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Monitoring Framework for Cross-organizational eGovernment Scenarios – a Process Oriented Approach

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Abstract: An increasing level of cooperation between public administrations on national, regional and local levels requires methods to develop interoperable eGovernment systems and leads to the necessity of an efficient modelling and implementation of cross-organizational business processes and their subsequent monitoring. In order to determine a collaboration's efficiency and effectiveness its performance needs to be measured. To measure cooperation more effectively the business processes spanning the public administration have to be provided with the relevant key performance indicators, so a business process monitoring and controlling is applicable. In contrast to the more efficient designing of cross-organizational business processes, the monitoring and controlling of these processes is a research area under development. Bearing in mind that current monitoring and controlling solutions are highly intra-enterprise oriented and often fail to consider the collaborative point of view, this paper presents an approach for the monitoring of cross-organizational eGovernment scenarios.

Keywords: Business Processes, Monitoring, Cross-organizational Scenarios, Framework, eGovernment

1. Introduction and objectives

Due to the increasing heterogeneity and dynamics of the European Union, more and more public administrations within Europe are challenged to work together and to adapt continuously to rapid technological changes. New legal settings, modernization, the need for improved quality of service, the search for competitive advantages and innovations as well as rapid technological advances create a new dynamic and complex administration environment, which requires flexibility and mobility from European public administrations. For these reasons different governments have to cooperate in order to modernize and innovate public administrations, to provide citizens and industries with new service offers, to encounter the contemporary prevalent high cost pressure, to reduce the current administrative overheads as well as to stay globally competitive and keep Europe attractive as a place to live, work and invest. In this respect the opening of an organization's borders is no longer regarded as a necessary evil, but rather as an opportunity with strategic importance within the European Union. However, how do you measure if the postulated win-win-situation by concentration on core competences is really achieved? The question is: Is the cooperation really as successful as it was intended to be or may it be improved? In contrast to the more efficient designing of governmental processes, the monitoring of these processes is an almost untouched research area now focussed on by this paper.

Technological concepts such as service-oriented architecture allow enterprises to interconnect their information systems for a cross-organizational business process

execution [1]; the support of monitoring and/ or controlling of the cross-organizational processes and the collaboration itself is still in the development phase. Because the focus has changed from the competition between single enterprises to an increasing competition between networks [2] it is necessary to enhance established concepts like Business Performance Management and Business Activity Monitoring that are focused on intra-enterprise processes. [3] [4] These developments raise the necessity to extend the classic understanding of Business Performance Management to networked businesses. This approach is reflected by the term Collaborative Performance Measurement. It means the collection of monitoring and controlling data in terms of key performance indicators (KPIs) [5] across organization's borders in order to measure the efficiency of cross-organizational business processes and to prearrange and support decisions for the lifecycle of a corporation. [6]

2. Monitoring of cross-organizational business processes

The following requirements were identified based on an extensive literature review of current monitoring approaches. Furthermore, we take into account the results of national and international research projects in the field of cross-organizational business process modelling and interoperability (e.g. R4eGov project or ATHENA project) [7]. Based on this we deduce and develop the mentioned objectives in order to enable a process-based monitoring of networked public administrations.

2.1 Requirements and presumptions

Business process monitoring concepts can be divided into the two categories intra- and inter-organizational monitoring. While the first category comprises only the monitoring of activities executed inside one organization, an inter-organizational business process monitoring analyses tasks executed by various organizations that are collaborating to reach a common objective. The monitoring of inter-organizational business processes requires various aspects, e.g.:

- Hide details about internal process performance and their realization from the partners
- Allow monitoring the execution of the overall cross-organizational business process
- Progress of a cross-organizational business processes must be globally visible
- Encapsulated private processes must be prevented from being tracked

The needs shown lead to the following specific requirements regarding monitoring of cross-organizational business processes:

Hide private performance information: This requirement is essential. It cannot be expected that each partner publishes its entire performance data and all contained (key) performance indicators. A solution is required that hides details about internal process performance and their realization form the partners. Thus, the solution should publish the relevant performance information only. There are different approaches for this in literature:

- Distinction between public and private processes (public and private views).
- Generate an "interface specification", e.g. an automaton that describes the required input, interaction patterns etc.

