The *GroupFlow* Framework:
Enterprise Model and Architecture of the Workflow System

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Abstract

The *GroupFlow* environment integrates concepts that are typically referred to as *workgoup 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 article describes the Enterprise Information Management Model and the distributed data and object architecture layout of the *GroupFlow* framework. The procedures for the specification of workflows based on this framework are outlined.

Keywords

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

1. The GroupFlow Project Environment

GroupFlow is to be considered as a comprehensive system approach supporting business process engineering, deployment, monitoring, and the operational infrastructure of distributed workflow management frameworks within an organization. The GroupFlow system comprises the tools necessary for business process design and monitoring as well as a complete set of operative modules for the various tasks and processes within a flexible LAN- and/or WAN-based workflow supporting runtime environment.

The conceptual approach of the *GroupFlow* system with respect to business process modeling, distributed data and object architecture design, user and process/agent interaction is in concordance with research and discussions that are drawn along the lines of studies such as published in Harrington (1991), Keen (1991), Davenport (1993), Hammer & Champy (1993), Ishii & Ohkubo (1991), Marshak (1992), or Medina-Mora, Winograd, Flores & Flores (1992). The importance of business process and workflow oriented system approaches to corporate information management has lead to the development of the *GroupFlow* framework. In another paper (Nastansky & Hilpert 1994), we have been focusing on complementary aspects of the entire *GroupFlow* framework, like e.g.:

- The business process paradigm underlying the design of workflow systems: a continuous scale between cooperation and automation.

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- The architecture of GroupFlow enabling various classes of workflows on a continuous scale between flexibility and predefined structures.
- Further aspects of the GroupFlow Modeler like integration in a distributed operative environment or the clustering approach.

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 developed using graphical front end tools. On the back end server side of *GroupFlow*, Notes technology has been exclusively used for data repositories of the actual business information content, for the workflow structuring parts, and the set of workflow runtime modules supporting processes like messaging, replication, event management, gateway connections, or cross-platform data exchange and process coordination.

2. The *GroupFlow* Enterprise Information Management Model

According to Bracchi & Pernici (1984) the major target of conceptual office modeling is to make office information system design easier and more reliable. Thus, goals for a conceptual design of office models are:

(1) Obtain a description of the enterprise. The large number of exceptions and special cases makes it impossible to reach a complete formal description of the office. However, the model should describe as many aspects of the enterprise as possible in a definitive way. It is important that this description

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is comprehensive not only to an analyst or systems designer but also to the staff members, managers and planners in the office. They should be able to validate the system, suggest modifications, identify inconsistencies, and maintain and further develop the system themselves.

(2) Identify processes that are no longer useful in achieving the current enterprise goals but are still performed, perhaps only because of habit. These processes are to be modified or completely replaced. In literature we find many different approaches for office or enterprise models. Some of them are discussed more deeply in Desai (1991), Dutton (1993), Lochovsky, Hogg, Weiser & Mendelzon (1988), Kubota & Ishii (1989), or Tueni, Jianzhong & Fares (1988). An enterprise model that is applicable to workflow design and processing obviously has to subsume at least the following layers of information management within the organization:
The information flow of an organization, the sequence of activities, the agents and resources such as office workers or organizational units playing specific roles when performing activities. The enterprise model is to encompass the decomposition of the whole application environment into a workflow-based sequence of tasks, the resources required for these tasks, and the objects accessed and manipulated during task processing. Also, task and process decomposition require to refine lower-level task activities and sublevel processes. *Fig. 1.1* represents the fundamental structure of the enterprise information management model underlying *GroupFlow*.

Infrastructure model	Process model	Information processing model
unit agent role workgroup resource relationship	business process task activity rule time	object type information links folder

Fig. 1.1: Outline of the Enterprise Model underlying *GroupFlow*

(1) The infrastructure model defines the structural components of the organization which can be represented within *GroupFlow*. This infrastructure model comprises the people who work at different locations/positions in different organizational units of an organization, the resources they use to perform their tasks, the formal groups/teams they belong to and the relations and formal communication paths between these groups. It determines the interrelationship between the units such as superior units. Also, the assignment of roles to agents describes what the actor of a role is expected to do within his working environment or within a special process.

