Reference Architecture for SOA

End2End Adoption Program

Reference Architecture for SOA

Version 2.0

Oct 2008
Acknowledgements

The authors wish to thanks their SAP colleagues Jin Son, Andrew LeBlanc, Darren Crowder, Karl-Heinz Hoffmann, the NW Product management, Holger Meinert for their contributions to this document.
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1 Introduction

The Reference Architecture for SOA describes broad range of SOA related concepts such as: Reference Architecture, Architectural Principles, SOA Process Patterns, Minimal and Heterogeneous Landscape, Detailed Capabilities Description, as well as Tools, Methodologies & Services for Architectural Planning.

The document starts with introduction to reference architecture and moves to injection point of SOA among related concepts like governance, integration, service modeling, architecture guidelines, service level, testing, monitoring, etc.

For the first time, this document introduces concept of SOA Process Patterns while touching upon process granularity of composites. SOA Process Patterns based approach aims to develop rapidly, precisely targeted, yet minimal architectural infrastructure.

For Service Oriented Architecture (SOA) initiatives, a process pattern driven method aims to provide a “guidepost” for fast yet, precisely targeted architectural infrastructure. Such method aims to deliver a baseline set of SOA architecture capabilities. SOA process patterns practice defines the needed architectural capabilities with baseline landscape tailored to meet particular business needs. Based on business requirements, vendor neutral SOA capabilities are discovered and then mapped to SAP products as well as other components that add values in solving particular business challenge.

To illustrate concept of SOA Process Patterns introduced earlier the document explores in-depth three exemplary patterns: Role-based UI & Backend Abstraction, UI Dashboard and Before/Post-Processes. For each of these patterns, the document explains business requirements detailing particular solution. As a result, it also offers complete and minimal set of capabilities required to support business needs. Those capabilities are expressed in form of bill of material that lists all the architectural building blocks and corresponding SAP software solutions.

Detailed SOA capabilities descriptions:

- Plan - planning your SOA Environment and transformation effort.
- Build - to deliver your solution based on Service Orientated Assets,
- Run - to execute SOA, and
- Management capabilities essential across the entire lifecycle.

Additionally the document lists and describes Tools, Methodologies, Services and Training resources that may be helpful when embarking on SOA journey.
2 Reference Architecture

2.1 Definition of reference Architecture

Reference architecture provides a proven architecture template for a particular domain. It also supplies a common vocabulary with which to discuss implementations. Reference architecture consists of a list of capabilities as well as their interactions with each other and with functions located outside of the scope of the reference architecture.

2.2 Relationship-map for SOA

SOA is surrounded and related to number of ideas and concepts. Figure 1 SOA and surrounding concepts relationship mind map illustrates the high-level relationship between SOA and linked architectural concepts. As such, this model is the starting point for SAP SOA reference architecture.

Figure 1 SOA and surrounding concepts relationship mind map
2.3 Positioning of a Reference Architecture in the SOA concept

A Reference Architecture is an integral part of any architecture framework as demonstrated in OASIS proposed reference model\(^1\).

A reference model is an abstraction used to understand the significant relationships among the entities of architectural environment. It enables the development of specific architecture using consistent standards and/or specifications supporting that environment by leveraging baseline set of unifying concepts, axioms, and relationships within a particular problem domain. Reference Model is independent of specific standards, technologies, implementations, or other concrete details.

Figure 2. SAP SOA Starter-Kit components to the OASIS SOA depicts relationship between the SAP SOA Starter-kit components and OASIS SOA reference model.

---

Figure 2 SAP SOA Starter-Kit components to the OASIS SOA reference model relationships
2.4 Conceptual reference architecture

The SOA Reference Architecture consists of three major building blocks:

- **PLAN** - Capabilities needed to outline the overall landscape
- **BUILD** - Capabilities needed to implement SOA
- **RUN** - Capabilities needed to run and manage the implemented software

Following Chapter for SOA Capabilities in Detail describes in details each capability, best practices, and potential solutions.

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**Figure 3 SOA Starter-Kit Reference Architecture (SAP 2008)**
3 Architecture Principles

3.1 Guideline for Principles

Architectural principles are used to provide an assessment framework that the enterprise can use to align tactical and operational decisions as well as its business and technology strategy. The rationale statement of each principle highlights its value to the enterprise, and therefore provides a basis for justifying architectural decisions.

Each Architecture Principle has the following format:

- **Name:**
  
  Name should be a proper representation of essence of the rule as well as be descriptive enough to allow quick recollection. Specific technology platforms should not be mentioned in the name or statement of a principle. Name must be unambiguous and avoid unnecessary modifiers such as "support," "open," "consider," "avoid," "manage(ment)." Name must be descriptive in nature yet succinct.

- **Statement:**
  
  Statement should unambiguously communicate the fundamental rule, again succinctly much like NAME. As the principle statements for managing information are similar across organizations, it is vital that the principle statements be unambiguous as well.

- **Rationale:**
  
  Rationale should highlight the business benefits of adhering to the principle, using business terminology. The rational leverages the similarity of information and technology principles to the principles governing business operations. In addition, rationale describes the relationship to other principles, and the intentions regarding a balanced interpretation. Furthermore, rationale describes situations where one principle would be given higher precedence and/or perceived more importance in decision-making process.

- **Implications:**
  
  Implication should highlight the requirements, for both the business and IT, for carrying out the principle - in terms of resources, costs, and activities/tasks. It will often be apparent that current systems, standards, or practices would be incongruent with the principle upon adoption. Thus, the impact to the business and consequences of adopting such principle should be clearly stated. Implication should allow proper discernment of impact and address the answer to "How does this affect me?" It is important not to oversimplify, trivialize, or judge the merit of the impact, rather some of the implications should be identified as potential impacts only, even though such implication may be speculative rather than fully analyzed.

For the SOA Starter-kit, we leverage the knowledge and experience of members of SAP’s Product Management and Active Global Support.

### Table 1 Example: ‘Adopt Service Oriented Architecture’ Principle

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Adopt Service Oriented Architecture</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>Solutions will be designed to enable a future adoption of Enterprise Services Oriented Architecture.</td>
</tr>
</tbody>
</table>
Rationale

This ensures Architecture is optimized to leverage SOA in a least disruptive way

Implications

• Adhering to SOA, means that the focus is shifted from implementation details to application assembly
• This facilitates component reuse where new composite processes or applications can be developed from existing application components
• This principle will help identify new ways to service enable existing applications in the overall landscape

Table 2 Monitoring Principle

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Monitoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>The Monitoring Principle enables a comprehensive visibility to manage SOA Landscape and any incidents.</td>
</tr>
</tbody>
</table>
| Rationale      | Give visibility into
  • The topology and ‘health’ of the SOA landscape and artifacts.
  • The provided, received, and agreed QoS and the compliance to it
  • The usage of a service or business process
  • Provide information to enable problem resolution and decision-making |
| Implications   | Provide visibility into the SOA landscape across the variety of technology platforms and communication protocols, including:
  • The runtime topology of the SOA landscape and the relationships between services, service endpoints, and operations regardless of the provisioning platform or the protocol used.
  • The E2E quality-of-service (QoS) – availability, performance, and security – provided by service, service endpoint, service operation, and business process. Measure QoS and compliance against a rich set of metrics and against pre-defined goals (policies and SLAs).
  • Inform of QoS violations and provide escalation/resolution paths
  • The E2E message flow and individual messages exchanged between consumers and providers.
  • Service and business process usage by technical consumers (invokers) and business customers.
  • Provide detailed and aggregated, real-time and historical view for monitoring data in one central place for the whole SOA landscape.
  • Provide quick navigation between the multiple SOA artifacts.
  • Present information in a variety of displays.
  • Enable slicing-and-dicing (filter, group search) of information along a rich variety of criteria
  • Enable reporting on monitoring information. |
### Table 3 Security and Identity Management Principle

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Security and Identity Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>Enforce a global standard for Security for the overall SOA Landscape</td>
</tr>
</tbody>
</table>
| Rationale      | Provide **efficient and effective** functional solutions to guarantee:  
|                 | • Confidentiality  
|                 | • Integrity  
|                 | • Availability  
|                 | • Accountability and non-repudiation  
|                 | protection across the technology platform |
| Implications   | Use standard based solutions to automate security configuration tasks as much as possible  
|                 | Complement standard based solutions for services with SAP proprietary technical implementations for service applications and systems, based on:  
|                 | • Considerations about level of security protection  
|                 | • Priority of supported SOA deployment scenario  
|                 | • Total Cost of Ownership of security definition to customer  
|                 | Complementary security management solutions for landscapes to standardize SAP security infrastructure (e.g. Access Management, Identity Management and Trust Management)  
|                 | Development of **consistent** implementations of security across:  
|                 | • major system components in SOA landscape (NW Portal, CE, ESR, PI, ERP)  
|                 | • complementary and related use cases and deployment scenarios that need to be supported  
|                 | Define dedicated best-practice enterprise services for security management (e.g. for x.509 certificate discovery) |

### Table 4 Runtime SOA Policy Management Principle

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Runtime SOA Policy Management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>A Runtime SOA policy is a service contract for regulating access to a service by a client application and the service’s subsequent behavior when the client invokes it.</td>
</tr>
</tbody>
</table>
| Rationale      | • Ensure control and compliance (risk-avoidance and/or best practices) to business and operational policies or regulatory controls  
|                 | • Ensure that services can be tracked, measured, repeated, and cost controlled.  
|                 | • Make systems more adaptive by specifying more of their behavior as policy rather than procedural code. |
• Rectify practices that are in non-compliance

**Implications**

• Policies provide a flexible and extensible framework for expressing the abilities, requirements, and preferences of services

• Categories: technical, architectural or business. Our focus is on technical types of policies only
  – (Technical Policy Categories: Security, Routing, Reliability, Mediation, SLAs and Logging)

• Service can have multiple policies and a policy can be applied to multiple services

• Scope
  – Service or Operation – “Apply to all HR service operations”
  – Content – “Apply to all Personal Identities”

• Span within and across corporate, divisional or departmental levels

• Policy Lifecycle Management – (see use cases)

• Policy enforcement points (PEPs)
  – Trigger events and actions (typically restrictive) automatically at runtime for non-conforming services
  – Active enforcement blocks a user whereas passive enforcement can just log and notify

• Special Considerations (Conflict Resolution, Exceptions, Client Negotiations, Discoverability of policy by consumers)

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**Table 5 Service-Level Agreement Principle**

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Service-Level Agreement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Statement</td>
<td>A service-level agreement (SLA) is an agreement between a service provider and a customer (users and roles) with agreed-upon guarantees of expected Quality of Service (QoS) levels</td>
</tr>
</tbody>
</table>
| Rationale      | • To extend the traditional IT concept of SLAs to loosely coupled services  
• To verify compliance to one or more defined service level benchmarks due to contractual or other reasons  
• Analyzing SLAs metrics allows IT to plan for growth, minimize risk, and justify additional investments  
• You (Service provider) distinguish yourself from the competition thru SLAs. Consumers have enforceable QoS guarantees |
Some common categories of QoS (non-functional requirements) are availability, performance (response time), usage, and security. May be offered as fixed packages including service operations, associated service levels, penalty upon violation, exceptions, validity period, terms for termination as well as price for using the service, typically expressed as "parameterized" SLA templates.

A service can have multiple SLAs for different customers. Service request metadata such as the grade of the service customer (gold, silver, etc.), or the security level (employee, customer, partner, etc.) could be used to determine the service level to offer to the user at the time of request.

Service levels must be monitored and recorded for reporting. SLA should provide detailed usage analysis over time to identify trends and revenue opportunities.

SLA may specify the measures to be taken in case of deviation and failure to meet the asserted service guarantees. Service level policies may perform actions such as activating additional service provides to keep the system within policy.

### Table 6 Testing Principle

<table>
<thead>
<tr>
<th>Principle Name</th>
<th>Testing</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Statement</strong></td>
<td>Providing business process correctness in a heterogeneous landscape</td>
</tr>
<tr>
<td><strong>Rationale</strong></td>
<td>•Ensure the landscape is running as expected even after changes</td>
</tr>
<tr>
<td></td>
<td>•Identify faults quickly and get them resolved ASAP</td>
</tr>
<tr>
<td><strong>Implications</strong></td>
<td>•Have a ‘repository’ of SOA Management relevant test cases</td>
</tr>
<tr>
<td></td>
<td>•Can be a subset of Tests created during development phase, identified for SOA Management</td>
</tr>
<tr>
<td></td>
<td>•Test cases to be associated with the relevant SOA artifacts that require to be tested</td>
</tr>
<tr>
<td></td>
<td>•Ability to define associations and dependencies between test cases</td>
</tr>
<tr>
<td></td>
<td>•Ability to structure the test according to layers</td>
</tr>
<tr>
<td></td>
<td>•Automation Testing</td>
</tr>
<tr>
<td></td>
<td>•Ability to run the test cases from the ‘Test Repository’ for specific interfaces / components as required</td>
</tr>
<tr>
<td></td>
<td>•Ability to report results and logs for analysis</td>
</tr>
<tr>
<td></td>
<td>•Manual Testing</td>
</tr>
<tr>
<td></td>
<td>•Triggering tests on specific SOA Artifacts (ex. Interface)</td>
</tr>
<tr>
<td></td>
<td>•Testing availability of service (call a service and receive a response)</td>
</tr>
<tr>
<td></td>
<td>•Extending the Test Scenarios</td>
</tr>
</tbody>
</table>
### Scheduled Testing
- Ability to schedule certain specific tests at specific times
- ‘Keep-alive’ : Periodically call infrequently used services to ensure they are still running and ‘in memory’

### Testing services

### Testing services synchronously and asynchronously
- Reporting / Logging / Alerting
- Support Root Cause Analysis

### Provide Layered testing
4 SOA Process Patterns

4.1 Introduction

In order to refine and instantiate a Reference Architecture, we apply the use-case driven approach. One of the most important benefits of SOA and service-enabled applications is the possibility to develop on top of composite applications. Composite applications are individual but tailored compound application either built on services or other applications. Based on the characteristics and business requirements of a composite application, SAP extracted and consolidated SOA process patterns (see SOA Process Patterns chapter for examples). Needed architectural capabilities are derived from SOA Process Patterns. Such SOA Capabilities will lead to construction of SAP specific deliverables and offerings that accelerate the respective composite application implementation. E.g. a bill of material with the needed SAP solutions or a customer showcase for validation purposes. Figure 5 illustrates path of SOA Projects based on SOA process patterns.
Sample SOA Process Patterns chapter describes three exemplary SOA process patterns.

First example leverages composite applications used for optimizing user interaction. It focuses on the creation of tailored user interfaces for specific user roles. This approach goes beyond designing of a single screen, rather different screens are arranged to guide users through their tasks in a procedural manner without busy screen real estate.

Second example describes business applications combining collaborative office functions. Composite applications are created by modeling process flow based on enterprise services. More importantly, the composite applications are independent from the life cycle of the underlying applications.

Third example describes composite applications contains business objects as well as business logic. Such applications provide functional extensions to existing applications. This kind of composite application is used, for example, for industry-specific enhancements that must be made very quickly, independent from release and upgrade cycles of underlying applications.

