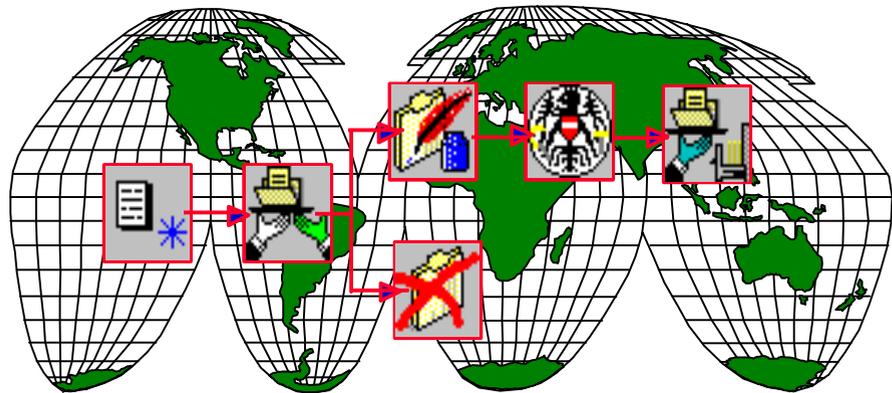


# Workflow and Internet: Catalysts for Radical Change

*A WfMC White Paper*



June 1998

Workflow Management Coalition <http://www.wfmc.org>

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# Foreword

Together, Workflow and the Internet are set to provide us with some astonishing results...

By closely combining the unprecedented information communication capabilities of the Internet with the strategic business processes automation and integration capabilities of Workflow engines, significant changes will be realized. These will enable a real acceleration of productivity improvement within information-related activities, and will pave the way for some totally new forms of work. These will include home work, mobile work and virtual enterprises.

The latter will be formed for the duration of a specific project and will build on the unique strengths of large corporations, small companies, and individuals, regardless of their physical location world wide. This trend will take years to develop widely, but the tools to support it are already there and some visionary companies and individuals are already using them convincingly.

## PURPOSE

The purpose of this White Paper is

- To explain how the integration of Workflow and Internet technologies can bring economic transformations that neither technology could achieve in isolation
- To present some of the benefits that companies can expect from those transformations
- To demonstrate how the efforts of the Workflow Management Coalition make this integration possible and provide a focus for integrating the cooperating technologies
- To explain how the WfMC intends to implement an increased commitment to Internet support.

## AUDIENCE

The impact of integrating Workflow and Internet technologies is such that it will concern the whole enterprise

- Its position on the market
- The way it is organized internally
- The way it cooperates with its partners and customers
- The way it is distributed geographically
- The working environment of its employees

## HOW TO READ THIS DOCUMENT

A first section positions today's usage of the Internet and Workflow. The Internet is mainly oriented towards external corporate communication and information, while Workflow is focused on handling business processes. The section shows how the combination of the two will bring explosive results in the medium term. The next two sections go into more detail about what Workflow will bring to the Internet, and what the Internet brings to Workflow applications.

Supporting evidence is included in a section devoted to the presentation of the WfMC Reference Model and showing how the WfMC specifications can be mapped onto Internet technology. It is followed by a statement of direction of the WfMC regarding further specification and standardization efforts.

The White Paper concludes with a summary of Workflow terminology, and a glossary of Internet terms.

**Internet applications move from communication to an active economic role**  
**The Internet will connect 200 million users in year 2000**

## **Internet and Workflow: An Explosion of Professional Applications**

Today, everyone is likely to agree on the fact that Internet is a major technological revolution which every company needs to consider. However, even 3 years ago it was not like that. Internet deployment around the world - both at public and professional levels - is the fastest technological evolution of this century. The Internet will connect 200 million users in the year 2000, and perhaps one billion in 2010. Within two or three years, the whole computer and telecommunication industries have redeployed their development and marketing forces to provide tools and services on the Internet, to enhance its infrastructure and standards and provide supporting products. The level of investment is unprecedented and has now gone far beyond the point of no return.

### **THE INTERNET AS AN INFORMATION MEDIA**

The primary applications of the Internet worldwide are for communication and information distribution.

Communication over the Internet includes a growing use of electronic mail, progressively replacing fax, postal services and, in many cases, phone. Communication also means use of news groups and forums where more structured asynchronous information exchanges can take place among users sharing common interest irrespective of their location, time zone, and organization.

Information distribution primarily means the development of corporate Web services, built as a source of information for different types of information user: not only customers and prospects but also potential partners, distributors, providers, journalists, shareholders and many others.

In a similar way, enterprises are using intranets as a major information and communication tool for their employees. The same software components can be deployed internally to disseminate company strategy and policies, organizational information, procedures, quality information and product life cycle company standards, job opportunities, training programs, and many other essential subjects of common interest.

### **THE INTERNET AND ELECTRONIC COMMERCE**

The Internet provides a way to enter transactions through forms. This capability can be used to take orders on-line, and is frequently offered on enterprise Web sites to ask for commercial documentation, ask for a phone contact, register in a distribution list, ...

Enterprises are starting to use such capabilities on their intranet by providing form-based electronic mechanisms to: register for a training session, request office equipment, make meeting room reservations, order documentation, and many others.

With electronic commerce, orders can be paid for on-line and guaranteed by a third party with a high level of security. By offering a full catalogue on-line and capabilities for electronic commerce, the enterprise moves

**Enterprises use the Internet as an information and communication interface to the outside world**

from the information domain to direct on-line commerce. This movement is just starting and it promises to grow rapidly as the number of Internet users grows.

With on-line ordering and electronic commerce, Internet applications move from the information/communication arena to a more active economic role. The Internet will bring two linked economic changes:

- Using the Web for electronic commerce enables an enterprise to offer products to every Internet user world wide (assuming worldwide delivery capability and no international trading law constraints). This will bring global competition to the market.
- Electronic transactions cost considerably less than other means. In the long term this will reduce the cost of sales and contribute to increased productivity in the global economy.

## A NEW RANGE OF INNOVATIVE SERVICES IS COMING

The Internet is already moving rapidly towards providing a wide range of services to connected users. Some of these services are on-line replacements of traditional services (e.g. help desk, customer feedback and survey, shopping for merchandise, etc.). Other services are unprecedented - for example, the email agent on [www.amazon.com](http://www.amazon.com) automatically notifies users about newly published books based on their reading preferences; the price comparison agent on [www.netbuyer.com](http://www.netbuyer.com) gives immediate price comparison for computer products across various vendors; the tracking agent at Fedex and UPS tracks packages to delivery, etc..

## BEHIND THE SCENES - BUSINESS PROCESSES

Such Internet applications are the enterprise's interface with its market. They enable the company to do business. Suddenly the Internet gives access to hundreds of millions of potential customers, and every enterprise will need to be in that marketplace. But the internal workings of the enterprise are not necessarily affected.

Most intranet applications replicate this situation by handling what is essentially "corporate communication", but seldom taking the extra step of providing tools to produce the goods and services that form the ultimate mission of the enterprise.

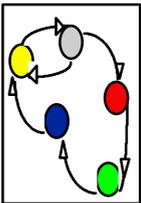
In other words, what happens behind the scenes is not addressed.

### *Services are Provided by Business Processes*

When a company implements a Web site for corporate communication, a complex process ensures that what the user sees on screen corresponds to the communication strategy of the company. This process will include various activities such as agreeing communication goals, assembling basic material into pages, previewing pages for comment, compiling the final version for approval before loading and opening the site.

