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## **The *GroupFlow* System:**

Workflow Management in  
Distributed Organizations

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**C S D S**

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## Workflow Management in Distributed Organizations

### Keywords

Workflow management, workgroup computing, business process design, groupware, distributed organizations, wide area information exchange, Lotus Notes

### Abstract

The *GroupFlow* environment integrates concepts that are typically referred to as *workgroup computing* or *Groupware* on the one hand, and *workflow management* or *business process design* on the other hand. *GroupFlow* offers business process and technology frameworks to set up versatile and flexible workflow systems for distributed information management within organizations and their outside communication partners. This report deals with workflow management in distributed organizations. The architectural concepts allow for both intra- as well as interorganizational information exchange.

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## The GroupFlow System: Workflow Management in Distributed Organizations

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### 1. Introduction

Workflow management targets a severe reduction of paper worked on inside offices, mailed between organizations, copied and carried around both by internal personnel as well as by external company representatives. All the required logistics to select necessary material and the costs involved are to be reduced.

In distinction from what is known as *electronic data interchange* (EDI) the *wide area workflow management* that is the subject of this report aims at a different level of functionality and flexibility for information processing.

While EDI is mainly utilized for order management as an *interorganizational* process type new integrated workflow management systems *within* enterprises - at least LAN based - support a higher degree of flexibility and functionality for office work. The integration of decentralized workflows into global processes requires a sound information flow within distributed organizations. New technology concerning both *software-* and hardware platforms are employed for a wide area process integration by distributed information systems that function both intra- and interorganizational.

Global markets call for organizational structures of distributed enterprises that are shaped like dynamic networks. This comprises the concept of *virtual* teams, corporations or enterprises as referred to in Hammer/Champy [1993], Moad [1994], Allian [1993], Clemons/Row [1992], or Miller [1993]: Such a virtual corporation may on the one hand embrace a short term arrangement in order to complete one particular, episodic task or on the other hand be based on a strategic partnership. Virtual teams may subsume inter- as well as intraorganizational relationships.

A short term virtual corporation consists of a temporal alliance between two or more corporations, for example to jointly develop a product in a shorter amount of time. In effect, without a well defined organizational layout and a vertical integration, locally distributed experts must be enabled to cooperate as closely and as effectively as possible. For some period of time such a team can be regarded as working in a virtual office.

In the form of a strategic alliance or other relationship virtual corporations are aimed to combine business units holding specific positions with others that have core expertise in some particular field in a way that benefits both sides.

In order to reflect and to support those dynamic business forms efficiently new architecture concepts and technology are necessary. Besides the required basic technological support of e.g. appropriate transmission media, some rather general concepts for wide area-oriented, distributed workflow management and business processes design are required. The process oriented both intra- and interorganizational information exchange has to provide new and specific instruments for the

- rapid information transfer (on media that have been referred to as "data highway"),
- common access to key data and applications,
- standardization of data format and content,
- data security (both confidentiality and safety), as well as the
- appropriate communication means in distributed teams.

Those tools for communication may complement an inter-enterprise electronic mail system with video- or computer-conferencing.

The design of the *GroupFlow* architecture for workflow management based on workgroup computing concepts addresses the above mentioned aspects. *GroupFlow* does not simply support structured data but also various, "rich", sometimes also called *natural* types of data and information. *GroupFlow* has been implemented using Lotus Notes as the basic development platform and underlying distributed architecture. The user interfaces on the client sides are either based on Notes-native *FORM* and *VIEW* concepts, or on other graphical frontend tools where appropriate for the respective user tasks to be performed. On the backend server side of *GroupFlow*, solely Notes technology has been used for data repositories of the actual business information content, for the workflow structure parts, and the various workflow runtime engines supporting processes like messaging, replication, event management or gateway connections. Due to the open architecture of Notes, the backend server side of *GroupFlow* is to be considered completely open. This inter-connectivity extends from real-time two-way linking of data sets being managed in 'legacy' transaction systems, to external processes to be initiated and controlled by *GroupFlow* around a variety of multi-vendor hardware- and software platforms defining the current infrastructure of an organization's IS-resources in an open client server environment.

In the following we will first discuss the major aspects for wide area workflow management before we describe some of the wide area related functionality of *GroupFlow*.

## 2. Dimensions of Workflow Management in distributed Organizations

The evolution from workflow management in one, non-distributed organization to different and distributed organizations adds a whole set of new dimensions to be considered. Organizational as well as technological matters define the requirements for secured and efficient *wide area* workflow management. Among the technological categories the way of routing information as well as the communication channel define the workflow specifications. The organizational context can either be *ex-* or *internal*.

### 2.1 Organizational Integration

Processes supported by the workflow management system can be divided into *internal* and *external* processes. Internal processes are bound merely to the *one* organization that they are performed at and are thus called *intraorganizational*. Processes that cross the organizational boundaries of an enterprise at least once are characterized as external or *interorganizational*.

### 2.1.1 Intraorganizational workflow

Intraorganizational workflows may be originated by events that occur internally as well as externally of the organization. They may also result in externally visible changes of the business. Still, the process itself is basically driven and handled by people *inside* of the one enterprise.

