FUJITSU

i-Flow™ Architecture White Paper

FUJITSU SOFTWARE CORPORATION

"i-Flow's server-side Java and pre-built Adapters are well-suited to support customer-facing processes for e-business. Workflow is going to be a core element of e-business, and i-Flow points the way to workflow architectures of the future. The Adapters that ship with i-Flow provide access to third-party components commonly used in workflow applications, such as LDAP compliant directory services, JavaScript, Microsoft SQL Server, and Oracle"

- Connie Moore, Vice President, Giga Information Group

"i-Flow is the first of a new generation of workflow products starting to emerge which are built from scratch for the Internet architecture. The key advantages that result from 100 percent Web-centricity are ease of management, deployment, participation and integration. A key area for process development is customer service and support. We think this is excellent positioning."

- Ronni T. Marshak, Patricia Seybold Group

"Fujitsu's i-Flow product offers a process automation framework that is built from the ground upon open standards and a fully server-deployed, multi-tiered architecture. Without the baggage seen with older approaches, i-Flow is well positioned to address the burgeoning new market for horizontal process automation solutions and the workflow-enablement of enterprise applications."

- Nathanial Palmer, Sr. Analyst, Delphi Group

"Architecturally, i-Flow is the most important and most flexible of any (workflow) that we have seen to date. A key strength is in the broad integration capabilities, which are the most comprehensive of any we have analyzed."

- Derek Miers, Principal Analyst, Enix Consulting, Ltd.

"Doculabs recently evaluated Fujitsu's i-Flow, and we were impressed with its Adaptor approach and its Web client implementation. i-Flow's object-oriented, JavaBeans-based approach will be valuable to large end-users, integrators, and OEMs alike.
Using the Adaptor objects, developers can quickly develop workflow applications and integrate them with other tech-nologies… significantly decreasing the cost of deployment. An SDK lets developers also write their own adaptors to tie in with almost any kind of business system. In addition, the use of JavaBeans means that the system has a thin-client architecture that can be deployed over the Internet or corporate intranets."

- Richard Medina, Senior Analyst, Doculabs

i-Flow Architecture White Paper

INTRODUCTION

Research indicates that the use of workflow technology can lead to remarkable cost savings, increased efficiency and productivity – in other words, big ROI. Workflow technology has evolved into business process management software with rich integration features and support for both human and application-to-application processes. Enterprises and software developers have come to understand that BPM can be applied to increasingly complex problems. Automating business processes end to end, integrating applications to process steps, and opening up processes for collaboration with partners, customers, and suppliers represent just the beginning of what can be expected in the future from BPM software.

Fujitsu's i-Flow is a customizable Business Process Management engine for web-centric applications. It is part of Fujitsu's INTERSTAGE e-Business platform and is also available as a standalone Java server. i-Flow has been tested on the leading J2EE application servers, allowing you a choice of e-business platforms.

i-Flow incorporates all of the components necessary for adding the process layer to business applications. Coding business logic into application logic is not a viable option given the pace of change in today's business applications. Developers should extract business logic from application logic and manage it in a separate process layer. This approach enables companies to respond to change requests immediately. More importantly, managers can now implement changes without technical assistance using graphical modeling tools. i-Flow provides an easy-to-use graphical user interface for controlling the process layer of your applications. Managers no longer need to wait in line for scarce IT resources to implement a simple change request.

i-Flow is designed to be embedded easily into other applications and products. It is ideal for supporting large scale enterprise deployments, Independent Software Vendors (ISVs) and System Integrators who need comprehensive business process management functionality for their applications.

Today's new business environment requires BPM technology that can be integrated seamlessly into e-business applications and molded easily to fit into changing architectures. i-Flow architecture is flexible, leaving the door open for future technologies and standards. It fits naturally into the dynamic and evolving business environment.

i-Flow makes embedding BPM features to applications simple. All of i-Flow's functionality from task management to graphical process design, can be easily embedded into other applications. In addition, i-Flow's features are easily customizable through a rich set of APIs.

