Adaptive Workflow
for the German Public Administration

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Key Words

Workflow Management, Enterprise Process Management
Adaptive Workflow, Ad-hoc Workflow

Abstract

The public administration represents a huge enterprise dealing with different and variable tasks. Apart from well structured processes like vacation or travel requests, they have to perform complex and long running activities depending on internal and external events. One major problem is that some parts of the processes can't be planned in advance or have to be modified during execution.

Using workflow management support for a wide area of business processes requires systems with powerful modeling and flexible execution mechanisms. Moreover administrators and users should be able to refine or modify pre-defined workflows manually. These ad-hoc modifications must be controlled concerning different aspects like workflow adaptivity rights, workflow consistency checks and workflow integrity rules.

After a short motivation and some information about the project PoliFlow, the first section will clarify some frequently used terms in the context of adaptive workflow and will introduce a simple workflow description model.
The second section describes the user scenario - the German public administration - with an example process that needs adaptive support.
After an overview of requirements and benefits of adaptive workflow management systems in section three, our solution strategy will be presented in section four. The paper will be finished with some conclusions and a short overview of our further research directions.

1. Introduction

1.1 Why Adaptive Workflow?

Looking at the evolution of workflow management systems, different roots can be made out. One of the oldest roots are data processing applications. Data and control flow between specific activities have been hard-coded supporting a special process. Accordingly, all the knowledge about these highly structured processes had to be known in advance and was fixed in the code. This approach was suitable for applications in the area of banking or insurance business, where well known and structured processes should be automated.
Then the first workflow systems could be used to manage different processes by isolation of process description and process execution. Nevertheless, the processes had to be well structured and most of the process properties had to be defined. Besides, systems have been built to support unstructured and cooperative work. In the research direction of CSCW methods and tools have been developed to support less structured processes, too.

In the meantime limitations of this distinction have been realized [NasHil94]. The majority of processes can't be classified as structured or unstructured. On the one hand processes can be semi-structured with some given and some unknown details. On the other hand most processes are composed of several parts where structured parts arise as well as unstructured parts.
Potentials of workflow systems exceed automation of single and isolated processes. Using workflow management systems for an enterprise-wide process support is the challenge for tomorrow. But therefore some properties are of special importance:

- Applicability for different types of processes within different application areas.
- Support of both, structured and unstructured process parts.
- Flexibility and adaptivity of workflow control.
- Supporting ad-hoc modifications during runtime.

1.2 The PoliFlow Project

The decision of the German federal government to move parts of the administration from the former capital Bonn to the new capital Berlin will have direct impact on the working methods of all federal departments. Due to the movement there is a need of new solutions for communication, coordination and cooperation in this distributed working environment. Therefore the research program POLIKOM was funded by the German secretary for education, science, research and technology (BMBF).

The mission of POLIKOM is to develop fundamental technological and scientific solutions, to support business processes in the German public administration by information technology. Due to the distribution of departments and the variety of business processes, there is a need for highly flexible workflow management of intra and inter department business processes with different levels of structuring [POLIKOM].

Some of the problems concerning flexible and adaptive workflows have been addressed in one of the four POLIKOM projects named PoliFlow. The aim of PoliFlow is to provide reliable, secure and adaptive Workflow for widely distributed application environments with integration of groupware and telecooperation services [PoliFlow].
Current research directions in the area of adaptive workflow are dynamic workflow modifications during runtime and the integration of unstructured process parts by

- supporting ad-hoc modifications of active workflows,
- integration of synchronous telecooperation services,
- integration of other groupware services.

1.3 Terms and Definitions

With the increasing number of workflow publications some terms like *adaptive workflow*, *structured and unstructured processes* or *ad-hoc workflows* are frequently used with different meanings, especially structured and unstructured workflows are often implicitly described with examples.
Describing the structure of a finished workflow isn't difficult, but typically execution of workflows means instantiating of workflow definitions that have been defined in the past. So the real problem is that all information required to perform the process should be available during buildtime [Wain+96].

From our point of view, two aspects determine the level of process structure:

- the time when information will be available (buildtime, instantiating, runtime) and
- the way information can be gathered (e.g. given by definition, automatically extractable, interactive/manually).