An agent can be both a human/person (actor) or an automated software agent. A human agent holds a position related to an organizational unit within the infrastructure model and in addition can play different roles to perform office tasks. Automated software agents perform a variety of information processing and communication procedures automatically using specific software modules. Examples could be Archiving, Relational database queries, complex price or status calculations and so on.

A formal unit matches the human agent with the organizational structure. A unit describes the elementary components of the organizational structure. The enterprise model underlying *GroupFlow* allows a unit to either be elementary or to be aggregated, like divisions or departments. Workgroups, on the other hand, offer flexible concepts for perpetual organizational (re-) modeling. Particularly informal, short-lived task forces can easily be built/grouped together.

(2) The workflow routing specifications are based on the process model of the enterprise. It holds information about the business process layout and definition, the involved agents, resources, etc. This module focuses on the process dynamics/specifications, their interdependencies, the steps to be taken within a process, their serial or parallel sequences, etc.

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). 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. The defined office procedure classes and their respective workflow routing specifications are distributed via the built-in replication mechanism of the underlying development and application platform. The actual routing and status man-

agement is handled in a local manner: the "intelligent" document compares its actual status with the also decentralized available routing information in order to find the next agent for further task performance.

(3) The *information processing model* traces the outline of the object types or information items such as messages, documents or forms that are manipulated and exchanged within the organizational infrastructure. It also describes the information links that can exist between the several objects. Information items or document objects can be included into folders. The functionality that actually drives the workflow routing is captured in *program objects sets* that are linked dynamically into the information object. The system architecture is designed in a modular and layered manner.

3. The GroupFlow Distributed Data and Object Architecture Layout

The architecture of the *GroupFlow* system framework (*Fig. 3.1*) consists of three major components that are outlined in a layered architecture model:

(1) 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. These components manage the structural information of the workflow as well as the messaging and synchronization activities. The scaleable business process structuring model that underlies *GroupFlow* is being discussed in Nastansky & Hilpert (1994). The protocol information stored in the *GroupFlow* repositories is further used to perform analysis comparing actual with planned, allowing anomalies to be spotted and corrected.

(2) The *GroupFlow* target application side encompasses the entities defining the authentic application functions of the business processes being enabled by a workflow system. Much of the processing within the *GroupFlow* system is performed based on predefined Lotus Notes-native form, view and macro/script templates. Continuous processes with certain routine characteristics are best modeled in shared document databases: The involved persons know about the existence of information in the database and the respective tasks to be performed. The complementary send (e-mail) model is basically applied for rather simple ad hoc routing applications. 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.

