Conceiving Interoperability between Public Authorities – A Methodical Framework

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Abstract

An increasing level of cooperation between public administrations nowadays on national, regional and local level requires methods to develop interoperable E-Government systems and leads to the necessity of an efficient modeling of collaborative business processes and their implementation. In this paper a framework to systematically develop interoperable systems in the public sector is described. The methodology is motivated and explained on the basis of an E-Government reference model for the German Plan Approval Procedure. In this context it is described how cross-organizational business processes can be modeled and transformed to technical process models in the form of Web Service protocols. After a motivation for the need of interoperability frameworks and a description of related work, section 3 introduces the methodical interoperability framework. Further detailing the contents of this framework, section 4 presents a method for the creation of collaborative business processes on a conceptual level. Section 5 changes to the execution level and describes how to implement the conceptual models created before with Web Service protocols. Section 6 concludes the paper and gives an outlook on future research.

1. Introduction

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.

An analysis of related work (cp. following section) reveals that current E-Government interoperability frameworks focus on the functional aspects of interoperability by providing standards and technical recommendations for selected aspects of IT system development. But they only offer limited support when it comes to methods for systematically implementing cross-organizational processes (CBP), e.g. by providing a procedure model of how to put the various standards involved in a CBP together. This raises the necessity for extending existing interoperability frameworks to methodical aspects that support the design and implementation of CBPs in the public sector. Note that the framework presented here does not focus on "soft" interoperability barriers, like different cultures of enterprise which might hinder cooperation, but presumes that the involved stakeholders are able to specify a valid cross-organizational scenario with semi-formal process models.

The paper is structured as follows: Section 2 describes related work, for laying the ground for chapter 3, which introduces the methodical interoperability framework and approach of R4eGov. Section 4 and 5 present an example of a CBP scenario demonstrating how the methodical interoperability framework can be applied. Section 5 concludes with a summary and an outlook on future research.

2. Related work

To enable a cooperation of public administrations and to cross-link the corresponding software systems the European Commission has launched several research and development programs in the area of interoperability.

Examples are the Interchange of Data between Administrations, Businesses and Citizens (IDABC) [11] or the MODINIS program [18].

The European Interoperability Framework (EIF) [6] was developed within the Interchange of Data between Administrations (IDA) program [5] of the European Commission and presents a framework for a common understanding of interoperability. The objective of the EIF is to support the delivery of pan-European E-Government services to citizens and enterprises. Based on general principles like accessibility, security or the use of open standards, EIF gives recommendations and guidelines for E-Government services in order to enable the interaction of administrations, enterprises and citizens across borders.

In order to fulfill the eEurope Action Plan the MODINIS program aims to analyze good practices all over Europe, to prepare the future structure for network and information security issues, to analyze the economical and societal consequences of the information society and to establish a common understanding of the single activities at national, regional and local level within the European member states. The identification of relevant and good practices in interoperability as well as the inclusion of the identified good practices in the European Commission's Good Practice Framework is the main objective of the study on interoperability at local and regional level [19] which is developed with the support of the MODINIS program.

In this context, the term interoperability is defined by the European Commission as "the means by which the inter-linking of systems, information and ways of working, whether within or between administrations, nationally or across Europe, or with the enterprise sector, occurs" [6]. To enable public administrations to open themselves towards other authorities as well to their customers and to collaborate with them, the public administrations have to be supported with E-Government interoperability frameworks and solutions which cover strategies, organizational concepts and information technology in order to link administrative business processes and to interconnect the corresponding application systems [22]. According to EIF interoperability frameworks should consider three levels of interoperability: organizational interoperability focuses on the interoperability of business processes and information architectures beyond the borders of different administrations. The semantic interoperability level aims at establishing a common meaning of the exchanged data, process models or used procedures. The linking of systems and the definition of corresponding technical standards in order to enable a seamless communication is addressed by the technical interoperability level [7].

