Applying Workflow Technologies to Integrate Utility Business Processes

Scott Neumann, CTO, UISOL
Kamaraj Shankar, Partner, UISOL
Ali Vojdani, President, UISOL

Abstract

The purpose of this paper is to describe how workflow technologies can be applied to the integration of utility business processes. The applications range from simple approval processes for a work order to complex processes such as outage restoration or preventive and corrective maintenance.

Currently, a key trend in systems integration is the use of web services to provide the means to integrate systems and products in an open, uniform manner, where externalized application interfaces are typically defined using web services definition language (WSDL). Additionally, there is also a trend towards the use of 'document-centric' WSDL, where web services are invoked using potentially complex business documents defined using a common model/vocabulary appropriate for the domain, such as the Common Information Model (CIM) for electric utilities, and XML Schema. This style of integration is readily supported by EAI vendors and an ever growing set of application vendors.

However, the use of web services, XML and a common model are not the end, but instead they set the stage for integration of business processes. Once the set of applications that participate in a business process have their external interfaces exposed via web services, the implementation of an integrated business process can simply become an orchestration of web services. The Business Process Execution Language (BPEL) specification is an XML-based specification which defines a business process in terms of the execution and coordination of web services. This orchestration is then performed by a workflow engine, which drives the process and permits monitoring, management and measurement of the process. These trends and standards also provide the opportunity for 'drag and drop' implementation and evolution of business processes using the new generation of workflow tools provided by a wide variety of vendors (e.g., TIBCO, Savvion and SAP). This also permits business processes to be readily evolved, realizing that business processes are subject to change, as opposed to the classic 'static' integration approaches.

This paper will show how business processes can be integrated through the application of emerging standards and workflow tools. The paper will also outline the utility applications for workflow technologies, the state-of-the art in utility applications of workflow, implementation considerations, and reported experiences and benefits.

Introduction

Utilities need to continuously improve their key performance indicators related to costs, reliability, customer service, safety, and regulatory compliance. To that end, they need to streamline and automate the underlying business processes such as new customer connection, metering, customer service, billing, outage restoration, asset maintenance, and power procurement.

To manage business processes efficiently, utilities deploy a number of computer systems including Energy Management System (EMS), Call Centers, Customer Information Systems (CIS), Asset Management, Supervisory Control and Data Acquisition Systems (SCADA), Outage Management Systems (OMS), Mobile Workforce Management Systems, Geographical Information Systems (GIS), Work Management Systems (WMS), Finance and Controlling (FI/CO) system and Load Management Systems (LMS). Each system provides specialized applications according to its particular role in the business process. Typically these systems are not all acquired from the same vendor, they speak incompatible vocabularies, they are not interfaced with one another, and they may be running on different computer platforms. To reduce integration efforts, a utility may deploy an Enterprise Resource Planning (ERP) application that may include capabilities for some of the applications referenced above in an integrated suite, as well as the back-office financial applications.

Efficient management of a business process, however requires automated and seamless flow of information from one system to another, coordinated executions (i.e., proper sequence of execution) of the applications in all systems involved in the process, as well as streamlining the workflow between these applications, employees and external entities. As an example, the outage restoration process involves various manual and computerized tasks to detect outages, log each event, manage customer trouble calls, issue trouble tickets, analyze outage events and trouble tickets, identify remedial actions, schedule repair work, restore service to customers, and report on each event. The outage restoration process can be significantly improved through computer-aided integration of these tasks as it is demonstrated by a number of real-life implementations at leading utilities (see reference 1).

Business Integration is a change management and system implementation methodology to aid the continuous comprehension and management of business processes that interact with people and systems, both within and across organizations. It enables effective collaboration among business process participants including employees, partners, and applications.

Many utilities develop point-to-point interfaces among the various systems, and code customized applications to move towards *Business Integration*. Developing these interfaces and codes are costly. Once developed, they are also difficult to change and expensive to maintain. Application of integration platforms that provide tools for Enterprise Applications Integration (EAI), Business-to-Business Integration (B2B),

Business Process Management (BPM), Workflow automation, Portal Building, and Business Activity Monitoring (BAM) could provide superior results (see reference 2).

An important step in implementing *Business Integration* is development of a common information model that can serve as an enterprise-level logical data model and help reduce the need for point-to-point data translations and mapping among applications. The Common Information Model (CIM) developed by the utility industry through the IEC can be leveraged to develop a utility specific CIM. More information on CIM can be obtained at the CIM User Site (http://cimuser.org). The important point to note is that CIM is an element of *Business Integration* and should be developed in the context of *Business Integration*, and driven by business needs for integration (see reference 3).

Where much progress has been seen with respect to the exchange of information between applications across an enterprise, application of workflow technologies to provide the means to seamlessly integrate business processes across an enterprise is new in the utility industry. This is especially true as enterprises move towards the use of Service-Oriented Architectures (SOA). Ideally, business processes should be viewed as being dynamic and subject to change. This is a paradigm shift from classical integration approaches.

Defining Workflow

Workflow is used to get the right information to the right people at the right time. A workflow connects people, processes and business objects as depicted in Figure 1.

