able to draw on an existing technical and organisational infrastructure for this endeavour at that time.

Serious activities to realise the vision of a process portal for citizens started in October 2000. The management of hamburg.de welcomed a project proposal presented by the author, but stated clearly that the initiative must be taken by actors within the city's administration. Encouraged by the finance department (being in charge of the city's e-government strategy), a head of department in the "Senatsamt für Bezirksangelegenheiten" (SfB, the city's central administration for IT procedures) was appointed to engage in a pilot project, and the citizens' application for postal vote was chosen as the first service to be supported through the web portal. The first stage of the project was then carried out within a 14-week course at the Informatics department of Hamburg University, where student activities included on-site analysis (based on interviews), modelling and implementation.

By the end of January 2001, the results of the first stage, including a prototype, were presented to members of SfB, hamburg.de, and to the city's manager in charge for the city state elections in September 2001. The half-day presentation highlighted several technical and non-technical issues which became constituent for the continuation of the project: a vision for e-government service provision, service modelling, operating the serviceflow network, architectures and components for IT support. In the following, these issues and a few more, which have become relevant since, are explained as far as they have helped the progress of the project. In terms of ANT, it is intended to describe what kind of technical and non-technical elements were enrolled in the network, how the project relies on this heterogeneous network, and how certain inscriptions became stabilised through boxing.

3.1 E-Government Strategy: Applying Serviceflow Management

In order to develop and use IT support for web-enabled cross-organisational transaction services, an appropriate organisational concept and policy was needed. Drawing on workflow management, business networking and customer relation management, the author and a colleague introduced the *serviceflow management* approach (Klischewski/Wetzel 2000, 2001a, 2001b):

- From the *customer's perspective*, a serviceflow gives a customer the feeling of being embedded in a coherent "flow of service" taken care of by the service organisation(s), where the service provided "follows", "accompanies" or "precedes" the customer 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 fulfil the client's need (based on standard processes).

Serviceflow management is intended to support service providers in co-operating to provide cross-organisational services. In domains such as e-Government (or e-health, tourism, education) the challenge is to manage personalised sequences of interrelated activities/operations carried out by actors (humans and non-humans) of different organisational units which, from the clients' point of view, add up to a personalised service.

In contrast to workflow approaches, serviceflow management implies that each work-place is a place of service (service point), the data "flowing" represents customer relations (not the 'products' to work on), all process models are resources for personalisation (not means of process control), and process governance is decentralised (no central flow engine).

At the presentation of the prototype and thereafter, the actors involved so far accepted and reproduced the organisational concept and policy related to serviceflow management, namely to achieve

- accountability, i.e. transparency (from the citizens' point of view) of authorities in charge throughout the chain of activities
- flexibility to address situated/changing needs of citizens and to enhance service quality to fulfil the legally granted rights of citizens.

This concept and policy have been unchallenged since. The application of serviceflow management in this project has been boxed and moved around in papers and presentations. Being inscribed in the project as the appropriate idea for service provision, it facilitated all other activities to proceed in a certain direction, excluding other concepts from being considered (e.g. modelling the portal as self-service points with the actual operation carried out somewhere in the back office).

3.2 Service Contract: Modelling Serviceflow Schema

The application of serviceflow management implies a certain modelling approach (cf. (Klischewski/Wetzel/Bahrami 2001). Based on object-oriented, workflow and user-oriented modelling 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. Modelling serviceflow helps (1) to identify standardised portions (service points) of the overall service, (2) to allocate responsibility for the service at each point, and thus (3) supports co-operation across organisations and/or organisational units. In our case, we have identified four service points for a citizen's postal vote application with related activities/operations in parentheses (see also figure 1):

1. providing assistance with the application for citizens at the city's web portal www.hamburg.de (opening application, automatic assistance in personalisation, on-site evaluation, confirming reception, serviceflow preview, offering/registering personal reporting channel, optional: saving application)
2. inspecting the application at the SfB (automatic 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 of the application by the respective voting office (validity check with up-to-date preconditions, preparing personal postal vote ballot, notification of the electoral

register, preparing postal vote ballot for dispatch, personalised exception handling if necessary)

4. reporting on process by 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.).