Specify the performance interfaces of the partners formally: It is important that the performance information demand to the partner has to be comprehensive, i.e. that all required performance information on the interface is sent to the partner. This may contain:

- The causal relationship at which point in time or after which event the performance information is required
- The type of the required performance information, e.g. time, cost, quality
- The causal relationship to the monitoring object, e.g. document, process step

In order to provide a framework that specifies the performance information that is required, performance interaction patterns could be used.

Map the KPI to workflow data/audit trails: Monitoring the execution of a cross-organizational business process starts with a common process performance model that all partners share and that is business oriented. From this performance model every partner extracts those parts that he has to analyze and augments them with workflow information he gets from workflow execution. Thus the used modeling language should be able to transfer the KPI from business level into workflow model on technical level like e.g. audit trails or workflow events.

Support the performance information flow*:* It is important that the performance information flow of the involved partners of a CBP can be represented by the modeling language. Especially a description of the needed performance objects of the partner in order to analyze their process parts is necessary. This may contain:

- The point in time the performance information is required
- The required monitoring object, e.g. business document, process step

Support of semantic annotation: In the context of monitoring cross-organizational business processes, we require a common set (dictionary) of KPI terminologies, a set of relations between KPI terms and their transformations. This includes the possibility of transforming KPI descriptions (models) from one language into another. It also includes the possibility of using the set of terms and their relations for performance modeling.

2.2 Core elements of cross-organizational monitoring approach

The core element of the monitoring approach is the cross-organizational business process monitoring (and controlling) phase, which should be implemented by each collaboration partner, containing all the performance information he wants to publish to the other collaboration partners. Correspondingly, Figure 1 displays the main elements of the overall cross-organizational business process management lifecycle.

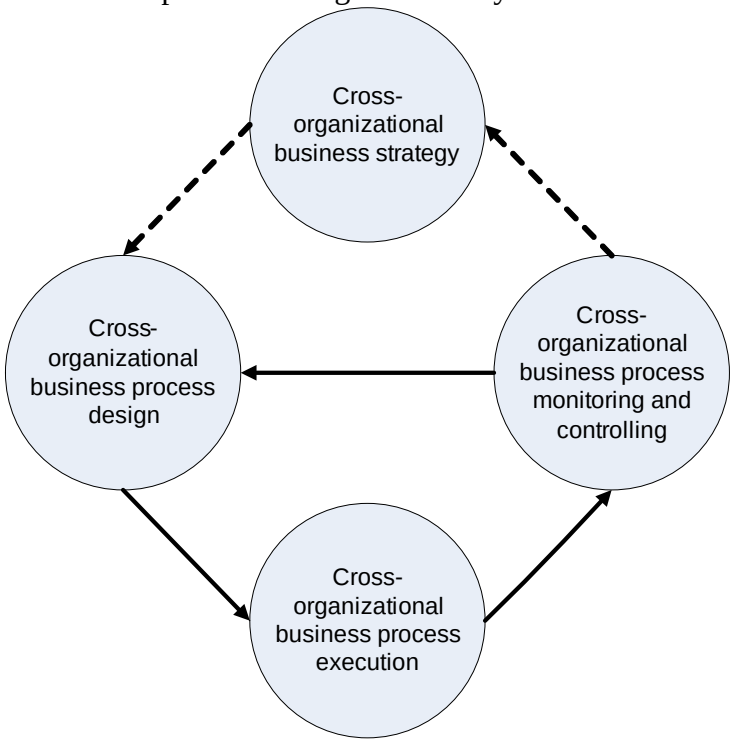

Figure 1: Cross-organizational business process management lifecycle

By considering the main phases affecting the monitoring and controlling system regarding the cross-organizational business process management (cross-organizational

business strategy, cross-organizational business process design, cross-organizational business process execution), we follow the traditional phases of (cross-organizational) business process management. [8] [9]

Cross-organizational business strategy: The cross-organizational strategy refers to the development of an overall strategy of how to determine goals, rules, and guidelines for the collaboration. In the context of monitoring, main objective is to provide goals and strategies to the cross-organizational business process component.