While the actors involved in the business process belong to a single organization a workflow may involve merely *local* team members as well as teams at *distributed* locations. In this report we focus on the latter category as a subset of wide area workflow. The more specific aspects of exclusively local workflow management are covered in other papers [Nastansky/Hilpert 1994a, Nastansky/Hilpert 1994b, Hilpert 1993]. There, we have focused on the complementary aspects of the entire *GroupFlow* framework.

Since intraorganizational workflow in general involves members of *one* business entity the necessary level of security management may be considerably lower than in case of interorganizational workflow.

We differentiate intraorganizational processes that run across distributed locations into those between distributed, but fixed, locations on both sides, and those between fixed and *occasionally connected* locations. The latter may also be referred to as *mobile computing*.

#### 2.1.1.1 Regularly connected distributed locations

Locally distributed enterprises can be comprised of singular distributed organizations with distributed sub units or corporations running one or more subsidiary companies. This encompasses close or strategic partner organizations as well as various distinct business units belonging to the same global enterprise.

Virtual teams comprise another sample scenario for distributed cooperative work. Still, processes in the context of what has been described as virtual enterprises above would rather be regarded as *interorganizational* workflow.

Even though the basic technical architecture to drive the information routing that underlies intraorganizational workflow may not be that much different from the interorganizational workflow, essential differences in terms of security are to be observed. The definitions of decentralized process subsets may be enterprise wide accessible within *one* organization. This is opposed to an interorganizational context where only the interface definitions between several process subsets would be globally defined and accessible. The same criteria for confidentiality applies for workflow *monitoring* measures.

Basically, identical interest spheres result in generally shared information. The major motivation for distinct information and content management between the several locations of *one* enterprise stem from the requirements for the *contents* of the actual work. Another reason for reducing the amount of shared information may stem from high communication costs e.g. long distances, low transfer rates, etc. The organizational definition of what comprises a *workgroup* with access to the same type of information specifies the intensity of information exchange - regardless whether shared or copied information.

Generally speaking, with regularly connected locations based on stable circumstances constant technical setup parameters for the information transport can be assumed.

#### 2.1.1.2 Occasionally connected distributed locations

In terms of security occasionally connected locations in general do not differ from the regularly connected. Rather, efficiency matters call for attention on different aspects, because occasionally

connected locations focus on *remote agents*. Those are very often the underlying conditions of *mobile computing*.

Thus, time as well as cost efficiency require a different setup of the information exchange in the context of occasionally connected wide-area workflow management. The data transmission costs are to be balanced with the required actuality and integrity of information. Also, it may be necessary to change the setup parameters according to differing individual circumstances such as the underlying transmission channels.

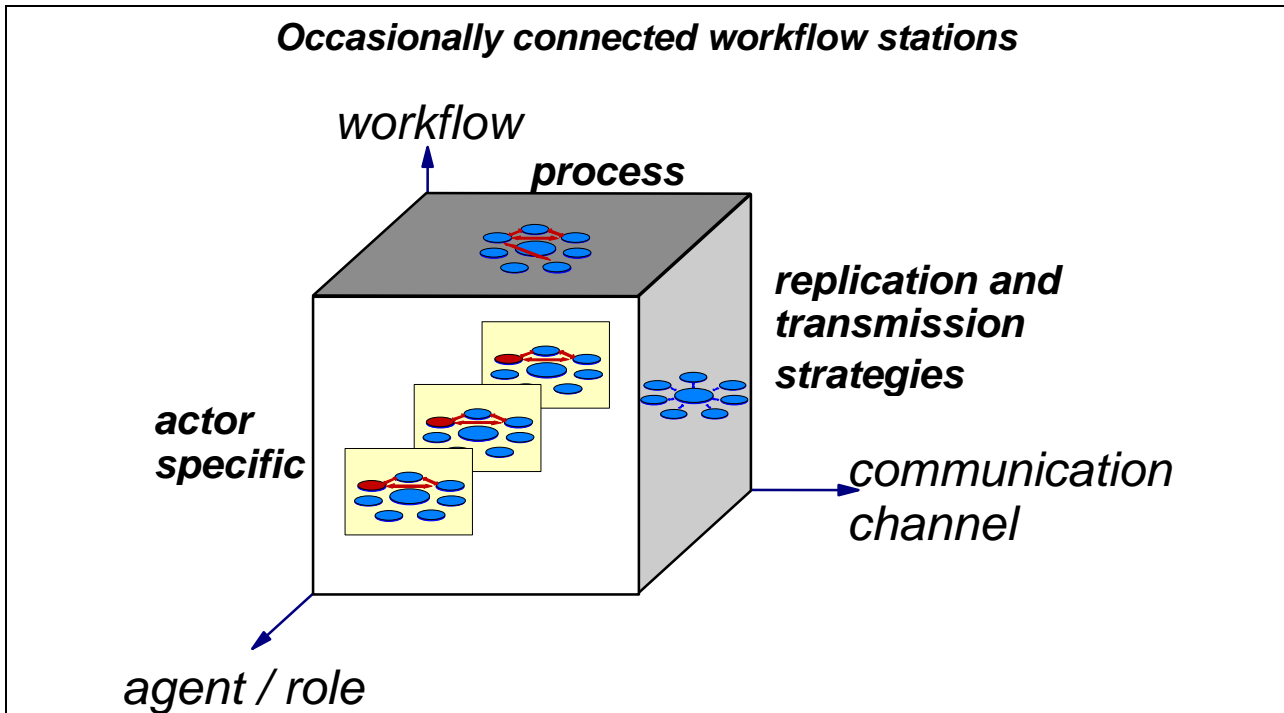


Fig. 1: Occasionally connected workflow stations

The content management for the workflow related tasks needs to adhere to the specific restrictions of mobile computing. All recurrently needed and accessed information has to be available on the mobile equipment. Here, the cost of storage capacity has to be balanced with the transmission costs and quality of service.

