Research

DECISION MAKER’S GUIDE:
SAP’s SOA-Based Process Integration

An updated assessment of SAP’s SOA Middleware Platform

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Executive Summary

For a number of years now, SAP has been building integration functionality into its suite of offerings through its SAP NetWeaver product line. Initially, the SAP NetWeaver Exchange Infrastructure (XI) product was the main focus for this activity. In 2005, however, SAP updated its offerings and brought all this functionality into NetWeaver, delivering one codebase that is capable of sustaining a range of functional capabilities, or usage types in SAP terms. Since then, SAP has continued to update NetWeaver to enhance its capabilities, and particularly its Process Integration usage type. SAP’s integration approach is designed with a number of key objectives in mind:

- Deliver the full range of integration options within a single platform
- Embrace and adopt industry standards wherever possible
- Place a particular focus on providing added value for SAP application users

So, SAP NetWeaver Process Integration 7.1 supports application to application (A2A), business to business (B2B), process-based, consumer-based and service-oriented (SOA) integration models. Integration is all XML-based, with support for standards such as WSDL, UDDI, BPEL and JCA. And for users of the SAP suite of applications, there are a range of powerful options to speed up integration efforts and improve productivity, such as the provision of a library of process templates that can be used and customized as required rather than having to be built from scratch. The SAP NetWeaver software is designed to be robust and scalable, offering an integration solution for both SAP and non-SAP users that provides an ideal base for service-oriented architecture (SOA) projects and initiatives. The following table provides a quick summary of the strengths of the SOA and process integration capabilities offered by SAP NetWeaver, and the remaining challenges it faces.

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<tr>
<th>Strengths</th>
<th>Challenges</th>
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<tr>
<td>Support for a full SOA methodology, including process modeling</td>
<td>Limited range of fully integrated adapters</td>
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<td>Enterprise Services Repository</td>
<td>Multiple development tools instead of a single environment</td>
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<td>- Breadth of information</td>
<td>Lack of integration to enterprise management frameworks</td>
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<td>- Design, configuration and runtime usage</td>
<td>No ‘advanced’ BAM functionality (eg predictive)</td>
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<td>- Governance features</td>
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<td>Program-centric and human-related process support</td>
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<td>High-end support</td>
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<td>- Powerful mapping option</td>
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<td>- HA support</td>
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<td>- Different qualities of service</td>
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<td>Strong productivity / agility features</td>
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<td>- Ready-to-run process templates for SAP applications</td>
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<td>- Pre-packaged, industry-specific content to address common business needs</td>
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<td>- Composition environment for building applications from reusable SOA-based assets</td>
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<td>Extensive B2B support</td>
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<td>Open, JCA-based adapter framework</td>
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<td>SAP Developer Network</td>
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<td>Market exposure and uptake</td>
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Figure 1: SAP NetWeaver strengths/challenges in the area of SOA and process integration
Introduction
The purpose of this paper is to assess SAP’s current strategy and offerings for providing a service-oriented architecture (SOA) based platform for process integration. There are two distinct areas included in this assessment – the support for the service-oriented approach to component architecture, and process support to enable business process integration to be managed effectively. These areas will be assessed in terms of provision of basic functional requirements and value-add areas of potential differentiation.

SOA platform requirements
In order to make the assessment, it is necessary to set the functional baselines against which the SAP offerings can be measured. On the SOA side, there is a range of functionality that most people have come to expect of an SOA platform. The diagram below summarizes the major functional categories.

**Figure 2:** Generic components found in an SOA platform

The Registry is a repository for information about available services, such as functionality, location and invocation rules. The communications pipe is augmented by gateways and adapters to hook into specific source and target technologies, applications and environments. Mediation services allow information to be transformed and enriched as it passes between components and services, and provide for the flow to be controlled and dynamically modified based on business policies and rules. Development tools fall into two categories: those that support the SOA infrastructure itself, and those designed to help with the creation, composition and deployment of the business services. Finally, the operational tools deal with management and governance needs such as controlling security, monitoring performance and resolving problems.

Apart from these functional areas, the SOA platform is also expected to support at least the key standards. In SOA terms these are:-

- XML
- Web Services
- BPEL (for orchestration)
**Business process support**

Service-oriented architecture makes individual pieces of business functionality available as reusable, loosely-coupled services. This makes SOA the ideal underpinning technology for business process integration and management. Processes consist of process steps, and these process steps can be represented by individual SOA services or orchestrated combinations of them. Combining business process support with SOA yields an environment where processes can be defined and changed quickly, easily and effectively, without the need to make sweeping technical code changes.

There are a number of functions required for this business process support. These are

- Process modeling and implementation
- Process execution, supporting both program-to-program and human-oriented activities
- Process analysis

These areas encompass both functionality and tools. The modeling refers to the ability to develop process flows graphically through flowcharts, and to assess the impact of the modeled behavior. Then the process flows need to be implemented and deployed for run-time execution. Flows are dynamically controlled, to enable business policies and rules to govern their execution, and finally some level of statistical reporting will be expected to enable performance to be assessed.

**Overview of SAP’s SOA and Process Integration Offerings**

SAP has been providing an increasing level of support for integration needs over the past few years. The current offering, which is the main focus of this assessment, is SAP NetWeaver, and in particular its Process Integration capability or ‘usage type’.

