# Human Activities in Distributed BPM

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**Abstract:** The general concept of inter-workflow system communications has been proposed by the WfMC in 1995. However, there has been little study or use case on general inter-workflow system communications, except for business massage exchange-based protocols. Since BPEL allows a local system to invoke remote BPEL Processes via Web Service interface, this can be used as a mechanism for inter-workflow communications for BPEL Processes. Currently, however, it causes a problem if the remote BPEL Processes use BPEL4Peole extension and include People Activities and Human Tasks. This is because BPEL4People has not anticipated Processes to be called remotely and there is no provision for the remote invocation of the user interfaces. This paper studies a possible mechanism in which a local system can invoke a remote BPEL Process with Human Tasks and let local users perform human activities via user interfaces that are defined in the remote Human Tasks.

## 1 Introduction

The aim of business process management system (BPMS) is to aid business processes with a good balance of manual and automated resources. The computerization is expected to contribute to the better organization and management of entire system by transferring some of the functionalities and activities to automated resources. The manual resources, i.e. human activities, have been recognized as one of the essential elements that drive the system [Ha05].

Although it is not the only model, it is thought that one of the natural models for business processes is a workflow model. To allow componentized and modular architectural design and to allow different vendors to integrate easily, it is also considered advantageous to implement the workflow model with Service Oriented Architecture (SOA) [Oa07].

One of such models, Web Services Business Process Execution Language (BPEL), was designed mainly for automated processes and Web Services were used [Oa07]. Scientific Workflows are also designed for automated processing of data [De08]. One of the Scientific Workflows, Taverna Workflow [Oi04], also resembles BPEL to some extent, probably because its workflow language was originally derived from the IBM Web Service Flow Language (WSFL), a predecessor for BPEL. A recent trend is that these automated workflows are now incorporating human interactions into the workflow designs and the systems. WS-BPEL Extension for People (BPEL4People) and Web Services Human Task (WS-HumanTask) extend the BPEL with a People Activity a Human Task, respectively [Ag07a, Ag07b]. In this paper, we refer them as BPEL4People unless we need to refer them separately. The Taverna Workflow now can have so-called Interaction Service nodes in its workflows [LO08]. The Interaction Service typically sends an email notification (a) with a simple question and a return URL or (b) with a URL for a Web application that provides interactions. The user may respond with a simple answer or use the Web user interface on a remote Interaction Service server to prepare more complex response, respectively.

Our system (Research Activity Management System, RAMS) also uses human activities in workflows [Da06]. It uses human-flow workflows (or group workflows) as it is loosely based on IMS Learning Design model [Im03]. Since this workflow is different from other types of workflows, we have initiated an integration project to incorporate Scientific Workflows and BPEL-based business processes into RAMS workflows.

There are different ways by which different types of workflows may integrate or communicate. This has been documented by the Workflow Management Coalition (WfMC) [Ho95] and we also produced a research document considering options in integrating human-flow workflows and Scientific Workflows [Ta07]. In Business Processes, inter-business communications as messages or choreography have been actively studied but there has been little study on more general inter-workflow communications.

One of the ways to achieve inter-workflow communications is that some workflows and BPEL-based business Processes can be invoked remotely. In RAMS, this can be easily achieved by providing a new Tool Activity [GD07]. We may name such an activity as Remote Process Tool Activity. Alternatively, a remote workflow may be integrated by converting it to a Web application with a Remote Web Application Tool Activity. The first of such an attempt was to integrate Pegasus Workflow Management System [Le08] by using a Web application interface. (The details will be published elsewhere). If the remote workflows or processes contain human activities, however, this poses a problem.

For example, a workflow definition of Taverna Workflow can be invoked from the Remote Workflow Tool Activity. If the execution point of the workflow encounters a human activity (Interaction Service), it should request a manual input from the invoker of the remote workflow who is on our system. Currently, each Interaction Service (representing a notification server) of a Taverna Workflow can be configured to send email notices of the required human activities to a fixed email address declared in its configuration. There is no way to allow the remote workflow server to accept dynamic email addresses for different invokers or to call back our workflow system to present the notification, human interface, or to return the results.