A major means to realize technical interoperability is the use of protocols, which formally describe the sequence and the nature of exchanged messages. Various standards exist to describe protocols, including the Business Process Specification Schema (BPSS) of ebXML [4], the Partner Interface Processes (PIPs) of RosettaNet (http://rosettanet.org), WS-CDL and the abstract processes of BPEL (Business Process Execution Language for Web Services), which are also called BPEL protocols [1]. To establish an E-Business conversation, several components are necessary: interfaces published in a network, interaction descriptions and partner roles, a standard vocabulary and an environment of security and trust [17]. RosettaNet, being a prominent example for E-Business protocols, contains all of the components listed above, but comprises only a predefined list of interaction patterns (called Partner Interface Processes, PIP) described with UML activity diagrams, text tables and XML documents. To provide more specific and technical process descriptions, Masud [17] and Khalaf [13] propose to transform PIPs, which represent proven well established reference models for CBPs, to BPEL processes. Though the methodology described in this paper also aims on generating BPEL processes, it does not focus on pre-established interaction patterns (like PIPs do), but allows the development of individual CBPs. Since Web Service standards provide interface descriptions (WSDL) and interaction descriptions (e.g. abstract BPEL processes), they can be seen as complementary to established E-Business protocol standards like RosettaNet.

Similar to the different ways of describing conceptual CBPs, different methods exist to specify protocols: the first describes the interactions of all partners with the help of global models; the second only describes interactions of one partner with a so called abstract process (also called process skeleton, process stub or public process). Abstract Processes describe interactions from the viewpoint of one partner, thus they can only describe the interactions between this partner and one or more of its partners but not the interactions between his partners where this partner is not directly involved. In comparison to abstract processes, global models allow better use of model checking techniques [8]. WS-CDL seems to be the only Web Service based standard for describing global processes, but only a few prototypical tools are supporting this standard. While global models are valuable in the design and analysis of CBPs, for implementing them in general, abstract processes are to be preferred: They comply with organizations demands of a de-centralized process execution (e.g. no central engine is required) and show as little process information as possible and only to immediate collaboration partners. BPEL abstract processes can either be used during design-time to ensure that private BPEL processes of the collaborating partners are complementary or they might also be used on run-time as input to a protocol engines.

3. Framework

The concepts and scenario analysis were developed in the context of the R4eGov research project. The objective of R4eGov is to enable E-Administration in the large, that is, to ensure the interoperability of the software systems used by public administrations in the European Union. A corresponding framework guiding the establishment of software systems in this environment should cover functional as well as methodical aspects. Functional aspects aim to describe, for example, which specific E-Government data specifications, interfaces, process models or open standards ought to be used on different local, regional and international public administrations. Methodical aspects describe on a more generic level the methods to be applied for creating interoperable software systems of public administrations. While the functional aspects describe static elements, e.g. a certain standard needed for the collaboration of two public administrations on the national level, the methodical aspects aim at describing the dynamics of establishing interoperable information systems, e.g. the various steps necessary to develop such a system. A framework covering functional aspects is described in [23]. The methodical aspects are covered by the framework shown below (see figure 1).

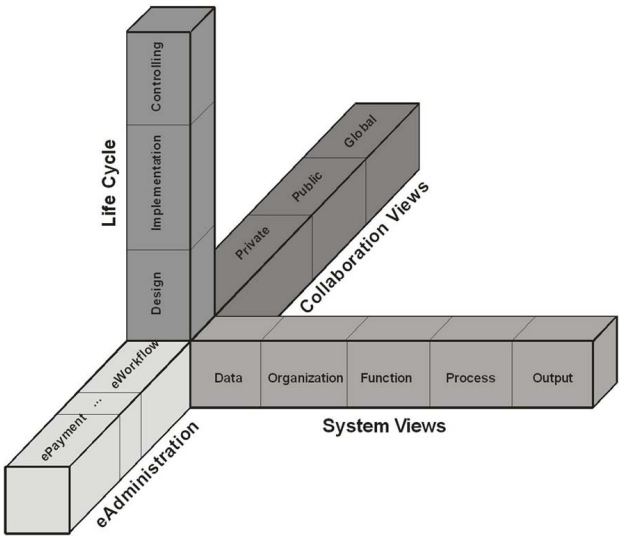

Figure 1. R4eGov methodical interoperability framework

The framework is built on four well known and proven dimensions:

