

# Workflow Management in the Internet Age

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## About the Instructor



Dr. C. Mohan joined the IBM Almaden Research Center as a Research Staff Member in 1981. In June 1997, Mohan was named an IBM Fellow for being recognized worldwide as a leading innovator in transaction management. He received the ACM SIGMOD Innovations Award in 1996 in recognition of his innovative contributions to the development and use of database systems. In 1992, he was elected to the IBM Academy of Technology. Mohan is the founding leader of the Dominotes project which resulted in the enhancement of Domino/Notes's scalability by the introduction of transactional recovery in R5. Prior to this, Mohan led the Exotica project which was focussed on the IBM workflow product FlowMark, the IBM messaging product MQSeries and the Lotus groupware product Notes. Mohan was a designer/implementor of the R\* distributed DBMS, the Starburst extensible DBMS and DB2. He is the primary inventor of the ARIES family of recovery and locking methods, and the Presumed Abort commit protocol. He has had major impact on IBM and non-IBM prototypes and products. Mohan's research results and designs have been incorporated in the IBM products DB2/MVS, DB2 Common Server (DB2/6000, DB2/NT, ....), MQSeries, S/390 Parallel Sysplex Coupling Facility, AdStar Distributed Storage Manager (ADSM), SQL/DS and VM Shared File System, in the IBM prototypes R\*, Starburst and QuickSilver, and in IBM's SNA LU6.2 and DRDA. Mohan is a consultant to IBM's database, transaction and workflow product groups.

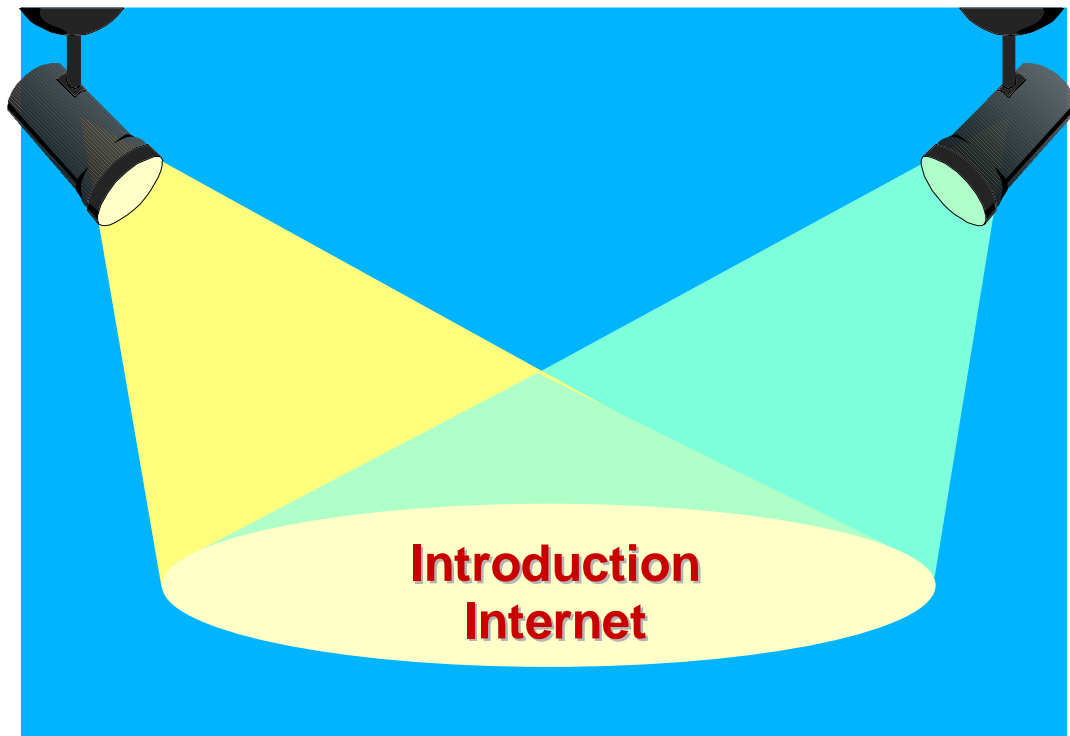
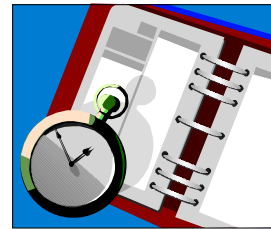
Mohan is the recipient of several IBM awards: an IBM Corporate Award for his contributions to database support for the S/390 parallel sysplex; an IBM Outstanding Innovation Award (OIA) for his coinvention of the ARIES recovery method which is being used in numerous IBM and non-IBM products and prototypes; an OIA for his inventions (ARIES, ARIES/IM, Commit\_LSN) and major contributions to performance, availability and concurrency in DB2/MVS V4; three OIAs for his algorithmic and hardware architectural coinventions for supporting the shared disks transaction environment in S/390 and DB2/MVS; an OIA for his coinvention of the Hybrid Join method which is implemented in DB2/MVS; an OIA for his coinvention of the Presumed Abort commit protocol which has been widely adopted in the industry and which is now part of the ISO-OSI, X/Open and DRDA distributed transaction processing standards; an IBM Research Division Award (RDA) for his work on transaction management in R\*; an RDA for his contributions to WDSF/VM; 9th Plateau IBM Invention Achievement Award for his patent activities (28 issued and 4 pending). Mohan was named a leading software inventor of IBM for 1994 and 1995, and a Master Inventor in 1997.

Mohan was the Americas Program Chair for the 1996 International Conference on Very Large Data Bases, a Program Vice-Chair for the 1994 IEEE International Conference on Data Engineering and the Program Chair for the 1987 International Workshop on High Performance Transaction Systems. He is an Editor of the VLDB Journal, and Distributed and Parallel Databases - An International Journal. Mohan received a PhD in computer science from the University of Texas at Austin in 1981 and a BTech in chemical engineering from the Indian Institute of Technology, Madras in 1977.

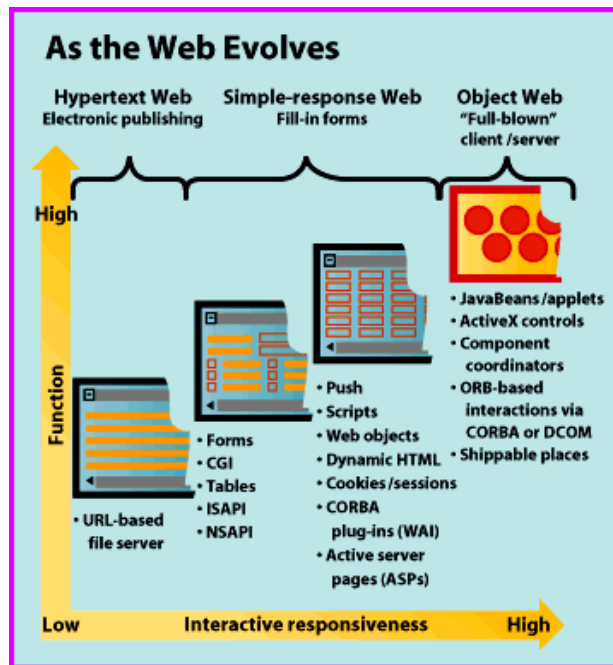
# Overview



- Introduction
- System Architectures
- Standards
- Product Summaries
- Research Projects
- Summary and Conclusions



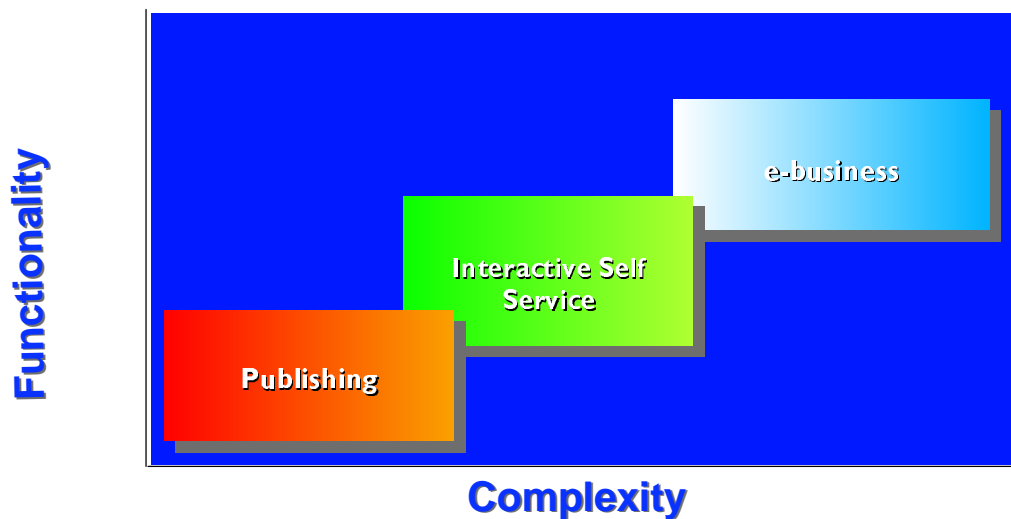
# Web Evolution



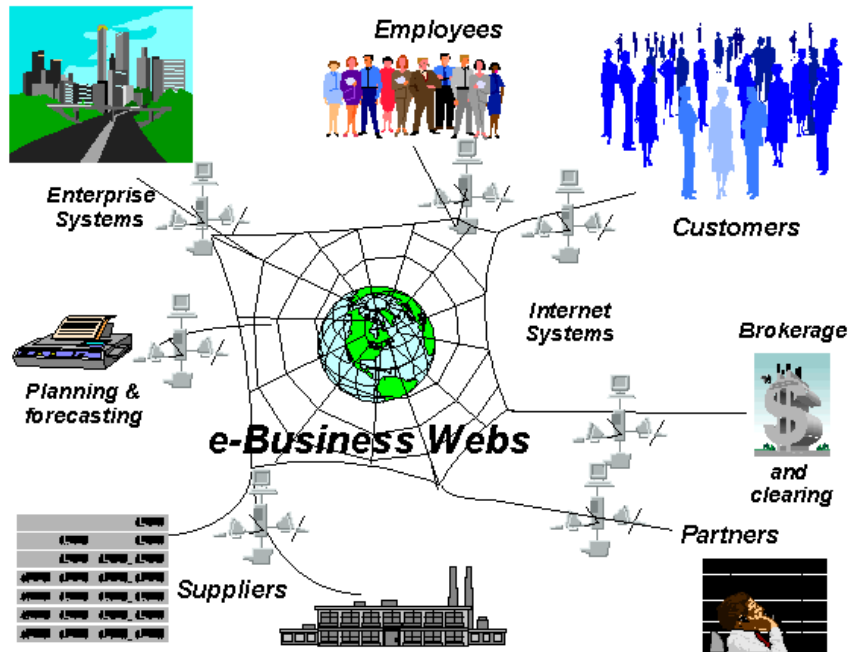
- 200M users by 2000
- 1B by 2010

Source: Byte

# Steps to e-Business

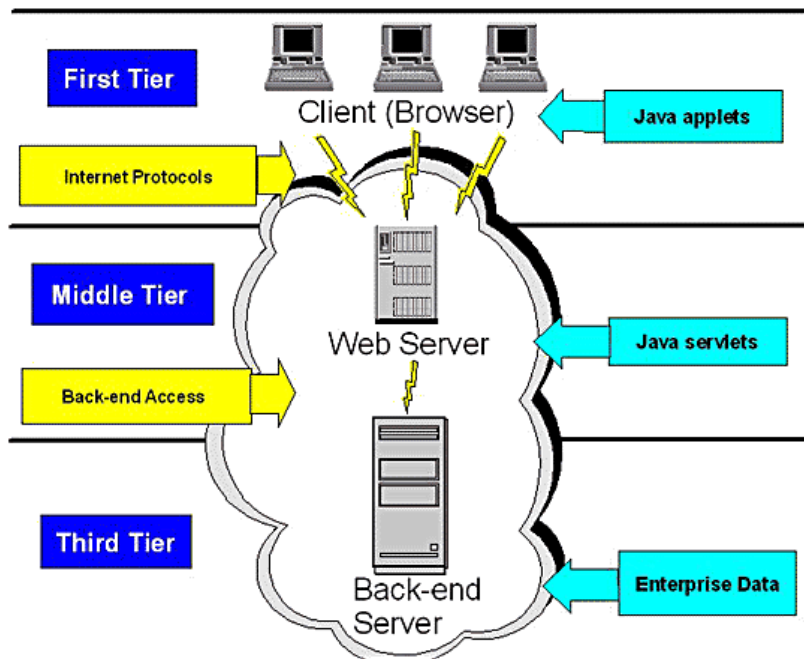


## Link Customers, Partners, Suppliers



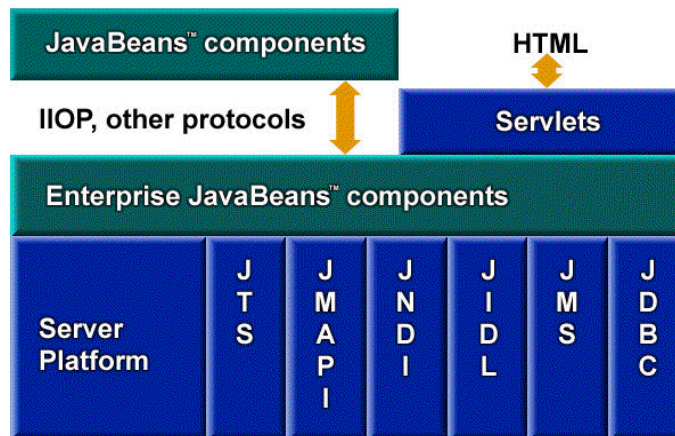
Source: Aberdeen Group

## Java-based 3 Tier Architecture





# Enterprise JavaBeans



Source: Sun

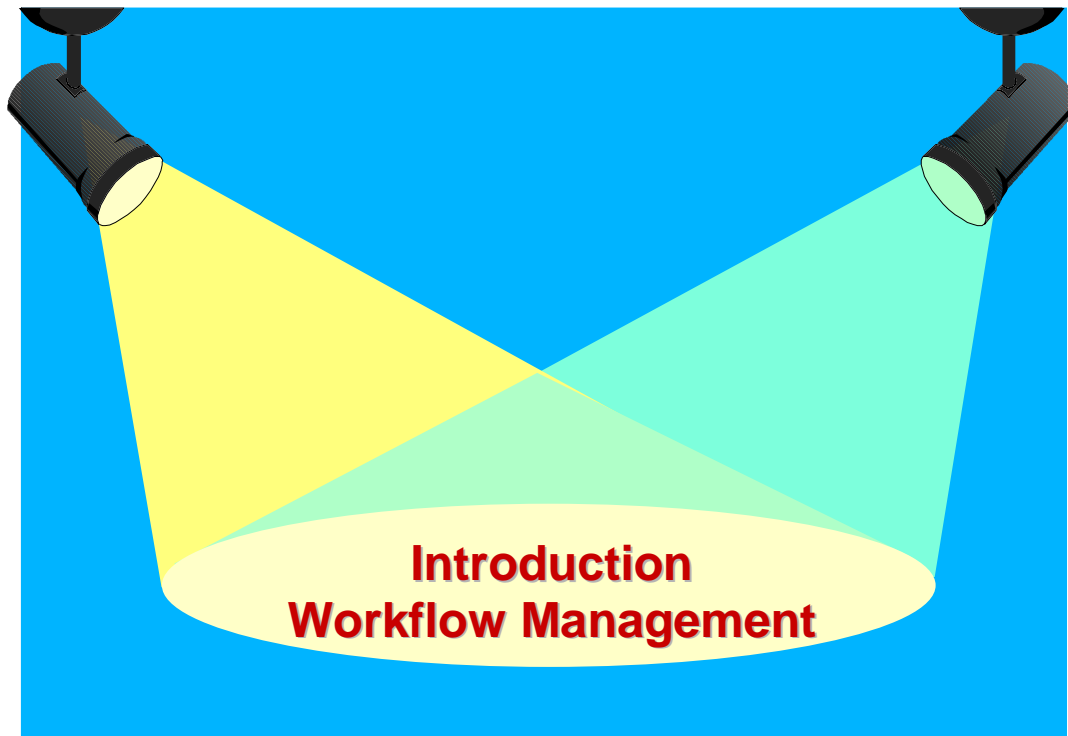
## Enterprise JavaBeans



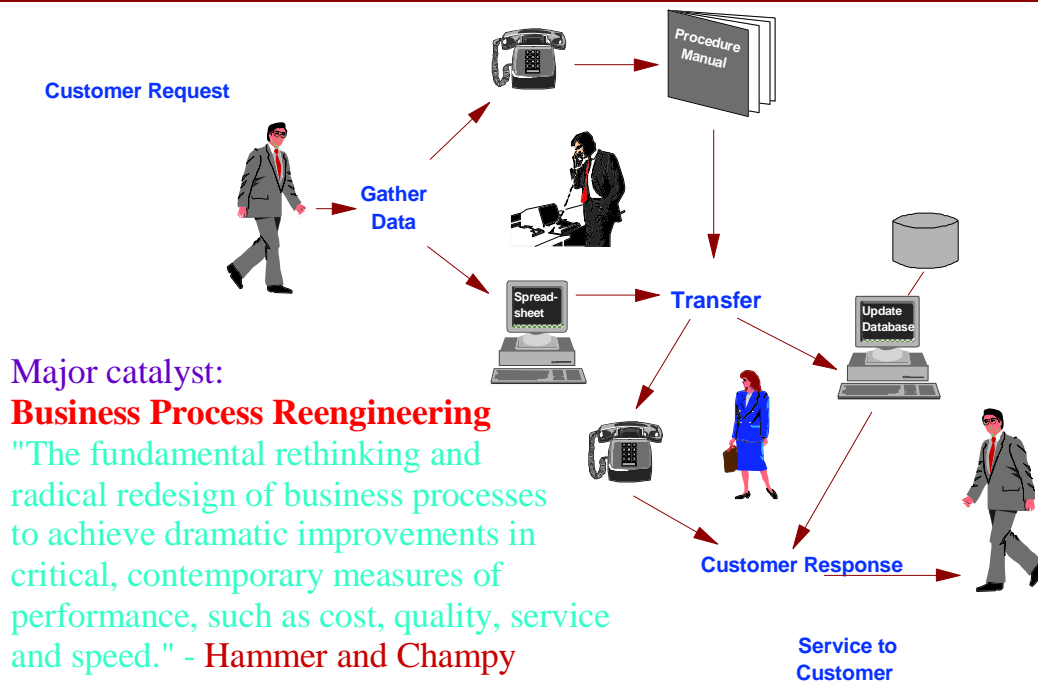
- CORBA provides infrastructure for EJBs
- EJBs are the component model for CORBA and Java platform for the enterprise
- Support 3-tier apps by defining support for
  - Client-server distribution
  - Transactions
  - Scalable state management
  - Security
  - Deployment
- **Server Bean:** Implements business logic which executes synchronously with a client program
- Supports transient and persistent objects
- Server components execute within a **component execution system**
  - Runtime services for threading, transactions, state management, resource sharing

