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BPM Engines/Tools

BPM Engines/Tools Research

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1. History

1.1 Revision History

Version	Date	Description of Changes	Reason	Made by
0.1	19.06.07	Created	Customer request for research	A. Cherepakhina
0.2	28.06.07	First draft with content		S. Xiao O. Moroz A. Cherepakhina

1.2 Review History

Version	Date	Reviewer	Reference
0.3			

1.3 Approval History

Version	Date	Approved by	Signature or reference

2. Introduction

2.1 Purpose

The main purpose of this document is to present the results of the research established by Luxoft to compare several BPM engines/tools and find out the most appropriate solution, which is eminently suitable to business and technical requirements of Customer.

2.2 Subject

A Business Process is a set of coordinated tasks, conducted by humans or systems, whose objective is to achieve a particular business goal. Business process management (BPM) leads to business optimization by implementing business strategy through modeling, developing, deploying and managing business processes throughout their entire lifecycle.

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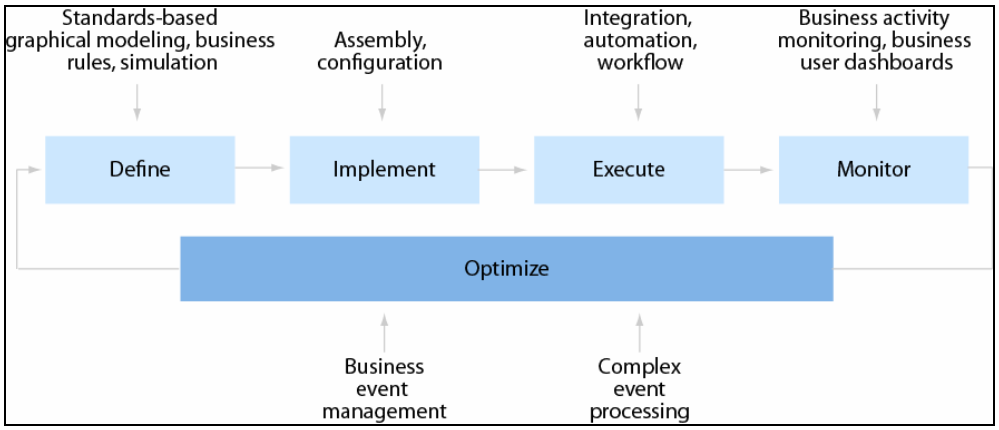
BPM acts as an enabler for the businesses in defining and implementing strategic business goals and then measuring and managing company's financial and operational performance against these goals.

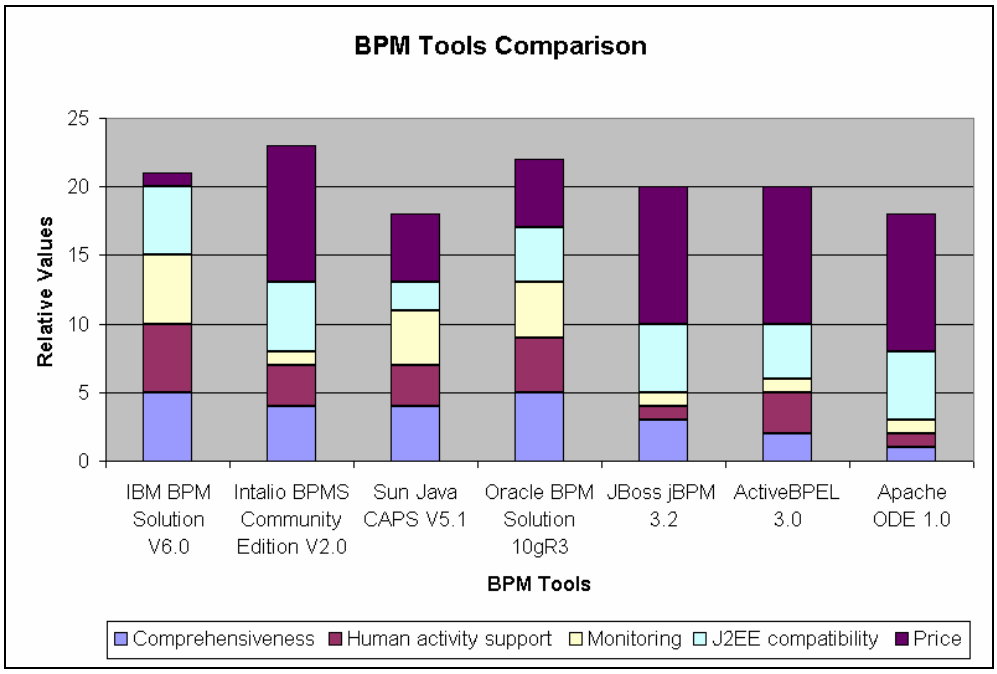
The power of optimal results from the BPM lifecycle activities is derived from the integrated set of the technology infrastructure and tools.

Such tools are known as BPM tools/engines. These products support the process modeling, execution, monitoring and optimization phase of the process life cycle.



2.3 Summary

We evaluated and compared 7 tools/engines for business process management. According to the Customer's needs, we compared them based on five composite criteria: **solution comprehensiveness** (whether the product provides complete solution to the lifecycle of business process management), **human activity support** (the extent to which the product supports incorporating human activities in business process), **business process monitoring and statistics** (whether the product has the ability to monitor, track, sort, filter and aggregate processes, events and actions), **J2EE compatibility** (support for J2EE standards and frameworks) and **price**.



During evaluation an especially high importance was put on product's price, as it is a major requirement by the Customer.

Under these assumptions, three products stand above others in the comparison. Interestingly, they stand out in different ways. While IBM offerings are the most technologically competent and complete among all the products we've evaluated, its high price tag could be a showstopper for the purpose the Customer is considering. Whereas, Intalio BPMS Community Edition has unbeatable price and relatively well rounded offerings, with exception on the monitoring department. The strength of its constituent open source projects lends a great deal to its overall score too. Oracle appears to have acceptable price tag and covers all territories of BPM tool with sufficient quality and coherence.

We therefore recommend using **Intalio BPMS Community Edition** for Customer's BPM needs for the following reasons:

- It is the most complete open source BPM suite offering available at the moment. Intalio BPMS is built on three high-profile open source projects: it uses Apache Geronimo, ODE and ServiceMix as its application server, BPEL engine and ESB platform respectively. All the above Apache open source projects are going strong with recent releases. For example, Apache ODE 1.0 was released only a few months ago.

- It includes an Eclipse-based BPMN modeler that is also an open source product. The product has strong modeling and simulation capability.
- It supports BPEL4People standard. This provides a good starting point for integration of human activities into business process.

The most significant weakness of Intalio BPMS is its lack of Business Activity Monitoring functionality in its offering. This weakness is shared by all the open source products evaluated in this research.

Our runner-up recommendation is **Oracle BPM** solution. We recommend Oracle BPM solution for the following reasons:

- It has the lowest licensing cost among all commercial products we have evaluated
- Oracle has put together a strong package. Part of the package comes from IRS Scheer, another one from Oracle SOA suite. Both products have very strong vision and implementation
- It provides a complete package for all aspects of BPM lifecycle. Most noticeably, it has a strong BAM component that all open source products lack
- Oracle is traditionally strong at supporting enterprise integration.

2.4 Scope

The scope of this analysis is limited by the explicit list of BPM engines/tools for evaluation, including the following products:

- ActiveDesigner/ActiveBPEL
- Apache ODE
- JBoss jBPM
- Intalio BPMS
- IBM BPM Solutions
- Oracle SOA Suite
- Sun Java CAPS

Solutions are evaluated basing on the list of requirements and criteria specified by the customer and listed in "Customer Needs" and "Estimation Criteria" sections correspondingly.

2.5 Definitions, Acronyms and Abbreviations

BAM	Business Activity Monitoring
BPEL	Business Process Execution Language
BPM	Business Process Management
BPMN	Business Process Modeling Notation
CORBA	Common Object Request Broker Architecture
DCOM	Distributed Component Object Model
ESB	Enterprise Service Bus
IDE	Integrated Development Environment
J2EE	Java 2 Platform, Enterprise Edition
JBI	Java Business Integration
JCA	J2EE Connector Architecture
JMS	Java Message Service
JSR	Java Service Request
LDAP	Lightweight Directory Access Protocol
ODE	Orchestration Director Engine
SOA	Service-Oriented Architecture
UI	User Interface
UML	Unified Modeling Language
WS	Web Service

3. Customer Needs

The Customer needs a BPM engine/tool that should meet the criteria listed in the sections below.

3.1 Easy Incorporation into Customer's Application

The BPM tool/engine should be deployable to most of the hardware and software platforms used by the Customer. It should comply with the architectural constraints set by the Company, for example, high availability, load balancing and fault tolerance; and work with identity management standards used by the Customer. It also needs to communicate with established applications via protocols and adaptors acceptable by the Customer. It should also be consistent with the SOA vision of the Customer.

3.2 Rich UI for Business Process Modeling and Analyzing

The BPM engine/tool should have wide and rich interface for business process modeling and analyzing. Business analyst with some programming skills should be able to define/change business process through this UI.

3.3 Low-cost or Open-source

BPM engine/tool should be low-cost or open-source. Max price should be lower than $10K per application (including all locations, all processors…, enterprise internal usage).

3.4 Key features

The key features of the BPM engine/tool should include:

- Ability to assign tasks on dedicated employee, task list and task status review
- Ability to describe and execute non-accurate business process (process with human-decision part, description and execution)
- Integration with Java web applications (e.g. Struts action)
- Integration with Spring Framework
- Ability to activate Business process through JMS message
- BPM-events processing
- Business process versioning
- Asynchronous business process execution
- Logging (required).