**Current offerings**

SAP’s functionality to support SOA and process-based integration is supplied through its NetWeaver family of offerings. The key component as far as SOA and process integration are concerned is SAP NetWeaver Process Integration 7.1 (SAP NW PI 7.1). This is the latest in a series of product upgrades based on the combination of the old integration offering, SAP NetWeaver Exchange Infrastructure (XI), together with the NetWeaver application server component. The diagram below shows the main building blocks of SAP’s Enterprise SOA solution, showing both the PI area of functionality and also the related SAP NetWeaver Composition Environment (SAP NW CE) layer.
The Process Integration (PI) layer provides the basis for SAP’s SOA provisioning and run-time infrastructure, while the Composition Environment (CE) layer contains the development tools for consuming the base-level services and events. Within the PI layer, the Integration Server is the vehicle for delivering the run-time part of the SOA functionality, while the Integration Builder and Enterprise Services Builder tools provide the development environment for creating the core building blocks of the SOA deployment.

An Adapter Engine handles connectivity to a range of packaged and home-grown applications and technologies, and can either run within the Integration Server environment or stand-alone. The NetWeaver Partner Connectivity Kit (PCK) offers another environment for adapter execution, providing a lightweight, small-footprint version of the NetWeaver environment to act as an on-ramp to the wider NetWeaver implementation.

**SOA and process integration use cases**

Before carrying out the assessment, it is worth reflecting on some of the use cases for NetWeaver’s process integration capabilities. It can be used in a wide variety of situations, such as

- Classical application integration (A2A)
- Delivering service provisioning capabilities (SOA)
- Business-to-business interactions
- Operational collaboration and workflow
- Program-level process modeling, integration and management
- Provisioning of enterprise portals

Some of these areas leverage additional functionality available in NetWeaver, such as the Enterprise Portal component. These use cases will be discussed in the later section on flexibility.
Review of product capabilities

The first step of the assessment process is to understand the product capabilities within SAP's NetWeaver-based solution, within the context of SOA and process integration needs. Once the salient features of the functionality are understood, it is then possible to make a general assessment. In order to make this assessment as useful as possible to end users considering SAP's various SOA and process integration offerings, it will be arranged in two parts.

- Basic functionality required to support SOA-based process integration
  - SOA platform requirements
  - Process support requirements
  - Tools for configuring the SOA deployment and building the base services and integrations
- Value-add functionality beyond the basic level of support

The reason for this split is that the basic functionality represents the fundamental level of functionality offered by all vendors of SOA and process integration solutions, and produces a good baseline for comparisons. However, the second section on value-add capabilities is likely to provide the areas of differentiation that may have the biggest effect on any purchase decision.

Basic requirements – SOA platform support

It is helpful to review SOA and process support separately, as discussed at the start of this paper. The area of development tools, however, makes more sense when looked at in combination. The first section will deal with the SOA requirements.

Registry

The registry is a key element of any successful SOA implementation. It has two extremely important purposes – to provide a repository where all information related to each service can be stored, and to provide the process flow information to be used at runtime to control operational execution across the SOA.

The usage of the registry to record service information is key to one of the drivers for SOA adoption – increased levels of reuse. The problem is that developers are generally rather resistant to reuse, preferring instead to design and develop everything from scratch. If reuse is to succeed, it must be really easy for the programmer to review lists of available services, and quickly understand what the services do and whether they are relevant. If a service looks a good candidate for reuse, then additional information is required to enable the programmer to understand how to invoke the service and receive the results, and any other relevant information such as security or quality of service requirements. In this case, the registry also provides a useful tool to implement corporate policies and procedures.

In runtime terms, the registry must be able to meet potentially high levels of demand efficiently, across the enterprise and beyond. This may well require federation and/or caching technologies. In some SOA registry tools, the development and runtime repositories are separated to make it easier to address the performance needs of the runtime component.

SAP NetWeaver provides the SAP Enterprise Services (ES) Repository, a central repository which combines a repository for all the process and integration definitions, and a UDDI V3-compliant services registry which is essentially a yellow pages guide of all available services and the information needed to use them. So, within this combined repository, business object, business process and service information is stored together with the related metadata. SAP has elected to provide users with a single logical repository rather than deliver separate offerings for design-time and run-time needs. This approach minimizes confusion for the user, while leaving SAP with the flexibility to implement whatever characteristics are required in the above roles under the covers.
The ES repository holds all sorts of information, such as

- Index of available services (with associated WSDL etc)
- XSD data types
- Data mappings (eg to/from XML)
- BPEL-based collaborative processes
- Process component definitions
- Service endpoint definitions
- Security settings
- Documentation

The last point is worth stressing. As well as specifying the information required for SOA and business process execution, the ES repository allows users to record documentation on particular services. This is extremely useful when trying to encourage a higher degree of services reuse. It makes it much easier for developers to find and understand the appropriate services for their needs, making it less likely that the developer will write new function from scratch.

Communications, Connectivity and Mediation services

This is perhaps the best understood area of all aspects of integration. There have been many solutions, from message brokers to ESBs (Enterprise Service Bus). The main requirements are:

- Multi-platform, asynchronous, message-based connectivity
- Connectivity with as many different environments, technologies and application types as possible
- A transformation/mapping service, to map data formats between target and source components
- Intelligent routing and orchestration, to allow dynamic determination of component linkage and flow
- Support for key integration standards such as XML and web services

The essence of the SAP approach is to use XML messages for all internal activities. Messages entering the Integration Server domain must be transformed to an XML format on entry, using the provided transformation tools or adapters. During message processing between components, mediation services are provided, such as format mapping and intelligent routing. Note that SAP refers to the transformation of formats between XML and non-XML as ‘transformation’, while transformation of XML data between source and target requirements is termed ‘mapping’.