## E-commerce Implications

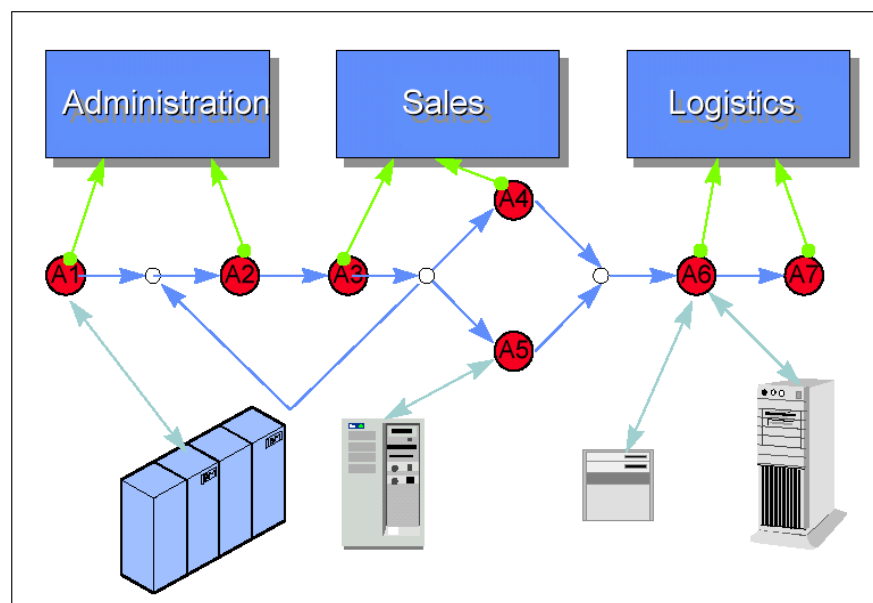
- \$200B business by Y2K; B2C requirements differ from B2B
- **Success factors:** Not just changes in technologies/products but significant process/organizational changes
- Exploit/expose enterprises' **operational** data
- Flexible marriage of old/new heterogeneous technologies
- No control on time of access (**24X7**) - negative publicity from info unavailability/slow responses (**QoS**) can be disastrous
- **Crucial:** Proper security support, ease of use
- **Node autonomy** concerns dictate use of advanced transaction techniques (e.g., sagas, compensation trans)
- Interoperable **workflow and object technologies** (OT) may be the glue but current OT implementations are not efficient, powerful or industrial-strength enough: **jFlow, OTS**
- **Low cost** - major requirement (fickle-minded customers)



## A Business Process



## A Business Process



Source: WfMC

## Definitions

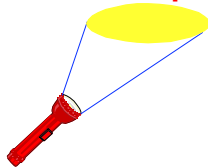


"... (workflow) works hand in glove with business process improvements to automate, track, and control processes and enable collaboration in the workplace"

"we call the operational aspects of a business process - the sequence of tasks and who performs them, the information flow to support the tasks, and the tracking and reporting mechanisms that measure and control them - the workflow"

"workflow software is designed to improve business processes by providing the technology enabler for automating these aspects of the workflow: routing work in the proper sequence, providing access to the data and documents required by the individual work performers, and tracking all aspects of the process execution"

"main purpose of a workflow tool is to allow the process logic to be modified separately from the task logic embedded in the user applications"



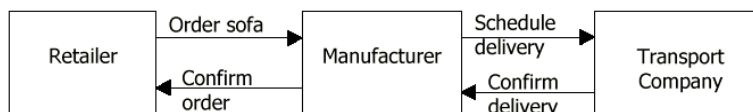
**GIGA**

(BIS Strategic Decisions)

## Business Drivers

Workflow needs increasing

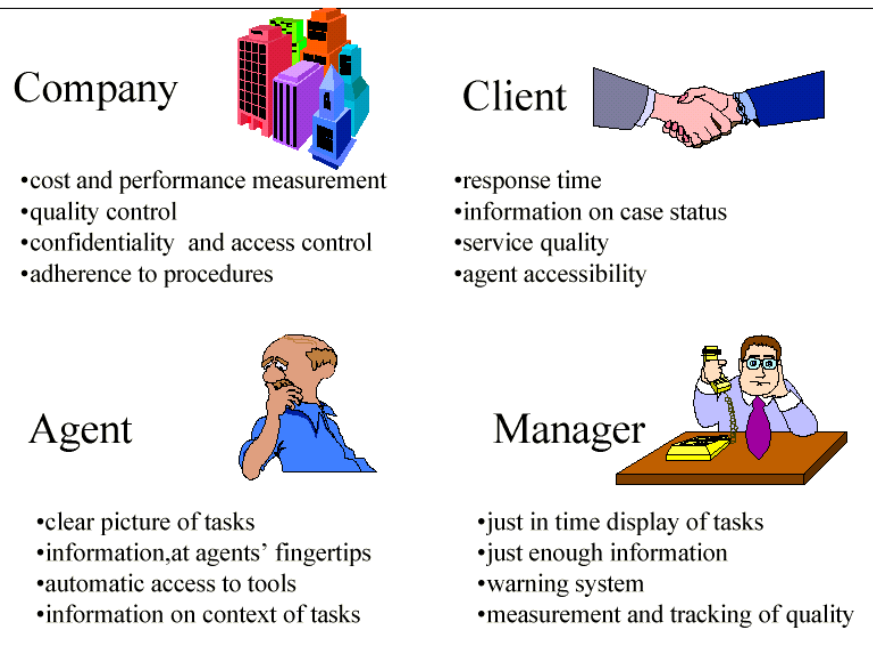
- Exploding e-commerce, especially business to business (B2B)
- Supply chain reengineering
  - Moving EDI to the internet
  - Intra and inter business process integration
- Realizing virtual enterprises
- Distribution of business intelligence data
- Component based app development allows easier integration of old and new apps via WFMSs
- Natural evolution of persistent messaging based app development
- Supporting heterogeneous software/hardware environments



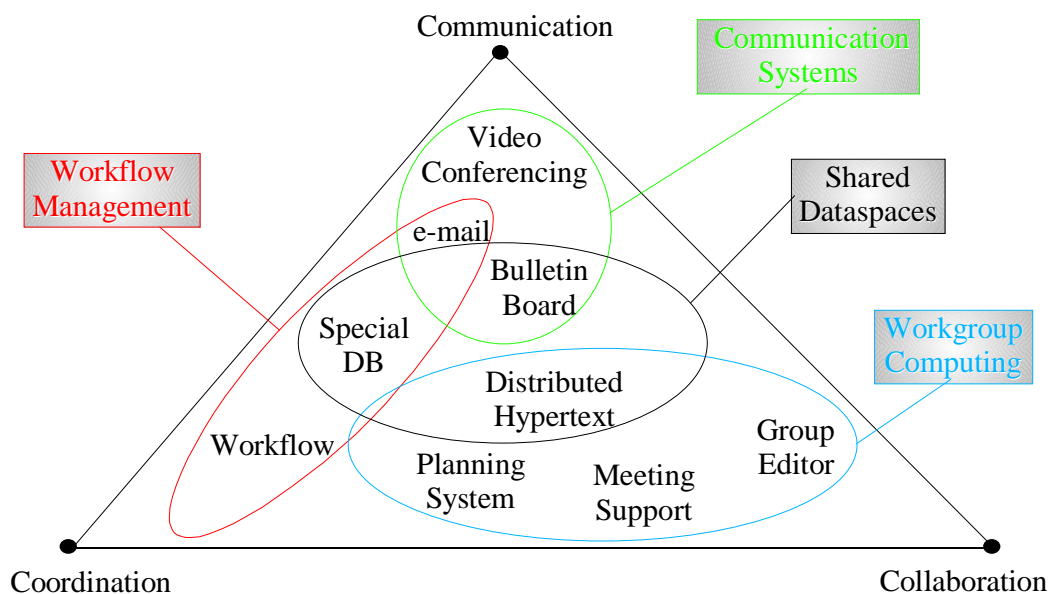
**Order Fulfilment Scenario**

Source: WfMC

# Workflow Benefits



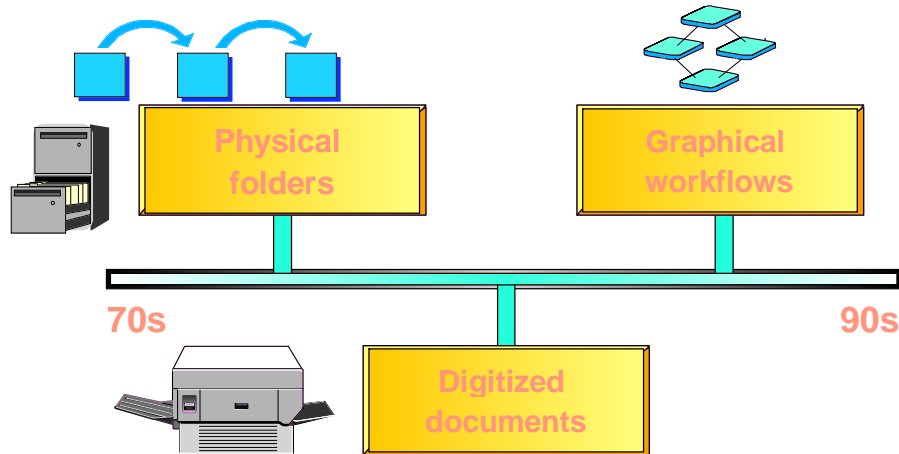
# Groupware



## Historical Evolution



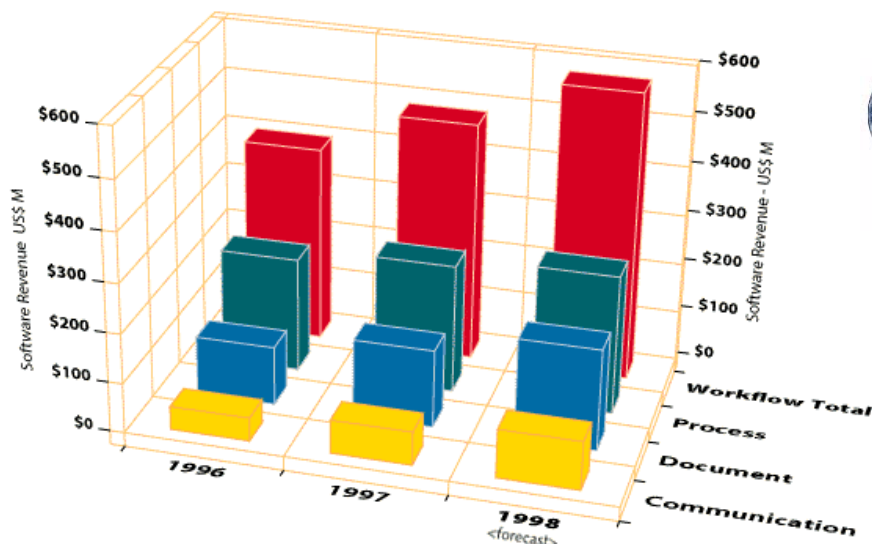
- Origins in office automation
- Manual routing of folders with routing slips
- Imaging-based document-centric systems
- General-purpose graphical workflow systems



## Workflow Market



- Delphi Group's research results (<http://www.delphigroup.com>)  
 96: \$395M, 97: \$481M (+22%), 98 forecast: \$578M (+20%)

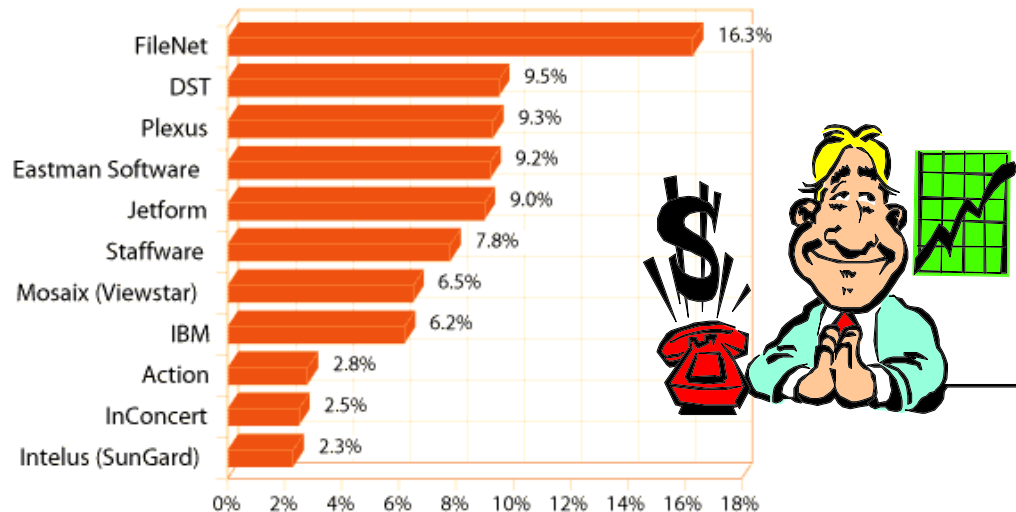


'1998 The Delphi Group, Inc.

## Vendor Market Shares

- Delphi Group's research results (<http://www.delphigroup.com>)

### Leading Process Workflow Suppliers — 1997



©1998 The Delphi Group, Inc.

## Development and Deployment

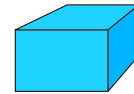
- End-user involvement is vital in WF app development
- They know their processes and how to improve them
- Their cooperation essential for successful deployment
- WFMSs still require significant integration and customization
- Great opportunities for systems integrators and consultants in production-class WF apps



"out of the box" workflow still not reality with most systems!

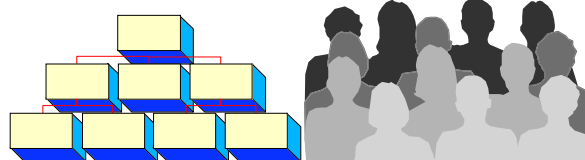
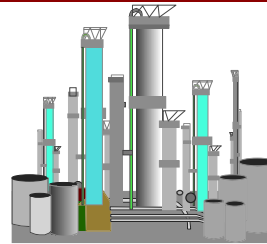
Longer sale cycle, sale requires executive approval, requires end user commitment; good consulting business (e.g. VARs)

## 3 Dimensions of Workflow



### ★ Process

Separate business  
logic from function  
logic



### ★ Organization



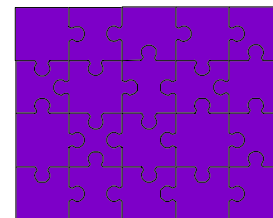
### ★ Infrastructure

## Technology Aspects



### WFMSs incorporate many technologies

- database management
- client server computing
- heterogeneous distributed computing
- mobile computing, internet
- graphical user interfaces
- app (legacy and new) and subsystem integration
- (transactional) messaging
- document management, imaging
- ...



### Several issues arise

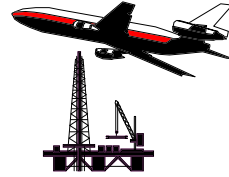
- performance, reliability
- scalability (# of clients, # of process instances, ...)
- cultural and human aspects
- ...





## Example Applications

- Insurance policy/claims processing (AVEMCO)
- Loan request handling
- Travel expense approvals
- Bug reporting and resolution
- Project proposal preparation
- System monitoring and exception handling
- System administration (e.g., DBA activities)
- Advertising campaign management (Young & Rubicam)
- New product development (SC Johnson Professional)
- Healthcare claims (Empire Blue Cross Blue Shield)
- Order management (Microsoft)
- Business licensing (Clark County)
- Customer relationship management (CRM)



Not just business processes

## Workflow Products (Partial List)

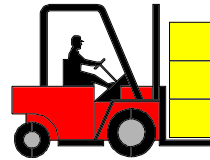
- |                                  |  |
|----------------------------------|--|
| • Action Metro (Action Tech)     | • OPEN/Workflow (Eastman Software)     |
| • Cosa (Ley)                     | • Oracle Workflow (Oracle)             |
| • Changengine (HP)               | • Plexus FloWare (BancTec/Plexus)      |
| • Computron Workflow (Computron) | • Process Manager (Netscape)           |
| • Conductor (Forte)              | • ProZessware (OneStone)               |
| • FlowMark/MQSeries WF (IBM)     | • Sitescape Forum Workflow (Sitescape) |
| • GroupFlow (Pavone)             | • Staffware (Staffware)                |
| • Groupwise Workflow (Novell)    | • TeamWARE Flow (ICL/Fujitsu)          |
| • InConcert (InConcert)          | • Ultimus (Ultimus)                    |
| • JetForm (Jetform)              | • ViewStar (Mosaix)                    |
| • Keyflow (Keyfile)              | • Visual WorkFlo (FileNET)             |
| • LinkWorks (DEC)                | • WorkFlow (CSE Systems)               |
| • Livelink (OpenText)            | • WorkParty (Siemens-Nixdorf)          |
| • Lotus Notes/Domino (Lotus)     | • W4 (W4)                              |

<http://www.concordium.co.uk/Products%20frame.html>

# Types of Workflow Products

- **Production:** InConcert, FileNet, FloWare, MQSeries Workflow (FlowMark), ViewStar

BIS: "... represents software designed to automate business-critical apps, most often some form of transaction processing ... often acquired to automate a specific business process or app"



- **Ad hoc:** Action, Keyfile

BIS: "routing and tracking of routine office work that is based on unstructured information"



- **Administrative:** Jetform, Staffware

BIS: "desktop software designed to automate administrative work driven by paper forms"



- **Collaborative:** ProZessware/Lotus Notes

BIS: "... automation of business-critical processes that are not transaction oriented"

