Service Integration

Dr. Gopala Krishna Behara

Introduction

Integration is reuse of data and functionality across applications, services and enterprises. The enterprise uses different applications for running its business. Lack of integration among applications leads to scattered data islands and duplicate data. Integration tries to unlock value by integrating applications, thus helping organizations to leverage their legacy applications and maximize the ROI for existing investments.

For there to be a common integrated infrastructure, along with end-to-end visibility of business processes spanning across the disparate systems, an approach for implementing new offerings from the existing legacy applications is required.

Integration based on services creates the stepping-stones for the SOA journey. Integration based on SOA principles and infrastructure goes a long way toward reaching business goals and building an IT eco system.

Need for Integration

Business cycles, operations, and responsiveness are constrained by several parameters in the enterprise. A few important and key root causes are

- Unmanaged, non upgradeable, non scalable applications
- Non-integrated stovepipe applications
- Complex, obscure, and inefficient business processes
- Mergers, acquisitions, and regulations
- Deviations from the enterprise strategic objectives in daily operations.

Integration technology can play a significant role in enabling the parameters described above by providing the vital glue whereby enterprises can overcome bottlenecks and make the businesses more responsive, eventually facilitating an early go-to-market. As a result, Integration technology will facilitate leveraging the existing assets while creating new business opportunities.

Motivation

There are many motivations for pursuing the Integration challenge at the enterprise level. The list below describes the major factors.

Agility

- Alignment of IT with business goal
- Responding quickly to new business opportunities
- Getting the competitive advantage
- Handling the launch of new products/services , while managing existing ones

Reuse

- Better return on investment on existing application through functional and data reuse.
- Bringing down TCO

Regulation

- Handling regulatory and government requirements with ease
- Better corporate governance

Visibility

- A well integrated system will facilitate acquisition and mergers, as it provides a better view of data, process, and information.
- It could reduce or at least automate error prone data duplication processes.

SOA

- Integration plays a pivotal role in turning an enterprise landscape to a SOA enabled infrastructure. SOA, in turn, offers significant benefits to the enterprise in terms of business process visibility, increased process efficiency, and much more.
- Providing the functional view of the organization provides vital clues on application redundancies. It could lead to better consolidation of applications in the entire IT landscape.

Integration and SOA

SOA is essentially a distributed architecture, with systems that span computing platforms, data sources, and technologies. A distributed architecture requires integration. By standardizing how systems interoperate, Web services simplify the task of integration. Web services alone, however, do not suffice. Organizations need an evolutionary approach to SOA that incorporates legacy (non-Web-services-based) systems. Integration software provides the bridge between the legacy systems and SOA, allowing organizations to leverage existing software assets while managing their transition to SOA.

Integration solutions also contribute mature technologies – such as messaging, routing, data translation and transformation, and event management – along with organizational disciplines that are necessary for full-fledged, enterprise SOA. Moreover, integration capabilities such as business process management (BPM) and business activity monitoring (BAM) allow organizations to realize a higher level of business productivity from SOA by enabling the optimization of business processes and the alignment of strategic objectives with operational actions. In essence, integration should play a central role in any organization's SOA strategy.

Service Oriented Integration

Service Oriented Integration is a more application-agnostic approach for integration. It is a functional integration technique which leverages exposed business functionality as services. These services are basically published and accessed in a standard way. SOA promotes assembly, orchestration, and choreography based on service, made possible by a Service-based integration.

Integration approaches used inside the enterprise have come a long way from the point-to-point customized integration approach to a more disparate Service Oriented Integration. An initial approach, with point-to-point integration can be termed more accurately an application-to-application integration where each application owner may get involved in sorting out the difference in platform, data semantics, and communication protocols. Some design document is prepared for this integration and for extra lines of code based on the design. This process gives us, first, point-to-point integration. It requires a host for the application and the communication protocol and port number details need to be coded inside the program or read from outside config files. This approach becomes very cumbersome as the number of integration points increase.

Due to large number of integration needs for an enterprise, a standard product approach is adapted. It basically uses EAI software and a myriad of adapters for legacy and ERP applications like SAP, Baan, Siebel, etc. It solves the point-to=point connection problem by providing central access to each integration application. It provides messaging, reliability, choice of transport and transformation. This approach is flawed by: the need for skill resources, an inherent complexity,, and the need for centralized control.