Tools will be discussed in greater detail in the next section. Focusing on run-time functionality and processing the first point to note is that, in addition to handling XML messages, the Integration Server has special support for handling SAP IDocs and RFCs. This is particularly useful for customers that have already invested in these earlier integration forms, allowing them to be brought into the new Process Integration environment. Secondly, during message processing the Integration Server not only deals with mappings and intelligent routing, but it also provides for routing to multiple receivers and executing on pre-defined collaboration procedures. The support for multiple receivers gives SAP functionality similar to that offered by Publish / Subscribe implementations, although there is no explicit functionality for a user to subscribe to a particular class of information. But by combining event-driven support with the support for multiple receivers, it would be possible to achieve Pub/Sub-like support. Apart from this, the collaborations capability offers the ability to agree such integration characteristics as security requirements between components.

Three levels of QoS (Quality of Service) are supported, based around WS-RM standards – two asynchronous and one synchronous. In asynchronous mode, users can choose between exactly once delivery, where messages are sent once and only once, or the same with the additional requirement of processing messages in the specified order. The synchronous option follows the traditional blocking model, where the sender waits until receiver confirmation.

Mapping of the XML data between source and target requirements is carried out through the use of Java mapping programs created with the Graphical Mapping Editor. SAP has also partnered with Informatica to
offer the SAP Conversion Agent which specifically handles bi-directional XML conversion needs for unstructured or semi-structured information, such as loaded from Microsoft Office tools or in interim formats like EDIFACT and FIX.

Connectivity is provided through the use of an adapter framework based on JCA (Java Connector Architecture). As well as providing the vital support for web services, there are a range of other adapters provided directly by SAP, and many more through third party relationships with iWay for application adapters, and Seeburger for EDI ones. SAP-provided adapters include SAP RFC, SAP Business Connector, SOAP, JMS, JDBC, email, FTP, HTTP and HTTPS. For those looking to build customized adapters, SAP offers built-in NetWeaver tools for this purpose. These tools are also available in the Partner Connectivity Kit, a lightweight small-footprint version of NetWeaver designed to provide an outboard adapter environment to act as an on-ramp to the full NetWeaver environment. The PCK is often used by third parties wanting to build specialized adapters for particular applications or technologies. There are already more than 60 certified third party adapters available from 20 vendors.

Standards support includes specific adapters for MML for MarketPlaces, RosettaNet for the high tech industry and CIDX for the chemical industry. In addition, a number of key web services standards are supported, such as WS-ReliableMessaging to provide interoperability with other service buses.

**Basic requirements – Business Process support**

Fundamentally, the three key functions required to deliver basic business process support are modeling/implementation, execution and analysis.

**Modeling and implementation**

The key to the modeling activities for most BPM tools is that the target audience for the modeling activity is often not particularly IT-skilled. BPM is all about integrating and managing operational steps across business processes, and offering an environment in which these processes can then be modeled and changed easily. But the driving force behind these activities is usually a business analyst, as opposed to an IT specialist, and so modeling support needs to be as accessible as possible to business people.

At the highest level, these business analysts generally start from an overall enterprise operating model, looking at the different aspects of the business and how each behaves. This defines the key business objects and how they interrelate, yielding the main processes for the business. Within each process, the analyst then defines the required business objects and process steps to perform the process in accordance with corporate policies and initiatives. The idea behind BPM is that the IT layer underpinning business operations is related closely enough to the processes to allow process changes to be simply and easily reflected into IT operations.

The requirements on BPM modeling and implementation are therefore to enable use of business analyst tools such as process flowcharts, without in-depth technical knowledge, and then to map changes onto the IT layer. Process flow is governed by the basic process structure combined with business policies and rules. In addition, there is a need for both static and dynamic dimensions to this process flow control, where the dynamic part can make process flow decisions based on real-time circumstances and events. SAP NetWeaver provides four tools to support the modeling of business processes and their associated integrations, which all interlink – Enterprise Services Builder, Integration Builder, Workflow Builder and a specialized modeling environment built around ARIS technology from business partner IDS Scheer. These tools are being gathered together into two main role-based groupings; tools for the business analyst for process manipulation, and more technically-oriented tools for developing integrations. In fact, SAP has announced a roadmap that will lead to the eventual unification of these tools into a common ECLIPSE framework, with additional support for developing business rules that will govern the forthcoming Business Rules Engine (BRE) capabilities.
Enterprise Service Builder is a Java-based tool that can be used both to graphically model the process architecture through the creation of what SAP calls Process Components representing the business flows required for each process or step, and to specify process flows in BPEL terms. These high-level process flows can include basic human interaction support too, although more detailed task-based workflow specifications are carried out using the Workflow Builder tool. All process definitions, whether BPEL or workflow, are stored in the Enterprise Services Repository, and Workflow Builder can reuse BPEL flows as part of larger workflows as required.

The Process Component support satisfies the high-level process architecture requirements that are part of any BPM solution, providing an environment and methodology for laying out the enterprise company value chain and associated process architecture. The Enterprise Service Builder is a graphical tool, designed to be accessible for business analysts. In addition to specifying the process flows, events can be defined to support a more dynamic, event-driven form of process execution. Also, UI texts are available in multiple languages and can be configured through the process editor. Additional BPM capabilities such as simulation and optimization will be covered in the later section on analysis.