Independent Software Vendors and solution providers have realized that embedding business process automation engines adds more than just bells and whistles to their product offerings. Increasingly, ISVs and solution providers rely on an embedded process management engine to stitch together the different elements and functions of their

applications. These developers have learned that homegrown, "quick and dirty" process management engines are dead-ends. They recognize the need for a flexible, full-featured solution, from a vendor whose core competence is process management.

According to Doculabs Analyst Richard J. Medina, "… developers can quickly develop workflow applications and integrate them with other technologies, decreasing the cost of deployment and taking advantage of existing investments." Ronni Marshak of The Seybold Group said "The key advantages that result from i-Flow's 100 percent Web-centricity are ease of management, deployment, participation and integration".

Industry Analyst Derek Miers from Enix Consulting put it more strongly, "i-Flow represents the third complete generation of workflow technology from Fujitsu Software Corporation and its sophistication reflects that. Designed to be embedded in application systems that leverage Web-based technology, Fujitsu Software Corporation has delivered a broad set of application functionality and tools that considerably speed up development processes and lower the cost of ownership. Rather than leaving it up to the developer to create applications on top of the core engine, out-of-the-box they provide fully functional and customizable components, handling all interactions with the engine and other infrastructure elements."

The i-Flow Enterprise Edition architecture is composed of several key building blocks:

- Server: A J2EE -based multi-threaded BPM engine that is optimized for performance.

- Reference Clients: A broad selection of out-of-the-box, browser-based clients are provided to give developers a head start. This includes interfaces for intuitive drag and drop visual process design, task management (including email notification), and process and user administration. You can easily customize the reference clients using i-Flow's rich set of APIs. You can easily create new applications or add BPM features to existing traditional or Web-based business applications.

Custom user interface developed using i-Flow APIs
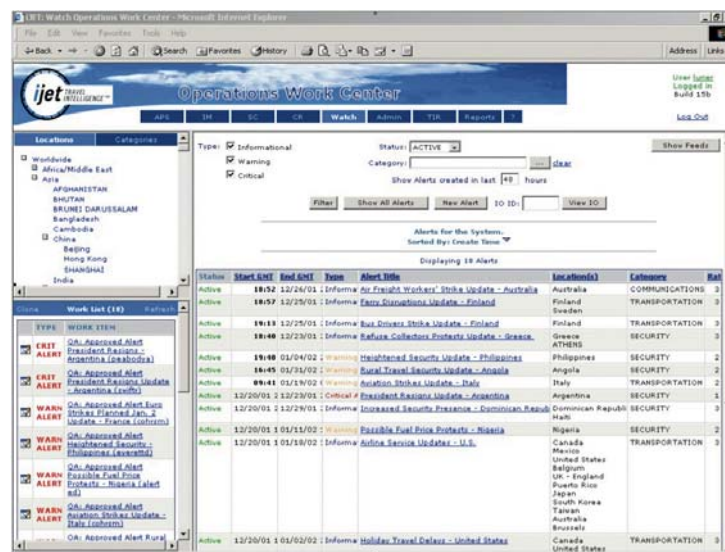
- Integration Adapters: The i-Flow BPM engine utilizes a set of Integration Adapters that connect it to third-party document management systems, directory services, databases and other applications. This approach allows developers to insulate their applications from their current and future IT infrastructures and build 'future-proof' applications.
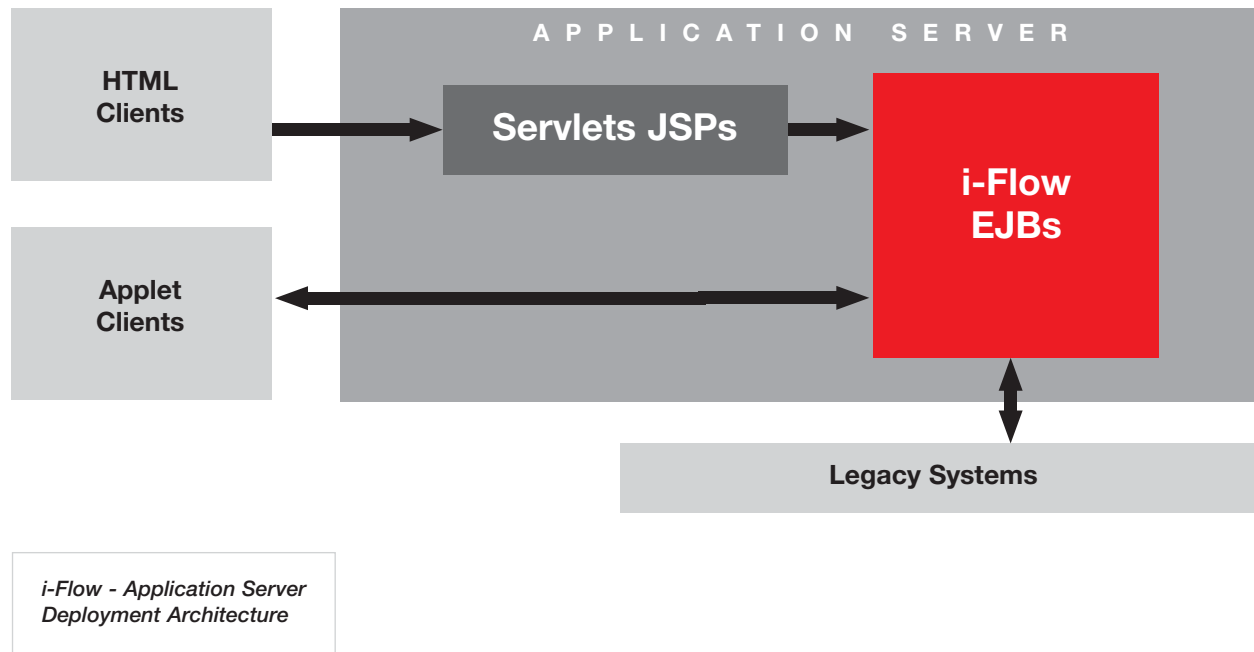
SERVER ARCHITECTURE