Once the site is on-line it will be regularly updated, this becoming a continuous enhancement process. So even an apparently static information service relies upon a complex and dynamic process for its content creation and maintenance.

**Business  
processes deliver  
the products and  
services**



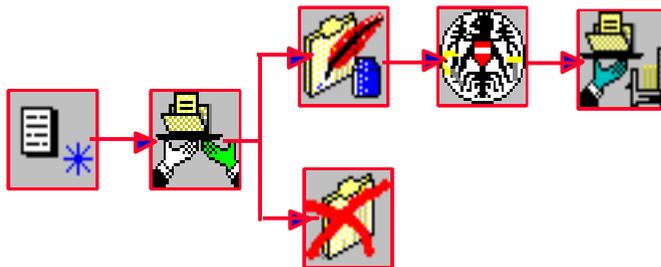
When the company takes orders on-line on its Web site, the site should be linked to the order processing process. This process might involve activities like, identifying the best depot to send the goods; selecting a delivery agent; communicating with depot and agent; raising an invoice possibly with international customs documents; monitoring delivery; answering customer queries on the order status, and processing exceptions such as delivering the wrong product to the wrong address, lost and damaged deliveries, freight problems, accidents, order cancellations and so on. This complex process is critical to the quality of service provided to the customer.

To give another example, a company offers an intranet browser to order office equipment from an electronic catalogue ranging from pencils up to computers. Behind the scenes a complex process handles verification and delivery of the goods ordered. First the order must be checked against budget and approved. Then it will be delivered from internal stock or ordered from a provider, possibly involving support or installation services. The company inventory will need updating... Here again, the process is complex, involving a number of different people internal and external to the company.

### **Workflow Assists Business Processes**

Workflow's primary mission is to handle business processes that span several areas in the company to support external demand. The following are the definitions given in the WfMC Glossary

- **Business Process** - A set of one or more linked procedures or activities which collectively realize a business objective or policy goal, normally within the context of an organizational structure defining functional roles and relationships
- **Workflow** - The automation of a business process, in whole or part, during which documents, information or tasks are passed from one participant to another for action, according to a set of procedural rules
- **Workflow Management System** - A system that defines, creates and manages the execution of workflows through the use of software, running on one or more workflow engines, which is able to interpret the process definition, interact with workflow participants and, where required, invoke appropriate IT tools and applications.

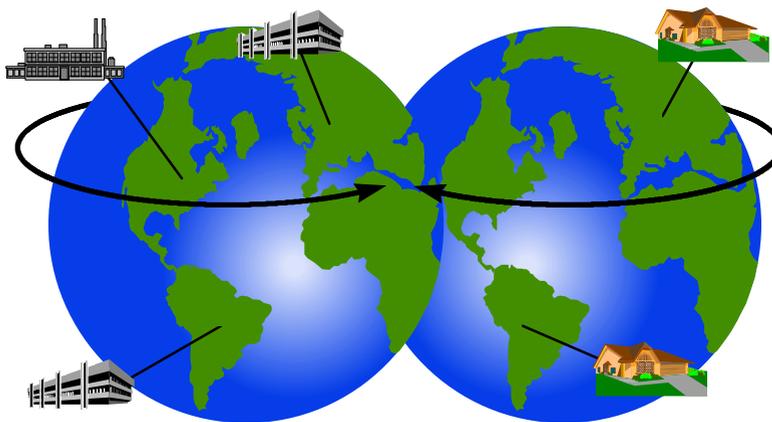


In each of the above examples, a Workflow application can handle the implied business process which is behind the Internet-initiated transaction. If the Workflow application is Internet- or intranet-enabled, then, from the user's point of view, the Internet becomes both the way to initiate a transaction and the trigger for the process that will service it. The Workflow engine will drive the process until completion by assigning activities to each implied actor in due time according to the procedure that the process must follow.

Through Internet-enabled Workflow, external (and internal) requests directly trigger the processes for servicing them. Through Internet-enabled Workflow, the Internet moves from a passive information role, to an active role as a medium for supporting the execution of business processes. With Workflow, both Internet and intranet applications suddenly penetrate to the place where

added value is produced - business processes. This is why Workflow and Internet are more effective in combination than alone.

## FROM THE GLOBAL VILLAGE TO THE VIRTUAL ENTERPRISE



The Virtual Enterprise

The Global Village

reconfiguration as the need arises.

The Internet offers any individual the ability to exchange information with anyone in the world as if they were in the same village - the "global village". This makes it possible to create communities of people with a common interest where distance is irrelevant. Electronic commerce is part of the scenario since any electronic shop is potentially part of the village.

Similarly, Workflow can spread across company boundaries and anywhere in the world on the Internet. This opens up a completely new way of doing business through home work, mobile work and virtual enterprises.

The potential economic impact of such an opportunity can be enormous. It is possible to realize cooperation between economic actors for common undertakings and allows dynamic

### *A Major Transformation of the Economy*

Workflow brings business process support capability to Internet applications, while the Internet brings its worldwide infrastructure and zero deployment costs to Workflow applications.

In the long term this will bring a major breakthrough in productivity, organization, international exchanges and economic growth through:

- Innovative products and services combining communication, electronic commerce and business process automation to provide effective and low cost customer service worldwide
- Innovative processes where the client is a direct participant in the process and Workflow-enabled processes track transactions across unit, company and enterprise boundaries
- Innovative organizations relying on Workflow-based end-to-end business processes to provide the best possible service, in spite of the internal structure being adapted to match market needs
- Dynamic win-win cooperation between enterprises and individuals. Better service for the market will be based upon optimum performance of each of the assembled partners being enabled through Workflow-controlled business processes.

## What Workflow brings to the Internet

Current Internet applications are well-suited to short-lived interactions between users and computer systems that provide information, services, etc.. But there is no support for long-running interactions. Workflow technology's main goal is to manage long-running, process-oriented applications. On the Internet it will be used to automate processes that seamlessly span heterogeneous Workflow systems and components, involving distributed participants. This is precisely what the Internet lacks today, and what Workflow brings to the table.

Handling processes is fundamental to modern organizations. Done well, it increases productivity, improves quality, reduces the time needed for customer service and enhances operational control.

Behind any Web application, there are processes. Workflow on the Internet provides the opportunity to automate those processes and provide continuity between a customer requiring service, and the production of those services.

Workflow systems support home workers by automatically dispatching tasks to the appropriate person at the correct location. They can log every participant action and produce detailed statistics making control of work at home feasible. For the same reasons it supports mobile workers. Workflow systems can cross company boundaries to build virtual enterprises.