4. Estimation Criteria

According to requirements listed in the "Customer Needs" section, we propose to use the following criteria to compare BPM tools/engines:

Criteria	Description
Architecture This group of criteria includes various platforms support, J2EE compatibility, etc. It is mostly concerned with the need to incorporate the tool into Customer's application, and integration requirements.	
OS Platform	How many operating systems do the product's design-time and runtime environments run on? Which ones?
Application Server Platform	How many application servers do the product's design-time and runtime environments run on? Which ones?
Database Platform	How many databases does the product work with for runtime? Which ones?
J2EE compatibility	Are the product's modules compatible with J2EE standards? Is JCA supported?
Globalization	Is the product Unicode-compliant? In which languages are localized version of user interfaces available?
High availability, load balancing and fault tolerance	What specific features and/or deployment options does the product provide for high availability, load balancing and fault tolerance? Is this functionality native to the solution or provided by another product?
Identity management	Does the product include integrated features for managing identification of users and authorization to specific information?
Vertical Industry Support	Does the product meet specialized requirements of banking and finance industries?
Cost This group of criteria addressses the Customer's cost requirements.	
Single server	Cost of single-server.
Multi server	Cost of multi-server /seats/ processors.
Support	Cost of support.
Process modeling This group of criteria defines how sophisticated the product's process modeling capability is. It mostly addresses the Customer's need for rich UI for business process modeling and analyzing.	
General features	Does the product support import/export of process models? Can it generate production logic? Does it provide features for testing and debugging of models prior to deployment?
Versioning	Does the product track and manage multiple versions of a process design? Are simulations and process documentation included in the versioning process? At what granularity is versioning done?

Criteria	Description
Modeling standards	Does the product support business process management notation (BPMN), BPEL, and XML Process Definition Language (XPDL)?
Role-based modeling	Does the product provide different but connected views of process designs for the business analyst, enterprise architect, and developers?
Business user control	Does the product support creation of business rules by business users? Does the product support the ability for business users to make rules changes directly? Can rule administration and permissions be delegated?
Protocols and adapters This group of criteria defines the product's capabilities in the areas of communication protocols and adapters. It is mostly concerned with the need to incorporate the tool into Customer's application, and the requirement for JMS message ability to activate Business workflow.	
Adapters	Does the product support a wide range of application and technology adapters? Does it provide adapters for banking and finance applications used by Customer? Do the adapters have an architecture guaranteeing the delivery and end-to-end management? Is coding required to configure the adapters?
Communications protocols	*Non-Web Service protocols*: Internet Inter-ORB Protocol (IIOP) Remote method invocation (RMI)/IIOP Remote procedure call (RPC) CORBA other non-Web services protocols *Web Service protocols*: SOAP over TCP/IP sockets SOAP over Secure Sockets Layer (SSL) SOAP over compressed sockets *Messaging protocols*: IBM WebSphere MQ Microsoft Message Queuing (MSMQ) Java Message Service (JMS) SOAP over JMS TIBCO Rendezvous.
Security (Audit, Authorisation)	How extensively does the product enable a secure integration and communication environment to be established? Does it have the ability to provide role-based authorizations? Does it support third-party tools for this function? Does it support the ability to integrate audit logs from multiple sources and ensure integrity of the log file? This criteria is mostly concerned with requirements for task management and the need to incorporate the tool into Customer's application.
Transaction Management This gourp of criteria defines how well the product manages transactions spanning multiple applications. It is mostly concerned with the need to incorporate the tool into Customer's application.	

Criteria	Description
Multistep transactions	Can the user define multistep transactions that can be rollback and/or compensated?
Compensating transactions	Does the product let the user define a process to compensate for a transaction that fails
Event management This group of criteria defines the event management cabalities required by the Customer.	
Event definition	Does the product provide a tool for defining events, including external events as part of a process.
Complex event processing	Does the solution have a correlation engine for transforming random events into meaningful patterns? Can the solution use these patterns to automatically generate corrective actions without human involvement?
State machine	Is a state machine provided for tracking the state changes of events?
Human-centric features This group of criteria defines the human activity support and addresses the requirement for description and execution of non – accurate business processes.	
Desktop integration	What productivity tool integration does the product support?
Human interaction	To what extent does the product support human interaction in business process to start, manage, and participate the process?
Resource assignment	To what extent can the product automatically balance workload across members of workgroups? How is it accomplished?
Monitoring This group of criteria defines the business monitoring capability. It addresses the requirement for logging.	
Action management	Does the monitoring component have the ability to take actions, both manual and automatic, based on business situations? Actions include the ability to send alerts, emails, launch Web services, and invoke business process execution language (BPEL) processes.
Process instance monitoring	Does the application have the ability to monitor, track, sort, filter, and aggregate process instances?
Service monitoring	How strong is the product's service monitoring capability, including analyzing the impact of security, availability, and performance events on business services, as well as performing root cause analysis?
Technical monitoring	Does the product support end-to-end technical monitoring of processes?
ESB capability	How sophisticated is the solution's standards-based enterprise service bus (ESB) functionality (standalone or embedded)?
Web Service Governance	Does the product provide features for supporting the governance of defined Web services?

Criteria	Description
WS* standards This group of criteria defines the extent to which the product supports SOA standards. It is concerned with the need to incorporate the tool into Customer's application.	
Core Web services	To what degree does the product support Web-services-based interactions? Broad support means support for the core Web services stack, including SOAP, Web Services Description Language (WSDL), UDDI (v2 and v3), Web Services Security (WS-Security), Web Services Interoperability (WS-I) Basic Profile, and Web Services Distributed Management (WSDM).
Extended Web services	To what degree does the product support extended Web service capabilities such as WS-Addressing, WS-I Attachments Profile, reliability (WS-Reliability, WS-ReliableMessaging, or WS-ReliableExchange), Web Services for Remote Portlets (WSRP), security (Liberty Identity Web Services Framework (ID-WSF)), WS-Policy, WS-Trust, Web Services Interoperability Basic Security Profile (WS-I BSP), transactions (e.g., WS-Transaction), notification/events, or binary Web services protocols?

5. BPM Tool Comparison

This section contains descriptions of products selected for current research.

5.1 IBM BPM Solution V6.0

http://www-306.ibm.com/software/info1/websphere/index.jsp?tab=products/businessint

Comprehensiveness	Excellent
Human activity support	Excellent
Monitoring	Excellent
J2EE compatibility	Excellent
Price	Poor

IBM occupies a unique spot in the BPMS vendor landscape: it is the first infrastructure software supplier to offer a complete BPMS — supporting the end-to-end lifecycle from analytical modeling to performance management and optimization — based entirely on Service Oriented Architecture (SOA). IBM has a long history in the traditionally distinct markets for workflow, application integration, and performance management software, and is today leading the charge toward enterprise transformation through SOA.

IBM BPM Solution V6.0 contains the following components:

- **WebSphere Business Modeler**

  IBM WebSphere Business Modeler is targeted at business analysts to help capture business design. This component can be used for documentation and compliance purposes, providing a visual and textual representation of processes, information, organization, resources, classifiers, and business measurements that can be shared across an organization. WebSphere Business Modeler includes a simulation tool that enables analysis of processes and testing of how well processes will hold up under different operating assumptions. The component is built on the Eclipse tool framework, which makes it easy to share information about your business design with other parts of organization and tools. In particular, a design from Modeller can be exported into WebSphere Integration Developer and Rational Software Architect so that application developers can use it as a blueprint for designing process flows for automating business design.

- **WebSphere Integration Developer**

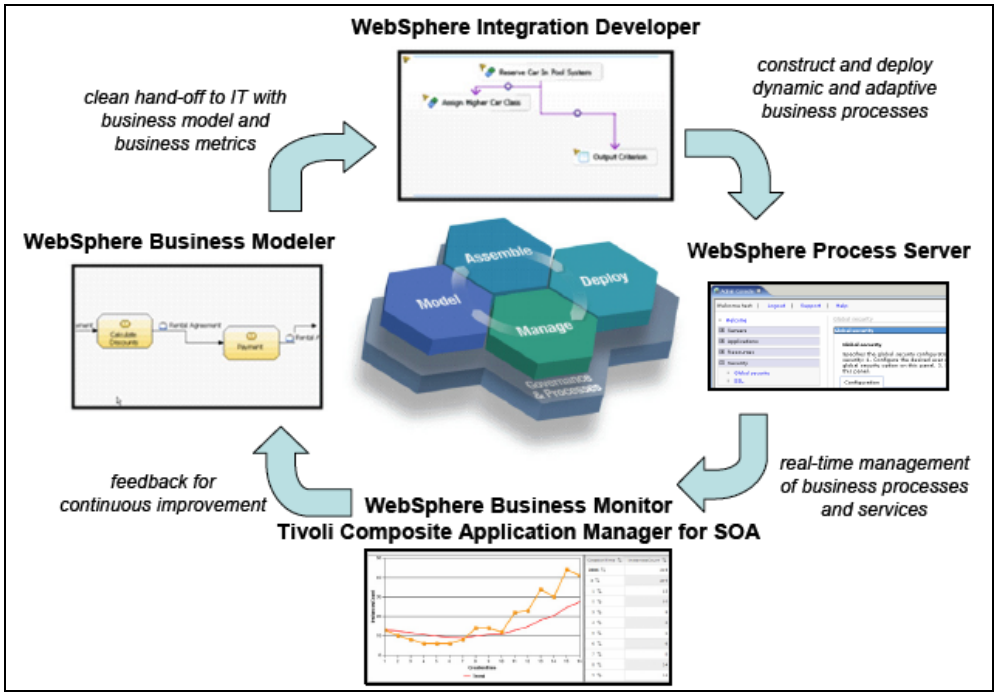
  WebSphere Integration Developer is an Eclipse-based tool designed to help create business process flows, state machines, and business rules. It simplifies integration with its Service Component Architecture (SCA), which uses BPEL for assembling business process tasks into workflows, which can then be deployed to IBM WebSphere Process Server. The component can directly import business models from the IBM Business Modeler. A developer can use a wiring editor for assembling service components, importing service interface definitions, and setting binding policies to build SOA-enabled applications.