## 2.1.2 Interorganizational workflow

Interorganizational processes may cross an organizational boundary one or more times. They occur between at least two or more enterprises. Thus, completely different security levels have to be observed than with the formerly discussed intraorganizational workflow. Once again we distinguish between regularly and occasionally connected distributed locations.

### 2.1.2.1 Regularly connected distributed locations

Business units that entertain a long-term, strategic relationship with each other can very well justify some effort for the initial setup of an efficient communication path between them. The more diverse the cases of process related communication and information exchange and the higher the volumes of workflows the more attention is to be paid to the configuration of the workflow interface between the enterprises.

Virtual corporations are regarded as a specific subset of this type of wide area workflow. Even though there may be cases that are actually lying in between intra and interorganizational workflow

the major idea is that of independent organizations - or parts of them - working closely together on a joint venture. For example, if several financial service institutes are setting up the salvation of some major business those virtual team would probably - at least over the period this project runs - form regularly connected distributed locations.

Among other interface parameters there must be specifications of, for instance, the structure of the information object that is to be transmitted. By identifying the quality and purpose of the specific job or case the type of workflow has to be defined. This refers to jointly developed workflow models that serve as common information routing prescriptions. Further, detailed specifications of the persons involved in both organizations - particularly at the entrance when the workflow is passed from one organization to another - have to be setup.

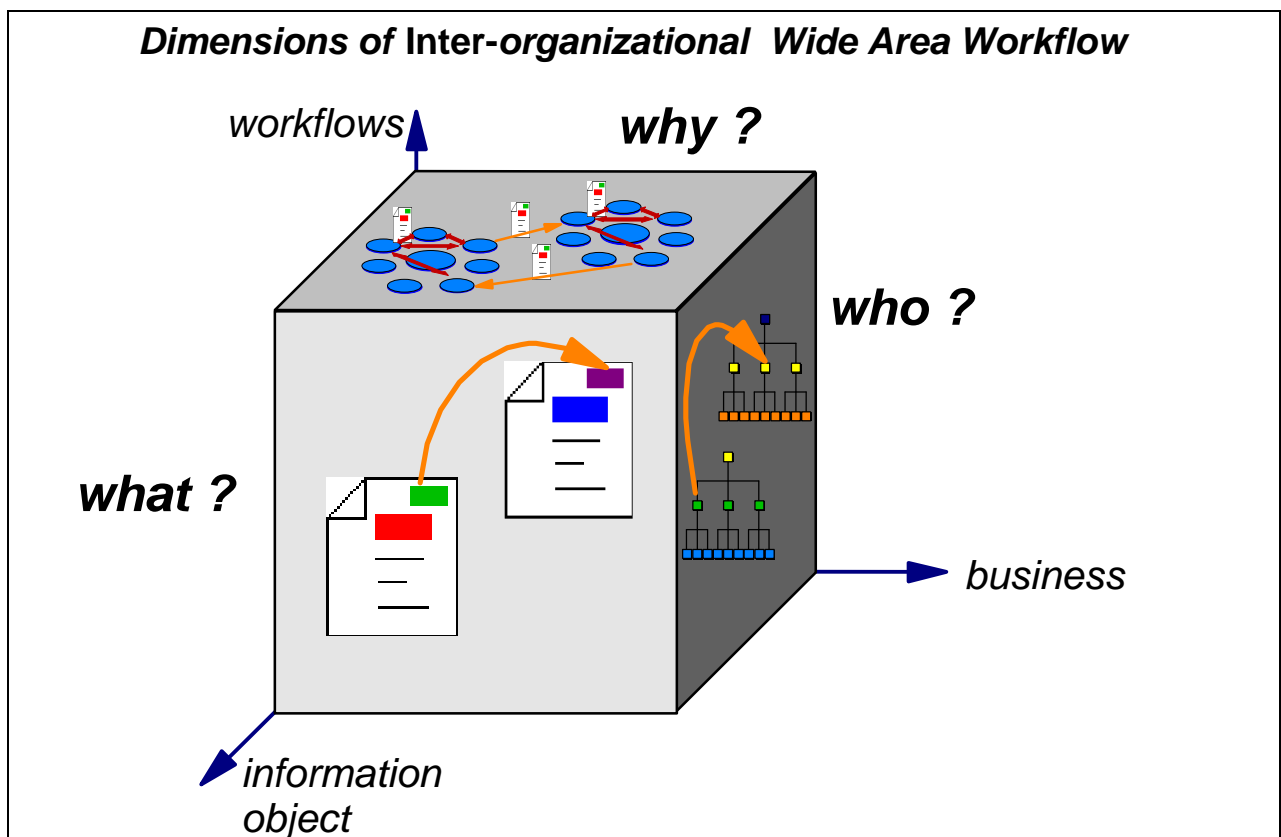


Fig. 2: Dimensions of interorganizational workflow

In terms of security as well as flexibility it is very important to keep the underlying workflow model as locally as possible. This means that only the interfaces between decentralized workflow subsets are defined globally - meaning for all involved partner organizations. The specific workflow model that each organization itself designs and applies for its subset of the wide area workflow can be regarded as individual and confidential. In general the partner organizations may only view external tasks on a global level. Actually, the collection of those *external tasks* will only be visible as *black boxes*.

