

VEC: Gateways for Cross-Organizational Document Flow

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To ensure the interconnection of business processes, outsourcing services require a rich flow of information between the service-providing and service-requesting organizations. Using the Virtual Enterprise Coordinator (VEC) and the Internet, organizations can outsource projects to external partners in a controlled way, while retaining the freedom to change the internal process definitions and document structures.

In recent years, document management systems (DMSs) and workflow management systems (WMSs) have supported the execution and management of asynchronous business processes. DMSs are software systems that store, retrieve, and manage data. WMSs facilitate the enactment of predefined business processes consisting of a number of steps called activities that are assigned as “work items” to employees. Well-defined and highly repetitive processes typically suit this kind of automation. WMSs have become commonplace in the administration of many large companies. They can be in the form of specialized systems such as IBM’s MQ Series Workflow and ICL’s TeamFlow, integrated systems such as IBM’s EDM Suite, or part of enterprise resource planning (ERP) systems such as SAP’s R3. In this article we use the term process management system (PMS) to describe a system that can manage rich media documents and support the workflow that governs the movement of these documents.

As companies continue to focus on their core business and streamline their operations, business processes not considered part of the “core” are increasingly outsourced. An example from the insurance industry is the on-site assessment of damage in personal insurance claims processes. If a customer makes a claim against an insurance policy, the insurance company hires a loss adjuster to inspect the damage on-site and assess whether the claim is justified. The loss adjuster

then performs an assessment process and writes the results in a report that also includes evidence such as digitized images of the damage.

As companies extend their business processes across organizational boundaries, they need information systems to support this step.^{1,2} For processes within a single organization, a process, its associated document flow, and the assignment of resources to activities can be defined by a central authority that has access to all relevant information. However, if a process spans organizations, the companies need additional privacy and autonomy.³ When organizations want to collaborate in a process, they must establish the terms of their collaboration in an agreement. This agreement defines the roles of the parties within the process, the common understanding of the process in terms of the work associated with each activity, and any documents to be exchanged.

We present the Virtual Enterprise Coordinator (VEC), a system that lets organizations maintain privacy, flexibility, and independence when using PMSs to manage cross-organizational business processes. VEC satisfies these goals by uncoupling the PMSs of the collaborating organizations and providing a way to define relationships between the processes of the two entities on the basis of an agreement.

For the VEC project we established the following principles that guide relationships between autonomous peer organizations that collaborate on the performance of a process:

- *Hierarchy and goal orientation.* We assume that one organization owns the overall process and that other organizations perform parts of it. The parts performed by each organization are defined as line item goals to be achieved and not as a detailed process definition. For example, if an insurance company assigns a loss adjuster to assess a claim, it does not prescribe in detail how the adjuster must proceed. Nevertheless, both organizations agree on the expected results of the assessment—the goal. In fact, organizations choose to outsource a task to another company precisely because the latter has greater expertise.
- *Privacy.* Effective processes are a key success factor in the service business and can lead to a competitive advantage. Since an independent organization does not want to disclose all details of its internal process models, a service

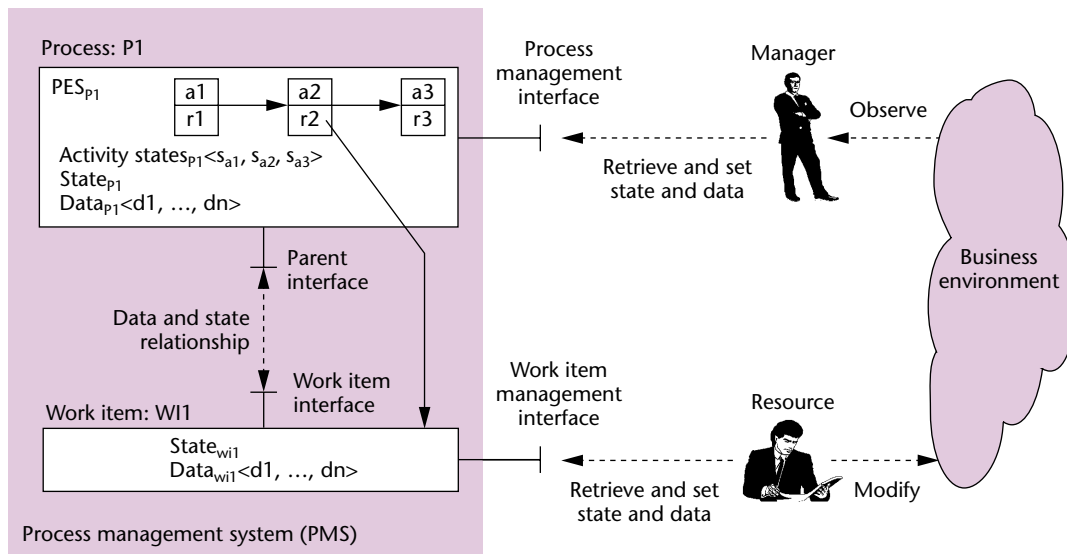


Figure 1. Managing asynchronous processes within an organization. Adapted from Ludwig and Whittingham.⁴

provider would usually not grant access to all internal information about the ongoing process. It also does not want to disclose its current use of resources, primarily concerning personnel. Likewise, a service requester does not want to disclose information to its business partners unless necessary.