Likewise, RAMS may invoke a remote BPEL4People-compliant process. However, the BPEL4People syntax allows the human activities to be performed by only the remote users on the remote host. It does not allow local RAMS users to perform the Human Tasks defined in the remote Processes [Ag07a, Ag07b]. For example, imagine a travel plan business process hosted on a remote host by some travel agency. When we invoke it from our system, we want the local invoker to fill in all the interactions required and to receive the output when it is completed. The current syntax allows human users on the remote host to perform the human activity, but not users on the local host.

Also, the nature of the processes and workflows containing human activities or of the Scientific Workflows is that they are long-standing. Most likely, the invoker will have to proceed with other Activities on the current workflow. The user may either return to check the results, receive a notification to retrieve the results, or use another Tool Activity that shows the pending jobs or returned results. In other words, asynchronous invoking arrangement should be in place.

For these reasons, invoking remote Business Processes or workflows that contain human interfaces poses a unique technical and research problem. BPEL4People V. 1.0 has been proposed only recently (June, 2008) and also no one seems to have considered the complication of invoking BPEL Processes with BPEL4People extensions as remote Processes. In our knowledge, there is no previous study that examined the full implications of invoking remote Processes or workflows that have to provide human interfaces. This paper, therefore, addresses these problems and presents a possible mechanism to achieve such interactions.

This paper first explains how a remote BPEL Process may be invoked by another workflow system, then points out the problem in case human activities are included in the Process, and presents a solution. Also, although the paper mainly focuses on BPEL and BPEL4People, it also compares it with Taverna Workflow in which an inter-workflow communication has been achieved by a simpler mean. Although the initial examples also mentions RAMS, the principle presented is general and not limited to any particular implementation. The figures used for illustrative purposes are loosely related to the UML Component Diagrams and Activity Diagrams (OMG07). A strict adherence to the UML formalism, however, is not observed.

## 2 Workflow Integration via Invocation

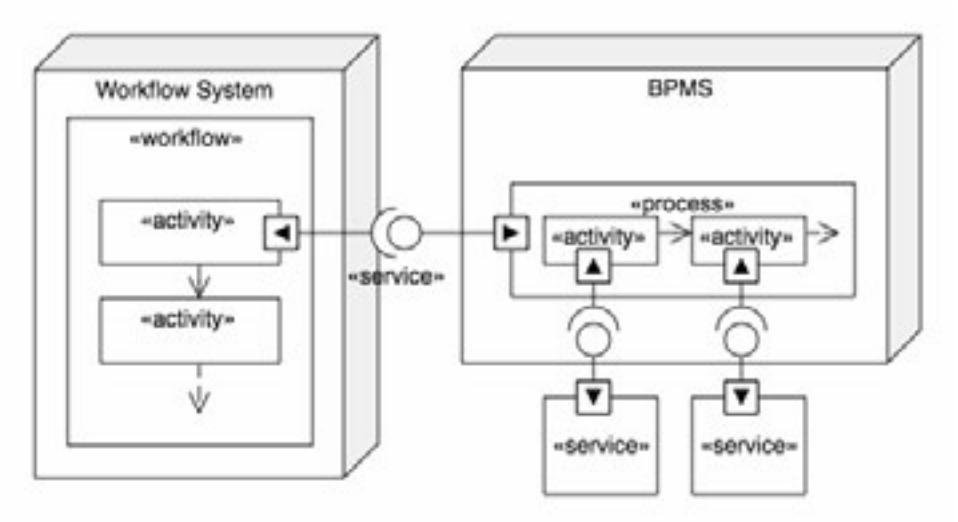


Fig. 1. Process Integration by Invocating a Process from an Activity.

One of the ways to integrate a workflow (e.g. a RAMS workflow) with a remote workflow (e.g. a BPEL Process) is to give a RAMS Activity an ability to invoke a remote Process. Our user Activities are called Tool Activities, because the activities use Tools that implement various tasks the end users can perform [GD07]. Tools are plug-ins and it is easy to extend the system by adding a new Tool that is capable of performing a new activity. Therefore, RAMS system can provide a newly created "Remote Process Tool" that can invoke a remote BPEL Process via Web Interface. The remote BPEL Process may further invoke other Web Services and return results to RAMS workflow that invoked it (Fig. 1).

## 3 Human Tasks in BPEL4People

In case of remote Processes with People Activity and Human Tasks, BPEL4People syntax allows only the remote users to work on the Human Tasks (Fig. 2).