4.2 Process Granularity of Composite Applications

To apply SOA process patterns successfully, an appropriate understanding of the granularity of processes is necessary. Under the assumption that composite processes are based on the process hierarchy defined in SAP’s Business Process Modeling Methodology (BPMM). The mapping of SOA Process Patterns is target to support the activity-level. Typical transactions in SAP System Applications are considered on this level. (e.g. VA01 Create SD SalesOrder).
If a composite application or process is on a higher level than the activity-level, it is recommended to decompose the process into more granular steps. This is the case in most of composite applications delivered by SAP, e.g. mySAP RPM (Resource and Portfolio Management).

### 4.3 SOA Process Patterns

Given the current level of maturity in technology, composite applications have great potentials, but they also have some limitations such as transactional behavior and cross-system error handling. In addition, the multiple technologies available to develop a composite make it difficult to deliver a consistent IT blueprint. In-depth knowledge of wide spectrum of technologies is required to choose the right one to solve particular problem. SOA Process Patterns method will solve such problems and deliver two results:

- consistent solution landscapes for a given process pattern, and
- evaluation of the complexity of implementing a business requirement as a composite.

Proper understanding of typical characteristics of a composite application is required to understand dimensions and complexities of SOA Process Patterns. Following aspects must be taken into consideration:

- **Process type**: businesses-to-business, application-to-application (e.g. Rosetta Net Integration), human-to-human, or human-to-application.

- **Level of “transactionality” of the process**:
  - information gathering (e.g. a reporting dashboard),
  - simple processes or human workflows,
  - cross system, complex process flows (transactional behavior across several systems) (e.g. an application, which implements “Sales Order Split” and creates several “Sales Orders” in one or many backend systems).
• Number of involved Business and Data Objects:
  o one Business Object \( \Rightarrow \) e.g. a simple creation of a Sales Order or a search for Business Partner
  o several Business Objects, e.g. a more complex Internet Sales Application with several BO interactions in order to Self Register a Business Partner before creating a Sales Order

• Data Semantics – Consistency of Business Object representation across multiple backend systems (e.g. the business partner is not represented by common Data type in all participating systems)

• Use roles might not be consistency when crossing between participating backend systems.

• UI technology varies between participating backend systems

• Security method and technology differs between participating backend systems

In addition, technological complexity of the underlying landscape must be taken into account, including:

• Diversity of the backend application Landscape providing Services:
  o one SAP System
  o multiple SAP Systems (Heterogeneous SAP Landscape, e.g. 1 SRM and 2 ERP Systems)
  o multiple SAP or non-SAP systems

• Homogenous technical Interfaces – Not all applications support web-service standards and integrate through an ESB-Technology leveraging application specific-/technical adapter.

In order to rapidly address above challenges SAP has identified the following SOA Process Patterns, which this document will explain in detail:

• Role-based UI & Backend Abstraction

• UI Dashboard

• Before-/Post-Processes

  Example of a “before process” is a multi stage master data creation process, where the composite covers the initial data creation, the data enrichment, but the final master data creation is done in the backend system.

• Backend Multiplexing

  In the backend-multiplexing pattern, one builds a process across homogenous systems (e.g. 2 ECC 6.0 Systems) and based on certain parameters interacting with one or more systems. This pattern, often used in Merger & Acquisition Scenarios, does not fully merge system landscape.

  Example: Checkout of an Internet Sales Application, which based on the customer, creates the Sales Order in one backend system.
5 Minimal Landscape

This chapter describes a path of simple SOA adoption. It focuses on specific composites-use-cases to reduce the overall complexity of the required Landscape. In order to simplify the SOA landscapes for purpose of this exercise, several constraints and assumptions have been made:

All Landscapes discussed cover only the latest releases of SAP products.

Heterogeneous Scenarios are not covered. Please refer to chapter 5 - “Heterogeneous Landscapes.”

Manage & Plan Capabilities are not covered. A single SOA Process Pattern does not drive those capabilities, but rather by the maturity of the overall SOA Adoption and IT Requirements. While it is questionable whether a Service Portfolio Management makes sense for the first composite with 10 services, when SOA is applied beyond initial proof-of-concepts, SAP strongly recommends developing an adoption roadmap of all Manage & Plan Capabilities.

The deployment options are distinguished only in Runtime (see minimal landscape – need a different label B&W color blind etc…) and Design Time (see minimal landscape – same). Dependencies to the underlying heterogeneous application landscape are not covered, as this aspect is very specific to particular implementation.

5.1 Sample SOA Process Patterns

SOA Process Patterns: Role-based UI & Backend Abstraction

In order to build a role-based UI or a canonical interface around one or more transactions from a backend system, reference architecture building blocks presented in Figure 7 Role-based UI & Backend Abstraction Minimal Capabilities are needed and might be affected.
Figure 7 Role-based UI & Backend Abstraction Minimal Capabilities

Human Service Consumer requires human interaction channel for data access. A problem addressed by this pattern has its roots in multiple user interface technologies. The UI consumes multiple services; these have to be adapted to the end users’ need.

It must be ensured that we are able to discover the right services. During the build phase, this is one of the most critical tasks. If we do not have the right services available, these have to be modeled in a service repository and implemented in the technology and backend application of choice.

The Service Adaptation capabilities in this case are used for backend abstraction in order to avoid close coupling with backend systems that leads to inflexible backend dependency that would be difficult to change.

Minimal Landscape and Bill of Material

By using the process of Architecture Planning, products set is derived from the conceptual view described in Reference Architecture. This results in a minimal set of SAP products being needed to start SOA implementation to meet “Role-based UI & Backend Abstraction” challenge.

Because of the great variety of landscape setups for SOA development as well as a goal to reduce the complexity, the building blocks are divided into the following categories:

- **Essential building blocks** are building blocks that are characteristic for particular SOA Process Pattern.
- **Subsidiary building blocks** are optional, depending on individual requirements; provide valuable support in SOA development or productive landscape respectively.
- **Cross-scenario building blocks** are not only mandatory in a SOA development landscape, but also in other scenarios.

Cross-scenario building blocks are not present in the component views (diagrams).

**Essential building blocks**

In order to fulfill the needs of the SOA Process Patterns “Role-based UI & Backend Abstraction,” several essential building blocks are needed:

**SAP NetWeaver Composition Environment (CE).** For Java based developments, an appropriate number of central application servers (AS) Java test systems for pure development and quality assurance purposes must be installed. In addition, the Developer Studio must be installed on each developer machine. One can install the AS Java in development mode along with the Developer Studio on each developer machine, if there is sufficient computing power available on the developer machines so that developers can test their own coding separately and avoid mutual dependency of changes from different sources.

**Enterprise Services Repository (ESR)** is the place where the service provisioning process starts. This means that at least one ESR instance is required in the development landscape for service provider developments that include new developments and service enhancements. Further instances of ESR are advisable in large development landscapes in terms of distributing workload and isolating development projects from one another. These ESR instances can be organized in a transport landscape if necessary. It is generally sufficient, however, to keep one single ESR instance for the entire development landscape, for the sake of low TCO.

An ESR instance is only optional for the service consumer developments. It plays no substantial role in a production landscape, regardless of service provider or consumer.

**Services Registry (SR)** SAP recommends running SR in the same system as the ESR instance. As for ESR, it is sufficient and advisable to run a single SR in the entire landscape.

**ABAP Workbench**, as an alternative to the Java development infrastructure also the ABAB development infrastructure, the ABAP Workbench is able to fulfill the implementation needs of the
SOA pattern. In addition, one can create additional business logic, e.g. for service adaptation, exposing and consuming web services, and building user interfaces with Web Dynpro.

**Subsidiary building blocks**

**Development infrastructure**, for better coordination of team development, a development infrastructure is advisable. SAP NetWeaver Development Infrastructure 7.0 and 7.1 (NWDI) fully supports Java SOA application development. Not only IDE-based developments such as Java EE, CAF applications, but also server-based application developments such as Visual Composer applications can benefit from the advantages of NWDI.

**Cross-scenario building blocks**

The **SAP Solution Manager** integrates and extends a comprehensive tool set needed to efficiently implement, administer, and operate all SAP solutions in the landscape. Since it is a central system, one needs only one Solution Manager System in landscape. If you do not already operate one, you should set up one along with your SOA landscape.

**System Landscape Directory**, SLD serves as the central provider of system landscape-related information for many SAP application scenarios. In an SOA development landscape, ESR retrieves information about software products and components from the SLD. Thus, if you do not already maintain an SLD in your landscape, you have to activate one along with the ESR.

**SAP NetWeaver Identity Management** provides the functions and services needed to integrate distributed identity data in the system landscape to efficient, heterogeneous identity lifecycle management.
All building blocks mentioned above are functional blocks. It is not necessary to run each of them in a separate system. Depending on computing resources available, one can combine many functional blocks in a single system with flexibility. The product view leads bill of materials described in Table 7 Role-based UI & Backend Abstraction - bill of materials.

### Table 7 Role-based UI & Backend Abstraction - bill of materials

<table>
<thead>
<tr>
<th>Building Block</th>
<th>SAP Software Solution</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESR</td>
<td>SAP NetWeaver CE 7.1</td>
</tr>
<tr>
<td>SR</td>
<td>SAP NetWeaver CE 7.1</td>
</tr>
<tr>
<td>CE</td>
<td>SAP NetWeaver CE 7.1</td>
</tr>
<tr>
<td>NWDI</td>
<td>SAP NetWeaver 7.0</td>
</tr>
<tr>
<td>SLD</td>
<td>SAP NetWeaver CE 7.1</td>
</tr>
<tr>
<td>Backend systems</td>
<td>All web service enabled application systems</td>
</tr>
<tr>
<td>Solution Manager</td>
<td>SAP Solution Manager 4.0</td>
</tr>
<tr>
<td>Identity Management</td>
<td>SAP NetWeaver Identity Management 7.0</td>
</tr>
</tbody>
</table>

**Supporting Information**

For more detailed information about the development process of a composite application, please refer to [SOA Development Handbook](#) published in SDN, which describes the end-to-end development process in an SOA environment. Many best practices that are mentioned above have been based on [Modeling services with CAF](#) and [Exposing web services with CAF](#).

**SOA Process Pattern: UI Dashboard**

In contrast to the Role-based UI & Backend Abstraction pattern, the UI dashboard pattern accesses information from different systems. Therefore, additional SOA Reference Architecture capabilities are needed.

We need to connect to different backend applications, where not all business functionalities may be service enabled. Therefore, Service & Event Bus capabilities are very important. Service & Event
Bus efficiently supports the integration and mediation of non-service enabled apps, supports service-enabling legacy systems, and handling system-centric processes, etc.

As one of the goals of this pattern is to allow user to retrieve a consolidated and harmonized view on the respective information and data. It is very often the case that transactional as well as analytical data are combined within one view. Therefore, Enterprise Information capabilities like Analytics or Data Warehousing are needed for sake of providing aggregated view on historical data, e.g. to reduce the decision making lifecycle. Business Intelligence is therefore becoming an integral part of day-to-day business, people expect actionable information to be embedded in business processes.

Business Rules capabilities support the decision making process through automation (e.g. automated calculation), and provide transparency and efficiency, as well as error reduction.

<table>
<thead>
<tr>
<th>Build</th>
<th>Run</th>
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<tbody>
<tr>
<td>Service Consumers</td>
<td>SOA Infrastructure</td>
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<tr>
<td>Human Interaction Channel</td>
<td>X-Functional Composition</td>
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<tr>
<td>Security &amp; Identity Management</td>
<td>Rules Management &amp; Event Resolution</td>
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<td>Runtime Platform</td>
<td>Service Adaptation</td>
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<tr>
<td>Connectivity Services</td>
<td>Service &amp; Event Bus</td>
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<td>Service Mediation &amp; Messaging</td>
<td>System Integration Services</td>
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<tr>
<td>Service Providers</td>
<td>Enterprise Information</td>
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<tr>
<td>Service Enabled Applications</td>
<td>Non Service Enabled Applications</td>
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</tbody>
</table>

**Figure 9 UI Dashboard Minimal Capabilities**

**Figure 10 UI Dashboard Build and Run components**
**Minimal Landscape and Bill of Material**

**Essential building blocks**

SAP NetWeaver Composition Environment (CE)

Enterprise Services Repository (ESR)

Services Registry (SR)

**Subsidiary building blocks**

SAP NetWeaver Process Integration (PI) PI offers among others the functionality of the Enterprise Service Bus (ESB) that facilitates service enabling of legacy systems, ccBPM, asynchronous service invocation, and service orchestration.

SAP NetWeaver Portal In most cases, it makes sense to run composite applications in a portal environment. Since the CE Application Server Java comes with a portal runtime by default, there is no need to maintain an extra portal system in the development landscape.

If active portal system that serves as central portal system exists, one can easily integrate the content of the CE portal using the Federated Portal Network concept (FPN). In this way, one retains a certain isolation level for the CE system and thus the composite applications, thus updating CE system independently of the remainder of the system landscape.

SAP NetWeaver Business Rules Management (BRM) BRM helps organizations create the technical framework (or software products) to compose, execute, deploy manage business rules spanning across various business applications used by different departments within an organization. It enables organizations to manage business rules for decision automation.

BRM describes a functional block, which is part of the SAP NetWeaver Composition Environment shipment and therefore does not have to run in a separate system. Depending on computing resources available, one can flexibly combine many functional blocks in a single system.

SAP NetWeaver Business Intelligence (BI) SAP NetWeaver Business Intelligence brings together powerful analysis tools, planning and simulation capabilities, and data-warehousing functionality - delivered through user-centric enterprise portal technology.

Additionally Business Objects Business Intelligence Platform could add to the Value of SAP NetWeaver Business Intelligence.

**Cross-scenario building blocks**

SAP Solution Manager

System Landscape Directory (SLD)

SAP NetWeaver Identity Management
Figure 11 UI Dashboard - build and run components

Table 8 UI Dashboard - bill of materials

<table>
<thead>
<tr>
<th>Building Block</th>
<th>SAP Software Solution</th>
</tr>
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<tbody>
<tr>
<td>ESR</td>
<td>SAP NetWeaver CE 7.1</td>
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<tr>
<td>BRM</td>
<td>SAP NetWeaver CE7.1, EhP 1</td>
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<tr>
<td>Portal</td>
<td>SAP NetWeaver 7.0</td>
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<tr>
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<td>SAP NetWeaver 7.0</td>
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<tr>
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<tr>
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<td>SAP Solution Manager 4.0</td>
</tr>
<tr>
<td>Identity Management</td>
<td>SAP NetWeaver Identity Management 7.0</td>
</tr>
<tr>
<td>Business Intelligence</td>
<td>SAP NetWeaver BI 7.0</td>
</tr>
</tbody>
</table>
Validation Information

In this case, we leverage the middleware layer to model a virtual Business Object and related Services in order to have an easy flexible data layer on which the reporting layer is based on.

With the introduction of this abstraction layer, we can slowly build transition scenarios to retire legacy systems or consolidate the backend systems, with minimal or no impact to the reporting frontend.

UI Dashboards, which gather data across a heterogeneous Landscape of ERP and/or legacy systems, brings set of Business Benefits that has been identified by reference Customer:

- Enablement of improved Customer Management through 360° View on customers in each and every process
- Lever towards increased revenue by a better management of customer product portfolios in shifting from “product centric” silo to “customer centric” IT support (customer centric placement of existing and new products)
- Processes complexity reduction by referring only to one central source of customer data – “one version of truth.”
- Faster introduction of process changes through usage of web services
- Behind the service 360° View is an Application-to-Application (A2A) communication that enhances stability and enables controlled changes in banking processes to reduce risk of change
- Readiness of IT-landscape for an improvement in adoption for processes and the elimination of old legacy systems (TCO Reduction)

Supporting Information

For an overview of UI technologies within the SAP NetWeaver product suite, please refer to the following presentation in SDN.