- **Internal flexibility.** A provider or requestor *wants* to reserve the right to change its procedures without asking or even informing a collaborator, as long as these changes do not affect the goal agreed upon.
- **External independence.** Although two organizations may wish to collaborate on a particular project, they also want to remain independent of internal changes of the other organization.

Given these objectives, we explore PMSs in cross-organizational processes. Companies usually establish an agreement to define the outsourced activity and the way in which the partners must disclose information. Such an agreement describes the circumstances in which both parties interact in the course of the service, and the agreement defines precisely the interface between the partner organizations. This enables a service-requesting or -providing organization to implement the agreement autonomously. A requester can outsource similar parts of a business process to various providers, whereas a provider can use the same internal process to serve various requesters.

Organizational boundaries in business processes

Processes are enabled, supported, and documented by a myriad of forms, documents, and other multimedia artifacts. Here, we focus on the movement and the consequences of the movement of the structure or contents of information between resources of various activities. Before we start, we need to analyze the way in which parts of business processes are divided and assigned across an organizational boundary, and how this affects the deployment of the PMS.

Process management within an organization

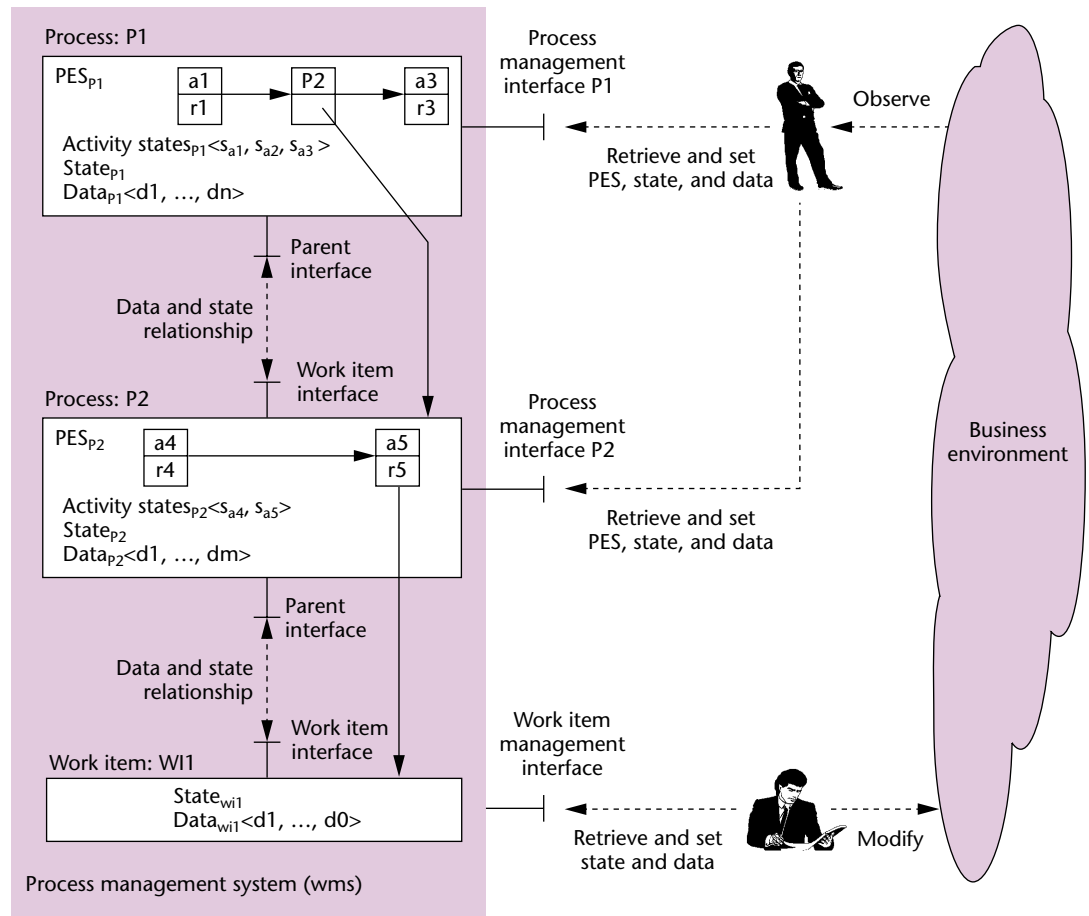
A PMS facilitates the management of a business process executed by a potentially large number of people using several different software applications. We introduce a simple, nonformal model of the main elements of a PMS (see Figure 1). This model describes most of today's commercial PMSs.

A process in a PMS consists of several elements. At its core is the process execution specification (PES), which describes the order in which various activities must be performed and to whom they should

Acronyms

DMS	document management system
ERP	enterprise resource planning
PES	process execution specification
PGM	provider gateway manager
PMI	process management interface
PMS	process management system
PPG	provider process gateway
QoS	quality-of-service
RGM	requester gateway manager
RPG	requester process gateway
SWAP	simple workflow access protocol
VEC	Virtual Enterprise Coordinator
WIMI	work item management interface
WMS	workflow management system

Figure 2. Managing asynchronous subprocesses within an organization. Adapted from Ludwig and Whittingham.⁴



be assigned—a process plan. It may include alternatives and parallel branches. In most of today's PMSs, this information comes from a template defined for a class of similar business processes. A process also represents the states of its constituent activities, which can assume the states of "initiated," "running," "completed," and "terminated". The completed state indicates a successful end of an activity, whereas terminated means that the objective of the activity was not achieved. A process also has an aggregate state that depends on the states of its constituent activities. Finally, a process has an associated set of data items—the forms and documents that are to be processed—that represent the input and output of activities and can also be used to compute the next activity to be executed according to the PES.