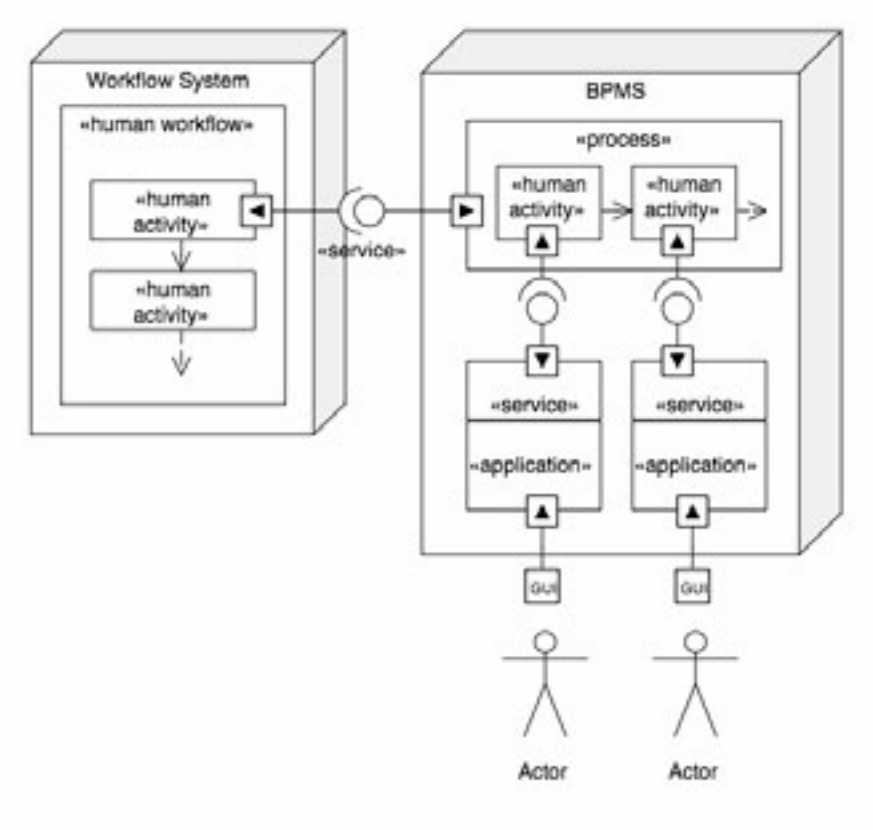


Fig. 2. Human Tasks in Process.

The Human Tasks are presumably managed by a Task Manager, which creates Task instances by reading the Process design and manages its life-cycle and provides a user interface, Task List, for users to work with life-cycle of Tasks (Fig. 3). (A Task Manager is not defined in BPEL4People, but it is a presumed functionality of collection of Task life-cycle management activities suggested by the standard). An end user can claim and start a Task from the Task List. Starting a Task will take the user to the application interface of the Web Service, which has implemented the actual work of this Task as an application. The Web Service has a triple interface, Web Services interface, Task life-cycle management interface and the application interface. Fig. 3 has omitted the life-cycle management interface since that is not relevant to the subject of this paper. BPEL4People also uses a term People Activity, but here it is called a human activity.