The i-Flow Enterprise Edition Server is a J2EE technology-based multi-threaded server that leverages the best features of Java. i-Flow's Web-centric design is based on distributed components, ensuring the ultimate in platform independence.
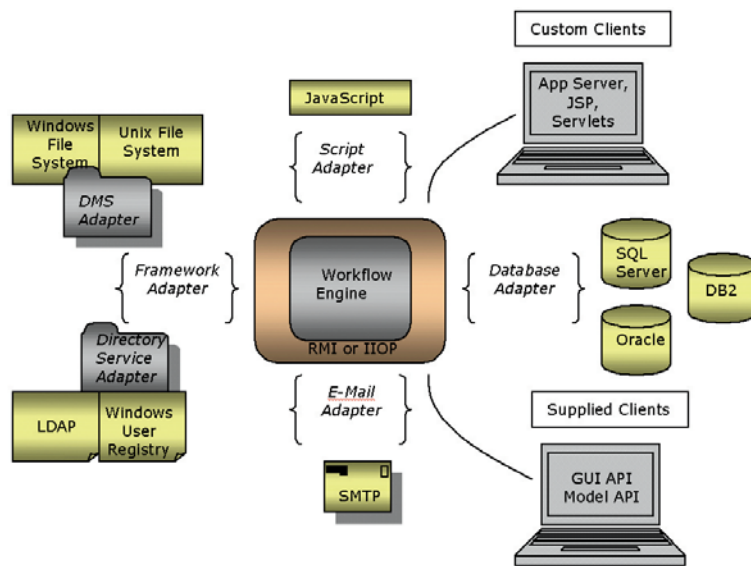
i-Flow - Standalone deployment architecture

i-Flow's component-based architecture provides a variety of integration methods for document management systems, directory services and third-party applications using CORBA/IIOP or RMI.

*i-Flow - Application Server
Deployment Architecture*

i-Flow's distributed server architecture utilizes industry standard RMI over IIOP protocol for object interaction while hiding the complexity of the underlying environment from external applications. All components in the environment interoperate via a rigorous set of Java interfaces.

i-Flow was designed from the ground up for high performance. Internally, all elements of the multi-threaded BPM engine have been optimized. Each integration adapter can reside on the same node or be transparently distributed across many nodes. This architecture can grow incrementally from a small compact system to a large system that can handle tens of thousands of processes per hour.

