



Service-Oriented Architecture for PLM
An Overview of UGS' SOA Approach

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1. Introduction

This paper describes Service Oriented Architecture (SOA), discusses the use of SOA in Product Lifecycle Management (PLM) solution enablement, the benefits that SOA can provide, and how one company, UGS, is adopting SOA throughout its product suite.

The term Service Oriented Architecture (SOA) describes a style of multi-tier computing in which resources on a network are made available as independent services that can be accessed without knowledge of their underlying platform implementation. SOA provides a uniform and consistent means to offer, discover, interact with, and use capabilities and services across a networked environment. Thus, an SOA defines services that are independent of the server that provides it and client that utilizes it.

SOA can also be regarded as a style of Information Systems architecture that enables the creation of applications that are built by combining loosely-coupled and interoperable services. These services inter-operate based on a formal definition (or contract, e.g., Web Services Description Language, WSDL) independent of the underlying platform and programming language. The interface definition hides the implementation of the language-specific service. SOA-compliant systems can therefore be independent of development technologies and platforms (such as Java, .NET, etc). SOA can support integration and consolidation activities within and among complex enterprise systems.

SOA is frequently, but not always, based on Web service standards such as SOAP (i.e., Simple Object Access Protocol) that have gained broad industry acceptance. These standards (referred to as Web service specifications) also provide greater interoperability and some protection from lock-in to proprietary vendor software. Web services standards relevant to SOA include:

- eXtensible Markup Language (XML)—a markup language for describing data in message packages or documents in a document format.
- Hypertext Transfer Protocol (HTTP and HTTPS)—a request/response protocol between clients and servers used to transfer or convey information.
- SOAP—a protocol for exchanging XML-based messages over a computer network, normally using HTTP.

- WSDL—an XML-based service description that describes the public interface, protocol bindings, and message formats required to interact with a web service.
- Universal Description, Discovery, and Integration (UDDI)—an XML-based registry to publish service descriptions (e.g., WSDL) and allow their discovery.

SOA is a generic model describing collaboration among services and can be implemented using any service-based technology. SOA is not specific to Web services and does not necessarily need to use any or all of the above standards to be “service-oriented.” For example, some service-oriented systems have been implemented using Common Object Request Broker Architecture (CORBA).

Primary guiding principles for development, maintenance, and usage of a SOA include:

- Reuse, granularity, modularity, composability, componentization, and interoperability
- Compliance to standards (both common and industry-specific)
- Services identification and categorization, provisioning and delivery, and monitoring and tracking

In some respects, SOA can be considered an evolution in architecture, not a revolution. It captures many of best practices or actual use of the architectures that came before it. SOA promotes the goal of separating users (i.e., consumers) from the service implementations. Services can therefore be run on various distributed platforms and be accessed across networks. This can also maximize reuse of services and the balancing of services across the platforms delivering them.

SOA departs from previous client/server architectures by providing a service-based, message-oriented integration that is normally built on industry-standard technologies. The services are delivered using common components versus early client/server architectures in which each client and process interaction with a server used application-specific interfaces and protocols. Key characteristics of Effective SOAs include that it is loosely-coupled, highly reliable, business process-focused and supports heterogeneous IT environments. The following table compares traditional client/server architecture with SOA.

Traditional C/S Architecture	Service Oriented Architecture
Object-oriented	Services based
Method or function driven	Message oriented
Tightly coupled	Loosely coupled
Application silos	Interoperating solutions
Application-specific interfaces and protocols for client and server interaction	Common interface definitions and protocols

Figure 1—Traditional Client/Server versus SOA

In an SOA, services are also defined with explicit boundaries. Services share data, but not copies of internal objects such that faults in the execution of one service will not corrupt the results of, nor crash, other services. This results in improved reliability and up-time of mission-critical business processes. Once a service is defined, it can be easily re-used and called from any process or client. This can significantly reduce the time and effort to develop and incorporate new capabilities to applications and business solution implementations. This flexibility in re-use of services enables development organizations and implementing companies to adapt new capabilities and processes faster, with less impact on production environments.

Providers of business solutions and applications are adopting SOA as the most cost effective method for developing, supporting, and enhancing their solutions and product suites. Enterprises are adopting SOA-built solutions because they provide a cost-effective, more easily adoptable, business-oriented platform for delivering required business functionality.