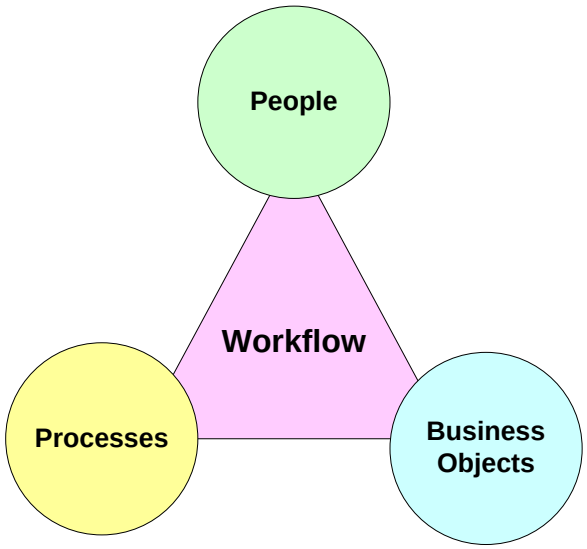


Figure 1: Workflow integrates people, processes and business objects (e.g., business documents) and delivers the right information to the right people at the right time.

There are several key terms and acronyms which are important to the discussion of workflow:

Workflow: A term that describes the automation of business operations, tasks, and transactions that simplify and streamline current business processes. A workflow is a model representing automated sequence of tasks that may be performed by a set of persons and/or systems. This model gets executed for every occurrence of process instance.

Process: A process typically relates to a business activity, and can be realized (i.e. automated) through one or more workflows. One example would be a purchase order approval. A process may identify information flows which are not automated (e.g. verbal communication or paper document flows)

Process Instance: A process instance is a specific occurrence of a workflow. An example would be the approval of purchase order 11543.

Task: A task is an activity or step that must be performed within a workflow. A workflow may have many tasks. An example would be the creation of a purchase order, and another example would be the approval of the purchase order.

Agent: An agent is a person performing a task within workflow. This is equivalent to an actor in UML terminology, and may sometimes be referred to as a participant. Within a workflow a specific task may be assigned to one or more agents, where typically the workflow will pause and resume upon an action being taken by the agent (e.g. submit, review, approve, reject, etc.)

Event: An event is generated by asynchronous business transaction and it can be used to trigger the invocation of a workflow. A workflow step can also wait for tbe occurrence of an event to proceed further.

Notification: A notification is a message sent to an agent to provide information of potential interest. For example, when a workflow requires the approval of an agent, an e-mail may be sent to the responsible agent to identify that action is required.

Deadline: Steps within a workflow may have deadlines. In the event that action has not been taken by a responsible agent within a specified deadline, the workflow may be designed to issue notifications, perform other tasks, reassign or escalate the task to another agent.

Document: Typically a business process involves one or more business documents. Within a workflow implementation, the document is an attachment used to convey information through the steps of a workflow. Examples of documents would include purchase orders, service requests, trouble tickets, bids, etc. Documents are usually derived from a domain-specific ontology, such as the CIM.

A workflow engine uses a set of process definitions to orchestrate the activities of people and applications. The implementation of a service-oriented architecture helps enable a workflow system to leverage applications within a workflow integration.