• System Views: The ARIS House [20] describes a concept to model different aspects of an enterprise. It covers five views of an organization that are necessary to model an integrated information system. The main goal of the different views is to reduce the complexity of a business process model and to simplify the development of an information system. Each view contains classes (e.g. functions or messages) with a similar semantic coherence. The data view comprises the description of messages (e.g. messages that trigger functions or are produced by functions) and other environmental data related to specific functions. The organization view creates the organizational structure indicating the organizational units which execute the functions. The function view describes the processes that transform input into output. The output view contains all material and non-material input and output. The structure of a system is described by the data, organization, function and output view whereas the dynamic aspect of the system is comprised by the process view (control view). The process view describes the relationships between the other views as well as the entire business process. Note that there are a number of other frameworks for categorizing and modeling organizational elements (e.g. Zachmann [25] and Cimosa [24]). But due to its broad acceptance in practice and its suitability to conceptually prepare Service-oriented Architectures (cp. [27]) ARIS was chosen as the basis for the system axis.

• Collaboration Views: Though the model of a complete CBP could be developed comprising detailed knowledge about each collaboration partner, normally stakeholders want to publish as few information as possible, and for example not share detailed knowledge about their processes even with partners they only indirectly interact with. Therefore, corresponding to the viewpoints of involved stakeholders, different process models are used, where each model represents a part of the "complete" CBP model. This different viewpoints are realized through the distinction of private processes (running inside one organization), process models that describe direct interactions between partner organizations (so called public processes) and high level process models describing the interactions between all partners involved in a joint collaboration (so called global processes) [9].

• Life Cycle: The business process management lifecycle covers the three broad phases of design, implementation and controlling of information systems [21]. The design phase refers to the modeling of existing or intended processes by using modeling languages like the Event-driven Process Chain (EPC) [12]. Based on the processes, the implementation phase aims at the execution of the modeled processes. The phase of controlling considers the performance measurement of the processes in order to reveal optimization potentials. These potentials can be used to restructure the process models and to adjust the corresponding systems.

• E-Administration: The fourth dimension is displaying specific administration procedures or services like E-Delivery, E-Payment or E-Workflow and thus represents the connection to the public sector. Even though the dimension displays specific processes or services, the

dimension can be used to display more complex processes or services like E-procurement by combining basic processes or services.

To illustrate the presented framework, in the following an example of a collaborative scenario is provided, demonstrating how public administrations can benefit from the methodical interoperability framework in order to open themselves towards other authorities and their customers. The example will focus on the following areas of the framework

• Lifecycle: In this paper only the design and implementation phase will be covered.
• Collaboration views. All three views are covered, though the focus lies on private and public process views.
• The eAdministration scenario is the German Plan Approval Procedure.
• System views: Though all five views of the ARIS are relevant for collaborations, the process view is central since it combines the other views. In this paper, we focus on the process view while a more detailed description of the other views is left for future research.

4. Design Phase

4.1. Different perspectives on collaborative processes: private, public and global processes

Before the technical realization of interoperable systems, they have to be planned and designed on a conceptual level, e.g. the shape of any cross-organizational business processes should be captured with semi-formal models. A business process can be defined as a continuous series of organizational tasks, undertaken for the purpose of creating output. Both starting point and final product of a business process is the out-put requested and utilized by corporate or external customers. A collaborative business process contains tasks that are undertaken by various organizations that are collaborating to reach a common objective. Business Process models are developed for the purpose of documentation, optimization and automation of business processes. Though models developed for establishing CBPs share these objectives, they differ in various aspects from the business processes used only inside one organization, e.g.:
•Need for Information Hiding. Though the information describing interactions between organizations should be visible, other parts of process model should remain inside one organization.
•Need for exact description. If elements are described ambiguously, this will lead to misinterpretations. Though this criterion is also relevant for corporate internal use, technical and cultural differences are usually bigger between organizations, increasing the probability for misunderstanding. Additionally, the distance between stakeholders is bigger, thus misunderstandings are harder to resolve.
•Need for model usability focused on collaboration partner. Since additional information increases model complexity, only interaction information required by the partner organization should be contained in the model. Nonetheless, the choice which information might be useful for the partner is subjective. For example, he might also be interested in a process activity that does not comprise an interaction with him, but still helps explaining interactions.