SAP NetWeaver makes extensive use of BPEL (Business Process Execution Language), with support for WS-BPEL 2.0 and BPEL4WS 1.1. BPEL is a standards-based language for defining message-based service orchestration, and has become accepted as the ‘norm’ in the marketplace. In general, the SAP process offerings provide pretty comprehensive execution facilities:-

- **Serialization** forces process steps to execute in a particular order
- **Request / Response** support includes time-out facilities to avoid hanging threads
- **Multicast** support can be used to broadcast messages to multiple receivers
- **Triggers** are available, such as timer or payload related

The Integration Builder is also Java-based, and deals specifically with handling the configuration aspects of integrations and process flows. The Business Workflow Manager provides the full version of SAP’s human-oriented workflow support, where the business process integration involves people as well as programs, although basic human interactions can also be addressed through Integration Builder’s process support. SAP covers all the basic requirements for a workflow manager. Essentially, using the graphical Workflow Builder tool, operating units can be set up, and positions defined within them. User lists can then be browsed, with a drag-and-drop facility to assign users to positions. The flow is defined in graphical flowchart terms, describing how work moves from one user-position to another. There are front-end workplace clients for the native SAP environment (SAP Business Workplace) as well as Web, Microsoft Outlook and Lotus Notes environments, although most client usage is through the Universal Worklist interface provided by the SAP NetWeaver Portal. As mentioned earlier workflows built with the Workflow Builder tool can be used within the Integration Builder flows, and vice versa.

**Execution**

The execution area of BPM is relatively straightforward. The process and flow definitions are extracted from the repository where they were stored at design time, and a run-time engine operating from within the Integration Server now controls the behaviour of the underlying IT implementation according to the process specifications. Any necessary calculations at the various flow decision points are carried out in order to determine the appropriate next step. The run-time engine also has the responsibility for managing state, to ensure that consistency can be maintained in the event of a failure or some other disruption.

In the SAP implementation, execution is controlled through the process flows, integrations and collaborations specified in the Enterprise Services Repository. Using the BPM engine in the Integration Server, flows can be decomposed into multiple paths and then be recomposed again. Steps may be serialized, to force in-order execution, or could be carried out in parallel where the process definition allows this. Messages can similarly be split or merged. Triggering is supported, so processes can be started on the occurrence of some event. In terms of flow control decisions, the normal range of choices is available such as Wait and Loop. Generally, SAP has broad support for most process integration needs.
It is important to understand that the Integration Server runs within a SAP Application Server environment, and can therefore benefit from a lot of the functionality already in place in the web server, such as availability, recovery and dispatching support. So, for example, the SAP Web Dispatcher can load balance activities across a cluster of web servers, for performance, scalability and availability purposes.

**Analysis**

Full impact, simulation and optimization analysis can be carried out through use of the SAP Enterprise Modeling Applications by IDS Scheer product, produced in conjunction with IDS Scheer and based around that company’s ARIS technology. However, within the SAP products themselves there are other facilities for varying levels of analysis. Event occurrences and other technical tracking can be carried out through the SAP Runtime Workbench, while the process integration component also interoperates with SAP CCMS for more general monitoring support. With the latest versions of SAP NetWeaver, however, the SAP NetWeaver Administrator becomes the central source for the monitoring and administration of all NetWeaver components.

Through use of the event management piece, SAP NetWeaver can deliver a level of Business Activity Monitoring (BAM). Essentially, any SAP process can generate an alert. In SOA and process integration terms, events can be defined and recorded in the Enterprise Services Repository. For instance, ‘milestone process’ events can be defined when the Process Components are being modeled which will subsequently result in a trigger during execution when the conditions are met. Notice that these events are business-oriented rather than technology-oriented.

When an event occurs, the SAP Event Manager filters the event according to the event specifications, and then routes the event as an XML message to trigger the required tasks and processes. So, for example, an event might be the raising of a purchase order. The filter checks to see if the PO is for a value greater than a specified amount, say $1M, and if so it then triggers a supervisory approval process.

But these events can now be monitored, with reporting going to the SAP Portal. It is this capability that enables users to implement a BAM solution, monitoring these business-related events and interpreting them into meaningful milestone measurements as required.

**Basic requirements – Development tools**

Development tools are best reviewed in a combined fashion, taking into account both SOA and wider process integration needs. The primary design-time tool is the SAP Enterprise Services Builder, while the configuration tool is the SAP Integration Builder. These rich Java clients handle two distinct views – one for dealing with the design-time information and the other to handle configuration information. In SAP terms, the Enterprise Services Repository combines a repository for design-time and a directory for configuration, so both tools store all definitions and specifications in this repository.

The Enterprise Services Builder offers a range of design-time facilities, as illustrated in the following diagram.
The process editor is the main vehicle for architecting the process flows, providing support for designing the Process Components that define how different processes and process steps work, and also the creation of BPEL integration flows. When the SAP Enterprise Modeling Applications by IDS Scheer component is used, any flows generated can be imported into the Integration Builder environment. The mapping editor deals with the definition of any mapping activities required, such as moving data formats into and out of XML. The condition editor allows events to be specified to support the event-driven functionality. Finally the data type editor handles the message and data types and formats.

Configuration support is offered through the Integration Builder tool, providing facilities as depicted below.
This is the tool for defining such information as routing rules, collaboration agreements and partner profiles. Integration Builder offers both straight editors and also wizards to make the configuration task easier.

The other relevant development tool is the SAP Workflow Builder, part of the SAP Business Workflow component. This is the tool that is used to construct task-oriented workflows to address the human-centric element of process integration and management. Although this tool is separate to the Integration Builder, it is possible to drive a BPEL flow created with Integration Builder from a Workflow Builder process specification. In addition, because workflow and other integration processing is carried out within the same run-time environment, information can be shared between workflow and general integration activities.

Composite application support
The tools discussed up to this point have all been related to building the process and service definitions and configuring them, to deliver the required SOA-based process integration functionality. However, there is another important development area within an SOA environment – composition. This refers to the ability to combine SOA services into composite applications, enabling users to deliver new project requirements quickly and easily through reuse of existing components.

SAP offers the SAP NetWeaver Developer Studio, part of the SAP NetWeaver Composition Environment (CE), to address this need. This is an ECLIPSE-based graphical tool designed to extract enterprise services definitions from the ES repository and provide an environment in which they can be manipulated and linked to create the desired composite application. These enterprise service building blocks could be pre-built.
services shipped by SAP, or ones created through use of the Enterprise Services Builder. In SOA terms, applications composed with the SAP NetWeaver Developer Studio are consumers of SOA services.