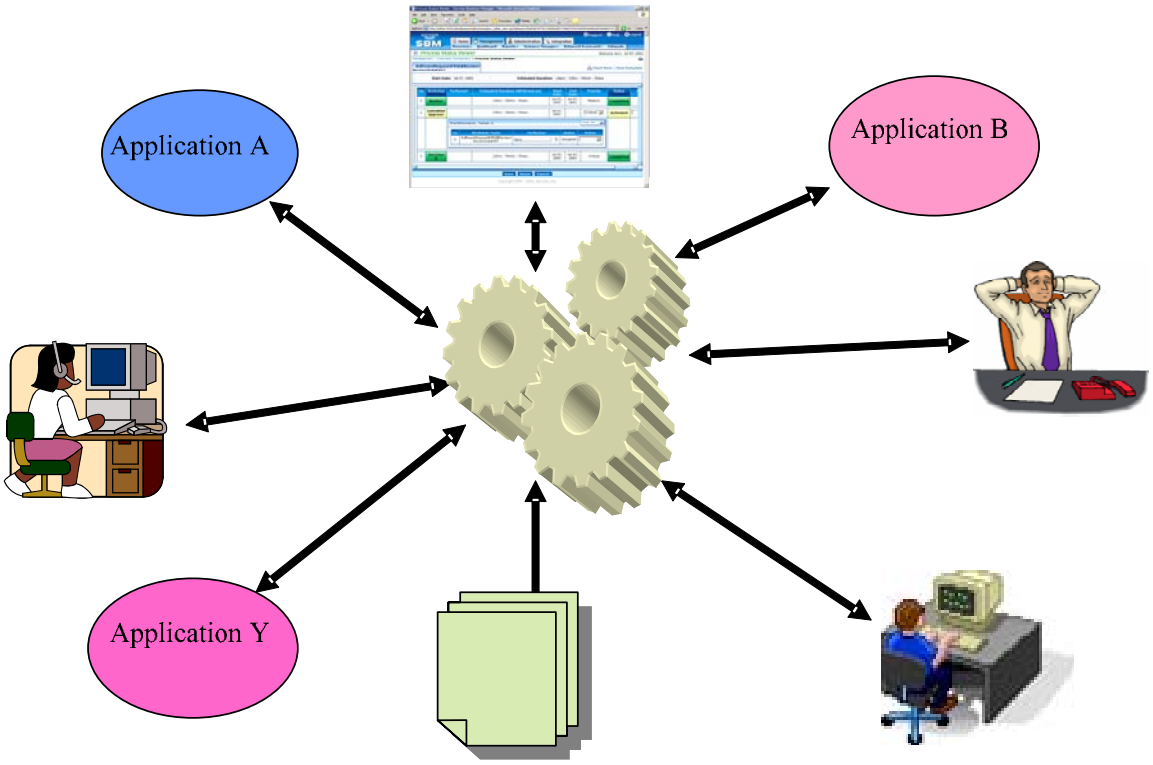


Figure 2: Modern Workflow engines can enhance operations efficiency through simplifying and automating execution of business processes that interact with people and systems, both within and across organizations, enabling real-time and efficient collaboration.

Workflow Examples

An example of Workflow is presented in Figure 3. The process diagram depicts a generic Corrective Maintenance process. The process involves collaboration among "external" applications creating Notifications, Customer Service Representatives, an ERP application used for Work Management, an office eMail application, maintenance Supervisors, Approver of the job Orders (if approval is required), and Field Resources. There are two major paths, depending upon whether or not the maintenance must be handled as an emergency or can be scheduled. In the non-emergency case more approvals are typically required. In the emergency case Notifications will typically be made to supervisor pagers, as well as e-mails.

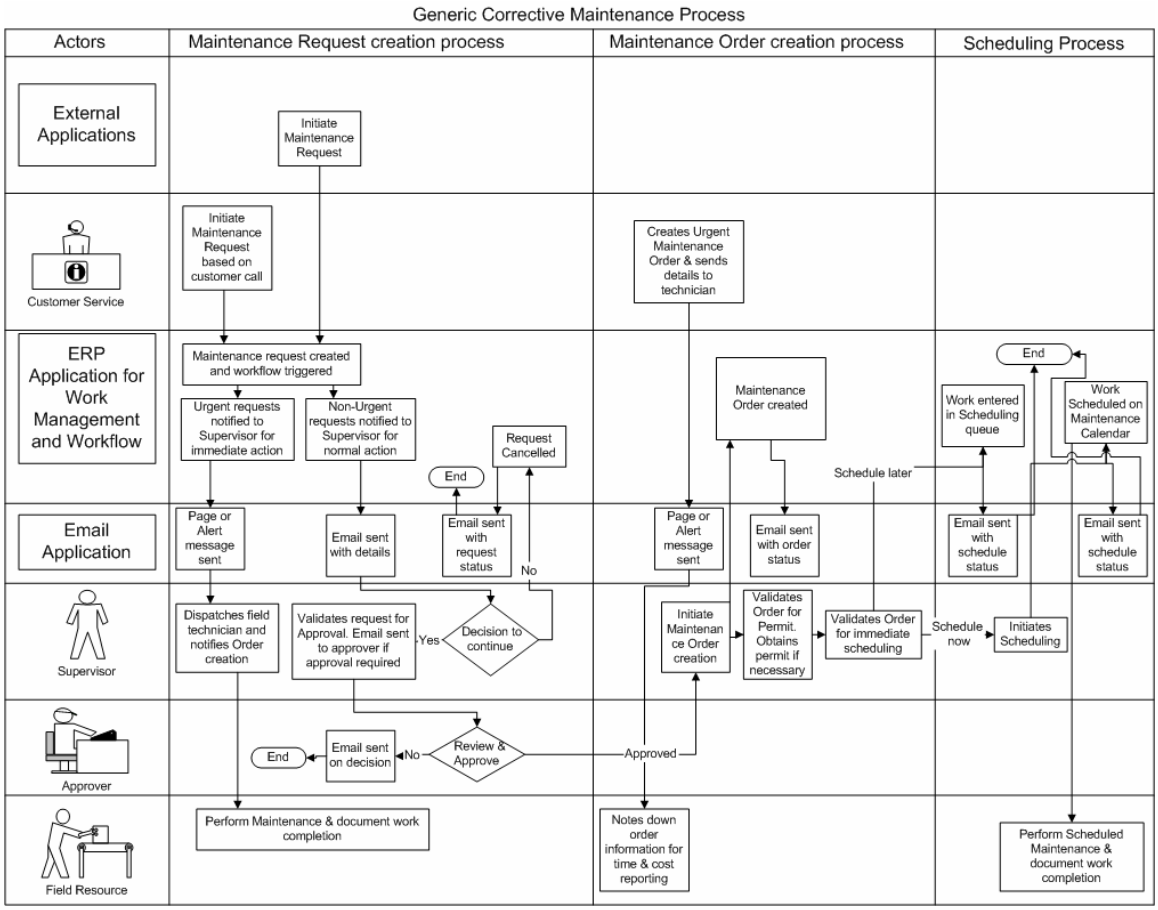


Figure 3: An example of Corrective Maintenance Process, involving workflow among people and applications involved in the process.