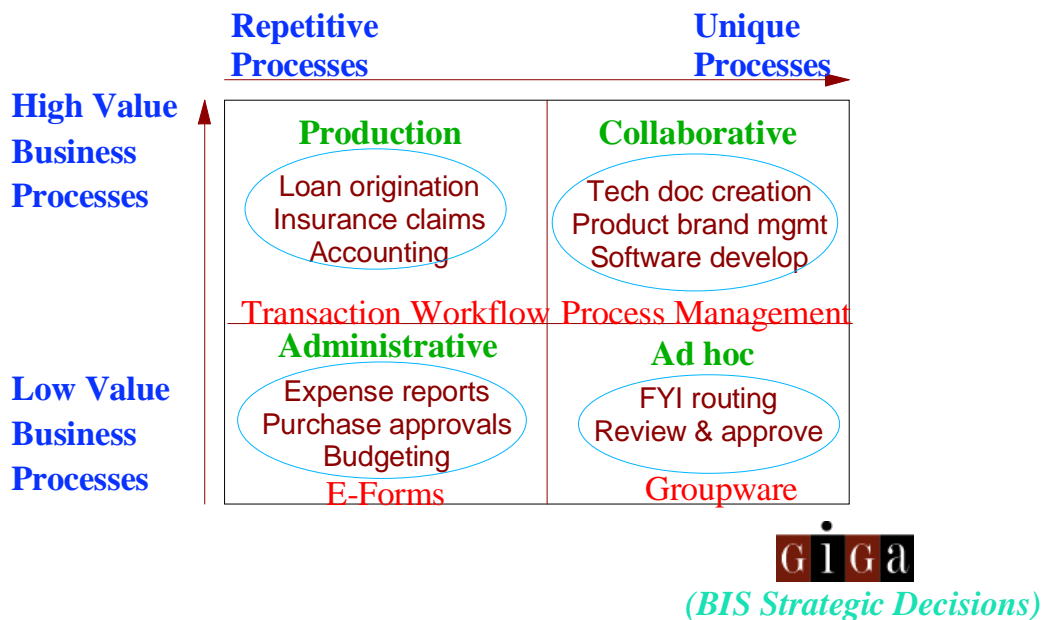


# Workflow Continuum

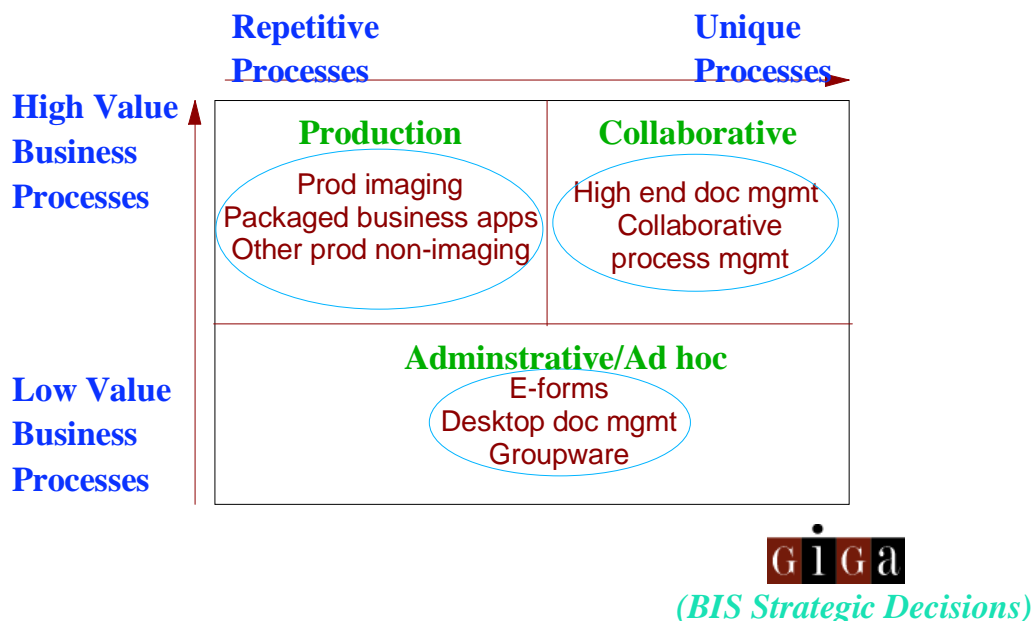
Cooperative Process		Semi-structured Process		Structured Process	
Ad hoc Workflow	Cooperative Team Process	Integrated Team Activity	Chained Activity	Ad hoc Exceptions	Standard Workflow
Spontaneous information gathering and routing between individuals	Step-by-step development of the workflow structure during the process	Many people work collaboratively with notifying structure, one of the team members assumes responsibility	Predefined number of participants being involved each once during the process step	When an exception occurs the end user can easily deviate from the normal process definition	Completely standardized, identical, and recurrent workflow structure



## Workflow Application Segments

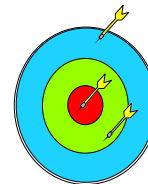
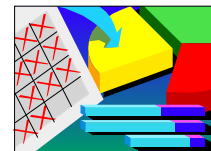
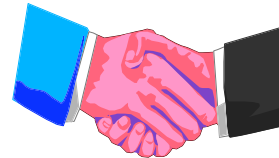


## Workflow Market Segments



## Business Trends

- **Vertical integration is the focus:** Telecom provisioning (InConcert), customer relationship management (Mosaix), ...
- **Mergers/partnerships of workflow, imaging and document vendors**
  - IBM buys Lotus; Lotus buys ONEStone**
  - ViewStar merges with Digital Systems Int'l to form Mosaix (acquired by Lucent)**
  - InConcert partners with BEA**
  - Keyfile partners with Commerce One**
  - Wang buys Sigma; sells workflow business to Kodak**
  - FileNET buys Watermark and Saros; partners with Novell**
  - BancTec buys Recognition; partners with NCR**
  - Open Text buys Odesta Systems & Lava Systems**
  - JetForm buys Delrina; partners with Open Text**
  - Pavone partners with NotesWare**



## Product Technical Trends

- **Integration of document management, imaging and workflow** (FlowMark-ImagePlus Visual Info-Domino.Document Manager, FileNet-Watermark-Saros)
- **App vendors added workflow features** (SAP, PeopleSoft, Oracle Workflow)
- **Web support** (Action, Plexus, OpenText, Staffware, Ultimus, Viewstar, W4)
- **Using WFMSs merely for process documentation** (e.g., ISO9000)
- **WfMC standard support**
- **Simulation and process modeling tools** (HOLOSOFX, BOC)
- **Combining BPR and workflow tools** (IDS-Scheer, Meta Software, BOC)
- **Call center and CRM integration** (Mosaix, FileNET, Staffware, Plexus)
- **Distributed workflow processes - i.e., multi-server executions** (FlowMark, InConcert, Staffware, ViewStar, Eastman OPEN/workflow)

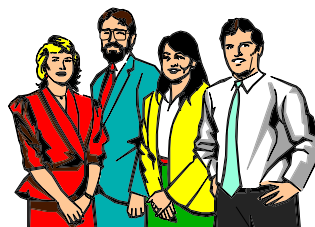
## Research Trends

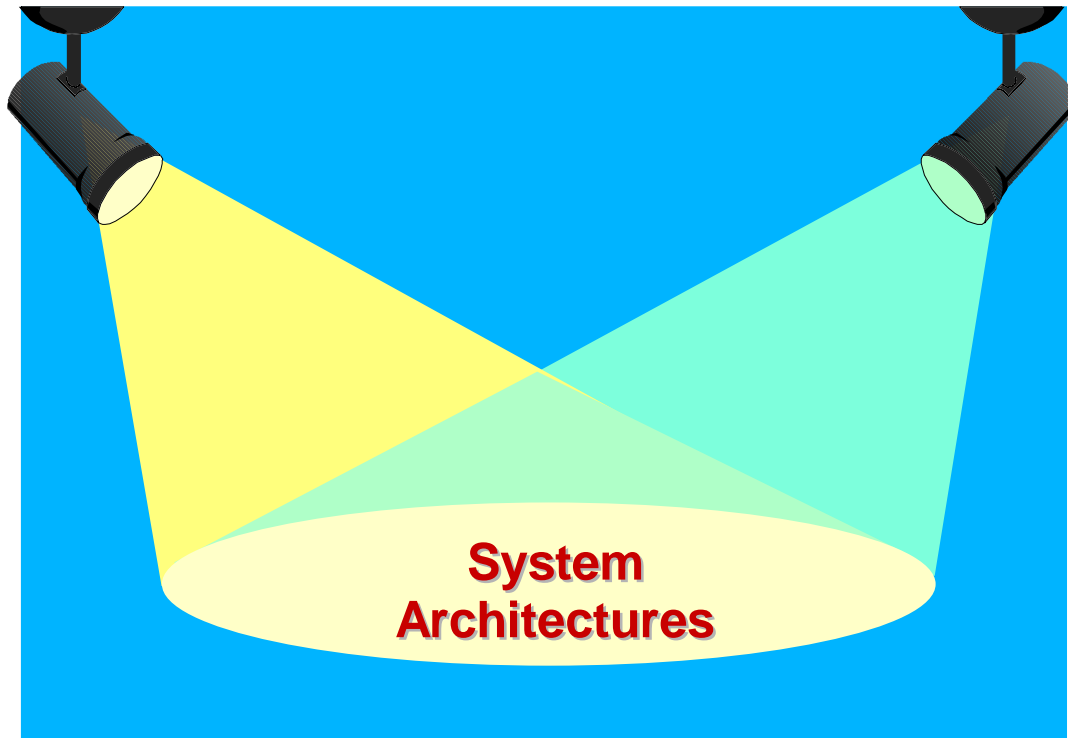
- Not enough research impact on product world!
- Action Tech emerged from Stanford work  
Compaq AltaVista Links (??) from Univ of Klagenfurt
- Ellis's Intelligent Control Nets (ICN) work at Xerox PARC  
implemented in Bull's now-defunct FlowPath
- InConcert resulted from CCA's research work
- Changengine came from HP Lab's OpenPM project
- METEOR2 (U of Georgia) commercialized by Infocsm
- Most academic and industrial research work focused on
  - Workflow specifications - intertask dependencies
  - Transactional workflows - extension of advanced transaction models (see my SIGMOD94 tutorial for survey and critique)
  - Extensions of active DB work to WFM: EvE, WIDE
  - CORBA environment: WASA, METEOR, METUflow
- Recent emphasis: scientific workflows, e-commerce



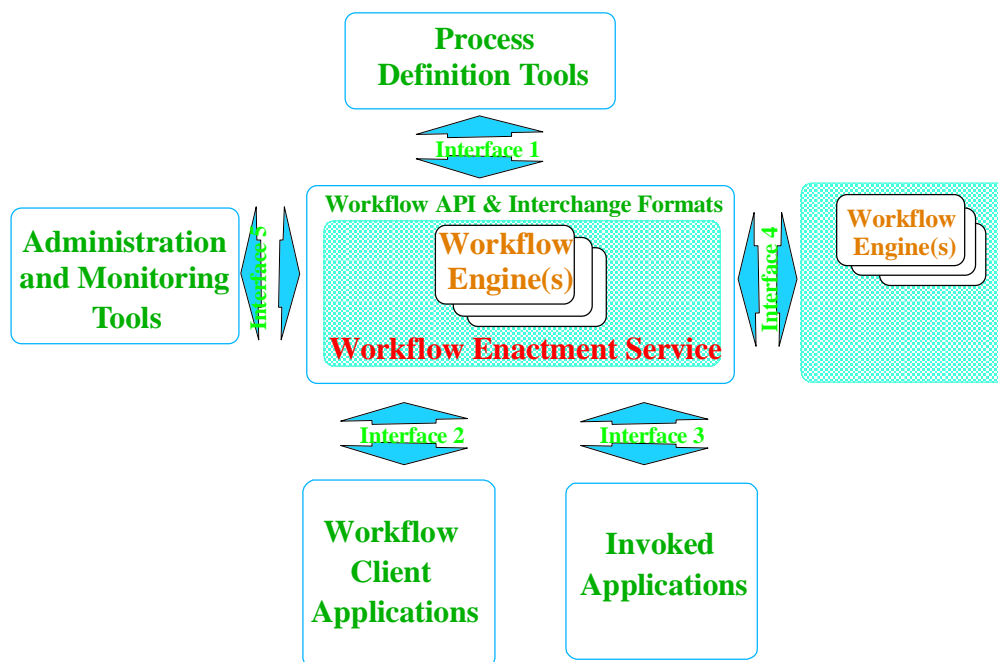
## Types of WFMS Users

- Business analysts (modelers)
- BPR consultants
- End users (work performers)
- Supervisors (oversight, ...)
- Administrators
- Programmers (activity implementors)

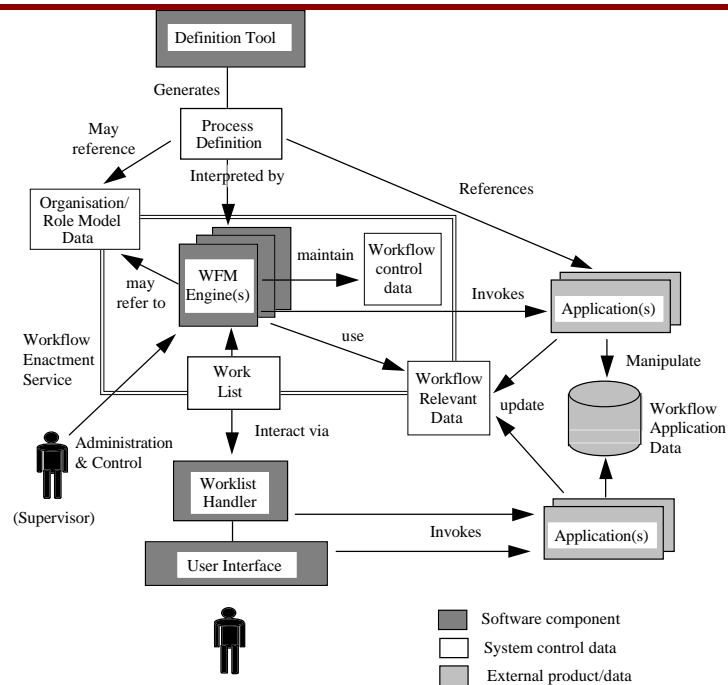




## Workflow Management Coalition Model



# Generic Product Structure

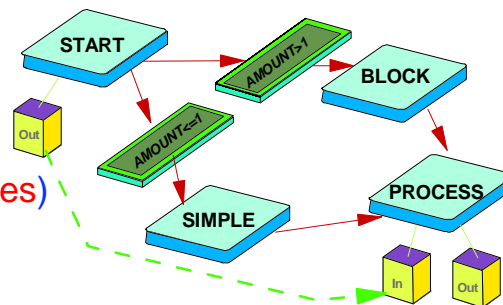


Source: WfMC

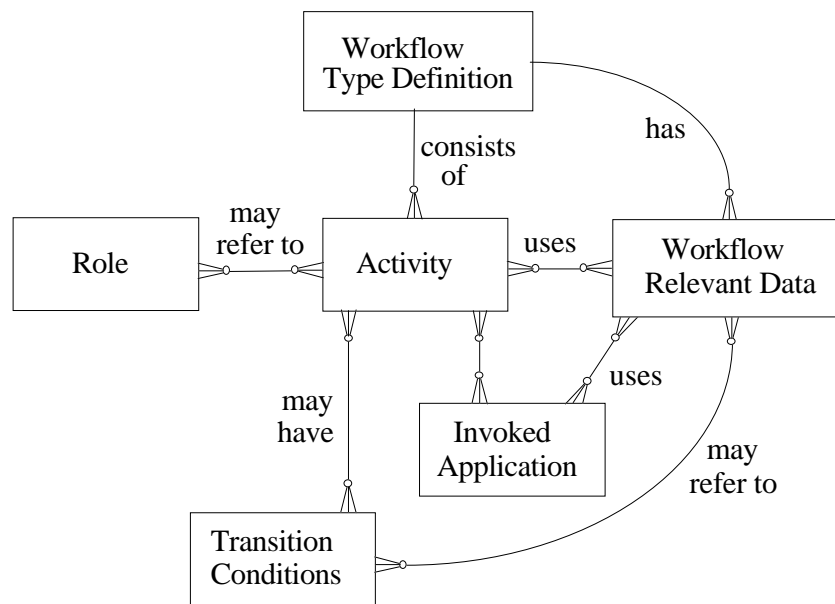
## Workflow Concepts



- Workflow/process/case/procedure/map (with versioning)
- Activities/steps (normal, start, end, split, join/rendezvous)
- Invoked apps
- Role
- Process relevant data
- Control connections and transition conditions (routing rules)
- Data connections
- Start and exit conditions
- Process graph navigation
- Process description language (e.g., FDL)
- Escalation/notifications
- Process control data
- Process and activity durations (deadlines)
- Priorities

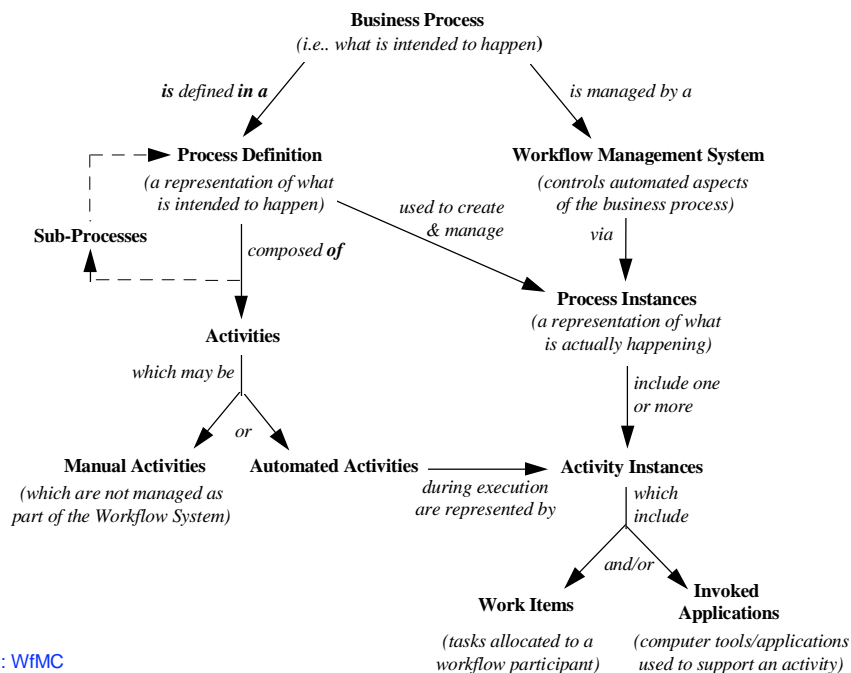


# Process Definition Meta Model



Source: WfMC

# Relationships between Concepts

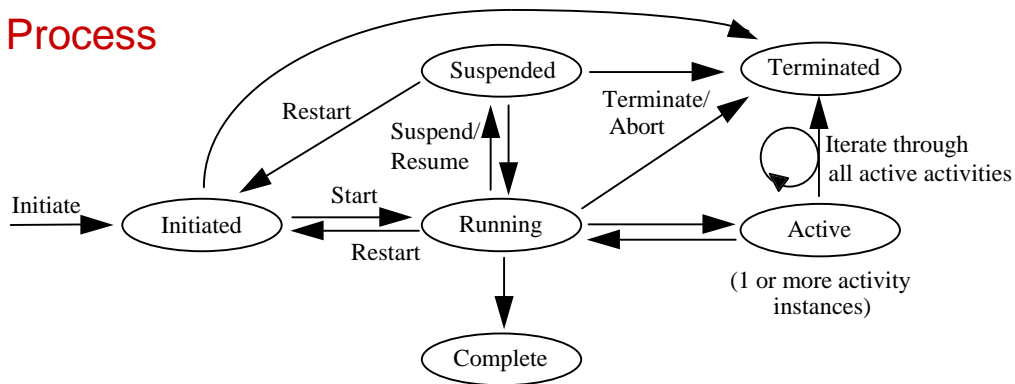


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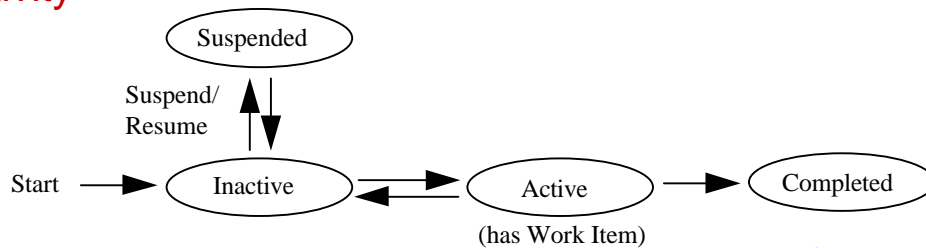