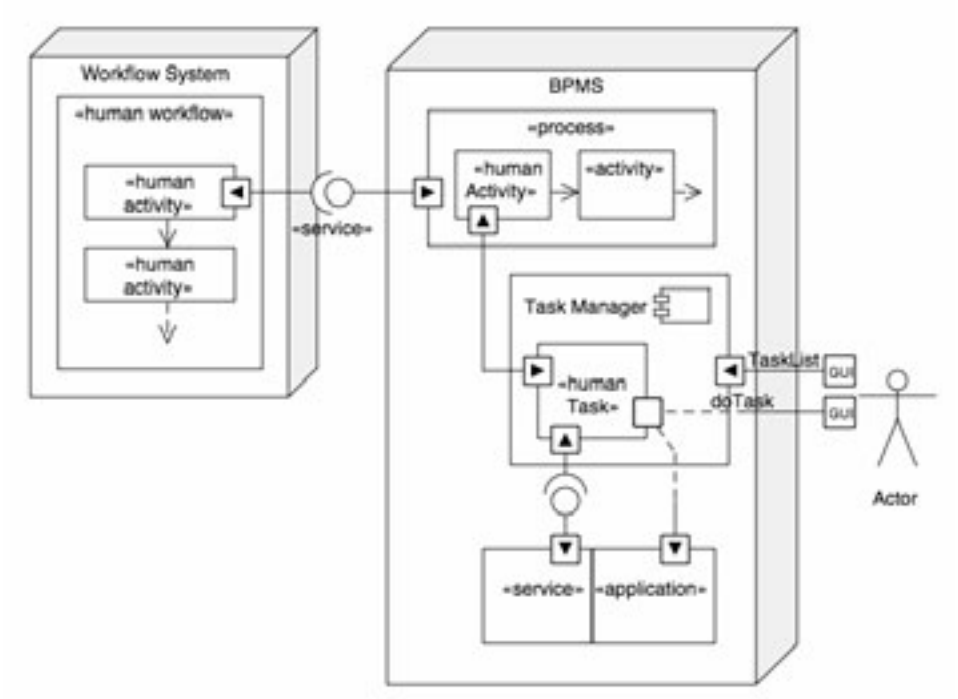


Fig. 3. Task Manager and Human Task.

## 4. Modifications Required for BPEL4People to Allow Local Users

RAMS may invoke a remote Process that requires remote users to provide some manual work (e.g Figs. 2 and 3). What we would like to achieve, however, is for the RAMS users, i.e. local users, to be able to perform remote Human Tasks defined in the remote Process.

The presumed Task Manager provides the Task List as a way for end users to access and manage Tasks as Fig. 3. The BPEL4People indicates that a remote Task List Client may access the Task List in a standardized manner. As Fig. 4, therefore, the Task List could be accessed by a local Task List Client on RAMS system. This looks as though the local RAMS user could do the Human Tasks. The only users, however, who can access the Task List Client (the users for that Task), are the users of the Process host, as it is defined in the BPEL4People syntax. It is not poossible for the local system to let local users to work with the remote Human Tasks.

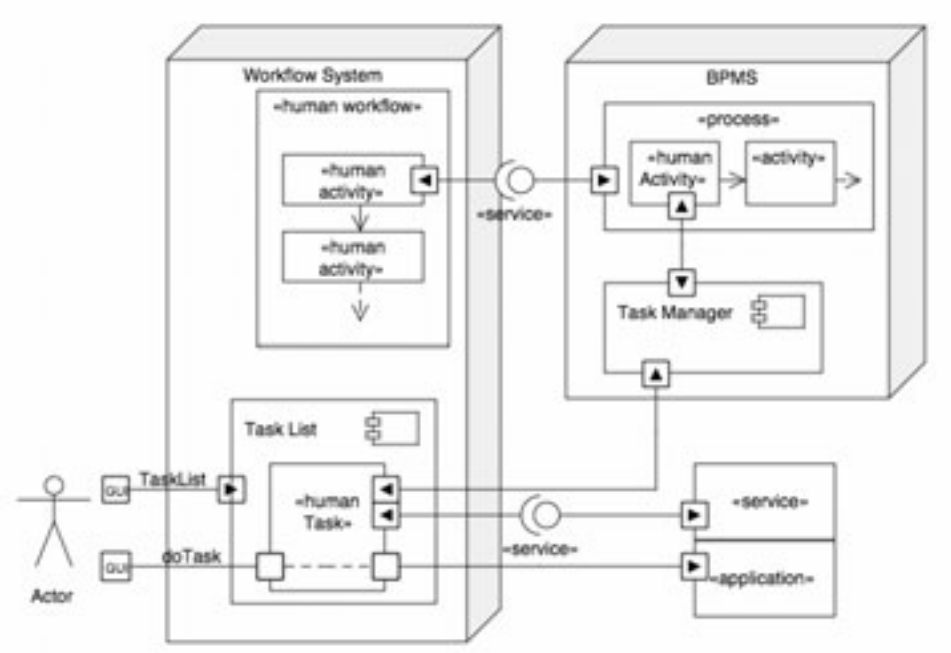


Fig. 4. Remote Task List Client.

BEPL4People allows the people information to be defined in the Process Input and a Human Task can use this information to determine the performer(s) of the Task. These are, however, remote host users. As in Fig. 5, what we need is (1) a user descriptor which describes the users of RAMS system and (2) the reference of a Task List Client to which these users belong and to which the Task Manager can redirect the Task information. In practice, probably a RAMS Task List Client will connect to the Task Manager and the Task Manager provides the List appropriate for that Task List Client. By selecting a Task on the Task List and telling it to Start (a Task life-cycle message), the end user will get the Task implemented by the Web Service.

