Engineering E-Government Platforms and G2G Solutions

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Abstract : We first identify the overall goals for future e-government in order to derive the engineering goals for future IT solutions. This is done with reference to classical production theories. Then we analyse in some detail the nature of the particular challenges and risks, which one has to deal with in developing IT solutions for international e-government. Finally we depict the design principles for such solutions as we provide recommendations how to organise the R&D process.

1 Introduction :

This paper is based on our research in two EU IST projects (FASME 2000 – 2001 and eMayor 2004 – 2006) and our R&D-cooperation with SAKD Germany within an GAI project, plus on further research with highly complex real-world scenarios. The question, which we are trying to answer, is: "How can we successfully deal with the problem, that for a typical cross-border G2C and G2G solutions, we have to deal with heterogeneity an all levels: ontologies, laws, processes, administrative cultures, citzens' expectations, and technology?" How can we achieve interoperability on all levels at the same time?"

The answer requires an understanding of challenges, requirements, and the basic, overall structure of a holistic IT solution for cross-organizational e-government. Once this has been achieved, we can draw up a concept for the engineering process, which tries to minimize risks for the cardinal aims of development projects for cross-organizational, even cross-border, e-government solutions. The complexity of the problem has been examplified in [Oostveen 2001]. Some basic principles how to achieve a solution have been depicted in [Riedl 2001]. Unforthunately, the deliverables of the eMayor project have not yet published for the public, and the concepts of the « Integrierte Vorgangsbearbeitung » developed at SAKD Germany are not publicly available.

2 R&D

One of main goals for contemporary R&D on e-government is to achieve an architectural understanding, how the traditional organisational constraints to the optimisation of "production" in public administration can be removed – or rather dissolved – with the help of IT. Thereby, production is understood to comprise all productive activities, in particular all services to the citizens and the enterprises as well as the procurement of information to political decision-making processes. IT enables to remove geographical and time constraints for information access and information validation, and thus it paves the way for an optimisation of production in the public sector.

2.1 Vision of the Future

We envision a future public administration, in which the best qualified experts and organisations may provide a service. Thereby, we assume that the quality will be defined in terms of both fundamental and pragmatic yardsticks, ranging from ethics over legal principles to management heuristics, the eventual selection of the "best" always following bounded rationality. The major part of the existing constraints for the allocation of service execution tasks will cease to exist, when the relevant data and data processing functions are transparently accessible for everyone, as long as her role entitles her to access them. This will not eliminate the difficulties in selecting the right person or organisation for a particular role or task, but it may dispunge many geographical constraints and constraints from organisational history. For example, on the one hand the local assignment of tasks will only be preferential or mandatory, when the knowledge of local affairs and characters is important to guarantee the quality of decisions to be taken, while on the other hand, the cooperation across distances and an unrestricted access to central information makes it possible to assign more decision competence to local agencies. In addition, monitoring capabilities will introduce an easily controllable transparency, which may help to evaluate and improve the quality of public administration (although it may also be misused to replace a common sense judgement of the quality of work by a number-centric judgement.) At the far out cutting edge of this development, most services can be outsourced either to the citizen herself or to an NGO representing a community of knowledge workers, while the knowledge about what is happening in the public sector will be transparently available for democratic decision-making.

2.2 Current State of Affairs and Future Change

Until now, a strong and defensive organisational structure with a complex assignment of tasks and insurmountable boundaries between organisational units hinders such an unconstrained assignment of roles and tasks. The term "silo structure" is often used in order to describe the resulting problems for administrative processes involving more than one government agency. However, similar problems may already exists within one and the same government unit leading to high response times for the citizen, high costs for the administration, and weak exploitation of information hidden in the system for the political decision making.

A redesign of the public sector from a purely organisational perspective might address all these problems, but it bears poor prospects. Since a major part of the organisational boundaries is rooted in the difficulties of earlier centuries to access or validate information, the key to a successful redesign of public administration is the development of an IT architecture, which enables us to eliminate the physical data and communication access problems. Such an IT architecture creates new affordances for civil servants as well as an incredible potential for cost-savings. It sets free a lot of resources and obliterates the pressure on the public sector, and thus, it could be the motor for change.