- The UI Technology Capabilities of SAP NetWeaver
- CE and Federated Portal Network: Running Content in a Remote Portal
- Find this and more information regarding the comparison between Visual Composer and Web Dynpro here: SAP NetWeaver Visual Composer and WebDynpro Java – FAQ UI and Modeling Recommendations with CE
SOA Process Pattern: Before-/Post-Processes

In this pattern, the composite process adds steps to an existing process implemented on a backend system. The steps are added before/after the existing core-backend process steps. Most workflow composites fall into this pattern. Therefore, it is very important to understand that a business process can be categorized by two basic sub-process types:

- Application Core Processes
- Composite Business Process

**Application core processes** are delivered by business applications. These processes are pre-defined, packaged and can be customized in applications such as ERP, CRM or SRM. By nature, these processes represent the core business functionality that "runs the business" operations.

The nature of **composite business processes** is to enable business process composition on the edge of application core (either before- or post-processes). They are driven by functional business requirements and specifications and their goal is primarily to provide added business value, speed, and quality of exception handling and delivery on the promise of innovative business ideas to improve efficiency and reach a sustainable process improvement impact.

Composite business processes are either **human-centric (collaborative)** or **system-centric (integration process)**.

Technical processes supporting system-to-system and system-to-human type of interactions are defined as system-centric.

**Human-centric composite business processes** focus primarily on cross-system and cross organization type of processes. These processes are primarily driven by business users and business activities; they combine user activities with User Interfaces (UI's) or via tasks in a task list and automated activities. They include either single service-enabled activities or modeled integration processes for mediation purposes as, e.g. automated data consolidation.

This SOA process pattern focuses on Human-centric composite business processes. Major difference to the other two SOA process patterns is that process composition capabilities are needed. They enable process-automation and include human call-outs. In this collaboration process structured data, which is seamlessly integrated through services and events, can be enhanced with unstructured data (e.g. attachments, notes) from an enterprise content management system.

Rules Management (RM) capabilities act as an accelerator for business processes and improve efficiency through decoupling of decision logic from process logic. RM captures, automates, and aligns critical business rules and the decisions they drive as reusable services. RM also correlates real-time business events based on rules.
**Minimal Landscape and Bill of Material**

**Essential building blocks**
- SAP NetWeaver Composition Environment (CE)
- Enterprise Services Repository (ESR)
- Services Registry (SR)

**SAP NetWeaver Business Process Management** describes a functional block, which is part of the SAP NetWeaver Composition Environment and therefore does not have to run in a separate system. Depending on computing resources available, you can flexibly combine many functional blocks in a single system. BPM as a technology (or software product) providing IT organizations with a framework of tools to model, deploy and execute processes that include human and system tasks (as, e.g. workflows) or that span across different business applications and require a broad set of integration capabilities.

**Business Process Management and Business Rules Management** co-existed in SAP systems for many years. SAP delivers the first process modeling & management experience that delivers automated decision-making and business rules management as an integrated experience (Embedded Business Rules Management).

**Subsidiary building blocks**
- Development infrastructure
- SAP NetWeaver Portal

**Cross-scenario building blocks**
- SAP Solution Manager
- System Landscape Directory (SLD)
- SAP NetWeaver Identity Management
Figure 14 Before-Processes/Post-Processes - build and run components

Table 9 Before-Processes/Post-Processes - Bill of Materials

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Supporting Information
An overview of BPM capabilities within the SAP NetWeaver product suite, please refer to the following documentation in SDN.

- https://www.sdn.sap.com/irj/sdn/nw-processmodeling
- SAP NetWeaver BPM Roadmap: Business Process Management Roadmap
- Main entry page for Business Rules Management Information on SD

5.2 Integration of Enterprise Services Buses (ESBs)

Integrating various ungoverned side-by-side SOA implementations in multiple departments (i.e. mergers and acquisition) at the ESB level is a first step and a quick win. If such SOA implementations have delivered on the initial promised value and accepted in the organization, a consolidation of actual infrastructure itself can be considered as a second step.

![ESB Integration Diagram]

Figure 15 ESBs integration

It is important to focus on linking the infrastructure (red connection in picture above) and not pushing the extra complexity into the consuming application to prevent bloated development and monitoring processes that would block the road for efficient consolidation in the future.

An overview of the system landscape and scenario used for the integration proof of concept can be found here. The full documentation for the scenario outlined above is not yet available, so please keep checking for updates on https://cw.sap.com/community/esc/cag10?view=blogposts
5.3 Registry Coexistence

Figure 16 Registry Coexistence
It is important to note that the architecture of SAP NetWeaver Services Registry, delivered as part of NetWeaver Composition Environment (CE) 7.1 and NetWeaver Process Integration (PI) 7.1, highlights UDDI v.3 Server (blue box). While SAP delivers its own implementation, UDDI v.3 Server can be seamlessly exchanged by another vendors’ UDDI product.

While one can use both the SAP tools via various interfaces shown above as well as the 3rd party UDDI vendors tools configuration options, only one store for service endpoint information and classification should be initially considered.

A detailed How-To Guide outlining this type of integration with the UDDI based HP product is available ("How to Set Up an Interoperable Scenario with SAP NetWeaver Services Registry and HP SOA Governance Systinet Registry Foundation").

NOTE: Although UDDI is a standardized way to store and represent classifications to assist managing large numbers of services, it may not be the most effective way to do so. As different vendors use different schemes, a common schema within an organization is needed. In addition, there are some non-UDDI compliant registry products on the market. Using these multiple stores for potentially the same data will lend to additional consistency maintenance step(s).
6 SOA Capabilities in Detail

Figure 20 describes SOA reference architecture in a conceptual vendor-agnostic view. In this chapter, we will describe the different capabilities and the available SAP Solutions.

6.1 Plan - Plan your SOA Environment, Transformation Planning

Implementation Methodology

SAP has developed a methodology for Accelerated Transformation for SOA to help set up SOA projects. Currently, this methodology is available in the SAP Online Shop (Starter-Kit for SOA on a CD).

Governance & Organization

A well-managed approach to organizational planning and certain expectation for transformation is needed for SOA implementations. Many ingredients for SOA – from human resources to IT infrastructure components – likely exist within a company. Initial step is to identify and prioritize the gaps on the way to SOA without reinventing the wheel.

Resources need to develop new skills to fulfill new roles within the framework of company's culture. Once resources' roles in designing and implementing SOA solutions are communicated and accepted, business usage of SOA applications will become evident. Thus, principles for sound decision-making process as well as robust escalation procedures in form of governance control are
needed. The key management responsibility in this phase is to apply the best organization and governance practices and provide a clear vision, guidelines, and a road map.

The figure below illustrates the Governance Organizational Domains that have to be managed. Additionally, establishment of Enterprise Architecture Governance is recommended. More information about governance can be found in the SAP paper “Enterprise Architecture Governance – ensuring Business and IT alignment.”

**Figure 18 The process behind enterprises Organizational Planning and Governance**

**IT and Business Alignment**

SOA changes the way in which business and IT deal with each other. This is a significant paradigm shift. The IT organizations need to thoroughly understand business requirements, become more responsive to business needs, and speak the “language of business.” Concurrently, business organizations need to communicate clearly what they need and be prepared to fund the need. With such coordination and paradigm shift, IT organization must provide the underlying architecture required to deliver and maintain services with business-level meanings.

This mutual understanding is the key to the design, development, use, and reuse of enterprise services that are synchronized with business needs. In addition, effective SOA governance is the key to creating this understanding. An SOA competency center serves as the nucleus that drives this understanding.

**SOA Competency Center**

A strong SOA competency center is vital to the evolutionary transition to SOA. The SOA competence board staffs and runs this center including business process owners from both line of business and IT side. Such executive-level sponsorship and strong leadership ensure that the SOA competency center is visible and viable across the enterprise.

The SOA competency center provides thought leadership as well as highly skilled planning and management resources. Through highly skilled planning and management resources’ primary responsibility are planning, management, consulting, and operations functions, it must also proactively ensure compliance, and measure achieved business value, and proactively mitigate risk. Serving as a central communication hub for all SOA activities, SOA competency center is the lighthouse an organization turns for guidance.
Supporting and overseeing the work of the SOA competency center, is a steering committee made up of executive level sponsors, line of business managers, and IT managers. Such steering committee addresses and resolves any conflicts of interest and handles escalations.

**Roles and responsibilities for SOA**

**Head of Enterprise Architecture**

One of the key roles in the SOA competency center is that of a Head of Enterprise Architecture. Working with line of business representatives and IT organizations, the Head of Enterprise Architecture is responsible for mapping business requirements and processes to IT services. The Head of Enterprise Architecture works closely with business organizations to identify their most pressing needs, addressing the critical business events to be supported by service based applications. In this role, the Head of Enterprise Architecture defines enterprise standards and makes recommendations for HR development in line with SOA progress.

Drawing on excellent technology, communication, and interpersonal skills, through SOA the Head of Enterprise Architecture drives innovation, coaching, and conflict resolution. In most companies, an existing human resource is appointed to the position. Providing rich technological expertise as well as business experience, the head of enterprise architecture typically reports directly to the CIO.

**Other Roles and Responsibilities for SOA**

Depending upon a company’s specific needs along its SOA road map, a number of other SOA-centric roles may be needed within cross-functional teams that are part of or are strongly linked to the SOA competency center. In most companies, existing employees can fill these roles. SOA-centric roles typically include the following:

- Business process experts identify abstracted and normalized business services and translate business requirements into enterprise service definitions. In some companies, an enterprise architect fills this role.
- Enterprise service developers implement enterprise services and create all of the integration logic necessary to map them to application services.
- Enterprise service composers align, combine, and arrange enterprise services to enable business processes for current and emerging needs.
- Service repository keepers identify services that are suitable for reuse, and they build and maintain a repository of such services.

**Change Management**

Change management is a core element of SOA adoption. To embrace anticipated changes and to ensure that unexpected events do not catch organization completely off guard, organization needs to have a robust change management plan in place. The change management plan defines objectives, milestones, procedures, required skills, and the lines of communication required to transform organization to a SOA-enabled corporation. Such plan reflects good SOA governance, ensuring that changes are processed in the appropriate manner in terms of time, people, and skills along the SOA journey. Services need to be modified and adjusted to keep up with changing needs. Such change management plan stipulates the rules and procedures for managing changes and versions.

Finally, the change management plan instills confidence, demands commitment, and provides a frame of reference for the orchestration of all SOA activities – from the organizational level all the way to the enterprise service level.

**SAP Service Offerings**

SAP Consulting offers a complete services offering around SOA Services.
Design and Model

Within the SOA framework, complex business processes can be broken down into smaller process composition of services. Process decomposition is accompanied by lower the associated skills barrier. Thus, good governance for service design and modeling delivers the following benefits:

- Increased productivity with immediately reusable enterprise services, collected in an enterprise services repository.
- Greater agility due to reliance on SOA solutions based on stable enterprise services that exhibit predictable behavior.
- Ensured alignment with business requirements achieved by involving all stakeholders and reflecting upon their views.
- Functional correctness and greater consistency of enterprise service semantics, data types or mappings, interfaces, and messages.


Portfolio Management

Portfolio Management provides the framework to implement a transparent investment decision process across various organizations. In this context, the enterprise services portfolio process ensures that the right balance drives a planning between an organization’s strategic priorities, market, external opportunities, architectural innovation, and available resources. Portfolio Management is mainly based on business value and the ability to execute. In planning cycles, the organization’s strategic priorities are verified and updated. These strategic priorities then drive the short list of development opportunities. Key components of successful Portfolio Planning and Management include:
• Clear definition of inputs to determine company and operational objectives, for example
  o Long Term Plans
  o Operational Near Term Objectives
  o Corporate Directives

• Objective, clear strategies and techniques for defining an appropriate and approved portfolio, including:
  o Definition of investment classifications for spend which yields a portfolio strategy and provides an appropriate “risk reward balance”
  o Metrics for business case measurement - techniques for measuring progress against business proposal

• Governance of the portfolio by a core team which includes strong executives sponsorship

• Active, ongoing reviews of approved projects and programs
  o To check progress against plan and to realign (or terminate) projects which no longer support changing business objectives and/or are not achieving their original business case objectives

**Enterprise Architecture**

Enterprise Architecture focuses on the planning of IT and enterprise architecture supported by standardized architecture frameworks. The SAP Enterprise Application Framework (EAF) is a methodology with its roots in TOGAF whose principles can be mapped to all the aspects of SOA governance. Many organizations today require a cohesive approach to understanding and adopting SOA across their enterprise landscape. SAP has developed a SOA Domain Model that highlights the key activities organizations should focus on and establish competencies in - designed in a logical way to support the typical IT life cycle. This is then used in conjunction with the SAP SOA Reference Architecture - which allows customers to create a blue print of their “as is” and “to be” architectures. Highlighting the areas where they have strengths, gaps, and possible problems moving forward in relation to their SOA adoption. The SOA Reference Architecture can be taken from a conceptual view, to a functional view and can even be mapped onto a specific Enterprise Architecture of a customer - highlighting IT projects, future road maps, and changes that may need to happen in the architecture to support the Business. This overall approach supports the SAP governance model and methodologies.

**6.2 Build – Delivering SOA Solution based on Service Orientated Assets**

**Implementation Services**

Implementation is the realization of an application, executed to a plan, design, and standards, within policy. Such realization involves delivering software component to a technical specification, creating composite application, or a service.

Within the SOA framework, complex business processes is broken down into smaller process components and business objects, represented in software as reusable enterprise services. To insure that these services deliver on their expectations, one needs implementation service that assures quality and smooth delivery of the solution.
Composite applications or "composites" will access existing functionality via service-enabled interfaces. SAP NetWeaver Composition Environment 7.1 provides a toolset for developing composite applications. It builds upon proven technologies that have been enhanced and integrated to provide greater functionality and flexibility.

Following are brief discussions of SAP NetWeaver Composition Environment 7.1 toolset.

**The SAP NetWeaver Development Infrastructure** (NWDI, or JDI in previous releases), together with the SAP NetWeaver Developer Studio, provides a complete Java development environment. Developers, quality managers, testers, and administrators have everything they need for the software creation process in NWDI central services.

**SAP NetWeaver Developer Studio** is an integrated environment for the development of J2EE-based, multi-tiered business applications. It is based on open-source Eclipse IDE, providing an open and extensible development environment using Java and web services.

**SAP NetWeaver Visual Composer** allows composing model-based business applications in a flexible way. One can create pattern-based or freestyle user interfaces using simple drag-and-drop services and then define the data flow between them.

**SAP Business Rules management Modeling & Implementation** enables business process experts and IT professionals to create and maintain business rules for embedded decision automation in composite applications and business processes. This helps improve rules quality, change management and re-use.

**AcceleratedSAP** is a step-by-step methodology for speeding up the implementation of an SAP ERP system. ASAP can reduce the time required to implement an ERP system by as much as 50%.

**The ABAP Workbench** provides an integrated development environment to support entire software development cycle with ABAP Editor, Transformation Editor, Debugger, ABAP User Interface, and Web Dynpro for ABAP, Business Server Pages, Classic Dynpro, and GUI Controls.