However, the SAP NetWeaver CE goes further than just serving the needs of SAP application-based composition. Contract-first service definitions can be extracted from the ESR for any Java-based service, and composition can then take place in the ECLIPSE-based development environment, with SAP’s enterprise class Java application server providing an environment for processing business logic. This provides SAP users with a way to service-enable and run their own Java applications or packages.

**Value-Add Considerations**

These are the factors relating to SAP’s SOA-based process integration platform that can be regarded as going beyond the basic requirements, adding potential differentiators and more value to the solution. As in the two previous sections of the assessment, these will be dealt with in a selection of different categories.

**Governance**

SAP has implemented an SOA-oriented governance environment that starts with a high-level design methodology and filters down to the implementational details. The SOA landscape can be modeled in terms of the Process Components that define the business flows embodied by particular processes and steps, and the Integration Components that describe how different components interact at execution time. The Enterprise Services Builder offers the tooling to define these components and store them in the Enterprise Services Repository. They can then be reused as required in creating new process flows, and called up at execution time to control operations.

As well as storing process and integration specifications, the Enterprise Services Repository also holds information on any web services created such as the WSDL required for invocation. Importantly, additional information can be added to these repository entries, providing a means to handle versioning and business policy implementation such as security and authorization specifications.

Another important piece of governance-related functionality in SAP NetWeaver PI is the support for global data types. The Enterprise Services Builder tool supports the definition in the ES repository of company-wide data type definitions based on international standards such as ISO 15000-5 and UN/CFACt CCTS. These global data types can then be used as reusable semantic building blocks for services interfaces and message types.

**Manageability**

Administration and management of the SAP NetWeaver PI implementation are handled today by the SAP NetWeaver Administrator (NWA), the focus for managing all of the SAP NetWeaver components. NWA supersedes the SAP NetWeaver Runtime Workbench, which previously offered this support, although SAP continues to offer users the option of using either tool today. Supported management functionalities include:

- Monitoring
- Tracing
- Testing
- Archiving

The monitoring feature enables message tracking end-to-end, encompassing the integration engine itself and the adapters used to move information into and out of the engine. Message logs can be reviewed and analyzed, with drill-down facilities for additional detail. Component analysis integrates directly to the central SAP system monitoring facility, CCMS. It checks to ensure that the different runtime components that deliver the NetWeaver functionality are all present and working properly, with any error situations being reflected to CCMS. The performance analysis feature covers processing of such performance statistics as message throughput and latency. Information can be aggregated and filtered based on a range of factors such as time
intervals or message attributes. The message alerting component allows alerts to be delivered to the required recipient, such as through email or SMS.

SAP NetWeaver Administrator also provides the facility of mapping the monitored information to the process definitions contained in the Enterprise Services Repository, putting it into an end-to-end business context. This makes it possible to provide information in a more accessible format, such as showing a graphical representation of a process flow, and where the flows are operating smoothly or backing up.

**Scalability, Reliability and Performance**

As might be expected, the SAP solution scores highly in the area of scalability, reliability and performance. SAP has had considerable experience in these factors through its mySAP Business Suite, which is often used in a mission-critical environment.

On the scalability front, SAP leverages its Web Dispatcher engine to provide the ability to use multiple different engines. The dispatcher can drive multiple application server instances, and carry out load-balancing across them. This provides for scalability in the processing power sense, but also enables processes to be executed in parallel where the defined process flow allows. Of course, if certain process steps have to run in order, then SAP provides a serialization capability to enforce this.

Also on the scalability side, SAP’s solution is not forced to rely on XSLT for data mapping. XSLT is a standard, and as such is supported by most SOA and integration solutions, but it has a number of drawbacks. One is that XSLT performance is generally weak in high-volume environments, and the other is that it is not equipped to deal with more complex or specialized transformation/mapping requirements. SAP NetWeaver uses Java mapping programs, created through the graphical mapping editor, to handle mapping needs as efficiently as possible. Existing XSLT mapping definitions can be imported if required. On the question of transformations, although NetWeaver provides functionality in this area, SAP offers the SAP Conversion Agent based on Itemfield’s transformation engine to address more complex transformation needs.

Service reliability is protected by a range of availability features. The dispatching function means that most of the integration tasks, such as mapping and flow control, can be architected using redundant systems or at least with a switchover capability. The Enterprise Service Repository, a key potential single point of failure, is preserved through the use of both caching and redundancy to preserve its availability. Even the Integration Engine itself can run in multiple copies. In the rare cases where a single point of failure does exist, such as the Application Gateway used as a security shield when deploying a business-to-business solution, HA hardware-based solutions such as clustering are supported.

Performance in terms of throughput is aided by the multi-tasking, multi-threading architecture. In response-time terms, performance is assisted by the provision of different classes of service for the underlying SOA framework. These also contribute to better reliability and scalability. The two asynchronous options are exactly once message delivery, and exactly once in order - that is, serialized. The SAP approach to exactly once delivery is to send messages until they are acknowledged as having been received by the recipient. Received messages are checked for duplicates, which are discarded. For the serialized version, message identifications are checked to ensure the correct order is maintained. The synchronous option involves a blocking model, where the sender waits for a response, or a time-out.