Depending on these pieces of information, workflows will be performed and controlled. Adaptivity in the context of workflow management means that some aspects of performing workflows can only be determined during runtime instead of being totally defined during buildtime.

1.4 Process Representation

To discuss certain properties of adaptive workflows our workflow model will be briefly introduced. The model should be used for external representation of workflows for which it must be both, easy to understand and powerful anyway. For this reason an activity-oriented notation has been chosen, where activities and subworkflows (double-lined) are represented as nodes and explicit predecessor-successor relationships are represented by directed edges. Edges can be inscribed with conditions about workflow control data and internal (e.g. finished(Activity)) or external events. If there are more than one outgoing edges all predicates will be evaluated to determine the workflow paths. In case of more than one incoming edge, the conditions hold information whether the preceding activities need to be synchronized or not.

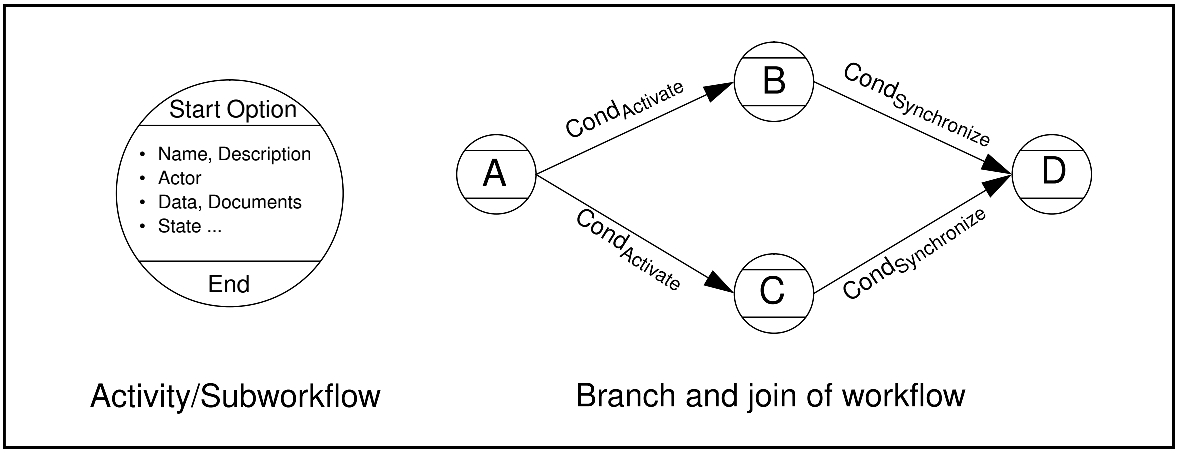

Figure 1: External workflow representation

Activities and subworkflows can also be inscribed with conditions. There are two conditions which are important for specifying complex and descriptive workflow control structures.

- The *Start* condition indicates when an activity can be started.
- By defining an *Option* condition activities can be marked as optional. If the condition is fulfilled, the activity will be canceled and won't be started any more.

Furthermore each activity (or subworkflow) holds a set of attributes that specify characteristics like name, description, specific types, data flow, used documents and applications, actors, current state etc.

2. User Scenario

The public administration represents a huge enterprise dealing with all kinds of tasks. Different characteristics of the user environment represent the challenges of workflow systems for tomorrow. The public administration is typically structured into three levels: federal, regional and local authorities. In spite of a certain autonomy of the single authorities there are lots of connections between them. As a result they need coordinative and cooperative support for a variety of business processes flowing between widely distributed organizations [Schwen96].

2.1 The German Public Administration

The organization and smaller business processes of the public administration are very well structured and defined. Typical characteristics are exact job descriptions, task formulations and allocations of responsibilities. These processes are similar to processes in other office automation environments (e.g. vacation requests or accounting of official journeys).
Nevertheless there is a vast number of processes that need adaptive support. Especially in complex and long-running processes activities have to be managed in explicit planning phases which have an impact on the following process parts. Because of the strictly defined rules how activities have to be performed, processes get very complex and modeling of all exceptions gets too much expendable. Within these complex processes we can find lots of unstructured parts which can't be planned, defined or automated ahead.

Some complex subtasks have to be fulfilled by cooperative groups or external organizations. Long running processes often contain decision points and need process refinement during execution. Besides, some pretended structured and active processes need to be modified because of new restrictions, decrees or decisions of the legislature.