**Solution Extension SAP Enterprise Modeling by IDS Scheer** includes SAP Business Designer helps design business processes and connect with the SAP Solution Manager. SAP Business Process Optimization adds quantitative process analysis to Web-based modeling with the help of extensive simulation functionalities. SAP Enterprise Modeling operates on business processes models. SAP Process Performance Management analyzes processes running in SAP solutions and automatically generates graphic documentation.

### Service Definition and Discovery

An integration platform must provide comprehensive life-cycle management tools that build and maintain SOA infrastructure. It has to ensure that all solution life-cycle phases are covered. One of the most important phases is the analyzing and discovery phase. During the analysis and discovery phase, one must analyze the overall business requirements and map them to existing IT landscape. Typically, one needs to identify needed business objects and enterprise services, locate available enterprise services in the repository for reuse, and identify missing services required to support the new business processes.

SAP NetWeaver delivers Enterprise Services Repository (ES Repository) serving as the central location that IT professionals can define, access, and manage SOA assets like Enterprise Services and business objects. In addition, ES Repository is the central location in which enterprise services are modeled and where enterprise services metadata is stored. It consists of two key components:

**The Service Repository** that stores the definitions of enterprise services and business processes, as well as the metadata of all services objects. It also provides a central modelling and design environment. The services repository stores the definitions and metadata of Enterprise Services and business processes while providing a central modelling and design environment for creating, aggregating, and using Enterprise Services.
The Services Registry supports the publication, classification, and discovery of Enterprise Services defined by SAP, partners, or custom across the IT landscape. This UDDI-compliant registry also enables the management and governance of service-enabled applications. The services registry is an integral part of an enterprise service repository. Supporting the publication, classification, and discovery of enterprise services for reuse in enterprise SOA applications, the services registry provides runtime governance by providing information about all services and service definitions in the enterprise SOA landscape, including references to the Web Service Description Language (WSDL) file and to the locations of the callable service endpoints.

Using an integrated set of tools for accessing the ES Repository, solution designers and developers can easily access SOA assets to build composite applications and enable adaptable business processes.

Testing

Quality assurance and control for distributed environment including message and database services along with web services requires comprehensive tools and skill set driven by architectural test principle. It requires that both producers and consumers services are tested on a continuous basis. It is important to invest in a testing framework that would provide the visibility required to find the culprit in architecture.

Quality control and assurance tools, SAP offers a comprehensive set of testing and quality management tools to help ensure the quality, performance, and reliability of SAP business applications. These tools enable to change quickly, intuitively, and cost-effectively by applying a testing strategy that supports organization throughout the entire life cycle of SAP applications. Tools include: LoadRunner application by HP, SAP Quality Canter application by HP, SAP Test Acceleration and Optimization, SAP Test Data Migration Server, SAP Solution Manager, SAP Computer Aided Testing Tool, SAP NetWeaver Developer Studio and ABAP Workbench.

Quality control and assurance services, SAP Services offer a comprehensive collection of testing and quality management services. With services across all aspects of testing – accelerated testing, testing automation processes, building a reusable test library to accommodate business changes, and testing, and performance management for technical upgrades and enhancements – our testing services will help maximize the ROI in SAP projects. Testing services include: Testing strategy and assessment, Testing Center of Excellence, Performance testing, Functional testing, Independent validation, and verification, ongoing test maintenance.

6.3 Run – Execute SOA

Service Consumers - Provides interaction channels to consume enterprise services

Application Interaction Channel

SOA builds business applications out of software services that are delivered by system applications. Service consumer locates entries in the broker registry using various find-operations and then binds them to the service provider in order to invoke one of its web services. Business process management (BPM) is a method of efficiently aligning and orchestrating an organization with the wants and needs of clients. It is a holistic management approach founded in SOA.

Business processes can be described in two ways. First, as executable business processes that model actual behavior of a participant in a business interaction. Secondly, as abstract business processes that are partially specified and not intended to be executed. An abstract process may hide some of the required concrete operational details. However, abstract processes serve a descriptive
role with more than one possible use case, including observable behavior and process template. WS-BPEL is a standard based mechanism to model the behavior of both executable and abstract Processes. WS-BPEL provides a language for the specification of executable and abstract business processes. By doing so, it extends the web services interaction model and enables it to support business transactions. WS-BPEL defines an interoperable integration model that should facilitate the expansion of automated process integration in both the intra-corporate and the business-to-business interactions.

**SAP ccBPM Cross-Component Business Process Management** supports an integration process. Integration process is an executable, cross-system process for processing messages. In an integration process, one defines all the process steps that are to be executed and the parameters relevant for controlling the process.

**SAP Auto-ID Infrastructure** Radio frequency identification (RFID) technology electronically captures, stores, and transmits data about assets and materials via radio waves or other nonphysical transmission technology – digitizing physical objects that can be interpreted transparently by IT systems.

**Human Interaction Channel**

SOA creates ultimate platform for human-to-human or human-to-machine interaction. This platform is founded on business applications composed of services.

The BPEL language specifies the behavior of business processes providing that the activities of the processes are web services. However, human interactions are omitted. Despite wide acceptance of web services in distributed business applications, the absence of human interactions is a significant gap for many business processes instances. BPEL4People extends BPEL from orchestration of web services to orchestration of role-based human activities. The WS-HumanTask specification brings in the definition of human tasks and notifications.

Composite applications have a key role in SAP’s SOA strategy. They combine automated process steps implemented using services with human user interactions. SAP, along with other technology vendors, published a set of specifications, which define how human interactions can be integrated in web services based business processes as well as SOA based applications.

SAP NetWeaver enables business users to coordinate, monitor, and execute business tasks arising from automated process flows. Business tasks are activities generated either by the company’s underlying business processes or by the users themselves -- as personal reminders, to collaborate with others, and/or to delegate work to colleagues.

**SAP Central Access to Tasks** provides centralized task management from which business users can manage, respond to, and delegate daily work items. The work items can include notifications, alerts, mission-critical workflows, approvals, and ad hoc tasks. Work items can be generated from automated business processes or raised by colleagues.

**SAP Forms Based Processes** enables business users to design interactive forms that can be used to define department procedures without the need of IT involvement. Business users can complete the tasks by simply filling in an online or offline form. A guided navigation helps the business users through the procedure, tracking the course of the procedure, and seeing at-a-glance the tasks that have yet to be completed.

**SAP NetWeaver User interface** enables developers to enhance the user experience to improve usability and interactivity. SAP delivers model-based and programmatic tools that provide support for open standards for greater productivity and flexibility. As such, developers can create or enhance user interfaces to meet the needs of users.

**SAP NetWeaver Portal** enables IT organizations to provide secure and role-based access to relevant applications, information, web content, and processes from SAP as well as third party sources. The portal also delivers collaboration features that enable individuals, teams, and interested parties to work closely together towards common goals.
SAP Forms Based Processes Duet for Microsoft Office and SAP - designed, developed, and supported by Microsoft Corporation and SAP AG - brings together the software of these two market-leading companies to give information workers access to information and utilities by seamlessly bridging two software environments.

SAP NetWeaver Mobile enables IT organizations to extend their company's business processes to support a mobile workforce. It includes features such as always-connected and occasionally-connected clients as well as voice interaction.

SAP Business Workflow enables the design and execution of business processes within SAP application systems. Workflow processes are delivered as content in SAP Business Suite. It is possible to enhance those workflows and create new workflows. Business workflow is integrated with Organizational Management and Business Intelligence.

Cross Functional - Provides cross cutting functionality that all assets can utilize

Virtualized Infrastructure
Platform virtualization is performed on a given hardware platform by host software (hypervisor), which creates a simulated computer environment. Hypervisor is a virtualization platform that allows multiple operating systems to run on a host computer at the same time. The guest runs just as if it were installed on a dedicated hardware platform. Typically, virtual machines are simulated on a single physical machine; their number is limited by the host’s resources. Guest system requires access to peripheral devices to function, and the simulation must support the guest's interfaces to those devices.

SAP Adaptive Computing Controller provides a central point of control for flexibly assigning computing resources to run any service on any server at any time. The tool provides the capability for enterprise services computing. Encompassing the four building blocks of the IT landscape – computing, storage, network, and control – the Adaptive Computing Controller tool enables: Hardware and operating system provisioning, Data storage, Network provisioning, Adaptive computing control operate, observe, and manage an adaptive business solution from a central point.

Runtime Platform
Runtime platform is a server that hosts an API to expose Business Logic and Business Processes for use by other applications and provides number of infrastructure services.

SAP NetWeaver Application Server provides an open and reliable infrastructure for deploying highly scalable Web applications and web services. Features and functions include: Security, Persistence layer support, Deployment, Scalability, performance, and high availability, Software logistics and life-cycle management, The SAP NetWeaver Application Server is the central foundation for the entire SAP software stack. It also provides a platform for other NetWeaver components (Portal, XI, and so on), as well as for ABAP and Java applications. The full Java EE standard is supported. The SAP NetWeaver Application Server is the further development of the SAP Web Application Server.

Security & Identity Management
Organizations face a difficult challenge in today’s security-conscious world having to support transparent enterprise boundaries, location-independent users, and the growing demands for regulatory compliance. IT organizations have to safeguards their business, while helping users and business processes to proceed unhindered by security operations. As such, integral part of protection is security and identity management process.
Authorization is a key concept in security. It is concerned with allowing access to resources. Authorization is a process that protects resources allowing access to those resources by consumers with privileges to use them. Resources covered by authorization include data, services as well as physical devices. Authorization is a separate concept to authentication, and usually dependent on it. Authentication is the capability of confirming user claim. This might involve confirming the identity of a person, the origins of an artifact, or assuring that a service or computer program is a trusted one.

As identity management (IdM) deals with user credentials, IdM is administration of information as held in a directory that represents items identified in real life and related to security (e.g. users, devices, services, etc). Identity management functionality includes the following; user information self-service, password resetting, management of lost passwords, workflow, provisioning of identities, and de-provisioning of identities from resources. The ability to manage the provisioning and removal of identities centrally, and consolidating the proliferation of identity stores, are part of the identity management process.

**SAP NetWeaver Identity Management** provides IT organizations efficient and secure management of internal and external identity accounts in a heterogeneous environment. It enables IT organizations to coordinate and join existing accounts using directory services, to set up a complete workflow, to provision access to systems, and support distributed management of accounts.

**SAP Authorization Management** supports business process flows by ensuring that authorized users have appropriate applications and data used to support the business process. IT organizations can define roles with minimal permissions, provide read-only access to data, and segregate process duties when required. Authorization is defined to support business requirements.

**SAP Authentication and Single Sign-On** supports a variety of authentication methods including user IDs/passwords, SAP logon tickets, x.509 digital certificates, and the Kerberos network authentication protocol. In addition, IT organizations can use SAP to integrate SAP and non-SAP systems into a single sign-on landscape based on the open standard Security Assertion Markup Language (SAML).

**Composition – Compose Assets into Business Solutions**

**UI Composition**

User Interface Composition produces the user interface. Such user interfaces generally span several backend system contexts, and may present data from two or more systems simultaneously. User interfaces consume web services either from the business logic layer or from the backend layer to retrieve and update data. They do not contain any business logic. UI and business logic decoupling is implemented by using services of the business logic layer only. User interfaces are integrated in the overall composite process by being wrapped into a callable object.

**SAP NetWeaver Visual Composer** allows composition of model-based business applications in a flexible way without manual coding. With SAP NetWeaver Visual Composer, creation of pattern-based or freestyle user interfaces with simple drag-and-drop services as well as defining the data flow between them is streamlined. When a model is deployed, SAP NetWeaver Visual Composer translates the model into the required code for the application.

SAP NetWeaver supports a broad range of user interface and client technologies ranging from dedicated clients such as the SAP NetWeaver Business Client, widgets, various web browsers, as well as technologies for client-independence and multi-channel rendering - AJAX and Adobe Flash-based user interfaces.
Process Composition

Service composition involves the development of customized services often by discovering, integrating, and executing existing services. It is not only about consuming services, however, but also about providing services. This can be done in such a way that already existing services are orchestrated into one or more new services that fit better in composite application.

During Business Process Composition, a business process expert evaluates potential solutions to meet identified business needs.

The Composite Application Framework (CAF) is part of SAP NetWeaver Composition Environment 7.1. It helps to realize the clear separation between the process and user-interaction-related components on the one hand, and the actual business logic provided as services on the other. CAF is a standardized platform for developing all needed components of the service and object layer of a composite application. These components are:

- Business Objects (Entity Services)
- Business Logic (Application Services)
- Connectivity to external services (web services and BAPI/RFC, local and remote persistency)
- Service Provisioning

CAF also provides a comprehensive toolbox that includes: Programming abstractions, a programming model, Metadata, Authorization concepts, modeling of relationships between business objects, integrated into lifecycle management SAP NetWeaver Development Infrastructure (SAP NWDI).

SAP Business Workflow enables IT professionals to model and execute workflow processes within SAP application systems. SAP delivers workflow templates as pre-packaged content with SAP Business Suite applications. Using SAP NetWeaver, IT professionals can modify these templates to enhance workflows delivered by SAP or create new workflow processes.

Rules Management & Event Resolution

Business rules describe or represent constraints on the behavior of the business. Business rules represent the core business logic of each organization; they guide and control the basic business processes that form the backbone of any business transaction.

The business rules management (BRM) functionality of SAP NetWeaver is a major part of SAP NetWeaver Composition Environment and is designed to help organizations build agile applications that can evolve at the pace of fast-changing business requirements and at the same time distribute responsibilities appropriately. SAP NetWeaver enables organizations to manage business rules for decision automation. Business users participate in and control rule definition and change, while business process experts’ model, validate, deploy, update, and archive business rules through their life cycle. As such, IT organizations can work with business users to manage business rules that drive process flow and execution. The benefit is improved decision-making transparency and efficiency, as well as error reduction.

SAP Informed Decision Automation SAP NetWeaver enables business process experts and IT professionals to execute centrally defined business rules as part of composite applications and business processes. Rule execution can be monitored and analyzed by business users as well as business process experts or IT professionals for auditing and optimization purposes. Centralized decision automation helps improve decision-making quality across organizations and business applications.

SAP End to End Rule Management enables business process experts and IT professionals to manage the complete life cycle of business rules. This includes rules versioning, customized approval mechanisms, current or historical rule activation, all based on a rule repository supporting access control, query and reporting as well as change alerting and logging.
Service Adaptation

Service messages from the client are intercepted by the adapter. The adapter then applies an XML specification to select appropriate XSL documents for the required transformation based on the incoming message. Once the adapter has applied the transformations using the selected XSL documents on the message, it then forwards the resulting message to the destination server identified in the XML specification. The reply from the server may also be transformed before being sent back to the client. There are distinct motivations for choosing to locate the adapter at the client or server; these are discussed in the following sub-sections.

One can use the various adapters in the SAP Advanced Adapter Engine to convert XML- and HTTP-based messages to the specific protocol and format required by these systems, and the other way around. Using Integrated Configuration, one can define a local Message Processing on the Advanced Adapter Engine. The Advanced Adapter Engine provides mapping and routing for this locally. Message Processing is executed on the Advanced Adapter Engine from one adapter to another without the involvement of the Integration Engine.

Enterprise Information – Deliver Business Insight into corporate information and minimize risk

Enterprise information management is a wide-ranging discipline for gathering, structuring, describing, transforming, and utilizing information, regardless of organizational and technological boundaries.