To describe and automate collaborative processes in the last years three different types of process models were established (e.g. [9], [1]): 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 view point (cp. for example [14]). It captures all allowed interactions 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.

While more technical definitions of public processes focus on digital message exchanges (e.g. [3]) on a more conceptual level, interaction models can also describe material exchanges as well as the place and time of such exchanges (cp. [15]). A process can be seen as the combination of various organizational dimensions, e.g. the dimensions function, organization, data, output and control [20]. A function represents a business activity, the organizational view describes departments and roles involved in the activity, data and output describe digital and material entities consumed and produced by functions and the control flow combines these views and puts the functions in a timely order (see figure 2).

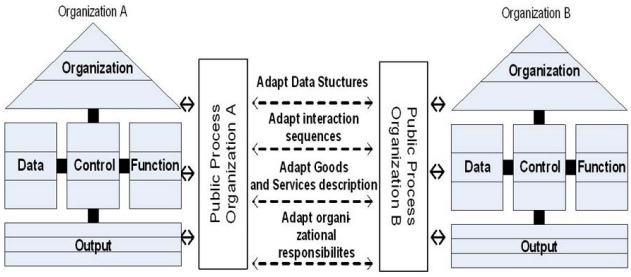

Figure 2. Using the 5 system views to adapt the public collaboration views

Public processes can be seen as interfaces of private processes and should contain all information necessary to enable the interaction of different private processes. Therefore, beside the sequence of functions contained in an interaction, public processes also have to display information regarding the exchanged data (e.g. which structure an exchanged message has), the goods and services exchanged as well as the organizational departments and roles involved in the interaction. For this kind of business process description the event-driven process chain [12] found broad acceptance and will also be used in this paper.

4.2. A collaborative process between public administrations: The Plan Approval Procedure

In the following, the CBP-concept will be shown on the basis of the scenario. A Plan Approval Procedure (PAP) is a special, formal administrative procedure, whose single regulations are described in detail in the §§ 72 et seqq. of the Administrative Procedures Law (VwVfG). The aim of the PAP is to achieve the obligatory official approval of a plan (OAP) by a so called Plan Approval Decision [16]. An OAP enables the matching of a number of public and private interests, which are addressed by a plan. Thus, it represents a substitution of necessary official decisions, like for example administrative decisions or permissions by only one administrative act and at the same time eliminates possible further claims for omission [2]. An OAP also determines exactly where the construction will be located later on. The regulations of VwVfG apply only if there is no prescription in a more specific law. These specific laws also determine for which procedures a PAP is necessary. An OAP is, for example, necessary for the construction of streets (according to the Federal Street Law (FStrG)) or the construction of airports (according to the Air-Traffic Law (LuftVG)) [10]. A PAP can roughly be divided into two main steps: a "hearing procedure" and a "decision procedure". Because a PAP is required for most of the construction projects and involves various partners like public administrations, businesses as well as citizens, it is a suitable procedure to illustrate the conceptual modeling and implementation of collaborative business process in the public sector. At the beginning of the PAP, the project agency (e.g. a manufacturer) submits the plan for the construction project to the hearing agency. This plan is then checked and published by the hearing agency. After the plan has been published, the parties involved (e.g. the citizens and the retailer) have the right to have a look at the plan and, if necessary, raise objections. The hearing agency checks these objections and decides, in consultation with the parties involved, whether the plan has to be revised or not. In case of a necessary revision, the plan has to be revised by the project agency (e.g. the manufacturer). Afterwards, the revised plan is submitted to the hearing agency again, which then forwards the plan to the approval agency. The Plan approval agency has the assignment to check the procedure according to the rules, to accept the plan and to announce it.