2. Business Opportunity

One of the strengths of a SOA is its power as a mechanism for more easily delivering a system that directly supports business processes and operating models. By providing a uniform and consistent means for interaction and access to application functionality (i.e., updating a Bill of Material in several applications simultaneously), use of SOA reduces complexity – and custom coding and implementations – of defining the steps and actions of an end-to-end business process. This provides a structure for solution providers and IT organizations to deliver against actual business requirements more quickly and flexibly. Enterprise architects believe that SOA can help businesses respond more quickly and cost-effectively to the changing market conditions. This style of architecture promotes re-use at the macro (i.e., service) level rather than micro levels (e.g.,

objects). It can also simplify interconnection to and usage of existing IT assets. These capabilities are increasingly important to manufacturing enterprises.

Manufacturing enterprises are facing many challenges today, including:

- How to compete in a global market
- How to bring innovative products to market faster, better, and at less cost
- How to leverage their scarce resources to the maximum
- How to leverage previous investments in technology and applications

While not a solution to all these challenges, the use of a SOA can help address many of these issues. A SOA helps manufacturing companies:

- Enable participants in their extended enterprise to work together with minimal co-dependence or technology dependence as the SOA provides common mechanisms that can be called by applications built using differing technology
- Specify the standard to which organizations, people, and technologies must adhere in order to participate in the business processes of the extended enterprise
- Enable the software to more effectively and seamlessly support complete end-to-end business processes, not just portions of processes without extensive custom development
- Use a variety of technologies to facilitate interactions throughout the extended enterprise

Use of SOA helps reduce costs associated with making changes to business systems and applications, integration between departments or companies, and maintaining and leveraging legacy systems. Also, because a services infrastructure reduces the complexity of integrating multiple business systems, it can reduce the cost of acquisitions/partnerships and make it easier to integrate the systems and processes of the merged entities.

PLM applications are complex in that they must integrate with design tools, analysis tools, and multiple other business systems. In addition, they must deal with a diversity of complex product-related data. Bringing this diverse and frequently large set of product data to the business users that must act on it has been challenging especially when multiple PLM applications across several “divisions” of an enterprise have different CAD/CAE environments or when there are multiple PLM applications and/or ERP systems that are trying to manage a consistent product definition. Using SOA, a common set of service calls can be made to multiple applications and information repositories via a single user

interaction, thus achieving a significant productivity gain compared to performing each update independently.

As an example, one feature of a PLM application that has been particularly difficult to implement is “Impact of Change” analysis within the context of the engineering change process. Potential engineering changes must be evaluated for the business impact that it is likely to have as well as the business risk it may pose. A comprehensive Impact of Change report uses the product data to interrogate how much inventory or which customers are likely to be affected by the potential change. This type of report can only be generated when the product data is integrated to the customer order backlog, the inventory on hand information, and other pertinent information. This information is typically not found in a PLM environment but is part of an ERP application. Again a SOA approach can simplify, from the user and the IT perspective, the effort needed to query all the appropriate sources of data to provide the user with the appropriate information needed to make an informed decision.

The goal of a SOA is to provide a single integrated view to the user of all of the available application functionality – a portal into business processes and the associated information. For example, if a user must update several Bills of Material (BOMs) across multiple data applications, which may be deployed on a global scale, a SOA-enabled user interface could present a single “Update BOM” button that would initiate a request for an update to all of the appropriate applications with an update BOM function that should be impacted by the user’s action. While the user would only perform one interaction, the SOA would manage the complexity of updating all of the connected applications and databases by executing an “UPDATE_BOM” procedure in every site.

Another benefit of SOA driven user interfaces particularly important in today’s globally distributed environments, is the ability to providing a single entry point (or portal) for all clients. Providing and controlling access to product-related information and processes when working with design and supply chain partners can be a very complex and difficult problem. Each partner, and even each division within an enterprise, may use different applications to perform the same or similar function. If these functions can be accessed or initiated via a service, it greatly simplifies the time and effort to create the virtual environment needed. Partner/supplier users and other business systems can request the service without needing to know what application will deliver that service. SOA portal user interfaces can be designed so that they focus on the user’s business tasks without having to use multiple applications APIs or protocols. Because the SOA approach is built on

using a defined set of services, each individual’s user interface can be role and work task context-driven and presented in custom terminology and for specific needs. This enables the user to focus on work tasks without trying to sort out the complexities of the overall IT environment, thereby improving productivity and work morale.

An SOA also enables companies to more rapidly adopt and deploy new applications or update and enhance current applications and processes. This allows engineering managers to quickly respond to critical product development and deployment issues by more quickly, easily (and with less cost), introduce applications or changes in procedures necessitated by critical product development and deployment issues. Most importantly, a SOA-enabled environment helps Chief-Information-Officers (CIOs) to dynamically support changes in business environments and processes with far less cost and risk than has been previously possible. Using an SOA accomplishes this by integrating service-connected PLM, ERP, and legacy product data applications where the application processes or services have been ‘exposed’ in standardized protocols.