2.3 R&D-Goals

In order to nurture change, R&D on e-government should provide three types of results

- Architectural blueprints for sustainable government application integration (GAI) and government-to-government (G2G) cooperation
- Architectural blueprints for global digital identity, i.e. for an identity management by the individual interacting with a heterogeneous world and for an identity management by government agencies which accommodates controlling and security tasks with privacy protection
- Engineering processes and methods to build GAI, G2G, and globally usable identity management solutions

Indeed IT architectures are at the heart of future solutions for a redesign of public administration as they describe functional and non-functional properties of the information processing, but they have to embedded in a multi-disciplinary context of usage requirements and constraints. This is of particular importance as well as highly challenging as long as an international homogenisation of public administrations is politically not feasible

While holistic GAI and G2G architectures are needed for the pursuit of optimisation goals, architectures for digital identity management are needed in order to guarantee the scalability of solutions, which requires the decoupling of identity handling and service execution. Furthermore, due to the multi-disciplinary nature of the design tasks, which have to fulfil multi-disciplinary requirements, traditional engineering approaches are likely to fail, as a common language for the cooperation across disciplinary boundaries is missing. Therefore, we need a blueprint for a trans-disciplinary engineering process, too, consisting of a process structure and quality achievement and control methods.

Apart from the partially monolithic nature of legacy systems, and apart from the scattered distribution of data throughout the system, the key challenges for all the architectural blueprints stem from the high heterogeneity of all architectural ingredients, as well as from the unforeseeable change of the architectural context. One primary goal of GAI and G2G solutions is to automatically provide administrative transactions with the data they need – that is also with the quality needed – in such a way that the privacy of citizens is not illegally violated. The first requires a transfer of information across physical, logical, and organisational boundaries, while the latter implies that the citizen is able to control all that transfer of her personal data between different administrative contexts, which is another reason why identity management independent of service architectures is critical. IT architects designing blueprints for both have to be aware that both cultural, social, and political environments as well as the laws change – the latter including data protection laws in general and interpretations of what an administrative context is in particular. A sustainable IT architecture has to be adaptable to these changes, which may lead to more or less challenging functional requirements and more or less stringent constraints on the actual, digital data provisioning. These changes both cannot be foreseen and have to be anticipated in the architectural design.

Note that all those benefits usually mentioned upon a discussion of the potential future benefits of e-government – such as process optimisation, or improved output controlling – will nearly straightforwardly result from an effective and efficient, lawful provisioning of data – or rather trustworthy meaningful information – to the administrative transaction processing as depicted above. Therefore, it is recommendable to restrict the research goals to that provisioning and to omit anything more ambitious. The resulting problems are complex enough and should not be overloaded with further complexity.

We would like to mention that other primary, but less important, goals for GAI and G2G are

- Support for the direct G2G communication via the Internet – either agent to agent or within groups of decision makers, and either synchronously or asynchronously
- Sharing of functionality among different agencies, both governmental and business, in order to reduce the overall costs arising in the public sector

The first should be well integrated with solutions for information provisioning, but causes security and interoperability challenges of its own, as existing communication protocols are technically not interoperable, while human communication structures are organisationally and

culturally not interoperable. We shall not discuss them here. The second is a classical EAI goal, with some possible subtleties, which shall not be discussed here either.

3 Challenges

3.1 Optimisation

There are three classical production theories: transformation theory, flow theory, and customer value theory, each of which implies characteristic optimisation concepts ([Koskela 2000], chapters 3 – 5). As e-government promises the delivery of one-stop-services to the citizens, it focuses on the third theory, while GAI and G2G focus on the second, namely the elimination of redundant data acquisition and data storage. Unfortunately, constraints arising from data protection and public law as well as the heterogeneity of ontologies, processes, and services in different public administrations severely limit the potential for an elimination of redundancy. Within a particular national government domain, we may apply techniques from EAI, subject to the named restrictions, part of which should be negotiable as they stem from abstract legal definitions, which were formulated without the knowledge of IT capabilities. However, beyond national boundaries simple EAI techniques are obviously impossible: We rather need B2B-like integration techniques there.