# State Transitions

## Process



## Activity

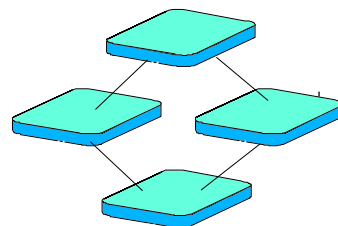


Source: WfMC

# Process Graph (Map)

## Features differ widely from system to system

- Hierarchical process composition
- Drag and drop
- Object orientation
- Different views of graph
- Zoom in and out
- User defined icons for activities
- Pre-defined activities
- Not convenient for import/export of process definitions



## Control Flow

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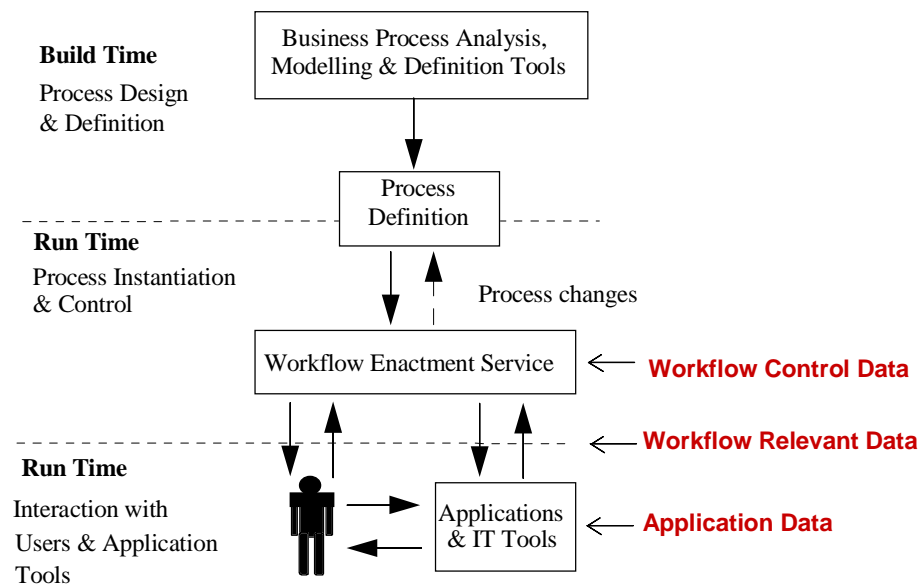
- Similar to programming in the large
- Sequential, parallel, looping flows; parameterized, dynamic instantiation of parallel flows
- Usual considerations: modularity, structured programming, ...
- Explicit vs. implicit looping constructs
- Forced termination/restart of activities/processes
- Pre- and post-conditions, including dependencies on timer and external events

## Data Flow

---

- Circulating objects (e.g., documents) versus parameter passing (e.g., container orientation)
- Data security and persistent store management considerations
- Data passing between containers via data connectors
- Passing by value vs. reference (files, URLs, ...)

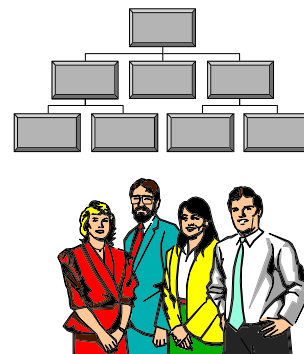
# Types of Data



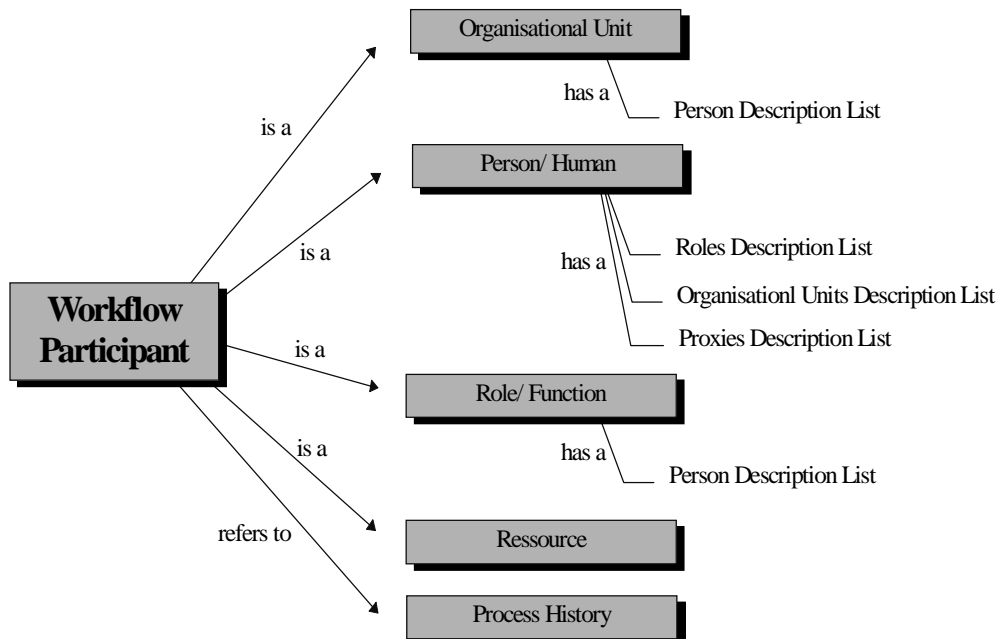
Source: WfMC

# Organization Modeling

- Modeling of staff relationships and organizational units
  - Degree of sophistication
  - Using other organization directories
  - Reassignment/delegation to handle temporary change in people's roles, responsibilities or work schedule
- Specific versus generic staff assignment
  - UserIDs
  - Roles, ...
- Static versus dynamic role resolution
- Predefined versus dynamically defined roles
- Extracting from other repositories (X.500, LDAP)



## Participant Assignment



Source: WfMC

## Workflow Repositories



- Stores process definitions, process control data, ...
- Type of repository
  - Mostly RDBMSs (e.g., ODBC compliant)
  - Sometimes Notes (e.g., Action, GroupFlow, ProZessware)
  - OODBMS (FlowMark used ObjectStore, MQ WF uses DB2)
- Types of accesses
  - Mostly update transactions
  - Short duration transactions
  - Highly concurrent accesses
  - Stored procedures improve performance
- High availability is crucial
- Two-phase commit with actions' apps makes atomic state transitions feasible

## Process Definition and Execution

- Buildtime
- Runtime
- Worklist
- Administration
- Staff/resource assignment, role resolution
- Messaging infrastructure
- Enterprise-wide workflows
- Process import/export utilities



## WFMS Types

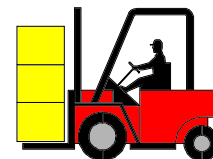
### Ad hoc WFMSs

- Messaging system (e.g., MAPI) used as primary routing mechanism for workitems (e.g., documents)
- Routing list carried in message
- Process logic executed within client app



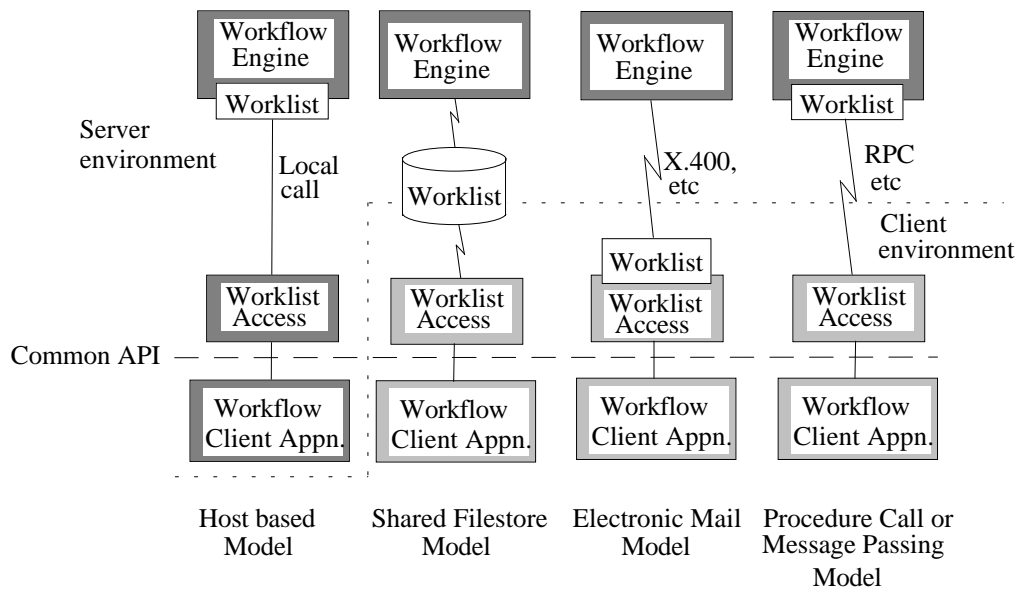
### Production WFMSs deploy server-based engine to

- Maintain process models
- Enforce routing rules
- Track documents'/processes' locations and status



Messaging used primarily for user notifications, reminders and alerts

## Worklist Handler Implementations



Source: WfMC

## Workitem Handling

Workitems = Ready activities

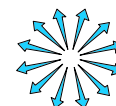
- **"Push" products**

- WFMS determines next workitem to be done
- for repetitive, highly structured processes
- either wholly automated or run by legions of heads-down clerks

- **"Pull" products**

- mainly for knowledge workers
- let workers choose next piece of work from in-box
- workers can change routing, prioritization, etc.

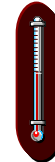
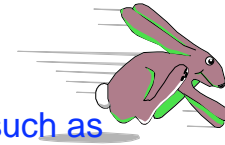
Same workitem in >1 worklist: synchronization issues



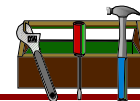
## Tools



- Animation
  - Training tool to demo how a process works
  - Validate individual activities to detect problems such as redundancies, dead ends or missing parts - "debugging"
- Monitoring: Visualization of process executions
  - Paths taken
  - Activities executed
  - Ready activities
- Process modeling methodologies/tools (e.g., ARIS, HOLOSOFX)
  - 4GLs of workflow management
  - Generate process schemas (a la 4GLs -> SQL)
- Activity programming (e.g., VisualAge, PowerBuilder)



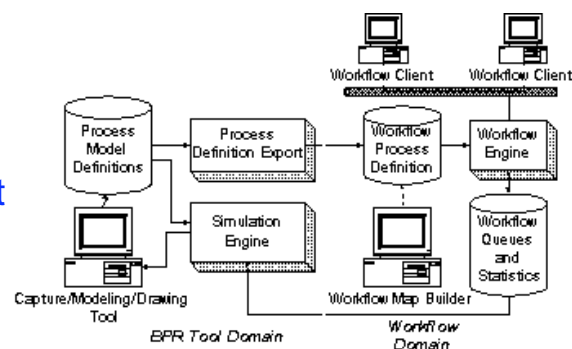
## Tools



- Simulation
- Audit: source of data for BPR

### Analysis tools help identify

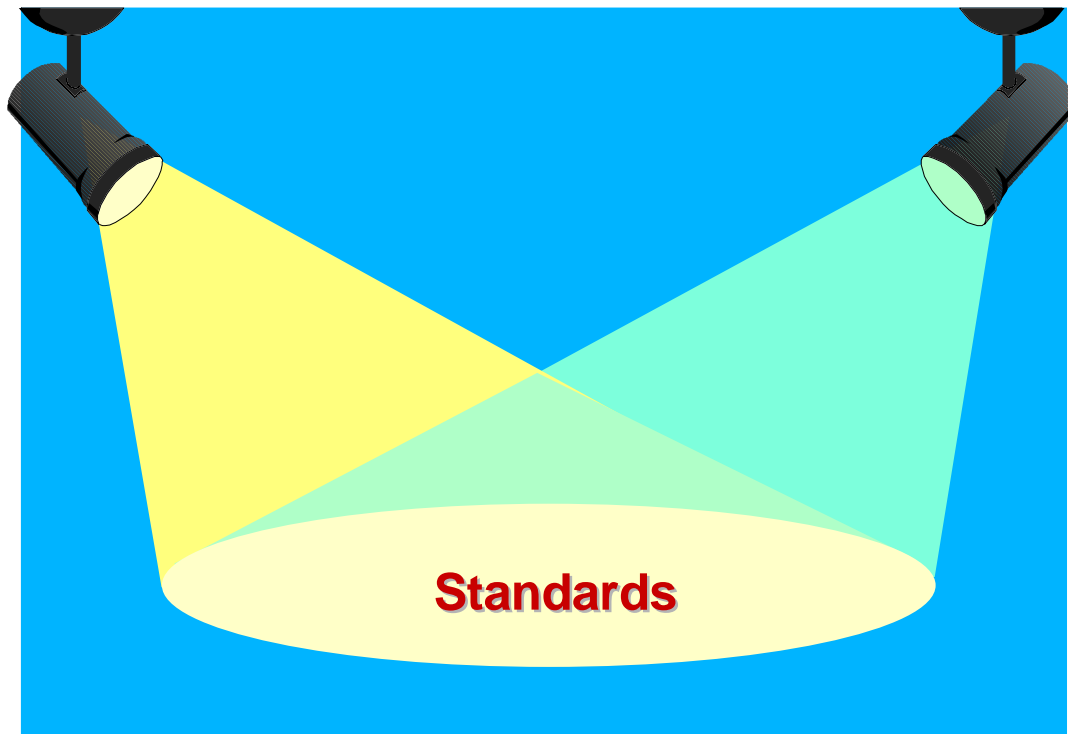
- Task consolidation
- Task automation
- Unnecessary tasks
- Areas for improvement



Source: B. Silver

## Document Management (DM)

- Digital capture, storage, retrieval and display of documents
- Images, voice, text, video, ...
- WFMSs with
  - built-in DM (Eastman OPEN/Workflow, Keyfile)
  - tight coupling to separate DM product (Pavone GroupFlow)
  - loose coupling (IBM MQSeries Workflow)
- Document Management Alliance (DMA) creating APIs to allow document exchange across document repositories  
<http://www.aiim.org/dma/index.html>





# Workflow Management Coalition (WfMC)

- Established in 8/93 for standards development
- 200 members (vendors, users, analysts, integrators, univs, ...)
- 5 working groups corresponding to 5 interfaces in reference model (WFMC-TC-1003, Issue 1.1, 1/95)
  1. Process definition model and interchange APIs
  2. Client APIs
  3. App invocation interface
  4. Workflow interoperability
  5. Administration and monitoring
- Terminology and glossary document (WFMC-TC-1011, Issue 2.0, 6/96)
- Process Definition Interchange (interface 1) Process Model - defines WPDL (WFMC-TC-1016P, Document Status 7.04, 11/98)
- Workflow management API (interface 2 & 3) spec (WFMC-TC-1009, Version 2.0e, 7/98)
- Interoperability (interface 4) abstract spec and internet e-mail MIME binding (WFMC-TC-1012, Version 1.0, 10/96; -1018, Version 1.1, 9/98)
- Audit Data (interface 5) spec (WFMC-TC-1015, Version 1.1, 9/98)



## WfMC



- Interface 1: Process definition interchange Q&A and Examples (WFMC-TC-1016-X, Draft 7.01, 1/99)
- Workflow and Internet: Catalysts for Radical Change, WfMC White paper, 6/98
- Workflow Interoperability - Enabling E-Commerce, M. Anderson, R. Allen, WfMC paper
- Organization Model (WFMC-TC-1016P) being revised
- Workflow Security Considerations - White Paper (WFMC-TC-1019, Issue 1.0, 2/98)
  - Especially important in the context of interoperability
- Liaisons with other groups: Black Forest, OMG, Document Management Alliance
- Workflow management user group created recently
- Handbook published in 1997
- ➔ <http://www.aiim.org/wfmc/>

## OMG and Workflow

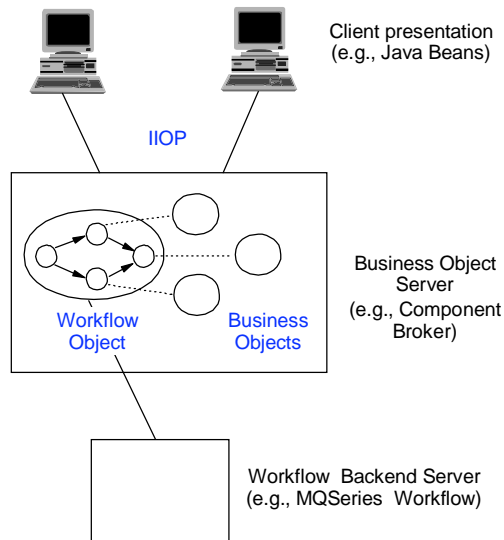


### Workflow Management Facility RFP

- Define interfaces for workflow Business Objects
- IIOP-based client - server communication
- Interfaces and semantics for manipulating and executing interoperable objects and its metadata

### WfMC Submission Approved

- Addresses workflow control, monitoring and interoperability
- Business Object integration
- Based on WfMC standards
- 20 submitters, including IBM



Workflow Management Facility Specification (bom/99-03-01), accepted 11/98

[http://www.omg.org/library/schedule/CF\\_RFP9.htm](http://www.omg.org/library/schedule/CF_RFP9.htm)

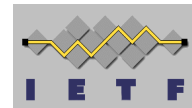
## OMG and Workflow

- bom/99-04-01: Workflow **Resource** Management Facility RFP
- Submissions due: October 25, 1999

## Internet Enablement

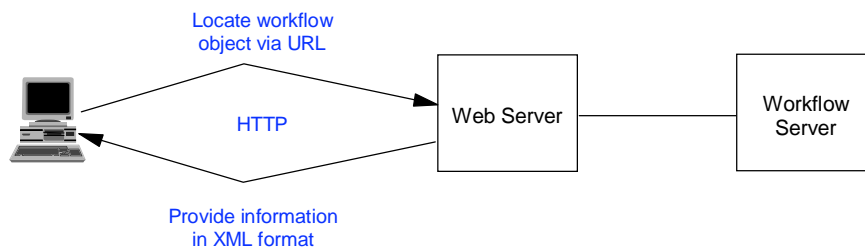
- Current APIs mapped to IDL
- Java mappings of API being carried out
- WfMC recommends usage of DMA APIs for document management integration  
DMA is mapping its APIs to the internet
- EDI community moving to internet technologies  
XML with SMIME being considered a serious candidate