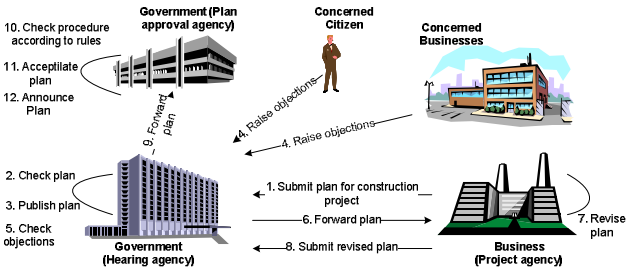

Figure 3. Plan Approval Procedure – Global process as interaction diagram

In figure 3 the simplified global process of the PAP is illustrated as interaction diagram. Accordingly, the interactions between all parties involved in the scenarios are depicted. In general, for establishing CBP models, either a Top-Down procedure or a Bottom-Up procedure can be applied. A Bottom-Up procedure starts from existing private process, derives corresponding public processes and based on this establishes global processes. Since we start with a given global process, a Top-Down procedure is applied: From the global process of figure 3 public processes are derived.

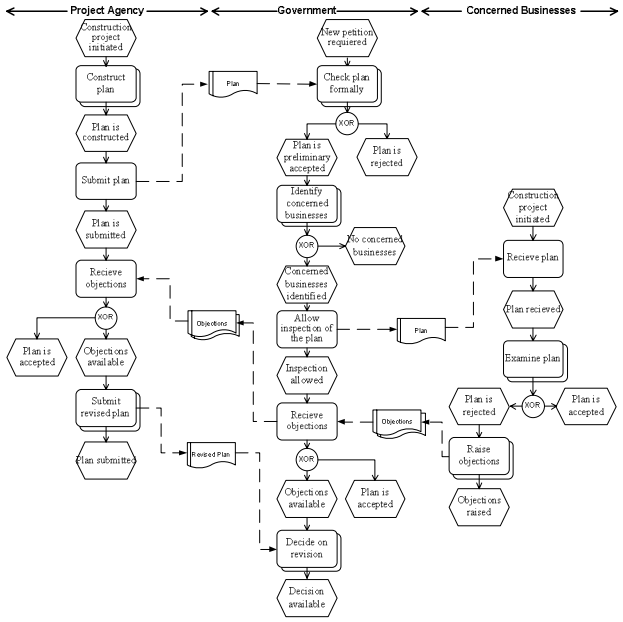

Figure 4. Part of the Plan Approval Procedure - Public Processes of Project Agency, Government and Concerned Businesses

Figure 4 shows three corresponding public processes. The disassembly of the global process to public processes was guided by the following principles: First, the public process has to show the other party in which sequence which messages are exchanged. Nonetheless, since the global process is public anyway, no information hiding must be involved in developing the public processes, e.g. all information shown in the global process can be shown in the public processes as well. For the sake of reducing complexity, these functions might be left out of the public process. On the other hand, even if functions are not directly involved in interactions, they might provide the collaboration partner with a better understanding of the process and also allow their own party to adapt its private processes better to the public process. The function "Examine plan" of the government public process is an example of such a function.

Second, to constrain complexity, the public processes show only interactions on the level of the global process. Interactions happening below that level are displayed in sub-protocols. For example, the function of "Raise objections" of the concerned business contains a communication with the function "Receive objections" of the government. The symbol of the messages lying on each other indicates a finer grained exchange of messages. The corresponding sub protocols are displayed in sub public processes. Note that public processes on this level of granularity often display standard situations which are applicable in various contexts and thus can be seen as re-usable interaction patterns.

Third, since the global process indicates the organizational units responsible for functions, the public process functions should be derived accordingly: Each function of a global process that is annotated with organization A must appear in the public process of organization A. If more parties have an organizational unit attached to this function, it has to be decided how this function is split up. Normally, an exchange of messages between the parties must take place. An example is splitting of the function "Check objections" from the global process to the two functions "Comment objections" and "Decide on revision" from the public processes of government and project agency.