Enterprise Content Management

ECM capability covers structured, weakly structured and unstructured content across all of an enterprise. ECM enables management of content, wherever it exists, supported by capture, deliver, store, and preserves capabilities. Key characteristics of ECM are:

- Enables management, processing, and use of content.
- Ensures legal compliance concerning privacy, content metadata, and records management.
- Overcomes the restrictions of information silos. It is a uniform method for all types of content.
- Provides content without regard to the source or the required use.
- Eliminates expensive redundancies and associated problems with content consistency.
- Foundation for collaboration, jointly usable content databases, simultaneous and controlled information processing.
- Integration of content in the context of joint processing

ECM works with broad range of content media types: electronic and scanned documents including: emails, internet and intranet resources, metadata, models including business process models and workflow instances, images, voice and video, relational and other databases, data warehouses.

With the SAP Knowledge Management capabilities of SAP NetWeaver, IT organizations can plan, build, and operate an integrated KM environment. Using tools provided by SAP NetWeaver, information workers can create and publish documents; classify, approve, and share information; and search for or be notified about information. With knowledge management, companies can turn unstructured information into organization knowledge.

Web Content Management manages content presented on Internet and Extranet. SAP Web Content Management makes it easier for information workers to create and organize web content for a portal. With the web page composer tool, information workers can create and update content, web pages, and sites without requiring the involvement of IT. To ensure consistency across the enterprise, IT organizations can use the web page composer tool to create page templates, layouts, and styles.
Web Page Composer (WPC) is based on the standard portal and knowledge management capabilities of SAP NetWeaver. Thus, sites, pages, and content are managed in knowledge management, whereas user and role management, page building, and rendering are facilitated by the portal. The main benefit of this concept is that WPC combines the existing capabilities of both and extends them with valuable WCM functions.

Document Management controls documents lifecycle from their creation through to long-term preservation. SAP Document Management, SAP NetWeaver offers capabilities to handle the creation, storage, and delivery of documents in a business context. A close coupling with the SAP Business Suite ensures an enterprise wide consistency across structured business objects and documents.

The Knowledge Provider (KPro) is a cross-application and cross-media technical information infrastructure within the framework of SAP Web Application Server. The modularity and openness at the heart of the Knowledge Provider are demonstrated in its modular services and its clearly defined interfaces.

SAP Content Server is a stand-alone component in which a large quantity of electronic documents of any format and with any content can be stored. It can be accessed via the Knowledge Provider (KPro) or via ArchiveLink.

ArchiveLink standard scenarios are fundamental to the easy implementation of document integration. ArchiveLink features: automated storage and management of incoming documents based on WebFlow, automated linkage and storage of incoming documents using bar codes, ad hoc processing of incoming documents.

Electronic Records Management, ERM refers to the pure administration of records, important information and data that companies are required to archive. SAP Electronic Records Management, Records and Case Management enables quick access to the information required for successful transaction processing. The content managed with records management technology includes both transactional or application data (structured data) and the unstructured content in related documents.

Enterprise Search

The Enterprise search enables information sharing within organization. Enterprise search indexes documents from a variety of sources including: shared or local file systems, intranets, internet, internal and external search providers, documents, transactional and analytic management systems, e-mail, metadata repositories, databases and then presents a consolidated and federated list of relevance ranked documents from these various sources. Enterprise search federates all repositories and search providers in one central search functionality.

It is role based and enforces security policies through putting in place access controls. If user has no access to information in transactional and analytic management system, he will not be able to find the information in search.

Advance options of enterprise search capacities are:

- Text analytics, it is a set of linguistic, lexical, pattern recognition, extraction, tagging/structuring, visualization, and predictive techniques.

- Context sensitive actionable search results. For example, user could execute report based on found analytics metadata.

- Taxonomy based search to improve search results. Content-based taxonomies are organized using existing content. Charts, computer directory/folder structures, or social tagging content is typically a 'content based' taxonomy. Subject taxonomies completely describe all of the terms in a field, as well as the hierarchical relationship between the terms.

- Automatic and manual subject indexing and tagging of information. Based on the information contained in processed content, automatic classification. Information is evaluated based on
 predefined criteria or in a self-learning process. Preset inputs profiles improve subject indexing. These can describe document classes that limit the number of possible index values, or automatically assign certain criteria. Input designs also include entry masks and their logic in manual indexing.

The SAP NetWeaver Enterprise Search helps information workers navigate critical business information by enabling seamless, secure access to SAP and non-SAP information and processes. SAP NetWeaver Enterprise Search delivers highly relevant results, suggests actions that reflect the end user’s role in the enterprise, and recognizes the business context of the search query.

SAP Information Discovery

- Search and Navigation (BusinessObjects Polestar, BusinessObjects Intelligent Search)
- Search Engine Integration (Google Desktop Plug-in, Google Search Appliance Plug-in)

**Data Warehousing**

Data warehousing is an ability to consolidate data from multiple business, mostly transaction processing systems and store it specifically structured for query and analysis. A data warehouse is an integrated, time-variant, and non-volatile collection of data in support of management's decision-making process. A data warehouse is a central repository for all or significant parts of the data that various business systems collect in an enterprise. The primary purpose of data warehousing is to provide easy access to specifically prepared data that can be used with decision support applications such as management reports, queries, decision support systems, executive information systems, and data mining. Data warehousing allows manipulation on data without affecting source systems. Data warehousing characteristics:

- Separates querying and reporting activates from others business, mostly transaction processing systems for performance and security reasons. Data warehousing is physically separated from transactional system to avoid interference.

- Use data models and technologies optimized for querying and reporting. Modeling techniques used in data warehousing speed up querying and reporting (e.g., a star schema). Data warehousing technology is optimized to perform analytic and reporting operations. There are server technologies that may speed up query and reporting processing (e.g., bit-mapped indexing).

- Environment where minimal amount of DBMS knowledge is required to write and maintain queries

- Repository of cleaned up consolidated data from a longer span of time than can efficiently be held in a transaction processing system

- Consolidated information view from all relevant business systems.

Integral part of data warehousing is capability to support data mart. A data mart is a subset of an organizational data store, usually oriented to a specific purpose or major data subject that may be distributed to support business needs. Data marts are analytical data stores designed to focus on specific business functions for a specific community within an organization. Data marts are too often derived from subsets of data in a data warehouse. Although in the bottom-up data warehouse design methodology, the data warehouse is created from the union of organizational data marts.

**SAP Data Warehousing**, SAP supports three conceptual layers of data warehousing. With the first approach, IT organizations integrate data from heterogeneous systems into an enterprise data warehouse. IT professionals use a rich tool set to perform data modeling, data transformation, and data distribution to create the warehouse. The second approach supports a subset of multi-dimensional models to support real-time data access.

**SAP BI Accelerator**, Organizations can improve the performance of queries, shorten batch times, and reduce administration tasks using the SAP NetWeaver BI Accelerator appliance, which runs on
specifically configured hardware supported by SAP partners. SAP NetWeaver BI Accelerator uses a powerful search and classification engine, sophisticated in-memory data compression, and horizontal and vertical data partitioning to improve query performance radically with zero administrative overhead.

**Data Quality Management**

Data Quality Management Services enforce data quality rules for both data values and structures. Data quality rules relate to following data attributes: accuracy, precision, completeness, reliability, availability, timeliness, freshness, consistency, uniqueness.

Data quality management involves profiling, validation, cleaning (scrubbing, cleansing), standardization, match data updates and preparing data for decision support, governing of maintaining data in appropriate data stores, accessing and analyzing data in quality perspective.

A data warehouse is key supporting capability of quality management. It is often used to examine business trends to establish a strategy for the future. DQ services may request Enterprise Information Integrity Services.

**SAP Master Data Quality** helps organizations to achieve consistent master data of high quality. This requires data profiling, de-duplication, data normalization and standardization, data validation, and enrichment capabilities. As a result, organizations can ensure accuracy, validity, completeness, consistency, and timeliness of master data.

**SAP BusinessObjects Data Quality Management** allows organizations to centralize the discovery, correction, and prevention of data quality issues across the enterprise through a single graphical interface. It ensures the integrity of data, maximize developer productivity, and ensure complete data for all operational and analytic initiatives. Also Available: Data Quality Management for SAP Solutions and Oracle's Siebel CRM.

**SAP BusinessObjects Universal Data Cleanse**, (UDC) parses, standardizes, and identifies non-customer and region-specific data. Typically, customers feed that information to operational applications that perform further processing for analysis by the business, or they feed it into a matching solution that looks to uncover the overlap, duplicates, or other relationships to gain efficiencies. Universal Data Cleansing extends the data cleansing capabilities beyond customer information.

**SAP BusinessObjects Data Insight** monitors, analyzes, and reports on the quality of information. Gain control of information assets with redundancy profiling, drill-down frequency distributions, cross-column and cross-table comparisons, pattern recognition, and analysis. Cleansing and data standard rules can be directly passed to Data Quality, which creates very efficient integration.

**SAP BusinessObjects Watchlist Security** allows organizations to match their internal company databases against government or association watch lists to uncover matches or suspect transactions automatically. Verifying current business data against these lists ensures that organizations do not support, unknowingly, identified criminal suspects—such as terrorists, money launderers, drug traffickers, or individuals from sanctioned countries.

**SAP BusinessObjects Postalsoft Solutions**, Business Objects Postalsoft mail automation software can be customized. From address correction and encoding, to mail preparation and entry planning—all Postalsoft solutions are CASS™ (USPS Certification Process for ZIP + 4® Matching Software) and PAVE™ (Program Measuring Presort Accuracy)* certified and consist of the same proven modules, which can be scaled to provide the capabilities required.

**Analytics**

Analytics is a capability to provide answers to analytical queries that are multi-dimensional in nature quickly. Complexity of analytics tasks vary from compound to ad-hoc queries with a rapid execution time. The output of analytics is typically displayed in a matrix or pivot format. Analytics capabilities
are used for querying and reporting, the main output from data warehouse systems either are tabular listings, queries with minimal formatting or highly formatted reports. Reporting involves querying data sources with different logical models to produce a human readable report.

Aggregation is one of key analytics capabilities. It is a process of combining data entries from different creation, capture, and delivery applications. The goal is to combine and unify data from different sources, in order to pass them on to storage and processing systems with a uniform structure and format.

Often implementation involves ETL capabilities into a reporting data warehouse and then use of one or more reporting tools. Reports can be distributed through all of the SOA interaction channels.

With SAP NetWeaver and Business Objects capabilities, business users and IT professionals can access enterprise information to drive sound-decision making to improve business results. Business users can design and execute ad hoc queries and format reports to analyze business information. With the Business Explorer Analyzer tool, business users can design and interact with Excel-based BI applications and workbooks. Using a visual modeling environment, business users can configure BI applications and deploy the results in an enterprise portal. Finally, using state-of-the art planning methods and tools that operate against accurate data, organizations can perform business planning to predict and react flexibly and quickly to changing business conditions.

**SAP Reporting, Analysis and Planning.** Business Explorer (BEx) provides flexible reporting and analysis tools for strategic analyses, operational reporting, and decision-making support within a business. These tools include query, reporting, and analysis functions. An employee, with access authorization, can evaluate past or current data on various levels of detail, and from different perspectives, not only on the Web but also in MS Excel.

In addition, using **BEx Information Broadcasting** to distribute Business Intelligence content from SAP BW by e-mail either as pre-calculated documents with past data or as links with live data; one can also publish it to the Enterprise Portal.

The **Business Explorer** allows a broad spectrum of user’s access to information in the SAP BW using the Enterprise Portal, the Intranet (Web application design) or mobile technologies.

**SAP Embedded and Process-Centric Business Intelligence** to provide context-specific business information to users via a user interface that supports the user's work style; IT organizations can embed BI data and capabilities directly into operational processes and thus improve strategic and operational decision-making.

It is often very useful to embed Business Intelligence data and capabilities directly into our operational processes and user interfaces, to provide user- and context-specific BI data to every employee. This approach complements SAP classic BI capabilities by adding a flexible infrastructure and tools that can embed BI into applications for strategic and operational decision support.

It is planned that Visual Composer provides capabilities to embed and call Enterprise Reports (Crystal Reports), Xcelsius Dashboards and the Pioneer Web/Excel client directly from within Visual Composer Models.

**SAP BusinessObjects Crystal Reports Server 2008** is a complete report management solution that enables IT professionals to securely share, schedule, and deliver interactive reports over the web, in email, and Microsoft Office documents.

With **SAP BusinessObjects Query Web Intelligence** both self-service access to data and intuitive information analysis are available in one product, helping users turn business insights into effective decisions.

**Master Data Services**

Master data services administer non-transactional reference data entities. The objective is to provide processes for collecting, aggregating, matching, consolidating, persisting, and distributing such data and ensure consistency and control in the ongoing maintenance and application of this information.
Capabilities of master data services include: source identification, data collection, data transformation, normalization, rule administration, error detection and correction, data consolidation, data storage, data distribution, and data governance.

Master data services rely on other services such as: data networks, file systems, a data warehouse, a data mart, an operational data store, data mining, data analysis, data federation, and data visualization. Master data services heavily rely on data quality services.

Master data services operate on such entities as customer, product, employee, and vendor. Master data services identify the sources from which to collect descriptions of these entities. In the course of transformation and normalization, administrators adapt descriptions to conform to standard formats and data domains, making it possible to remove duplicate instances of any entity. Organizational Master Data repository is a system of record for referential data, from which all requests for a certain entity instance produce the same description, irrespective of the originating sources and the requesting destinations.

**SAP NetWeaver Master Data Management (MDM)** enables organizations to consolidate and harmonize their master data within heterogeneous IT landscapes. With SAP NetWeaver MDM, organizations can ensure cross-system data consistency and accelerate the execution of business processes. In this context, SAP NetWeaver MDM is indispensable within an enterprise service-oriented architecture (SOA).

**SAP Master Data Integration**, Successful master data management in heterogeneous IT environments requires that the information exchanged between the central master data repository and connected business applications is based on a solid communication layer. In this context, SAP NetWeaver provides a complete framework for enabling the exchange of master data used by SAP NetWeaver components, SAP Business Suite applications, and 3rd party applications. IT organizations can use SAP NetWeaver to support inbound and outbound data transfer processes (for example, extraction from remote systems, data import, and data syndication to remote systems) and to service-enable access to master data using APIs or web services.

**SAP Master Data Operations**, SAP NetWeaver provides tools that enable organizations to ensure the effective governance and operational processing of master data. Organizations can define data models to aggregate master data from disparate sources, ensure security through role-based access to master data, enable users to locate master data via enterprise searches; create, structure, and maintain master data within relevant workflows; and publish data to appropriate systems.

**ETL**

Extract, Transform, and Load (ETL) is a process in data warehousing that involves extracting data from outside sources, transforming it to fit business needs which can include quality levels, and ultimately loading it into the end target, i.e. the data warehouse. ETL can also be used for the integration with legacy systems. Usually ETL implementations store an audit trail on positive and negative process runs.

Data federation is closely related to ETL in a result that it delivers. It is also known as Enterprise information Integration software that streamlines the integration of data from many distributed sources without replicating or moving the data from the original sources. Data Federation provides applications with standardized access to integrated views of data through a single data layer that masks the complexity of the diverse underlying data sources.