## SWAP Initiative



### Simple Workflow Access Protocol (SWAP)

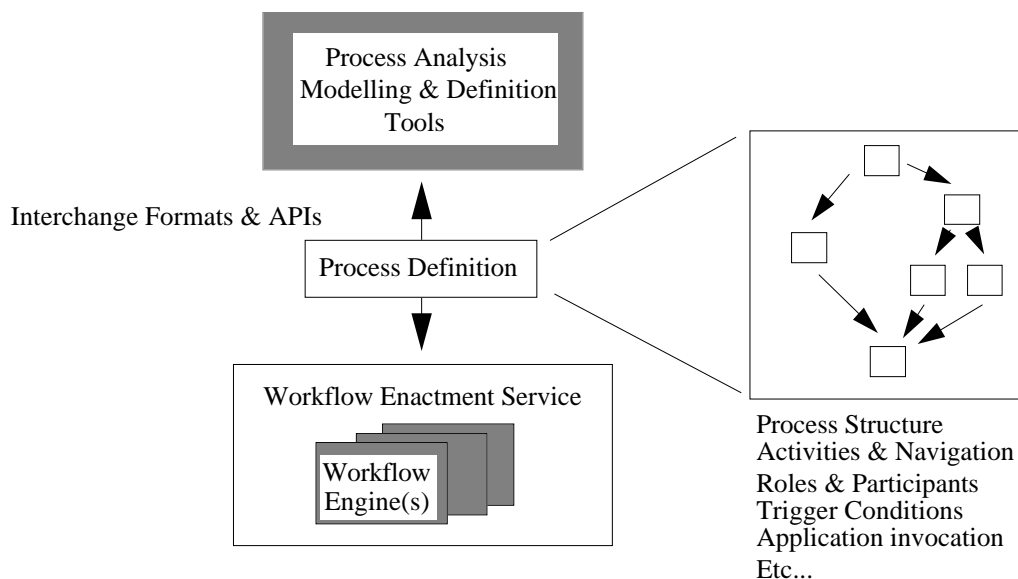
- Simple interoperability protocol for workflow in an Internet environment
- HTTP-based binding of the jFlow specification
- XML-based encoding of information exchange
- Proposed by Netscape, HP, Sun
- Status: Initial discussions started
- Proposal at Internet Engineering Task Force (IETF)



## Interface 1

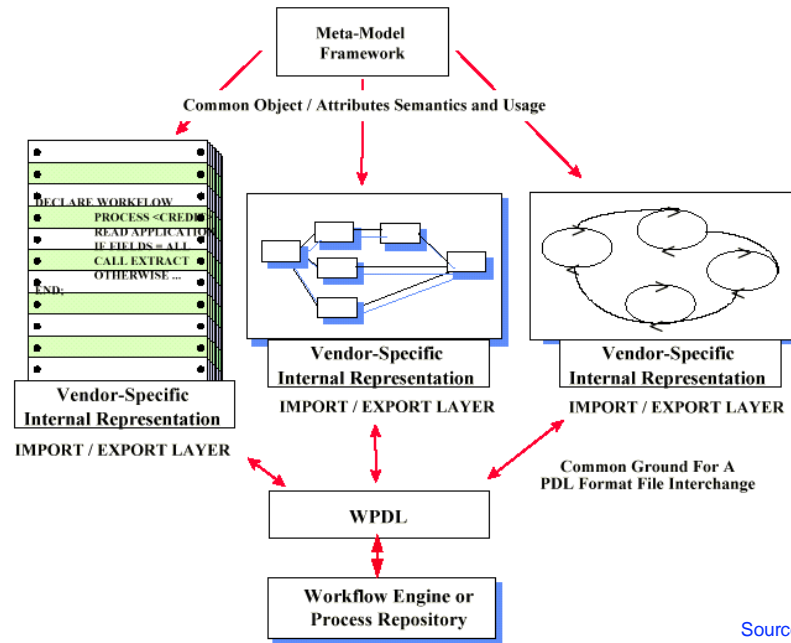
- Spec defines
  - Metamodel for describing process definitions
  - Grammar for WPDL for process definition interchange
  - APIs for manipulating process definitions
- Distinction between development and runtime
- WPDL extensible to handle info used by different tools
- WPDL based on languages of IBM's FlowMark, Ley's Cosa and SNI's WorkParty
- API to query, retrieve or modify individual elements of a process definition - bindings for C and IDL
- Organization models not included

## Process Definition



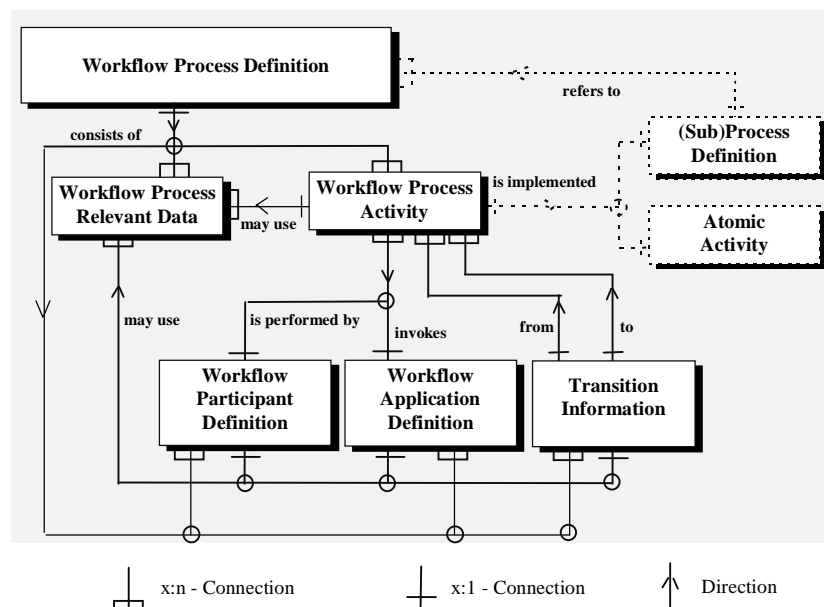
Source: WfMC

# Process Definition Interchange



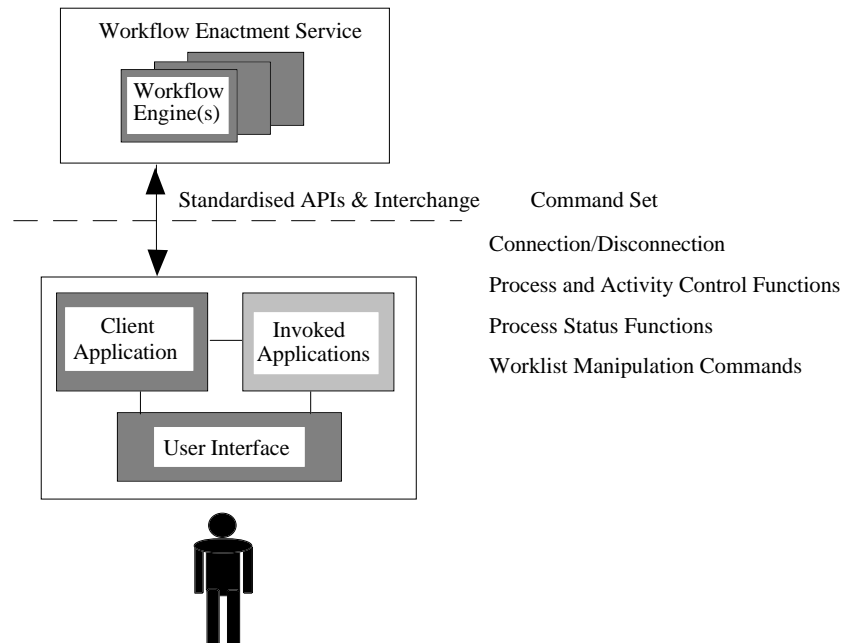
Source: WfMC

# Process Definition Meta Model



Source: WfMC

# Client Applications



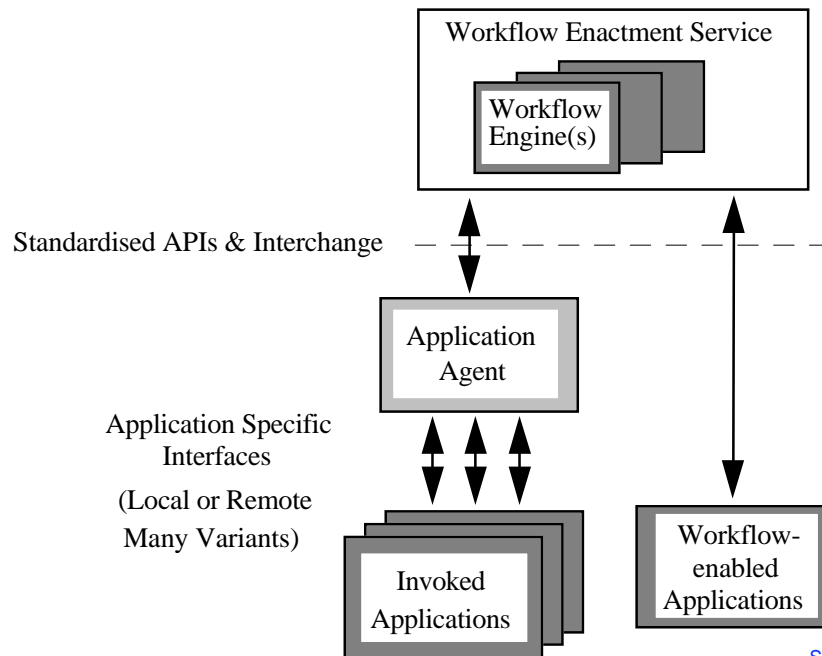
Source: WfMC

## WAPI Specification (Interface 2)

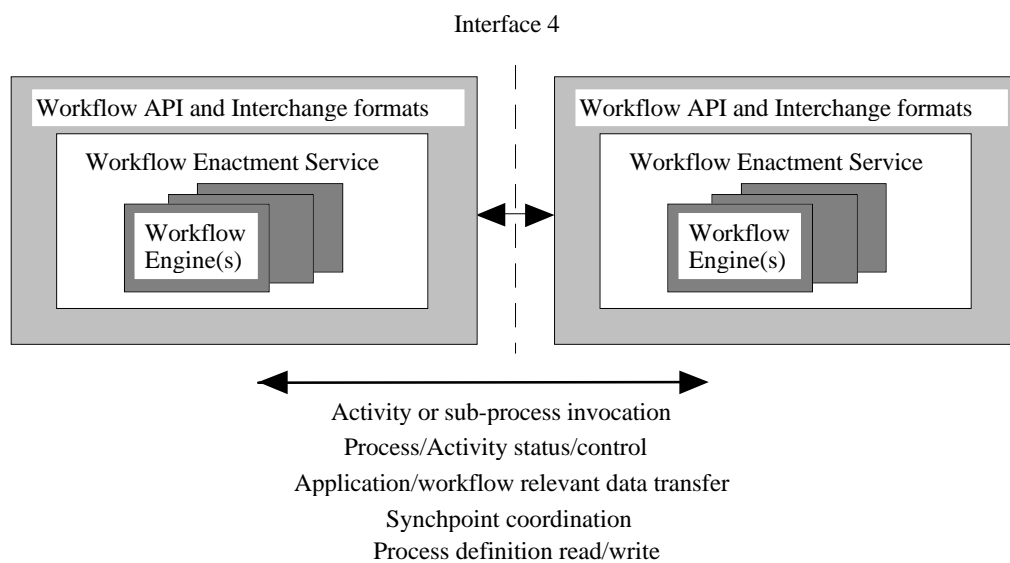


- **Connection functions:** connect/disconnect to/from server
- **Process control functions:** query process definitions & attributes of instances, create/start/terminate instances
- **Activity control functions:** query/change activity instance states or attributes
- **Process status functions:** query status of process instances
- **Activity status functions:** query status of activity instances
- **Worklist functions:** query or change states of workitems
- **Administrative functions:** changing states of process/activity instances

## Invoked Applications

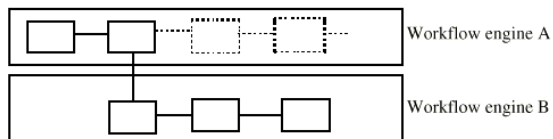


## Interoperability

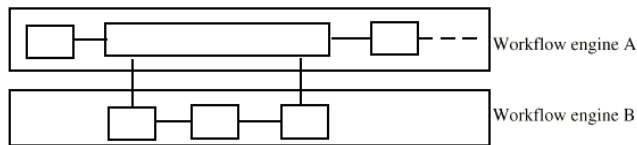


# Models of Interoperability

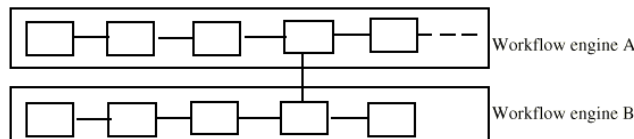
## Chained



## Nested Subprocess

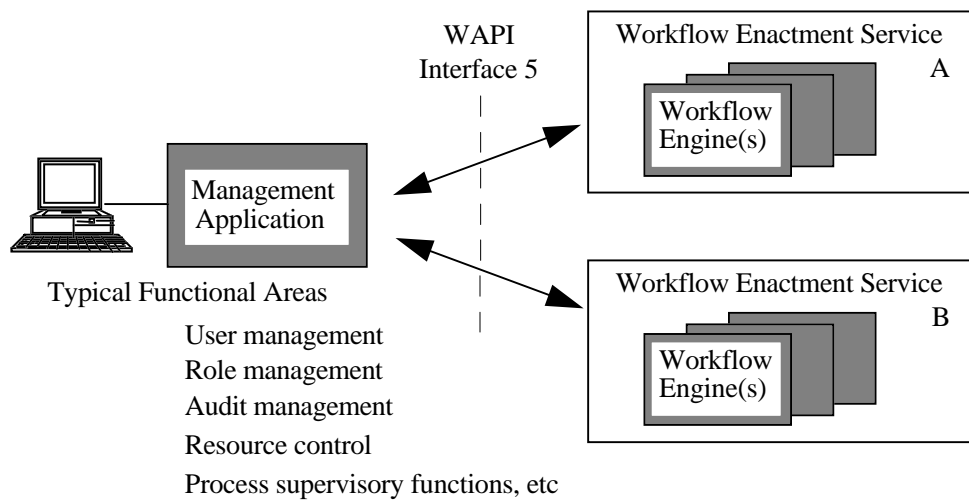


## Parallel Synchronized Not in standard



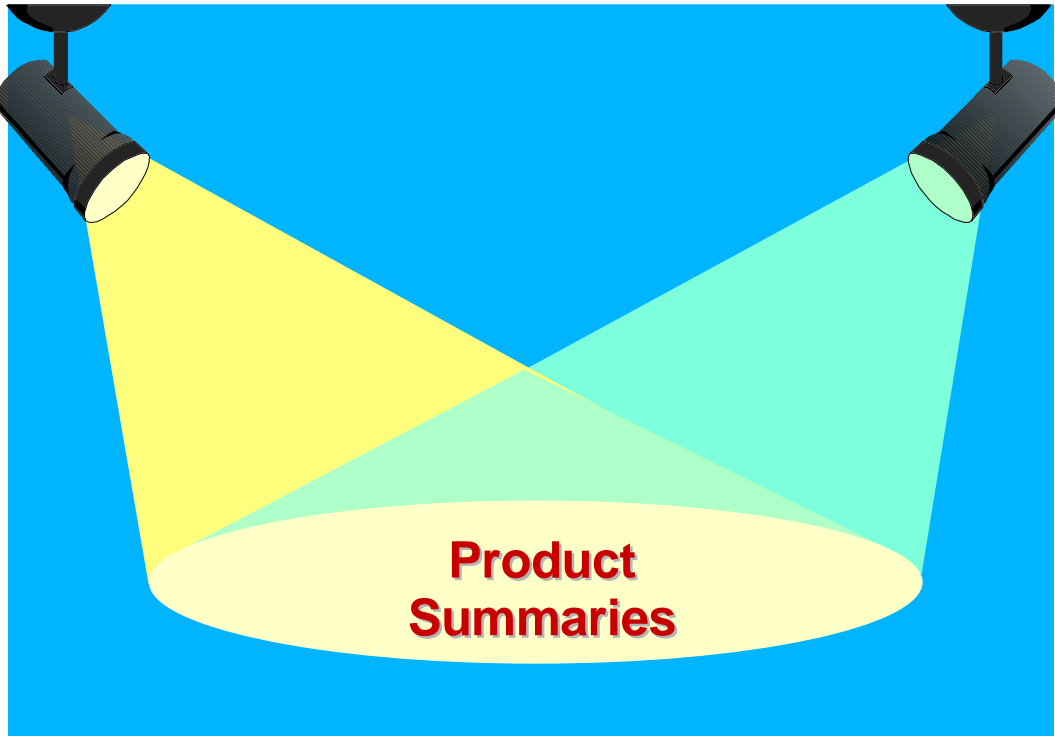
Source: WfMC

# Administration and Monitoring



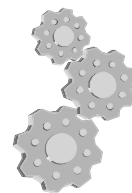
Source: WfMC





## Anatomy of IBM's FlowMark (MQ WF)

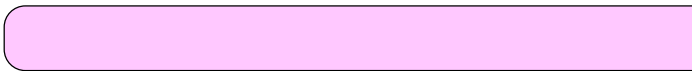
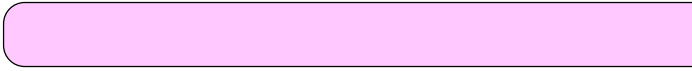
- Released in 1994; now, Version 3 (MQSeries Workflow)
  - Written in C++; uses DB2 as repository
  - Building blocks interface to related products (e.g., Visual Info, Lotus Notes, MQSeries)
  - Distributed workflows (not yet in MQ WF)
    - subprocesses executable in other domains (specified statically or via input container)
    - no distributed workitem support
  - Animation tool, auditing
  - FlowMark Description Language (FDL) - some tools generate FDL (e.g., ARIS, HOLOSOFX)
  - Customers: ANZ Bank, MetLife, Deutsche Telekom, HYPO-BANK, Mutual Group
  - **EDMSuite**: FlowMark, ImagePlus, Domino.Document Manager
- <http://www.software.ibm.com/ts/mqseries/workflow/>



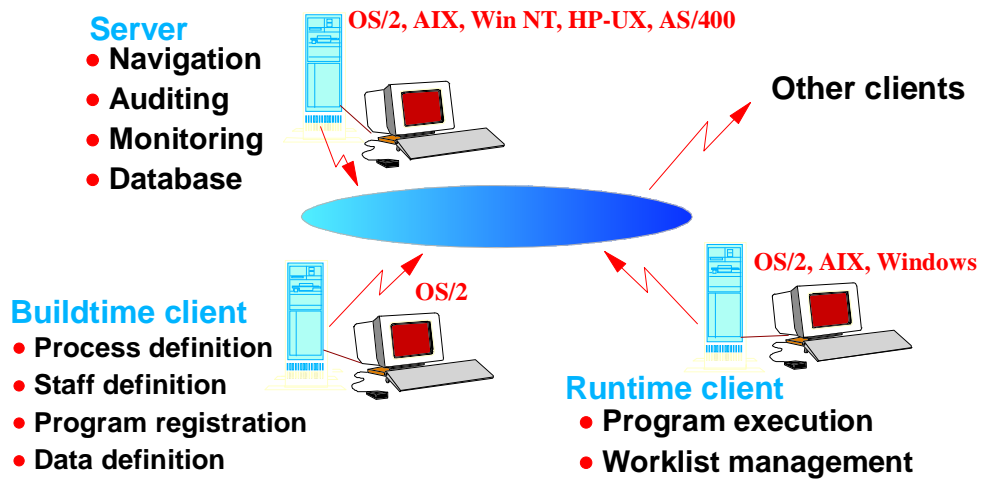
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## Family Traits