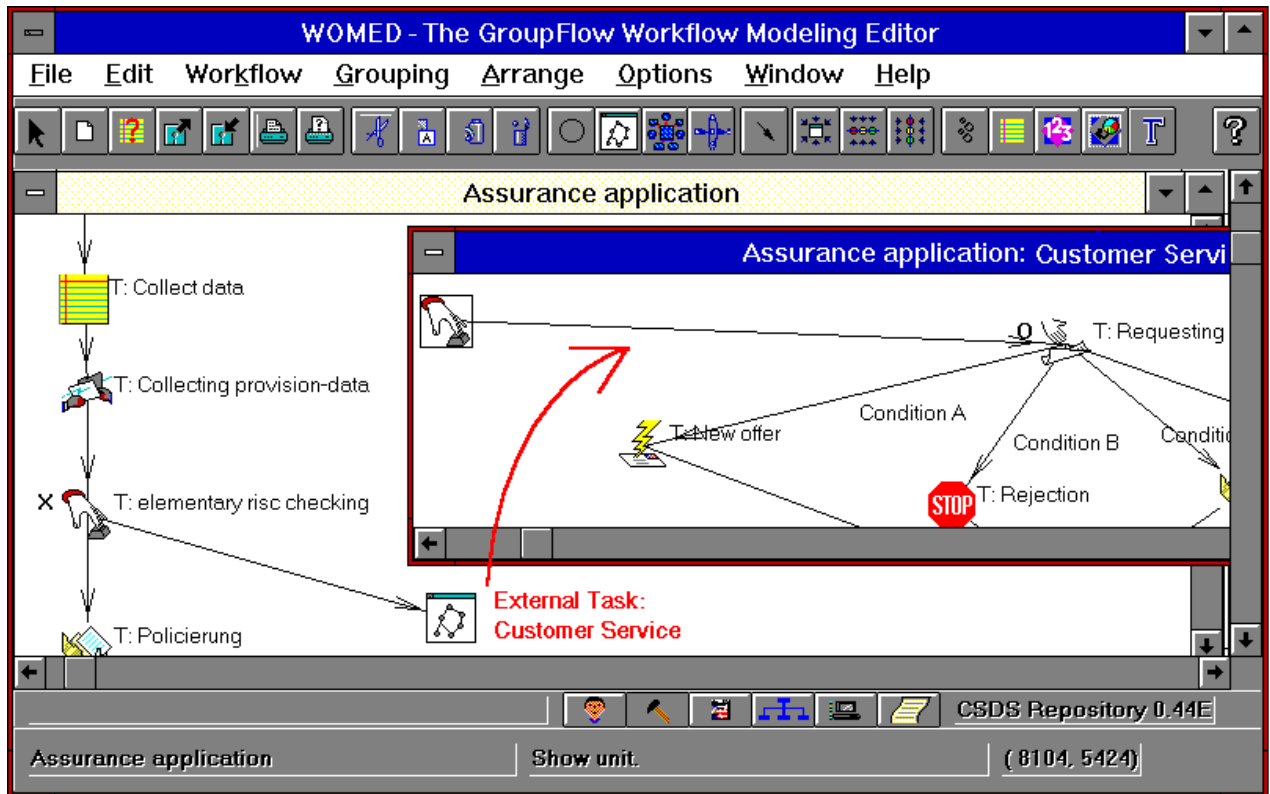


Fig. 3: Tasks appear as black boxes

The wide area workflow management architecture supports various different types of interorganizational workflows:

- In a simple case a workflow can be handed over from one organization to another in a *one-way street* manner. Both partners are regarded as equal in terms of the control over this workflow. In general there is no feedback expected on the side where the workflow started. Thus, there would be just a single intersection between two organizations.
- A more generic and thus complex scenario requires the hand over of workflows with expected return, such as a customer request for instance. This involves a workflow status management concept that generates status reports, enforces deadlines, etc. The number of organizations involved in this wide area workflow type can differ as well as the amount and type of information to be exchanged, and the manner of how these workflows are routed. In this case there is a clear assignment that one organization - usually the one that initiated the workflow - acts as the controlling force for this workflow.
- A third case is basically structured as the one described above. The difference is that in this case both organizations are regarded as equal in terms of the control over the workflow. That way more specific features for negotiation procedures have to be provided.

### 2.1.2.2 Occasionally connected distributed locations

For the occasionally connected locations of external organizations with merely sporadic contact the cost of setup have to be minimized. A rather simple access with a common, rudimentary functionality that requires a minimum or even no organization specific setup will be sufficient. This qualifies for low volumes, with rare or even unique communication instances between two organizations.



This may apply for scenarios where both are corporate partners. Also, when consumers contact enterprise, such as for example the standard query of an automobile industry customer asking where and at which production stage his or her new car may be at a given moment.