For an activity to be performed (a_2 in Figure 1), the PES creates and assigns a work item ($wi1$) to the appropriate resource (r_2). The state of the work item represents the state of its activity as described above. Its associated data is a subset of the data items of the process in which it takes part.

Resources retrieve their work items from their work list. Using the work item management interface (WIMI), resources can read and modify the data and the current state of the work item (for example, they can change the state to running or declare the work item completed). The representations of states and data items in the process to which the work item belongs reflect these changes. Each time changes of state or data are reported to a process, the PMS evaluates the PES and, if necessary, generates new work items and assigns them to resources. Likewise changes in the attributes of the process are reported to the work items. This reporting occurs through the parent interface of a process and the work item interface.

The process can be monitored and controlled using the process management interface (PMI), with which a (human) process manager can read the states of individual activities, the entire process, and the data items. The process manager can also set their values (such as set the process's state to terminated). The need to manage a running process arises if the process manager learns about a change in

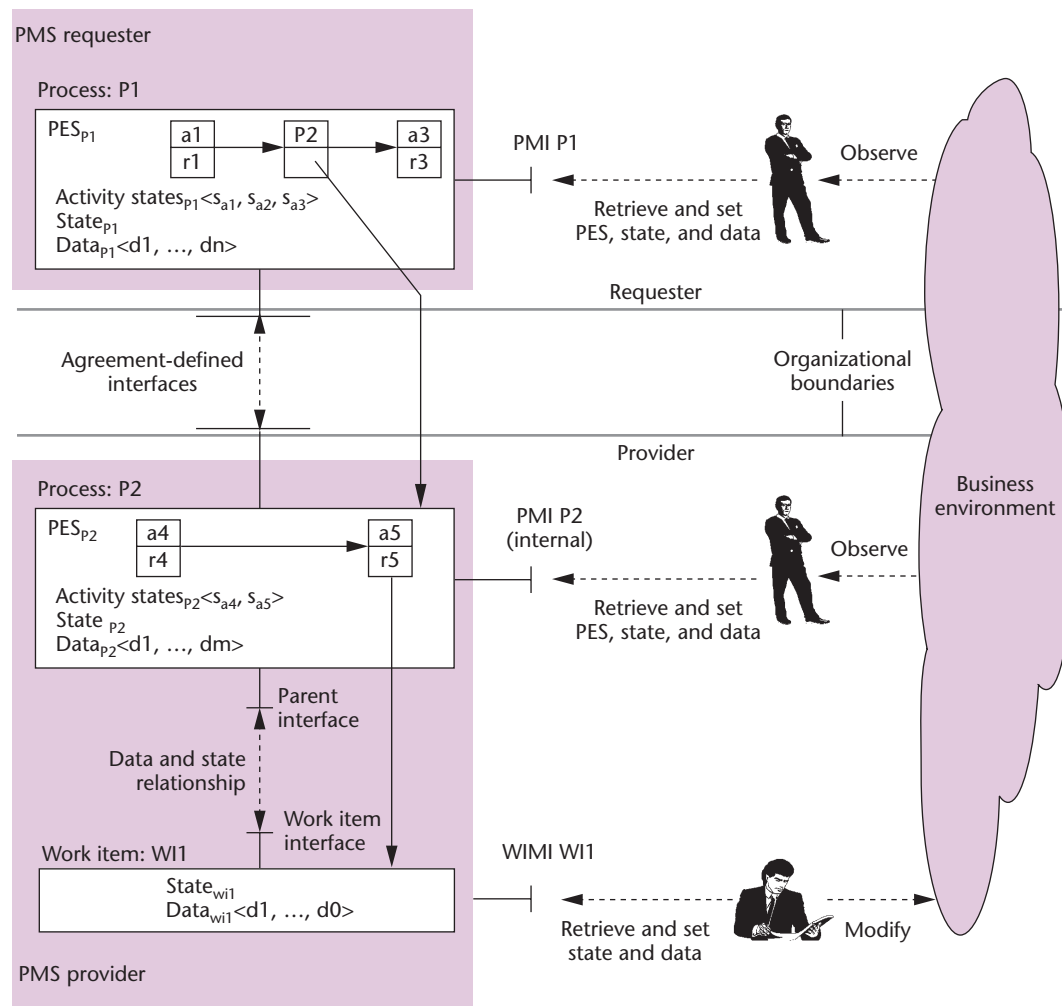


Figure 3. Managing asynchronous cross-organizational processes. Adapted from Ludwig and Whittingham.⁴

the state of the business environment that was not foreseen in the PES of the process. In the case of the claim against an insurance policy, the process manager could learn that the police have since recovered a stolen good, rendering the process unnecessary. This type of occurrence is difficult to model in the PES since it can happen unexpectedly. For this reason, it is typically easier to let the process manager manually set the state of the process to terminated. A precondition for reasonable management of undefined situations is access to the PES of a process and the current values of the attributes. Therefore, the PMI also allows a process' PES to be read.

Managing a subprocess

Complicated processes can be divided into potentially reusable subprocesses that can be delegated to other resources to make them easier to manage.