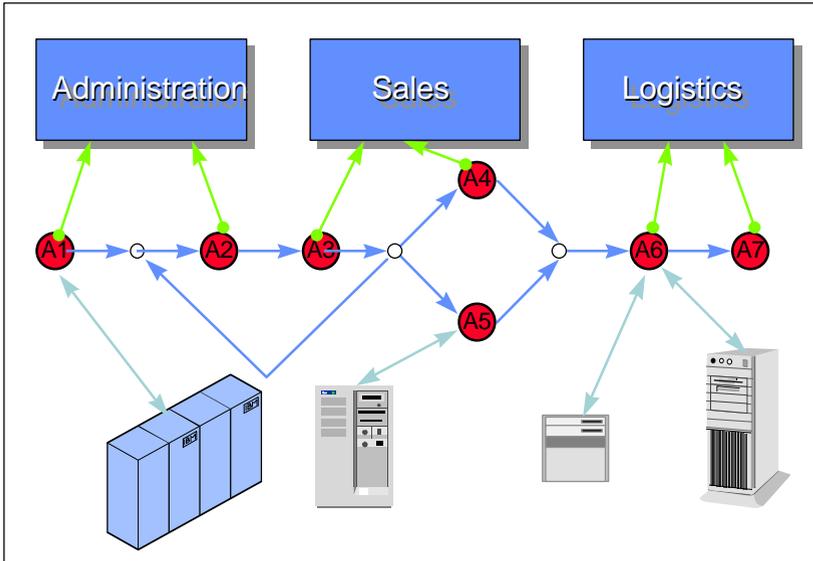
Teamed with Workflow, the Internet can penetrate beneath the skin of information and marketing to the inner heart of the production work performed inside and between enterprises. It will bring the Internet into the professional arena.

In the following sections, we present the various benefits of Workflow and how they can be translated into the Internet environment.

**Workflow  
manages long-  
running,  
process-oriented  
applications**

## THE MAJOR FUNCTIONS OF A WORKFLOW APPLICATION

### *Procedure Representation and Interpretation*



The central feature of a Workflow engine is the representation of the procedure that a business process must follow. It is this representation that is interpreted by the Workflow engine to assign activities to participants according to the state of each process in progress and to move the process forward from one activity to the next. This ensures that the activity will be executed by the participant who has the proper expertise and authority.

The process representation is made graphically and some engines can display it on the participant screen to show the state of a process. For example, a customer who placed an order through an Internet electronic commerce application could monitor the steps leading to delivery.

### *Dispatching Work to the Right Participant at the Right Time*

Through the Internet, participants external to the enterprise, home workers and mobile workers will be assigned their work automatically and

dynamically according to each specific case. The work queues of each worker can be centrally monitored and adjusted as required.

### *Integration of Existing Applications*

Most workflow activities invoke existing applications. The Workflow engine transfers the necessary information to and from those applications.

A Workflow engine on the Internet is a tool to integrate, as part of a long-term transaction, several existing applications.

### *Assistance with Activity Execution*

A key component of Workflow engines is the worklist handler which gives the participant a list of activities assigned to him, and which helps the participant prioritize their list of activities.

On the Internet, this could be implemented with HTML forms or Java-based handlers or both. The essential feature is that ANY workstation equipped with a browser can access the Workflow engine and participate in the automated processes.

### **Monitoring and Alerting**

Workflow engines are able to define deadlines for each process and monitor them. They are able to deal with missed deadlines by a variety of actions such as alerting a supervisor, changing priorities, or even changing the path to be followed inside the procedure.

This is an essential feature in an Internet environment where workflow participants are not co-located and can be members of different organizations.

### **Statistics**

Workflow engines log every single event with a time stamp. They provide statistics from that log on each class of business process, for example; average duration of the process, average duration of each activity, average waiting time for a process.

These statistics can be used to monitor the activity of remote participants like mobile and home workers. They can also be used as the foundation of virtual enterprise management to check the performance of every partner against a negotiated service contract.

## **BENEFITS OF WORKFLOW APPLICATIONS**

### **Increased Security**

In a Workflow application, each participant sees only those tasks assigned to him or her by the Workflow engine. Participants' access is controlled by defining the rules of assignment for each activity within each procedure.

#### *Practical Internet applications*

- Only department heads can approve expense accounts
- Credit checks can only be initiated by a chief accountant

### **Enhanced Reactivity**

By eliminating manual actions between the end of one activity and the next, one workflow can reduce the time between the start of a business process and its successful completion,.

#### *Practical Internet applications*

- Administrative procedures bound by a legislated time limit
- Legal proceedings
- 48 hours order delivery guarantee

### **Clear Progress Reports**

Workflow applications provide detailed progress reports, including activities in progress, their status and the person responsible, a view of the remaining activities to be carried out, all in a matter of seconds. Clients as well as members of the organization can be given exact information on the status of a business process.

**Measurement of every activity: the key to process improvement**

**Up to 90 per cent reduction of the total time has been achieved**

*Practical Internet applications: answering status requests like*

- Where is my order?
- Where is the latest version of the catalogue in its approval cycle?

### **Productivity**

By taking charge of activity planning and assignment, Workflow eliminates most supervisory tasks. With Workflow the user sees a list of activities to be completed. Once he or she chooses an activity, all the documents and forms attached to that activity appear at the workstation automatically. When it is completed, the information created during its execution is automatically filed in its proper place.

*Practical Internet applications:*

- Responses to public inquiries addressed to a government department
- Settlement of an automobile accident claim in an insurance company
- Health claim settlement files processing

### **Quality and Cost Control**

A Workflow application maintains a diary of all the events it controls, including date and time, the tasks concerned and the name of the participant. Information from the diary provides reports on costs and progress of each activity, and performance of the procedures themselves.

*Practical Internet applications*

- Monitoring deadline targets
- Measuring process costs and performances
- Monitoring quality of customer service
- Identification of bottlenecks

## **WORKFLOW'S BENEFICIARIES**

The benefits of workflow can be seen at all levels:

**20% to 50%  
productivity  
gains are usual;  
above 70% has  
been reported**

## Company Benefits

### Company



- cost and performance measurement
- quality control
- confidentiality and access control
- adherence to procedures

### Client



- response time
- information on case status
- service quality
- agent accessibility

### Agent



- clear picture of tasks
- information,at agents' fingertips
- automatic access to tools
- information on context of tasks

### Manager



- just in time display of tasks
- just enough information
- warning system
- measurement and tracking of quality

Workflow increases control over the productivity of information-related tasks. While reinforcing confidentiality and access-control measures, Workflow brings factory methods for managing and controlling processes.

### Client Benefits

Clients benefit from improved service quality, better response time, clear information about the status of their request and more accessible company agents.

### Company Agent Benefits

Each agent sees a list of activities they have to carry out and can organize their own work accordingly. The context of each activity can be presented. For agents, Workflow means flexibility in their work, speed of execution and a high comfort level.

### Manager Benefits

Workflow systems present managers with decisions to be made at the appropriate time and with enough information to enable them to intervene effectively. They can act sooner, more rapidly and with greater fairness. Workflow gives constant access to the status of each case, and a monitoring system allows managers to keep processes under control. Workflow can revolutionize the supervisory function, bringing it much closer to its industrial counterpart.

### Organization Analyst Benefits

With Workflow-assisted procedures, organization analysts have every kind of statistic necessary to analyze workloads, costs, peak periods and many other aspects of the company's operations. They can use simulation tools to model procedural refinements, at an unprecedented level of detail and accuracy and the logged data is available at marginal cost.

## What the Internet brings to Workflow

Workflow is about the management of long-running, process-oriented applications. Traditionally, such applications have been executed within the confines of 1) local area networks, and 2) individual enterprises. The Internet has opened up the possibility of deploying long-running, process-oriented applications that run across 1) wide area networks, and 2) multiple enterprises.

### ZERO APPLICATION DEPLOYMENT COSTS

Once a Workflow server is installed on the net, it can serve the whole intranet and Internet community. There is no need to install user agents on each of the potential Workflow participants' computers. This is essential for applications with a relatively low volume of activities per participant but a potentially large number of users. The cost of installing user agents on every workstation would be prohibitive even though, with modern procedure definition tools, they are relatively simple and cheap to develop.