Other activities/operations not focussing on or reflecting the citizen's personal/situated need are considered support processes, in this case the delivery of the postal vote ballot by regular mail.

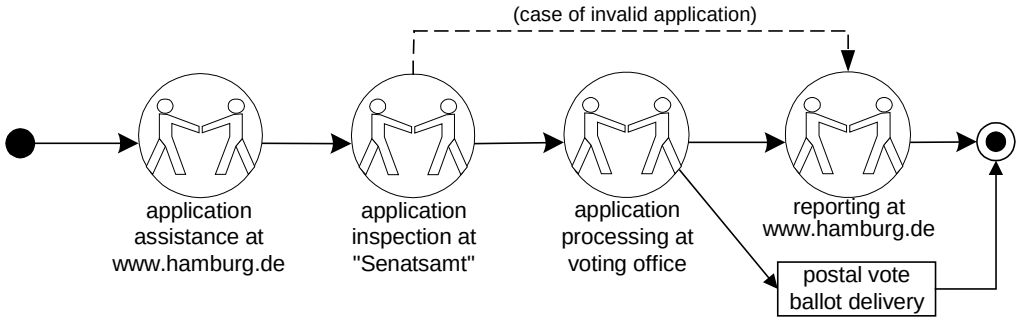

Figure 1. Serviceflow model for a postal vote application

While the process described above seems fairly 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 a citizen's

- moving to a new address before the voting office starts processing his/her application (voting offices open only a few weeks before the election date)
- having lost the postal vote ballot and needing a new one
- not needing to use postal vote after all and wanting to vote at the polling station.

However, the administration expected the majority of the personalised serviceflows to follow the designed pattern.

In our case, the above serviceflow model and the modelling approach in general is now one of the corner stones of the co-operation between the different service providers (hamburg.de, SfB, and the city's election department responsible for the temporary voting offices). All parties involved have acknowledged that the underlying modelling concept of serviceflow management applies a general perspective and that the selected process of applying for postal vote is only one first example that demonstrates the city's new capabilities and shows how to manage the organisational and technical aspects of e-government transaction services.

3.3 Operating the Serviceflow Network: Using XML

Within the project, it has been accepted (following the suggestion of the author) that IT support for serviceflow management must meet the following requirements:

- In the chain of consecutive service points there is always exactly one service point in charge after process initialisation and before process termination (except in case of concurrency).
- Each service point in charge has full control of the process (within an agreed technical and organisational frame), there is no (necessary) central instance.
- It must be possible to handle a (large) number of individual serviceflows at the same time.

– It must be possible to handle a (large) number of different kinds of serviceflows at the same time (i.e. based on different serviceflow patterns, which may change over time).
– All process information which needs to be communicated between service points must be persistent and portable.

On the way to establish appropriate IT support, questions of systems design and systems architecture had to be agreed on. Having just established the outsourcing arrangement for the portal hosting, there was no actor who was willing or able to forge an integrated system for the postal vote application service (i.e. a central database, file server, web portal, workflow engine, etc.). Thus, the cross-organisational transaction process management had to cross IT systems barriers. Those barriers included technical borders such as firewalls and incompatibilities between a web-oriented and a mainframe-oriented environment, but also non-technical barriers owing to the different locations, organisations, cultures etc. of the respective computing centres and IT departments.