Role resolution—assigning tasks to appropriate users—is supported through the use of LDAP Directory Server on NT and UNIX or Windows 2000/NT User Manager. Users who already have one of these directory server solutions in place can use them and do not have to maintain duplicate directory servers for their applications. This approach leverages the capabilities of existing infrastructure investments.

With the directory services, database, e-mail client and script adapters in i-Flow, developers can build applications that stretch across the extended enterprise (including customers, partners and suppliers). For example, a task can be assigned to a customer or supplier and an email generated to them with the appropriate URL link included for the work item. i-Flow based applications streamline business processes across the enterprise and beyond.

CLIENT ARCHITECTURE

All client functionality is delivered through a Web browser. Out-of-the-box, there are several fully functional clients delivering a wide range of features. These Java-based clients are constructed from robust and reusable components that can be used "as is" or extended and enhanced to meet the specific requirements of custom applications (source code is provided).

The out-of-the-box clients provide a broad range of supporting functionality suitable for most process-oriented applications as follows:

Development Manager – used to design templates (sometimes referred to as process models), start processes from those templates, modify processes at run-time, access tasks, and check process status and history.
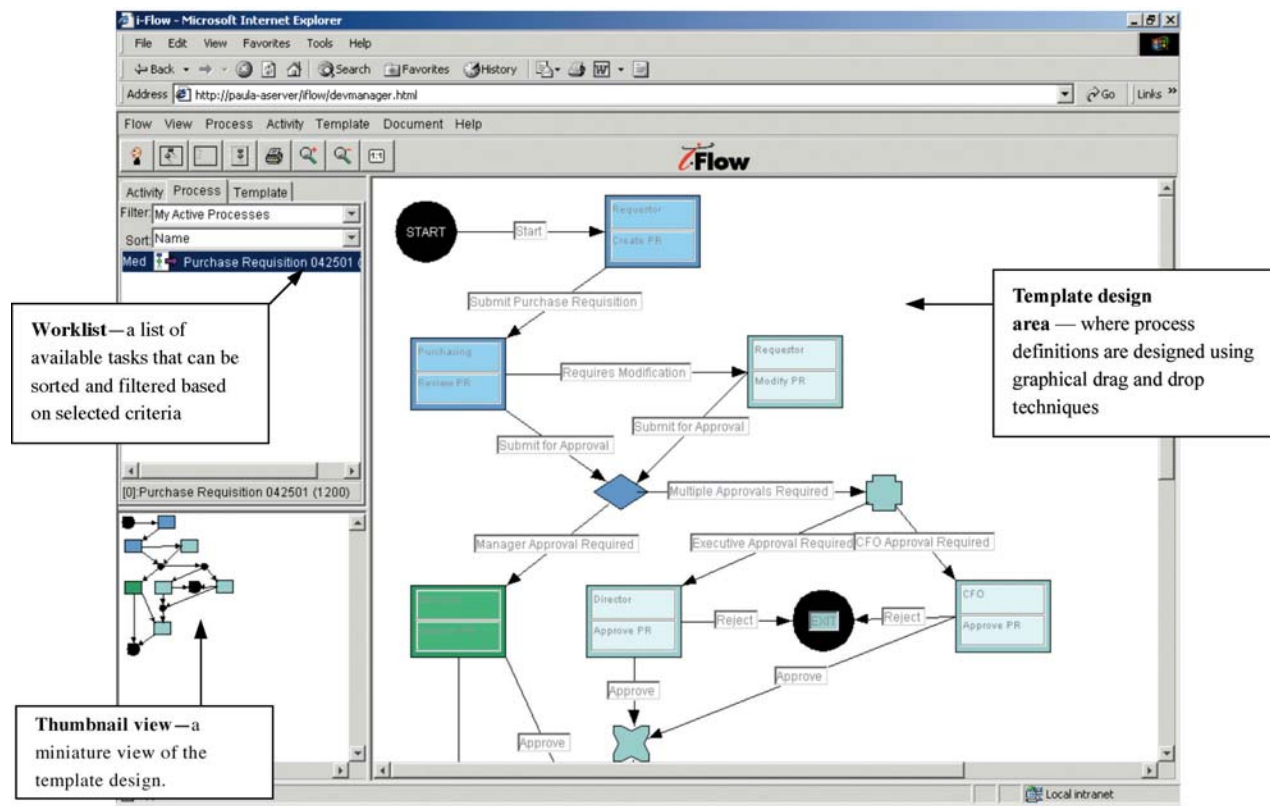
The browser-based Development Manager client provides users with work lists, forms, attachments and real-time process monitoring. This client also contains an intuitive drag and drop visual process design interface that allows developers and power users to define templates and edit processes directly from their Web browsers at design-time or run-time.