The user descriptor has to be in a form both the Task List Client and the hosting system (RAMS) can coordinate to allow those users to access the intended Tasks. The details of a Task List Client and its working with the user authentication and access policies in BPEL4People (although they are implementation dependent and not defined in the BPEL4People specifications in the first place) have to be extended in order to allow this integration of the remote Process invocation.

As to the Task List Client reference, both the Task List Client and the Task Manager must recognise it in order to allow connections and to recognize sub-domains of the Tasks according the invoking hosts.

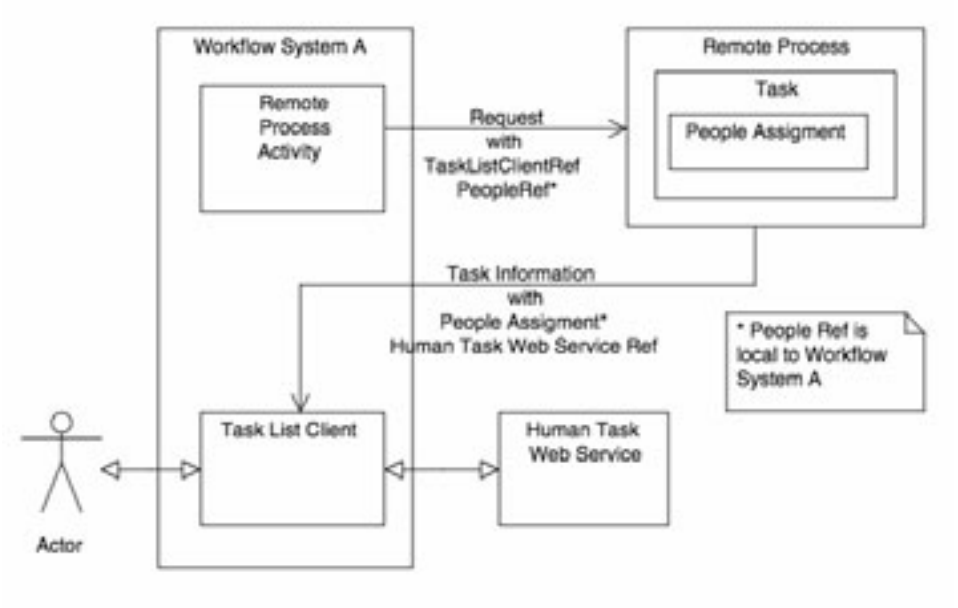


Fig. 5. Passing Task List Client and People References.

## 5. Asynchronous Call and Tool Activity

As it has been mentioned, in case of RAMS, Tool Activities are used to invoke remote processes. In fact, the Tools assigned to Activities give different abilities to Activities as Fig. 6. Therefore, in case of RAMS, for example, the ability to invoke remote Processes can be actually implemented with a Remote Process Tool.

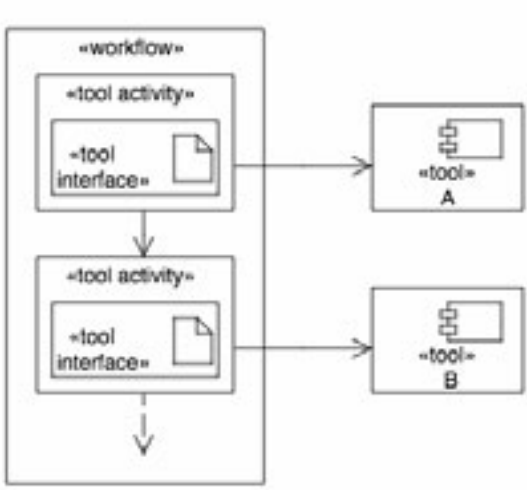


Fig.6. Tool Activities and Tools.

The Processes with Human Tasks may provide synchronous Process Web Service interface as Fig. 7 (A). Since it is most likely that they contain asynchronous calls to Human Task Web Services, it may be natural to postulate that those Processes are offered with asynchronous Web Service interface as Fig. 7 (B).