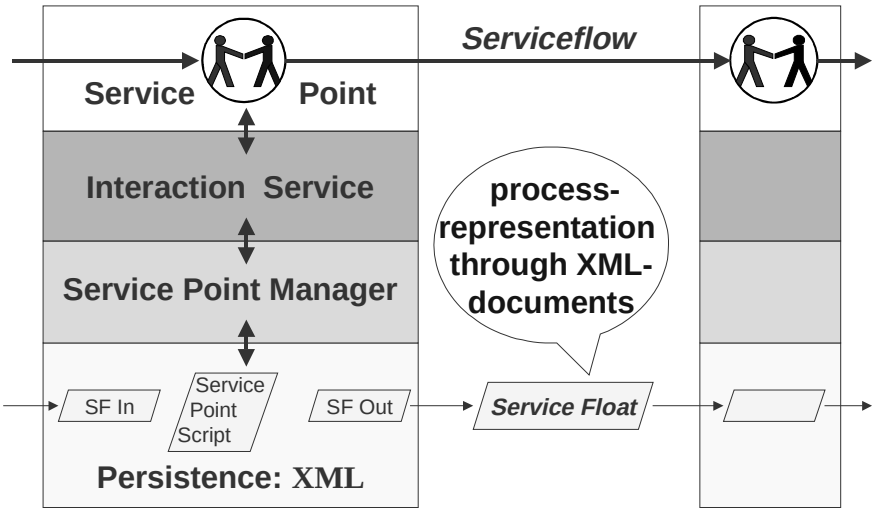

Figure 2. Context of serviceflow process representation

To realise a serviceflow management in those circumstances, it was suggested to send a *service float* from service point to service point. The service float represents the relevant process information to be processed at each service point through a service point manager component which interfaces with a component that enables human-machine interaction (see figure 2). All service floats contain the following elements (see figure 3):

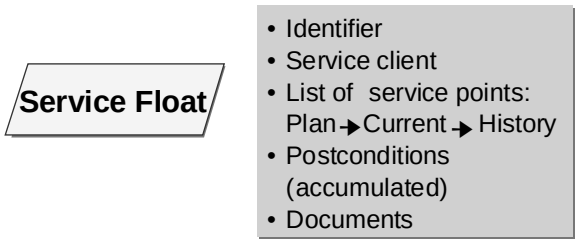

Figure 3. Structure of the XML documents representing servicefloats

- an identifier for individual serviceflow (based on serviceflow type/variation)
- basic information on the serviceflow client (with possible reference to comprehensive client data)

- the current service point (service points are described by identifier, name, type, provider, address)
- lists of scheduled and passed service points
- a list of accumulated postconditions
- a list of documents, i.e. short message texts or references to full documents or document folders

When starting a personalised serviceflow, a service float will be created by personalising a copy of the respective service float "master" (which represents the standard process for the type or variant of serviceflow in question) including the schedule of service points for this process. At each service point, the service float is evaluated and the activities for the individual client will be started off according to the activities modelled for this particular service point (in addition, a service point script master may be used to support service point activities). To enable flexibility at this point, it is allowed to carry out activities according to the situated needs of the client (possibly different from those prescribed in modelling) as well as change the serviceflow schedule by adding, deleting or changing the order of future service points. After all service point activities have been carried out, the service float will be updated and sent to the next scheduled service point. To enable smooth co-operation, the following rules for dynamic service float handling have been introduced:

1. Activities/operations are carried out according to the negotiated serviceflow model and/or as specified in the service point script.
2. The 'current service point' is transferred into the list of passed service points while at the same time the list of accumulated postconditions is supplemented with the postconditions achieved at this service point
3. The first from the list of scheduled service points is extracted to replace the current service point.
4. The address of the new current service point is evaluated and the service float is dispatched to this address

In our case, the actors involved have accepted these rules and started to implement relevant IT support (i.e. mainly to automate the processing of the XML documents as specified above). All together, to enable a cross-organisational e-government serviceflow management, the organisations involved had to agree on the following prior to IT implementation:

– a set of serviceflow models as a basis for co-operative process management
– a set of XML DTD and XML "master"-documents
– a set of rules on how to manipulate and share the XML documents (see above).

All three of these issues have been documented and shared between the project partners.

3.4 Implementation of IT Support: Architectures and Components

In the case described, IT expertise was necessary to select, develop and/or supplement new or existing IT components. The author (on behalf of HITeC, Hamburg University's technology transfer organisation for information technology) assisted the service providers involved to set up the appropriate IT solutions for the respective service points. Based on the prototype presented, it was recommended to follow a four-layer client-server architecture:

1. Front-end: client to present the user interface
2. Interaction: server layer to organise the user dialogue
3. Serviceflow application: server layer to realise the XML document processing for process representation

4. Persistence: the server's file system or data base for saving and retrieving XML documents

The IT architecture for a web-based service point as suggested for the postal vote 'application assistance' is shown in figure 4. The user dialogue is organised by a set of templates created in the web content management system (WCMS). These templates include Java method calls addressing the public interface of the serviceflow application layer implemented in Java.