With **SAP Data Management and Integration- ETL and EII** organizations can access, integrate, and improve the quality of data from disparate sources using extraction, transformation, and loading (ETL), enterprise information integration (EII), and data quality technologies. They are supported by SAP NetWeaver Business Intelligence and capabilities from Business Objects.

**SAP BusinessObjects Information Management** gives a 360 degree view of business with tools that enable access any type of data (structured and unstructured) from virtually any source; integrate
data using flexible approaches through data federation or extraction, transformation and loading (ETL); and deliver reliable data with the ability to clean data during the ETL process.

- **Data Integrator**, deliver integrated and trusted information to accelerate performance across business.
- **Data Federator**, create a unified view of data sources with virtual data integration.
- **Text Analysis for Data Integrator** read and structure text for a complete view of customer, market, and business information.
- **Rapid Marts**, accelerate the deployment of analytic solutions with packaged data integration and ETL tools for enterprise applications, such as SAP and Oracle.

**Cross Reference**

One of the challenges of distributed computing environments is presence of information entities that model the same, similar, and related business concept in unrelated locations. These entities could reside in separate application module, remote application, event outside of company physical network.

To note references and relationships between information entities in and distributed loosely coupled environment it is necessary to provide cross reference service. This service is able to register and share information about objects relations.

The keys that identify entities representatives in each location are usually different. As a result, it is necessary to assign the keys of objects to one another and to register this relationship and make it ready for querying and modification.

**SAP Unified Key Mapping Service**, UKMS enables key mapping, it is the assignment of keys. The keys are IDs of objects, such as master data objects (products, material, and business partners), customizing objects, or organizational terms.

To define the environment in which an ID is valid, a set of attributes that describes the validity of the key is supported in addition to the actual key value. These attributes are the attributes of core component type.

**Service & Event Bus**

**Business Activity Monitoring**

Business Activity Monitoring capability enables aggregation and analysis of real time information about activities inside organization and broader business network. A Business Activity can be either a business process that is orchestrated by Business Process Management software, or a business process that is a series of activities spanning multiple applications. BAM is an enterprise solution primarily intended to provide a real-time monitoring of business activities.

BAM delivers information concentrated key performance indicators used to provide assurance and visibility of activity and performance. BAM delivers information that is usually displayed in form of dashboard. Additionally BAM offers event correlation to detect and warn of impending problems.

BAM often features trouble notification, which interacts with the service desk’s ticket systems. E.g. a groups of people can be sent emails, voice or text messages. The message will explain the nature of the problem. Moreover, automated problem solving, where feasible, can correct and restart failed processes.

Key BAM distinction from the dashboards of BI is in that events are processed in real-time in BAM systems, whereas BI dashboards refresh at intervals by polling or querying databases. While managing business performance emphasizes strategy life-cycle management, monitoring business
activity focuses on business operations and addresses the management of operational performance. It helps achieve excellence in business processes and overall operations.

Return on investment from implementing BAM is driven by ability to recognize and respond to events, as well as to resolve events quickly so that users can resume their standard activities. The ability to resolve business events helps users make timely and informed decisions. Organizations gain visibility on business processes and instant alerting of significant events, which helps executives and business users prevent problems before they occur. With an integrated business activity monitoring approach, companies are well positioned for business on the competitive edge of application core (either before- or post-processes).

SAP NetWeaver provides a business activity-monitoring infrastructure so that business users can measure, collect, analyze, and present relevant and timely data about business activities within the enterprise and those that involve customers or partners. SAP NetWeaver features capabilities to monitor, administrate, and analyze the performance of individual and end-to-end processes. By monitoring business process, business users can respond to critical business events, and measure key performance indicators for business processes.

**SAP Business Process Monitoring** is framework providing advanced capabilities. SAP powered BAM capability provides the technical infrastructure for enabling users to: take action on significant and critical events considering the correct business context and to monitor measure and enhance their business processes efficiency. SAP offering provides reliable BAM Infrastructure:

- Embedded Event Infrastructure enables collecting, pre-filtering and publication of events for cross-system use across SAP systems
- Process Milestone Monitoring enables subscription and handling of business process events and also building consistent business process instances
- Process Efficiency Analysis provides process related reporting with SAP NetWeaver Business Intelligence (SAP NetWeaver BI).

### Service Mediation & Messaging

A mediator is a pattern that promotes loose coupling by keeping objects from referring to each other explicitly, yet vary their implementation independently. In the world of services, the emphasis is more on technology-neutral. A mediation capability that is placed in between a service producer and a service consumer enables number of functions, such us: Transport protocol conversion, Data format conversion, Service policy enforcement, Service processor pipeline, Service invocation and dispatch.

SAP NetWeaver PI supports reliable processing of messages and different levels of quality of services. To guarantee the consistency of data, SAP NetWeaver PI uses the quality of services Exactly Once (EO), Exactly Once in Order (EOIO), as well as Best-Effort (BE).

Within SAP NetWeaver Process Integration, the most notable standards supported are the following: Web Services Reliable Messaging (WS-RM), Web Services Security (WS Security), Security Assertion Markup Language (SAML), Business Process Execution Language (BPEL) and Universal Description, Discovery and Integration (UDDI).

**SAP Mapping and Routing** enables IT professionals to facilitate communication between service-enabled applications through its enterprise services bus (ESB). Built-in mediation capabilities are used to reconcile incompatible protocols, structural maps, schema, and data formats between provider and consumer applications. Reliable transport and queuing capabilities provide mechanisms for handling different quality-of-service levels at runtime. Support for various connectivity options include handling different end points, such as file, database, web services, Java Message Service (JMS), Remote Function Call (RFC) documents, intermediate documents (IDOC) for electronic data interchange (EDI), RosettaNet Implementation Framework (RNIF) messaging, and so on... To support different usage scenarios, flexible deployment options of the service bus are available. Various topologies of the service bus include standalone, packaged with the applications, or federated
across the enterprise. As such, IT professionals can facilitate the integration and flexible reuse of business functionality across a SOA-based landscape.

**SAP XML Validation** in SAP NetWeaver Process Integration. XML based messages in standards like: RosettaNet, CIDX, PIDX, etc. have specified the requirement to validate XML messages at various stages of message processing. XML validation checks the structure of a message. One can validate the payload of both inbound and outbound messages. The structure check is performed using XSD or DTD. This feature can be used for both A2A and B2B integration.

**SAP Service - Mapping Factory Service Offering.** SAP Mapping Factory is a Service offering by SAP Consulting helping customers to implement their own integration scenarios.

**Connectivity Services**

Connectivity refers to the use of computer networks to link to resources. It is ability to extract information and invoke remote services contained in remote information systems one or many. Ability to connect to complex as well as legacy systems and manage the production of information and services out of those systems, and at the same time, publish information to those systems as needed is one of fundamental capability of SOA.

Connectivity is a pattern of software. It describes connection into source or target systems through some type of point of integration. Connectivity is reusable set of software services that can extract and publish information to source or target systems. It is a common interface into source or target systems. It provides a consistent set of services. Connectivity facilitates visibility into links to source and target systems'. This visibility is essential to manage source or target systems outages.

SAP NetWeaver Process Integration (SAP NetWeaver PI) enables IT professionals to facilitate application-to-application and business-to-business process integration. With SAP NetWeaver PI, IT professionals can connect applications and data sources to integrate processes using standards-based XML and Web Services (WS) messaging. It also supports industry-standard protocols to improve communication with business partners. Finally, it provides an open adapter framework that allows IT organizations to use SAP and partner adapters to support connectivity across a heterogeneous landscape. Because SAP NetWeaver PI is based on a standards-based SOA infrastructure, it enables organizations to more effectively design, configure, and execute processes across the business network.

Connectivity functions to enable different sender and receiver protocols to be used. The Integration Server works together with the Advanced Adapter Engine for this. The Advanced Adapter Engine is closely linked to inbound and outbound processing in the Integration Server and it can run either centrally on the Integration Server or de-centrally in the relevant application system (to optimize performance).

**SAP and Partners Adapter**, SAP offers several adapters to connect the Integration Engine to SAP legacy systems, as well as to external systems (SAP market place). Partners of SAP provide adapters for several applications or industry standards. These partner adapters are sold and delivered through SAP: iWay and SEEBURGER Adapters. Partners of SAP provide adapters for several applications or industry standards. These partner adapters are sold and delivered through SAP.

**SAP Conversion Agent by Informatica**, to complete the integration capabilities of SAP NetWeaver, SAP in partnership with Informatica - a leading vendor of data integration technology - has developed the SAP Conversion Agent by Informatica. This Conversion Agent enables efficient development of data transformations for incoming and outgoing unstructured and semi-structured data and messages into XML.

With **SAP Web Services based Connectivity**, developers can connect applications and data sources to integrate processes using web services. In particular, developers can use one infrastructure to define, implement, and use web services in an industry standards based way. SAP NetWeaver supports synchronous, asynchronous, stateful, and stateless web service models --
enabling developers to support different integration scenarios. WS-RM describes a protocol that allows messages to be delivered achieving a certain quality of service. WS-Reliable Messaging is Independent of network technologies, based on Web Services specification.

**Partner Connectivity Services**

Connectivity is generic capability required to meet SOA integration needs. Extended enterprise covers number of external partners that participate in the business process. It is crucial to enable affordable and rapid integration of such participants into enterprise business process. Partner Connectivity Services meet such requirements.

**SAP Interoperability with Business Partners**, The SAP Partner Connectivity Kit enables smaller business partners or subsidiaries to integrate their system landscape with the SAP XI of their business partner or head office. The SAP PCK is a J2EE-based application that uses the Adapter Framework, which is in turn part of the Adapter Engine. The Adapter Framework provides its own queuing and logging services. It is based on the SAP J2EE Engine (as part of the SAP Web Application Server) and it is JCA-compliant.

**System Integration Services**

System integration is the capability to bring together physically or functionally number of systems into one and ensure that the subsystems function together to fulfill a business goal. Integration Services create an aggregation of systems cooperating so that the system is able to deliver the over-arching functionality. System integration involves integrating existing disparate systems. Each of systems must have interfaces. Integration involves joining the systems together by connecting their interfaces together. If the interfaces do not directly interlock, the mediation services can provide the required mappings. System integration is also about value adding to the system, capabilities that are possible because of interactions between subsystems.

Enterprise systems quite often cannot communicate with one another in order to share data or business rules (islands of automation or information silos). This lack of communication leads to inefficiencies, identical data are stored in multiple locations, or straightforward processes are unable to be automated.

System integration is the capability of linking such systems together in order to simplify and automate business processes to the greatest extent possible, while at the same time avoiding having to make sweeping changes to the existing applications or data structures.

**SAP ccBPM**, Cross-Component Business Process Management supports an integration process. Integration process is an executable, cross-system process for processing messages. In an integration process, one may define all the process steps that are to be executed and the parameters relevant for controlling the process.

One must implement integration processes to define, control, and monitor complex integration processes that extend across enterprise and application boundaries. The design and processing of integration processes is also known as cross-component Business Process Management (cross-component BPM, ccBPM).

Business Process Management provides SAP Exchange Infrastructure with functions for stateful message processing: The status of an integration process is persisted on the Integration Server. Thus, one can specify how long an integration process must wait for further messages to arrive, for example. Furthermore, this enables process messages within an integration process; for example, one can collect certain messages and then send them in a particular order.

Cross-component Business Process Management is integrated into SAP Exchange Infrastructure: Integration processes are objects in the Integration Repository or Integration Directory and are integrated with the other objects, for example, message interfaces and so on.
**Event Processing**

An event is a significant change in state. When a consumer orders a shipment of goods, the shipment object is created and its state changes. Dispatching system architecture may treat this state change as an event to be detected, produced, published, and consumed by various applications within the architecture. Event-driven architecture (EDA) is a software architecture pattern promoting the production, detection, consumption of, and reaction to events.

EDA may be applied by the design and implementation of applications and systems that transmit events among loosely coupled software components and services. An event-driven system typically consists of event emitters and event consumers. Consumers have the responsibility of applying a reaction as soon as an event is presented.

Event-driven architecture can complement service-oriented architecture (SOA) because services can be activated by triggers fired on incoming events.

Business event management is the process of capturing real-time business events from multiple sources and assigning them to the appropriate decision-maker for resolution based on the business context of the events.

With SAP NetWeaver, IT organization can enable an event-driven architecture. Business events from multiple systems are distributed to the appropriate decision makers in the context of the relevant business processes and are optimally resolved. One can also enable an auto-ID infrastructure to sense and control automated signals in real time. SAP NetWeaver enables:

**Business Activity Monitoring** – Business activity monitoring acts on significant events or groups of events and take action in the right business context. With SAP NetWeaver, one can monitor, measure, and analyze the efficiency of business processes.

**Business task management** – Business task management presents right tasks to the right people so they can complete their tasks on time with the best results. With SAP NetWeaver, one can automate online processes, support offline processes, and coordinate access to tasks across the enterprise.

**Service Provider**

**Service Events**

Service events are optional for a service specification. Service layer management framework should be capable to capture all major service events as part of the service run-time-policy. If there are consumer driven policies around the service events, it should be part of the service specification.

**Service Enabled Applications**

Companies have long sought to integrate existing systems in order to implement information technology support for business processes that cover all present and prospective requirements needed to run the business end-to-end. Service enabled applications must support the interoperability and the sharing of data. These applications can be used by different groups of people both inside and outside the company, and new applications built from a mix of services from the global pool exhibit greater flexibility and uniformity. Building all applications from the same pool of services makes achieving this goal much easier and more deployable to affiliate companies. Principle guiding service enabled applications are:

- New client functionality can be built on top of existing business services.
- Well-defined interfaces-changes can be made without affecting clients.
- The interface to the service is implementation-independent and is self-contained.
• Can be dynamically invoked
• Supports evolving business models including new business requirements
• Resilient to technology changes
• Continuous small changes can be made versus sporadic large ones.

**SAP Enterprise Services Workplace** gives access and information to productized enterprise services in a hosted environment to build applications on the productized enterprise services driven by composite application requirements from customer, partners, and SAP. Developed and deployed on the latest version of the mySAP Business Suite 2005, this version of the ES Workplace is available for partners, developers, and customers in a hosted form with opportunity to browse and test enterprise services.

**Enterprise Services (ES) bundles** are collections of enterprise services that can be used to extend the functionality of SAP ERP 6.0 or other solutions of the SAP Business Suite. Each ES bundle, which consists of enterprise services that will be made available as part of the Enhancement Packages for SAP ERP 6.0 or as a specific software add-on for other SAP Business Suite solutions, provides a new set of services along with documentation of how the services can extend and reconfigure processes in a specific business scenario.

**The SAP Enterprise Services Wiki**, a section of the SDN/BPX Wiki, exists to explain what ES bundles are in general and to provide details of the services offered for specific ES bundles. The goal of the ES Wiki is to engage the community of developers inside SAP and those in the customer and partner organizations who are using services in ES bundles and to promote the sharing of information. That is why anyone who has an idea can add it to the wiki encouraging education and sharing.

**Non Service Enabled Applications**

In reality, not all of applications in a typical system landscape are service enabled. The usual approach taken to enable integration with legacy applications is to build a proxy service that encapsulates the legacy application. The proxy service exposes the capabilities of the legacy application through a standards-based interface, and its implementation uses whatever means available to communicate with the legacy application. If the legacy application exposes an API, one can wrap the API using existing service framework. If the legacy application only enables communications via an online user interface, one can use a screen scraping technology to create the proxy service.