5. Implementation phase

5.1. Relating conceptual CBPs to Business Protocols

In order to execute collaborations between two or more partners apart from a modeling method for CBPs, a method which allows companies to execute CBPs is needed. Therefore, the concepts of Private Process, Public Process and CBP described above for the aim of modeling CBPs on a conceptual level, can be matched to the more technical, Web Service and protocol related terms of abstract process and global model to enable their execution by IT systems. The interactions between various parties (e.g. CBPs respectively global models) can be described with WS-CDL, interactions of one service with its partner services (e.g. public processes respectively abstract processes) can be described by BPEL.

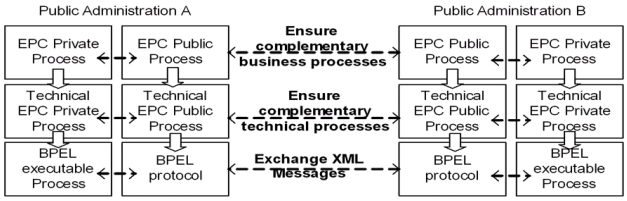

Figure 5. Process types involved in protocol development

Since the interactions realized by protocols should be controlled by business analysis, we propose an EPC based design of the (BPEL) protocols. As figure 5 illustrates, we propose a two step transformation from the EPC level to the Web Service level. On the upper level, private and public processes are modeled by business analysts as described in section 3. Afterwards, these EPCs are enriched with Web Service specific information and shaped according to conventions for compliance with

BPEL processes. These models contain the Web Service invocations (also describing the message exchanged between collaborating administrations) and all control flow information relevant to specify the sequence of interactions. Note that this type of EPC processes can also be used as a visualization of BPEL processes. In the second step these technical EPC processes are further enriched by BPEL programmers, e.g. with variables used in a BPEL process to realize the control flow specified by the technical EPC process, and annotated in XML.

In section 3 it was described how conceptual models are derived in a coherent way, ensuring that the public processes of collaborating parties are complementary. Following this model driven approach ensures that the implementation of the CBP is compliant to the conceptual model. Nonetheless, since the technical model contains further information (e.g. the name of Web Services to be invoked), the technical public process models have to be synchronized as well.

Loop), nearly all control flow elements of EPC can be transformed to BPEL. If the EPC functions represent interactions (e.g. "receive message", "send message" etc.), they can be transformed to corresponding BPEL orders, if an EPC functions represents activities not captured by the BPEL syntax (like "Examine plan" in figure 4) an individual Web Service has to be created that will be invoked by the BPEL process. In Ziemann and Mendling [26] further details regarding the transformation of EPCs to BPEL are described. The result of the transformation from the EPCs in figure 4 to the BPEL aligned EPCs is illustrated in figure 6.

The whole interaction takes place between three Web Services, one offered by the Project Agency ("ProService"), one by the Government ("GovService) and one by the Concerned Business ("ConService"). The left side shows the abstract process of the Project Agency which interacts with the abstract processes of the Government. On the right the interaction between the abstract processes of the Government and the Concerned