Cross-organizational business process design*:* With regard to cross-organizational business processes, the design-time phase actually comprises the generation of a process model that spans over multiple organizations.

In principle this can be performed in a centralized and a decentralized way. A centralized model creation can be considered implausible due to the individual demand of protection: real-world organizations usually do not agree to fully expose their knowledge and their processes to a third party. A decentralized model creation, however, implies the existence of different modeling individuals, each of which generates only parts of the process. Within this procedure they may follow different modeling paradigms, methods and languages, so this approach requires both a technique for assuring the consistent individual model creation and a technique for the integration of the partial models.

Cross-organizational business process execution*:* This level provides a more detailed view on the cross-organizational business processes representing the complete control flow of the process. Non-executable tasks are not regarded. Also the message exchange between single tasks is modeled on this level and can be monitored. On execution level the cross-organizational business process is modeled in the modeling language of a concrete business process engine. Main objective of the technical execution environment for cross-organizational workflows regarding monitoring issues is the systematic development and provision of (workflow) performance information needed to derive business performance information.

Cross-organizational business process monitoring*:* Monitoring generally means to be aware of the state of a system. The monitoring system has to ensure that the monitored system (the cross-organizational process) produces an output within the defined tolerances defined for the target values. The system measures the output as well as the input of monitored system. In this context, the following monitoring approaches can be distinguished:

- Realtime-Monitoring compares the actual values with the target values provided by the controlling system at run-time and displays the performance information (e.g. status of process steps or business documents) in a graphical way. If the monitoring system allows a modification of the cross-organizational processes, real-time adjustments can be done.
- Feedforward-Monitoring measures the input, especially disturbance values, before they enter the monitored system in order to define preventive measures to ensure the desired output.
- Feedback-Monitoring compares the actual values of the output with the target values provided by the controlling system after process execution. The monitoring system provides the actual values to the controlling system. If a deviation exists, the controlling system adjusts the target values or performs necessary measures to the design-time to compensate the disturbances that may have caused the deviation.

Cross-organizational business process controlling: Controlling of an undertaking consists of seeing that everything is being carried out in accordance with the plan which has been adopted, the orders which have been given, and the principles which have been laid down. Its object is to point out mistakes in order that they may be rectified and prevented from recurring. Since monitoring is impossible without target values, the controlling system

has to provide these values to the monitoring system. Main objective of the controlling system is the ex-post analysis of the executed processes with the goal of discovering optimization potentials. Once a potential for optimization is found, it can be realized by changing the process model accordingly in the design-time phase. In contrast to the monitoring system, the controlling system denotes all actions that aim towards measurement and examination of running and finished processes regarding a mid- and long-term view.

2.3 Process type-related monitoring

This paper focuses mainly on the monitoring and controlling aspects within the cross-organizational business processes at design-time. To describe and automate cross-organizational processes in the last years three different types of process models were used [10] [11] [12]: private, public and global process models.

- A private process model is described from the viewpoint of an individual organization. Though it may contain activities that represent interactions with other organizations, it is developed for internal use and thus may contain confidential information to be hidden from other organizations.
- A public process model is also described from the viewpoint of an individual organization. It describes the interaction of one organization (e.g. Organization A) with one (B) or more (C) partner organizations. It describes all activities of A being part of this interaction (e.g. “Send RFQ Message to B”, “Receive Quote Message from C”) and the sequence of these activities. One way to create a public process is to derive it from a corresponding private process by abstracting all information from it that should be hidden from partner organizations.
- A global process model describes interactions between two or more organizations from a global viewpoint. It captures all interactions allowed between all partners involved in the collaboration. Thus, while a public process only captures the interactions between the organizations A and B as well as the organizations between A and C, a global process model could contain additionally the interactions between B and C.

Based on the modelling of private, public and global processes Figure 2 illustrates the monitoring related issues within the process types shown above.