- **WebSphere Process Server**

  WebSphere Process Server is the primary hosting environment for business processing. Built on WebSphere Enterprise Service Bus, it includes support for both Web Services Business Process Execution Language (WS-BPEL) based process flows and business state machines. The component also supports the integration of business rules in process and service selection. WebSphere Process Server integrates with WebSphere Portal to deliver business process management through a portal — there is support for human tasks in a business process. Human tasks are defined as activities within the process definition that are carried out by users. This includes built-in support for task assignment, pick lists, scheduling, and escalation policies in case a task is not processed in a timely fashion.

- **WebSphere Business Monitor**

  WebSphere Business Monitor enables monitoring of business processes in real time, providing a visual display of business process status. The component complements WebSphere Business Modeler. It helps in creating dashboards for visualizing the performance of a business, based on the key performance indicators that are identified in a business design. WebSphere Business Monitor provides tools that enable a user to set situational triggers and notifications of potential bottlenecks or workload imbalances. Ultimately, WebSphere Business Monitor helps better understanding of how business design achieves business objectives, and provides guidance about how to refine and optimize that business design in case goals are not being met.



IBM is strong both in its vision and current offering of its BPM solutions. It has the greatest breadth of functionality among all the tools in this research. Its support on enterprise environment is also the strongest among tools evaluated in this document. Also, IBM has shared a strong development roadmap, has an extensive vertical strategy and provides a broad product portfolio.

- **Architecture**
  - **High availability, load balancing and fault tolerance**. IBM's BPM solution provides high availability, scalability, clustering, failover, and security. This infrastructure allows to implement multiple styles of deployment, depending on the configuration required in the network to distribute work and increase capacity and performance
  - **Globalization**. The Modeler 6.0 is Unicode-compliant. The strings are externalized, but Modeler does not support end-user translation. Interface is available for the following languages: Arabic, Brazilian Portuguese, Chinese (Simplified), Chinese (Traditional), Czech, English, French, German, Greek, Hebrew, Hungarian, Italian, Japanese, Korean, Polish, Russian, Spanish, Turkish
  - **Identity management**. The product provides a security component to manage user identities, profiles, and relationships. Several different user repositories can be configured including LocalOS, LDAP, custom, and a new federated repositories selection that allows multiple registries to be treated as a single realm. The product also allows a "super administrator" to set up authorization groups of specific resources (nodes, servers, clusters, applications) and assign different users to the various roles within those authorization groups, thus enabling management of users and authorization to specific information.
  - **Vertical Industry Support**. IBM provides industry accelerators across 18 verticals.
- **Processing Model**. The solution provides the ability to import models from Visio, as well as WSDL and XML Schema Definition (XSD) information from various sources, including the WebSphere Service Registry and Repository
  - **Versioning** is performed at the project element level
  - **Modeling standards**. The standards supported include BPEL, WSDL, UML, and portions of BPMN
  - **Role-based modeling**. The business analyst can design and view the process using the Business Modeler. A developer can then view that same model in a BPEL view using WebSphere Integration Developer, and an enterprise architect can view the same model from the Business Modeler as UML using Rational Software Architect. Thus, IBM's product provides customized but connected views for each role in the process design. The product supports different editing modes based on a user's skill profile and the target technology for the implementation of the model.
- **Adapters and Protocols**
  - **Adapters**. IBM develops and supports a wide range of application and technology adapters without reliance upon OEM relationships
  - **Communications protocols**. The IBM BPM solution supports IIOP, RMI/IIOP, XML-RPC, JAX-RPC, CORBA, COM, and .NET. Support is also provided for reliable Web services connectivity via SOAP/MQ and SOAP/JMS, as well as WebSphere MQ, JMS, and XMS.

- **Transaction Management**, including support for J2EE transactions and transaction compensation
- **Event Management**, including complex event processing (CEP) and business state machine component
- **Human-centric features** include desctop integration (via a set of JSF components), support for human tasks, and flexible resource assignment
- **Monitoring**. An Adaptive Action Manager component detects business situations that can occur in a process and can take a variety of actions; monitoring options include process instance monitoring, service monitoring, and technical monitoring (the latter two based on Tivoli solutions)
- **ESB capability**. The BPM solution has a full standalone ESB engine embedded in the runtime. It is a flexible connectivity infrastructure for integrating applications and services, designed to enable the development of SOA. It delivers a standards-based connectivity and integration solution that allows users to create and deploy interactions quickly and easily between applications and services, with a reduced number and complexity of interfaces
- **Web Service Governance** is supported based on WebSphere Service Registry and Repository (WSRR) functionality
- **WS* standards**
  - **Core Web services**. IBM's BPM solution supports all major industry standards for SOA. The product supports Web services standards, including SOAP 1.1 and 1.2, WSDL, UDDI v2 and v3, WS-Security, and WS-I Basic Profile. Support for WSDM can be found in IBM's SOA appliances
  - **Extended Web services**. The IBM product provides extended Web services, including WS-Addressing, WS-I Attachments Profile V1.0, WS-I Basic Security Profile, WS-Atomic Transactions, WS-Notification, and WS-BusinessActivity.

5.2 Intalio BPMS Community Edition V2.0

http://www.intalio.com/

Comprehensiveness	Good
Human activity support	Satisfactory
Monitoring	Poor
J2EE compatibility	Excellent
Price	Excellent

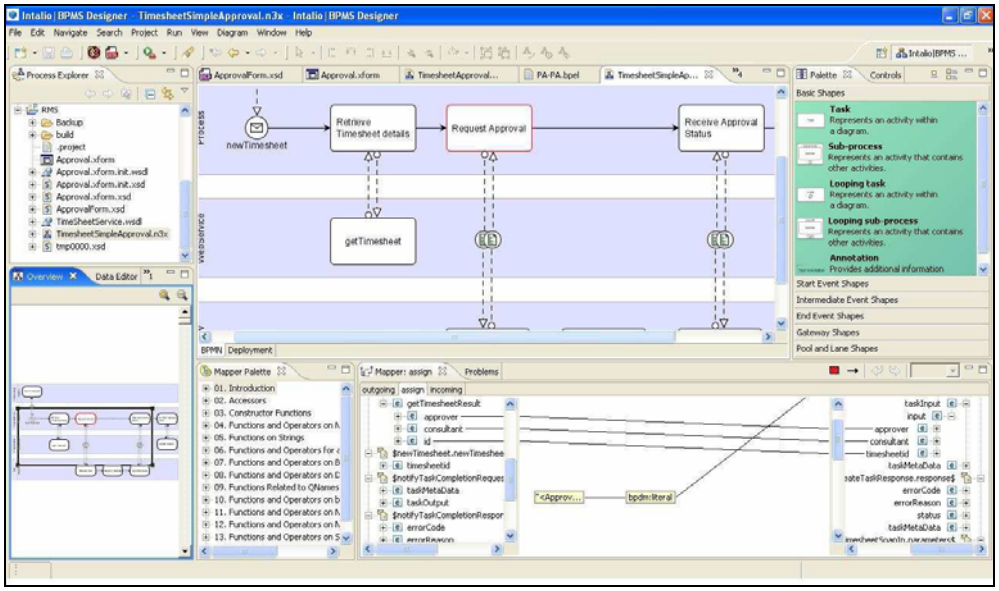
Intalio BPMS Community Edition is released under Mozilla Pulic License, amended with an attribution provision, which allows others to use, share and improve the software but limits the ability of the commercial competitors to redistribute modified versions. Intalio BPMS Community Editor uses existing open-source technologies, such as MySQL, Derby and Geronimo and includes new functions developed by Intalio.

Intalio|BPMS is the first complete open source BPM Suite composed of several products to allow the design and execution of business processes:

- BPMN Designer, upcoming integration with UML, with a visual data mapper
- BPEL Server: Intalio acquired FiveSight, and therefore their BPEL PXE engine
- Human workflow engine, written in BPEL
- User interface framework based on XForms/AJAX; XForms Designer is also integrated in Eclipse, which generates the code and configuration to integrate with the workflow engine.

BPMS Designer is a process modeling tool written with the latest Eclipse technologies that provides a set of applications to allow process developers to implement business processes without having to write code. On top of the Eclipse platform it provides all the tools for process designer including modeling at the business level, describing technical details, building connectors to external systems, mapping data in and out, specifying business rules, designing workflow user interfaces and deploying the code into runtime environments.

BPMS Designer is built around the BPMN Modeler, which provides several usability features that optimize the creation of complex processes.



Intalio BPMS also includes a BPMS server. This server is built on Apache Geronimo and Apache ODE.

Apache Geronimo 1.1 is an open source J2EE 1.4-certified open source application server. Unlike other J2EE application servers, Geronimo comes preintegrated with external resource components like a database, a messaging server, and a directory server. Geronimo is built on a highly customizable and modular architecture. It functions as a framework supporting existing open source components to form a complete J2EE application server package composed of over 30 best-of-breed open source projects. Geronimo is built on the GBeans architecture in which the Geronimo kernel acts as the central core, providing common security, deployment, administration, management, and life cycle services for these components. All the other services built into the server are provided by external components. Developers can custom-build these components for Geronimo or pull them in from other existing open source projects. Geronimo has gained popularity among the open source development community, and the highly anticipated release of its newest version, 1.1, provides several major enhancements to this powerful application server.