2.2 The Business Process

The process being described here will not be performed exactly this way. Due to complexity of the total process only a slightly modified process part will be introduced to show special features that need adaptive support.
Caused by the relocation of some authorities from Bonn to Berlin new buildings have to be acquired or built. As user input a document with all needs and wishes will be required to start a planning phase for the buildings. This chapter will describe the planning phase which can last up to half a year.

Having completed a first project plan including time, personal and cost schedule the explicit planning phase is next. Therefore all necessary plans will be created, checked and the project plan will be updated. After that a detailed cost schedule will be produced and appended to the documentation. The user has to validate the plans making some annotations and giving or refusing his or her agreement.

Then all documents and plans have to be checked by the responsible regional authority. If there are any complaints, they have to reenter the planning phase. Otherwise a decision has to be made whether the building activities will be approved or not.
Subprocess *Cost Schedule* can be refined into a coordination task where responsibilities will be assigned, several scheduling tasks where the costs will be determined, and a documentation task where all the results will be brought together to generate the cost schedule document. Within the scheduling tasks some rules are given how costs have to be analyzed. To determine the costs for cheap goods is quite simple. The actors compare some prices and choose the best offer. If the costs will exceed a certain limit, they need three written offers and in special cases a prescribed advertising operation has to be performed.

2.3 Ad-hoc Modifications During Execution

Within this scenario the need for multiple and different adaptations can be identified.

1) Usually the planning phase starts after user requirements have been completed and advance notification of costs has been approved. In some situations these preconditions must be overruled to start the process at once.
2) While making the *Project Plan* some external documents (e.g. letters to other authorities) must be added to the workflow or additional activities (e.g. agreements to define the time schedule) must be started in context of the given process.
3) In special cases predefined workflow paths can be changed to shorten some bureaucratic steps. E.g. having an extremely urgent request, the actors may decide whether their disciplinarian need to sign a document or if they should directly hand it down.
4) The subworkflow *Planning Phase* contains highly creative tasks depending on several constraints which can't be defined and automated during buildtime. So it needs to be refined ad-hoc at runtime where, all necessary tasks can be defined and modeled (e.g. assigning external offerers, allocation of internal resources etc.). The results of this planning activity heavily influence further workflow parts because they have to be integrated.
5) The subprocess *Cost Schedule* must be coordinated, too. Depending on the contents and structure of the generated plans, work will be divided into single tasks and maybe assigned to special actors. These tasks eventually also need ad-hoc refinement or actors

need to start several subworkflows (e.g. asking for offers, starting advertising operations or procurement of external documents).

6) Due to complexity of the performed activities, frequently queries to other workflow participants are required. Communication can be either asynchronous via mail or synchronous via phone or videoconferencing but the results of these discussion must be fixed with the activity results.