The Service Oriented approach, on the other hand, proposes a standard way of integration based on services. It could be implemented via different technologies or patterns. In this approach, the designer is basically concerned with functionality and granularity, rather than plumbing issues between the applications. The underlying integration infrastructure should take care of interaction between the services. It provides a more uniform approach to all integration needs, like b2b, portal, data integration, and so on.

The following diagram depicts a SOA Integration.

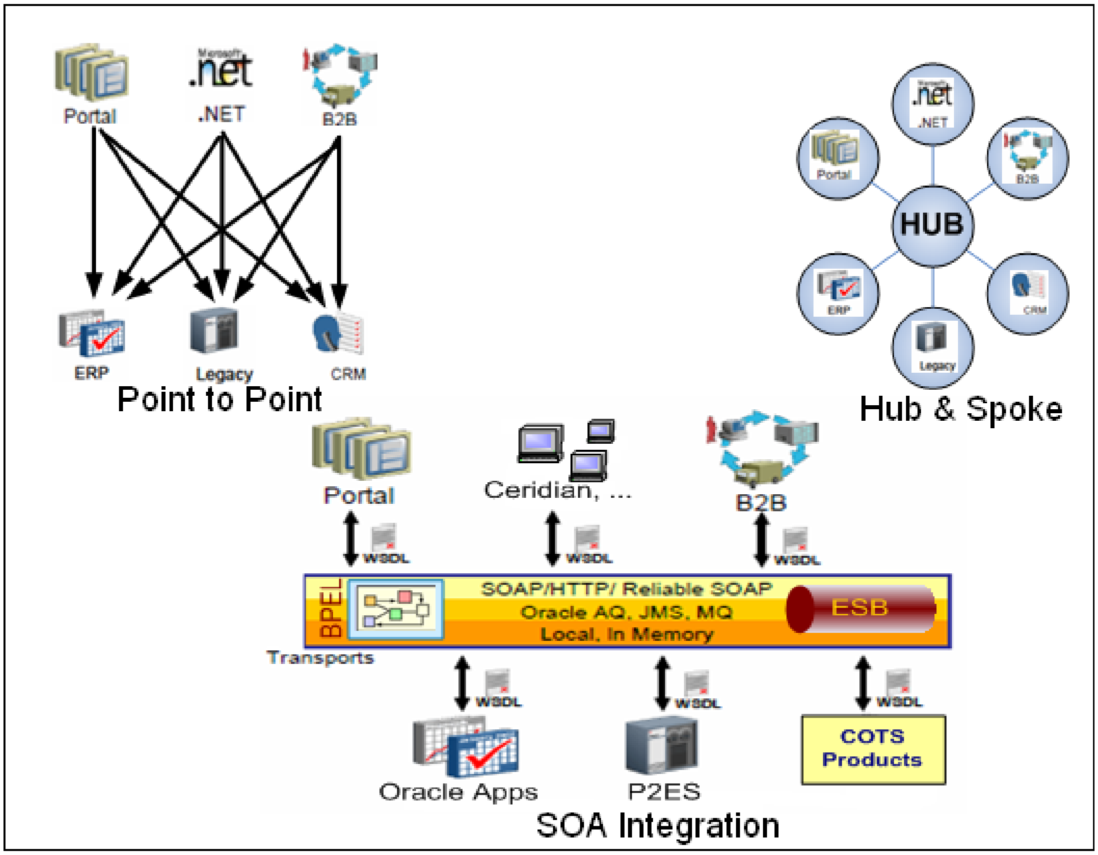

Figure 1. SOA Integration

A comparison of different integration approaches is depicted below.

Integration Approach	Advantages	Disadvantages
Point to Point	• Simple to implement • Short time to market • Can use existing tool	• Infrastructure concerns needs to be handled or decided by application guys • Happens more at application to application level; may not be aligned properly with business goals • Doesn't scale • Tight coupling
EAI	• Asynchronous model • Rule based transformation • Avoid N to N connection with Hub-and-spoke model • Offer many powerful functionalities	• High TCO • Use of proprietary protocols • More inclined toward data level integration rather than process • Application API based integration, it basically give shade of application level integration rather then abstracted functional interaction • API based integration, result in more fine grained functionality. Which are difficult to manage • It depends heavily on Hub-and-spoke model which can result in single point of failure
Service Oriented Integration	• Application agnostic integration approach • Standard based • Loosely coupled • Reusable and independent service are used for integration • Multiple models are supported • Resource requirement at implementation level will not be a big risk as it works with standards • More scalable approach as standard message routing and transport is provided by BUS. Transformation and task flow is provided by mediation modules	• Maturing concepts • More control required over service definitions as it should not end up with Web Service wrapper around existing functionality • Lot of scope for improvement for SOI infrastructure e.g. ESB, Service containers