Like an individual activity, the PES defines the

use of a subprocess in its top-level process. A subprocess (P2 in Figure 2) has the same structure as any other process plus an additional interface for communication with its parent process. The relationship between parent process and subprocess is the same as that between a process and a work item. Therefore, a subprocess provides a work item interface to its parent. The PES forwards modifications of state and data items to the other party. A subprocess aggregated state is represented in the activity state vector of its parent process. The relationship of a subprocess to its work items is the same as for top-level processes. Since a subprocess is a process in its own right, it has a unique PES and PMI.

Outsourcing a subprocess

Let us assume a situation in which one requester organization runs P1 and another organization (provider) performs P2 on the requester's behalf (Figure 3).

The relationship between the requester's parent process P1 and the provider's subprocess P2 differs from a relationship within an organization in the following ways:

1. In most cases the parent process and subprocess control different PMSs.
2. Before a working relationship is established, P1 and P2 are known only within their respective organizations. The connection between them must be made explicitly. In this context, connection means that both organizations have to provide an interface at the organizational boundaries that the other organization's process can use to report changes of values of data items or state. Typically, the provider would report when the process state changes to running. When the subprocess has been completed in the provider's PMS, it would send back the modified data and declare its completion.
3. The PESs of the parent process and subprocess do not need to be revealed and, thus, remain hidden within their respective organizations even after the connection has been established. The parent process and subprocess can then be fully and effectively managed only from within their respective organizations where they can access the PES. Process managers cannot consider information about processes in another organization in order to make management decisions for a process within their organization.
4. Organizational boundaries imply boundaries of terminology. Data items that represent the same objects of the business environment may have different names in different organizations. The same applies to states of activities and of processes.

To enable two processes in different organizations to interact, two prerequisites have to be met: First, the two organizations must reach an agreement that defines how the two processes interact using common terminology. Second, there must be a mechanism that establishes the link according to an agreement. To connect two processes in a parent process/subprocess relationship the two organizations need to agree on

- the name of the subprocess that the provider

should perform on behalf of the requester,

- the names and types of the relevant data items needed in the subprocess,
- the names and the meaning of states of the subprocess, and
- the names of the operations to retrieve, and modify states and data objects in both organizations.

An agreement can be achieved in one of two ways. Set up and apply a standard to each relationship between two or more partners, or specify the agreement on a case-by-case basis.

Connection architecture

The connection architecture uses gateways to maintain each partner's privacy, independence, and flexibility for the duration of the collaboration.

Structural overview

Gateways provide controlled external access to services within a domain in a company's process management by its PMS.³

Figure 4 shows the main elements of an infrastructure and their interaction to establish process-to-process relations through gateways.

- *Requester gateway manager.* Gateway managers set up connections and administer the gateways. Agreements are supplied to them so that they know which connections can be activated. A requester gateway manager (RGM) receives calls from internal processes to establish connections in the same way as an internal (human) resource would be notified of a new task. If an agreement is available for a particular request, the RGM asks the appropriate provider gateway manager (PGM) to grant access to the relevant subprocess. If successful, it creates a new requester process gateway (RPG). From the point of view of the internal process, it behaves like an ordinary work item generator.
- *Provider gateway manager.* A PGM is the RGM's counterpart in the provider's organization. It receives calls from outside the provider and establishes connections. If an agreement has been supplied to the PGM, it creates the appropriate subprocess in the PMS and a provider process gateway (PPG).