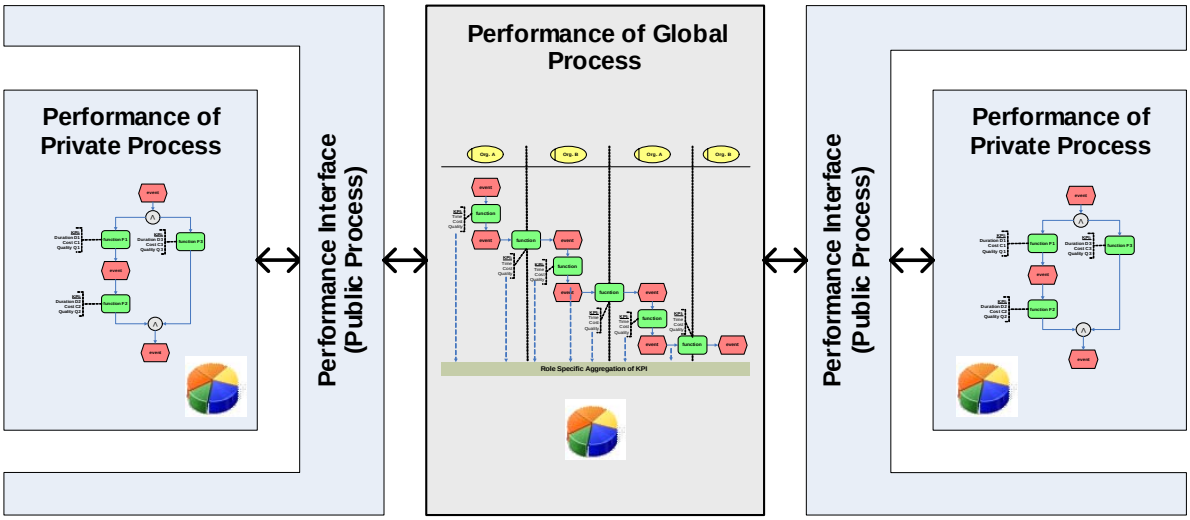

Figure 2: Monitoring framework

Each enterprise offers information (derived form private performance information) to the partners in a collaboration sphere public performance in order to measure the performance of the global process. Apart from conceptual process models (e.g. modelled with the event-driven process chain) and corresponding performance information also the

technical counterparts are necessary (e.g. log files from workflow engines) to support monitoring system with actual values of the performance indicators. In this context, the monitoring of private processes is a well-known research area [13] [14]. Thus, the following section deals mainly with the monitoring of public (and global) processes.

2.4 Monitoring of public processes

From the management perspective, the ability to execute a business process is not sufficient. To enable the ability to improve the design and the way of execution, it is mandatory to be able to measure the target object, i.e., to reveal performance indicators of the cross-organizational business process. In the intra-organizational case, this means to extract historical execution information from a single process execution system (mostly a workflow management system) and to calculate the performance indicators from them. In contrast to that, the cross-organizational case is rather complicated. On the one hand, there are multiple execution systems that hold only partial information about the execution of a single cross-organizational business process. Thus the challenge is not only to compose data from multiple sources, but also to identify linked process chunks and to reconstruct the complete structures of historical cross-organizational business processes under the side condition of heterogeneous data and system ownership.