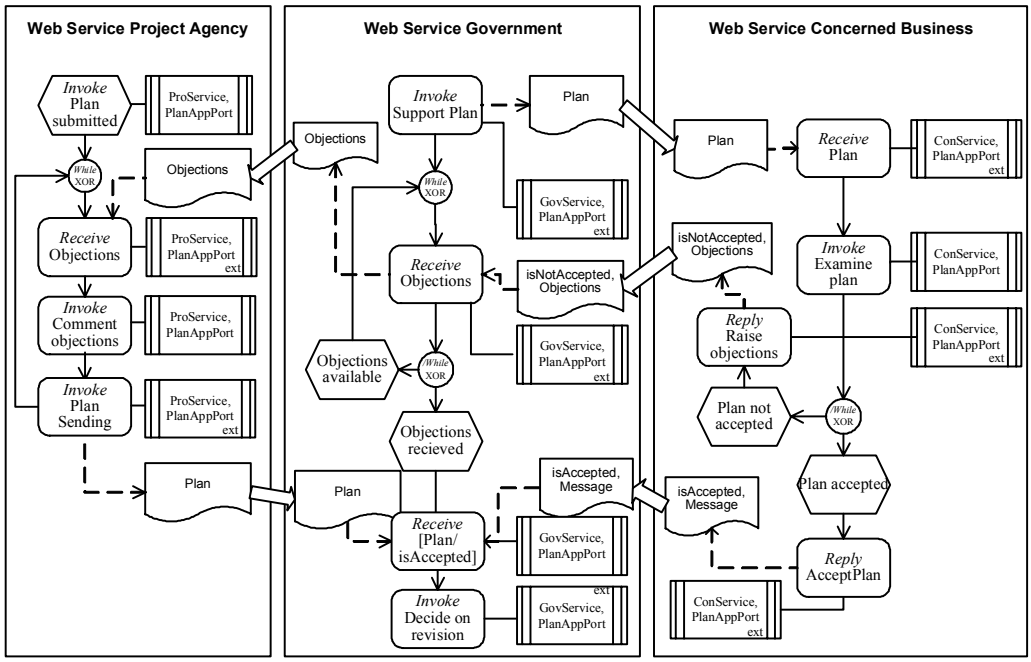

Figure 6. Technical EPC processes: Public Process of Project Agency, Government and Concerned Business

5.2. Deriving Web Service Protocols for the Plan Approval Procedure

Based on the public processes shown in figure 4, now technical EPC models are derived that contain the BPEL syntax necessary to specify the interactions between both parties. Since BPEL can represent both a graph based and a block-oriented control flow (e.g. a containing a While

Business is shown. The source and destination services are attached to the interaction activities, e.g. "Invoke Support plan" sends a message called "Plan" to the concerned business service. The notation distinguishes between internal Web Services (e.g. "Comment objections" is invoked by a Web Service inside the project agency) and external Web Services, marked with the letters "ext". The abstract processes only contain the

information necessary to describe the interaction with the other Web Service.

6. Summary and future research

Rapid advancements in technologies and regular emergence of new legal settings raise new challenges for public administrations. Thus, in recent years the development of interoperability frameworks has gained importance due to the fact that more and more public administrations within Europe are challenged to work together and to adapt continuously to rapid technological changes. Without interoperable E-Government systems, today's public administrations struggle to keep pace with rapid evolving economic alterations.

In this context, we presented a framework that supports the systematic development of interoperable software systems in the public sector. The frameworks consists of four axis: 1. system views as known from enterprise modeling, 2. collaboration views displaying different model types for representing cross-organizational processes, 3. an application development life cycle and 4. a dimension that represents specific eAdministratrion scenarios. This concept was motivated and illustrated on the basis of a German E-Government reference model.

We described how this framework can be instantiated using EPCs (design phase) and BPEL (implementation phase) to describe models in different life cycle phases and demonstrated the transitions between this phases.

Providing a connection with the second axis, we illustrated the scenario as a global model and described how public process models can be derived from private processes and to be implemented with BPEL protocols. BPEL protocols were chosen as the target due to BPEL's explicit support of the private process/public process concept, which enables a corresponding mapping to private and public EPC processes. Accordingly, we described a transformation of the EPC based concepts to model CBPs public processes to BPEL abstract processes and illustrated this transformation by the use case introduced before.

Due it's central position this paper focused on the process part of the systems view (1. axis) while a more detailed description of the other views, e.g. how organizational roles can be communicated to partners is left for future work.

Since the controlling phase is an important part application development and enables public administrations to measure the efficiency of collaborative business processes, future research requires the development of concepts for the controlling of collaborative business processes considering public and private processes. Further on, future research should try to apply this approach for other case scenarios than PAPs and to analyze the use of supporting tools that ease the task of exchanging process models between different public administrations and to distinguish between the different model types used in CBPs. While the PAP is dealing with interaction of German public administrations, in the R4eGov project the described framework is currently tested for use in more complex, European cross-border interactions. It can be expected, that the resulting framework could not only be used in Europe, but in other continents, also. In this context another point for future research is the comparison and connection of the presented framework with other interoperability frameworks.

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