Apache ODE executes business processes written following the WS-BPEL standard. It talks to web services, sending and receiving messages, handling data manipulation and error recovery as described by the process definition. It supports both long and short living process executions to orchestrate all the services that are part of customer's application. ODE 1.0 is released recently with WS-BPEL 2.0 support. It supports JBI standard as its communication layer, more specifically; it uses ServiceMix high level ESB API to the engine to allow integration with the core with virtually any communication layer.

Apache ServiceMix is an open source distributed ESB built from the ground up on the JSR 208 specification and released under the Apache license. The goal of JBI is to allow components and services to be integrated in a vendor independent way, allowing users and vendors to plug and play.

- **J2EE compatibility**. Intalio BPMS includes three Apache projects: Geronimo, ODE and ServiceMix. It also uses Eclipse RCP framework as foundation of BPMS Designer

- **Process modeling**. On top of the Eclipse platform Intalio BPMS Designer provides all the tools for process designer including modeling at the business level, describing technical details, building connectors to external systems, mapping data in and out, specifying business rules, designing workflow user interfaces and deploying the code into runtime environments

- **Adapters**. Communications with JCA resources and legacy applications are facilitated by Apache ServiceMix. Apache ServiceMix is an open source distributed ESB built from the ground up on the Java Business Integration (JBI) specification and released under the Apache license. The goal of JBI is to allow components and services to be integrated in a vendor independent way, allowing users and vendors to plug and play

- **Communications protocols**. Apache ODE uses ServiceMix high level ESB API to the engine to allow integration with the core with virtually any communication layer

- **Human interaction**. BPEL4People is a paper authored by IBM and SAP that defines human workflow functionality and architectures (called 'constellations') in a WS-BPEL (aka BPEL) environment. Intalio's implementation of the BPEL4People model is made without any extensions of modifications to the standard BPEL 2.0 specification. Instead, ad-hoc task management services are deployed on top of the J2EE platform and are made available as Web services through WSDL interfaces, while using standard BPEL processes for advanced workflow patterns such as multi-channel notifications and alert escalations

- **Complex event processing**. BPMS Server generates events to allow tracking what is exactly happening in the engine and produces detailed information about process execution. These events are persisted in the database and can be viewed in the Console.

5.3 Sun Java CAPS V5.1

http://www.sun.com/software/javaenterprisesystem/javacaps/index.jsp

Comprehensiveness	Good
Human activity support	Satisfactory
Monitoring	Good
J2EE compatibility	Sufficient
Price	Satisfactory

Sun Microsystems enters BPM market via its acquisition of SeeBeyond Technology (one of the leading vendors in the integration space) in summer of 2005. Sun Microsystems's Java CAPS is a comprehensive and well-integrated platform built entirely through internal development. One of the key factors in Sun's decision to acquire the SeeBeyond Technology was the high level of J2EE compliance that the SeeBeyond tools provided, maximizing technology synergy during the firm's movement into the Sun family.

Sun Java CAPS is comprised of a combination of composite application integration products layered on top of infrastructure products. All are supported by a proven set of end-to-end graphical tools that deliver optimized source code for standards-based collaboration and business process execution. Developers may operate on the graphical model or directly on the source code which is synchronized with the graphical model. Additionally, developers may roundtrip with external IDEs.

The current product retains the core components of the earlier product (eGate Integrator, eInsight BPM, eXchange Integrator, eTL Integrator, eVision Studio, and eBAM Studio), but the SeeBeyond portal solution was replaced by the more capable Sun product and is referred to as the Java System Portal Server.

The next release of Sun Java CAPS will be made available as open source technology.

Components include:

- **Sun SeeBeyond eGate Integrator**. A J2EE compliant and Web services-based, distributed integration platform that serves as the foundation of Java CAPS. eGate Integrator provides core integration including comprehensive systems connectivity, guaranteed messaging, and robust transformation capabilities. It does this while providing a unified environment for integration development, deployment, monitoring, and management

- **Sun SeeBeyond eInsight Business Process Manager**. This product layers above eGate Integrator to enable process-driven integration. It allows business analysts to model, test, implement, monitor, manage, and optimize business processes that orchestrate the flow of activities across any number of Web services, systems, people, and partners. The product provides an open, graphical modeling environment using BPMN and BPEL

- **Sun SeeBeyond eVision Studio**. Generates interactive, composite Web pages for human interaction with applications and business processes without requiring any programming. It provides a graphical page layout designer and a rich set of GUI components. Portlets may be created in eVision Studio and implemented within the Sun Java System Portal Server

- **Sun SeeBeyond eTL Integrator**. Optimized for extracting, transforming, and loading bulk data between files and databases. It provides an ETL development and runtime environment that is fully integrated into the Java CAPS platform, and specially optimized for processing very large record sets

- **Sun SeeBeyond eBAM Studio**. BAM is a strategy that identifies actionable events based on combinations of real-time (or near real-time) business events across many different applications and other information resources. Sun SeeBeyond eBAM Studio provides configuration wizards that allow users to define rules for BAM and relevant business KPIs. It also provides a runtime environment for the execution of these rules, and displays components for graphical depiction of changes in the KPIs over time. The end result is a BAM composite application with end-user dashboards, reports, and alerts generated without any programming

- **Java System Application Server**. Provides a foundation for delivering enterprise class application services and Web services

- **Java System Portal Server**. Provides a user portal for collaboration with business processes and composite applications layered on top of legacy and packaged applications that are integrated using Java CAPS integration products

- **Java System Directory Server Enterprise Edition (EE)**. Serves as a directory backbone for composite application integration behind the Java System Portal Server. It enables today's mission-critical enterprise applications and large-scale extranet applications to access consistent, accurate, and reliable identity data for significant operational and cost efficiencies

- **Java System Access Manager**. Delivers open, standards-based authentication and policy-based authorization within a single, unified framework for the support of composite application integration. It secures the delivery of essential identity and application information on top of the Sun Java System Directory Server EE, and scales with growing business needs by offering single sign-on (SSO), as well as enabling federation across trusted networks of partners, suppliers, and customers.

Features of Sun Java CAPS evaluated in this research are listed as follows:

- **Architecture**
  - **High availability, load balancing and fault tolerance**. Runtime components achieve fault tolerance and high availability via clustering at the application level, J2EE level, and in conjunction with the operating system clustering software (such as Solaris Clusters). The persistence capabilities also offer both fault tolerance and high availability, using a transactional storage algorithm combined with a grid capability for completely uninterrupted service
  - **Identity management**. Java Composite Application Platform Suite (Java CAPS) includes identity management through Java System Directory Server plus Java System Access Manager
  - **Vertical Industry Support**. Sun provides specialized solutions for several sectors, including healthcare, consumer goods, automotive, oil and gas, high-tech, and telecom.
- **Process modeling**
  - **General features**. Models implemented in BPEL can be imported, but there are still differences in semantics that will likely result in the need for some modification of the model. Once such modification occurs, the model can be executed by the engine. Testing and debugging of the models are included
  - **Versioning**. The Java CAPS repository is a metadata store designed to hold metadata across all dimensions of composite applications and manage the lifecycle and versioning of this metadata for multiple users who are organizationally or geographically dispersed. It supports import/export, versioning, recursive drill-down impact analysis, and capture and storage of service and XML metadata
  - **Modeling standards**. The product supports BPMN and BPEL. Workflow is implemented by Sun proprietary service invocations (these could, of course, be called by external parties via the API exposed to proprietary or thick-client applications)
  - **Role-based modeling**. Java CAPS provides roundtripping in all of it's configuration canvases, including in the business process designer. Business users can manipulate the BPMN models, and technical professionals can use a code-oriented editor, either the one provided with Java CAPS or an external one. Users can switch back and forth between the connected views.
- **Protocols and adapters**
  - **Adapters**. Adapter types include database access, hierarchical (e.g., IMS), network (e.g., CA IDMS) and file-based (e.g., Adabas and Virtual Storage Access Method (VSAM), etc.) data sources, and packaged application adapters (e.g., Oracle, PeopleSoft, SAP, and Siebel, etc.), communication adapters (like HTTP(s), FTP, TCP/IP, etc.), and mainframe through screen based integration (e.g. 3270, 5250, VT100, Wise, etc.) and also CICS/IMS. Guaranteed delivery is provided only with XA compliant adapters. The configuration of the eWays is completely integrated with the Java CAPS single configuration environment (the Enterprise Designer), which provides wizards for instantiating the eWays and binding to real systems

- **Communications protocols**. CORBA, IIOP, RMI, and COM are supported out of the box. SOAP over HTTP and SSL are supported. IBM Websphere MQ, Microsoft Message Queuing (MSMQ), and JMS are supported out of the box. Customers typically use the JMS support to interact with TIBCO (as opposed to the proprietary RV protocol).

- **Transaction Management**. Support for J2EE transactions and transaction compensation

- **Event management**, including event definition support, complex event processing and business state machine support

- **Human-centric features**

  - **Desktop integration**. The Java CAPS eVision product allows for the construction of user presentations (implemented as JSP) from a drag-and-drop interface that is integrated with the business process management layer. CAPS provides various libraries, including eGate API Kit, WLM APIs, etc., that can be used by desktop applications for tighter integration with composite applications

  - **Human interaction**. Human interaction is modeled with the same canvas that system interaction is modeled; Sun uses BPMN as well as BPEL for both. Human activity is tracked by a worklist manager that contains the tasks assigned to users or groups of users. The tasks can be executed by user presentations created in Java CAPS (as in, for example, a company intra-net), forms shared by email, or via a Java API that can be embedded in any other application

  - **Resource assignment**. Resource balancing can be configured and calculated at runtime using an algorithm in the business process. However, the product does not have features provided out of the box.