Another example of a utility process that can often be improved through Workflow automation is the Unplanned Outage process depicted in Figure 4. Within this process, trouble calls are correlated to determine the existence and predicted device for an outage. An outage order is then created, which waits for an operator to assign the outage to a troubleman who uses a mobile data system. The troubleman works the outage, making decisions and performing restoration actions. As the outage is worked, status information is returned. In the event of damaged equipment, a report is made to an ERP system for follow up work. Completion of the order by the troubleman can then initiate processing and outage status updates in other systems.

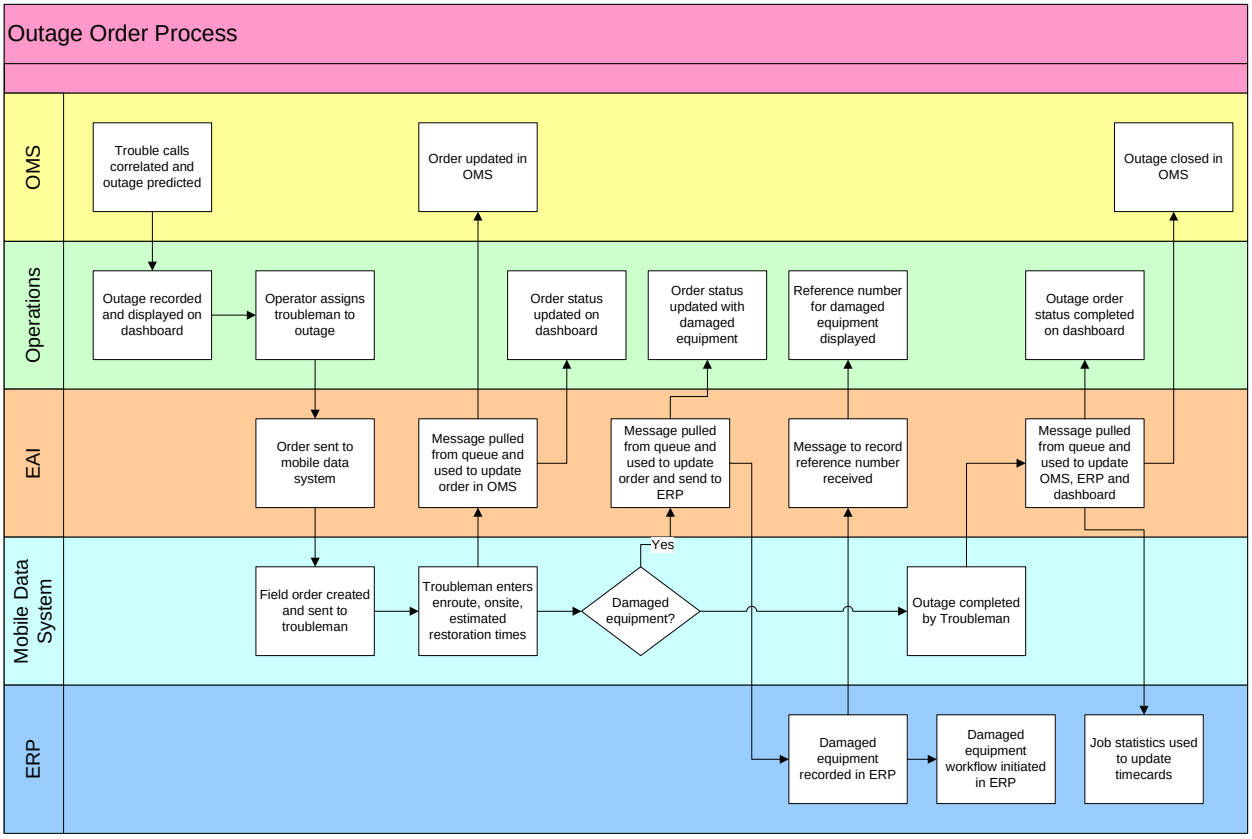


Figure 4: An example of Outage Order Process, involving collaboration among OMS, Operations, EAI, Mobile System, and ERP.

Workflow Definition and Implementation Process

The definition, design and implementation of workflows require an understanding of the business processes to be automated. It is important to have an understanding of the business process, the participants and their interactions. Often this is achieved through the use of Unified Modeling Language (UML). It is common to model business processes both within the enterprise and with business partners.

There are many tools which can be used to provide and electronic description of the business process, where some of the more advanced tools can seamlessly advance the process definition into implementation. Very often these tools start with the development of a swim lane (activity) diagram, which defines a process in terms of participants, the sequence of steps taken and the hand-offs to other participants.

Once this is defined at a high-level it is possible to begin to model the process. Development continues through the definition of details such as the definition of user forms and documents which are used to convey information through the process. At some

stage an organizational hierarchy is applied to the process which is used to determine the assignment of tasks and addressing of notifications.

Once defined, the lifecycle of a business process is described as a cycle of the following steps:

1. Integrate and automate the process
2. Monitor the process
3. Manage the process
4. Evolve the process

Supporting Technologies and Standards

There are many technologies and standards which are important to the implementation of workflow and associated tools. These include:

- XML is a key, enabling technology for the implementation of modern integration architectures and workflow.
- Web services provide a platform and language neutral interface for service requests. Benefiting from XML, HTTP and SOAP, interoperability is defined by the WS-I specification.
- Service-Oriented Architectures (SOA) are not new, but have benefited and proliferated through the standardization provided by web services.
- Business Process Execution Language (BPEL) for Web Services is an XML dialect which permits a workflow to be defined as an orchestration of web services.
- WS-I is a key standard which defines the interoperability of web services.
- WS-Eventing is a standard which is being developed to provide web services to be used for event processing.
- Ontologies: CIM (IEC 61970/61968), Open Applications Group, OpenGIS are examples of domain models which can be applied to integration
- Messaging: JMS, SOAP. It is important to note that JMS defines an API, not a wire protocol, which introduces issues related to interoperability and the capabilities of the underlying messaging system. Also, SOAP can be transported by JMS as opposed to HTTP.