This opens workflow applications to very large communities of users, even with low volumes of transactions per user giving enormous potential in terms of number of applications. By reducing deployment and maintenance costs to the minimum, the total cost of implementing a procedure is drastically reduced. Workflow applications thereby become accessible to smaller enterprises.

**Workflow  
becomes viable  
for large  
communities of  
users**

### UBIQUITY

Any user with a browser is a potential workflow application participant - wherever they are located. Compared to the traditional client/server approach, this is a fundamental paradigm shift that opens up entirely new perspectives.

Mobile work becomes natural, the only software required is a browser on a laptop with adequate plug-ins, along with an Internet access point. With a laptop, the mobile worker can access their workflow work list and handle all the pending tasks from any available phone.

Home work can be deployed in the same easy way. The old problem of updating the home computer software configuration has completely disappeared. Users belonging to different companies can share the same procedures through the Internet. Projects which bring together employees of different companies can use their own internal project procedures for the duration of the project regardless of varying company specifications.

### INTEGRATION TOOLS

Through its Web HTML- and CGI-based protocols, the Internet imposes a stateless, connectionless mode of interaction to applications. An important consequence of this is that a single call from a browser to an application must correspond to a transaction at the application level that can be activated through an API

interface. An increasing number of applications are being interfaced in that architecture to benefit from Internet infrastructure, including document management, office automation, databases, business application packages and so on.

When implementing the actions of an activity in a workflow system, applications must be invoked either through an API or through screen painters when an API is not available. In most cases, application invocation must correspond to a transaction, but APIs are usually at a very low level. Internet enabled applications provide exactly the level required by Workflow.

In addition, and remaining within the “one call - one transaction” constraint, Internet technology provides rich and powerful object-oriented integration technologies through Java, Java Beans and their application bus: IIOp for access to CORBA compliant objects, RMI for access to distributed Java objects, ActiveX in the scope of Microsoft’s DCOM distribution architecture.

The very large Internet community gives a reasonable guarantee of continuity and support for those interfaces, making them the preferred target for workflow application integration.

## DISTRIBUTION AND VIRTUAL ENTERPRISE

Internet architecture and infrastructure naturally promotes distribution to *participants*. Furthermore, Internet addressing mechanisms (URL, CGI call-backs, ...), make the distribution of *servers* completely transparent. For example, a workflow application in San Francisco can store document references as URLs pointing to Web servers in Atlanta used as a document management system. The user will receive from the workflow server in San Francisco a task to validate a document, and by a simple click the document will come from Atlanta, transparently. When accepting the document in its workflow activity, this workflow can call a project management application transaction in Chicago to register the event in the project planning database - again transparently.

If this document is the specification of a software module to be developed by a subcontractor with its own workflow system in Berlin, the San Francisco workflow engine can automatically trigger the workflow process to initiate development based on the specification in Berlin using the WfMC protocol for inter-operation of workflow engines over Internet electronic mail using MIME encoding.

In addition DCOM, CORBA, and distributed Java provide Internet-based, distributed object technologies. They provide interface description languages and services that allow distributed objects to be defined, located, and invoked. The primary benefit of using them is to encapsulate the heterogeneity of software components within standard, inter-operable wrappers. The current OMG effort for a workflow standard for CORBA will allow interoperability of workflow systems and services modeled as distributed objects.

IIOp and RMI are protocols used by CORBA and distributed Java objects respectively for inter-object communication. Conceivably, IIOp or RMI could be used for workflow system inter-operation across the Internet. For example, the WfMC Interoperability Interface could provide a IIOp or RMI binding side by side with its current Internet email binding.

**The Internet facilitates the distribution of Workflow applications**

## ELECTRONIC DATA INTERCHANGE

Electronic Data Interchange specifies techniques enabling exchange of structured data between computers across a network. The data is coded so that it can be exploited by the receiving computer without manual intervention, provided the receiving computer is aware of the encoding conventions and of the meaning of the encoded fields.

To do this EDI requires two layers of conventions. The first one is a communication layer which handles the information flow between computers; in most cases electronic mail systems are used for this. The second layer is made up of encoding conventions governing the internal structure of the flow in order to represent both data and their structure (like fields of a form).

The Internet offers both communication channels and encoding methods; for the first, the MIME protocol associated with email, and for the second, HTML and the Web browser (later XML).

The WfMC Interoperability Specification makes direct use of the two layers of any EDI technique but superimposes them on Internet ones: Internet email/MIME.

The Interoperability Specification adds to those EDI-like capabilities a third level that expresses the control flow between workflow engines needed to implement a single process spanning systems. Through this third level the Interoperability Specification offers much more than a simple data interchange capability by providing the means to operate overall process control and synchronisation across heterogeneous workflow engines - and to do that over the Internet.

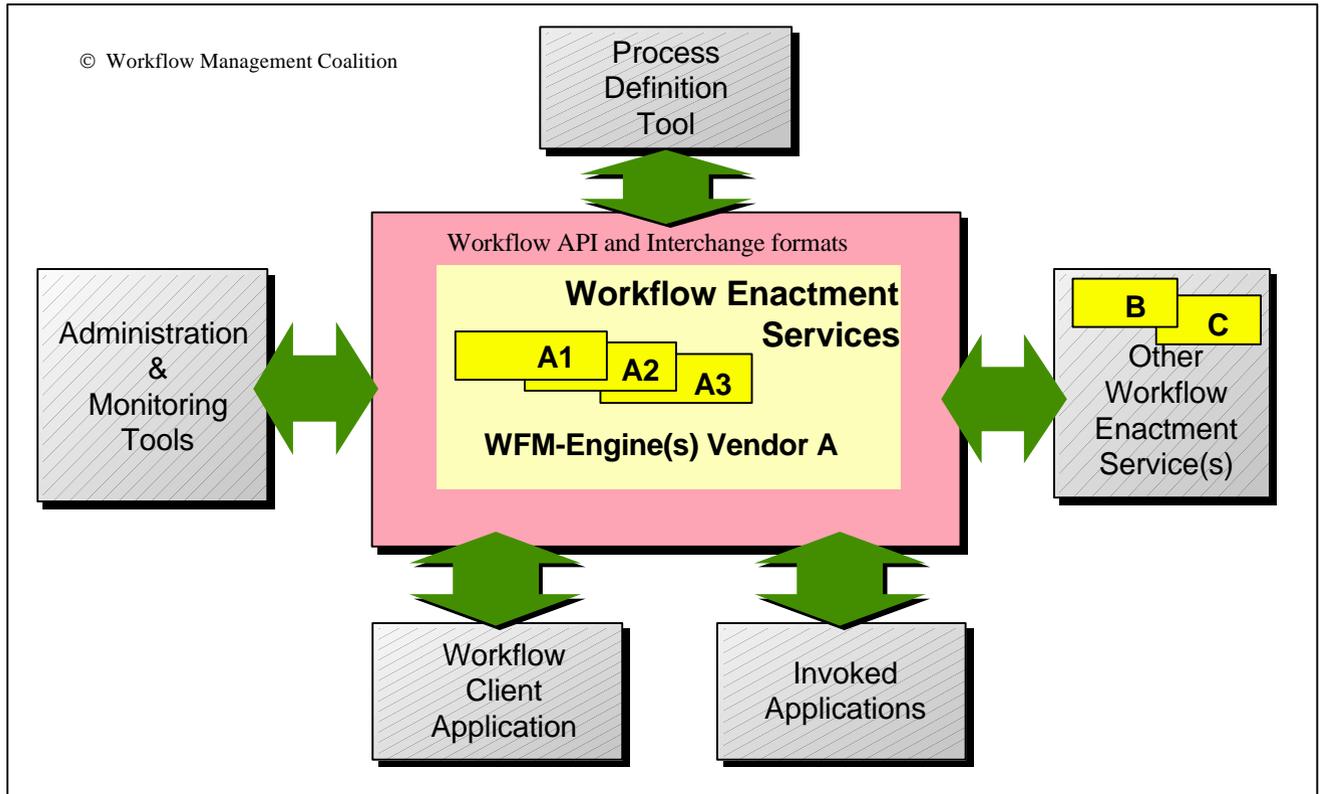
In the longer term, there is a strong trend to evolve present X400/ASN1 encoding based EDI protocols to Internet email/XML based protocols in order to take advantage of the Internet infrastructure. The WfMC will follow that trend and evolve its standards to support these emergent standards.