- **Monitoring**

  - **Action management**. All of the features are supported. Error events can be routed to the alert agent, which offers alarms based on email, page, or fax. In addition, the alerts can themselves be interpreted as business events, meaning that any business process can be created to implement more complex processing logic (implemented in BPEL), such as launching Web services. The BAM product sits on top of the BPM product to monitor the critical KPIs and can create various business alerts based on some preset conditions. These alerts can then trigger other business processes, allowing for triggering both automatic and manual actions

  - **Process instance monitoring**. The Enterprise Manager provides a single Web-based management environment for the Java CAPS. The Enterprise Manager shows instance data color-coded based on state and progress, both in a list summarizing instances and a graphical drill-down showing the entire business process model

  - **Service monitoring**. The product provides comprehensive monitoring facilities for services and business processes. This functionality is provided through a unified management interface that can be used to monitor deployment environments and drill down to individual service instances and partners

- **Technical monitoring**. This is done from the Enterprise Manager, which provides a full browser of the business and technical aspects of the composite applications.

- **SOA Features**

  - **ESB capability**. The core of Java CAPS is the eGate product, which is a full ESB implementation

  - **Web Service Governance**. The product features dual binding architecture allowing service implementation and consumption in any native technology for which bindings are defined. Web services are supported as both front- and back-end binding technology. The product governs all types of services in a uniform way, regardless of specific implementation or consumption technology; naturally, governance of Web services is completely supported

  - **Core Web services**. Business processes in CAPS can be automatically exposed as Web services and can invoke other Web services in turn. The WSDL interfaces for Web services are generated and published when composite applications are built. The WSDLs are published to a UDDI-compliant registry. The Web services exposed from CAPS are WS-I BP-compliant. However, users can create Web service interactions that are not compliant with WS-I BP. Web services can be secured both at transport level using SSL and HTTP basic authentication and at message level using OASIS WS-Security tokens. WSDM is being investigated for a future release

  - **Extended Web services**. Sun has partially implemented the Liberty WSF protocol, basing it on its support for SAML. Java CAPS also implements security as per WS-I BSP.

5.4 Oracle Business Process Management Solution 10gR3

http://www.oracle.com/technologies/bpm/index.html

Comprehensiveness	Excellent
Human activity support	Good
Monitoring	Good
J2EE compatibility	Good
Price	Satisfactory

Oracle Business Process Management (BPM) solution is a set of open, standard-based Oracle Fusion Middleware components for modeling, executing, managing, and optimizing business process applications. Oracle BPM uses closed-loop engineering to eliminate process gaps and gain control over its entire business process lifecycle. The result is an agile and flexible platform, based on existing applications, that allows the business to react quickly to new business requirements and improves productivity.

Oracle BPM consists of components from Oracle BPA Suite and Oracle SOA suite.

Oracle Business Process Analysis (BPA) Suite speeds process innovation by rapidly modeling business processes and converting them into IT executables. Oracle contracted with IDS Scheer and based the BPA suite on IDS Scheer ARIS Design Platform. It is a comprehensive set of integrated products that allows business users to design, model, simulate, and optimize business processes to achieve maximum operational efficiency.

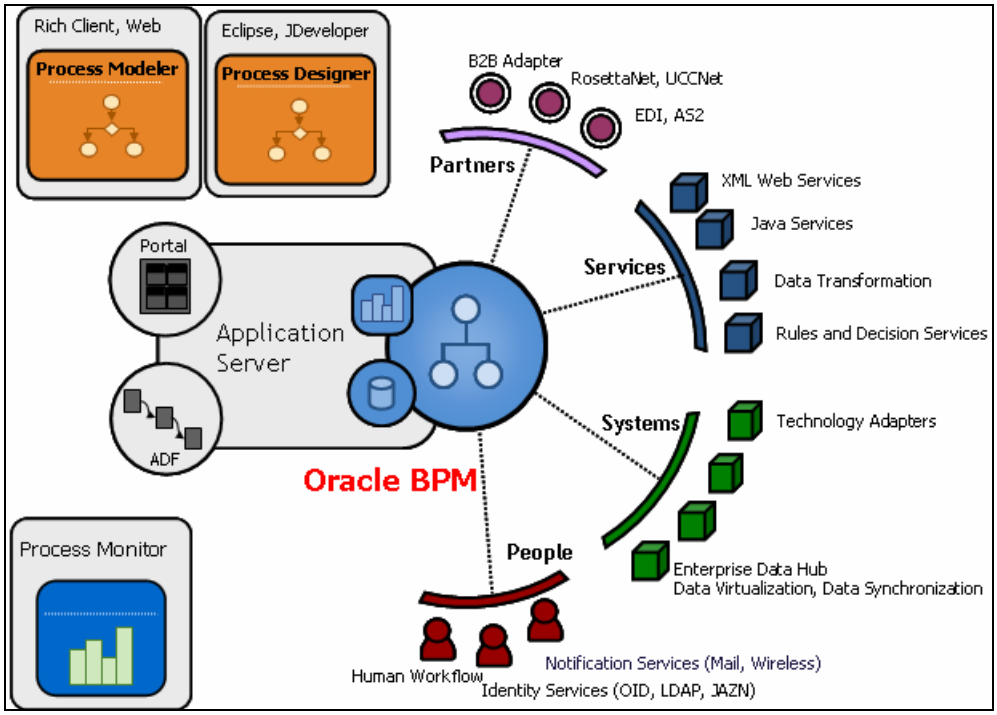
Oracle BPA has the following components:

- **Business Process Architect**. Standards-based tool for process modeling. Uses various standards-based notations and templates such as BPMN, EPC, etc.
- **Business Process Repository**. Server component for sharing the process repository across multiple users in a collaborative environment
- **Business Process Simulator**. Tool for simulating the process models based on a set of discrete events to do "what if" analysis
- **Business Process Publisher**. Publishes process models to a large audience outside of the core team designing the process models.

Oracle SOA Suite is a comprehensive, hot-pluggable software suite for the building,deployment, and management of a SOA. This includes the service-oriented development of applications, service-oriented integration of applications and IT systems, and process orchestration of system services and human workflow. It plugs into heterogeneous IT infrastructures and enables enterprises to incrementally adopt SOA. The components of the suite benefit from common capabilities including a single deployment and management model, tooling, end-to-end security and unified metadata management.

Oracle SOA consists of:

- BPEL-based Process Manager to compose services into business processes
- BAM solution to gain real-time visibility into operation and performance of business processes and services
- Business rules engine to capture and automate business policies
- Multiprotocol ESB to connect applications and route messages
- Web services management and security solution to enforce authentication and authorization policies on services
- Services registry for discovering and managing the lifecycle of services
- Integrated Service Environment (ISE) to develop, debug, profile, and deploy services.



Aspects of Oracle BPM solution are evaluated as follows:

- **Architecture**
  - **Globalization**. Oracle BPA is based on IDS Scheer ARIS. ARIS is Unicode-compliant and offers detailed features for translation and user generation of translations. ARIS supports multilingual modeling, multilingual methods and user interface
  - **High availability, load balancing and fault tolerance**. Oracle SOA Suite includes built-in support for clustering, enabling the clustering feature across application servers, including Oracle Application Servers, BEA WebLogic, IBM WebSphere, and JBoss
  - **Identity management**. The Oracle SOA Suite uses the Web Services Manager (WSM) component to authenticate and authorize in an integrated fashion across the stack. WSM authenticates and authorizes Web services requests against identity management infrastructures such as LDAP directories, Oracle Access Manager, or CA's eTrust SiteMinder, and plain files (mainly used by developers for test purposes)
  - **Vertical Industry Strategy**. The Oracle Business Process Analysis (BPA) Suite includes SCOR, eTOM, and ITIL models as starter process templates. The vendor also provides support for many industry-specific processes in its lineup of Oracle Applications, but it is not yet built on the Fusion middleware infrastructure.
- **Process Modeling**
  - **General features**. Oracle BPA Suite is based on the OEM of IDS Scheer ARIS Design Platform, which provides sophisticated modeling capability. Modeling outside of the BPA suite is done via a Rete-based rules engine. This is based on the JESS standard for which Oracle has created a UI that makes the tool usable for business analysts

- **Versioning**. The release cycle management solution (RCM), offered as a solution package, provides the capability to track the complete modeling life cycle (from model to review, release, and archive)

- **Role-based modeling**. The product provides a comprehensive collaboration environment for business analysts, enterprise architects, and developers, but the respective views are not linked

- **Business user control**. The Web-based authoring environment enables business users to create rules. Multiple options are supported for business users to change rules, including the ability to tweak controls by changing variables, customize rules within set up constraints, and make any change, including creation of new rules. Rule administration and editing permissions are based on roles.

- **Protocols and adapters**

  - **Adapters**. The Oracle SOA Suite features broad adapter support with more than 300 adapters, which includes those developed and supported by Oracle and OEMed from Attunity and iWay Software

  - **Communications protocols**. The Oracle SOA Suite supports RMI/IIOP, RPC, CORBA and .NET remoting through Web Services Invocation Framework (WSIF), delivering a very extensible binding framework.