Workflow Development Tools

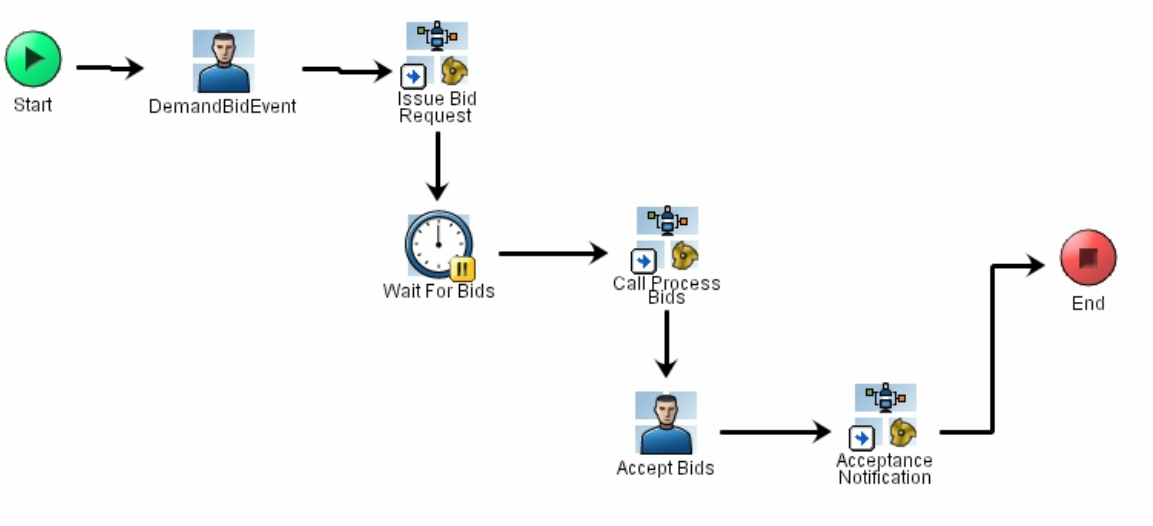
The tools used to define and implement workflows are key to short term and long term success. There are many workflow designer tools on the market which now make it the process a matter of ‘drag and drop’ configuration as opposed to conventional coding using a programming language such as Java, C++, Visual Basic or C#. Typically the designer tools will provide the capability to seamlessly integrate custom code within the

design environment, but certainly one measure of the capabilities of a designer tool is how much custom code is required to implement a workflow, where less is better and none is best. It is interesting to note that this movement to drag and drop configuration is analogous to the movement from assembly language to C and from C/C++ to Java (as two examples) experienced in the 80s and 90s.

A designer tool will typically have one or more palates containing objects which can be configured into the workflow to perform various activities. Each palate object has specific parameters related to the activity performed by the object which can be configured. Examples of objects that would be commonly seen on a designer palate would include:

- Show a form to a user
- Collect and validate entries from a form
- Perform a database query
- Perform a database update
- Invoke a web service interface
- Wait for a web service request
- Send a message
- Wait for receipt of a message
- Send an e-mail
- Wait for a timer
- Perform data translations
- Perform document transformations
- Read from or write to a file
- Iterate on a list
- Test for a condition
- Invoke another workflow
- Execute a command
- Execute custom code (e.g. Java method, Java class, …)
- … others as appropriate for the tool

Each workflow has a ‘start’ and an ‘end’ node. Between the start and end nodes, activity objects from the palate are connected, forming one or more paths from start to end. The start node may be configured with place holders for input values to be supplied when the workflow is invoked. Very often, workflows will be initiated with a business document, typically in an XML format, or a reference ID to a transaction whose data can be accessed from a repository such as a database. The following example shows a high level workflow for a Demand Bid process related to an Energy Demand Response Network.