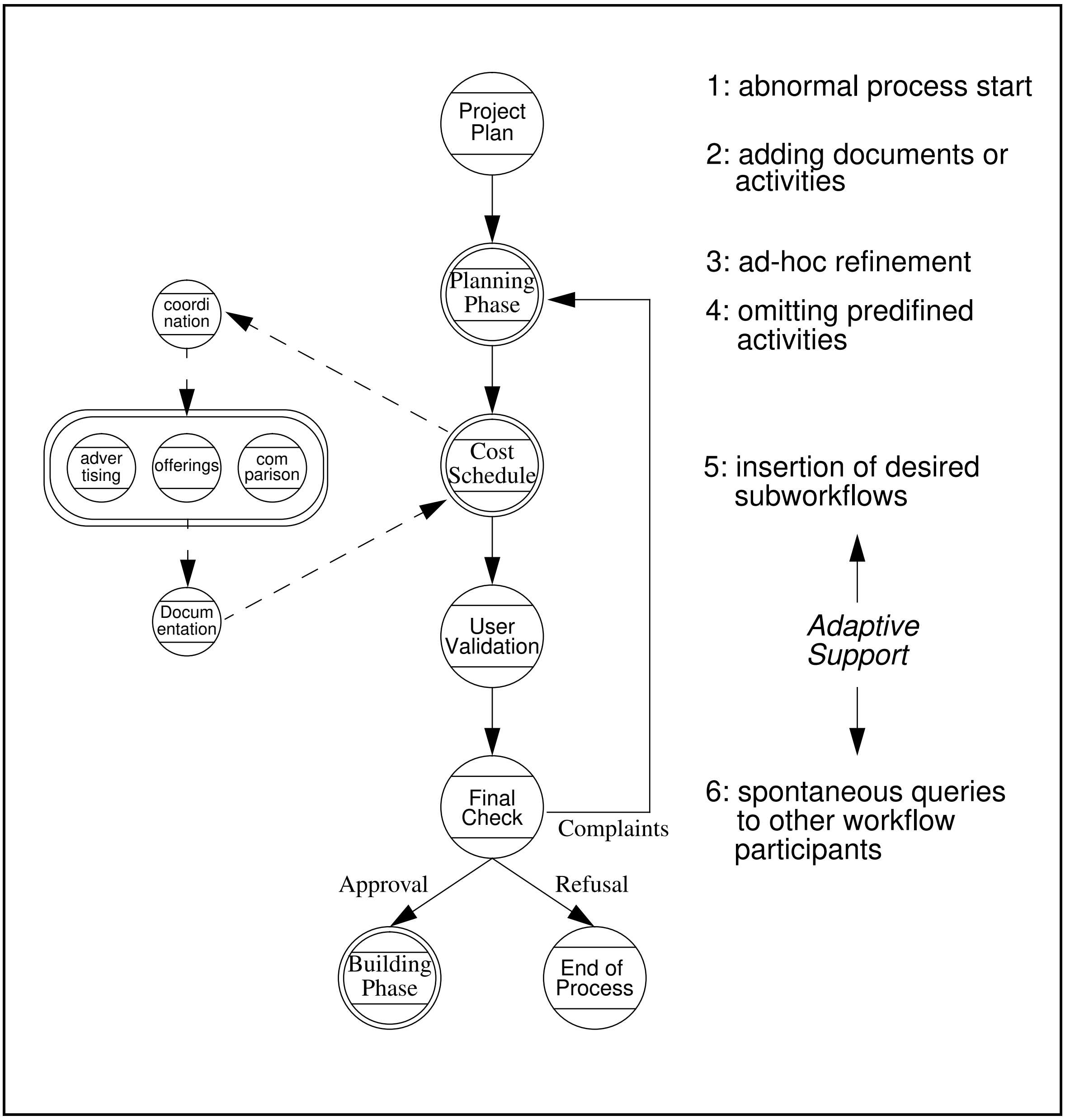

Figure 2: An example process that needs adaptive support

3. Adaptive Workflows - Requirements and Benefits

In this chapter some global requirements of adaptive support will be derived from the user scenario and significant current solution approaches will be shortly introduced.
Following this, existing challenges, unsolved problems, and potentials of benefit in the direction of adaptive workflow will be discussed.

3.1 Requirements For Adaptive Workflow Support

There are some important requirements arising from the described scenario. Some adaptations can always be inhibited through detailed modeling but nevertheless there will be a big advantage in adaptive support.

- Modification of single workflow attributes

To inhibit a large amount of exceptions it should be possible to modify special workflow attributes during runtime. Sometimes there is a need to assign single tasks to a special actor (e.g. *Cost Schedule - coordination*) or to modify preconditions or temporal aspects of an activity. In some situations it may be useful to change predefined workflow rights (e.g. access rights of documents) or to initiate external events.

- Abnormal process start or stop

Workflow owners, administrators, or other participants sometimes need to start or stop special activities or subworkflows. Perhaps workflow participants must be notified about the abnormal start/stop or other actions have to be performed.

- Omitting of defined activities/subworkflows

In special situations workflow actors decide that following activities should be omitted or suspended. Taking these measures workflows can be continued in spite of local problems within pending activities.

- Workflow extensions (add-ons)

According to the latest information it might be necessary to add activities or subworkflows to the active workflow. These addings can be related to subsequent process parts or to activities that are still under work. In the first case activities and subworkflows can be added to the workflow description and get activated the familiar way.
In the second case adaptive support is needed where predefined activities or workflows can be started in the context of the given workflow. There are three different ways of synchronizing ad-hoc part and predefined workflow:

- The new part runs independently and doesn't need to be synchronized.
- The new part has to be synchronized with the end of the calling activity.
- The new part has to be synchronized with another part of the given process.