- **Transaction Management**

  - **Multistep transactions**. Oracle SOA Suite includes a BPEL Process Manager (PM) component, goes beyond BPEL to support XA transactions for synchronous processes or synchronous portions within asynchronous processes

  - **Compensating transactions**. Oracle SOA Suite includes a BPEL Process Manager (PM) component, which implements the BPEL standard and has full support for long-running transactions, including compensating transactions per the BPEL specification.

- **Event Management**

  - **Business event management**. The BAM component of Oracle SOA Suite includes an event engine that can track events, and based on rules initiate actions. The BPEL component supports asynchronous out of band events and can modify the process execution based on such events. However, the vendor does not provide a component that supports comprehensive BEM optimization features

  - **Complex event processing**. The BAM component of Oracle SOA Suite includes an event engine that can track events, and based on rules initiate actions. The BPEL component supports asynchronous out of band events and can modify the process execution based on such events. More sophisticated CEP capabilities, including the notion of filters, time windows, and event correlation, are in advanced stages of development and will be available soon. However, the vendor does not have a component that supports comprehensive CEP optimization

- **State machine**. The BPEL component of the Oracle SOA Suite supports some state management capability, but a state machine is not provided as part of the product.

- **Human-centric features**

  - **Desktop integration**. A worklist application is provided for participants to find, organize, and perform work. It also enables the setting up of rules, vacations, etc. The worklist application includes out-of-the-box reports. JSP forms are automatically generated based on the payload data. Integration is also provided with Oracle Application Development Framework (ADF), a JSF-based technology for rich clients

  - **Human interaction**. People may participate in processes as: participants (perform work using worklist applications, emails, or other clients), initiators (track status of processes initiated), supervisors (manage performance of work by reportees using reports and other features within worklist applications), group owners (manage rules including rebalancing rules for a group/role), process owners (perform any action on behalf of any participant; reassign or rebalance, etc.), administrators (track state of process, take corrective actions, etc.), and notification recipients (receive a notification as an email, call, voicemail, SMS, or fax)

  - **Resource assignment**. The human workflow component enables process owners and group owners to enable automatic rebalancing of work. They can create rules to conditionally rebalance using one of the provided rebalancing algorithms — round robin, least busy, most productive — or a custom algorithm. They can also create rules to conditionally reassign work to a particular user or group and can reassign an instance of work.

- **Monitoring**

  - **Action management**. Oracle BAM supports action-oriented dashboards that enable business users to act from the context of the dashboards, and it supports setting up automated rules to invoke actions based on conditions

  - **Process instance monitoring**. Oracle BAM has the ability to monitor and track BPEL processes, filter instances (filters and sorts can be created or customized by end-users flexibly and easily), and aggregate instances (aggregate functions can give average time for process completion, total time for end-to-end process, etc.)

  - **Service monitoring**. In addition to the Oracle BAM discussed above, the Oracle SOA Suite includes a Web Services Manager (WSM) component that supports monitoring of access control events (authentication and authorization) and SLAs defined at the Web service level. Root-cause analysis is supported by the Oracle BAM component discussed above

  - **Technical monitoring**. The BPEL PM component features administration consoles for end-to-end technical monitoring of processes. Process status is presented graphically, as well as textually, to aid audit and analysis.

- **SOA Capability**
  - **ESB capability**. The Oracle SOA Suite includes ESB functionality, which features a multitransport bus that supports JMS, SOAP, Web services, and a wide range of more than 300 adapters, from legacy to enterprise applications, databases, files, email etc. Its breadth of protocols based on open standards reduces complexity and increases performance for customer implementations. The built-in persistence to database or files, fast-path in-memory, and native support for third-party messaging systems provides a robust messaging model
  - **Web Service Governance**. The Oracle SOA Suite includes a Web Services Manger (WSM) component, which supports governance by defining security rules for access control and SLA. Graphical views of governance metrics are provided by the monitor component of the WSM product
  - **Core Web services**. Oracle provides support for a broad range of Web services technology, including but not limited to SOAP, WSDL, UDDI (v2 and v3), WS-Security, WS-I Basic, and WSDM, plus other core capabilities, including WSIF, WS-Addressing, and WS-Policy
  - **Extended Web services**. Complete support for extended Web services includes WS-Addressing, WS-I Attachments, WS-RX, Liberty, SAML, WS-Policy, WS-Trust, WS-BSP, REST, Asynchronous Web services, and more.

5.5 JBoss jBPM 3.2

http://www.jboss.com/products/jbpm

Comprehensiveness	Satisfactory
Human activity support	Poor
Monitoring	Poor
J2EE compatibility	Excellent
Price	Excellent

JBoss jBPM is a flexible, extensible framework for process languages. jPDL is one process language that is build on top of that common framework. It is an intuitive process language to express business processes graphically in terms of tasks, wait states for asynchronous communication, timers, automated actions. To bind these operations together, jPDL has the most powerful and extensible control flow mechanism.

jPDL has minimal dependencies and can be used as easy as using a Java library. But it can also be used in environments, where extreme throughput is crucial by deploying it on a J2EE clustered application server.

jPDL can be configured with any database and it can be deployed on any application server.

jBPM has the following componets:

- **The jPDL graphical process designer**. The designer is a graphical tool for authoring business processes. It's an eclipse plugin that supports both the business analyst and the technical developer. This enables a smooth transition from business process modelling to the practical implementation. The plugin is available as a local update site (plain zip file) for installation via the standard eclipse software updates mechanism

- **The jBPM console web application**. The jBPM console web application serves two purposes. First, it serves as a central user interface for interacting with runtime tasks generated by the process executions. Secondly, it is an administration and monitoring console that allows to inspect and manipulate runtime instances. The third functionality is BAM. These are statistics about process executions. This is useful information for managers to find bottlenecks or other kinds of optimisations

- **The jBPM core library**. The JBoss jBPM core component is the plain Java (J2SE) library for managing process definitions and the runtime environment for execution of process instances.

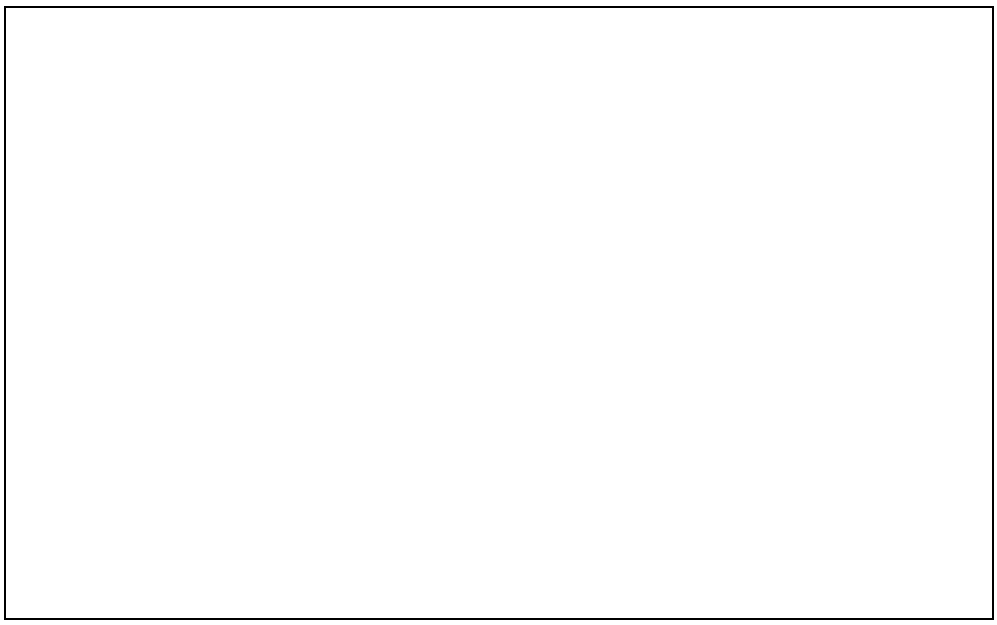
  JBoss jBPM is a Java library. As a consequence, it can be used in any Java environment like e.g. a webapplication, a swing application, an EJB, a webservice, etc. The jBPM library can also be packaged and exposed as a stateless session EJB. This allows clustered deployment and scalability for extreme high throughput. The stateless session EJB will be written against the J2EE 1.3 specifications so that it is deployable on any application server.

  The library jbpm-jpdl.jar has some dependencies on other third party libraries such as e.g. hibernate, dom4j and others. For its persistence, jBPM uses hibernate internally. Apart from traditional O/R mapping, hibernate also resolves the SQL dialect differences between the different databases, making jBPM portable across all current databases.

  The JBoss jBPM API can be accessed from any custom Java software in a project, like e.g. a web application, an EJB's, a web service components, message driven beans or any other Java component.

- **The JBoss jBPM identity component**. JBoss jBPM can integrate with any company directory that contains users and other organisational information. But for projects where no organisational information component is readily available, JBoss jBPM includes this component. The model used in the identity component is richer then the traditional servlet-, ejb- and portlet models

- **The JBoss jBPM Job Executor**. The JBoss jBPM Job Scheduler is a component for monitoring and executing jobs in a standard Java environment. Jobs are used for timers and asynchronous messages. In an enterprise environment, JMS and the EJB TimerSerive can be used for that purpose. But the Job Executor can be used in a standard environment



Special highlight of jBPM's features include:

- **Architecture**
  - **High availability, load balancing and fault tolerance**. Clustering, caching, fail-over, load balancing is provided by services of application server JBoss
  - **Identity management**. jBPM will provide (in the future) a component to manage that simple user-roles model. This many-to-many relation between users and roles is the same model as is defined in the J2EE and the servlet specs and it could serve as a starting point in new developments.
- **ESB capability**

  jBPM does not have ESB capability. JBoss has a JBossESB offering, with the following features:
  - Support for general notification framework. Transports supported include JMS (JBossMQ, JBoss Messaging and MQSeries), email, database or file system
  - Support for data transformations using Smooks or XSLT
  - Listeners and action model to support loose-coupling of interaction steps
  - Content based routing using JBoss Rules or XPath
  - Support for registries, using JAX-R and jUDDI out-of-the-box
  - Durable object repository.