**Workflow adds  
control flow to  
EDI applications**

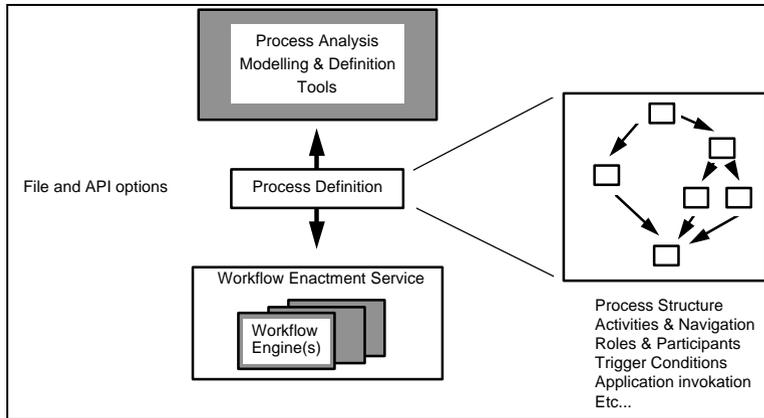
# The Reference Model and the Internet

The WfMC has defined a Reference Model for Workflow technologies and isolated five major Application Programming Interfaces that provide inter-operability of workflow engines. Those APIs can be used in different ways depending on the architecture deployed for the assembled technologies: host based systems, client/server systems, and the Internet.

We will look at each of the five interfaces with their potential benefits, how each can be mapped onto the Internet, and what new possibilities this offers.



## PROCESS DEFINITION INTERCHANGE INTERFACE



The Process Definition Interchange interface deals with process analysis, modelling, and procedure definition tools. It:

- Proposes a Meta Data Model which represents those objects in a process definition which are necessary for interchange
- Defines a standard interface between process definition tool(s) and the workflow engine
- Produces a process definition 'format' which various products can understand and are able to convert for their own use.

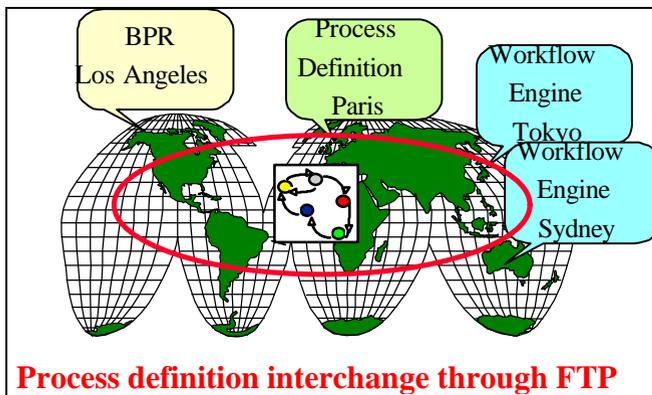
### Benefits

This interface facilitates the use of different workflow procedure definition tools to produce procedure

descriptions to be used by several different workflow engines. It is categorized into conformance classes to accommodate the large spectrum of tools covered by workflow.

By using the same procedure definition format, Business Process Reengineering tools can load the results of a complete BPR cycle directly into the workflow engine, accelerating live implementation of the reengineered business processes and lowering the development costs.

### Internet Usage and Impact



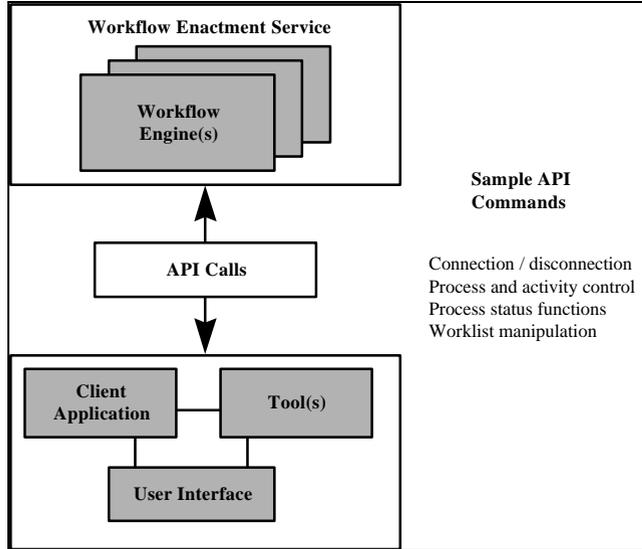
The capability to produce a procedure definition in a text format and load it into different tools can be used to handle the definition of procedures over the Internet in a totally distributed way. Procedure definitions can be exchanged through FTP or as email attachments between servers.

A BPR service in Los Angeles could be used for analysis of the business process.

The resulting process description could be sent to a Paris-based Process Definition tool where a detailed procedure description will be produced.

The resulting procedure definition could then be loaded into workflow engines in Tokyo and Sydney.

## WORKFLOW CLIENT APPLICATION INTERFACE



The Workflow Client Application Interface (WAPI) enables workflow client applications to retrieve, perform, submit, and monitor work.

- It defines standards for the workflow engine to maintain work items which the worklist handler presents to the user
- It defines a standard for a flexible means of communication between a workflow enactment service and a workflow client application.

### **Benefits**

WAPI facilitates the implementation of a workflow user agent that can be used with different workflow engines. Conversely, the same workflow engine can interact with users using different user agents - some users through the native user agent, others through a Web browser.

An application can implement a computerised user agent through this interface. For example to integrate the workflow user interface inside a complex industrial design desktop.

### **Internet Usage and Impact**

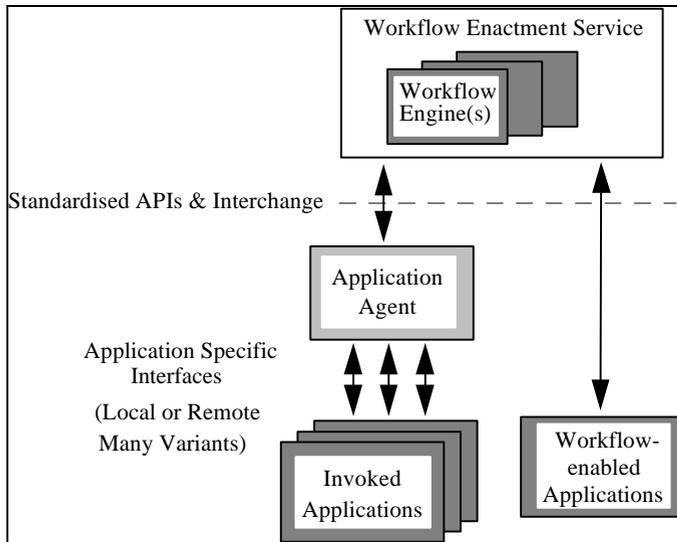
WAPI is the main interface used to provide access to a workflow engine from an Internet browser using CGI calls.