The main goal of IT optimisation is to create an IT infrastructure, which is centred upon the optimal support for execution of administrative transactions, and which creates logically equivalent support for any transaction throughout the system. In other words, we want to build a *pseudo-homogeneous government infrastructure* for the execution of administrative transactions on top of a highly and multiply heterogeneous legacy infrastructure. The infrastructure has to provide – either a priori or on the fly upon availability – the necessary validated information to actual execution process, and it has to provide – a posteriori, possibly earlier than the total completion of the transaction – documentation functionality including a routing of the documentation to its destination. Furthermore, in some cases it has to guarantee the partial anonymisation of the documentation. Obviously, a priori information provision and a posteriori documentation should be carried automatically whenever possible, but care has to be taken that neither the privacy nor the civil rights of the concerned citizen are violated.

The infrastructure should be a middle-ware like platform, which can be implemented with every legacy system without a change of ontologies and processes used so far, and only requiring a minor change of law. It should support a simple accounting of services and it should provide flexible transparency, based on a clear meta-transparency. Putting it very simply, the infrastructure must not require a critical change of existing systems, it should be embeddable into all existing systems, and it should hide the differences and incompatibilities of remote systems from the local transaction service execution.

Since one-to-one mappings between administrative domains do not scale to European-wide solutions, we have to build a virtual, globally shared, information transfer space, which can be understood as a global government integration broker ([Juric 2001], chapter 2). By its very nature, this broker will only work for a very restricted information domain, for which cross-border, cross-organisational, information transfer is achievable. Thus the depicted government infrastructure will have to rely primarily on local integration of data-sources, unless major changes of the political system in Europe lead to a revolutionary homogenisation of public administration.

3.2 Architecture

We have argued, that we need blueprints for integration architectures. But, what, after all is an IT architecture? Intuition may be taken from construction and the fine art. On the one hand, we have an *outside perspective* and an *inner functonality* of an e-government architecture, on the other hand, it should exhibit *integritas*, *consonantia*, and architectural *claritas*, whereby the last means that it generalizes to much more functionality than that planned or foreseen during the design phase. The outside perspective relates to the fact that an e-government portal represents the state and that it provides a conceptual model for the public space. The inner functionality provides services for the citizens and work-space for the civil servants. Clearly, these perspectives depend on each other. From these observations we may also deduce a separation into IT functionality, including non-functional properties, and governmental context.

What distinguishes IT solutions in public administration from those in business is the far reaching consequence of the outer perspective, that is the trust and confidence it supports or it destroys. Furthermore, the interplay of complex is more rich than in business, and thus a good IT architecture for GAI and G2G is harder to design than one for EAI and B2B, and it requires a documentation with respect to more contexts as well as a validation against a richer set of scenarios. However, something comparable to a pseudo-homogeneous IT infrastructure has not even been built in e-business yet.

Like in ordinary EAI, the first step towards an integration architecture is the development of a top-down view, and the next steps are bottom up: system integration – data-level integration – application interface integration – business method integration – presentation integration ([Juric2001], chapters 1 & 2). Other than in EAI, the support from the top-management is not good enough to guarantee practical success, but the commitment of all top-managements from all involved government agencies is necessary. Due to the high independence of single agencies and due to the lack of shared goals, this commitment is hard to achieve. In addition, we equally need the support from a critical part of the civil servants, because it is them who own the organisational knowledge and we are less free to reinvent that organisational knowledge than in business due to the constraints from public law and the impact on society as a whole.

Furthermore, the lawfulness of each single transfer of personal data from one administrative context to another has to be validated with obvious consequences on the integration of databases. In fact, policy enforcement becomes a new and critical task of GAI architectures and G2G platforms. It requires the explicit formulation of policy rule base including heuristic how to deal with contradictory policies, which is one the celebrated core competences of publication administrations. Monitored, distributed human exception handling may help to further develop that rule-base during its lifecycle, but to the best of or knowledge no such solution has ever been implemented in practice so far.