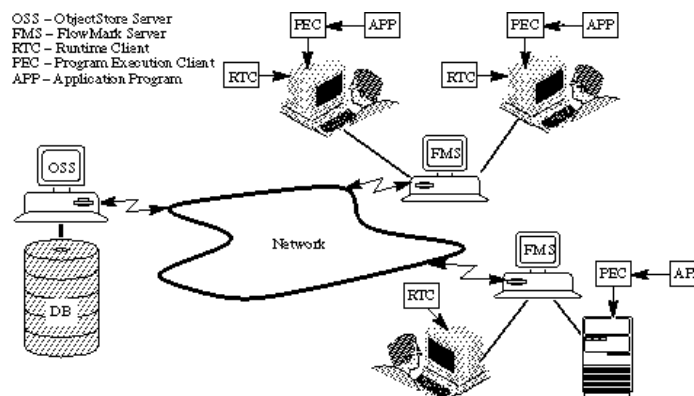
➤ Modular set of offerings



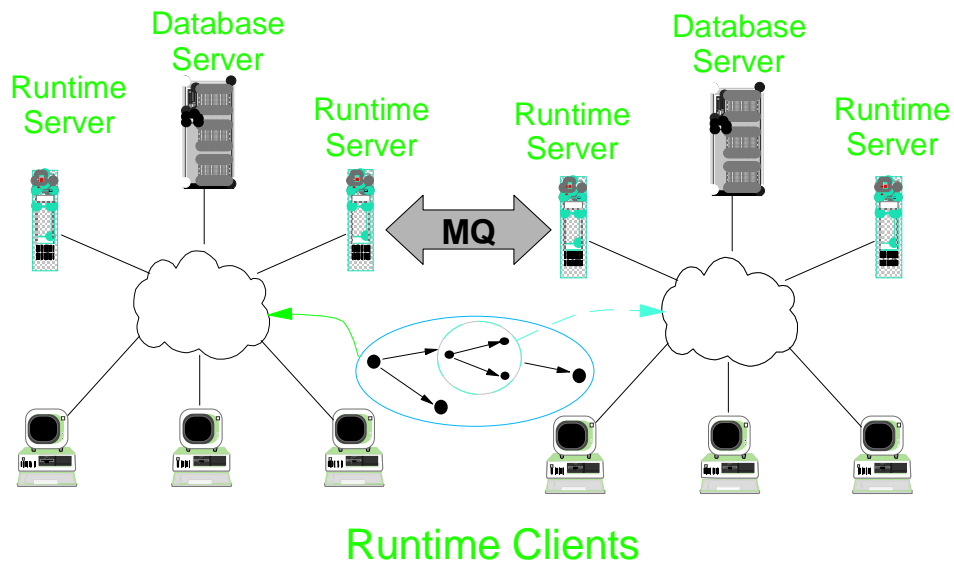
## FM: Environment



## FM: Runtime Architecture



## FlowMark System Interaction

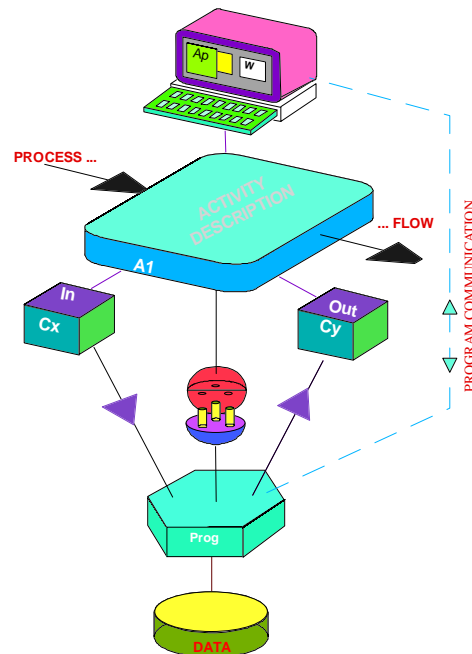


## FM: Components

Buildtime	Graphical process definition Staff, program and data registration Verification and animation
Runtime	Process execution, navigation Process monitor Worklist management
Administration	Audit trail Import/Export
Others	Application Programming Interface (API) Program invocation

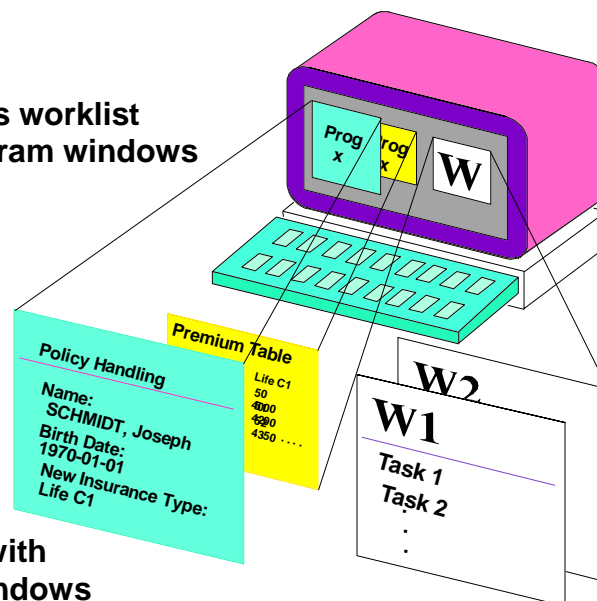
## FM: Execution

- User starts activity
- Activity describes program to be executed
- Registered program is called
- Program takes process relevant data from "in" and puts data into "out" data containers
- Program communicates with user and processes the data



## FM: End User's View

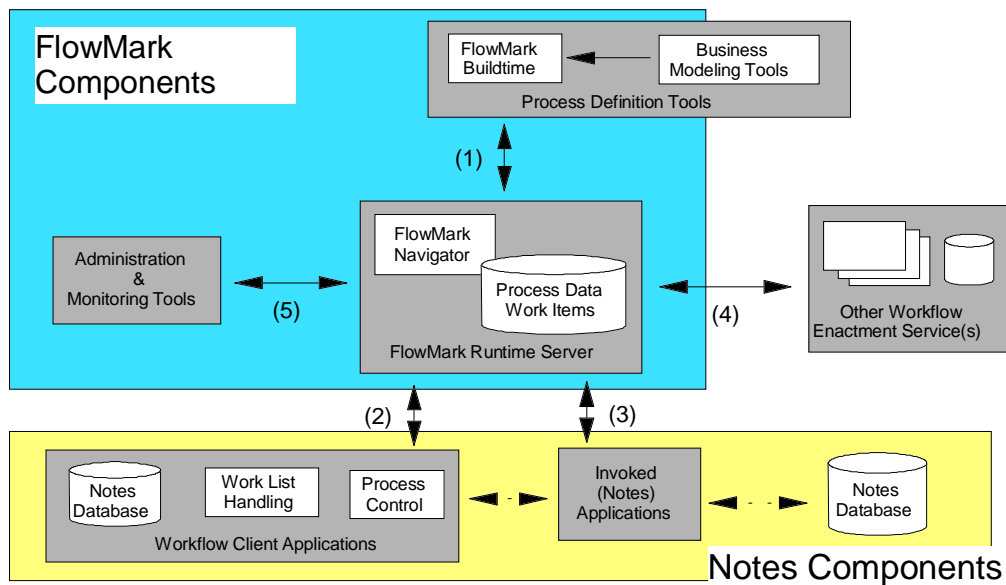
User sees worklist and program windows



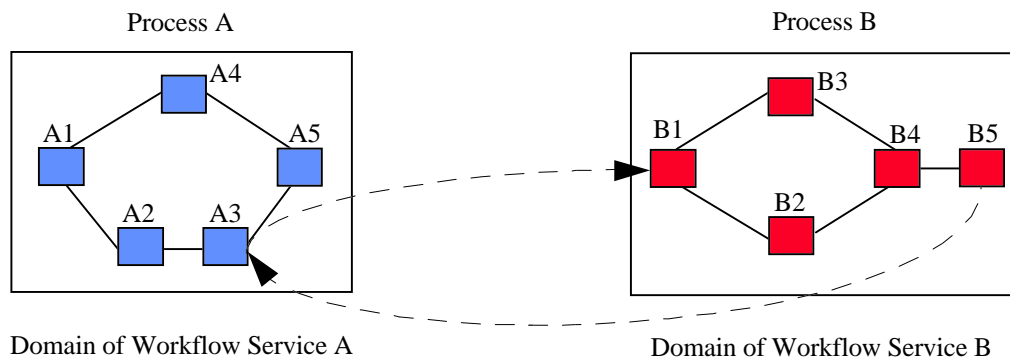
User interacts with the program windows

Worklists show the assigned activities

# FlowMark Notes Runtime Frontend



# Distributed Workflows



Source: WfMC

## FM: Staff Concepts

- Hierarchical organization model
- Each person has a **level** (0-9), belongs to an **organization** and can play many **roles**
- Each person can have a **substitute** and can be a substitute for many persons
- Each role has a **coordinator**
- 3 predefined roles
  - System administrator
  - Coordinator
  - Manager
- Can grant authorities to
  - Define staff
  - Model processes
  - Manage process instances in specific categories
  - Access other people's activities

## FM: Staff Assignment and Resolution

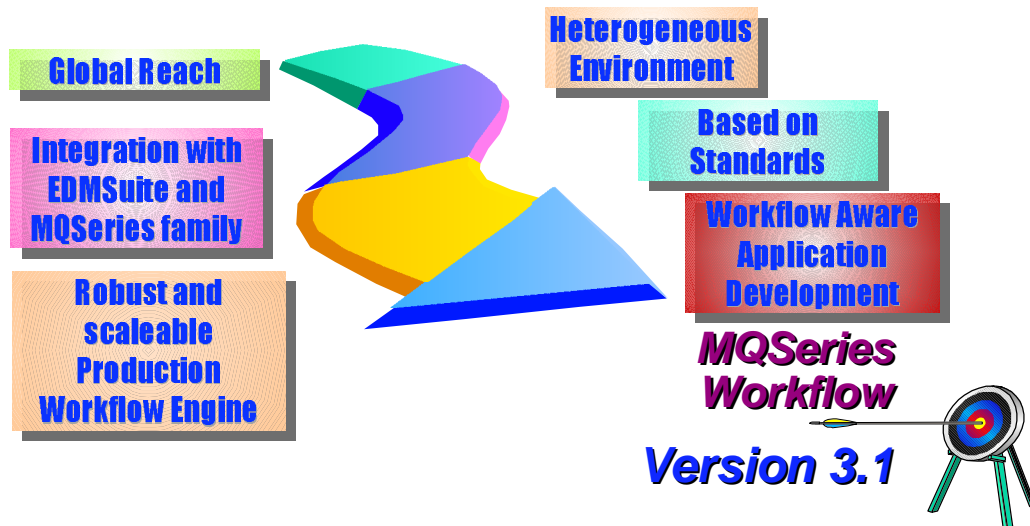
### Assignment Possibilities

- Specific person(s)
- Role, organization, level
- Process starter or his/her manager
- Starter of an earlier activity (or manager)
- Any qualifying staff of another activity except its actual starter
- Input container values

### Resolution

- ◆ Takes into account staff substitutions
- ◆ Defaults in case resolution fails
- ◆ All qualifying staff notified about ready activity

# FlowMark Strategic Directions



## IBM MQSeries Workflow Version 3 Objectives

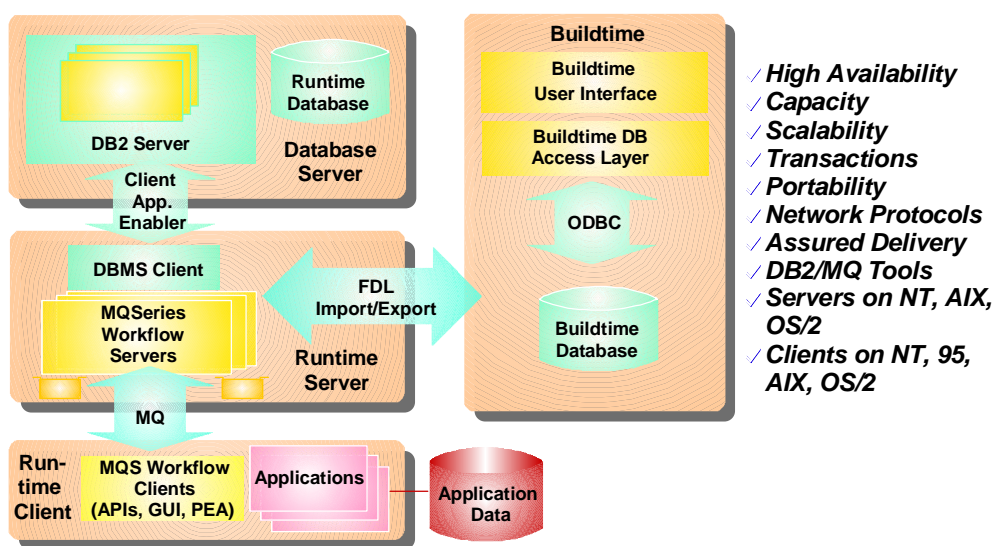
- **Establish solid base for enterprise workflow**
  - ➡ Replace ObjectStore with DB2 Universal Database as DBMS
    - Scalability and performance
    - Platforms (OS/390 in addition to OS/2, NT, AIX, HP-UX servers)
    - Robustness
  - ➡ Replace Telepath with MQ Series for communication
    - Network independence
    - Robustness (assured delivery)
- **Full coverage and exploitation of the Windows 32 Bit platforms on the client side**
  - ▶ New Runtime Client based on official MQSeries Workflow API and ActiveX technology
  - ▶ New ActiveX Controls Toolkit for client construction
  - ▶ New Buildtime covering Windows NT and 95 platforms



## The New Generation...

- **MQ Workflow V3 is a re-implementation of FlowMark V2**
  - ▶ New architecture
  - ▶ New 'IBM middleware on IBM middleware' concept
  - ▶ Totally new code base
- **Plan was established on customer feedback and experience about critical areas in V2**
  - ▶ Robustness and scalability of ObjectStore
  - ▶ Robustness of Telepath
  - ▶ Special focus areas of V3.1:
    - Performance and scalability of runtime SW to enable growth paths for customers
    - Usability of buildtime and runtime clients
- **Some tradeoffs had to be made regarding compatibility with FlowMark 2.3 (due to technical reasons or effort)**
  - ▶ Examples of functions not available in 3.1:
    - No bundles
    - No service brokers
    - No remote sub-processes
  - ▶ 2.3 compatibility APIs are being provided (with some inherent restrictions)
  - ▶ Staging of some functions (3.1.0/3.1.1/3.1.2)

## MQSeries Workflow 3.1 System Structure The Move to DB2 UDB and MQSeries...

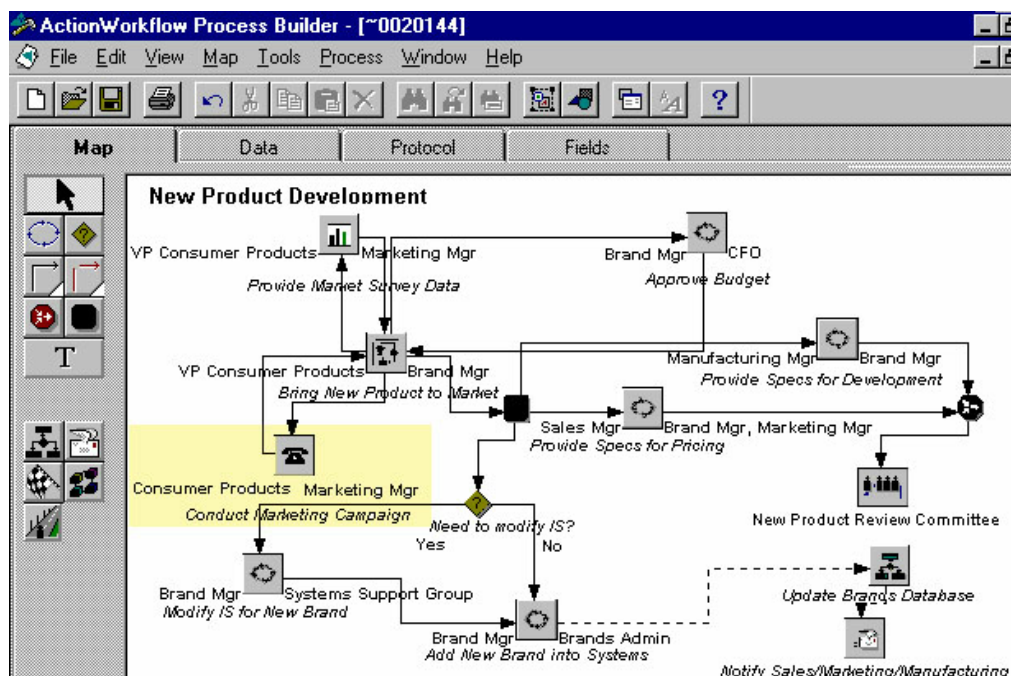


## Action Workflow System (Action Technology)

- ATI founded in 1983; Now Enterprise Series 3.0
- Components: **Builder, Manager, Metro**
- Process modeling based on **customer-performer paradigm** (Speech Act theory)
  - 4 phases in each workflow loop: **preparation, negotiation, performance, acceptance**
  - Paradigm found to be difficult by users
- OS/2, NT for Notes and SQL Server environments
- Part of Cincom's TOTAL Framework app assembly environment
- Partners with PC Docs to integrate CyberDOCS
- Customers: Baylor Health Care, Clark County Dept of Business License, Lockheed Martin, Blue Cross Blue Shield of Alabama, Nations Bank
- <http://www.actiontech.com/>



## Action Process Example



## Action Builder

- **Analyst and Developer Editions**
- For "as-is" and "to-be" process modeling & analysis
- Time & value/loss of each phase of loop specifiable
- Computes total time and value of each process
- Automatic escalations and notifications
- VB-compatible scripting language for detailed customization (invoking external apps, ...)
- **Agent Performers:** automate tasks - can communicate with any DLL, ODBC database or OLE automation server
- **Workflow Templates:** Point-and-click interface to define a range of processes from a simple "to-do" to complex negotiation conversations
- **Protocol Wizards:** Based on answers to questions, create underlying app, flows and database
- **Route Component:** For *route-review-vote-approve* process

## Action Manager

- **Manager for Notes**
  - OS/2 server task processes most workflow documents
    - Limits ability of users in decentralized, dial-up or remotely linked sites to share same workflow
    - No special client SW
  - Builder creates forms in central TransNotes DB
  - Workflow definitions in another Notes DB
  - Users interact with TransNotes DB
  - Frequency at which Manager processes workflow requests tailorable