❑ Explicit modeling of adaptive constructs

Besides some situations where adaptive support can't be predicted there are some workflow parts where adaptive support can be anticipated. Therefore special constructs must be integrated into the workflow model to define for example interactive decision points or predefined refinement activities. In comparison to unexpected adaptations some workflow aspects can be (partly) defined in advance, respectively adaptations can be restricted by constraints.

3.2 Current Solutions

The requirements stated above are very important to applicability of workflow management systems. More and more vendors have recognized the problem and different solutions can be found on the workflow market. Regarding the evolution of today systems three directions can be observed:

- Integration of simple ad-hoc workflows
  Lots of vendors followed this approach and offered an opportunity for ad-hoc modeling of simple workflows. Most of these systems (typically based on Windows and mailing) provide user friendly graphical interfaces to model document oriented flows. But usually there is no way to model several workflow aspects of complex workflows depending on rules and events.
- Integration of groupware platforms
  Another direction is to support unstructured work by integration of groupware platforms. The idea is quite simple, too. By adding the functionality of CSCW systems certain unplanned ad-hoc and group tasks can be supported. But like media breaks between online and printed documents within one process we now have to observe breaks between structured and unstructured parts of work. The main problem of this approach is that work during these unstructured phases can't be controlled by the system sufficiently. This often results in the loss of several advanced but important features, like security or consistency.
- Workflow modifications by administrators
  Some systems offer the opportunity to change some aspects of active workflows during execution. Following this approach adaptations of defined workflows will be possible. The main problem concerning this solution is that these modifications typically have to be performed by process owners or administrators because special skills will be required e.g. editing a workflow instance description.

3.3 Unsolved Problems and Benefits Concerning Adaptive Workflow Support

All present solutions are successful for specific process types or several workflow aspects but restrictive to others. Beside the difficulties of the approaches stated above, there are some other problems concerning adaptive workflow support. Some of them will be addressed in the next section where a solution strategy will be introduced.
Other problems need to be analyzed and addressed in future research work.

- Why have adaptations been necessary? Could they have been predicted or not? Can they be avoided or not?
- Should adaptations affect only one specific workflow instance or should they be assigned to all (active) instances of one workflow type. How can they be assigned?
- Should modifications of active workflows been performed anyway? What about rules and constraints which define restrictions to control modifications?
- Who is allowed to modify the workflow? When and under which circumstances may workflow participants use adaptive support?
- Could adaptive support be offered to all workflow participants in a user friendly way?

General benefit of tools depends on quality and quantity of the support which will be achieved with. Related to workflow management systems quantity aspects are applicability for a wide range of processes or user-friendliness. The main quality aspect can be described as the level of support the system provides for the users.
Regarding these requirements adaptive support will increasingly become a relevant factor for applicability of workflow management systems. Especially the public administration needs adaptive workflow to support all the different processes that have to be managed between cooperating organizations.

Some benefits could also be partly achieved with traditional workflow systems but they will be considerably influenced by adaptive support.
Enhancements of process quality can be obtained through flexible and fast responses to unexpected events. Lots of exceptions will increase the costs of modeling workflows, that's why adaptive support will result in considerable cost savings.
By performing adaptations users are able to participate in the processes in an active way. Autonomy of the actors will be encouraged although the system guarantees global control. This will lead to high acceptance and motivation of workflow participants.
Finally adaptive support will have positive impact on project management tasks because they will be heavily supported by the workflow system. Project leaders will be able to adjust the defined processes to current situations.

4. Solution Strategy

Information needed to perform a workflow (instance) will typically be administrated by the workflow management system. The main idea of the following solution approach is to define an interface for modification of workflow instances. Using this interface workflow participants may perform modifications or use adaptive support which results in modifications of the workflow instance. Modifications will be checked and performed by a component called *workflow modification services*.

4.1 Flexible Workflow Systems

Maybe the best solution to handle adaptations is to avoid them. Combining very flexible execution mechanisms with powerful modeling techniques will be the best basis.
As stated above one major reason for adaptations is that modeling of very complex control flows regarding lots of exceptions will be highly expendable or impossible (for several systems). Furthermore adaptations which can be anticipated particularly can be supported automatically.