**Advanced Adapter Engine** allows connection to the Integration Engine to SAP systems (RFC adapter) and non-SAP systems. One may use the various adapters in the Adapter Engine to convert XML- and HTTP-based messages to the specific protocol and format required by these systems, and the other way around.

Using integrated configuration in the Integration Directory one can define a local message processing on the Advanced Adapter Engine with very low effort. The Advanced Adapter Engine provides mapping and routing for this locally. Message processing is only executed on the Advanced Adapter Engine from one adapter to another without the involvement of the Integration Engine gaining great improvement in performance.
6.4 Manage – Provides core functionality that is required across the entire lifecycle (plan build and run)

SAP delivers software and services to help IT organizations efficiently operate mission-critical business application and leverage investments in existing software technology. The SAP NetWeaver technology platform offers tools and methods that support life-cycle management tasks – including landscape design, application management, software logistics, and operations. With these tools, IT organizations can manage the IT landscape efficiently, improve the availability of applications, and optimize daily operations.

Landscape Design and Architecture

SAP provides tools and methods that IT organizations can use to plan, design, model and optimize their IT landscape. During this planning stage, IT organizations design the layout of their IT landscape, decide how to deploy SAP NetWeaver in the landscape, determine how to improve availability by using software virtualization, identify technical infrastructure prerequisites, and consider internationalization requirements. As a result, IT organizations can determine the deployment scenario which best meets business demands with lowest possible TCO.

Actual customer landscapes and resulting requirements for a SOA and SOA Management platform vary greatly. Therefore, SAP offers three clearly delineated deployment scenarios:

- Limited footprint deployment
- Business unit wide deployment
- Enterprise wide deployment

The first two of these deployment types rely exclusively on SAP provided solutions. Only for the truly enterprise wide SOA deployment with the highest demands on SOA Management, SAP recommends to leverage the tightly integrated AmberPoint solution or other dedicated SOA offerings like SOA Software. All three deployment types are discussed below.
SAP’s SOA Management Offering – Deployment Scenarios

Deployment Scenario 1 - Small Footprint

Deployment Scenario 2 - Business Unit to Enterprise Wide

SAP NetWeaver with AmberPoint Integration - Business Process Platform

- Process Integration (PI)
  - Service bus
  - BPM & BAM

- Enterprise Services Repository
  - Registry UDDI v3 compliant

- Solution Manager
  - End-to-End Solutions Operation

AmberPoint

Deployment Scenario 3

SAP NetWeaver - Business Process Platform

- Process Integration (PI)
  - Service bus
  - BPM & BAM

- Enterprise Services Repository
  - Registry UDDI v3 compliant

- Solution Manager
  - End-to-End Solutions Operation

SAP NetWeaver with AmberPoint Integration - Business Process Platform

- Process Integration (PI)
  - Service bus
  - BPM & BAM

- Enterprise Services Repository
  - Registry UDDI v3 compliant

- Solution Manager
  - End-to-End Solutions Operation

AmberPoint

Deployment Scenario 4

Composition Environment (CE) - Java EE 5 compliant

- Composite development
- Service connectivity
- Registry UDDI v3 compliant
- NetWeaver Administrator LIGHT (*)
Figure 20 SAP’s SOA deployment types
SAP’s SOA deployment types

Deployment Scenario 1 – Small Footprint

The small footprint deployment scenario is based on our NetWeaver Composition Environment (CE), which includes a UDDI v3 compatible service registry as well as a fully featured, yet lightweight version of NetWeaver Administrator for SOA Configuration and Management as well as Security and Identity Management. All tools are based on Java EE5 stack without any ABAP dependencies. It is important to mention that the small footprint scenario can include the ESR as an optional component. This allows provisioning of services according to SAP’s methodology. The ESR is not a default component since service consumption – the main composition use case - is already enabled via the included registry. This lightweight deployment scenario is suited for limited, unified, and controlled landscapes as in a store environment of a retail chain. The integration of a Point of Sale (POS) system is a good example. Additionally SAP is leveraging and promoting this scenario within its ecosystem of partners. The lightweight deployment option reduces the barrier of entry for new partners, and subsequently enables fast innovation and deep integration of the partner’s offering with our overall platform.

Deployment Scenario 2 – Business Unit Wide to Enterprise Wide

This scenario leverages the entire SAP NetWeaver SOA stack and provides full-blown SOA Management capabilities. Main components are the Enterprise Services Repository (ESR), the NetWeaver Process Integration (PI) service bus, the Registry and the NetWeaver Administrator. The key difference to the previous example is the centralized metadata management in the ESR including the services modeling and the design time governance. Secondly, it provides full service bus capabilities including transformations, routings, BPEL based BPM and Business Activity Monitoring (BAM) based on event management capabilities. Best fit for this scenario is on a business unit level, for example a dedicated manufacturing plant. In this situation, all relevant SOA and SOA Management requirements are fulfilled. Depending on customer requirements, this can of course scale to an enterprise wide heterogeneous SOA Management solution.

Deployment Scenario 3 – Enterprise Wide

For true heterogeneous landscapes of enterprise scale, SAP recommends to use an integrated instrumentation from vendors like AmberPoint. As mentioned before, due to the lack of comprehensive SOA Management standards, this is the only feasible approach to manage other SOA platforms like IBM or Oracle closely. Additionally, customers using AmberPoint do not only have a best-in-class SOA Management solution, but also tight integration to the NetWeaver platform including Business Intelligence. SAP and AmberPoint have a strong relationship as well as a development agreement to offer an integrated solution. Another choice of a SAP NetWeaver certified best-in-class SOA Management vendor is our partner SOA Software. It is important to understand that all three discussed scenarios can seamlessly co-exist within the worldwide business network of SAP customers.

Other SOA Building Blocks

There are additional enablers that are highly relevant for a successful SOA implementation. The most important ones are lifecycle management, security and identity management, master data management, business activity monitoring (BAM) and SOA testing. All these additional building
blocks are service enabled for easy consumption within the SOA landscape and drive end-to-end composition and management.

**Global Risk and Compliance**

Successful companies reach corporate accountability by proving to stakeholders that their business is reliable, compliant, and sustainable. Achieving this level of operations and reporting requires a unified risk management and compliance strategy that guides people, standardizes processes, and integrates technology to embed GRC at every organizational level. Service oriented architecture (SOA) enables loosely coupled applications to be assembled from a set of internal and external services (web services) that are distributed over a connected infrastructure. The distributed nature of SOA makes addressing security concerns a critical success factor.

SAP solutions for governance, risk, and compliance (GRC) promote corporate accountability by unifying corporate strategy, control initiatives, opportunity discovery, and loss mitigation across the extended enterprise. Managing GRC across the extended enterprise allows processes and strategies to be evaluated within the company and extended to partners, suppliers, and customers – truly representing the reach of the enterprise.
**IT Organization and Governance**

SOA governance is the rules an organization applies to the enterprise services and web services that are delivered and consumed. SOA governance covers not only SAP delivered enterprise services but also home-developed or acquired web services from an independent software vendor. The goal is to ensure a smoothly running and integrated business without exposing the nature of software.

**Good Governance for SOA Processes**

Companies that are successful in their SOA initiatives have introduced the roles. Figure 5 shows an example of a successful organizational structure that delivers SOA processes built on enterprise services.

The organization shown in Figure 5 can master growing complexities and ensure the enterprise-wide orchestration of SOA activities. This organizational model integrates traditional roles (like program management and decision-making) with SOA-specific roles (like head of enterprise architecture, repository keeper, and so on) to deliver the value of SOA.

![Figure 22 Governance for SOA Processes](image)

This organizational structure delivers key benefits:

- It enforces effective governance, preventing a shelf-ware or "Wild-West" approach to SOA.
- It eliminates the costly and wasteful duplication of services.
- It ensures the buy in and the effective reuse of services across the enterprise.
Active Process Models

Business Process Management (BPM) as a management discipline helps business organizations standardize and continuously optimize the operational processes that have the largest impact on achieving corporate performance goals (e.g. cost reduction or enhanced business quality), as well as improved business flexibility throughout the complete business processes lifecycle. BPM as a technology (or a software product) provides IT organizations with a framework of tools to compose, model, deploy, execute, and monitor processes that include human and system tasks or that span across different business applications and require a broad set of integration capabilities. SOA is the architectural enabler of business network transformation, the way that both the members and the processes in the network communicate with each other – through services. SOA is an enabler of Business Process Management and at the same time, BPM provides value on top of a service-enabled platform:

- Business Process Transparency
- Business Process Flexibility
- Business Transformation
- Support for model-driven process execution for all process dimensions (human- or system-centric)
- Standardized business content on all levels of process abstraction and for multiple personas in an organization
- Support of business process analytics comprising business process monitoring
- Simulation and optimization capabilities, as well as business activity monitoring (end-to-end business process and event driven on multiple process instances)

Technically, a business process is defined as a “set of linked activities that creates value by transforming an input into a more valuable output.” SAP differentiates the business process definition further by establishing two basic sub-process types:

- Application core processes
- Composite business processes

By nature, application core processes represent the core business functionality that “runs the business” operations: from financials, controlling, and human resources to materials management, and from procurement and sales order management to supply chain and customer relationship management. Application core processes are delivered via SAP business applications as part of the SAP Business Suite. These processes are pre-defined, packaged and can be customized in applications such as SAP ERP, PLM, SCM, CRM or SRM. They are exposed as reference content in the Enterprise Services Repository (ES Repository) and SAP Solution Manager.

Composite business processes need to provide ad-hoc capabilities to enable flexibility and quick reactions in case of business changes or critical business events in out-of-bound situations. The nature of composite business processes is to enable business process composition on the edge of application core. They are driven by functional business requirements and specifications and their goal is first and foremost to provide added business value, speed, and quality of exception handling and delivery on the promise of innovative business ideas to improve efficiency and reach a sustainable process improvement impact.

Composite business processes are either human-centric (collaborative) or system-centric (integration process).
Technical processes supporting system-to-system and system-to-human type of interactions are defined as system-centric.

**Human-centric composite business processes** focus primarily on cross-system and cross organization type of processes. Though these processes are primarily driven by business users and business activities, they combine user activities (with User Interfaces (UI's) or via tasks in a task list) and automated activities (either single service-enabled activities or modeled integration processes for mediation purposes as, e.g. automated data consolidation).

This SOA process pattern focuses on exactly these Human-centric composite business processes. As a key capability and as a mayor differentiator to the other two SOA process patterns, process composition capabilities are needed, which enable process-automation with human call-outs. Within this process collaboration the structured data, which are seamlessly integrated through services and events, can and should be enhanced with unstructured data (e.g. attachments, notes) from an enterprise content management system.

Rules Management capabilities act as an accelerator for business processes and improve efficiency through decoupling of decision logic from process logic, through capturing, automation, and alignment of critical business rules and the decisions they drive as reusable services, as well as through rules based correlations for real-time business events.

**Main entry page Software Logistics & Lifecyle Management**

SAP provides comprehensive software deployment and change management capabilities to implement ever-changing business processes securely. These capabilities include approval workflow, technical deployment, and optionally project management functionality. As such, IT organizations can support continuous change that results from business, organizational, or technical requirements.

Software Logistics provides tools and processes to manage system landscape throughout the whole life-cycle. Besides the initial implementation of an application, the tools support the continuous application and system optimization that result from business or organizational changes, or the implementation of additional functions. SAP's Software Logistics aims at further simplification and automation of all life-cycle related tasks and at the reduction of administration effort.

**Life-Cycle Management** enables IT to efficiently implement and operate mission-critical business processes and to leverage existing investments in technology infrastructure and applications. The SAP NetWeaver platform runs application management processes and optimizes all facets of an application's life cycle. This offers tools and methods supporting all life cycle stages from landscape design, application management, software logistics, and operations.

No organization can start an SOA initiative completely from scratch. In fact, one may already have proven applications that are leveraged for developing and reusing services. To accommodate this, such organization will need a platform that ties the existing IT infrastructure and integrates the existing suite of solutions, composite applications, partner solutions, and custom-built applications with newly developed enterprise services portfolio. Drawing on this integration platform, one can flexibly and rapidly design, build, implement, and execute new business strategies and processes – without replacing or redesigning proven applications.

An integration platform must provide comprehensive lifecycle management tools that build and maintain SOA infrastructure. This platform is critical to SOA success throughout the solution life-cycle phases:

- Analyze and discover
- Model and build
• Compose and orchestrate
• Integrate and deploy
• Manage and optimize

**Figure 23 Software Logistics & Lifecycle Management**

**Analysis and Discover:** During the analysis and discovery phase, one analyzes the overall business requirements and maps them to existing IT landscape. Typically, one needs to identify needed business objects and enterprise services, locates available enterprise services in the repository for reuse, and identify missing services required to support the new business processes.

**Model and Build:** For all missing capabilities identified in the analysis and discovery phase, next phase is to design and model business objects, plan new business logic, model and build user interfaces, reuse existing assets, create new services, and publish new service information in the repository.

**Compose and Orchestrate:** The next step is to compose views by reusing implemented services and business objects and then to compose and orchestrate services and views to form new business processes.

**Integrate and Deploy:** The next step is to become productive – packaging and deploying SOA applications, configuring applications for runtime (adapted to the IT landscape), testing and validating applications, and executing deployed applications.

**Manage and Optimize:** During this phase, life-cycle management tools support managing change, maintaining versions, and monitoring enterprise service and business process execution (for example, business process performance, availability, process progress, and events) as well as continuous improvement through iteration, based on error tracking and resolution.

The design-time governance in an enterprise services repository and the runtime governance delivered through a repository services registry provide a stepwise approach that evolves into increasingly robust governance realizing full benefits of robust Life Cycle Management for Business Rules as SOA matures.

Developing SOA based upon a robust integration platform provides the necessary governance discipline as an integral part of the environment. Governance of the SOA lifecycle ensures compliance with proven design principles. Lifecycle management tools for governance automate support and help to encourage the reuse of enterprise services.
End to End Monitoring

The foundation for every successful SOA strategy is laid during design-time. From the architectural bird’s eye view, services are identified, designed, modeled, and finally published if they do not already exist in the design-time services repository.

Design-time governance ensures that the right services are correctly designed and are available for runtime use. A key element during design time is the abstraction of semantically well-expressed services. Design-time encompasses the life-cycle phases of service identification, design, and implementation. The service provisioning phase transitions services from design time to runtime, exposing services to the entire organization by making these services available for productive use through the enterprise services repository. Runtime encompasses the life-cycle phases of service deployment, management, and analysis.

![End to End Monitoring Diagram](image)

**Figure 24 End to End Monitoring**

How to Ensure Effective Design-Time and Runtime Governance

It is essential to have an environment that automatically provides design-time and runtime governance for SOA in an evolutionary, stepwise manner. One should always address existing services first and bring them under full governance control before provisioning new services. Simple spreadsheets may suffice during the early stages of SOA adoption, but more powerful tools, enhanced capabilities, and broader skills are required to ensure adherence to service design principles as SOA matures.