In these cases, however, unless we call the Tool from the Activity as asynchronous call as Fig 7 (C), the progress of the main workflow will be blocked, that is, it must keep the end user waiting at the Remote Process Activity. In case of RMAS, the system allows the user to log out at the Activity and to come back at the exact point to continue, this does not pose a strong problem. This is different from automated Processes (There is no user, and the automated Process blocks).

If we allow asynchronous calls from the Remote Process Activity to the Tool as Fig. 7 (C), the user will be able to move ahead on the workflow without waiting for the response. The user, then, must come back to the Activity to retrieve the results later.

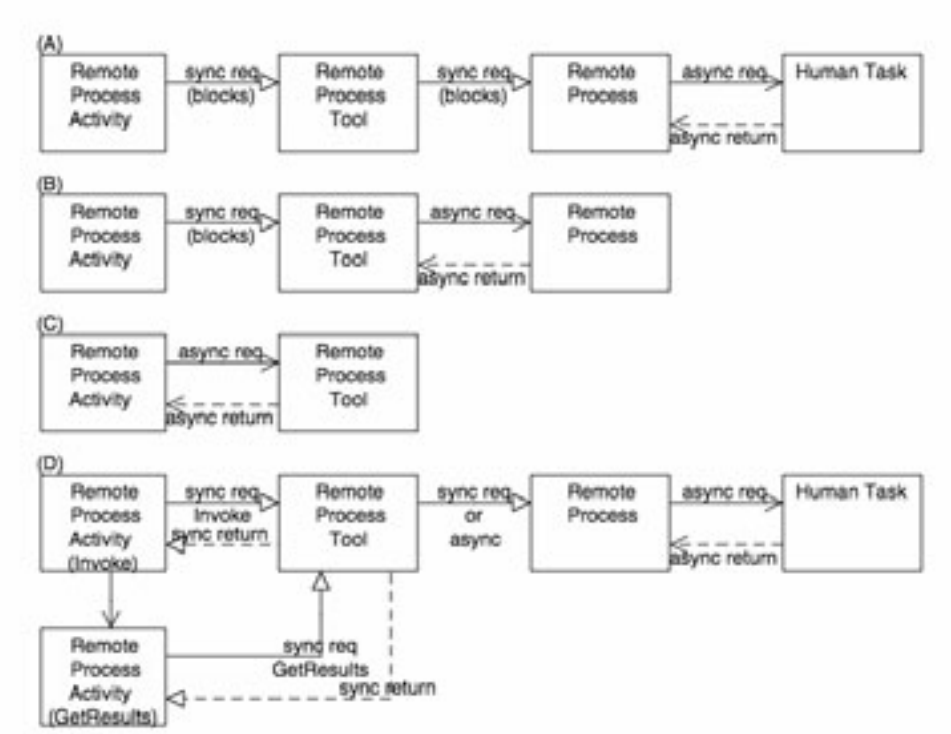


Fig. 7. Asynchronous Web Services Interface and Tools. With (B) and (C), the full details are omitted to draw attention to the asynchronous calls only.

Fig. 7 (D) is an alternative arrangement that a Remote Process Tool with two Activities. The first Activity submits the Remote Process invocation request. It returns immediately if the invocation request is successful at the Tool level, although the Tool itself my block

on the Remote Process if it sends a synchronous request to Remote Process. Later in the same workflow or in another workflow, another Remote Process Activity (e.g. GetResults) may be configured to send a synchronous request to the same instance of the Remote Process Tool. This will return either with the results of the Process or with "Remote Process still pending" message. This type of arrangement may be useful. Or, we may put a waiting Activity on a workflow with a periodic notification loop to check on the return of the asynchronous call. This would allow us to keep the job instance for the Tool maintained by the waiting loop.

## 6 Security for Remote Process Tool

Although the security is often out of scope of BPEL and BEP4People, we need to consider the outline of the security concerns.

Our local users have logged on the RAMS first, and we would like to see a Single Sign On (SSO) mechanism implemented between all the clients and servers involved. We assume that the Web Services Security is employed. Web Services Security uses a security token for authentication when a client connects to a Web Service. To do an SSO, this security token must be shared with all the secondary connections and with the clients.

First, a user authenticates with RAMS and the security token must be passed from RAMS to the Web Service interface of the remote Process. Then, the Task List Client must be able to securely connect to the Process host. Most likely, the Task Client's security context for the Task Manager is not shared on the remote BPMS, and the security token, which was already passed to the Web Service interface, must be propagated and correlated with the Task List Client.