Some concepts providing flexibility are used naturally like modularization [Jablon94] and usage of variables in control structures (e.g. for separation of organizational aspects like roles). But they are not sufficient at all. Some short examples will be given how workflow management systems can be made more flexible.

- Apart from prescriptive descriptive control structures must be supported, as well.
- Internal, external, and temporal events should be integrated and included into conditions and predicates. Also knowledge about history and causal aspects should be included controlling flexible workflows (e.g. assigning tasks to special actors).
- Specific organizational procedures (e.g. delegation, check-back, hold-files etc.) and predefined adaptations (decision points, ad-hoc refinements, predefined startable subworkflows etc.) can be integrated to avoid difficult manual adaptations.
- Advanced organizational support (roles, representative rules, single actors/groups etc.).

4.2 Workflow Adaptivity Rights

Avoidance is quite important but not all adaptations can be avoided or automated. There are lots of situations where expected or unexpected modifications will be required. Therefore it has to be defined which adaptations may be performed by which actors. These rights may be bound to temporal or other constraints (e.g. state of the engine, current role of the actors). Due to variety of adaptations and workflow parameters that are desired to be changeable detailed and separate modeling of all aspects is impossible. So it will be necessary to reduce the complexity by classifying users, workflows and adaptations to define appropriate rights for certain combinations.

- Workflow roles
  Some systems at the time offer several special workflow roles (like administrator, owner, designer) which are linked up with adaptivity rights (see chapter 3.2). But this kind of static assignment is not flexible enough because some rights need to be assigned dynamically. E.g. actors should only be able to modify activities they are currently working at.
- Workflow types
  Depending on the level predefined workflow attributes have to be definite, workflows can be grouped together being classified (e.g. regulation, default, suggestion). Depending on this workflow type adaptivity rights can be handled more or less restrictively.
- Adaptivity types
  In addition to workflow roles and types adaptations can be grouped and classified according to the level they will affect predefined workflows. So adaptivity rights could be linked with groups of comparable adaptations.

Another way to simplify modeling of adaptivity rights can be achieved by inheritance (as default value) between workflow and subworkflow respectively between subworkflow and activities.

4.3 Workflow Consistency and Integrity Rules

Adaptations will be caused by external and unexpected influences; an adaptation which is necessary in one situation may be forbidden in another one. For that reason further concepts have to be integrated to control desired adaptations.

One way to manage these adaptivity constraints are structural consistency and integrity rules. Consistency rules typically will be defined depending on the workflow model and will be fixed. Integrity rules can be oriented at single workflow types and differ from process to process. Performing workflow adaptations, the system has to check consistency and integrity rules and decides whether the modifications will be accepted or not. This aspect can also be integrated into the concept of adaptivity types.

For example adaptations which violate some structural constraints will have more effect on the workflow hence a high adaptivity right will be necessary to perform them.

Whereas very local adaptations of workflows typed suggestion ensuring all structural constraints could be performed by any current actor.

4.4 Editing Workflows ‘On the Fly’

Using a very powerful workflow model combined with a highly flexible execution machine the effort of defining, refining or modifying workflows will increase rapidly. Besides, the skills required to edit the processes will increase, too.
But like stated above user-friendliness and simplicity of using the systems are major requirements for workflow management systems. An additional requirement for adaptive systems will be that all workflow participants are able to perform necessary adaptations (maybe within different levels of detail).

Therefore a simple user interface is needed to specify desired modifications within a graphical workflow editor. The relation between external (for the user) and internal (for the system) workflow representation must be unique in both directions.
Further adaptations will be supported by offering predefined workflows (libraries) and other features like advanced organizational procedures (e.g. hold-files).