Task Manager – displays the user's assigned tasks and the forms and attachments associated with the tasks. Used to access, review and complete tasks.

New Process – used to create new processes from existing templates.

E-mail Work Item – When users receive an e-mail notification about a task, they click on the link in the message body to display the E-mail Work Item Client with the work item loaded automatically. The E-mail Work Item Client is most suitable for infrequent users like managers who are not normally logged in to the Task Manager and would not be aware that a task had been assigned to them.

Administration – used to import, export, archive or delete templates and modify or delete user profiles. Also used to create new versions of existing templates.

Server Dashboard – systems management tool for monitoring adapter and server logs with graphical representations of i-Flow activity levels and key performance indicators.

i-Flow Reports – used to display and print a variety of reports about processes, templates and tasks. The i-Flow Reports source code is provided with the product so that developers can create customized reports.

- **Process Reports** display information about processes based on various parameters including process state, process duration, and the users who initiated the process.

- **Template Reports** display information about the number of templates based on their states and the owners of the templates.

- **Task Reports** display information about the number of tasks based on their states and the users assigned to those tasks.

- **Query Reports** are generated by SQL queries that developers can write and run against the views that are provided of the i-Flow database—TemplateView, ProcessView and TaskView.

In addition, the i-Flow database schema is documented in the i-Flow Developer's Guide enabling users to query any i-Flow data for reporting purposes.

Access to the Model and GUI components that underpin these interfaces is provided (along with the GUI source code), enabling developers to further extend existing clients or create entirely new applications. In the Enterprise Edition, Model components are used to encapsulate the state of the client objects and interactions with the server via EJBs. The purpose of the GUI components is to provide developers i-Flow user interface components such as the work list.

As a direct result of the Web-centric focus of the i-Flow clients, there is no need to upgrade thousands of client systems every time new functionality is added. Users see new features as soon as they are loaded onto the server. This means that users can access processes anytime from any Internet connection anywhere in the world.

BROAD INTEGRATION CAPABILITIES

Adapter Technology

Integration Adapters act as a protective shell that insulate the i-Flow engine and i-Flow applications from changes in the other components in the IT infrastructure.

Software developers will realize the importance of this approach—it insulates the BPM application from the IT infra-structure and other applications, improving the flexibility and adaptability of the software.

Document/Directory Framework Adapter

The Document Management System (DMS) and Directory Services Adapters (DIR) sit within a common document/directory framework adapter (the DD Framework Adapter). The DMS Adapter is used to store documents that will be used as attachments. The DIR Adapter handles role resolution. The common parent (the DD Framework Adapter) authenticates user access permissions and controls access to documents via the DMS Adapter.

DD Framework Adapter				
Document Management	**Directory Services**	**Database Adapter**	**Script Adapter**	**Mail Adapter**
NT/Windows 2000 File System, Unix File System	NT/Windows 2000 User Manager; LDAP	Oracle 8.1.5 - 8.1.7, SQL Server 7.5/2000, DB/2 7.1	JavaScript	SMTP

Out-of-the-box Integration Adapters

Database Adapter

The Database Adapter uses JDBC to access databases. The Script Adapter enables integration with other databas-es and applications through JavaScript. This makes it possible for companies to seamlessly integrate existing IT applications at the server level.

Script Adapter

The Script Adapter interprets JavaScript code that is defined within processes and evaluated under the control of the i-Flow server. JavaScript can be used by i-Flow applications to communicate with databases and other applications to access data not stored in the i-Flow database—to populate fields in an i-Flow form, for example.