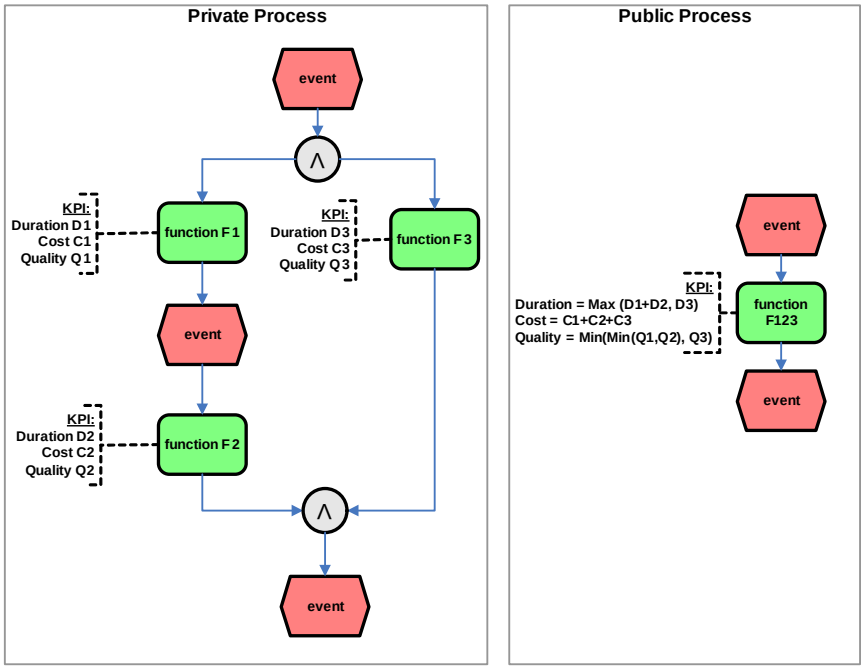

Figure 3: Example of monitoring public processes

On the other hand this information on the reconstructed process not necessarily leads to performance indicators for the process. Namely, the calculation of these indicators requires the valuation of process execution data. This valuation (e.g., the cost function) is a business secret itself. Therefore an overall indicator processing cannot be performed without exposing individual business knowledge. Thus we propose to calculate public key performance indicators in a way equivalent to the execution data processing: each organization transforms the process information gathered from the execution systems into its individual (private) key performance indicators. These figures will then be used to compute the public key indicators. Following this procedure, the organizations are not obliged to publish their calculation scheme and only communicate the resulting values.

Figure 3 visualizes this monitoring and controlling concept with respect to the KPI. In order to hide information, the functions F1, F2 and F3 of the private process were aggregated to the function F123 of the public process. Since monitoring and controlling of

cross-organizational processes requires real performance information, the partner has to provide the aggregated performance information of the public function F123. In the example, the duration D123 is calculated as the maximum of the sum of the duration D1 and D2 and the duration D3, since the process splits on two branches. In a uniform manner, the cost C123 of the Function F123 is calculated as sum of the single cost values C1, C2 and C3. The quality Q123 of Function F123 is calculated as minimum of the quality of Q1, Q2 and Q3.

In general, the following operations could be used to derive and compute the public KPIs:

- Add(v1,v2): Calculates the sum of the given values v1 and v2.
- Avg(v1,v2): Calculates the average of the given values v1 and v2.
- Min(v1, v2): Returns the minimum of the given values v1 and v2.
- Max(v1,v2): Returns the maximum of the given values v1 and v2.

The operators can be combined as shown in Figure 3.

The inter-enterprise coordination builds on a distributed business process model where partners manage their own part of the overall business process. A cross-organizational business process specifies tasks that each of the parties is required to perform as agreed in their contract (specified in terms of business level models). Although the cross-organizational business process model will not be executed and therefore does not exist on execution level [15], it is required for the specification of the message exchange on the technical level. It can be used for monitoring and controlling purposes in the actual enactment phase. The performance of a process view can therefore be considered as a proxy for its corresponding performance of the private process. Based on performance values of the public processes, the performance values of the global process can be computed.

During the run-time of the cross-organizational business processes, the technical execution environment uses the process description and KPI definition to extract the performance values from the involved workflow management systems [16]. Therefore it is mandatory that the performance models are specified both on the business and on the technical level. In order to map the execution data (e.g. log-files) to the KPIs of the business process models, audit trail events as for example recommended by the Workflow Management Coalition can be used [17].

3. Conclusions

Rapid advancements in technologies, regular emergence of new technologies and new technical paradigms for “doing business” lead to an enforced competition in global markets and raise new challenges for networked public administrations such as shortened time cycles or shortened time-to-make decisions. Without appropriate IT systems enabling a day-to-day monitoring and controlling of business behaviour and decision supporting of business actions and reactions, today’s public administrations struggle to keep pace with rapid evolving economic alterations.