SAP NetWeaver PI also offers a message packing facility, where a batch of messages can be gathered together and transferred in one operation to improve throughout and performance. Packed messages do not need to be related at all, but are simply sent to the receiving system as a block and then made available individually to the target services and applications. The choice of whether to pack messages and which ones to pack is configured in the sending system – this decision is effectively transparent to the receiving system applications.
Another performance facility supported by the SAP NetWeaver PI layer is the ability to use the adapter engine in stand-alone mode. In normal usage, the adapter engine runs as part of the Integration Server, and messages are passed to the Integration Server for mapping and routing. However, as part of configuring the integration it is possible to define a local message processing capability which will be carried out in the Adapter engine itself, without the need to hand the message over to the Integration Server. This can have significant performance benefits, avoiding the additional overhead of full integration server processing.

In the area of reliability, one measure that has been added to SAP NetWeaver PI is the XML validation function. Using this mechanism, an agreed schema can be stored in the Enterprise Services Repository, and this schema is now used to validate runtime messages. This helps to prevent operational errors, and also improves overall governance.

**Flexibility**

SAP NetWeaver supports a range of different SOA and process integration use cases. For instance, as can be seen from the above discussions on SOA, it is perfectly possible to use the NetWeaver software to enable a service-oriented architecture. Web services created outside of NetWeaver can be imported into the Enterprise Services Repository, and legacy or home-grown applications can be brought into the SOA through the use of the SAP and third party adapters. In a similar fashion, classical application integration can also be carried out with SAP NetWeaver support.

An important use case covered by the SAP solution is that of collaborative, human-oriented workflow support. As discussed in the previous sections, apart from some basic user interaction facilities provided through the Integration Builder tool, the SAP Business Workflow software provides the full range of facilities needed to operate task lists, manage user roles and progress work-items through the desired process. The one drawback in the SAP solution is that different tools are used to build the human-oriented workflows and the program-centric BPM ones. However, SAP separates these tools based on roles – the higher-level, process-oriented tools such as that used to build detailed workflows, and the lower level, integration-oriented tools used to handle the more technical side of the task, which helps to explain the use of two different tools. In addition, as SAP fills out its announced roadmap around SAP NetWeaver BPM (Business Process Management) and BRM (Business Rules Management), this will clarify the situation.

Business-to-business integration is another area of value-add flexibility offered by the SAP NetWeaver process integration capabilities. SAP obviously has to have a good understanding of the requirements of different industries to deliver an effective mySAP Business Suite to the market as a whole. It has leveraged this knowledgebase to build in a range of facilities designed to enable safe and secure integration between business partners. So, for example, it supports a wide range of EDI standards through its partnership with Seeburger. It also has specific partner profiling capabilities, where information about partners can be built and stored in the Enterprise Services Repository, and an Application Gateway is provided to sit at the perimeter of the enterprise, to protect integrity and security from exposure to the outside world.

Another area of flexibility is provided by interoperability with other SAP components. So, for example, the Business Intelligence component can be used to add value to the BAM and associated analysis capabilities already discussed.

**Usability and Productivity**

For existing SAP Business Suite users in particular, SAP NetWeaver’s process integration capabilities score highly for added value in the area of usability and productivity.

Clearly, one of the challenges for SAP application users is that a number of business processes are at least partly contained within the SAP applications themselves. This presents a problem for companies looking to move down the BPM route on a more widespread basis. How can the processes embedded within the SAP applications be interlinked with other processes outside of SAP’s domain? The answer lies in the SAP Solution Maps, sometimes called Business Maps. These Solution Maps describe the processes being executed by the applications, including the solution variants such as industry vertical differences. As SAP
rolls out its announced roadmap around BPM and BRE, the BPM facilities will use these process templates as the basis for user process development, and rules control of the SAP applications will be possible through the BRE component.

SAP has also introduced the concept of Enterprise Services Bundles. These are pre-packaged bundles of web services, complete with business logic and semantics, providing templates of common industry-specific or cross-industry operations such as ‘Order to Cash’, ‘Hire to Retire’ and Logistics Execution. These bundles provide templates that can be customized as required, but that offer a rapid and productive way to deliver value that is easy to implement.

Another source of productivity improvements is the SAP Developer Network (SDN). SAP has established a community base for all people involved in NetWeaver activities, including end users, systems integrators, implementers and partners. The SDN resources provide forums, bulletin boards and a wide array of technical documentation and content for browsing and reviewing. SAP offers an SDN-hosted tool, the Enterprise Services Workplace, for browsing and working with these Solution Maps. Using the tool, the user can work through the embedded processes, drill down as required, and upload relevant processes to ARIS. Now the user can innovate on top of the SAP-provided process, using ARIS to model the new, composite application, produce a BPEL representation and merge it into the Integration Builder environment where further enrichment can take place before deployment. This functionality therefore provides an excellent way for users to build on their existing investments in SAP applications, and bring those applications into the new BPM environment, in a usable and productive fashion.

**Standards adoption**

SAP’s approach to standards is to consider them very much from the user’s perspective, as opposed to market movement. So, it does not tend to jump onto every latest standard as a marketing exercise, but instead likes to be clear in its own mind about the value and applicability of the standard to its customers.

At the lowest level, SAP NetWeaver is built around XML. XPATH, XSLT, SOAP, WSDL and UDDI are also supported to ensure that message transmission, processing and web services are all covered. SAP is also active in the BPEL area, offering BPEL views of process execution flows as required, although in common with many other vendors it has added its own enhancements to satisfy those requirements not addressed by the current BPEL specifications. In the area of security, SAP also supports WS-Security, WS-Policy and SAML.

On top of this, there are a number of standards-related areas where SAP is currently active, either evaluating standards for potential adoption or working to produce standards where none exist today. For example, SAP is working with IBM on BPEL4People, an extension of BPEL to deal with the needs of human-oriented process integration, and is also evaluating BPMN. It is also involved with the SCA and SDO initiatives as part of its work to support composite applications.