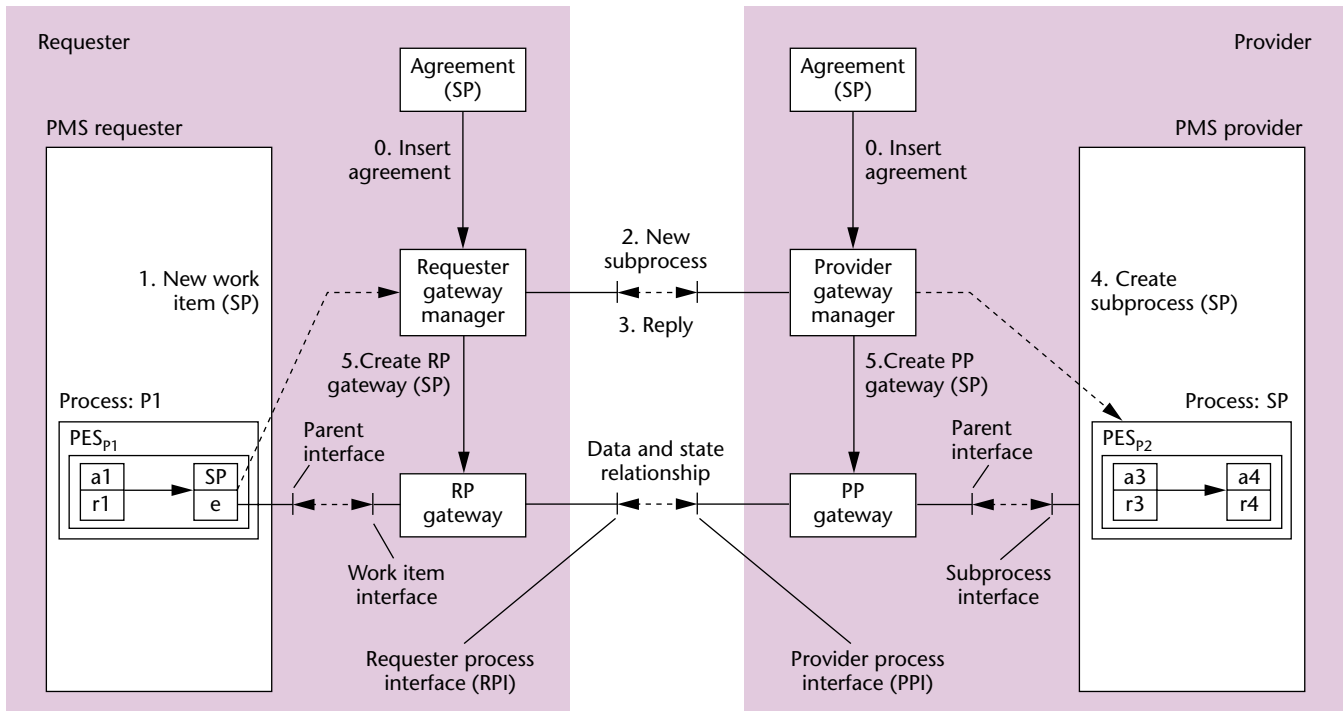


Figure 4. Agreements to establish a particular process relationship. Adapted from Ludwig and Whittingham.⁴

- **Provider process gateway.** At the boundary of the provider's organization, a PPG ensures that requesters access only the subprocess as agreed and that it forwards state and data changes to the requester. It also provides a parent interface to a subprocess.
- **Requester process gateway.** At the boundary of the requester, the RPG controls the top-level requesting process and handles the interaction with the provider's PPG. It provides a work item interface to top-level process and uses the process' parent interface.

The RPG and PPG mediate all cross-boundary communication between processes. The gateways and the gateway managers behave like ordinary internal processes, work items, and generators. Thus, the top-level process in the PMS is independent of the organization that performs one of its subprocesses. It assigns a subprocess to the virtual user, labeled "e" in Figure 4, which is the RGM.

Agreements: General and flexible parts

It is necessary to define which aspects of the process relationship will be specified in bilateral agreements and what the assumptions are that govern all gateways as a general standard. The subprocess name and the relevant data items will be

different for different kinds of tasks. An agreement supplied to a gateway manager contains the following information: requester, provider, the name of the process to be performed, and relevant data items.

The common names of the states of the subprocess and the names of the operations may be defined generally. For VEC, we assume the state model as introduced in the previous section. The interfaces to external organizations provide the following operations:

PGM interface:

```
new subprocess(process name)
```

RGM interface:

```
accept(process name)
```

```
reject(process name)
```

Provider process interface:

```
supply data item(data item name, value)
```

```
start process()
```

```
terminate process()
```

Requester process interface:

```
supply data item(data item name, value)
```

```
process terminated()
```

```
process completed()
```

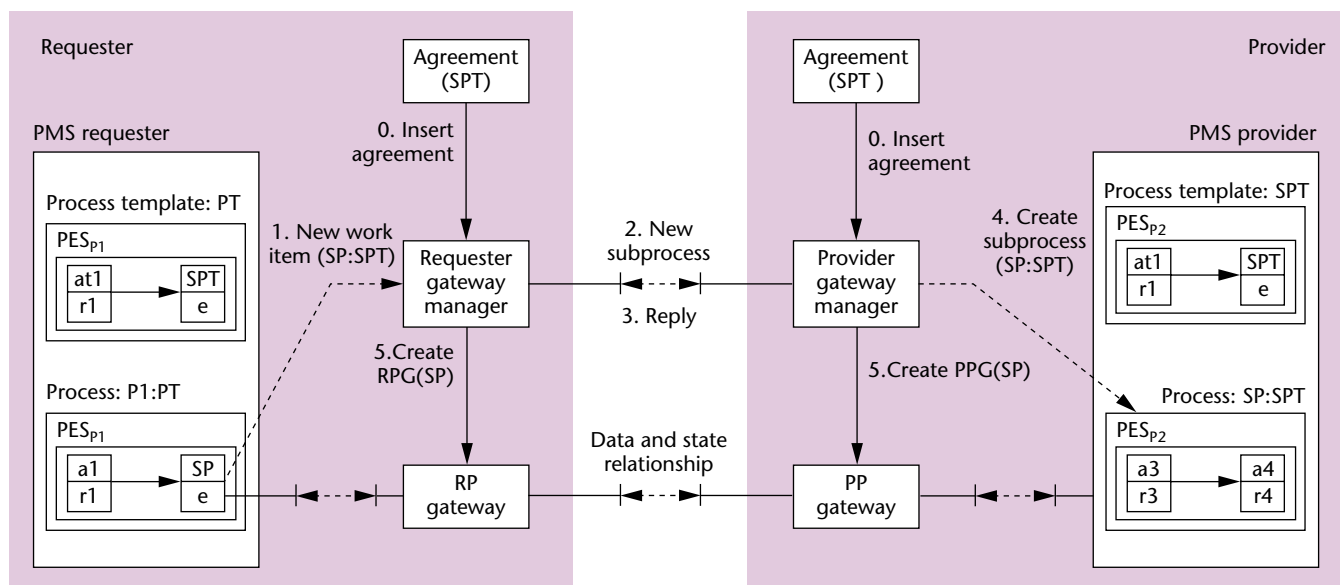


Figure 5. Gateways on the process template level. Adapted from Ludwig and Whittingham.⁴

Agreements supplied to the gateway managers define the domains of the interface functions' parameters.