Table 1: Integration approaches

Enterprise Integration Requirements

An enterprise has several different business requirements for integrations. It is quite possible to categorize all those integration requirements as a collection of integration use cases. The basic integration scenarios are

- Enterprise Application Integration – Includes Adapters, Message brokers, EAI Suites, ESB, and Application router. Critical components of application integration include transactional integrity security, the ability to face what is happening and exception-handling mechanisms. Application integration technologies include adapters, message brokers, EAI suites, Enterprise Service Buses (ESB's), and application routers.

- Application integration can be a component of A2A, B2B, or a composite application.

- Multi channel Access – Access via channels like browsers, PDA's, mobile phones, etc., are used for information exchange. Web browsers, Personal digital assistants (PDA's), mobile phones, interactive voice response units, and other special purpose devices are used to receive and send information. The expansion of access channels represents an opportunity for enterprises to better serve their employees, customers, suppliers, and partners anytime and anywhere.

- Data Synchronization – Synchronize the information in disparate systems. An enterprise must choose one of the following approaches when it decides to automate the synchronization of data:

    - Transferring flat files
    - Performing database level updates
    - Using an application program interface (API) or application adapter

- Mainframe Integration – Mainframe Integration can be part of various integration scenarios, including data synchronization, application integration, B2B, Composite applications, and multi channel access. The best solution for the Mainframe integration is Wrapping existing mainframe transactions into reusable web services that can be accessed from any source. Wrapping enables greater reusability and flexibility. The best approach for integration depends on characteristics of the mainframe application, the implementation time frame, and whether the integration is part of tactical or strategic implementation.

- B2B Integration – Automating transactions with partners, suppliers, and customers is commonly referred to as business-to-business (B2B) integration. Enterprises require B2B integration when they are attempting to streamline the supply chain, connect to electronic exchange, or comply with industry and regulatory mandates that require electronic communications to business entities outside the enterprise. B2B integration requires support for different data formats, including EDI, XML, and custom flat files as well as standard industry protocols.

- Unified view of information also known as *record of truth* uses:
    - Physical aggregation of data into one place
    - Data warehouses (updating at predefined intervals); not a current snap shot
    - Data marts (updating at predefined intervals) ; not a current snap shot
    - Distributed query; current and most up to date snap shot.

- Composite Applications – application assembled from components that may originate from various underlying systems. Portals Consolidation into one portal for an enterprise.

- Business Process Management (BPM) – Business processes are typically composed of a combination of automated and manual tasks and activities. The main goals and benefits of BPM include workflow Management – to manage task lists, accept or change assignments, balance workloads, and account for changes in resource availability due to vacations, illness, etc.

- Business Activity Monitoring (BAM) – combines information from multiple systems to create real-time digital dashboards that provide real-time feedback for the enterprise. BAM dashboard gives stakeholders in an organization access to information that helps track and manage key performance indicators (KPI)

Various Integration Technologies

Different integration technologies and infrastructure services are needed to accomplish different integration use cases. Therefore, enterprise will inevitably acquire a collection of technologies to meet their diverse business needs. The following section explains how different kinds of integration technologies address different integration business needs. The following picture describes the typical Integration road map.