The organizational categories of workflow management in wide area networks can be summarized as the following:

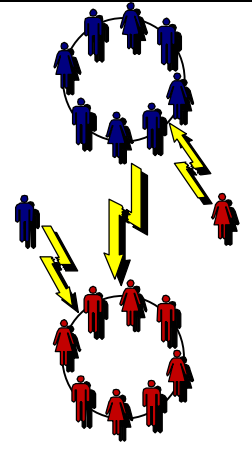
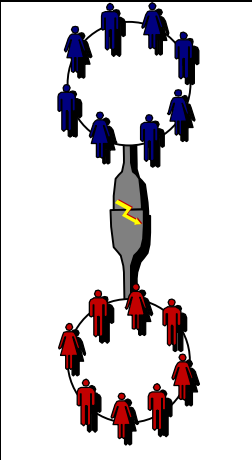
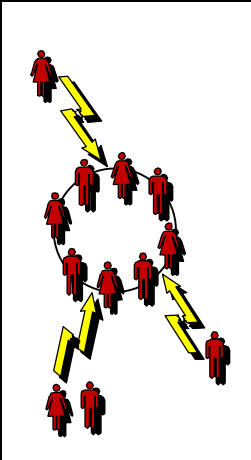
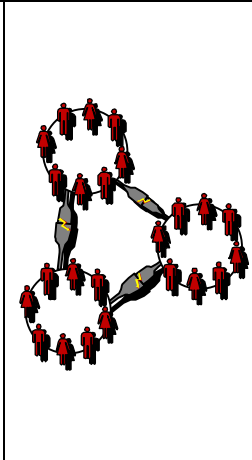
<b>organization</b>	<b>Inter organizational</b>		<b>Intra organizational</b>	
<b>connection</b>	<b>occasionally connected</b>	<b>regularly connected</b>	<b>occasionally connected</b>	<b>regularly connected</b>
<b>location</b>	static / mobile	static	mobile	static
<b>communication carrier</b>	client / server	server / server	client / server	server / server
<b>security, autonomy</b>	protected computing, complete autonomy, well defined information items accessible	protected computing, complete autonomy, well defined interface with a fixed set of interchangeable data	shared computing, identical access level as local team members, encryption for transportation security	shared computing, discrete / partial access overlap, same access as one virtual team
<b>information processing technology</b>	regular email, sporadic information push or pull	regular email, mail-in databases	adaptable selective replication model	fixed selective replication model
<b>sample scenario</b>	customer / supplier	distributed business, strategic partners	sales force	subsidiary (-ies)
				

Fig. 4: Organizational categories of wide area workflow

## 2.2 Technological Constraints

Beside the organizational environment technological constraints have to be considered for the design of a distributed workflow management system, including the underlying communication channel as well as the information routing mechanism.

### 2.2.1 Communication Channel

The communication channel available may vary between highly efficient LAN based and WAN environments with possibly varying quality and transmission costs. ISDN based high speed

communication at fixed locations allows for higher transmission volumes than modem connections that could possibly be used with wireless telephone systems. Information exchange strategies and content management concepts are required that take into account the transmission cost and time, acceptable volumes, etc.

## **2.2.2 Information Routing**

Generally speaking, the transport of information can be achieved in two different ways: All pieces of information can be routed from one person to another by actually sending messages from the one to the other (send model), or, by giving access to common information bases (share model). Both concepts are supported within the GroupFlow framework.

### **2.2.2.1 Send Model**

In an open and flexible ad hoc workflow scenario the send model as a basic message transport seems to be most appropriate. All information contained in document objects is sent from one actor to another in an email based store-and-forward manner.

This model is basically applied for rather simple ad hoc routing applications. It is easy to set up a new email based workflow. Usually the addressee does not expect any request beforehand. The focus of the next agent's attention is pushed on incoming documents to be worked on or to be forwarded. The personal email serves as the user interface. In such a mere point-to-point routing scenario it may be difficult to track the status of a specific workflow at a given moment.

Typical sample ad hoc workflows can be found for general purposes in office communication environments, in project management of individual tasks, or, customer requests that cannot be matched with any known standard service pattern within the organization.

### **2.2.2.2 Share Model**

Workflow applications that are basically performed by team tasks within self managing workgroups have more of a routine typology than email based ad hoc workflows. A team task with these characteristics can best be supported by an information system that offers some type of structured bulletin board or shared workspace. Shared document databases for teams as offered by groupware technology form an isomorphic and efficient foundation for team task support. The so called share model provides - in a somewhat complementary approach to the send model - a public view on the current jobs all team members are working on. The share model enables group access to shared information databases by viewing a single source of information from different, customized perspectives.

The major goal is to organize information for group usage and interaction. Thus it is possible for the team to flexibly react on unexpected changes within the office staff, such as absence from the workplace. Other actors can easily notice pending jobs of absent personnel and react accordingly. In many cases, this rather soft procedure of work assignment and supervision has proven to be much more practical than modeling complicated logical rules for replacement of absent personnel. When considering lean organizational concepts a workflow management environment should at least offer means for decentralized and independent work assignment by the team members themselves.

Continuous processes with certain routine characteristics are best modeled in shared document databases: Each person involved knows about the existence of information in the database and the respective tasks to be performed, or responses expected. Thus, all staff members concerned with these workflows consult the database on a regular basis checking for new documents applying a sort of pull approach towards information. They will react by working on existing documents

(modify, complete, add data; set status fields), forwarding, copying, archiving documents, creating response documents, or initiating new documents.