3. SOA in the PLM Industry

The use of SOA by developers of PDM, ERP, and other business applications is enabling the implementation of PLM environments, allowing them to present new features to users, engineering managers, and IT managers as well as remove much of the complexity in integrating the PLM environment with other business applications and processes. Because of the previously described strengths of SOA, many of the major PLM solution providers are converting to an SOA for development and delivery of the product suites. The following paragraphs provide a brief, high-level status of the use of SOA by a number of the leading PLM solution suppliers.

Agile has been incorporating services and components of a service-oriented architecture within its product suite for several years. Agile’s Integration Server was originally built on a proprietary services foundation but has since been converted to use industry-standard services protocols. Agile’s philosophy is to use services to create a more flexible architecture upon which to develop and deliver its products and as a platform to deliver business-oriented services. Agile supports J2EE, XML, and Web services standards and their Supply Chain Security facility is built on a services paradigm. Additionally, the Cimmetry products also natively support SAP’s NetWeaver platform.

In the past Dassault Systèmes (DS) was focused on building their products on the CAA V5 architecture. In June 2006,

they announced their V5 SOA (Service Oriented Architecture) strategy. V5 SOA will provide services in five key domains:

- V5 SOA User Experience (search, navigate, collaborate)
- V5 SOA Business Process Integration and Management (dynamic business process modeling)
- V5 SOA IP Modeling, Integration and Management
- V5 SOA Enterprise Foundations (live applications, online applications, search infrastructure, collaboration)
- V5 SOA Openness (Web services, standards, connectors, multi-CAD, PLM IDE)

DS plans to leverage its strategic technological partnerships with IBM and Microsoft to optimize V5 SOA on their respective platforms (WebSphere and .Net). In June of 2006 DS announced its first SOA based product – ENOVIA 3D Live.

The Oracle SOA Suite is a complete set of service infrastructure components for building, deploying, and managing SOAs. Oracle SOA Suite enables services to be created, managed, and orchestrated into composite applications and business processes. The SOA Suite is a J2EE offering that can be deployed in a number of containers, including IBM's WebSphere, BEA Systems' WebLogic, JBoss and OracleAS. By default, the suite installs in an OracleAS container and includes a built-in OracleLite meta-data repository.

Oracle's SOA Suite includes a BPEL-based Process Manager to compose services into business processes, a Web services management and security solution to enforce authentication and authorization policies on services, a business activity monitoring to deliver real-time insight into business operations, an enterprise service bus, a business rule engine, and an Integrated Service Environment (ISE) to develop, debug, profile, and deploy services. Oracle is also developing and providing an SOA framework, Fusion Architecture, similar to SAP's NetWeaver and others.

PTC's Windchill was developed using web technology and standards and PTC has continued to expand and leverage this architecture to create a service-oriented environment. PTC began incorporating services with the Windchill Version 6 release. In the current product suite, all communication between Windchill and PRO/E Wildfire is via web services. PTC supports SOAP and WSDL web services technologies as well as full J2EE support, including standard JSP tag libraries, JMS, and Java Connector. Most actions are available as services and can act against every applicable Windchill object. Their integration engine

supports Java native and XML/XSL representations and data transformations. PTC is using Windchill Web Services to integrate Windchill with BPEL-Driven Enterprise Process Servers, such as:

- TIBCO BusinessWorks
- IBM WebSphere (PTC is IBM-Certified and listed in their SOA Business Catalog)
- Oracle BPEL Process Manager

SAP is moving to an SOA-based framework across all applications with NetWeaver at its core. SAP's Enterprise Services Architecture (ESA) is a service-oriented architecture that merges SAP's enterprise application content with the open composition platform, SAP NetWeaver. They have been re-architecting the SAP suite for several years and state that they will complete the move to a SOA in 2007. SAP is providing both an SOA platform (i.e., NetWeaver) and a suite of SOA-enabled applications (i.e., mySAP).

SAP has the most advanced messaging, position, and credibility when it comes to SOA of all PLM solution providers, primarily due to their overall NetWeaver investments, and their focus to become more of a platform company. The mySAP PLM interfaces will be extended in order to be compliant with the new Enterprise SOA standard. In addition new interfaces based on Enterprise SOA will be added for the area of mySAP PLM, in order to accomplish a more complete connectivity between mySAP PLM and other applications.

The usage of Enterprise Services for mySAP PLM will be rolled out during 2007 to partners and customers.

All of the major PLM suppliers continue to expand their use of SOA and this will over time, make PLM environments easier to deploy and to enhance.