Business processes running in SOA are composed of multiple enterprise services provided by different servers. A holistic support approach is required in order to ensure availability and high performance of business processes, to safeguard data consistency, and to guarantee that the individual services are maintainable and upgradeable without disrupting the end-to-end business process flow. This all is delivered via SAP’s central application management and administration solution SAP Solution Manager. A service desk and related functions for locating and analyzing the root cause of disruptions simplify the management of error messages and reduce the time required for problem resolution significantly. Standardized processes and tools for managing software and configuration changes help...
to improve software maintenance processes, to minimize the impact of change-related incidents, and to provide tracking and transparency of changes. Integration testing of the end-to-end processes, not just single services, is another measure to ensure quality of the end-to-end solution. In addition, SAP Solution Manager delivers methodologies and related tools to streamline IT projects on different layers, including the implementation of new or change of existing business processes, upgrade of single applications within the SOA, and the setup of end-to-end solution operations processes within the IT organization.

**Service Registry**

At the core of SOA life-cycle management is an enterprise services repository, complete with a services registry. An enterprise services repository is the central library where all enterprise service metadata is illustrated and explained. The repository is the metadata repository for all enterprise service objects used in SOA application development. It provides enterprise service and application design-time governance, ensuring that enterprise services adhere to the enterprise services modeling methodology and align with standard data types and enterprise service semantics. It provides information for the definition of business processes, enterprise services, and service metadata, central modeling of services, and the design environment. The repository enables the reuse of enterprise services and stores information for modeling and composing new applications.

**Runtime Governance and Management**

SAP provides a comprehensive and complete platform runtime governance and management. SAP's goal is to provide as part of SAP Solution Manager a comprehensive base offering for SOA management and runtime governance in a multi-platform environment. As a key building block and the backbone of SAP's SOA offering, SAP NetWeaver Process Integration 7.1 (PI 7.1), which comes complete with SAP Enterprise Services Repository and Registry, offers robust SOA management capabilities to support SAP's governance model.

**SOA Management and Runtime Governance in Heterogeneous SOA Landscapes: Integration between SAP and AmberPoint**

AmberPoint is a selected partner of SAP who is integrating the product capabilities for SOA management and runtime governance of its SOA Management System (SMS) with SAP NetWeaver to enable customers to manage their heterogeneous, multi-platform SOA implementation at runtime. A Collaborative Development Agreement has brought AmberPoint's technology to the SAP NetWeaver platform. With this development agreement in place, AmberPoint will extend SAP's offering with out-of-the-box SOA management capabilities for web services implemented in Java and ABAP on the SAP NetWeaver platform.

AmberPoint SOA Management System (SMS) is a set of facilities that applies policy-based, runtime governance to SOA landscape in a non-invasive manner (without modifying the source code of the services). It offers higher levels of visibility, control, and compliance across heterogeneous, multi-platform SOA landscapes. Key integrated capabilities of AmberPoint SOA Management System include:

**Monitoring, Logging, and Alerting on Key Service Performance and Availability Metrics**

AmberPoint brings an end-to-end visibility to the service dependencies and message traffic underlying a business process. It monitors the services' throughput, average response time, availability, and fault count, and to apply out-of-the-box or custom logging policies for troubleshooting or auditing purposes. Its integrated alerting capabilities enable the SOA Administrator to take mitigating or problem resolution measures proactively or reactively based on aggregated monitoring data.
Creating, Managing, and Reporting Capabilities for Policies and Service Level Agreements (SLAs)

One can create SLAs to ensure and verify that services meet the expectations of service consumers. AmberPoint SLAs are based on performance metrics (response time, throughput, fault count, or availability) that can measure service operations. Based on this, one can generate in-built historical and real-time reports on SLA compliance for individual customers.

Interoperability with SAP's Service Registry for Discovering Enterprise Services

AmberPoint's UDDI service capabilities identify all the services that comprise an SOA application, including the Java and ABAP web services running on the SAP NetWeaver platform. It provides management and security policies to those services automatically and provides real-time visibility into the as-deployed topology across the heterogeneous landscape.

Detects Errors and Exceptions

AmberPoint's integrated capabilities for monitoring, logging, and managing exceptions facilitate problem isolation for identifying the bottleneck service in a process. One can additionally set up conditions-based, automated problem resolution actions that AmberPoint is to take upon a detected error.

Delivers Enforced Security between Service Consumer and Provider

AmberPoint applies authentication, authorization, and cryptography policies to service communication. It protects the service at the endpoint by securing the communication between the management intermediary (the AmberPoint agent) and the service endpoint. It also makes the client application aware of the provider-side security policies and protects the transactions between the client and the service network.

Administration, Operations and Management

Administration

SAP NetWeaver is the platform for running business processes. It is essential to ensure that all productive components are configured and administered to run at maximum performance. SAP NetWeaver Administrator is a new Web Dynpro-based Java application that focuses on monitoring and administration, and optimizing administrative work. In the past, the administration of Java components was very time consuming. Now, with SAP NetWeaver Administrator, SAP offers a powerful administration and configuration tool to bundle and centralize many administrative tasks. This reduces the time spent on configuration and administration tasks, which in turn reduces the total cost of ownership (TCO).

Benefits

- Fast and efficient administration and configuration of a single SAP NetWeaver component as well as the entire SAP NetWeaver system landscape.
- A state-of-the-art, web-enabled, and context-oriented user interface that eases overall administrative work.
- Helps IT management to work more efficiently, thereby reducing TCO
One central tool that covers the complete SAP NetWeaver platform.

**Operations**

SAP NetWeaver [Operations](#) deals with tools and methods to efficiently run an SAP NetWeaver system landscape and ensure reliability by optimizing performance, increasing system availability, support business application, legal compliance and security issues, ensure flexibility, and speed up administration and problem solving tasks.

**Management**

SOA Management Information on SD:


**SAP NetWeaver Solutions**

The figure below shows the basic components of Business Intelligence (BI) for structured data, Master Data Management (MDM) for master data, and Knowledge Management (KM) for unstructured or semi-structured data (see sidebar). Additionally, Enterprise Search services ensure efficient information access across these data types. These components are unified through a common metadata layer and made available through the EIM consumer services (BI, MDM, and KM) layer (see sidebar). Finally, data integration including extract, transforms, and load (ETL); enterprise application integration (EAI); and enterprise information integration (EII) capabilities; along with data quality and information lifecycle management constitute the necessary provisioning infrastructure.
Figure 25 SAP NetWeaver Enterprise Information Management
7 Tools, Methodologies & Services for Architectural Planning

7.1 TOGAF

The Open Group Architecture Framework Version 8 Enterprise Edition (TOGAF 8) is a detailed method and set of supporting resources for developing an Enterprise Architecture. Framework developed and endorsed by the membership of The Open Group’s Architecture Forum, TOGAF 8 represents an industry consensus framework and method for Enterprise Architecture that is available for use by any organization around the world - members and non-members of The Open Group alike - subject to license conditions - see Downloading TOGAF 8.1.

As a comprehensive, open method for Enterprise Architecture, TOGAF 8 complements other frameworks as TOGAF 8 is used in conjunction with more focused aspects of architecture or for vertical sectors such as in Government, Defense, and Finance.

The latest version of TOGAF 8 is Version 8.1.1.
Figure 26 Overview ADM - Overview Graphics of TOGAF's Architecture Development Method
7.2 SAP’s Enterprise Architecture Framework

**SAP Enterprise Architecture Framework for Enterprise SOA**

The SAP Enterprise Architecture Framework for SOA (SAP EAF) is an extension of the TOGAF Enterprise Architecture Framework specifically designed to support the effective adoption of package and package services solutions in a Service-Oriented Enterprise.

As described in a set of documentation published by The Open Group, TOGAF may be used freely by any organization wishing to develop enterprise architecture for use.

The TOGAF Architecture Development Method (ADM) is a generic method for architecture development designed to deal with most system and organizational requirements. However, it will often be necessary to modify or extend the ADM, to suit specific needs. (TOGAF 8.1 Manual, 2002).

SAP EAF is a complementary set of additions to TOGAF to support the specific characteristics of packages and services.

SAP EAF was developed between January and April 2007 by a joint team of over 30 SAP and Capgemini Enterprise Architects, most of which are TOGAF 8.1 accredited practitioners.

The key features of SAP EAF:

- Vendor agnostic
• Technology independent
• Solution independent
• Not another Framework built from scratch
• Based on TOGAF 8.1 as the source for methods, definitions and visualizations
• A set of artifacts, examples and training materials highlighting the ‘delta’ from TOGAF
• Provided with patterns, templates, accelerators and reference models for services-based packaged solutions, and in particular for SAP
• Provided with EA Tools, Training and Case Study support
• Already proven with customers

7.3 SOA Discovery Server

The SAP Discovery System for SOA is a fully configured SAP landscape appliance designed for innovation and exploration.

The SAP Discovery System for eSOA leverages the full stack

- Experience Enterprise SOA today
- “No Assembly Required”
- Pre-Configured Environment
  • mySAP ERP
  • SAP NetWeaver
  • Example ESA-enabled composite application
  • Fully documented configuration
  • Pre-installed OS and DB
  • Based on SAP Best Practices
  • Flexibly Packaged on a Server

Prototyping, developing, and learning environment at your fingertips

With this system:
• Test drive SOA today, in local/internal environment
• Get hands-on experience with a practical example of an SOA-enabled composite application
• Interact with a showcase of both today’s technology and upcoming solutions

Please find further Information here (https://www.sdn.sap.com/irj/sdn/esadiscovery).
7.4 Solution Composer

The Solution Composer is an SAP solution accelerator tool for planning, defining, documenting, and communicating business solution requirements.

It includes pre-defined up-to-date content, reflecting industry reference models and their relation to SAP applications and products. The delivered content is also available for browsing through SAP's corporate website.

This content assists business and IT organizations, partners, customers, and SAP identifying opportunities and serves as a starting point for the development of specific process/solution models.

Although the tool gives the user the opportunity to start from scratch to produce a solution, the main benefit here is the opportunity to match the business process reality of a customer to SAP coverage and subsequently gaps. With up-to-date content as a basis, it also provides overview of the industry and application.

As an offline PC-based tool, Solution Composer supports the browsing and development of Solution Maps and Business Scenario Maps by providing functionality that allows you to:

- Modify and create Solution Maps and Business Scenario Maps
- Assign business goals and objectives, products, key performance indicator (KPI) definitions, user-defined properties, and attached documents to Solution Maps
- Assign role information, business documents, and other attached documents to the Business Scenario Maps
- Map business capabilities and functions to technical products and status (for example, is there functional coverage from an SAP or partner solution / existing, planned, not planned yet)
- Export the Solution Maps and Business Scenario Maps into HTML and PowerPoint slide format

SAP's Solution Composer delivers Solution-specific as well as Industry-specific Views on SAP's Product portfolio. Of special interest to Architectural Planning are the NetWeaver Solution Map and the Industry Specific Maps. Moreover, Industry Specific Maps provide sample Value Chains for the different Industries.

On the level of Processes, one can discover the possible Configuration Variants for SAP's Solutions. Configuration Variants are best practice processes that are available in SAP Solution Manager for configuration.

Solution Composer is available from the SAP service marketplace under https://service.sap.com/s-composer.

7.5 EAF Customer Examples

Colgate Palmolive

Colgate Palmolive (CP) is a long-standing SAP customer with a large SAP Footprint. As an “innovator” of the industry, they agreed to develop an enterprise architecture proof of concept (PoC) and offered to serve as a reference customer for SAP.

The POC was an initial step in starting and formalizing the usage of the EA Discipline with the intent to establish foundational elements necessary to establish the EA discipline within CP.

The key driver to develop this Proof of Concept (POC) is to utilize the methods and tools prescribed by SAP Enterprise Architecture Framework (EAF) and apply the framework to meet Colgate
Palmolive’s immediate needs to demonstrate the relationship between Business and Information System Architectures.

In the initial POC, the scope was limited to Information System Architecture only. The primary goal was to develop traceability between CP’s application architecture and business processes. The secondary goal was to develop an Enterprise Data Model (EDM) for CP and depict the logical relationship of the data entities defined within CP EDM.

The Visions for the POC effort are outlined below.

- Develop Architecture Principles
- Functional/Process decomposition for two specific process areas (using SAP Solution Maps)
- Relationship of processes to logical application components
- Develop target architecture models in ARIS
- Create and model CP specific Catalogs/Matrices/Views
- Evaluate how the EA POC could support or enhance CP GRID process
- Develop a Core Diagram for CP

Following figure summarizes the key deliverables developed in this three weeks effort.
7.6 Architectural Service Offerings

Business Transformation Consulting (BTC), part of SAP Field Services, offers Business Rules Roadmap: Business Rules Management Roadmap

BTC offerings are classified broadly under three categories based on type of stakeholder as described in Table 10 BTC Architecture Services Classification.

<table>
<thead>
<tr>
<th>BTC services categories</th>
<th>Sub category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Executive Advisory Services</td>
<td>Organization &amp; Business Network Services</td>
</tr>
<tr>
<td></td>
<td>Business &amp; IT Strategy Services</td>
</tr>
<tr>
<td></td>
<td>Engagement Model Services</td>
</tr>
<tr>
<td>Business Process and Platform Services</td>
<td>Business &amp; Value Services</td>
</tr>
<tr>
<td></td>
<td>Business Process Services</td>
</tr>
<tr>
<td></td>
<td>Platform &amp; Architecture Services</td>
</tr>
<tr>
<td>Quality and Transformation Services</td>
<td>Program &amp; Project Management</td>
</tr>
<tr>
<td></td>
<td>Organizational Change Management</td>
</tr>
<tr>
<td></td>
<td>Quality Assurance Services</td>
</tr>
</tbody>
</table>

Enterprise Architecture services classified in (2) Business Process and Platform Services’ subcategory “Platform & Architecture Services” will support following customer objectives

- Discover and evaluate the business benefits of implementing or enhancing SAP solutions
- Design and realize the expected business value and benefits
- Utilize best practice in industry-specific and cross-industry processes
- Leverage SAP’s platform and architecture concept to enhance business performance
- Optimizing the architecture, reduce TCO, and free up budget for innovation

Enterprise Architecture services are

1. Enterprise Architecture Workshop

The primary objective of this service offering is to introduce customers to SAP EA Framework and provide the background and drivers for SAP to focus on EA Initiative. Customers derive the following value and benefits from this service offering

- Determine how EA discipline can be applied to support any of customer’s current transformational needs (strategy, pain points etc)
- Knowledge Transfer about SAP EA initiative and EA Framework
- Overview and Value of Enterprise Architecture
- Perform quick assessment of customer’s EA practice maturity

2. Enterprise Architecture Practice – Getting Started

The primary objective of this service offering is to prepare a customer for the effective deployment of Enterprise Architecture within an organization. The service introduces the key elements of an EA Practice namely Organization, Roles and Responsibilities, Processes and RACI definition,
Introduction of SAP EA Framework, and EA tools. Customers derive the following value and benefits from this service offering

- A clear path to EA Practice launch, based on SAP knowledge and industry best practice (the use of SAP EAF provides additional confidence in this approach)
- Integrate EA processes into the As-Is organization to bring quick wins and demonstrate the value of EA
- Get started with EA discipline and open the door for future enhancements

### 7.7 EA Training Offerings by SAP Education

When commencing SAP EAF engagement, it is important that an EA understands the approach is to follow the SAP EAF methodology. SAP EAF methodology is documented in the narratives of each of the phases. SAP offers an Enterprise Architect Education and Certification curriculum, delivered globally by SAP Education, to ensure Enterprise Architects receive the appropriate training in the SAP EAF methodology, approach, tools and techniques resulting in an industry recognized certification.
Figure 30 EA Training Offerings by SAP Education