The process related data that form the contents within the shared document databases are distributed via the built-in replication capability of the underlying development and application platform Lotus Notes. The information exchange based on this architecture allows to share information over distributed locations as if the team members were located in a single *virtual office*.

For an efficient information exchange it is even more important to utilize the functionality to filter the amount of data to be replicated: the *selective replication* concept offers means to focus on that particular subset of data that is going to be needed at the location that initiates the replication process. Any type of information objects can be selected according to contents, formats, dates, etc. or any combination of the above. The selection setup functions support an efficient information transmission.

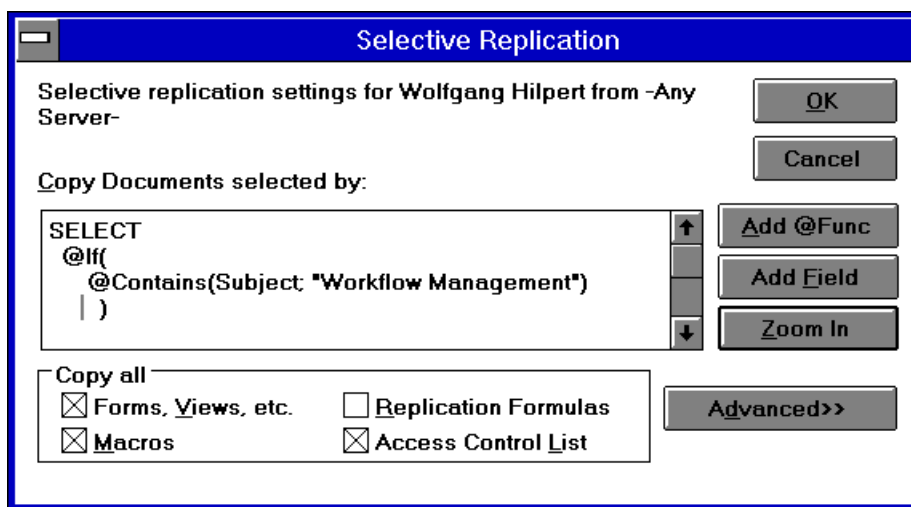


Fig. 5: Setup of selective replication model

The integration of both the send model and the share model as technically supported by the Lotus Notes platform can efficiently result in a variety of combinations over a wide spectrum. This spectrum stretches between email based applications including mechanisms like automatically sending a mail notification to the next responsible person. On the one hand This extends the usual shared databases which employ a push approach, focusing the actor's attention on a newly inserted or modified document in the shared database. In our opinion this almost continuous transition and combination of the two models provides a far better flexibility and reflects real business process requirements better than either mere transaction based process management systems or pure email based routing applications.

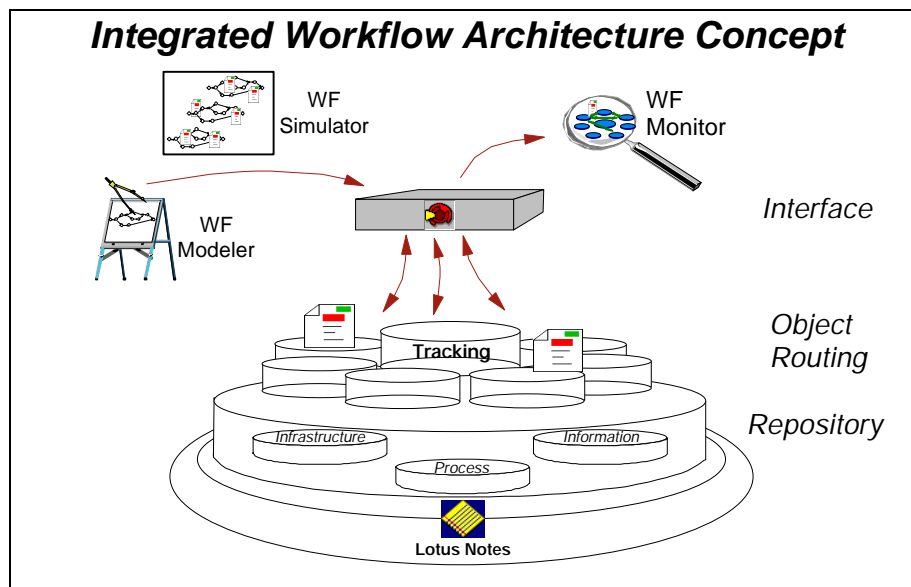
### 3. GroupFlow Wide Area Information Processing

Based on the previous classification of information exchange we developed a concept for wide area information processing that enables efficient information dissemination in both the intra- and the interorganizational context.

### 3.1 The GroupFlow System Framework

The *GroupFlow* system framework for workflow management based on groupware encompasses three major components [Hilpert 1993]:

- (a) the back end components managing the structural information of the workflow management system as well as the messaging and synchronization activities,
- (b) the target application(s) being embedded in various distributed and networked workflow-driven tasks including their associated data repositories, and
- (c) a tool environment, based on a set of independent interactive graphical tools, enabling a variety of workflow related functions, like workflow modeling, redesigning, analyzing, monitoring, or content (re-) structuring functions.



**Fig. 6: GroupFlow Framework**

(a) The *GroupFlow* back end components encompass the distributed workflow structure repository, the workflow-protocol or routing-status tracking functionality, and the replication and workflow routing engine.