## Action Metro

- Internet business process manager; now, Version 1.1
- Includes
  - **Application Center**: Set of 20 pre-built app templates - sales, marketing, admin, human resources, engineering
  - **Development Center**: Environment to develop and deploy workflow-enabled intranet apps
- **Metro AutoPilot**:
  - Form-approval app tool for the web
  - Goal: get apps up and running in 10 minutes

## Visual WorkFlo (FileNET)



- First company to popularize imaging-based workflow ('85)
  - Visual WorkFlo (released 12/94): *Object-oriented*, production WFMS with no image dependence
  - Work objects, instruction sheets, work performers
  - Includes OLE Automation support
  - Adaptors for interfacing to external apps like Excel, Power Builder and Lotus Notes
  - "Push" and "pull" models, but no worklist handler
  - Dynamic process modification
  - Meta's BPR tool (Workflow Analyzer) generates WorkFlo model - document, simulate & optimize
  - HOLOSOFX integrated its BPM tool (Workflow-BPR)
  - Release 3.0: ability to build contingencies
  - **Customers**: American President Lines, Amoco, Bankers Trust, Budger Rent a Car, Credit Suisse, Kansas Dept of Revenue, C.I. Mutual Funds
- <http://www.filenet.com/>



## Visual WorkFlo



### Components: Composer, Conductor and Performer

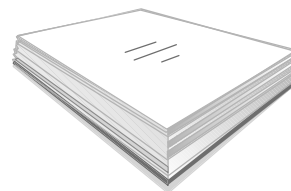
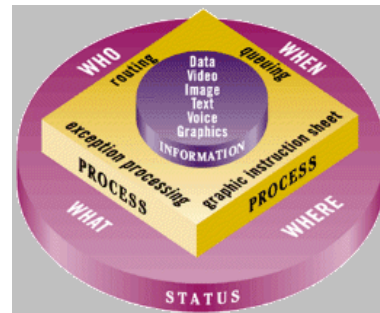
#### Composer features

- OO features including inheritance, class, polymorphism, encapsulation
- Timer operations: Begin, Suspend, Resume, End
- Delay
- WaitForEvent
- GoTo/Label

#### Conductor standard reports

- Volume
- Delay
- Completion/Throughput
- Queue depths

WorkFlo Connection provides an automatic means to initiate workflows from external systems

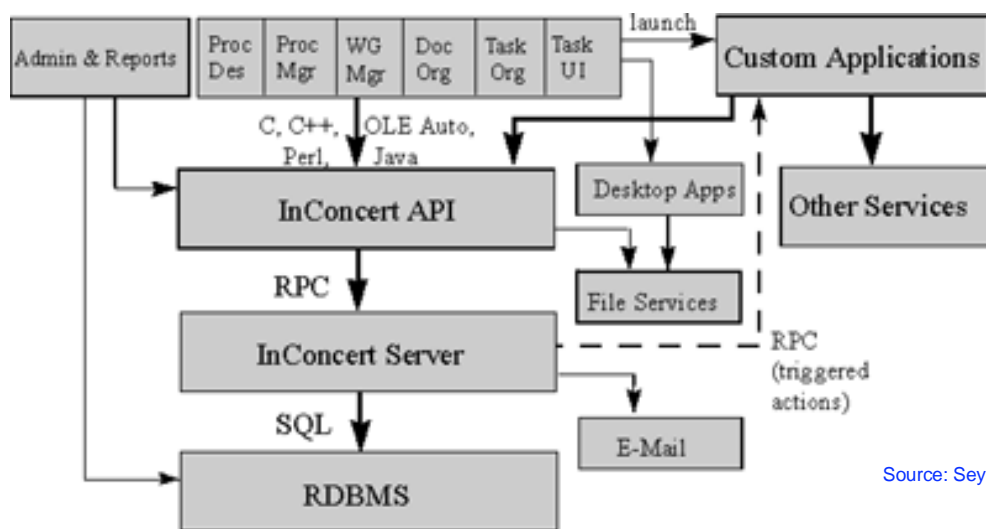


## FileNet Ensemble

- Message-based (MS Exchange/Mail or Novell GroupWise) workflow system for less structured, ad hoc and collaborative work
- Core of Novell's GroupWise Workflow Notes/Domino version in the works
- Work items received in standard mailboxes
- Can attach to workflows
  - URLs - on clicking, launches web browser and web page
  - Open Document Management API (ODMA) document references
- OLE automation support for application integration
- WorkFlo Central: Organizes workflow info into 3 folders - work items, workflows sent, workflow reports

- Document-based
  - Process = tasks + roles + references
  - Exception handling via **dynamic modifications**
  - Object-oriented with > 400 APIs (C, C++)
    - Process is a data object, not a program or script
    - **Inheritance and user-definable extensions**
  - Extensible condition-action triggers (system/app defined events)
  - Server uses RDBMS as repository; RPC for client communication
  - Clients: Process Designer, Process Manager, Task Organizer
- <http://www.inconcertsw.com/>

## InConcert Architecture



Source: Seybold

★ Customers: Logicon, SAIC, TV Guide, AT&T, MCI, Bell South

## InConcert

- **Teoss**
  - Solution for operational support system (OSS) for telecom
  - Ties together different legacy systems that support OSS process, providing templates for frontends as well as workflow apps for feeding info from one system to another
  - Streamlines provisioning - processing and activating - telephone line and communications services, including billing
- Announced **InConcert 2000**, next-generation Enterprise Business Integration backbone
  - Part of BEA Systems' eLink product family
  - TXM option: tightly integrates with BEA TUXEDO
- Integrates with CACI's SIMPROCESS enterprise modelling and simulation software
  - Animation of flow simulation for visualization
  - Customizable performance measurements - activity cost, service levels, ...

## TeamWARE Flow (ICL/Fujitsu)

- Enterprise-wide document routing system
- **Targetted at ad hoc and production workflow**
- Process instance = shared data space + plan(s)
  - Plan = activities + roles
  - Shared data space = documents + other artifacts
- History info stored in a DB
- Integrated with TeamOFFICE groupware services and TeamMessaging - former's directory and security mechanisms can be used
- User programs run under Windows
- OO workflow engine
- **Dynamic modification of a running process's schema**
  - <http://www.teamware.us.com/cgi-bin/pltn?A:/twhtml/pguide/twflow.htm>





## TeamWARE Flow



- Uses TeamMail for document passing between users
- Any ODBC-compliant DBMS as repository
- A process can evolve as it executes (process capture)
- Events supported: Event sendable to an activity when another activity starts/ends
- Timer nodes for introducing delays
- TCL (tool command language) for writing scripts
- Planner: for drawing plans
- Viewer: for viewing work lists, processes, histories, forms
- Forms Builder: data fields linkable to a database
- Customers: Meiji Life Insurance



→ <http://www.fsc.fujitsu.com>

## Livelink Workflow (Odesta/Open Text)



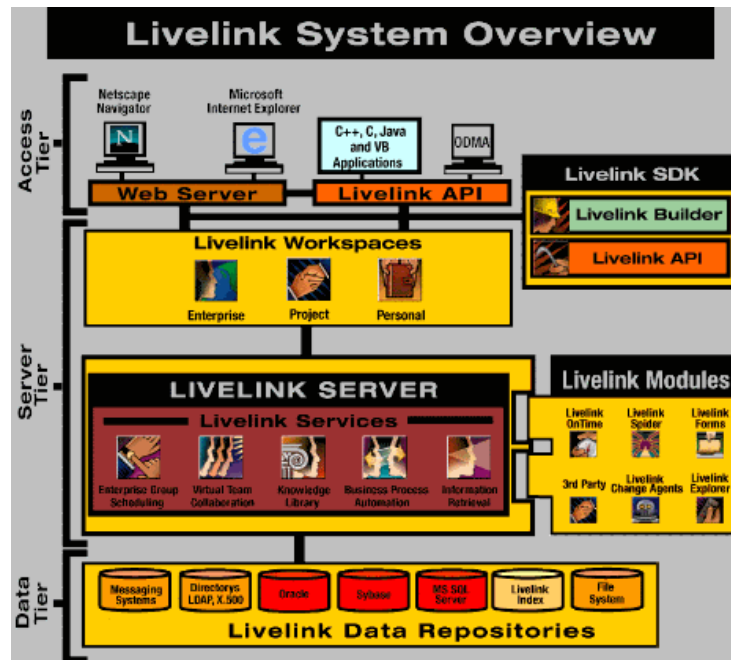
- Odesta acquired by Open Text
- Partners with JetForm
- Routes documents and folders (Package) through work process, with audit trail (all versions of files)
- Custom process graph attributes
- Milestones: placed between tasks to denote major points in workflow for display in status reports
- Due dates specified with per-step dates or durations or with an explicit overall due date
- Status monitor for progress against milestones
- Object-oriented OScript scripting language
- Oracle, Sybase or MS SQL Server for repository
- Latest release: 8.0



→ [http://www.opentext.com/livelink/ll\\_workflow.html](http://www.opentext.com/livelink/ll_workflow.html)



# Livelink Workflow



Source: Seybold

# Livelink Workflow

- Netscape-based client in Livelink Intranet 7.0
- Suite: Project Collaboration, Workflow, Search, Library
- Builder: A visual OO app development toolkit
- Partnership with JetForm to provide Java-based forms
- Workgroup version bundled with Netscape SuiteSpot 3.0

## Staffware (Staffware)



- UK firm with 150K seats (4000 servers) in 35 countries
  - Merged with CSE Systems (Austria) in 1996
  - Latest release: **Staffware 97**
  - A form and an action associated with every step
  - **Distributed workflows**
    - Master, Slave servers
    - Cases, steps transferable from master to slaves (e.g., for disconnected operation)
  - **S.N.A.P. product**: for loose integration with Notes
  - No integrated document/imaging capability
  - Integrated with MS Exchange client
- <http://www.staffware.com/>

## Staffware

- **Personal Workflow**: Standalone version for single remote notebook users
- **Staffware Global**
  - Java-based client for all browsers
  - Dedicated web server only for login security
  - Communicates with Staffware Queue Server
  - Lacks new process definition and admin features
- Won 2nd Workflow/Imaging Gold Award from Giga in 1996
- Customers: AT&T, Blue Cross Blue Shield (Florida), Brigham Young University, National Commerce Bank, Veterans Benefit Administration, CIGNA HealthCare, Citibank, Yarra Valley Water

## OmniDesk (Sigma/Wang/Eastman SW)

- Wang buys Sigma; Kodak buys Wang's SW business
  - First to intro graphical maps ('89) - originally image based
  - Tightly integrated document management
  - Release of Wang's OPEN/Workflow (3.0)
  - Multi-server design with global document locking
  - Powerful "event waiting" feature
  - Offline mode provides disconnected operation
  - World's largest production workflow/imaging installation
    - Empire Blue Cross and Blue Shield
    - 3500 users at 5 major sites
    - 140M image documents
  - Lacks an organization model
- <http://www.eastmansoftware.com/>



## Ultimus (Ultimus)

*Ultimus*  
Workflow On the Web

- Latest release: 4.0; Suite: Workflow Server, Web Server, Designer, Org Chart, Administrator
  - Workflow Object: Tightly integrated with Microsoft Transaction Server
  - Implemented using COM: any COM-compliant app can be workflow-enabled by embedding Ultimus Workflow Object into app
  - Targetted at administrative workflows, web enabled
  - Distributed spreadsheet for use in a workflow process
  - Spreadsheet (= Microsoft Excel) allows specification of pieces of data collected by process and relationships between them
  - Main spreadsheet split into local spreadsheets for activities
  - Data in main linked to data in locals
  - Data transfers occur when activities start/end
  - Spreadsheet data can be used for flow control
  - Each activity has a form associated with it
  - Form specifies tasks that must be performed at an activity
  - Popular desktop products (Word, Notes, ODBC DBMSs) usable as part of workflow via Flobots
  - Built-in organization chart capability
  - Periodic triggering of processes possible
- <http://www.ultimus1.com/index.htm>

## ViewStar System (ViewStar)

- Founded in 1986; Latest release: 4.2 (10/95); Merges with DSI in 1996 to form Mosaix.
  - >300 installations, ~ 30,000 seats
  - Includes document management support
  - Multi-site workflows supported using MS mail, Exchange, ...
  - Repository: Oracle, Sybase, SQL Server
  - **Process Architect**: Business process modeling/ building tool
  - **Application Designer**: Tool for "snapping together" elements of an app in point-and-click fashion
  - **Business Process Interface (BPI)**: Rich, component object interface to ViewStar system - APIs and OLE 2.0 controls
  - **Process@Work**: Workflow management via the web
  - Customers: Airtours plc, Frito Lay, Halifax Housing Society, Texaco, Texas Commerce Bank, Zurich-American Insurance
- <http://www.mosaix.com>

## Keyflow (Keyfile)

- Started in 1989, privately held
  - >3,000 systems, >50,000 users, 50 countries; Latest release: 2.0
  - Keyflow integrated with MS Exchange and Outlook Forms
    - Exchange user directory
    - Exchange mail for transport
    - Exchange database for storage and replication
    - Exchange public folder for workflow plans, policies, procedures
    - Exchange Inbox for workitems
  - Dynamic modification of process flows
  - Attach OLE and ActiveX objects, files, ...
  - Time of day alerts for building date and time deadlines
  - Release 2.0 introduced APIs and agent technology (monitoring, external events, "push" semantics)
  - Customers: HiLife Inc., Northrop Grumman Marine Systems
- <http://www.keyfile.com/>

## FloWare (BancTec/Plexus)

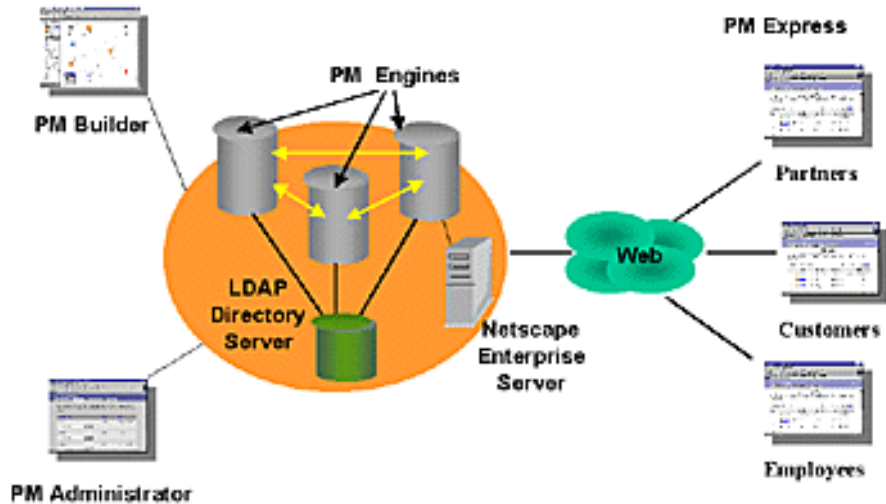
- Released in 1992; Currently, Version 3.1
    - 1st non-imaging product with graphical process definition
  - Production workflow system with > 200 "stand-alone" systems (12K seats)
  - Support for multiple servers in V3
    - Distributed workflow processes
    - Administration from a single location
  - OEM customer: NCR (ProcessIT)
    - ProcessIT's new features to be added to FloWare V4 (e.g., transition conditions)
  - Customers: Sallie Mae, British Telecom, Chemical Bank, Inland Revenue of Singapore
- <http://www.plx.com/>

## Process Manager (Netscape)

- Process definitions, routing logic stored in LDAP directories
  - 4 components: builder, engine, administrator, express tool
  - Inter-organizational exchange of process logic using LDAP's inherent replication facilities in a secure manner
  - Workflow routing extends back and forth through firewalls
  - Engines run on Netscape Enterprise Server and Netscape Directory Server
  - Express lets users participate in, start, or search for processes through any browser interface
  - Administrator allows auditing and monitoring of processes
  - Leverages digital certificates and SSL protocol for extranet security, and supports SMTP messaging systems so users can send process notifications via email
- <http://home.netscape.com/processmanager/>

## Process Manager

### Netscape Process Manager



## Oracle Workflow

### 5 Components

- **Workflow Builder:** Activities can be functions/notifications - Functions call PL/SQL stored procedures to perform automated activities or to retrieve info from the app; notifications deliver messages to users electronically
- **Workflow Engine:** Consists of a set of tables and PL/SQL procedures responsible for managing process executions
- **Electronic Notification System:** Users can receive notifications in e-mail, via web in Web Notification Viewer, or in 10SC Oracle Apps
- **Workflow Monitor:** Web-based graphical monitoring tool
- **Workflow Definitions Loader:** Moves definitions between DBs and files

<http://www.oramag.com/oracle/98-May/app.html>

## SAP Business Workflow (SAP)

- Inherent part of R/3 design; participates in all levels of R/3 processing
  - Workflow manager in Business Middleware layer
  - Integrated Inbox for mail, fax, work items, notifications
  - Process definition and runtime data stored in R/3 DB
  - Workflow process graph notations same as those of R/3 Business Navigator
  - Event generation/wait supported
  - Many SAP apps support workflow mgmt with BW as standard; these apps' workflows supplied as templates
  - Business Object Repository keeps type definitions of R/3 objects - workflow activities can invoke methods of such objects
- [http://www.sap.com/mall/newstand/litera/bw\\_e.htm](http://www.sap.com/mall/newstand/litera/bw_e.htm)

## SAP Business Workflow

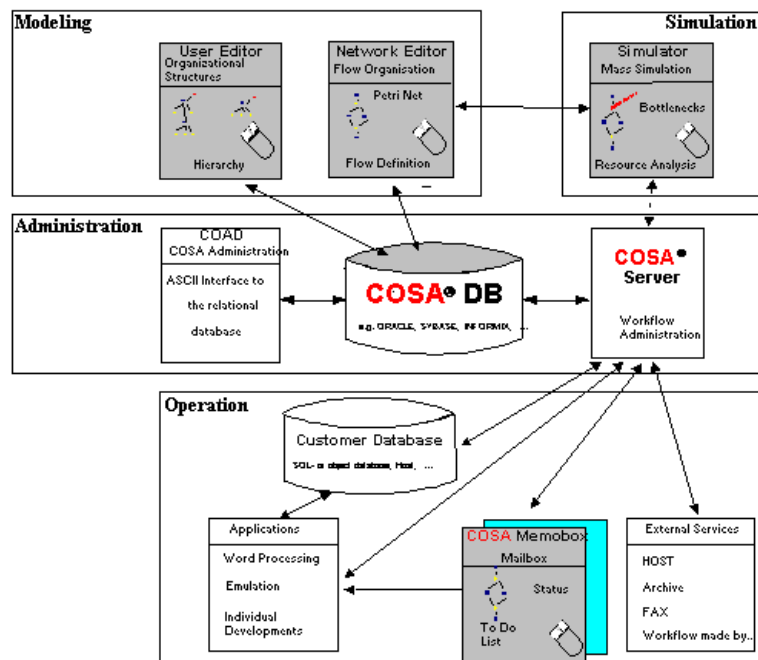
- Business Workflow components
  - Workflow Editor
  - Workflow Manager
  - Workflow Item Manager
  - Event Manager
- Contents of a container
  - Object references
  - Status info
  - Parameters
- Types of containers
  - Workflow
  - Workitem
  - Role parameter
  - Event parameter
  - Method parameter