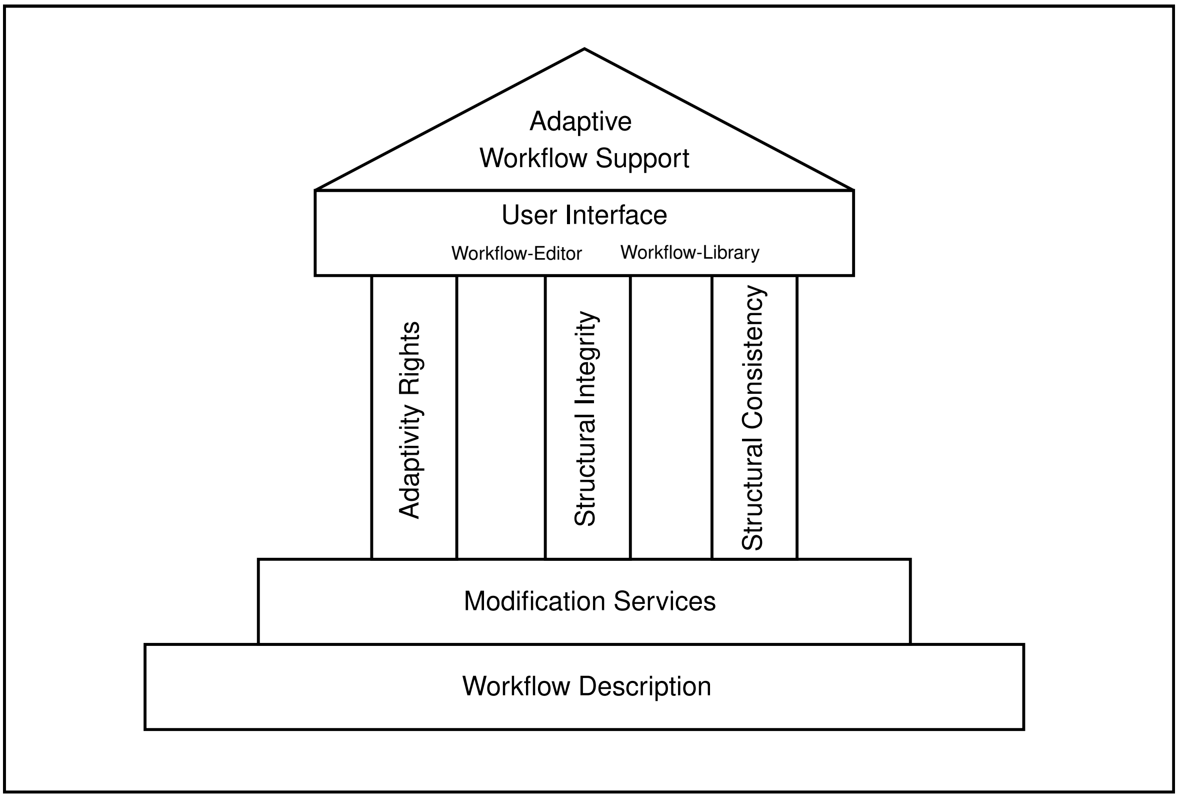

Figure 3: Adaptive workflow systems supporting unstructured tasks

5. Conclusions and Further Work

The growing number of computers in industry and administration and the distribution of organizations all over the world will heavily influence enterprise process management.
In this paper needs and challenges of adaptive process support especially in the application environment of the German public administration have been discussed. Finally a solution strategy has been introduced to show how structured and unstructured processes can be continuously supported by adaptive workflow systems. Because of the heterogeneity of this scenario the results can be easily applied to other business areas.
Currently all parts of the presented strategy are still under work. Based on a flexible workflow model using THOR-Nets (high-level petri nets) adaptivity rights will be integrated. Main challenges concerning our research work have been identified in the area of structural integrity rules. After completion of analysis applicable concepts will be developed and realized.

6. Bibliography and Further Information

[Jablon94] Jablonski, Stefan : MOBILE: A Modular Workflow Model and Architecture. In Proc. 4th Int. Working Conf. on Dynamic Modelling and Information Systems, 1994.

[NasHil94] Nastansky, Ludwig; Hilpert, Wolfgang : The GroupFlow System : A Scalable Approach to Workflow Management between Cooperation and Automation. In Wolfinger, Bernd (Hrsg.) : Innovation bei Rechen- und Kommunikationssystemen. Springer, Informatik Aktuell.

[Schwen96] Schwenkreis, Friedemann : Workflow for the German Federal Government - a position paper. In Proc. of NSF Workshop on Workflow and Process Automation in Information Systems. Georgia, 1996.

[Wain+96] Wainer, Jacques; Weske, Mathias; Vossen, Gottfried; Bauzer-Medeiros, Claudia M. : Scientific workflow systems. In Proceedings of NSF Workshop on Workflow and Process Automation in Information Systems. Georgia, 1996.

POLIKOM and PoliFlow
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