5.6 ActiveBPEL 3.0 and ActiveDesigner from Active Endpoint

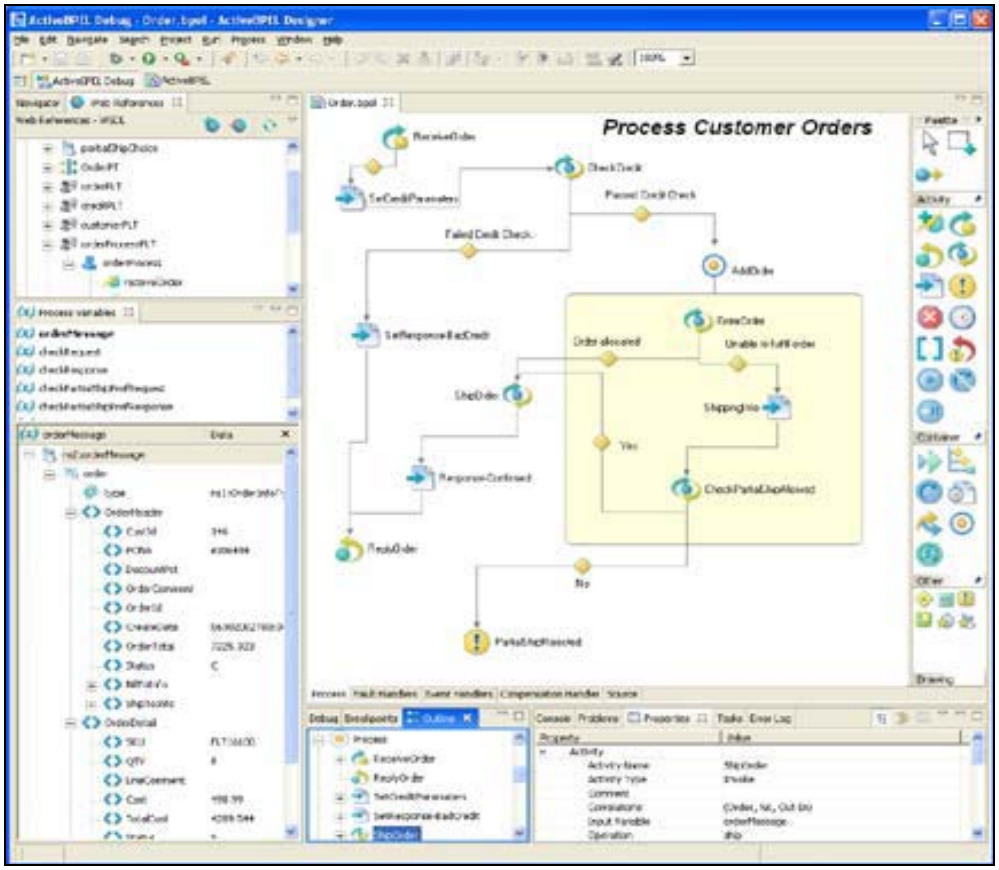
http://www.active-endpoints.com/index.htm

Comprehensiveness	Sufficient
Human activity support	Satisfactory
Monitoring	Poor
J2EE compatibility	Good
Price	Excellent

The ActiveBPEL product family includes open source and commercial SOA orchestration solutions that form the foundation for fast, cost-effective business and systems integration. ActiveBPEL Designer allows users to create and test BPEL processes, and then deploy those processes to ActiveBPEL Enterprise servers that scale from desktop to data center and meet the most rigorous performance demands. Enterprise developers and systems integrators use ActiveBPEL to reduce the time and complexity of implementing SOA applications. ActiveBPEL is also the embedded, best-in-class solution for many leading software providers who include BPEL in their own products.

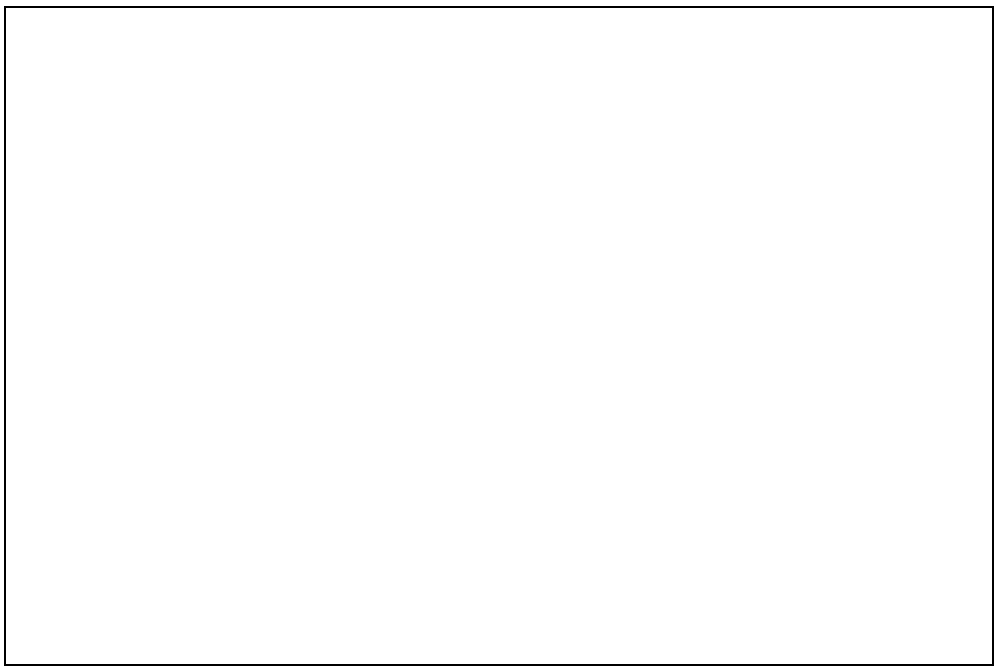
ActiveBPEL Designer is an integrated environment for rapidly building, testing and deploying applications based on the BPEL standard. A native Eclipse Ready technology that combines intuitive BPEL authoring tools with an embedded version of the ActiveBPEL engine technology, ActiveBPEL Designer is used by thousands of architects and developers to build loosely-coupled, composite SOA applications.

- Eclipse-Ready BPEL development environment
- Drag and drop process diagramming
- Web References - intelligent WSDL catalog
- Template based message mapping
- Reusable BPEL components (BPELets)
- Advanced Find and Where-used controls
- Business operation and WSDL creation assistants
- Auto-generation of BPEL process definitions
- Full design-time simulation
- Pushbutton deployment to ActiveBPEL Enterprise servers.



The ActiveBPEL open source engine is a commercial-grade open source implementation of the BPEL standard. The ActiveBPEL engine is made available under the GNU General Public License (GPL).

There are three main areas in the architecture of the ActiveBPEL engine: the engine, processes, and activities. The ActiveBPEL engine coordinates the execution of one or more BPEL processes. Processes are in turn made up of activities, which may in turn contain or link to further activities. The ActiveBPEL engine creates a process from a BPEL process definition and then executes this process.



Key benefits of using ActiveBPEL engine technology include:

- **Completeness**. The ActiveBPEL engine comprehensively implements both the BPEL4WS 1.1 specification and the WSBPEL 2.0 standard. The engine supports the full complement of BPEL activities, event handling, exception handling and scope/compensation management
- **Industrial Strength**. In addition to comprehensive BPEL support, the ActiveBPEL engine includes high-end features like deployment packaging, process persistence, event notifications and console APIs
- **Growth Track**. As a distributor of commercial products based on the ActiveBPEL engine, Active Endpoints is committed to the ongoing development of ActiveBPEL technologies. The ActiveBPEL open source project will continually benefit from the contributions of both Active Endpoints and the ActiveBPEL community at large

Active Endpoint has also a commercial offering for high-end BPEL engine.

ActiveBPEL Enterprise Servers has the following high-end features:

- Process versioning
- Process hydration/dehydration
- Process exception management
- Load balancing and fault tolerance
- Alerting and notification services
- Reliable messaging and sub-process execution support
- RDBMS and XML database persistence
- Advanced endpoint location services

- Rich browser based consoles (text and diagrams)
- Standard interfaces: Web services, EJB, Java, .NET
- Pluggable Web services frameworkWeb services administrative APIs.

5.7 Apache ODE 1.0

http://incubator.apache.org/ode/

Apache ODE executes business processes written following the WS-BPEL standard. It talks to web services, sending and receiving messages, handling data manipulation and error recovery as described by your process definition. It supports both long and short living process executions to orchestrate all the services that are part of an application.

Comprehensiveness	Poor
Human activity support	Poor
Monitoring	Poor
J2EE compatibility	Excellent
Price	Excellent

The key components of the ODE architecture include the ODE BPEL Compiler, ODE BPEL Engine Runtime, ODE Data Access Objects (DAOs), ODE Integration Layers (ILs), and user tooling.

- **ODE BPEL Compiler**

  The BPEL compiler is responsible for the conversion of the source BPEL artifacts (i.e. BPEL process documents, WSDLs, and schemas) into a compiled representation suitable for execution. The output of the compiler is either a "good" compiled representation, or a list of error messages indicating problems with the source artifacts.