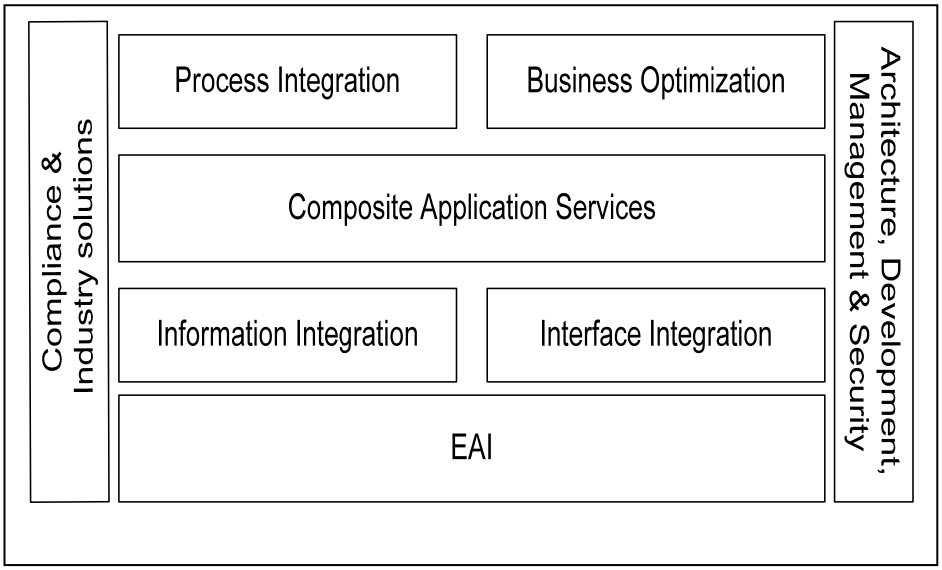
Compliance & Industry solutions
Process Integration
Business Optimization
Composite Application Services
Information Integration
Interface Integration
EAI
Architecture, Development, Management & Security

Figure 2. Integration Technologies

Application Integration Services

Application integration services offer the basic features and capabilities required to integrate and connect applications reliably and securely. These services include

- Connectivity to the applications. Connectivity is generally achieved using adapters, which enable a standard application connectivity approach and eliminate the need to program against proprietary application program interfaces (APIs). If Web services interfaces are available, application connectivity may be achieved without an adapter. Application connectivity may also be achieved at the database level using a database adapter or a direct SQL interface.

- Data transport and routing capabilities to move information reliably and securely between systems. Application integration solutions typically use a message-based approach to moving data, and they support a variety of topologies that link systems together in a scalable and flexible manner.

- Data transformation and mapping capabilities. These enable data to be converted to and from the required target representations.

- Infrastructure services to implement the application integration scenarios described in the previous chapter. These include support for transactions, application-level security, and exception management services.

The core application integration capabilities often play a role in other integration services, such as information integration, interface integration, composite applications, process integration, and business optimization with business activity monitoring (BAM). Without the underlying application integration services, these other integration services require point-to-point connectivity with back-end applications, which limits agility and reuse.

Technologies that provide application integration services include

- Message brokers
- Integration servers
- Enterprise service buses (ESBs)

Information Integration Services

Information integration (a.k.a data Integration) services consolidate and integrate structured and unstructured information from multiple sources, and manage it at an enterprise level to promote data consistency. The key to managing distributed information effectively is metadata. Metadata plays an important role in enabling interoperability among systems because it allows data to be understood and exchanged consistently across the systems. Enterprise metadata repositories that provide real-time data services enable reuse. The next step in data management services and integration productivity is semantic integration. Semantic integration captures the meaning and context of data within source systems in a metadata repository.

Data integration involves a framework of applications, tools, techniques, technologies, and management services for providing a unified and consistent view of enterprise business data to business processes and business users.

Applications are custom-built or vendor-developed solutions that utilize one or more data integration tools.

- Tools are off-the-shelf commercial products that support one or more data integration technologies. These tools are used to design and build data integration applications.
- Technologies implement one or more data integration techniques.
- Techniques are technology-independent approaches for doing data integration.
- Management services support the management of data quality, metadata, and data integration system operations.

Data integration techniques

The three main techniques used for integrating data are

1. Data consolidation
2. Data federation
3. Data propagation

These three techniques may, in turn, use changed data capture and data transformation techniques during data integration processing.

Data consolidation

Data consolidation captures data from multiple source systems and integrates it into a single persistent data store. Essentially, with data consolidation, there will be a delay, or latency, between the time updates occur in source systems and the time those updates appear in the target store. Depending on business needs, this latency may be a few seconds, several hours, or many days.

Data federation

Data federation provides a single virtual view of one or more source data files. When a business application issues a query against this virtual view, a data federation engine retrieves data from the appropriate source data stores, integrates it to match the virtual view and query definition, and sends the results to the requesting business application. By definition, data federation always pulls data from source systems on an on-demand basis. Any required data transformation is done as the data is retrieved from the source data files.

Data propagation

Data propagation applications copy data from one location to another. These applications usually operate online and push data to the target location; i.e., they are event-driven. Updates to a source system may be propagated asynchronously or synchronously to the target system

Enterprise Content Management

Another technology that handles the integration of unstructured data is Enterprise Content Management (ECM), which is focused on the consolidation of documents, Web information, and rich media. ECM products concentrate on the sharing and management of large quantities of unstructured data for a wide user population. These products add a content management layer on top of a shared data store. This layer provides metadata management, versioning, templates, and workflow.