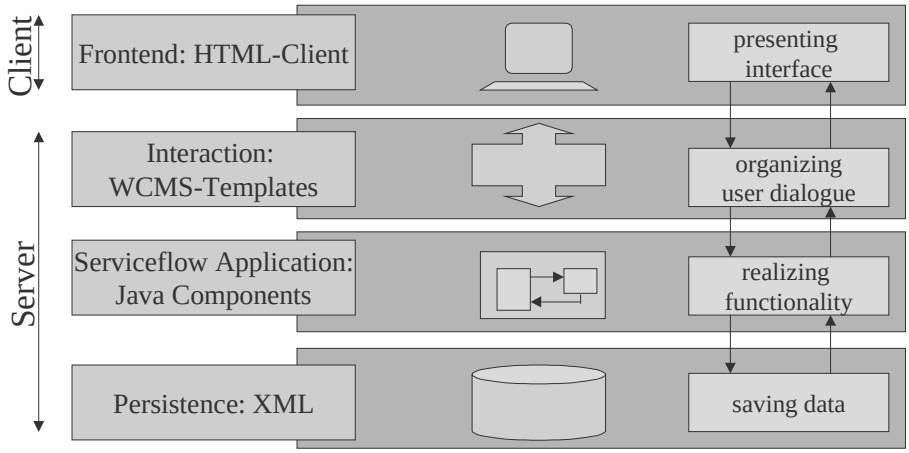

Figure 4. IT architecture for a web-based service point

After the presentation of the prototype, both hamburg.de and the SfB were convinced that providing an appropriate IT support for the e-government service at stake would be a task that can be achieved with available resources (personnel, finance, existing IT). Both partners have seriously considered using the Java components as included in the prototype. Both of them, however, each for different reasons, finally decided to implement a different solution (see figure 5):

1. hamburg.de: at the time of implementing the IT support for serviceflow management, the portal provider considered changing major elements of the technical infrastructure (in particular, the web content management and delivery system). Unsure about the future pay-off of programming investments, the existing XML functionality of the WCMS was used for processing the service floats. This solution required the least effort, but it has only little potential for re-use in other e-government services.
2. SfB/voting offices: For a number of years, the voting offices have relied on a mainframe solution, developed and supported by SfB, for automatic inspection and interactive processing of postal vote applications. This is hosted within the city's central computing center ("Landesamt für Informationstechnik", LIT). As the IT experts involved had no experience with the development and support of systems based on Java, so they chose Visual Basic to implement components with the same functionality for processing XML service floats (as far as needed for the postal vote application). Those components also provide an interface to the existing mainframe solution.

The case reveals that, although a common approach to systems architecture has been accepted and the availability of an IT component for general use significantly paved the way for the project, the IT components actually developed and used to process the XML service floats have not been moved around and used by other service providers. Thus, in contrast with the other elements of the project, they were never used as a common resource.