A front-end service located at a Web server interprets CGI calls from a browser and translates them into a series of WAPI calls to the workflow engine. The results given by the workflow engines are mapped into an HTML form where appropriate callbacks are inserted when required. The form is then forwarded to the browser for form display and further user interaction.

Through this generic interaction model, a front-end can implement a worklist handler, as well as an activity execution model based upon HTML forms-based data entry and display, with embedded Java code for local computing and transformations at the browser level if needed.

With WAPI, a unique CGI-based front-end can be implemented for several different workflow engines.

## INVOKED APPLICATION INTERFACE



This interface is for application agents and applications which have been designed to be "workflow enabled" (i.e. to interact directly with a workflow engine).

In a simple case, application invocation is handled in the same location as the workflow engine using information within the process definition to identify the nature of the activity, the type of application to be invoked and any data requirements. The invoked application may be local to the workflow engine, co-resident on the same platform or located on a separate, network-accessible platform; the process definition contains sufficient application type and addressing information to invoke the application.

### Benefits

The Invoked Application interface offers one way to write applications so that they can be invoked by workflow engines regardless of the specific engine used.

Similarly it offers a way to create workflow enabled applications so that they can directly invoke the services of different workflow engines with only one implementation.

### Internet Usage and Impact

The Invoked Application Interface is basically an API for use in a client/server relationship.

It can be used as the basis for encapsulating Web-enabled remote application workflow service invocation.

For application invocation from a browser, the mechanisms provided by Internet standards are used directly. They include CGI call-backs (more and more applications can be invoked through CGI), IIOP for CORBA enabled applications, MIS for Distributed Java Objects, ActiveX and Java Beans for local browser execution.

## WORKFLOWINTEROPERABILITYINTERFACE

In the Workflow Interoperability Interface the information and control flows between heterogeneous workflow systems are defined.

There are two major aspects to interoperability:

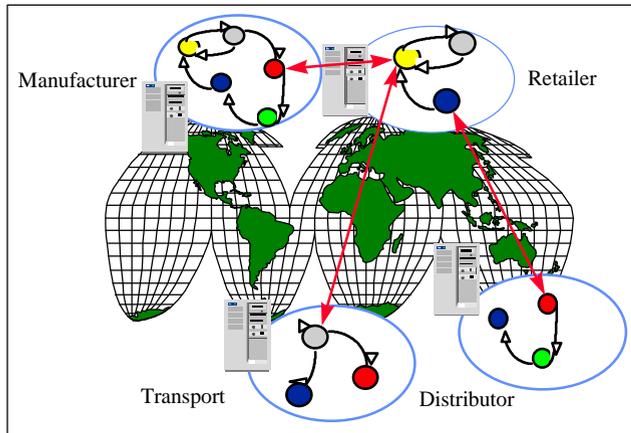
- The extent to which common interpretation of the process definition (or a subset) is necessary and can be achieved
- Runtime support for the interchange of control information and to transfer data between the different enactment services

### Benefits

By exchanging electronic information and commands through networks, workflow interoperability goes far beyond traditional EDI applications by supporting processes that cross enterprise boundaries:

- One procedure can span several workflow engines
- Enterprise wide workflows can be built using several different workflow engines
- Virtual enterprises can be implemented by the co-operation of engines

Within a large enterprise this facility may be vital when specialised workflow applications use their own environment (like in CAD/CAM applications) and need enterprise-wide integration into a global process, thereby bringing together contributions from each department to provide best service.

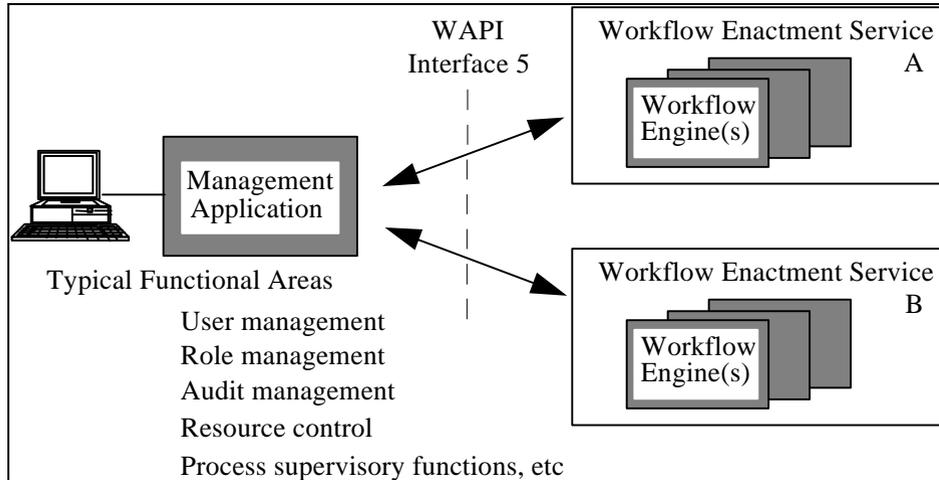


### Internet Usage and Impact

Workflow engines can cooperate without human intervention across the Internet. This is the basis for virtual enterprise application deployment.

This graphic representation (left) has been demonstrated several times by the WfMC. It implements a supply chain process through four independent workflows cooperating through the Internet via MIME message exchanges, formatted according to the Workflow Interoperability Interface specification.

## SYSTEM ADMINISTRATION & MONITORING INTERFACE



The interface illustrated shows an independent management application interacting with different workflow domains. Other implementation scenarios are also feasible; for example, the management application may be an integral part of one enactment service, though it is capable of managing various functions across additional (heterogeneous) workflow domains.

### Benefits

A simple administration system can manage several workflow engines.

Logs collected by several engines can be gathered at a central point

and processed to produce aggregated statistics.

### Internet Usage and Impact

- Central administration across the Internet of remote servers
- Mobile administration workstation
- 24-hour administration by three shifts in Paris, Tokyo, Los Angeles
- Outsourcing administration.

## Strategic Directions for the WfMC Standardization Efforts

The Internet infrastructure provides seamless access to global resources via URLs. A variety of software technologies are built on top of this infrastructure (email, ftp, telnet, http to name a few) by defining their own protocols. Email is connectionless, while ftp, telnet and http are connection-oriented. All four are stateless.

Workflow is a technology, and not an infrastructure. It can use the Internet efficiently as its communication infrastructure. This means that the Internet offers workflow technology a way to scale far beyond the confines of a LAN or single enterprise.

The workflow fundamental that should catch the attention of the Internet community is that a workflow protocol provides natural support for long-running process management across the Internet (long can be months or even years) unlike other protocols running on the Internet.

In terms of technical strategies, this means that:

1. The Internet is an infrastructure ideally suited to Workflow and consequently WfMC specifications must maximize both the ease of Internet integration and the capacity to fully reap the benefits of all of its features
2. Workflow brings a distinctive feature to the Internet, and this specific advantage must be exploited.

This leads to four major directions.