**Market factors**

One of the problems for companies looking to invest in SOA and process integration tools is that many of the vendors have limited market exposure today. In contrast, SAP has had significant success with NetWeaver in general and the Process Integration component in particular. By the end of 2007, SAP claimed more than 18,000 NetWeaver deployments, with at least 1000 ‘powered by NetWeaver’ partner offerings and 10,000 trained consultants. So the NetWeaver platform has had significant opportunity to benefit from this level of customer exposure, assuring a high degree of customer input and quality.

But the process integration usage case has also achieved significant penetration, with 3,900 installations, 2,200 of which include integration with non-SAP applications. These are highly creditable figures, putting SAP NetWeaver’s process integration solution in the leading group of SOA and process offerings in the marketplace. Admittedly, most, if not all, these users will be SAP application package customers, but it is impressive to see so many using the SAP process integration facilities to integrate non-SAP applications too, helping to dispel the impression that SAP NetWeaver PI support is only for use with SAP applications.
Anyway, regardless of the usage scenarios, the net effect on software quality and capability of this market exposure will still be highly beneficial.

**Assessing SAP NetWeaver’s Process Integration Capabilities**

The review of the functionality provided by SAP NetWeaver for process integration was carried out in terms of its basic level of support for SOA and process integration, and then its value-add differentiators. The assessment will take the same approach.

**Assessment of basic support for SOA and process integration**

As far as basic support for SOA and process integration goes, the SAP solution appears to tick all the boxes. The Enterprise Services Repository provides all the necessary functionality to fulfill registry needs, and handles both registry and repository requirements in one package. Web services created outside of the SAP NetWeaver infrastructure can be imported into the ES Repository. It supports browsing, analysis and selection of existing services, and unlike some of the competition it also allows the user to put additional user-specific information into the various entries such as documentation, explaining the use of the service and making it more likely the service will end up being reused. Process definitions are also stored in the repository, making it the basis for SAP’s process integration modeling methodology.

Overall, SAP offers strong functionality in the area of communications, connectivity and mediation. The use of Java mapping programs, rather than XSLT, and the provision of the SAP Conversion Agent gives users a lot of extra power, flexibility, scalability and performance. In particular, the fact that unstructured and semi-structured data such as from Microsoft Office products can be accessed through the SAP Conversion Agent broadens the range of potential solutions greatly. Reliance on a third party for most of the application environment adapters may be a bit of an exposure, but this is actually the way that most vendors address connectivity needs today.

The three levels of QoS offer more flexibility. In particular, many competitors do not offer the ‘exactly once, in specified order’ class of service. This is very useful in more complex process flows. On the migration/coexistence front, SAP has been careful to include support for previous technologies such as SAP IDoc and RFC. This will be very important to existing SAP users who have already invested in these technologies.

In the past, SAP’s overall Integration Server implementation was based on the classical ‘hub-and-spoke’ message broker architecture, but SAP has now delivered its first version of an ESB implementation based on distributed rather than centralized integration, removing the need for a large investment in the ‘hub’ upfront and providing a greater degree of architectural flexibility in a true, peer-to-peer sense. In its latest release, SAP NetWeaver PI offers distributed integration support, supporting SOAP messages and the ability to utilize standards-based JMS messaging engines as well as SAP’s own. The result is that deployment has become easier and more cost effective, while the user is offered the flexibility to choose to operate over some corporate-wide messaging backbone.

Process integration support is very good in the SAP solution. At the SOA level, SAP offers a methodology and the tools to model the process components that make up each process step, providing strong governance mechanisms to ensure consistency such as global data types. For users wanting a more extensive range of modeling and analysis functionality, the ARIS-based partnership with IDS Scheer ensures the user has access to industry-leading enterprise and business modeling tools. The ARIS linkage ensures SAP to offer powerful impact analysis facilities. In addition, whether using the Enterprise Services Builder to create process flow models or making use of the SAP Enterprise Modeling Applications by IDS Scheer tool, the fact that SAP Business Suite process flows can be extracted and imported to the modeling
environment offers a great deal of value to the overall process integration scenario for existing SAP customers.

The support for events and triggers, together with other process integration requirements such as time-based facilities, means that the SAP NetWeaver process integration offering is pretty comprehensive in its functional coverage. Perhaps the only other drawback is the lack of support for UML.

On the tools side, the Enterprise Services Builder offers powerful support for building process component models and defining integrations, while the Integration Builder provides thorough coverage of configuration needs. The attractive, role-based approach to functional presentation helps to personalize the view for specific needs. The tools are graphical, although there are quite a lot of menu-based data collection screens. The SAP solution supports both program-centric, production-based process integration and the human-oriented workflow variety, which is a strong factor in SAP’s favour compared to a number of competitors. The only drawback is rather unfortunate packaging, with potentially four tools required to develop process integration solutions – Enterprise Services Builder for model development, Integration Builder for configuration, Workflow Builder to address any but the most basic human interaction needs and SAP Enterprise Modeling Applications by IDS Scheer for the full range of enterprise modeling and analysis functionality. It would be more appealing to have all process integration development available within a single environment. However, in fairness to SAP it has announced a roadmap covering BPM, BRE and tools in general, where it is promising to bring together these tools into a unified ECLIPSE framework, and group them into two roles-based classes for business process analysts or integration developers.

One area where SAP scores well is composition. Often, process integration vendors forget the need to offer an environment in which new applications can be composed from the SOA process and service components. This is a major issue, since one of the strong drivers of SOA investment is the ability to become more agile, able to address new business requirements quickly and easily through the composition of the reusable component pool offered by SOA. However, SAP has delivered worthy support for composite applications through its Composition Environment Developer Studio. This tool provides an ECLIPSE-based studio for application composition, and can be use to assemble applications made up of pre-built SAP enterprise services and/or user-developed ones. This composition support puts SAP in a strong position relative to many other suppliers.