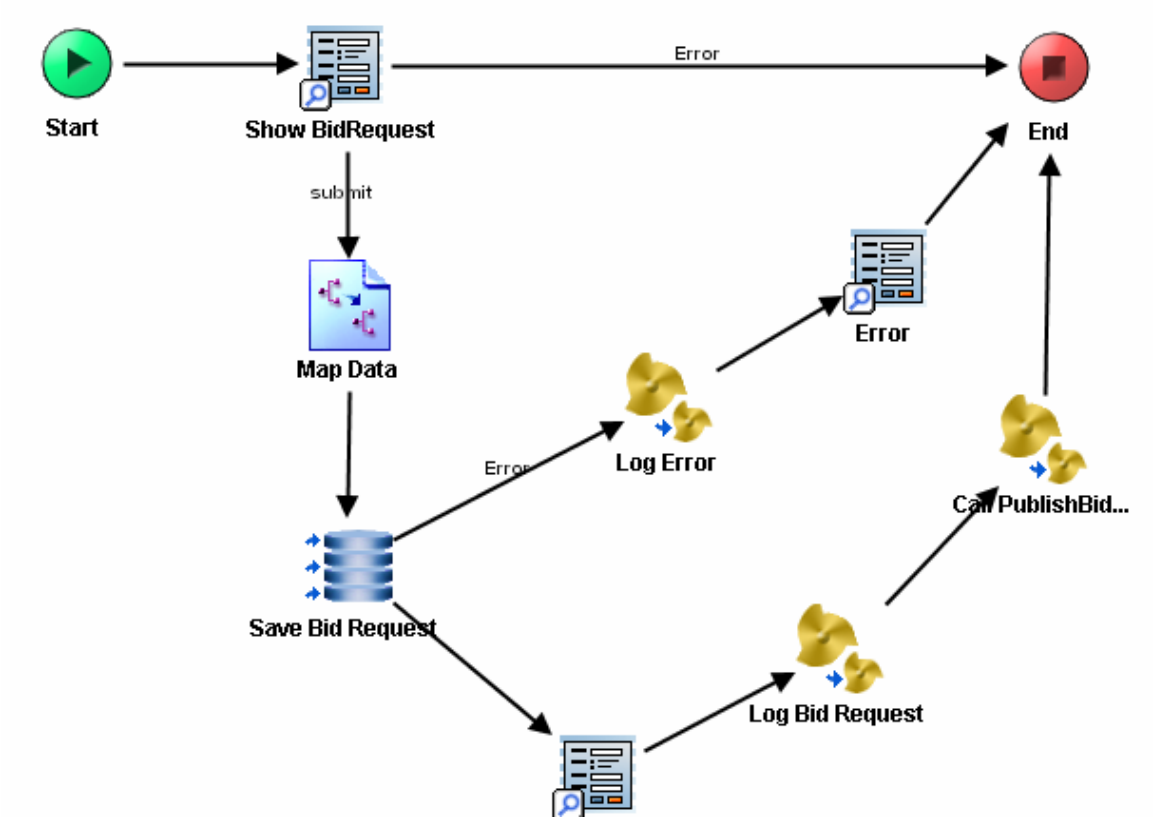


Where any one activity can be initiated from one or more paths in the workflow, the completion of the activity will typically identify the next activity to be performed always, depending on a condition or in the event of an error. Depending upon the workflow product utilized, parallel activity paths may or not be allowed.

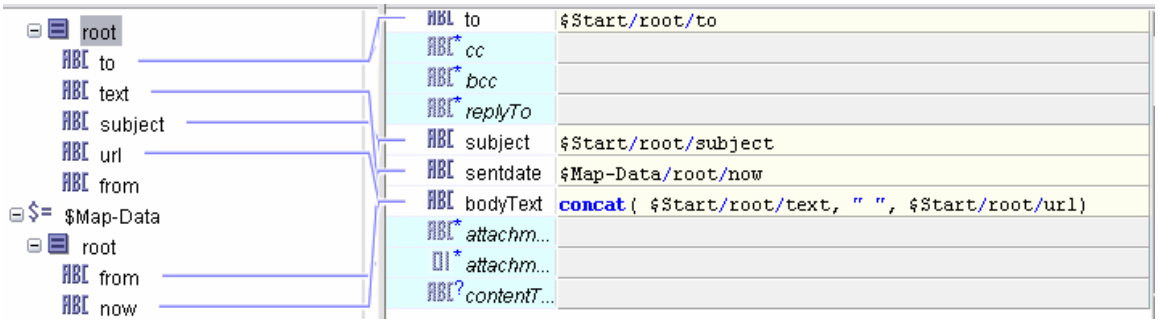
Within a workflow definition, there are a variety of means to control flow from one step to another. Some tools have sophisticated rule processing capabilities, where others have simple conditional tests.

Workflows can be configured to be triggered in a variety of ways. One example would be the submission of a web form. Another could be the receipt of a message by an EAI infrastructure. Workflows could also be triggered periodically, but most commonly workflows are triggered by an event.

Just as there are now sophisticated, drag and drop programming tools such as Microsoft Visual Studio and JBuilder, the workflow development tools are to the point where it does not require a highly skilled programmer to implement a workflow. A workflow may invoke sub-workflows or processes defined at a lower level of implementation. The following example shows the definition of a form flow which is invoked within a workflow, which presents and processes user entries from a web form.



Given a knowledge of XML, SQL, XPath and WSDL, a designer can typically implement a very sophisticated workflow using the graphical environment alone. The following shows an example of how the input to a task can be mapped graphically or using XPath.