### USE INTERNET STANDARDS AS THEY ARE AS FAR AS POSSIBLE

Through the definition of an architecture open to a wide range of applications, the five specifications of the WfMC can be used to distribute Workflow functionality over the Internet: procedure definition, user agent and application invocation, inter-operation of workflow engines, and administration. For example, MIME was used directly as the first binding for the inter-operation of workflow engines.

### PROMOTE DIRECTIONS FOR INTERNET STANDARDIZATION

Although this is not a goal by itself, WfMC will monitor Internet standardization activities to detect areas where future direction may impact the capacity of workflow specifications to be deployed over the Internet. This will be through the direct participation of WfMC members in the appropriate standardization bodies.

The first action of the WfMC in this direction is its direct participation in the SWAP protocol development based upon HTTP. The know-how developed by the WfMC on interoperability of workflow engines through the development of interface 4, as well as the one developed through the Jflow OMG submission will form a strong basis for SWAP development. The WfMC is establishing a working group of members who are committed to support the IETF (the Internet Engineering Task Force) in developing this new HTTP-based

easy-to-implement workflow interoperability protocol consistently with the already established Reference Model for workflow interoperability.

## **SUPPORT AND PARTICIPATE TO ADVANCE STANDARDIZATION EFFORTS**

WfMC will be directly involved in advancing standardization efforts related to distributed environments where they can have a major impact on the widest possible integration of workflow technologies.

### **OMG**

WfMC members have submitted a complete set of CORBA-compliant workflow services based on the current API mapped to IDL. If OMG adopt this proposal it would extend OMG services by including a very powerful set of workflow services accessible in a distributed and uniform way. OMG mapping over Internet through IIOF would then provide the Internet distributed support for OMG-compliant workflow services.

### **Java**

Java is the key to complex application development and deployment over the Internet. The WfMC plans to progressively provide a Java definition for each of its APIs, with the client interface as the first one. This is the basis for the development of a Java-based “workflow components” market that will accelerate and reduce the cost of development of complex workflow applications.

### **DMA**

WfMC recommends the use of DMA APIs for Document Management Integration. Access to those services from Internet-based Workflow applications will rely upon DMA work for mapping its interfaces over the Internet.

### **EDI/XML**

The EDI community is looking for Internet-based technologies. XML, perhaps associated with SMIME, is a serious candidate. Progress will be followed by WfMC with input if necessary to ensure an easy binding of the Interoperability Interface with the resulting standard.

## **EVOLVE WfMC STANDARDS TO MAKE MAXIMUM USE OF INTERNET TECHNOLOGIES**

In the long term, deployment of workflow applications over the Internet will create complex, independent networks of workflow automated processes crossing geographical and organizational boundaries.

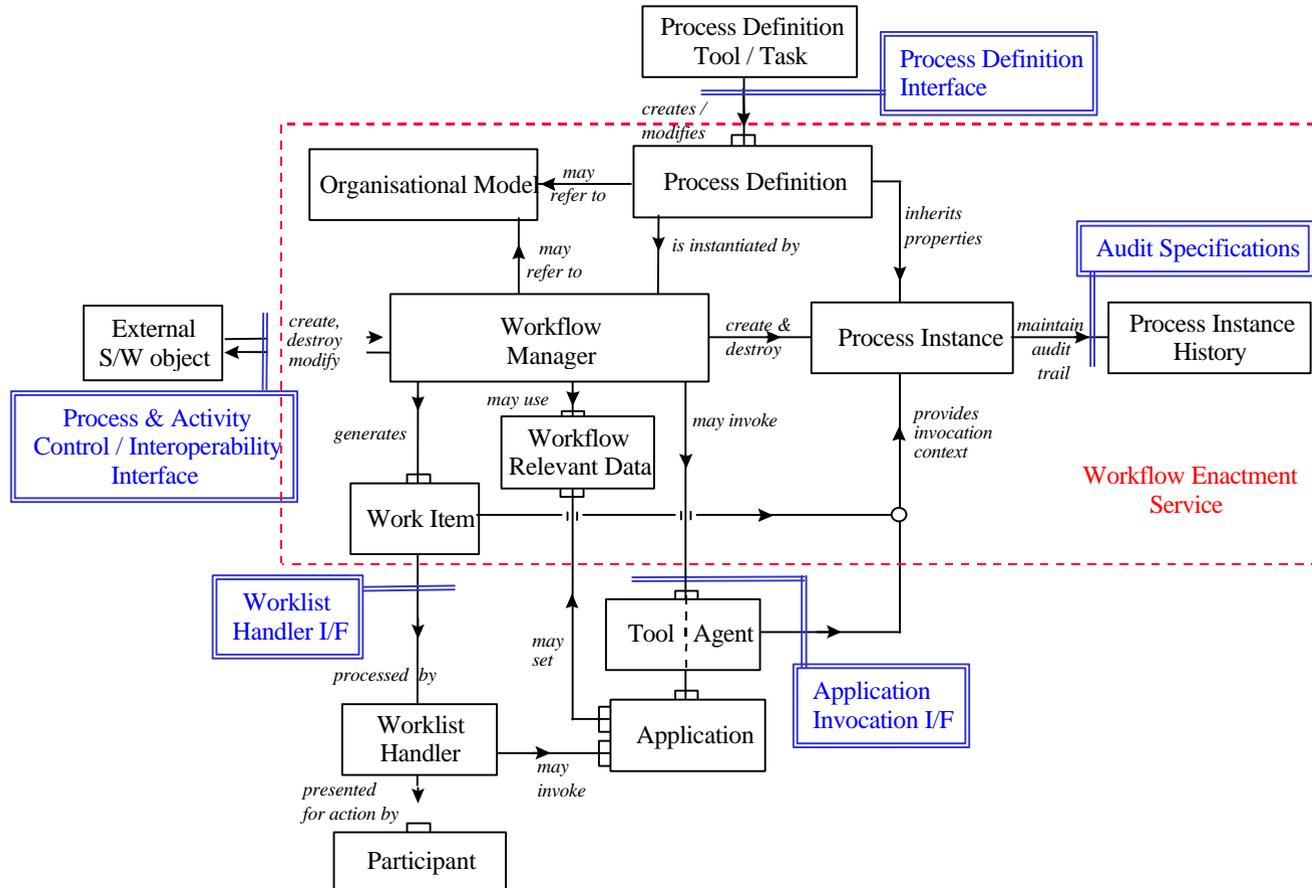
A single user might be involved concurrently in several different processes with no commonality. This complex management environment might become unworkable with the current workflow architecture.

To handle such a situation, it is important that the workflow architecture evolves towards an enhanced structure for distributed implementation using heterogeneous workflow components at the level of application and worklist invocation. More specifically, WfMC will explore solutions so that the user has a unique logical

service where he can find all his pending work items regardless of which services on the Internet hold the related process instances.