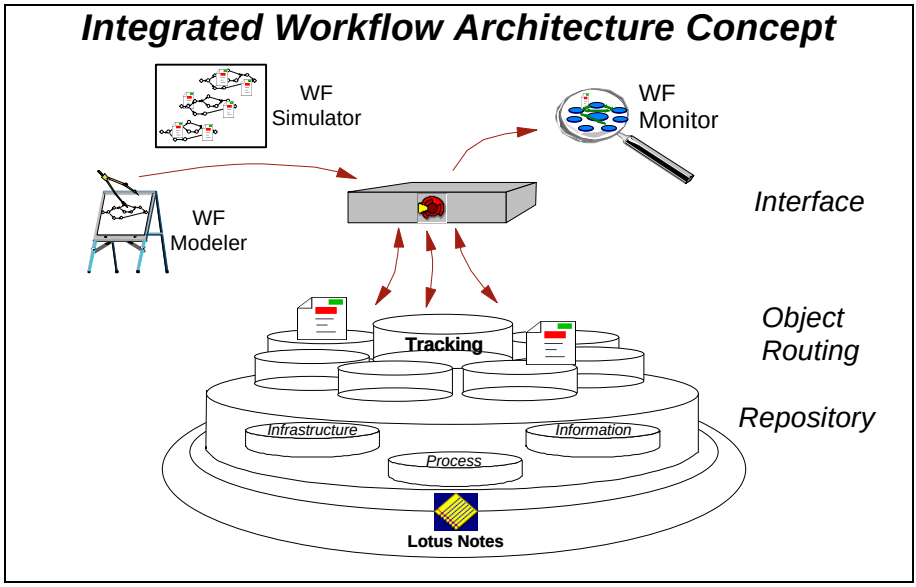

Fig. 3.1: *GroupFlow* Framework

(3) 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: *GroupFlow Modeler*, a graphical workflow modeling editor, and the graphical *GroupFlow Monitor*. The *GroupFlow Modeler* supports both workflow top-down as well as bottom-up design, dynamic clustering, update, redesign, and simulation of workflows. The organizational layout can also be graphically modeled and related to workflows using the higher clustering levels of the *GroupFlow Modeler*. Any data defining the graphically modeled specifications are stored in Lotus Notes database objects and hence can be exchanged across distributed locations using the replication mechanism. The *GroupFlow Monitor* supports various message tracing functions between agents. Particularly planned and actual workflow routing can thus be visualized and compared. A subset of the monitoring functionalities - the *GroupFlow Analyzer* - visualizes document routing and message exchange within any Lotus Notes database application. The results of this kind of analysis allow to derive information for possible re-design options for the workflow with the *GroupFlow Modeler*.

4. Procedures for *GroupFlow* Specification

In order to actually utilize the *GroupFlow* system in a comprehensive workflow application a few major deployment phases have to be run through. It is important to recognize that these phases are highly interdependent. In an actual installation, typically it will be necessary to iterate back and forth between the outlined phases. The phases are as follows:

(1) analysis and workflow concept design,

(2) implementation of the workflow system,

(3) application of the workflow system, and

(4) monitoring and analysis of actual workflow

4.1 Workflow Concept Design

In a first phase the business process side of an application has to be analyzed and (re-)constructed before the actual implementation of the workflow system can go under way. This involves the investigation of existing or planned processes to eliminate potential bottlenecks and/or redundancies. The flow of the information, the decision points and the various forms of data and information presentation have to be investigated.