An ECM content store can act as a data source for an EII or ETL application. The key here is not simply to provide access to unstructured data, but also to access the metadata that describes the structure, contents, and business meaning of that data. This is analogous to the issues associated with accessing and integrating packaged application data where the metadata is again important to understanding the business meaning of the data. In both cases, it is important to evaluate not only what data and application sources are supported, but also the level of integration with the source data and metadata.

Interface Integration Services

Interface integration services provide access from a variety of front-end devices to a variety of back-end systems. The technologies that provide interface integration services include portals and mobile integration gateways.

Portals

Portals provide an integrated user interface to multiple back-end systems. Many EAI solutions focus on automating transactions across systems. But a portal solution integrates information into a browser for a particular purpose or set of users, providing a single touch point for the delivery of application services.

Mobile Integration Gateways

Mobile devices have different screen sizes, resolutions, and interface requirements. Mobile integration solutions usually include a specialized server that provides the transformation services for each target device, along with security. This server integrates with back-end systems either directly (point-to-point) or through an integration platform. The mobile integration server typically uses message queues and logs to guarantee that messages will be delivered once, and only once, even in the event of a system failure. To support occasional users, it controls message delivery by organizing messages into transactional groups, and determines when messages are delivered, based on the type of network connection. To address the insecurity of mobile communications, the ability to encrypt data is important.

Service Registries for Governance

UDDI is the registry standard for dynamically discovering and invoking Web Services. UDDI was originally created to manage the cataloging of public web services. Registry products typically incorporate some level of Web services management capability to make the registry more useful within the enterprise.

Composite Application Services

The development, deployment, and management of composite applications would involve the following major list of activities:

- Develop new services
- Create service abstractions by combining several low-level services into a more useful, reusable high-level business service
- Design and model the behavior of the composite application, including how information and messages flow across services, and how services need to be orchestrated in support of a business process
- Discover services or browse from a registry of available services
- Manage policies and service level agreements to engender trust and enable the reuse of services
- Deploy the resulting solution into a managed run-time environment

Technologies most commonly associated with composite applications include Web services, service orchestration capabilities, and service registries with effective governance.

Web Services

Web services define a standardized interface (Web Services Description Language, or WSDL), a standardized communication protocol (Simple Object Access Protocol, or SOAP), a standardized repository for registering and discovering Web services (Universal Description, Discovery, and Integration, known as UDDI), and standardized message encoding using XML.

These standards enable a Web service to reside anywhere and be accessed from everywhere, making Web services well suited to the role of providing aggregated functionality within a composite application and being the standard for inter application interfaces.

Orchestration

To create a composite application from a set of Web services, it is necessary to define the flow of control across services and also the dialog control logic. This is achieved using service orchestration. This latter approach basically allows developers to modify the way services are linked together without changing the services themselves. Business Process Execution Language

(BPEL), a vendor-led initiative, is gaining mind share and market share as the orchestration standard.

Process Integration Services

A process-driven approach to integration improves the alignment between IT and the organization. It starts with the development of business process models that business people can understand and review. These models depict a shared understanding of the end-to-end business process. Using process integration technology, the models can then be automated. This significantly reduces the chance of misinterpreting the business requirement or getting the process wrong. Since processes can span departments, business units, and organizations, no single individual may own or even understand the end-to-end process.

An enterprise business processes may be automated, manual, or collaborative. Frequently, an end-to-end business process includes both automated and manual processes (workflow). From an integration perspective, each type of process has different requirements and therefore calls for different process technologies. The technologies that deliver process-level integration include business process management for handling automated (and sometimes manual) processes, workflow management for manual processes, and groupware or collaboration platforms.

Business Optimization Services

Business Optimization services enable the organizations to align business strategies with coordinated actions. The goal of the BPM is to streamline the processes, but optimizing individual processes does not necessarily lead to optimization at an enterprise level. The goal of the Business Optimization is to optimize at the enterprise level and to align all parts of the enterprise to enhance business performance.

Business Optimization Services include the technologies that enable business performance management. Business Performance includes methodologies like Six Sigma, Balanced scorecard, Lean, and technology infrastructure.