3.3 Double Complexity & Typical Risks

In order to develop the depicted infrastructure, we have to deal with a high heterogeneity on most (if not all) levels of the architectural design: ontologies, law, data, applications, processes, services, user expectations, etc. In addition, we have to deal with requirements, constraints, and tools from different disciplines: law, management science, political science, sociology, psychology, economics, applied mathematics, etc. By its very nature the architectural solution will consist of non-interoperable perspectives drawn up by experts from different, incompatible disciplines. And each of the perspectives will have to integrate non-

interoperable parts, none of which are static in the long run, nor are they clear in the eyes of the different stakeholders. Thus we have to deal with a double complexity, to which competing stakeholder interests and permanent change add further challenging dynamics. Resulting Risks are higher than in e-business projects.

The main risks for an R&D project developing a government infrastructure as depicted above are the following anti-patterns

- *No integritas:* the top-down view, which is a precondition for any successful integration project, is only defined vaguely, systems workloads is only defined by way of examples, system boundaries are unclear, and as a consequence, involved experts do not really know what they are developing – in some cases, after the completion of an R&D project, its members are not even able to name the cardinal aims of the targeted solution
- *No consonantia:* the different perspectives fall apart, they do not form a consistent IT architecture, as they do not relate to each other – this may even hold for actual IT components, if the top-down view failed, but the possible failure of the interplay of disciplinary perspectives is more critical
- *No unplanned sustainability:* the system is optimised for some selected processes and services and does not generalise – as a consequence, the infrastructure is not sustainable
- *IT-focussed design:* only IT design methods are used, user-friendliness is widely and the design of affordances is completely ignored, technical work-flows are implemented and traditional knowledge from paper-based work is ignored – as a consequence ghost problems arise, while true concerns of citizens are ignored, and the overall architecture is highly complex and does not help to optimise production as it lacks a simple conceptual model: if it works nevertheless, performance is likely to be disastrous once it has to handle more than a toy example
- *Generic design:* this elaborated form of IT-focused design tries to develop solutions for any application scenario within a wide range, it creates architectural structure by abstract logical IT reasoning without any understanding of the application contexts and its particular challenges – usually it scales to global usability, but does not work for a single application scenario, and usually every part of it perfectly makes sense, but their sum doesn't
- *Technology-independent design*: this other elaborated form of IT-focused design tries to develop solutions, which can be implemented with any framework, it works well during the top-down design phase, but it is likely to fail for the detailed design: technological capabilities of existing frameworks are ignored with obvious implications
- *Security by comparison:* the system is more secure than its paper counter-part if it is evaluated with respect to traditional security risks, but its newly created risks resulting from the integration of information and computing resources are ignored

The first two risks result straightforwardly from the doubly high complexity, but the others are related to it, too. A lack of anticipation of the future, namely the analogon of the unplanned add on to claritas in the fine arts, may destroy the value of an error-free architectural design. Reductions to IT or generalisations from IT are admissible but in practice their consequences are often disastrous. The same holds for unduly projections to non-digital counterparts.

3.4 Key challenge

Due to the dominant role of national tradition in Law, we will have to deal with incompatible legal constraints for a long time. There is also little hope to standardise processes, which follow local tradition and culture, but there is some hope to standardise services, because

these are defined by the very nature of the public sector, although in general not all of them are implemented in a country. A standardised set of services would be very helpful for GAI and it may be used to develop a road-map for future R&D as well as for accompagnying measures towards a convergence of European administration. However, this does not really help us with G2G integration.

The key challenge for GAI and G2G is semantic data integration. Semantic data integration is both necessary and nearly sufficient, because data transfer may be achieved in several ways, e.g. by exporting document services as Web services, and more elaborated redesign of public administration may be built on top of data integration. Within a national administrative domain semantic data integration is a hard but feasible task, across national borders it is the limiting barrier for a cost-effective real time implementation of one-stop e-government. As we have implicitly indicated above, a one-to-one mapping of ontologies in different regions would not scale, and thus the integration broker needs its own ontology for information transfer, which acts as a boundary-object-like intermediary for the transfer of data between different agencies using different ontologies. Although it is pretty unclear hoe such a virtual ontology for European-wide data exchange may be developed, for the rest of the paper we shall assume that for some integration domain the definition an intermediary ontology is possible, which allows for an inter-organisational information transfer.

4 Solution

We shall now shortly sketch the basic principles for developing high quality blueprints blueprints and for implementing low risk development processes.