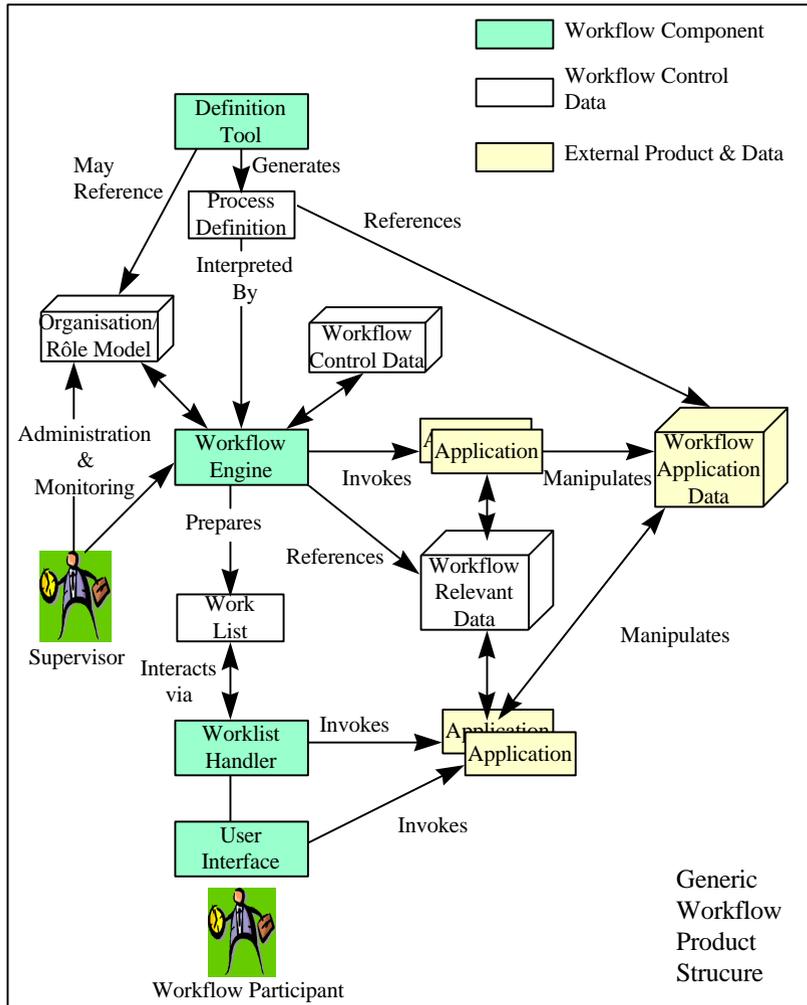
## AN OBJECT ORIENTED REFERENCE MODEL

The Workflow Management Coalition has initiated the development of an object oriented model of workflow technologies. It will form the basis for all future developments and particularly those intended to benefit from and to support Internet technologies.



# Appendix

## WORKFLOWGLOSSARY- SOME KEY TERMS



A full Glossary of Workflow terms is published separately by the Workflow Management Coalition. It is available from the WfMC Web site: <http://www.wfmc.org>. However, a diagram summarizing some of the key terminology used in the Reference Model referred to in this paper is included here.

## INTERNET GLOSSARY

### *ActiveX, see also Java Beans*

ActiveX is an OO technology for developing reusable software components to be executed from an Internet browser.

### *CGI*

Common Gateway Interface—an interface for external programs to "talk" to the HTTP server. Programs that are written to use CGI are called CGI programs or CGI scripts. CGI programs do things like handle forms or perform output parsing not normally done by the server.

*This is essential to implement activities through HTML pages and to implement integration of other applications.*

### *CORBA, DCOM, Distributed Java*

DCOM - Microsoft's Distributed Component Object Model. Based upon DCE mechanisms. CORBA - Common Object Request Broker Architecture from OMG. Both of these, along with Distributed Java are distributed object technologies. They provide interface description languages and services that allow distributed objects to be defined, located, and invoked.

*The current OMG effort for a workflow standard for CORBA will allow interoperability of workflow systems and services modeled as distributed objects.*

### *HTML*

Hypertext Markup Language is a formatting language used for documents on the World Wide Web. HTML files are plain text files with formatting codes that tell the browser how to display text, position graphics and any form components, and how to display links to other pages.

*A ubiquitous standardized way of implementing workflow activities in a code that is interpreted by the browser.*

### *HTTP*

Hypertext Transfer Protocol is the method for exchanging information between HTTP servers and clients.

*The foundation for Web implementation.*

### *ICAP*

Internet Calendar Access Protocol

*This might be important for the time management features of workflow engines*

## ***IIOP, RMI***

IIOP, Internet Inter ORB Protocol, when supported inside a browser either in its native form or as a downloadable plug-in provides access from the browser to remote applications through the CORBA protocols. RMI is a protocol used by Distributed Java objects for inter-object communication.

*IIOP and RMI provide an elegant way to integrate through the browser applications invocation when an activity implies a combination of interaction from the user with application access. IIOP or RMI may be used for workflow system interoperation across the Internet. For example, the Interoperability Interface could provide a IIOP or RMI binding side by side with its current Internet email binding.*

## ***Java***

A programming language that features dynamic relocation and multiple environment execution through a virtual machine hosted in the browser environment. Java code is downloaded when required by the browser.

*This enables workflow activity programming in a portable and automatable way.*

## ***Java Beans, ActiveX***

Java Beans and ActiveX are OO technologies for developing reusable software components which can be downloaded and executed from a browser. Developers can develop independent Beans and ActiveX components, and others can script these components together from within container applications to create new applications.

*The technology provided behind those components is a powerful OO integration technology that will ease the implementation of workflow activities integrating complex actions.*

## ***MIME***

Multi-Purpose Internet Mail Extensions. This is an evolving standard for multimedia email and messaging. It incorporates a way to encode information in a standardized way.

*MIME encoding conventions and application programmatic interfaces are used as one of the possible bindings of the WfMC Interoperability interface for the inter-operation of workflow engines.*

## ***LDAP***

Lightweight Directory Access Protocol, defines a simple access method from a mail agent or a browser to an X500 directory.

*This is important as a user directory source of information.*

## RMI, see IOP

RMI is a protocol used by Distributed Java objects for inter-object communication.

## SMIME

Secure MIME, a message encoding protocol providing secure transport by supporting DSA based encryption.

*This will enable secure message exchanges between workflow engines for critical applications.*

## SWAP

Simple Workflow Access Protocol is the result of an initiative announced by Netscape, Sun and HP on April 13th 1998. Supported by dozens of workflow vendors, SWAP will be developed under the banner of the IETF (Internet Engineering Task Force). It provides a simple protocol over HTTP for workflow process invocation and control. Its goal is to complement the ongoing efforts of the Workflow Management Coalition in providing robust and powerful interoperability standards between workflow engines. It does this with a simple protocol, sufficiently easy to implement so that universal acceptance is promoted through rapid adoption by application developers. It is most appropriate where participants have IP networks and is particularly suited to intranet and Extranet work processes. The WfMC has decided to support this effort by establishing a working group of members who are committed to supporting the IETF in developing this new, HTTP-based, easy-to-implement, workflow interoperability protocol.

*By providing a simple, efficient, and easy-to-implement protocol, SWAP will provide a universal intranet/Internet means to invoke, monitor and control workflow processes between workflow engines and invoking applications. It may open the way to hundreds of applications with straightforward requirements.*

## URL

Uniform Resource Locator - the addressing system used by the server and the client to request documents. It is often called a location. The format of a URL is [protocol][machine:port]/[document]. A sample URL is <http://www.wfmc.org/index.html>

*This enables reference to documents that are anywhere on the network. For workflow it provides easy integration of document management (the workflow engine just keeps the URL of the document).*

## XML

eXtensible Markup Language, a powerful extension of HTML going towards the power of SGML without its complexity.

*XML has the capability of defining and transferring complex structured data. As such it is a serious candidate for implementing electronic data interchange protocols over the Internet.*

*Combined with MIME it may form the next generation of binding for the WfMC Interoperability Interface.*

### **XLL**

eXtensible Linking Language, a companion of XML.

### **XSL**

eXtensible Style Language style guides, a companion of XML.