JavaScript code is placed in special code fields accessed through the visual process design interface located in the Development Manager. The Script Adapter automatically evaluates JavaScript code when tasks start and finish, when processes start and finish, when forms are opened and closed, when roles are resolved, and when timers expire. Scripts can also modify the actions of nodes (for a description of nodes, see page 12).

When a form is attached to a task, the JavaScript associated with the form is executed when the task is started. This fetches the form data from non-i-Flow databases or other applications, so the form data is available when the form is opened.

i-Flow forms can be populated from the i-Flow database or from external databases by using JavaScript.

JavaScript code embedded in i-Flow can access i-Flow's APIs as well as JDBC, servlets, JavaBeans, Enterprise JavaBeans (EJBs), Java Server Pages (JSP) and the Java Messaging Service (JMS).

i-Flow has pre-defined JavaScript set and get methods for roles and processes. Developers can also write their own JavaScript extensions to add custom functionality as needed. To speed up this tedious and error-prone task, i-Flow provides a script generator that creates JavaScript wrappers for Java methods being invoked from templates.

Customizing Adapters

Once a component is integrated through an Adapter it interoperates seamlessly with the i-Flow server. Developing new DMS or DIR Adapters is a well-documented procedure. The source code for all existing DMS and DIR Adapters is shipped with the product and serves as an example for developers to follow. The tight integration of a simple DMS typically takes about one week of a developer's time.

Application Server Integration

i-Flow can run on the leading application servers or as a stand-alone server allowing you to choose the e-business platform you want. The Enterprise Edition i-Flow server provides an EJB interface, which exposes its objects to applications and client tools. A user may access the server via the i-Flow client or a customized client developed using the Model API provided with i-Flow.

Client- and Server-side Integration

The i-Flow APIs allow developers to embed advanced BPM functionality into their applications. The rich set of APIs allows developers to process-enable their applications without making i-Flow visible to end-users and business users.

The i-Flow APIs are divided into two distinct areas—the Model API and the GUI API. The Model APIs allow developers to directly access all of the underlying i-Flow server functionality. The GUI APIs are used to remove or modify the default i-Flow user interface. The source code for the GUI components is supplied with the product.
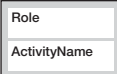
PROCESS SUPPORT

i-Flow is capable of handling even the most difficult process problems. It easily supports sequential, parallel and conditional tasks, using the directory services environment to determine the user to whom work should be routed at run-time. i-Flow provides designers with the capability to chain processes together at run-time, spawning new processes as required. i-Flow incorporates advanced support for sub-processes which allows dynamic binding at run-time. Developers are able to build sophisticated dependencies between nodes and parallel threads of activity.