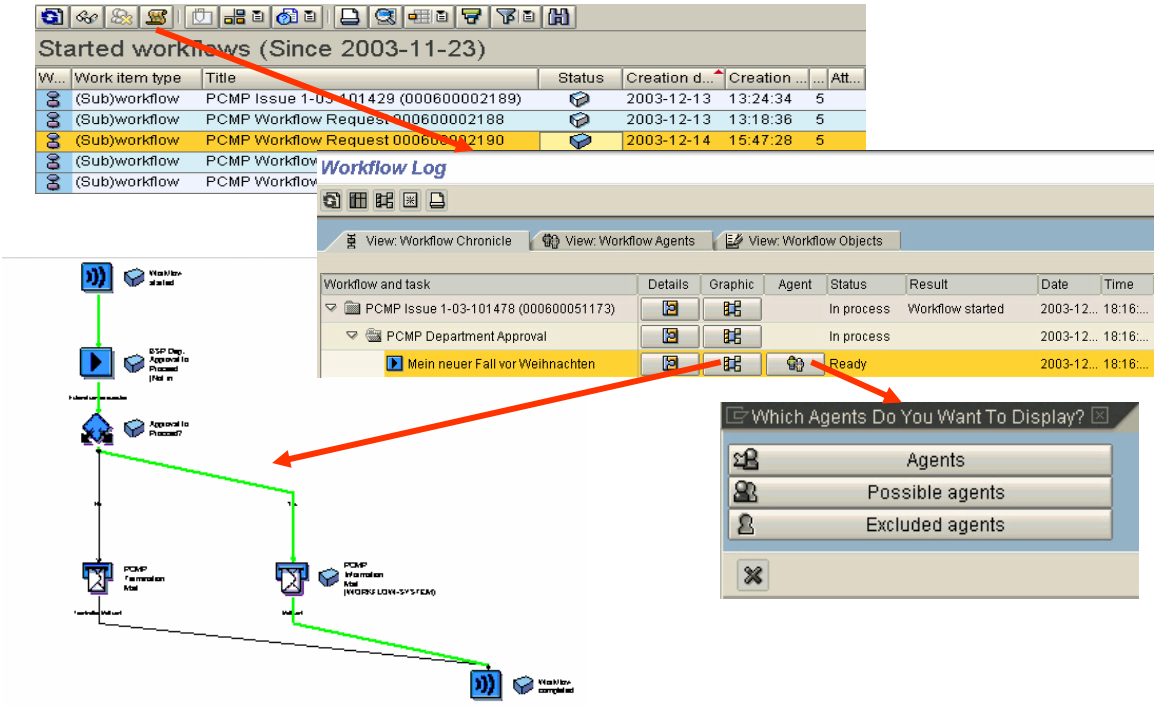
One area where vendors are currently attempting to improve their offerings is in the definition of user interfaces. At present, templates are provided which simply, but yet constrain, the definition of a web GUI. The GUIs can be ‘beautified’ through the implementation of customer style sheets using CSS or direct editing of HTML. More sophisticated GUI capabilities are now being incorporated by vendors which provide for greater user interface functionality through simple drag and drop configuration.

Workflow Products

There are many workflow products on the market, with many new products entering the market every day. Most EAI vendors have begun to incorporate workflow capabilities into their products. Many enterprise and ERP applications vendors are doing the same.

A workflow product will typically have three main components: a designer, a workflow engine and an administration tool. The designer is used to 'configure' the workflow, providing a definition of the workflow which can be used by the workflow engine at runtime. Most workflow products now support web service and application server integration.

The administration tool is used to track and control active process instances. The administration tool can often also be used to control and automate the deployment of a process definition. The following example shows how the SAP workflow log shows the status of process instances. An administration tool can also be used to reassign a task within an active process, or cancel the entire process.