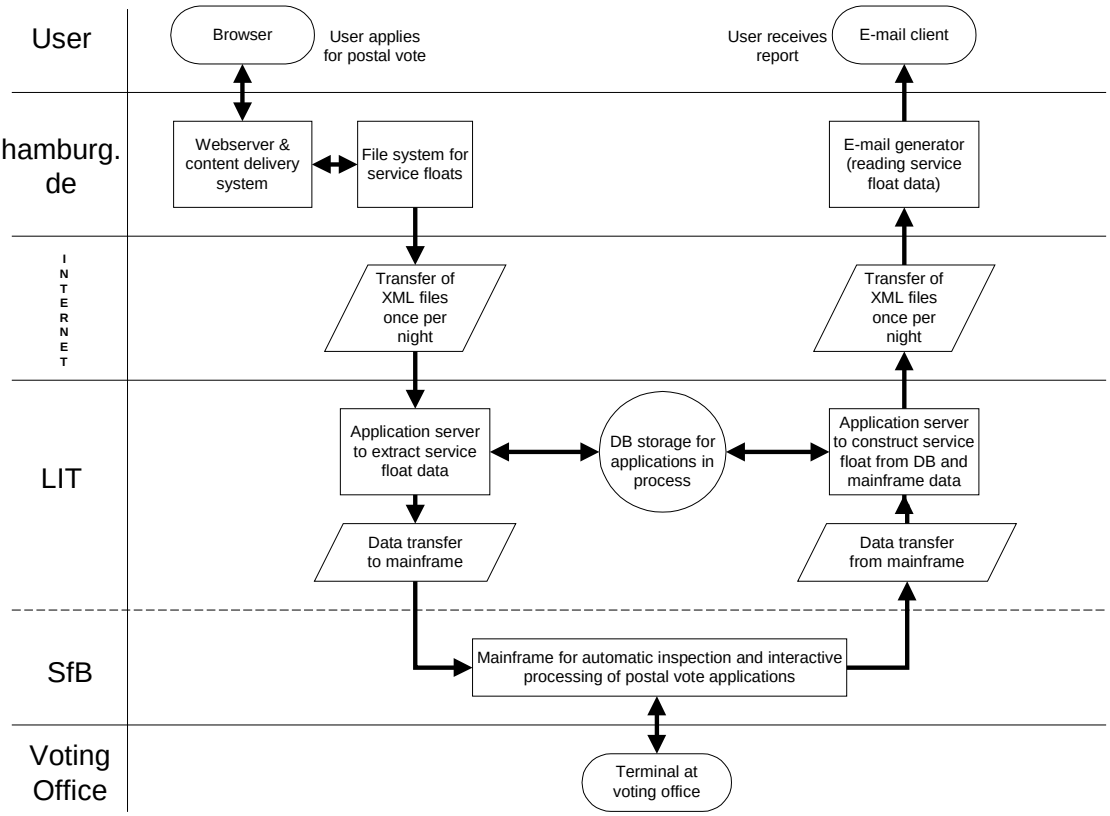

Figure 5. Interrelation of IT components involved in processing a postal vote application via www.hamburg.de (simplified chart)

3.5 Electronic Data Interchange: Connectivity, Security, Privacy

As the actors proceeded with implementation during the spring of 2001, the requirements for exchanging the XML files became more obvious: ports, file systems, schedules, protocols, encryption etc. All these needed to be negotiated in terms of standards and service levels to be applied. These negotiations also involved the LIT, which handles all in- and outgoing data transfer for the city's administrative units. The discussion of technical measures to be taken was closely related, on the one hand, to the existing corporate IT infrastructures of the actors involved and, on the other hand, to the state of the art of IT and telecommunication, the standards established, and IT components available on the market. Considering the complexity of the issues and the capabilities on the side of each actor, it was decided to start with exchanging XML files only once a night, leading to a response time of two days for the whole service.

A second line of negotiation among the project partners was opened to discuss and eventually cope with privacy problems related to the application of the new service. Negotiations, which also involved the city's data protection commissioner, resulted in a document describing the complete IT architecture, the risks, and the counter measures taken. The effort of scrutinising data protection issues was motivated by a number of political factors related to the public discussion on privacy and on the "right" way to grow into an information society. As future e-government projects within the city of Hamburg will draw on the postal vote application project, all actors involved were interested to set a standard, i.e. to solve privacy issues to a degree acceptable for the projects to follow.

3.6 Service Development and Resource Management

The postal vote application service was developed to support the city state government election in September 2001. From the beginning, it was intended to reuse the service for future elections as well as for other kinds of services that provides legal documents on the application by citizens. In the summer of 2001, when all partners involved prepared for the launch of the city's first e-government transaction service, they also started to reflect about the next e-government services to be developed and introduced. Looking ahead, they realised that they must co-operatively cope with overarching issues such as at least

- agreement on service quality (e.g. improvement of overall response time, failure management)
- creation, distribution and update of serviceflow models and XML documents
- providing efficient and cost-effective IT support for those service providers without IT competence
- updating privacy and security issues.

Given the successful launch and use of the postal vote application service, the established teamwork will continue to pave the ground for a multitude of future e-government services in the municipality of Hamburg. Also, negotiations have started with other administrative bodies in Northern Germany who consider adopting this new approach. Thus the question has become relevant which of the technical and non-technical elements are essential resources and/or may be transferred to another application context to set up a process portal for another municipality.