Agreements on a process template level

Two organizations might decide to conduct a cross-organizational process many times but want to avoid supplying a new agreement every time. In today's PMs, processes are built on the basis of process templates (schemas, classes), so agreements can be reached on that level. Instead of naming an individual process in an agreement, the process-template name is part of an agreement made at the template level.

Whereas the interaction between RPG and PPG stays the same, the setup of those gateways changes to some extent (see Figure 5):

- If the RGM is to establish a connection, it needs to know the name of the particular subprocess and the name of its template.
- If the RGM requests its counterpart to establish a connection on the basis of a template-level agreement, it has to provide the name of the subprocess as well as the template name. The following function extends the interface of the provider gateway manager:

```
new subprocess(process name,
               process template name)
```

The gateway managers on both sides have to create the gateways in a way that they apply to

individual processes, even if the agreement occurs at the process-template level.

Mappings

The agreements and standards described in the previous sections let organizations connect processes across organizational boundaries. Gateways ensure the privacy of both the provider and the requester. However, if the cooperating parties must use the agreed-upon terminology inside their organizations, they forfeit flexibility and independence. For example, if a loss adjustment company wants to provide the same type of service to more than one insurance company, either all the organizations involved have to agree on one terminology or the loss adjuster has to provide a separate process template for each agreement. This is feasible only if the adjuster has business relationships with a limited number of parties. The same problem applies to a requester if the same type of subprocess is commissioned to various providers using type-level agreements.

To address this issue, the partners define the data and structures needed to cross the organization boundary. The participating organizations define and agree on common terminology to describe these data. With each agreement reached, mapping between inter- and intra-organizational terminology should occur. In addition to the agreement, this mapping must be provided to the gateway managers in order for the gateway to perform the mapping.

Figure 6 shows an example of the requester's side of a connection. The agreement states that a sub-

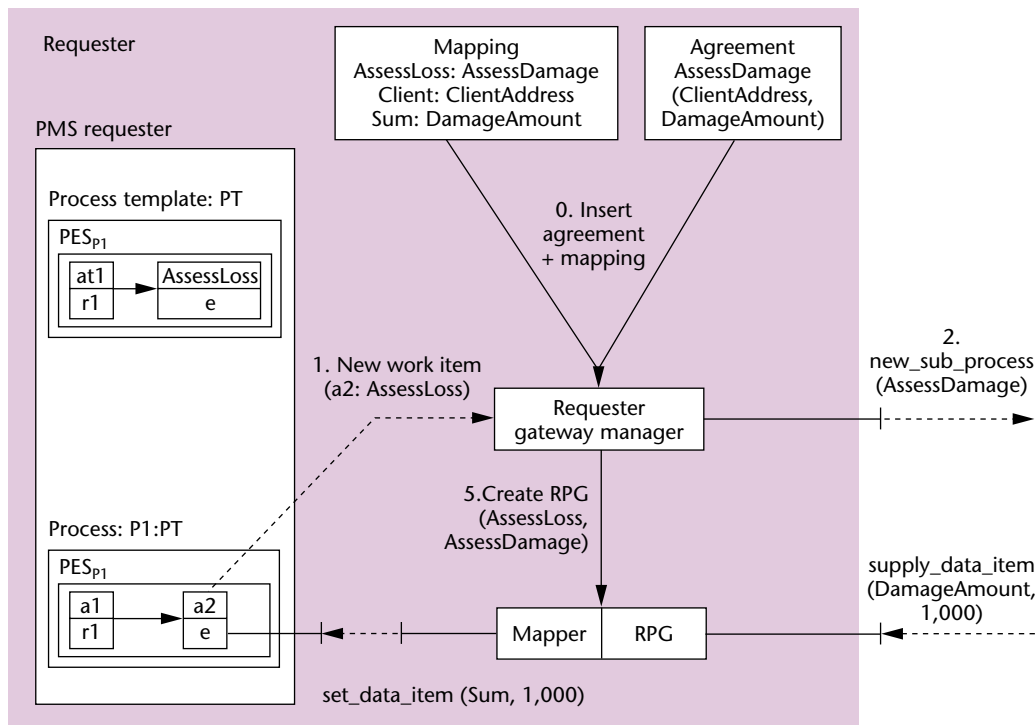


Figure 6. Gateway with mapping functionality. Adapted from Ludwig and Whittingham.⁴

process of the type AssessDamage can be passed to the provider, (relevant data items are ClientAddress and DamageAmount). Within the requester's PMS, the process template defines that an AssessLoss must be performed (relevant data items are called Client and Sum). Whereas the respective provider performs the subprocess, the gateway translates calls from the common to internal terminology.

Benefits of the architecture

The VEC architecture supports the relationship principles discussed in the introduction. It enables different organizations to establish basic process/subprocess relationships between their respective PMS in a way that recognizes the different needs of cross-organizational workflow management.

- **Hierarchy and goal orientation.** With VEC, the goal of the subprocess is represented by a common understanding of its common name and its data items. However, no provision exists for the requester to specify the PES that the provider should invoke to perform the task.
- **Privacy.** The gateway and gateway managers send and control all communication from a process to the outside and vice versa. No direct interaction between PMSs of different organizations takes place. No information is

exchanged beyond what has been specifically defined in the agreement according to the related process and subprocess.