4.1 Architectural Solutions

Any implementable architectural blueprint has to accept political reality and it must not produce any unnecessary tight coupling through IT. It has to avoid typical lock-ins for growing solutions, such as a binding of identity to services, mandatory synchronisation, centralised control, etc. In particular, it should be based on the following principles

- *Conservation principle:* It must be possible to integrate existing systems into the G2G solutions without altering them – this is a political conditio sine qua non, although in general a GAI-minded redesign of existing systems will be worth the foort
- *Administrative transaction processing at the center:* The system's conceptual model should be based on a universal model for the support of the administrative transaction processing, which supports the execution of classified administrative services – this helps to streamline design activities and it tremendously helps to achieve scalability without necessarily violating the conservation principle
- *Separated identity management:* Globally usable digital representatives securely act in effigy of the citizen and the civil servant as trustworthy customers of digital services, for which purpose they are able to select the personal data the citizen wants to reveal – this avoids an implicit coupling of services through identity data and it is both necessary and sufficient to guarantee the citizen's privacy rights on the level of the application protocols
- *Localisation of information :* The system does not handle personal data of citizens on a global scale ; instead it imitates traditional information processing in the public sector as it handles documents with statements about the local validity of well-defined personal data at a given time and at a given location – this avoids a synchronisation lock-in, and in particular it improves failure tolerance and performance
- *Decentralisation of activity:* Workflows for one-stop e-government services are loosely coupled based on the client/server paradigm. Logically, it can be realized with document transfer via a well-structured virtual information transfer space, which decentralises the

integration of legacy systems – this avoids a centralisation lock-in, and in particular an aggregation of legal contradictions within policy enforcement

The core components for the implementation of G2G solutions beyond GAI within an administrative domain will be document services, which enable that some administrative transaction processing is not only provided with necessary, locally accessible data, but also with remote information, which is encoded according to the virtual ontology of the integration broker and packaged into a digital document, which provides context information.

4.2 Engineering Process

The ISO reference model for open distributed processing, RM-ODP [ISO/IEC 14753], suggests to proceed in five steps, in each of which a design viewpoint is developed: the enterprise viewpoint, the information viewpoint, the computational viewpoint, the engineering viewpoint, and the technology viewpoint. It has been suggested by the German SAGA standard to use that reference model for the development of e-government solutions. However, care has to be taken that the developed IT architecture is not covered by a resulting huge amount of design, that the pieces of the design fit together, and that the user interaction is well supported by the rest of the architecture. Comparing the approach with the typical EAI approach, it becomes apparent that the enterprise view corresponding to the top down approach is of critical importance, and that there is some danger that process integration and presentation level integration could not get enough attention. Based on a clear understanding of the above design principles, the first may be only a minor danger, but the latter will always be critical for the user acceptance. Furthermore, in a multi-disciplinary design team, non-IT-experts are likely to struggle hard with the oo-minded nature of RM-ODP.

We recommend to perform several redesigns of the architecture before it is implemented, based on a sequence of development scenarios. From the very beginning, the chosen scenarios should be as complex as needed for the final outcome, and each of the scenarios should be based on a real world context, which can be easily understood by all team members. The shared real world knowledge will support a convergence of views of experts from different disciplines, while the high complexity will reveal the necessity to develop a holistic architecture, which is more than just a software architecture. Since law is a critical constraint for e-government solutions, the scenarios should be chosen that complimentary areas of law are “covered”.

5 References

[Koskela 2000] Koskela, Lauri, An Exploration towards a Production Theory and its Application to Construction, thesis, ISBN 951-38-5566-X, 2000

[Juric2001] Juric, Matjac B., Professional J2EE EAI, Wrox Press 2001

[Oostveen 2001] Oostveen, Annemarie & Peter van den Besselaar, Linking databases and linking cultures; the complexity of concepts in international E-government. In: Beat Schmid, Katarina Stanoevska-Slabeva, Volker Tschammer, Towards the E-society: E-business, E-Commerce, and E-government. Dordrecht: Kluwer Academic Publishers, 2001. pp 765-774.

[Riedl 2001] Riedl, R.:Interdisciplinary Engineering of Interstate E-Government Solutions. Proceedings of the Fourth International Conference on Cognition Technology: Instruments of Mind, Warwick 2001.