Compared to workflow systems being offered on the marketplace *GroupFlow* is innovative in its back end architecture: The workflow routing engine has been completely modeled around the rich functionality for LAN-/ WAN-wide communication support inherent to Lotus Notes. The message dissemination functionality are complemented by its genuine replication-driven information sharing and accumulation paradigm. The workflow repository reflects the entities that are relevant to business process design and management. Based on a composite *enterprise model* the repository comprises structural information about the dynamics of the various business processes and the general organizational structure as well as internal application design specifications. The scalable business process structuring model defining a workflow continuum and underlying *GroupFlow* is being discussed in Nastansky / Hilpert [1994].

The protocol information stored in the *GroupFlow* repositories is further used to perform analyses comparing actual with planned, allowing anomalies to be spotted and corrected.

(b) The *GroupFlow* target application side encompasses the entities defining the authentic application functions of the business processes being enabled by a workflow system.

As opposed to workflow systems supporting automation of bulk data processing tasks within rigid sequencing patterns the *GroupFlow* approach primarily is *user and team focused* in supporting the actual processing of business data. In this user interaction focus *GroupFlow* is taking a similar starting point as that used in Medina-Mora/ Winograd/ Flores/ Flores [1992]. On the other hand, *GroupFlow* extends as well to workflow systems which aim at complete automation as their principal goal. Thus, the core of the *GroupFlow* application architecture is modeled around the groupware paradigm underlying its host environment Lotus Notes, and extending its functionality to a scale ranging from single user interaction to automatic software agent processed operations.

Using this approach, a *GroupFlow task* representing a workflow step of the supported business process comprises the following options for processing agents:

- a user is processing the task in an interactive fashion (user agent), or
- a software process is performing the task automatically, processing data in a workflow event driven schedule (software agent).

Typical interactive user agent processing includes: form and document oriented processing (i.e. 'fill-in-the-form' type work, rich document processing around many 'natural' data types [images, speech annotation, video], both based on Notes-native compound document editing), synchronous work with document embedded objects based on their supporting tool server environment (i.e. OLE, on MS Windows or OS/2 workstations), or supply of appropriate business parameters and initiation of asynchronous software-processes to be performed in finishing a task.

Much of the processing within the *GroupFlow* system is performed based on predefined Lotus Notes-native form, view and macro/script templates, that are ready to run, but also customizable to organization specific requirements. On the other hand, *GroupFlow* is to be considered completely open for interconnecting incoming as well as outgoing processes within a LAN- / WAN-based cross-platform environment by providing a variety of bootstrapping, hooking, or event handling concepts. The target applications have access to and are controlled by the workflow back-end engine.

(c) The *GroupFlow tool environment* provides an open set of independent interactive graphical tools enabling a variety of workflow related functions. Currently, the *GroupFlow* system offers as its key tool environments: *WOMED*, a graphical workflow modeling editor (supporting workflow top-down design, dynamic clustering, update, redesign, simulation), and *GroupFlow Analyzer* (supporting various message tracing functions between agents). These tools are designed as graphical front ends linked directly into the runtime data structures supporting the operative tasks of the *GroupFlow back end components*.

### 3.2 The *GroupFlow* "Post Office" Concept

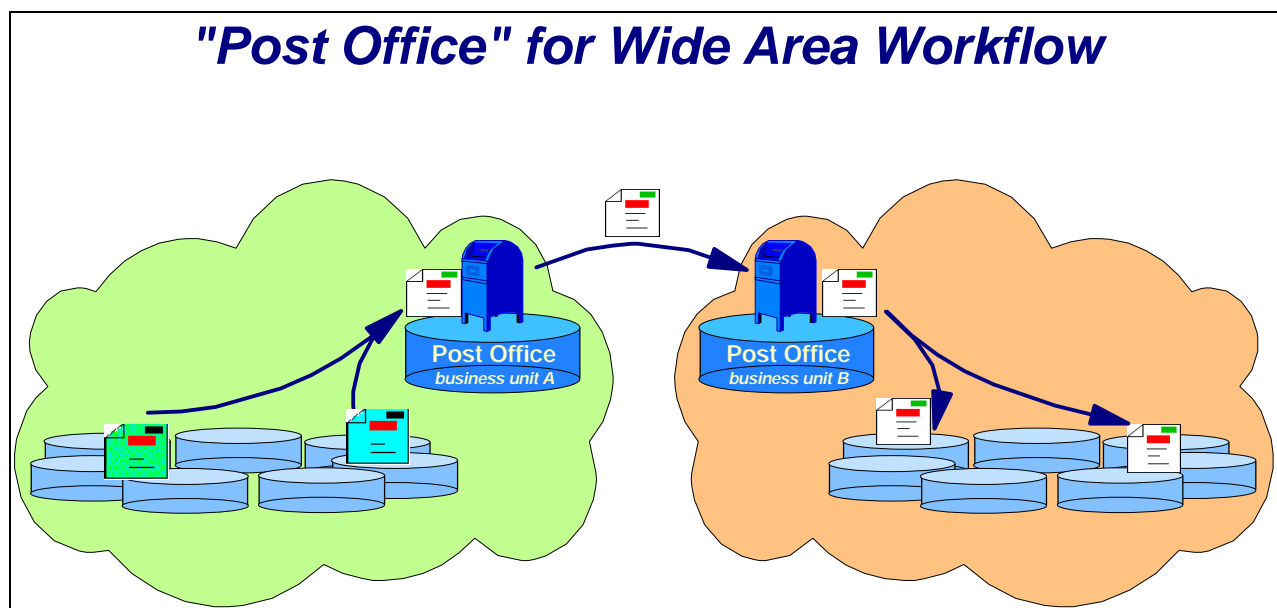
In order to address the interorganizational processes as described previously the above outlined architecture concept is to be complemented by a *post office* concept. In analogy to traditional ways of information exchange we find specific transmission agencies. They control the submission and reception of external communication items. This dedicated agent keeps control of the process identification and status. The post office functions as the interface to the outside world in the wide area workflow context.