Technology Choices

Generally, avoid using BPM if the workflows or business processes are of a simple to moderate complexity because a team with knowledge of an existing development platform would be significantly faster in developing these workflows or business processes using an ordinary programming language. Two key characteristics of a business process are its dynamism (frequency of change), on the one hand, and the complexity of coordination the particular process requires on the other.

Different types of processes are best addressed using different types of technologies, such as EAI, application servers, or BPM/Workflow.

Frequency of Change\Complexity of co-ordination	**Low**	**Medium**	**High**	**Technology**
Low	√	€	€	App Server
Medium	€	√	√	EAI
High	×	×	√	BPM

Legend:

√ -- Best Fit

× -- Over Kill

€ -- Implementable with App server considerable cost and Time

Integration Road Map

An integration roadmap is laid out considering the following:

- As-is assessment
  - IT portfolio inventory (Applications, Processes, Services, Infrastructure – hardware, software, servers, etc)
  - SOA adoption of the organization
  - SOA maturity level of the organization

- To-be state – *The Holy Grail*
  - Vision, goals, and objectives of the organization
  - Envisioned/Proposed IT environment that supports the organization’s vision

- Transition plan to highlight
  - Tactical steps such as conversions, adoptions to yield high ROI, and quick buy-ins from the business
  - Strategic approach to establish full-fledged SOA foundation – in an incremental fashion – keeping *the holy grail* state in perspective
  - Establishing formal SOA governance charter including competency center with responsibility to detail standards and best practice guidelines, Services/Processes implementation oversight, and continuously keeping abreast of the SOA governance charter itself to align itself with ever-changing business needs

The following table highlights the correlation among various integration maturity levels to different SOA maturity levels:

	Service Integration Maturity Level	Characteristics	Mappings to SOA Maturity Level	Mappings to Scope of SOA Adoption
1	Fundamental SOA	• Point-to-point integration • Pilot projects • Platform dependent	(1) Initial Services	(1) Intra-dept, Ad-hoc projects
2	Networked SOA	• EAI based on Hub-and-spoke • Flexible and loosely-coupled • Self-contained, Modular, componentized • Mediation services • Reliable messaging • Vendor dependent	(2) Architected Services	(2) Inter-dept, Business units
3	Process enabled SOA	• Open standards based interfaces • Heterogeneity and distributed systems • Externalized business rules • Event driven processes (EDA) • Composite applications • End-to-end business processes orchestrated using BPEL • Versioning • Internal security • Performance management • Business Activity Monitoring (BAM)	(3) Business Services (4) Collaborative Business Services	(3) Cross business units
4	Dynamic SOA	• Dynamically reconfigurable services • Complex message processing • Automatic SLA management through Grid technology	(5) Optimized Business Services	(4) Enterprise, Extended enterprise

Conclusions

This article addresses the different integration methodologies in SOA perspective. Integration technology plays a significant role in enabling the enterprise. Integration also helps in leveraging the existing assets of an enterprise to generate new business opportunities. SOA is a more generic approach to all the integration needs like B2B, Portal and Data Integration. In SOA, the services used are reusable and independent and loosely coupled. It is the more scalable approach as BUS provides the standard message routing and transport. Based on the frequency of the change and the complexity of the coordination of the processes, the decision on the usage of the type of integration is discussed in the paper. Various integration technologies are discussed in detail, and modeling them in respective services/infrastructure addresses the different business needs of the enterprise. Finally, the correlation among various integration maturity levels to different SOA maturity levels are articulated in the paper.

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Glossary of Terms

Acronym/Abbreviation	Definition
A2A	Application to Application
B2B	Business to Business
BAM	Business Activity Monitoring
BPM	Business Process Management
BPEL	Business process Execution Language
EAI	Enterprise Application Integration
ECM	Enterprise Content Management
EDI	Electronic Data Interchange
EII	Enterprise Information Integration
ERP	Enterprise Resource Planning
ETL	Extract, Transform, Load
ESB	Enterprise Service Bus
IT	Information Technology
PDA	Personal Digital Assistant
QOS	Quality of Service
ROI	Return on Investment

SOA	Service Oriented Architecture
SOAP	Simple Object Access Protocol
SOI	Service Oriented Integration
TCO	Total Cost of Ownership
UDDI	Universal Description, Discovery and Integration
XML	Extensible Markup Language

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Author

Dr. Gopala Krishna Behara is a Senior Enterprise Architect in the Wipro Consulting Services, a division of Wipro. He has a total of 13 years of IT experience. He can be reached at gopalkrishna.behra@wipro.com

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