## COSA Workflow (Software-Ley)

- First release on mainframe in 1986!
- Enhanced Petri net formalism for modelling workflows: Conditions on edges, Subnetworks
- Components: Network Editor, User Editor, Memobox, Server, Simulator
- **COSA SoftLink**: Integrate with Lotus Notes and MS Exchange
- **COSA Intranet**: HTML worklist handler and HTML-based execution
- **COSA FlowModeller**: Simulation and optimization tool
- Customers: Deutsche Post, Ford Motors, Philips

<http://www.cosa.de/>

## Cosa Ley Architecture



Source: Ley



## World Wide Web Workflow (W4)

- French company
- Supports exception paths explicitly when deadlines and alerts occur
- Allows deferring routing until a condition is met or a specific date
- Automatic workload balancing among staff

<http://www.w4.fr/en/>



## Lotus Notes/Domino (Lotus/IBM)



- Provides infrastructure for workflow management: no built-in higher level graphical process definition capability
- Products like Action Workflow, GroupFlow, ONEStone provide missing functionality
- Combines forms, document management, messaging, replication
- R4: agents, LotusScript (Visual Basic like + OO concepts)
- OLE enabled
- Routing embedded in forms via macros or scripts
- Address book allows very basic organization modelling
- Transactional logging support in R5 - Almaden project
- Lotus buys Germany's ONEStone
- Customers: Chase Manhattan Bank, Fireman's Fund, Shell Chemical

→ <http://www.lotus.com/>

# Lotus Domino/Notes: Going Forward

## ► Transactions and high scalability in R5

Major Advances in Web Development

SMTP, IMAP, MAPI, POP, LDAP

HTTP

NNTP

IIOP

NRPC

Best of Breed Internet Messaging

OBJECT SERVICES API (OLE, Java, LS, C++, C)

ROUTING WORKFLOW

VIEW INDEXING

FULL TEXT INDEXING

REPLICATION

ENCRYPTION  
DIGITAL  
SIGNATURES

ACCESS CONTROL

DIRECTORY

DOCUMENT CONTAINER

CALENDAR-  
ING

SCRIPT  
ENGINES

OBJECT SERVICES

OBJECT STORE



## ► 34 million seats

Continued Innovation in Collaboration and Knowledge Mgmt

Increased Openness, Ease of Administration and Usability

# GroupFlow (Pavone/NotesWare)



- Graphical process definition capability on Lotus Notes
- Notes databases used to store
  - GroupFlow Repository (workflow structures, task definitions, staff assignments, forms, processing structures, routing specs)
  - Organization data (personal profiles, team organization, role assignments)
  - Application data
- Architecture covers spectrum between unstructured ad-hoc workflows and highly structured workflows
- Special support for rerouting documents or assigning tasks to other people to handle exceptions at runtime
- Result of research project at Univ of Paderborn
- <http://www.pavone.de/>, <http://www.notesware.com/>

## ProZessware (ONEstone Information Technologies)

- WFMS on top of Lotus Notes/Domino
  - ProZessware Designer: Graphical process designer
  - ProZessware Engine: Runtime engine
- <http://www.onestone.de>



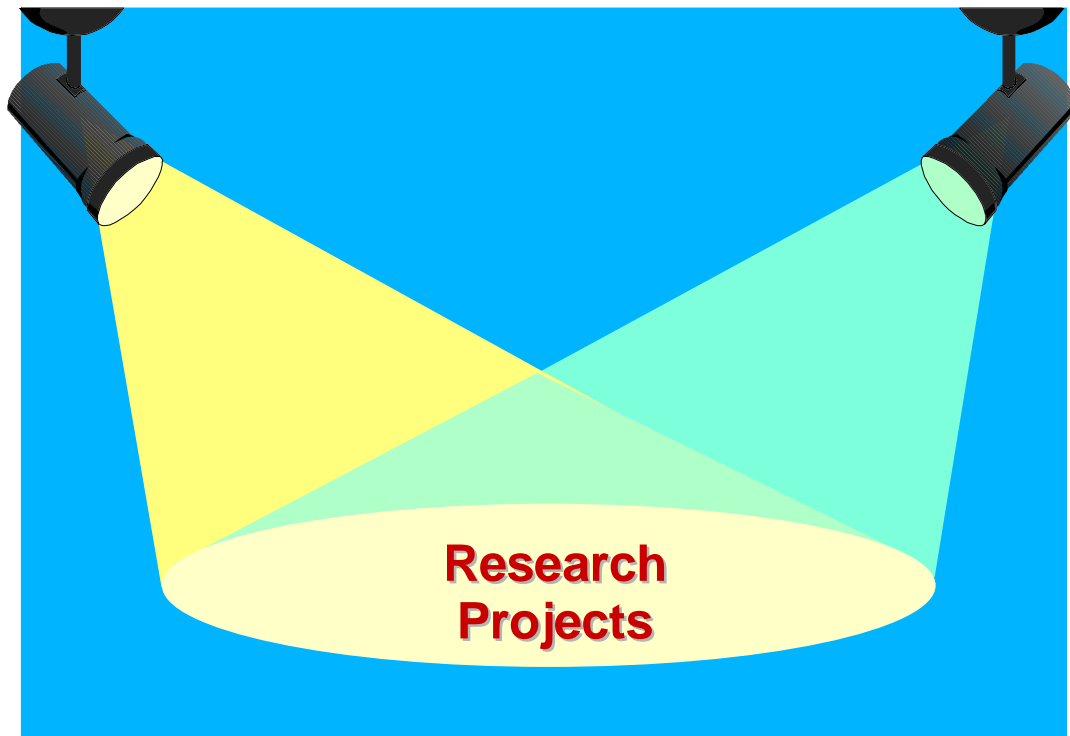
## GroupWise Workflow (Novell)

- GroupWise V5.0
    - Suite of integrated document management features
    - Message-based workflow technology (optional feature)
  - Workflow works with NDS (Network Directory Service)
  - Core workflow engine: FileNet Ensemble
- <http://www.novell.com/groupwise/encyclopedia/>

## Meta WorkFlow Modeler

- Bridges available to generate inputs to following WFMSs
  - Automated Work Distributor from DST Systems
  - Panagon Visual WorkFlow from FileNet
  - FloWare from Plexus
- WorkFlow Modeler models can be transformed into dynamic models and workflow output with Meta's WorkFlow Analyzer toolset
- WorkFlow Modeler models can be saved in Meta's Business Model Repository that centrally stores versions of all models and maintains detailed revision history
- Activity-Based Costing allows association of cost info with a model and addition of this cost info directly to the model
- Supports IDEF0 for process modeling, IDEF1X for data

<http://www.metasoftware.com/prodwfm.html>



## Ongoing Research Projects

### Interorganizational Workflows

- CrossFlow (IBM Zurich, GMD IPSI, Univ of Twente, KPN Research, ...) <http://www.crossflow.org/>
- MARIFlow (METU, ETH Zurich, Hebrew Univ) <http://www.srdc.metu.edu.tr/mariflow/>
- ACEFlow (University of Zurich, EPFL, ...) <http://www.ifi.unizh.ch/dbtg/Projects/ACEFLOW/>
- WISE (ETH Zurich, IvyTeam, onlineSOLUTIONS) <http://www.inf.ethz.ch/departement/IS/iks/research/wise.html>

### Scientific Workflows and Dynamic Schema Changes

- WASA<sub>2</sub> (Univ of Muenster) <http://wwwmath.uni-muenster.de/dbis/Weske/common/wasa.html>
- ADEPT (Univ of Ulm) [http://www.informatik.uni-ulm.de/dbis/f&l/forschung/workflow/ftext-adept\\_e.html](http://www.informatik.uni-ulm.de/dbis/f&l/forschung/workflow/ftext-adept_e.html)
- HematoWork (Univ of Leipzig) <http://www.informatik.uni-leipzig.de/ifi/abteilungen/db/Research/hemato.html>

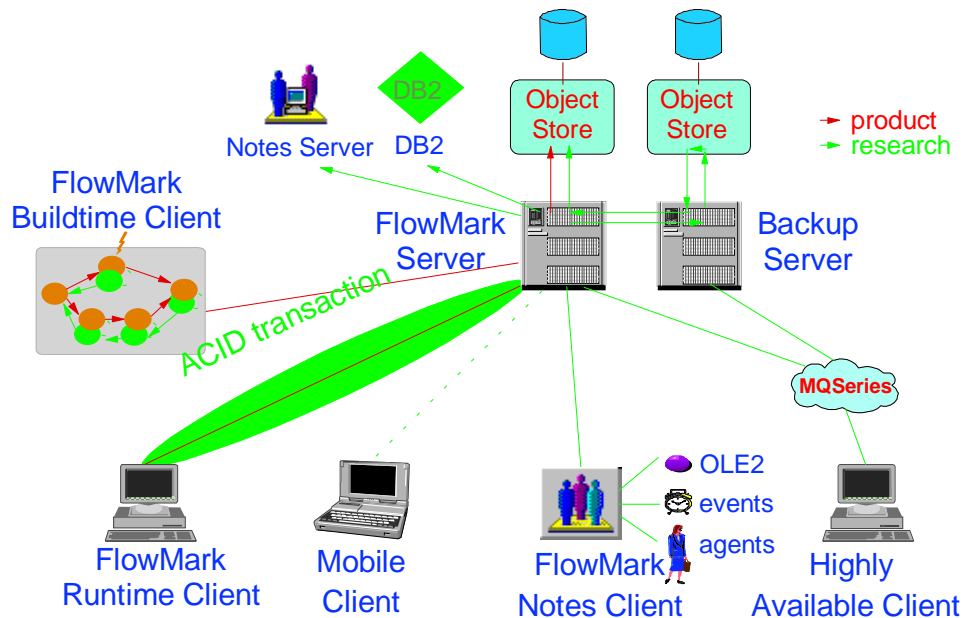
### CORBA-based Architectures

- METEOR2 (Univ of Georgia) <http://lstdis.cs.uga.edu/workflow/>

## Past Research Projects

- Exotica (IBM Almaden Research Center): IBM's FlowMark <http://www.almaden.ibm.com/cs/exotica>
- Panta Rhei (Univ of Klagenfurt): Compaq's AltaVista Links <http://www.ifi.uni-klu.ac.at/~herb/workflow.html>
- OpenPM (Hewlett-Packard Labs): HP's Changengine <http://www.hp.com/pressrel/sep98/24sep98.htm>
- MENTOR (Univ of Saarland and UBILAB) [http://paris.cs.uni-sb.de/public\\_html/projekte/projects.html/#mentor](http://paris.cs.uni-sb.de/public_html/projekte/projects.html/#mentor)
- LabBase/LabFlow (Whitehead/MIT & Univ of Toronto) <ftp://genome.wi.mit.edu/pub/papers/>
- METUFlow (Middle East Technical Univ, Ankara) <http://www.srdc.metu.edu.tr/metuflow/>
- WIDE (Sema Group, Politecnico of Milan, Univ of Twente, ...) <http://www.sema.es/projects/WIDE/>
- MOBILE (Univ of Erlangen) <http://www6.informatik.uni-erlangen.de:1200/Research/wfm.html>
- Contracts/APRICOT (Univ of Stuttgart) <http://www.informatik.uni-stuttgart.de/ipvr/as/projekte/apricots/apricots.html>

# Exotica Project Overview



## Exotica Research Summary

### Past Research

- Availability and scalability through replication
- Advanced transactions
  - compensation
  - failure window scenarios and possible solutions
- Mobile computing: prototyped disconnected support
- Distributed workflow using MQSeries
- Several papers published

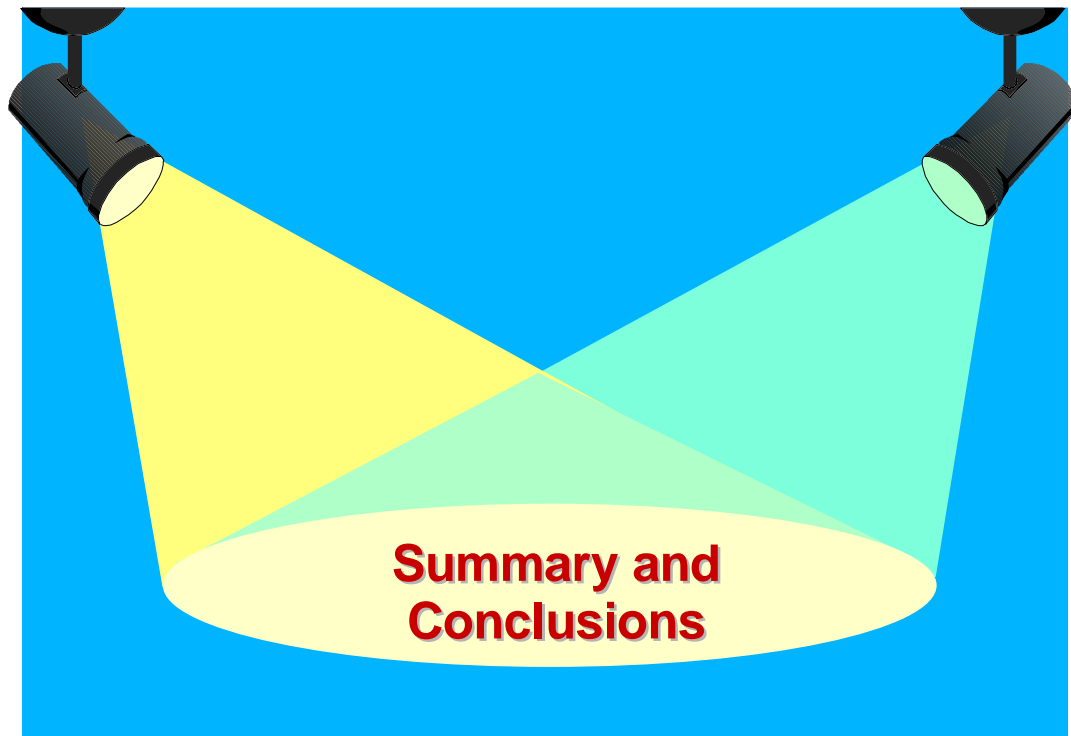
### Future Research?

- Enhanced mobile support
- Alternate stores: DB2, Notes
- Object-oriented workflow
- Agent-based workflow with events
- Integration of production (FlowMark) and ad hoc (Notes) workflow
- Desktop integration: OLE2, Visual Basic, LotusScript

→ <http://www.almaden.ibm.com/cs/exotica/>

## Opera/WISE (ETH Zurich)

- **Opera:** Process support kernel prototype
  - Extensible architecture
  - Exception handling as in programming languages
  - Advanced transaction concepts
  - High availability features (Exotica project ideas)
- **WISE:** Extension for interorganizational workflows
  - Prototype links SAP R/3 and FlowMark workflows



## Advanced Features and Open Issues

- Modelling of external events (SAP)
- Exception handling: schema changes to running processes (InConcert, GroupFlow, TeamWARE Flow, Visual WorkFlo)
- Enterprise-wide workflow (OmniDesk)
- Process schema inference by system (TeamWARE Flow)
- Transactional workflows (compensation, ...)
- Web support with Java exploitation (electronic commerce) - Wide Area Workflow
- OO workflows (Visual WorkFlo)
- Interoperability of different vendor products
- Mining techniques for audit data
- "What if" modelling and analysis capability
- Mobile/remote computing (Plexus)
- Fault tolerance (e.g., automatic switch over on server failure - OmniDesk)

## Advanced Features and Open Issues

- Users' requirements (BIS end-user survey 8/95)
  - ease of use
  - software reliability
  - exception handling
  - interoperability
- Integration of telephony systems
- Workflow benchmarks (e.g., Doculabs)



## Product Evaluations and Benchmarks

- Doculabs benchmark with focus on customer relationship management (CRM) app, 2/99
  - FileNET: Panagon Visual Workflow 3.0
  - Fujitsu: iFlow 3.01
  - JetForm: InTempo 4.0 (Beta)
  - IBM: MQSeries Workflow 3.1
  - Keyfile: Keyflow 3.1
  - Mosaix: ViewStar 5.0
  - Oracle: Oracle Workflow 2.0
  - Plexus: FloWare 5.0
  - SNS: OPEN IMAGE 2.2.6
  - Staffware: Staffware 97 & Staffware 2000 (Beta)
- 4 apps that involve production, administrative and collaborative workflow: new order processing, call center, customer complaint handling, new product development

[www.doculabs.com/articles/our\\_latest/WF99\\_Inform.html](http://www.doculabs.com/articles/our_latest/WF99_Inform.html)

## Summary

- Workflow market is becoming **hot again!**
- Many products with advanced features emerging from mergers and/or partnerships
- Convergence of workflow, imaging, document management, ...
- Research work is going beyond narrow areas
- Standards are playing a significant role



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- "Work Flow Without Fear", K. Trammell, Byte, April 1996.
- "Drive the Revenue with Workflow", B. Chambers, R. Medina, K. West, Imaging Magazine, February 1999.  
Available at [www.doculabs.com/articles/Our\\_latest/WF99\\_Imaging.html](http://www.doculabs.com/articles/Our_latest/WF99_Imaging.html)
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Available at [www.doculabs.com/articles/Our\\_latest/WF99\\_Inform.html](http://www.doculabs.com/articles/Our_latest/WF99_Inform.html)

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- "Usability of Some Workflow Products in an Inter-organizational Setting", J. Juopperi, A. Lehtola, O. Pihlajamaa, A. Sladek, J. Veijalainen, Proc. IFIP Working Conference on Information Systems Development for Decentralized Organizations, Trondheim, August 1995.
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- "An Overview of Workflow Management: From Process Modeling to Workflow Automation Infrastructure", D. Georgakopoulos, M. Hornick, A. Sheth, Distributed and Parallel Databases, Vol. 3, No. 2, April 1995.
- "Tutorial: Advanced Transaction Models - Survey and Critique", C. Mohan, Presented at ACM SIGMOD International Conference on Management of Data, Minneapolis, May 1994. Available as [http://www.almaden.ibm.com/cs/exotica/tran\\_models\\_tutorial\\_sigmod94.ps](http://www.almaden.ibm.com/cs/exotica/tran_models_tutorial_sigmod94.ps)

## Web Information Sources

- Workflow Management Coalition (WfMC)  
<http://www.aiim.org/wfmc/>
- Workflow and Reengineering International Association (WARIA)  
<http://www.waria.com/waria/>
- Workflow on the Web (Concordium Software)  
<http://www.concordium.co.uk/>
- Workflow and BPA/BPR Links (VTT)  
<http://www.vtt.fi/tte/staff/ojp/workflow.html>
- KMWorld Magazine  
<http://www.kmworld.com/>
- Techinfocenter  
<http://www.techinfocenter.com/>
- Workshop on Cross-Organizational Workflow Management and Coordination  
<http://www.zurich.ibm.com/%7Ehlu/WACCworkshop/>