Thirdly, the Human Task Web Services that will be called by the Task List Client via the Task Manager also requires the security token to be passed. Finally, the security token must be propagated from the Web Service context to Human Task application implemented by the Web Service and correlated with the Task Client which must log on to the Human Task Application.

## 6. Taverna Interaction Service

In case of Taverna, it has a simple Notification mechanism. As shown in Fig. 8, if we could send a remote workflow with an email address of the RAMS user, who would like to receive the notification when human interaction is required, it seems to solve the problem of integration.

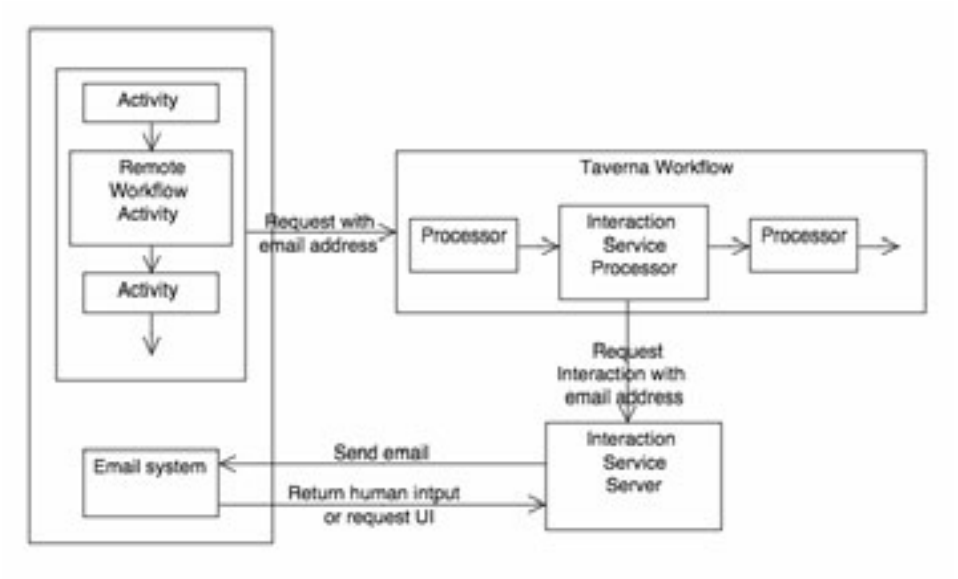


Fig. 8. Using a Dynamic Email Address with Remote Taverna Workflow.

## 8 Discussions and Conclusions

In order to be able to invoke remote Processes with human activities, this paper suggested modifications to BPEL4People to add the people reference and the Task List Client reference to its syntax. It also suggested that accessing the Task Manager of the remote system from the local system with its own Task List Client to handle the life-cycle of remote human activities. In case of Taverna Workflow, it suggested to send email addresses of local system users to the remote host. Both are the measures to allow remote systems to be accessed by the local system users.

In principle, the proposed models should be sufficient examples to allow the local system to work with remote human activities. The models also indicate the general principle that the local user information must be relayed from the local system to the remote system for this type of cooperation to take place.

When generalised, the models do not necessarily assume Web connections. When the Web connections are presumed, however, they are not always reliable and fault-tolerance ability of the Web connection model should be investigated.

The particular BPEL4People example presented relied on the availability of the Task List Client on the local system as defined in BPEL4People. It is relatively a simple element that can be provided by BPEL4People developers to the local system as a pluggable element, since the main logic resides on the remote server. If that is not the case, this approach may not be feasible. As the BPEL4People-based systems may

become more common, we expect that a sharable Task List Client, which can be deployed by external systems, may become readily available.

To demonstrate the usage of the Task List Client with RAMS, we have depicted it as it is installed alongside RAMS on the host. For better integration, however, it may be possible to make a Tool that uses the Task List Client inside the main system, e.g. RAMS. Then, it can handle remote human activities inside the local workflow activities.

Even if the Task List Client does not become readily available, the idea of integrating human workflows and Business Processes/Scientific workflows is still a valid cause, and we should consider other possible ways for integrations [Ho95, Ta07]. As we indicated, we are not aware of similar work that focuses on inter-workflow integrations, other than inter-workflow messaging. We hope that our work will provide a starting point for increasing similar studies.

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