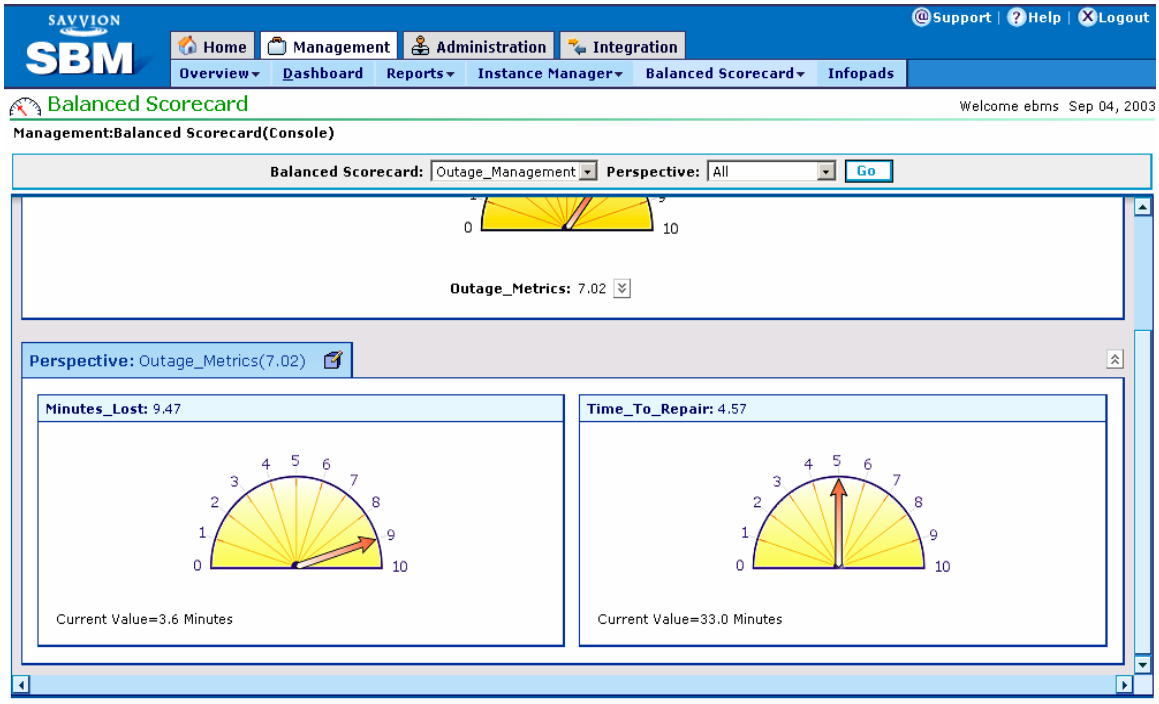


TIBCO is an example of an enterprise EAI which has been augmented with workflow capabilities through BusinessWorks WorkFlow. The BusinessWorks Designer seamlessly presents workflow capabilities as an additional set of palates, augmenting the standard set of integration object palates offered by BusinessWorks. While a large library of objects are supplied for drag and drop implementation, the Designer also supports the entry and compilation of Java code for the definition of a task. The advantage of a product like

TIBCO is that it has a significant amount of capability and large number of adapters that can be leveraged for integration.

Savvion is classified as a 'pure play' Business process Management (BPM) tool. The advantage of Savvion is that it is designed to permit very rapid development and deployment of solutions, leveraging existing infrastructure. It can also leverage existing web services and allows use of custom Java code when needed for complex integration.

Aside from capabilities to define, implement and integrate a process, Savvion also has tools which make it possible to calculate and display performance indicators. The following is an example from an unplanned outage process.



SAP is an ERP application suite which includes a workflow package as part of the standard offering. Using SAP Workflow, it is possible to configure business process as opposed to relying on custom ABAP programming. SAP Workflow can leverage ABAP programs, e-mail and web services. Support of web services allows SAP Workflow to extend processes beyond the scope of SAP. Conceivably, the SAP Workflow could be used as an enterprise workflow engine to drive processes within an SOA. The advantage of SAP Workflow is that due to its tight integration with business application modules, it can leverage the domain model and application functionality provided by SAP.

Microsoft workflow offering is called BizTalk. Where BizTalk defined the XML-based XLANG for process definitions, Microsoft is moving towards the use of BPEL. BizTalk is limited to use on Microsoft platforms and embraces Microsoft technologies such as

Visual Basic and the .Net framework instead of J2EE. Like other workflow tools it has a graphical environment for the implementation of workflows.

Implementation Recommendations

There are many ways to use workflow technologies to automate business processes. The key is to take approaches which provide the greatest opportunities for further automation and evolution of business processes.

Where possible it is always beneficial to leverage existing domain models, such as the CIM. This will provide a common vocabulary which will simplify integration.

Workflow applications use different methods of notifying the user about the task to be performed such as an email, text message, pager and other wireless mechanisms depending on the criticality of the task. Where many applications have an inbox for users to identify and act upon the tasks for which they are responsible, the e-mail inbox is more and more frequently seen as the inbox of choice. This has several benefits, such as minimizing the number of inboxes a user must monitor and providing all relevant information to perform the task. In such cases where an email notification does not provide means to act on the task, it should provide a URL link which would take the user to a web page where a user can perform the specific required task (e.g. approve a purchase order) or view the information of interest (e.g. details and status of an outage).

Within the implementation of the underlying services to be utilized by a workflow, care should be given to providing generalized interfaces that can be reused as opposed to many very fine-grained interfaces. This is an architectural issue as to the use of document-centric web service interfaces as opposed to RPC style interfaces, where document-centric web services can better support complex documents and associated integration, providing more opportunities for reuse of interfaces.

As a general integration problem, finding and eliminating isolated island of information is also key. Information that is stored in an enterprise or department database can be more easily leveraged within workflow integration than information which is stored in a localized repository or file, such as an Access database or spreadsheet.

Selection of the workflow tool should consider several factors such as tight integration with enterprise applications, providing standard open interfaces to enable interaction among applications, comprehensive design tool with templates for common workflow tasks, automated information capture avoiding duplicate data entry and tools for easy maintenance and support.

An important factor in workflow design is error handling. All error handling scenarios should be modeled within the workflow such as notifying the right person to handle errors or initiating corrective measures.

The use of web and portal technologies are also beneficial to workflow integration. In this way users can react to and perform steps in an overall process through a unified, location independent user interface as opposed to interaction with individual applications, often limited to specific locations.

Summary

Workflow technologies provide the means to seamlessly integrate business processes across the enterprise. The technologies used to implement workflows can also provide the means to rapidly evolve business processes to meet changing business needs, more through reconfiguration than through a costly reimplementation.

There are many benefits that can be realized through the use of workflow, which include but are not limited to:

- More efficient, consistent and timely execution of business processes through better coordination between people and processes
- Improvements in quality and productivity, with the reduction of the number of errors and number of manual execution steps
- Visibility of the process, allowing the current state (e.g. waiting, completed) of a process to be seen and controlled (e.g. re-assigned, cancelled) as needed
- Simplification of the process provides reductions in the level of training required to execute a process
- Active deadline monitoring helps insure timely completion of processes
- Processes cycles can be better measured
- The ability to evolve or improve a process through simple reconfiguration as opposed to coding
- Provides detailed documentation and audit trails for processes

References

The following references are relevant to workflow and associated technologies:

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