- **Internal flexibility.** By mapping the common view of a subprocess onto the respective internal representations, both organizations can modify PESes or associated document structures on both the individual and template level. However, an internal modification might result in a change of mapping.
- **External independence.** The gateways also protect cooperating processes in one organization from internal changes to the process in the other—as long as the modifying party carefully follows the mapping without changing its external interface.

Implementation of VEC

We implemented the gateway architecture in the VEC prototype.⁵ The functionality of the RGM and its RPGs is implemented by an “outsourcer” component, the PGM and its PPGs by the “insourcer.” Agreements and mappings are represented in a simple textual format and can be inserted into an outsourcer or insourcer using a putAgreement program. Communication between an insourcer and outsourcer is based on IIOP, the Internet inter-ORB protocol. We designed the out-

Related Work

Currently, researchers are doing a great deal of work in two related fields. First, the interoperability and connectivity of WMSs is an important issue as mature IT infrastructures tend to be heterogeneous. This primarily involves the problem of providing standard interfaces to WMSs for server-to-server communication. The Workflow Management Coalition, a consortium of WMS vendors and users, defined such an interface called Interface 4.¹ The simple workflow access protocol (SWAP)² is another initiative to connect WMSs that is being adapted as the Web binding to Interface 4. Second, researchers have worked on standardizing document exchange formats, based primarily on the Extensible Markup Language (XML). These standards help vendors build products on a common platform, but they do not help organizational processes per se. Because these standards do not focus on the relationship of internal to external views of processes, they do not address the issues of privacy, flexibility, and independence.

The Wide Area GroupFlow system³ is an approach to connect processes across organizational boundaries by providing gateways. Organizations can declare process templates as externally accessible, (that is, instances can be started by external systems). However, Groupflow is a closed system. The Workflow-based Internet services (Wise) research prototype enables a number of organizations to specify a common public process and assign individual activities to each organization.⁴ Each organization maps the activities that it performs within its internal process management system that its partners cannot access. Extricity's Alliance (<http://www.extricity.com/>) is a product that follows a similar approach. The Common Open-Service Market for Small- and Medium-Sized Enterprises (Cosmos),⁵ Wise,⁴ and MariFlow⁶ projects also include means to establish contracts to the global, shared process.

Another approach to connecting PMSs of different organizations is to establish a set of domain-specific messages and provide domain-specific gateways that map incoming messages to operations of the PMS. Several organizations compete in providing frameworks to define domain message standards. Some examples are RosettaNet (<http://www.rosettanet.org/>),⁷ and BizTalk.⁸ Other proposals such as the eCo Framework⁹ support the location and choice of the appropriate protocol. Gateways for RosettaNet are provided, for example, by Netfish (<http://www.netfish.com/>) and by Extricity's Alliance. Moreover,

traditional edi standards such as UN/Edifact and Swift and their corresponding gateways from numerous vendors follow this approach. The Coyote/Business Process Framework system implements a message gateway that is configured using so-called Trading Partner Agreements.¹⁰

References

1. *Workflow Standard—Interoperability Abstract Specification*, Tech. Report WfMC-TC-1012, The Workflow Management Coalition, Lighthouse Point, Fla., 1996.
2. K. Swenson, *Simple Workflow Access Protocol (SWAP)*, Draft Proposal of 6 May 1998, <http://www.ics.uci.edu/~ietfswap/swap-prot.txt>.
3. G. Riempp and L. Nastanski, "Workflow Management between Distributed Organizations—The Wide Area Groupflow Approach," *Proc. European Students of Industrial Engineering and Management (Estiem) IT-Vision Conf.*, F. Lehner and S. Dustar, eds., Deutscher Universitäts Verlag, Gabler Edition Wissenschaft, Wiesbaden, 1997, pp. 265-282.
4. G. Alonso et al., "WISE: Business-to-Business E-commerce," *Proc. Ninth Int'l Workshop on Research Issues in Data Engineering—Information Technology for Virtual Enterprises (RIDE-VE 99)*, IEEE Computer Society Press, Los Alamitos, Calif., 1999, pp. 132-139.
5. F. Griffel et al., "Electronic Contracting with COSMOS—How to Establish, Negotiate and Execute Electronic Contracts on the Internet," *Proc. Second Int'l Enterprise Distributed Object Computing Workshop (EDOC 98)*, IEEE Press, Piscataway, N.J., 1998, pp. 46-55.
6. I. Cingil et al., "An Adaptable Workflow System Architecture on the Internet for Electronic Commerce Applications," *Proc. Int'l Symp. Distributed Object Applications*, IEEE Computer Society Press, Los Alamitos, Calif., Sept. 1999, pp. 242-251.
7. *RosettaNet Implementation Framework (RNIF) Specification*, version 1.1, RosettaNet., Santa Ana, Calif., 1999.
8. *BizTalk Framework 1.0—Independent Document Specification*, Microsoft, Redmond, Wash., 1999.
9. H. Smith, "CommerceNet's eCo Framework in a Nutshell!," *Onotology.org*, <http://www.ontology.org/main/papers/eco.html>, 1999.
10. A. Dan and F. Parr, "The Coyote Approach for Network Centric Service Applications: Conversational Service Transactions, a Monitor, and an Application Style," *Proc. Workshop on High Performance Transaction Processing (HPTP)*, 1997, pp. 23-48.

sourcer and insourcer to work with IBM's MQ Series Workflow system in the following way:

Assigning activities to a particular user, External, marks them to be outsourced. External's worklist represents the means of communication for both provider and requester. The outsourcer and insourcer access External's worklist using the client interface, which provides similar functionality as Interface 2 of the architecture that the

Workflow Management Coalition defined.⁶ Using this interface, the outsourcer (RGM part) monitors the worklist and retrieves new activities to outsource (step 1 in Figures 4 through 6), and the insourcer creates new process instances in the service provider PMS (step 4). The client interface also monitors and propagates state and data changes by the outsourcer (RPG part) and insourcer (PPG part) once the connection has been made.