Templates (also known as process models) can be constructed using the browser-based Development Manager shown in the following illustration:
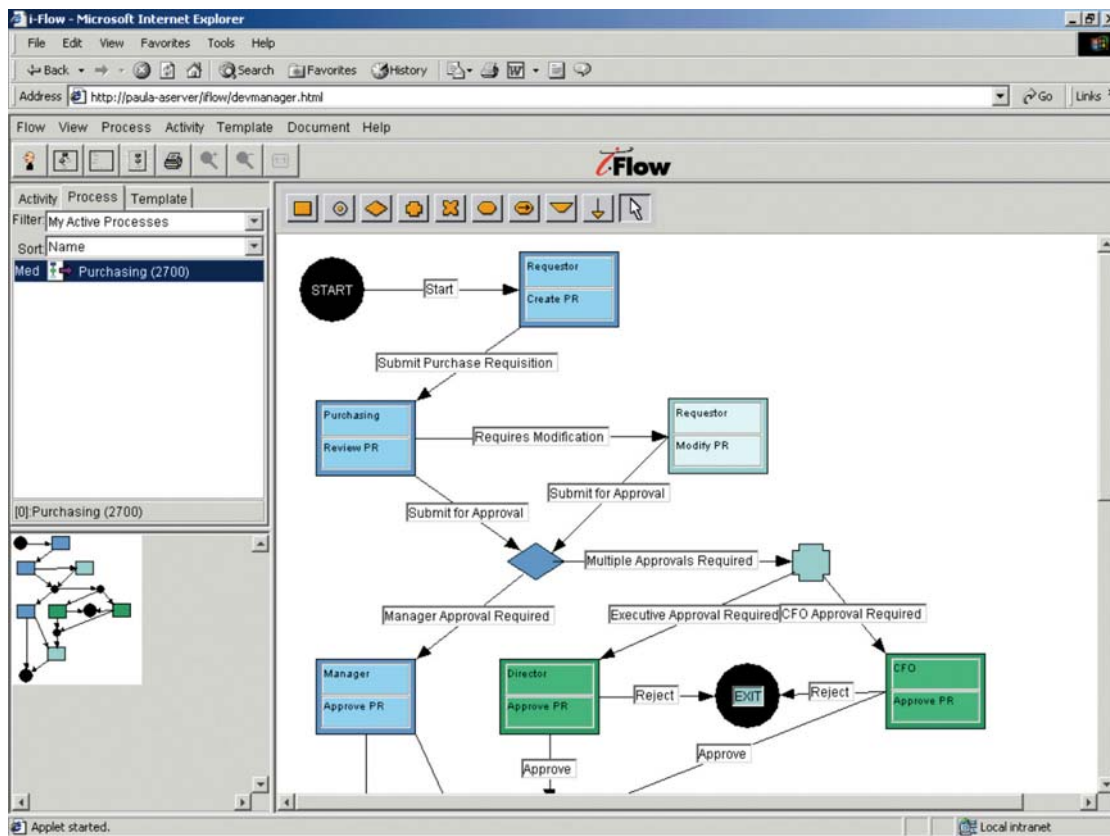
The browser-based Development Manager. The three 'panes' are reusable and extensible by developers.

Nodes are the building blocks for constructing templates. i-Flow provides the following node types:

- Start Nodes - Used to start a process.

  START

- Activities - Represent process tasks. They also specify any electronic forms associated with the task and the personnel assigned to carry out the task.

Role
ActivityName

- Condition Nodes - An automated decision point where the BPM engine evaluates the specified condition and chooses the appropriate path.

- Split/Join Nodes – The Or and And nodes are typically used to split and synchronize the process flow. When an Or node is reached, the node generates events on all of its outgoing arrows, splitting the process into parallel paths. When these parallel paths reach the And node, the process will not continue until all of the required events (incoming arrows) have completed successfully.

  AND

  OR

- Sub-Processes – Similar to subroutines, sub-processes allow the hierarchical decomposition and construction of nested processes, dramatically simplifying the construction of templates. Sub-process nodes enable users to specify which data items should be passed to the sub-process and what data the sub-process is expected to return to its parent process. Sub-processes are ideal for storing business logic that is frequently reused across the business processes.

- Chained Processes - Allows a process to spawn new independent process instances at runtime, after which the calling process continues its execution.

- Delays - Used to suspend a process for a specified amount of time (can be set dynamically at run-time).

- Exit Nodes - Closes the process and executes any scripts that are needed to clean up data sources or archive information and documents.

  EXIT

Authorized personnel can use i-Flow to add new sub-processes on the fly as required at run-time, binding the new sub-processes to the parent process. The template that underpins a process instance can also be modified at run-time. These modifications, known as process edits, can be saved as a new template for future use.

Template versioning is provided for easier management of templates. Users can generate new template versions and enter notes about each version. Administrators decide when a template is ready to be published to the production environment, and also determine when it is time to remove a published template and make it obsolete.

Role Resolution

Activity Nodes are assigned to roles (such as "Manager" or "Accountant"), using existing directory services. Role Scripts, which create custom context-sensitive role assignments, give developers the ability to further refine the group of people assigned to specific activities. Evaluation of the script can cause one or more users to be assigned to the activity. If no member of the Role satisfies the requirements of the script, the assignee for the activity defaults to the process owner. A set of JavaScript commands to support the implementation of context-sensitive role resolution is provided.

History

i-Flow maintains a history of every event that occurs during the running of a process. A number of attributes are recorded for each event—type, source, target, timestamp, and the user responsible for the event are examples of attributes.