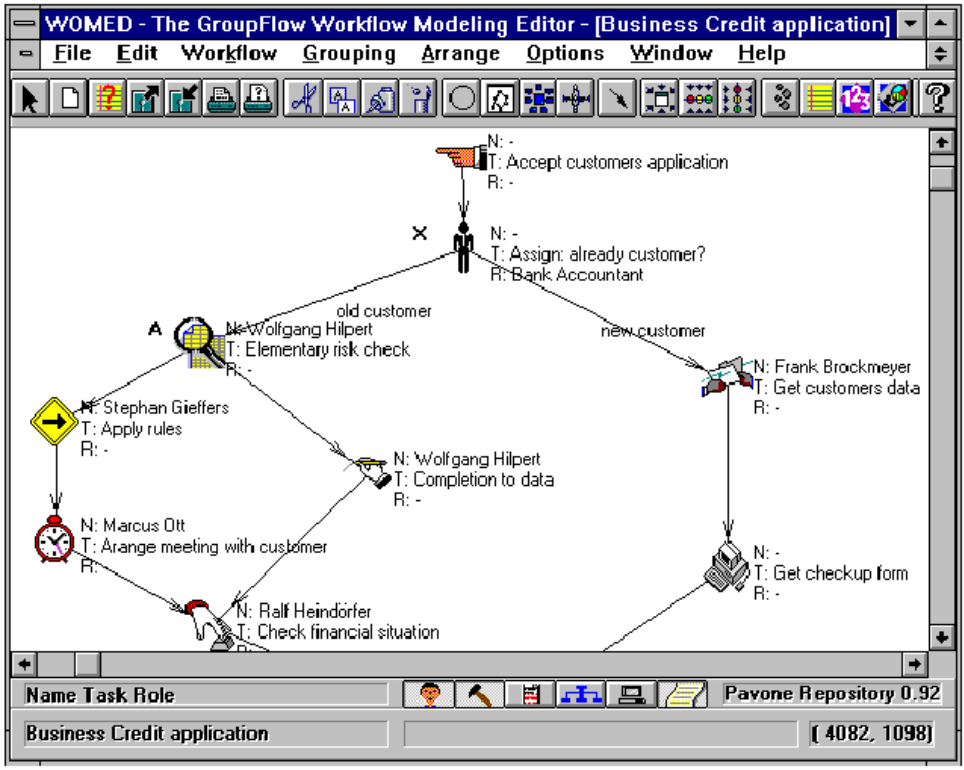

Fig. 4.1: The workflow modeling editor „*GroupFlow Modeler*“

In this first phase the concept of the process is developed. This includes the design of a graphical workflow model as well as of the related organizational structure layout. The *GroupFlow* modeling tools support the efficient presentation, discussion, and refinement of the new system design. In order to support the *ex ante* analysis of the business process model the derived workflow can be simulated. The simulation may focus on static structural aspects based on the workflow visualization, or, it may include dynamic sequencing patterns based on basic object flow simulation in the workflow graph. Thus, consistency checks and bottleneck detection are possible beforehand.

4.2 Implementation of the Workflow System

In order to implement a workflow application the graphical representation of the workflow as designed with the modeling editor is automatically transferred into operable workflow definitions. The graphical workflow model consisting of nodes and edges with its embedded specific properties and attributes is logically transformed and stored as operable routing specifications in the workflow repository. The transformation process involves both conceptual and technical interface capabilities.

The target workflow-enabled database applications interoperate with the workflow repository to use its specifications and to manage the actual workflow routing. These applications are used to activate the document object routing. They are designed to be driven by the specifications entered in the workflow repository and are used as prototype applications and thus form the basis for the design of the actual operative application databases.

4.3 Workflow Routing

For the application of the workflow system the users initiate actual workflow instances based on the specification and design performed at the former steps. Various alternatives exist of how a (human or process) agent can route a workflow object to the next appropriate agent in the chain:

(a) Standard Routing of Predefined Workflow:

The user initiates the object routing by composing new documents in the target workflow database application. All agents with access to the shared databases can locate their tasks in several different contexts or views. The current agent of a workflow finds her work to be done in her work assign-

ment area. The scenario described here is based on the shared database approach. There are many advantages to this solution, the most important being the team responsiblity for keeping track of processes. Still, there may be situations where a quick response is necessary. This implies the need for the application of a send approach for the workflow routing. Within the *GroupFlow* system we apply a combination of both models: basically, the document objects are hosted in common, shared databases accessable by all team members and are assigned for processing to one or more agents. In addition, an E-Mail notification supplied with a hypertext-/document-link that leads the addressee directly to her new task., is sent.