Value-add differentiators

So SAP NetWeaver satisfies the basic requirements for any SOA and process integration solution. But it also benefits from a range of added value characteristics, which could be differentiators in any purchasing decision.

Governance has clearly been a key consideration in SAP’s planning around process integration and SOA. The provision of modeling tools and the introduction of the Process Component concept helps to bring a methodology to SOA-based process integration architecture, enabling a greater degree of enterprise control. However, of particular note is the standards-based support for global data types as a means to force a level of consistency across the enterprise. Based around such standards as UN/CFACT CCTS, this support is something that most SOA solution vendors lack.

The Runtime Workbench is a useful tool for keeping an eye on what is happening with the end-to-end process, and it interoperates with the SAP systems management tool, CCMS. This provides a reasonably good level of monitoring support, although it is somewhat SAP-specific. To broaden the appeal, SAP needs to make Runtime Workbench alerts interoperate with other management frameworks, perhaps through the use of an SNMP agent. The move to provide Runtime Workbench functionality from within the NetWeaver Administrator is very positive from the user point of view when considered in the light of SAP’s stated intention to also bring in other NetWeaver monitoring tools such as the one for SAP Portal usage. The idea of eventually having a single administrator tool for all NetWeaver-related needs is very attractive.
The Enterprise Services Repository has been well thought out. Functionality is comprehensive, and the ability to put user installation-specific information into the records is a very useful feature. If a user employs the repository properly, it can not only improve the overall effectiveness of the SOA and process integration implementations, but it can also assist in enforcing required levels of governance. The combination of registry and repository needs in one package also makes life easier for users.

SAP offers a number of high-end features in its SOA and process support, such as support for clustering, message packing, the ability to architect redundant and standby instances of runtime components and the Web Dispatcher functionality to enable load balancing and improved efficiency. The range of classes of service provided include exactly once delivery of messages, an essential feature for many high-end environments, and the added support for forcing messages to be processed in order is also beneficial in some cases.

Perhaps the one high-end area where the SAP solution is weakest, however, is Business Activity Monitoring (BAM). SAP does offer some BAM functionality currently, such as the ability to raise business events from inside applications and to correlate events with business KPIs (key performance indicators), but it is still a long way from market-leading BAM solutions. Mechanisms for displaying activity information are rather primitive, and there are no direct pattern-analysis or predictive facilities to enable users to not just see problems but to anticipate them and take avoiding action.

Many competitive SOA offerings limit transformation support to XSLT-based mappings. This can be a big problem for larger customers, or companies with specific and sometimes complex mapping requirements. SAP’s Java program-based approach to mapping should be much more efficient, providing a clear differentiation from purely XSLT-based options. Also on the XML front, the XML validation feature should be very useful to improve service quality and enhance governance, for example when used to police interfacing agreements with business partners.

An intriguing area with a lot of promise seems to be that of SAP’s pre-packaged, industry-based content to accelerate integration activities. The type of content includes enterprise services, integration scenarios, message interfaces and associated message mappings, all pre-packaged based on the needs of particular industries. The idea of gathering together services, definitions, data types and mappings designed to address common and well-defined business needs, whether cross-industry like an Order to Cash process or industry-specific, offers a significant productivity boost and perhaps more importantly the opportunity for a quick win to help justify the investment in adopting an SOA model. If SAP continues to focus on extending this pre-packaged, industry-oriented content, this could become a significant differentiator for the SAP solution.

For those customers using SAP’s business applications there are, of course, numerous competitive differentiators. The SAP solution supports RFC and IDoc, for a start. But it is the ability to utilize the Solution Maps, bringing existing package-embedded processes into the process integration environment that offers the most benefit to existing SAP environments. This enables a much higher degree of process enrichment and value creation. Also, the creation of the SAP Developers Network promises to generate a significant and growing body of knowledge about SAP’s SOA and process initiatives.

Finally, the extensive take-up of the SAP NetWeaver’s process integration solution provides a great deal of assurance about product quality and functionality, especially compared to many other SOA and process vendors where customer experience may be extremely limited.
Summary

SAP has drawn a lot of threads together to produce SAP NetWeaver Process Integration 7.1. It is moving to a single approach for integration, superseding the older IDoc and RFC mechanisms, and it has evolved this solution into a complete SOA middleware platform. On top of this, it has delivered process modeling and integration support, spanning both program and human-centric workflow needs. Although the initial focus was on providing existing users ways to leverage and maximize their investments in SAP packages, the technology has sufficient functionality to now stand in its own right as a sound basis for SOA and process integration needs. At a purely functional level, it has good support for the mostly non-SAP environment as well as the more heavily SAP-oriented one, and the addition of pre-packed process bundles for common industry needs together with the provision of an environment enabling quick and easy application composition from SAP and user-built process components provides real opportunity for productivity and agility gains.

Naturally, in these relatively early days the picture is not perfect. SAP still seems to struggle to wrench its vision away from internally focused thinking focused on its own package-based world, but it is continuing to provide impetus and investment to its drive to move its solution to a more generalized market. However, it is not the few functional weaknesses that will be the most difficult hurdle for SAP to overcome if it is to widen the appeal of its SOA and process integration tools. The market still perceives SAP as first and foremost a package vendor, with tools designed for use with solely with those packages. Taking into consideration all the points made throughout this assessment, this would seem to be an unfair view, but SAP must continue to strive to counter this perception if NetWeaver’s process integration capabilities are to be accepted as anything other than an adjunct to SAP’s mainstream business applications suite.
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