Alternative approaches to implementation can be chosen, for instance using a different interface to the PMS such as the jointFlow standard for a workflow management facility that the object management group adopted.⁷ Although it has several restrictions, our prototype shows that VEC is an approach that can easily be implemented for today's PMS using available interfaces. More efficient implementations can be delivered by integrating the functionality closer to the PMS.

Conclusion and outlook

VEC gateways facilitate the integration of cross-organizational document flow on the basis of agreements. They establish a basic relationship between a process, enacted in the PMS of one organization, and a subprocess of it, performed autonomously by another organization on the first organization's behalf. These gateways at the organizational boundary of each organization are configured according to agreements that establish common terminology and a shared view of the subprocess that the organizations use. Agreements may be defined on a case-by-case basis or for a type of subprocesses that is provided and used regularly. The gateways map this shared view to the respective internal views and terminologies used in the PMS of the cooperating parties.

This novel approach extends current PMSs in two ways:

1. *Agreement-based connection infrastructure.* This provides the infrastructure necessary to outsource work to an external partner using a formal agreement.
2. *Mapping of processes and documents.* This "indirection" enables a provider to perform a subprocess for a business partner using a shared view of a process while maintaining the ability to change the internal process. They can also use the same internal process template to make agreements for relationships with other organizations. Similarly, a requester has the ability to pass the same kind of subprocess to various providers.

However, the approach introduced in this article does not cover advanced aspects of interorganizational process management. Some of them include:

- providing service requesters with an abstract model of the process so that they can track the process progress;

- limiting the applicability of operations to particular states of the relationship (for example, expressed in terms of the abstract process); and
- dealing with commercial aspects of business relationships such as charging for process execution, monitoring, and control operations.

Moreover, we want to define quality-of-service (QoS) measures for the process itself as well as for the execution of monitoring and management operations.

These issues require a more complex gateway model. The Crossflow project⁸ addresses these issues by extending the results of the VEC project using the concept of agreement-configured gateways. In this way, this project accommodates the advanced aspects previously mentioned. CrossFlow is a joint effort of several European companies, Europe-based corporate research facilities, and universities. It aims to support the complete business lifecycle among organizations, including the choice of business partners on a service marketplace, the definition of a contract in a rich language that can express aspects such as QoS conditions, and the ability of requesters to intervene in the process as necessary. **MM**

References

1. B.R. Konsynski, "Strategic Control in the Extended Enterprise," *IBM Systems J.*, Vol. 32, No. 1, 1993, pp. 111-142.
2. H. Ludwig, "Analysis Framework of Complex Service Performance for Electronic Commerce," *Proc. 9th Int'l. Workshop on Database and Expert Systems Applications (DEXA 98)*, IEEE Computer Society Press, Los Alamitos, Calif., 1998, pp. 638-643.
3. Y. Hoffner and B. Crawford, "Using Interception to Create Domains in Distributed Systems," *Proc. Joint Int'l. Conf. Open Distributed Processing (ICODP) and Distributed Platforms (ICDP)*, Chapman and Hall, London, 1997, pp. 251-263.
4. H. Ludwig and K. Whittingham, "Virtual Enterprise Coordinator-Agreement-Driven Gateways for Cross-Organisational Workflow Management," *Proc. Int'l Joint Conf. Work Activities Coordination and Collaboration (WACC 99)*, D. Georgakopoulos, W. Prinz, and A.L. Wolf, eds., Feb. 1999, (appeared in *ACM Software Engineering Notes*, Vol. 24, No. 2, Mar. 1999).
5. H. Ludwig, "Termination Handling in Inter-organizational Workflows—An Exception Management Approach," *Proc. Seventh Euromicro Workshop on Parallel and Distributed Processing (PDP 99)*, A.

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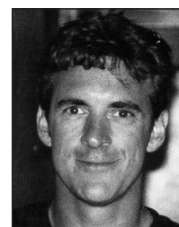
<http://computer.org/multimedia>

Antola, ed., IEEE Computer Society Press, Los Alamitos, Calif., Feb. 1999, pp. 122-129.

6. *Workflow Management Coalition Application Programming Interface (Interface 2&3) Specification*, Tech. Report WfMC-TC-1009, The Workflow Management Coalition, Lighthouse Point, Fla., 1998.
7. *OMG Business Domain Task Force*, BODTF RFP 2 Submission, Tech. Report bom/98-06-07, Object Management Group, Needham, Mass., 1998.
8. Y. Hoffner et al., "Architecture for Cross-Organisational Business Processes," *Proc. Second Int'l Workshop on Advanced Issues of E-Commerce and Web-Based Information Systems (WECWIS 2000)*, IEEE Computer Society Press, Los Alamitos, Calif., June 2000, pp. 2-11.



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