When a node is activated, at least three events are triggered: the activation of the incoming arrow, the activation of the node, and the action of the node and/or user input. An additional event is generated if the node subsequently activates an outgoing arrow. All of these events are recorded in the i-Flow process history (also known as audit data). Users can view this process history in the Development Manager client.

SECURITY

Ownership of Templates and Processes

In i-Flow, the owner of a template is the person who created it. During template design, process ownership can be directly assigned to members of a Role or programmatically assigned through the use of a Role Script. The Role typically narrows the set of users that is evaluated by the Role Script.

The template owner becomes the process owner by default if the assigned user is not found. This avoids deadlocks that would otherwise occur if the user had left the company and was no longer listed in the directory server.

Only someone with administrator rights can change the state of a template—from Draft to Published and from Published to Obsolete. Also, only an administrator can create a new version of a template and publish the new version. Publishing the new version automatically changes the state of the older version from Published to Obsolete.

Access to Documents

Most BPM systems use the process routing and role resolution specified in the process description as the mechanism for imposing secure access to the documents associated with the process.

i-Flow provides a more sophisticated alternative to this model, however. Access to documents is managed via the DD Framework Adapter. Each request to access a document is validated against the access permissions of the user as defined in the directory server, independent of the routing definition.

Access to Tasks

When a process is started, the users specified in the Role and/or Role Script are notified of the task in one of two ways. The most common way is for the task to appear in the user's worklist. The other way is for the user to be notified by an email notification.

Simultaneous access to the same task by multiple users is prevented by the Accept/Decline/Reassign feature. When a user accepts a task, the task becomes active in the user's worklist and the task is removed from the worklists of the other users. If all of the users decline the task, the task is assigned to the process owner by default.

CONCLUSION

i-Flow's architecture provides a superior BPM platform, enabling developers to easily create and deploy high performance business process automation applications. i-Flow is easily embedded into existing applications and systems. i-Flow-delivers a broad range of out-of-the-box functionality along with a set of Integration Adapters that enables organizations to leverage their existing IT infrastructure investments. The core elements of the i-Flow architecture are:

- The ability to run on the leading application servers or as a stand-alone server allowing you to choose the e-business platform you want.

- i-Flow's web centric design that provides strong support both for human interaction and application integration while enabling process change anywhere, anytime

- A high performance, J2EE-based BPM engine that is capable of handling tens of thousands of processes per hour.

- A Java client environment that delivers all functionality via industry standard Web browsers. Out-of-the-box clients include: a Development Manager with a drag and drop visual process design interface, run-time process editing, and process history; an E-mail client that notifies users of arriving tasks; a Task Manager Client that allows users to complete work tasks; an Administration Client for managing templates, processes and user profiles; and i-Flow Reports. The Enterprise Edition of the i-Flow Server provides an EJB interface, that exposes its objects to applications and client tools. A user may access the server via the supplied i-Flow clients or customized clients developed using the Model API. The Model API is provided with i-Flow.

- Integration Adapters that insulate the BPM engine and applications from changes in the underlying infrastructure while leveraging IT investments. This includes a standards-based integration framework to access document management systems and directory services. Integration Adapters are supplied out-of-the-box for common infrastructure components such as Windows NT/2000 and UNIX file systems, Windows 2000/NT User Manager, LDAP Oracle 8.1.5 – 8.1.7, DB/2 7.1, SQL Server 7.5/2000, SMTP and JavaScript.

- A wide range of capabilities for delivering BPM functionality to custom applications. Developers are supplied with Javadocs, API reference materials, Developer's Guide, code samples and boilerplate applications so they can access the full functionality of the environment and enhance many of the advanced features. Source code for modifying the browser-based clients and the Document Management Systems and Directory Services Integration Adapters are also included.

- Java-based application development designed for ease of re-use, lowering the cost of development and ownership.

- All of i-Flow's fully featured BPM functionality that can be embedded in custom applications, including advanced graphical features like template design and worklist views.

- Sophisticated context sensitive role resolution.

This broad array of features makes i-Flow the ideal platform for developing enterprise-wide process management applications as well as embedding BPM functionality into third party applications and systems.