  The compiled BPEL representation generated by the compiler is an object model similar in structure to the underlying BPEL process document. However, the compiled representation has resolved the various named references present in the BPEL (such as variable names), internalized the required WSDL and type information, and generated various constructs (e.g. default compensation handlers). The compiled representation (typically a file with the .cbp extension) is the sole artifact required by the BPEL runtime.

- **ODE BPEL Engine Runtime**

  The ODE BPEL Engine Runtime ("runtime") is found in the bpel-runtime module and provides for the execution of compiled BPEL processes. The runtime handles the dirty work of process execution by providing implementations of the various BPEL constructs. The runtime also implements the logic necessary to determine when a new instance should be created, and to which instance an incoming message should be delivered. Finally, the runtime implements the Process Management API that is used by user tooling to interact with the engine.

  To achieve reliable execution of processes in unreliable environments, the runtime relies on Data Access Objects (DAOs) to provide persistence facilities. The implementation of these DAOs can be customized, but is typically provided by a transactional relational database. The DAOs are described in more detail in the next section.

The runtime implementation of BPEL constructs at the instance level is via ODE's Java Concurrent Objects (Jacob) framework. Jacob provides an application-level concurrency mechanism (i.e. it does not rely on threads) and a transparent mechanism for interrupting execution and persisting execution state. Jacob is in very large part a Java implementation of the ACTORS concurrency model and shares many features with process algebras such as \pi -calculus. Essentially, Jacob provides a persistent virtual machine for executing BPEL constructs.

- **ODE Data Access Objects**

  ODE Data Access Objects mediate the interaction between the BPEL Engine Runtime and an underlying data store. Typically the data store is a JDBC relational database: in this case, the DAOs is implemented via the Hibernate data access library. It is possible to create custom DAO implementations that employ a mechanism other than JDBC to achieve persistence, although no such implementation is provided.

- **ODE Integration Layers**

  The ODE BPEL Engine Runtime cannot exist in a vacuum: by itself it is incapable of affecting any interaction with the outside world. For this it relies on the ODE Integration Layers (ILs). Integration Layers embed the runtime in an execution environment. For example, there are integration layers for AXIS2 and JBI. The fundamental function of an IL is to provide communication channels for the runtime. The AXIS2 IL achieves this by using the AXIS2 libraries to allow the runtime to communicate via Web Service interactions. The JBI IL achieves this same goal by tying the runtime into the JBI message bus.

  In addition to communication, an IL provides the runtime with a thread scheduling mechanisms, and manages the life-cycle of the runtime (i.e. configuring and starting the runtime).

Appendix. Comparison Matrix

Product	ActiveDesigner/ActiveBPEL	Apache ODE	JBoss jBPM	INTALIO	IBM BPM Solutions V6.0	Oracle SOA Suite	Sun CAPS
OS Platform	Windows 2003 Server / 2000 Server /XP Professional /2000 Professional RedHat 9.0 RedHat ES 9.0 SUSE 9.0	Windows 2000 Windows XP Linux MacOS X Solaris AIX	Windows UNIX Linux	Windows Linux x86	AIX HP-UX on PA-RISC HP-UX on Itanium Linux® on x86 Linux on x86-64 Linux on System z9 and zSeries Linux on POWER, iSeries Solaris SPARC Solaris x64 Windows	Windows Linux x86 ARIS components are usually either web-based or Windows-based	Sun Solaris 8, 9, and 10 with required patches (SPARC) Sun Solaris 10 (AMD Opteron) HP-UX 11i (11.11) on PA-RISC, and 11i v2.0 IBM AIX 5L Microsoft Windows 2000 SP3 and SP4, Windows XP SP2, and Windows Server 2003 R2 Red Hat Linux and SUSE Linux
Application Server Platform	Apache Tomcat BEA WebLogic Server IBM WebSphere Application Server JBoss Application Server Microsoft .NET Framework	Works with application server via AXIS@ Integration for JBI integration	Standalone, in a Java VM, inside of any Java application, inside any J2EE application server	Apache Geronimo	IBM Websphere	Oracle Application Server WebSphere JBoss and WebLogic	eGate Integrator is a J2EE technology-compliant and web-services-based distributed integration platform

Product	ActiveDesigner/ActiveBPEL	Apache ODE	JBoss jBPM	INTALIO	IBM BPM Solutions V6.0	Oracle SOA Suite	Sun CAPS
Database Platform	MySQL — version 4.1.7 Microsoft SQL Server 2000 — version 8.00.194 Oracle — version 10g DB2 — version 8.1	The ODE distribution includes a DAO implementation for JDBC databases built using Hibernate, which work with most RDBMS	Oracle MySQL Hypersonic SQL PostgreSQL and any other JDBC-compliant	MySQL Derby	Any database WebSphere application server can work with	Any database that the application server can work with	eGate Integrator can communicate with and link multiple applications and databases across a variety of different operating systems
J2EE compatibility	Based on J2EE servers and uses Eclipse	Integration with J2EE via JBI interface and AXIS2	Standalone, in a Java VM, inside of any Java application, inside any J2EE application server, for example JBoss	J2EE compatibility is ensured through Eclipse and Geronimo	The product is either based on Websphere application server, or Eclipse. Its compatibility with J2EE is protected by IBM's investment on its application server and eclipse	The application server used by Oracle BPM solution are all J2EE servers. IDS Scheer ARIS supports J2EE	Sun acquired the SeeBeyond technology for the high level of J2EE compliance that the SeeBeyond tools provided
Globalization	N/A	N/A	N/A	N/A	Strong	Strong	Supports Unicode
High availability, load balancing and fault tolerance	Multi-level load balancing and server fault-tolerance is available only at the commercial enterprise edition	No	Support by the hosting application server, JBoss for example, has HA, load balancing and fault tolerance features	Apache Geronimo supports clustering with its constituent Tomcat web container, or one can use third party clustering products with Geronimo	Strong	Strong	Strong

Product	ActiveDesigner/ActiveBPEL	Apache ODE	JBoss jBPM	INTALIO	IBM BPM Solutions V6.0	Oracle SOA Suite	Sun CAPS
Identity management	No	No	Will be provided in the future	Only in commercial version	Strong	Strong	Strong
Vertical Industry Support	No	No	No	No	Strong	Strong	Strong
Single server cost	Free	Free	Free	Free	$209,000.	$24,400	$20,000
Multi server cost	Free	Free	Free	Free	$955,000	$244,000	$200,000
Support Cost	Subscription model, support comes only for commercial version	No	Commercial support available from JBoss partners	Commercial support available		$4,400/per server/year	20%
Process Versioning	Available only from commercial version	No	No	Depend on Eclipse's integration with version control tools	Yes	Yes	Yes
Modeling standards	BPEL 1.1 and 2.0	BPEL 1.1 and 2.0	JPDL as native process language, supports WS-BPEL 1.1	BPMN, BPEL, WSDL and BPEL4People	BPEL, WSDL, UML, and portions of BPMN.	BPMN, BPEL, XPDL	BPMN, BPEL
Role-based modeling	No	No	No	No	Yes	Yes	N/A
Adapters	No	No	No	Strong	Strong	Strong	Strong
Communications protocols	No	No	JMS	Strong	Strong	Strong	Strong
Multistep transactions	Yes for commercial versions	No	Depends on embedding system	Yes	Yes	Yes	Yes

Product	ActiveDesigner/ActiveBPEL	Apache ODE	JBoss jBPM	INTALIO	IBM BPM Solutions V6.0	Oracle SOA Suite	Sun CAPS
Compensating transactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Complex event processing	No	No	No	Weak	Strong	Strong	Strong
State machine	No	No	No	No	Yes	No	Yes
Desktop integration	No	No	No	No	Yes	Yes	Yes
Human interaction	No	No	No	Supports BPEL4People	Strong	Weak	Weak
Resource assignment	No	No	No	No	Strong	Weak	Weak
Action management	No	No	No	No	Strong	Strong	Strong
Process instance monitoring	No	No	No	No	Strong	Strong	Strong
Service monitoring	No	No	No	No	Strong	Strong	Strong
Technical monitoring	Weak, via console	No	Weak, via console	Weak, via console	Strong	Strong	Strong
ESB capability	No	No	Not out of box, JBossESB has strong support	Strong	Strong	Strong	Strong
Web Service Governance	No	No	No	Weak, depends on Infravio X-Registry	Strong	Strong	Strong

Product	ActiveDesigner/ActiveBPEL	Apache ODE	JBoss jBPM	INTALIO	IBM BPM Solutions V6.0	Oracle SOA Suite	Sun CAPS
Core Web services	BPEL1.1 and 2.0	BPEL1.1 and 2.0	BPEL1.1	BPEL1.1 and 2.0	SOAP 1.1 and 1.2 WSDL UDDI v2 and v3 WS-Security, and WS-I Basic Profile	SOAP WSDL UDDI (v2 and v3) WS-Security WS-I Basic, and WSDM WSIF WS-Addressing, and WS-Policy.	WSDL, WS-Security
Extended Web services	WS-Addressing WS-ReliableMessaging WS-Security	No	JBossWS comes with: Web Service Metadata (JSR-181) EJB3 Stateless Session endpoints WS-Security for XML Encryption/Signature of the SOAP message WS-Addressing and JSR-261 WS-Transaction WS-Eventing WS-Policy MTOM/XOP	WS-Notification	WS-Addressing WS-I Attachments Profile V1.0 WS-I Basic Security Profile WS-Atomic Transactions WS-Notification and WS-BusinessActivity	WS-Addressing WS-I Attachments WS-RX Liberty SAML WS-Policy WS-Trust WS-BSP REST Asynchronous Web services	Liberty WSF SAML WS-I BSP