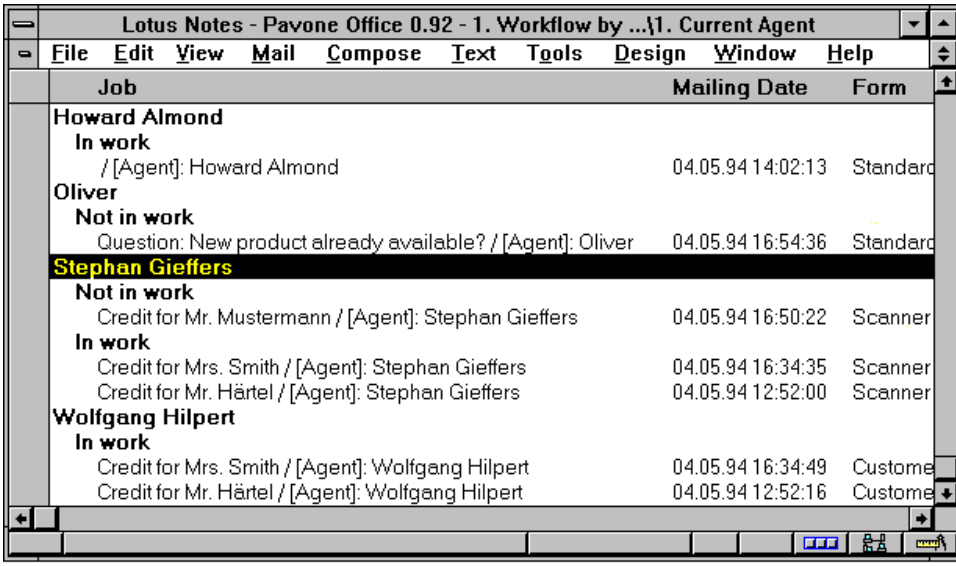

Fig. 4.2: View "Current agent"

When pushing the button for the 'next task routing' the user incorporates a key feature of the *GroupFlow* architecture. A background process determines who will be the next person in the routing chain based upon the proc-

ess specifications in the workflow repository for the chosen type of workflow and the individual circumstances of the current case.

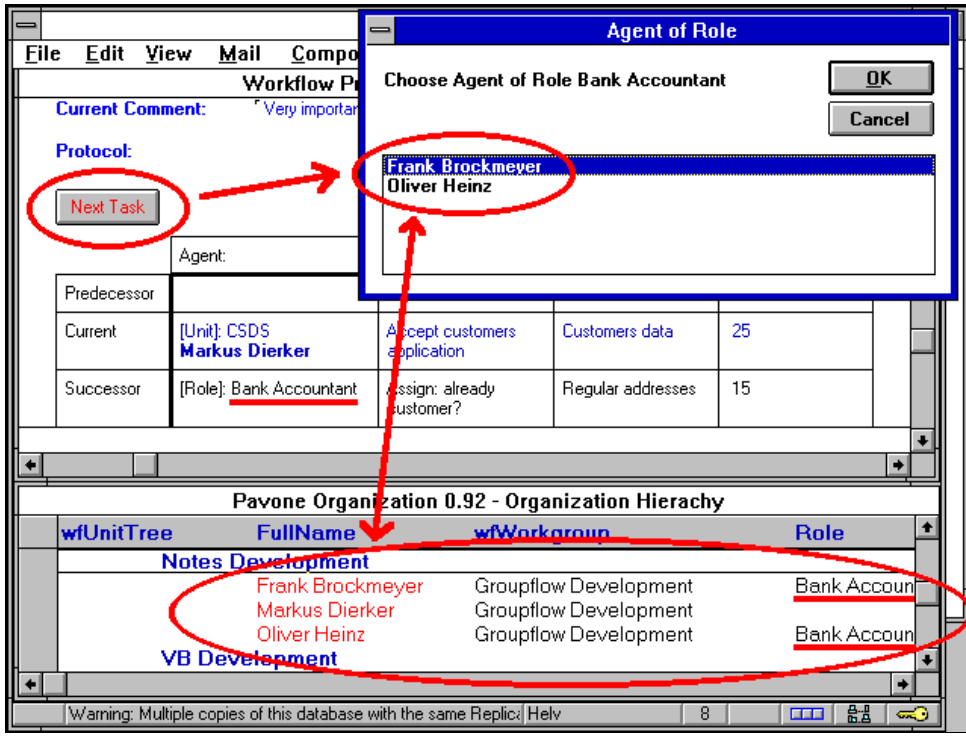

Fig. 4.3: Specify next agent more precisely at runtime

(b) Flexible ad hoc Modification and Exception Handling of Predetermined Workflows

The *GroupFlow* architecture supports modification of the standard routing sequence *within a predefined* workflow at run-time by ad hoc modifications and dynamic re-routing of tasks for special cases and exceptions. The *GroupFlow* environment integrates a set of structured mechanisms to han-

dle exception or disruption problems of various kinds in predefined workflows as described in Nastansky & Hilpert (1994).