4. Do You Really Want an Infrastructure 'Out of the Box'?

The main objective of this paper is to provide a case study which actors in the e-government domain (including researchers) can use to improve their abilities of reflecting on and contributing to the challenges at hand. To start with, we had set the focus on developing transaction services by asking

- what makes up an appropriate infrastructure for e-government process management?
- what needs to be done to set up this infrastructure?

Considering the data included here (study of only one case, with the author's view of the project remaining unchallenged), none can expect comprehensive answers. However, looking at the case as a source for empirical research, we have a basis to consider *what kind of answers* we want to provide. For example, answers could hint at an infrastructure for e-government process portals 'out of the box' such as "these are the resources you need, this is how you get them, and that is the way to apply..." Those who are in charge of managing projects would certainly love to hear it. But any out-of-the-box solution for a new cross-organisational infrastructure can only be successful when related to the specific environment and already existing corporate infrastructures. Perhaps research should rather concentrate on how to deal with "legacy" infrastructures in order to bring out something new?

Let's consider what we have achieved here. To start with, the notion of infrastructure was introduced as a heterogeneous actor network of technical and non-technical elements which social actors involved may/must use as resources to set up a computer-based application. Trying to generalise from the case, we have now been able to identify the following elements which make up one possible infrastructure to run an e-government process portal:

- Strategy for service provision: The serviceflow management approach as introduced above does not presuppose any kind of shared IT infrastructure except the processing and exchange of XML documents (thus, any kind of organisation - public or private - can easily join the co-operative serviceflow management). Drawing on this approach, the actors involved may independently look after their own IT support as long as they keep to the mutual agreement boxed in the other elements.
- Service provider contract: To arrange for co-operation on the operational level, service-flow schemes are resources for identifying standardised portions of the overall service, for organising the division of labour and for allocating responsibility for the stages of the cross-organisational service provision.
- Service arrangement: XML documents based on the serviceflow schemes are resources for personalisation in arranging, carrying out, and documenting individual serviceflows, thus improving the quality of service for citizens.
- Systems integration: In the e-government domain we cannot presuppose an integrated IT infrastructure for cross-organisational applications. Technical integration is achieved by exchanging XML documents based on the serviceflow schemes and by an agreement on how to process these XML documents.
- Solutions for IT support: The IT architecture and components are resources available for general use to support serviceflow management. It is up to each service provider to what extent those resources will be used.
- Technical network standards: Existing standards and technologies for electronic data interchange are essential for the e-government domain. Concrete solutions for new cross-organisational infrastructures are highly dependent on existing corporate IT infrastructures and routine procedures, being restricted by high demands on security and reliability.
- Legal issues: Organisational regulations and respective technical solutions are needed as resources to resolve, e.g., potential data protection problems. Available standards in this area decrease development expenses but may not be applicable as the legal conditions differ between municipalities.
- Process portal management: The actors involved need to establish an agreement as a basis for iterative service development and continuous management of providing and relating those resources as described above.

One way to deal with all this is to classify the resources – for example in terms of technical/non-technical, specific/non-specific to e-government, applies to all services/ applies to specific services, outsourcing possible/not possible, etc. – to look for possible standardisation of resources (within each category) and their relation (dependency) to other elements (of other categories). These would be steps towards providing a framework for out-of-the-box approaches to setting up a process portal.

Another way is to stick with ANT as a research method and learn more about enrolling, relating, transforming the resources acting within the infrastructure to make e-government process portals possible. Studying cases based on this research approach could reveal how resources are selected, formed and used, how existing infrastructure elements prescribe the development of process portals, and how the social actors involved try to set up a new infrastructure suitable to their environment. For practical purposes, those case studies need to be prepared so that practitioners are stimulated to reflect their own activities and environment.

Since research on e-government infrastructures is still at the beginning, this paper could only provide preliminary results and discuss future directions. For each project, there are choices to be made about the research method, the perspective on infrastructure, and the kind of

results to strive for. We need to make those choices in each case, but at this point we should not exclude any of the paths to explore e-government infrastructures.

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