The technical model functions as follows: workflow related document objects that stem from any of the various applications of one enterprise (*Fig. 7: business unit A*) are transferred into the post office application of that business unit. If specified accordingly the required modifications on these document objects will be automatically performed, such as the change of the used form, addition or deletion of specific data, or the actual *inclusion* of only linked-to data for example. If the linked-to

data is not accessible for the remote addressee it is necessary to *contain* or *attach* this information within the transmitted document object itself.

The pending document objects are then being sent from the post office of one enterprise to the post office of another enterprise (*Fig. 7*: business unit B). Because the post office database application is the main interface with other enterprises working on common workflows it suffices to agree on standards for the post offices - regardless of the internal workflow structure of any of the involved enterprises. This allows for an as independent as possible *internal* workflow layout at each location. Thus, most of the changes and refinements on the workflow definitions can be kept locally.

The incoming document objects at the post office of business unit B can then automatically be assigned to the appropriate staff according to local infrastructure and process specifications within the workflow repository.



**Fig. 7:** GroupFlow Post Office for wide area workflow management

As opposed to the previously described *shared* information approach based on selective replication this concept functions via an email-based information *send* mechanism. Thus, clearly defined common references with status control and receipt confirmation form the basis for common distributed workflow management. Still, the internal workflow structure itself remains a black box at the partner's site.

The common references encompass

- (a) the process specific data describing the workflow type as well as the actual job,
- (b) the type information object to be acted upon during the workflow,
- (c) the actor specific information defining the agent, the organizational unit, or the role involved in the workflow, and
- (d) communication channel specific characteristics.

(a) **Process** specific characteristic that are partially to be distinguished between the workflow type or class and the actual job or workflow instance to describe the enterprise information flows

applied by flexible or fixed communication relationships. The *compound workflow identification* consists of the workflow type and the unique job identifier. If both organizations do not use the same workflow type identifier aliases have to be managed.

Time restrictions such as deadlines or milestone events as well as priorities are included. The task that are expected from the partner organization have to be specified. This implies usually a rather aggregated level. With respect to as local as possible workflow definitions the target organization keeps the responsibility to define precisely the local subset of the workflow. So wide area workflow related organizations have only knowledge of an aggregated view of each others workflow steps.

Status control, return receipts as well as any legal reference is based on this identification. The status control includes such information as that a workflow has been received from the partner organization, keeps track of the process in an *audit trail*, shows whether the job has been worked on, rejected or completed. It possibly contains the date with intermediate results or problems that occurred as well as responsible persons. Means for an interorganizational workflow related dialog and exception handling are provided.

(b) The **information** container or document objects are specified with the data field formats and contents by common forms. The forms definitions that are available at the *post office* application of all involved organizations hold any workflow related information that are to be used. At the post office the information items are processed in a manner that merely the commonly required data - both structural as well as job specific - will be transmitted. This is regarded as an essential feature of lean and secured information exchange as a foundation for wide area workflow management.

(c) The **actor** specification refers to the involved people within the process. Particularly the people responsible for the workflow to external contacts are named. The person may be referred to by the actual name, by the position within the organizational structure as derived from the local name service, or more commonly by the role of the person within that organization. The type of reference of the addressed actor depends both on the knowledge level that the involved organizations have of each other and the type of task or workflow.

In general the actor should rather be specified abstract. The actual mapping with agents that hold positions or play roles is performed within the target organization. This way any information about organizational responsibilities can be kept within the organizational domain that provides the competence and knowledge about these responsibilities.

(d) The classification of the available **communication** media or carrier and the application of appropriate replication and transmission strategies are important for an efficient and cost effective communication. According to technical as well as economic criteria the transmission media such as ISDN or high speed modem and the tariffs such as night time savings rate - which amount to transmit when ? - have to be considered for the connection setup. The type and amount of transmitted data - the number of document objects, the document length, attachments, etc. - as well as the distance, duration and frequency of the communication have to be evaluated for an intelligent, well organized and carefully structured and efficient information exchange and replication strategy. The history as logged in the communication protocol has to be analyzed carefully for the suggested improvements.

In summary the post office concept as a common workflow interface component leaves room for a wide range of organization specific process customizations without the necessity to refine the interface between the involved enterprises. This concept may also integrate with other standardized protocols such as EDI. The post office concept can be applied in parallel with the model of shared

and (selectively) replicated information as well as the regular email functionality. Thus, a variety of options to choose from and combine the most appropriate is offered for a powerful and efficient information exchange as the basis for an integrated distributed workflow management within the *GroupFlow* framework system.

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