The possible modification rules applying to given workflows have been modeled on common exception situations in business processes, such as:

- *check-back* with previous agent,
- *inquiry* or question to anyone else,
- *task delegation* invoking a detour in routing path, or
- complete *change* of the underlying workflow.

As with all other activities of this workflow system, the exception handling to the standard workflow specifications must be thoroughly recorded.

4.4 Workflow Monitoring (*ex post* analysis)

The *GroupFlow Monitor* visualizes the *actual workflow* of the workgroup. Based upon the entries both in the target workflow application databases and the protocol in the tracking database, an *ex post* as well as a concurrent analysis of the business process can be performed. The most interesting feature of a *Monitor* is the possibility to compare the entries of the actual workflow instances with the underlying *common* or *planned* workflow type specifications in the workflow repository. In order to monitor the progress of the processes we propose three major dimensions to focus on:

(A.) *Snap shot*: static workflow analysis

For this view all document objects of all business processes that are currently being worked on are included in their actual status at present. This

view helps in estimating the current workload and the workload balance between team members.

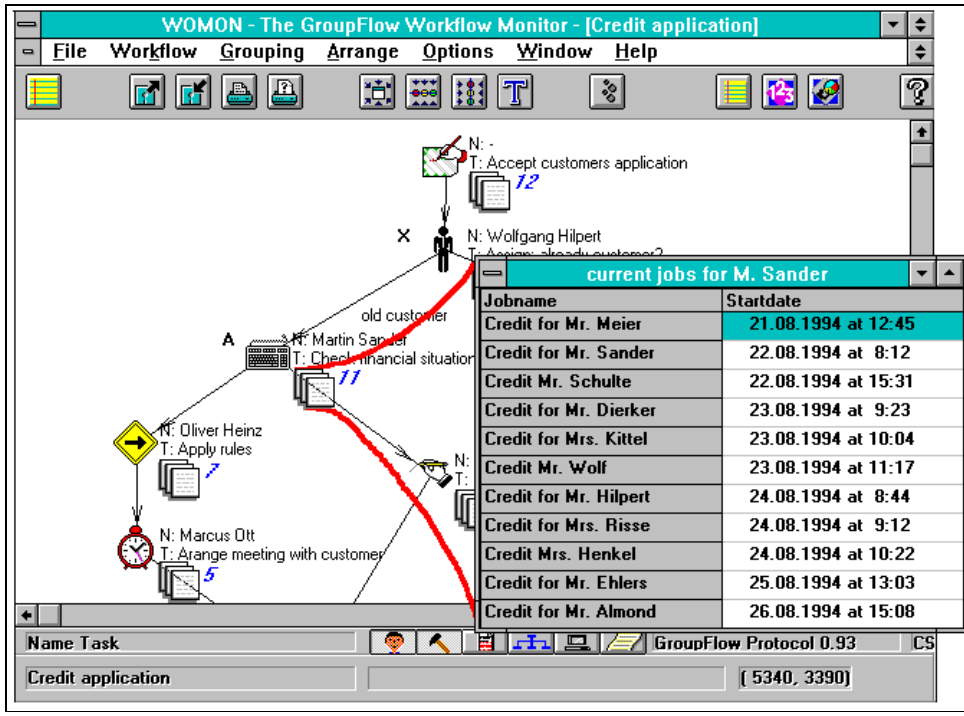

Fig. 4.4 : Monitoring of workflows

(B.) Process specific: dynamic workflow analysis

By determining a particular workflow or a specific cluster of workflows all document objects that have been dealt with during a process can be followed in their development over time. This view shows the currently active workflows, preferred routing paths and also relationships between activities such as time restrictions.

(C.) Actor specific: involvement in various processes

The third dimension of analysis investigates the activities of single actors or workgroups on document objects of various workflows. It can be shown how individual actors are involved in different workflows within the team over a longer period of time.

5. References and Acknowledgments

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