The proposed approach creates the basis for holistic monitoring and controlling functionalities in cross-organizational environments. It describes the underlying functionalities that build the basis for process improvements and re-engineering efforts. In a next step research will be undertaken in how far it is possible to bind economical values and figures to process indicators. Consequently it would be possible to ameliorate processes not only in respect to time and quality but also in respect to financial aspects. With the establishing of cross-organizational processes and their monitoring it should not only be possible to evaluate the performance and costs of certain processes and even parts of them, it also provides the opportunity to financially compare similar processes at different

organizations, to optimize them, to outsource certain tasks and still to observe the entire dynamics of the processes.

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References

[1] F. Kupsch, and Werth, D.: Process-Driven Business Integration Using Peer-to-Peer Technology. In: M. Khosrow-Pour (Ed.): Innovations Through Information Technology, 2004, pp. 1294-1300.
[2] L.M. Camarinha-Matos: Collaborative Business Ecosystems and Virtual Enterprises, Kluwer Academic, Norwell, 2002.
[3] A. Davila, T.G. Cucuzza, and P.F. Drucker: Harvard Business Review on Measuring Corporate Performance. In: Harvard Business School Press, 1998.
[4] A.-W. Scheer, W. Jost, H. Hess, and A. Kronz: Corporate Performance Management - ARIS in der Praxis, Springer, 2005.
[5] D. Permenter: Key Performace Indicators: Developing, Implementing, and Using Winning KPIs, 2007.
[6] T. Matheis, B. Simon, and D. Werth: Collaborative Performance Measurement. In: G. D. Putnik, M. M. Cunha (Eds.): Encyclopedia of Networked and Virtual Organizations, Hershey et al., Idea Group Inc., 2007.
[7] T. Matheis, J. Ziemann, D. Schmidt, M. Wimmer, P. Loos: Gathering requirements for eGovernment in the large – Conceptual framework and exemplary application. In: H. Krcmar, J. von Lucke, and P. Wolf (Eds.): eGovernment - von Kundenausrichtung, Prozessorientierung bis zu Hochleistungsportalen und IT-Infrastruktur als Herausforderung an die öffentliche Verwaltung. Multikonferenz Wirtschaftsinformatik, Munich, 2008.
[8] R. Espeyo et al.: Organizational Transformation and Learning. New York, 1996.
[9] A.-W. Scheer, and W. Jost: ARIS in der Praxis - Gestaltung, Optimierung und Implementierung von Geschäftsprozessen. Berlin et al. Springer, 2002.
[10] U. Greiner et al.: Designing and implementing cross-organizational business processes - description and application of a modelling framework. In: Proceedings of the Interoperability for Enterprise, Software and Applications Conference (I-ESA 2006), 2006.
[11] T. Andrews et al.: Business Process Execution Language for Web Services – Version 1.1, 2003.
[12] R. Khalaf, and F. Leymann: On Web Services Aggregation. In: B. Benatallah, and M. Shan (Eds.): Technologies for E-Services. Lecture Notes in Computer Sciences 2819, Springer, Heidelberg, 2003.
[13] H. Heß: Monitoring, Analyzing and Optimizing Corporate Performance — State of the Art and Current Trends. In: A.-W. Scheer, H. Kruppke, W. Jost, and H. Kindermann (Eds.): AGILITY by ARIS BPMN, 2007.
[14] W. Artley, and S. Stroh: The Performance-Based Management Handbook, Volume Two, 2001.
[15] K. Schulz, and M. Orlowska: Facilitating cross-organizational workflows with a workflow view approach. In: Data & Knowledge Engineering 51(1), pp. 109-147, 2004.
[16] S. Junginger, H. Kuehn, F. Bayer, and D. Karagiannis: Workflow-based Business Monitoring. In: L. Fischer (Ed.): Workflow Handbook 2004, Future Strategies, Lighthouse Point, 2004.
[17] M. zur Mühlen: Workflow-based process controlling, Logos Verlag, Berlin, 2002.