4. UGS' SOA Program

UGS has been evolving its product suites to an SOA for several years. With each new release of their products, NX, Teamcenter, and Tecnomatix, UGS has increased the level of services defined and used to implement those products as well as the amount of common services and code shared by the various modules of their product suite.

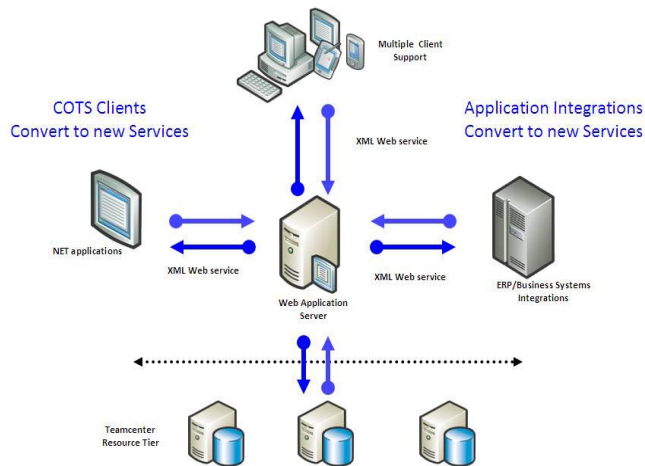


Figure 2—UGS Services Oriented Architecture

SOA brings technology and capabilities to Teamcenter that enable deployment of high performance, scalable, WAN-friendly reliable services. SOA is the first step in providing a single set of services across all clients, both external and internal. Not built on a specific platform, UGS' SOA implementation can be used to create a loosely-coupled integration with Teamcenter. Teamcenter's SOA services are accessible through a set of language-specific libraries that make it easy for programmer's with C, C++, C# (.NET), and Java experience to easily incorporate Teamcenter functionality into new and existing applications. A Web Services Interoperability Organization (WS-I) compliant WSDL helps integrate with almost any legacy technology.

SOA is part of the core Teamcenter product suite, so there is no option to select/de-select SOA. UGS' SOA is focused on core infrastructure support for any size deployment as well as high performance to support large, widely-distributed deployments. The SOA can be also be used both for an interactive (user involved) integration as well as a non-interactive (direct application to application) integration. The following figure presents UGS' SOA approach.

For Teamcenter, the full service-oriented architecture was delivered with the 2005 SR1 release in June 2006. While all basic capabilities are in place, not all services were implemented within the product suite at that time. Examples of SOA already implemented within the Teamcenter product suite include:

- Using a common set of services for information access, query, and classification in all Teamcenter modules
- Using SOA services for application integration both internal to Teamcenter and externally to other business systems, e.g., ERP
- Providing services to manage and integrate distributed systems
- Services for system definition and administration—all administrative functions use the same services across all modules

Delivery of the full SOA implementation will be reached with Teamcenter 2007.

5. CIMdata's Assessment

CIMdata has been, and continues to be very positive regarding UGS' approach to SOA and its implementation within their product suite. Their systematic, step-by-step approach has enabled both UGS and its customers to achieve increasing benefits with each new product release without disrupting their installed production systems. While this architecture work has not been very visible, it has delivered highly-productive results. UGS has steadily integrated a more advanced architecture within their product suite without trying to do it all at once. Without a lot of hype or "promises," over the past three years, UGS has quietly delivered more and more of its SOA without any upheaval in its installed base.

UGS' SOA approach is also helping "future-proof" their product suite, both for their customers and their developing organization. By breaking the applications into a set of services that can be called on demand, UGS is insulating their customers from changes in application design, functionality, and technology. Over the long-term, (and PLM solutions will be in place for years), the use of the SOA can significantly reduce a customer's exposure to costly upgrades and deployment expenses and will preserve their tailored implementations. Additionally, the move to an SOA reduces the cost and time required for UGS to develop and integrate new capabilities and services within its product suite.

UGS offers one of the broadest product suites in the industry, and one that continues to expand to address more and more of the comprehensive PLM environment. By migrating to an SOA, UGS has significantly improved its ability to more easily add functional capabilities to their product suite without major re-writes or lengthy coding and testing times. An SOA will help UGS respond more quickly to both market and customer demands and will enable their customers to incorporate updates faster and with less impact

on their production PLM environments. Using an SOA will help UGS maintain its position as a leading supplier of PLM solutions.

6. Summary

For manufacturing companies of all sizes and in all industries, SOA-based PLM solutions provide the ability to expand the level of functionality available, improve the user's experience even as more and more diverse users work within the PLM environments, and reduce the cost and complexity of deploying and maintaining a distributed PLM environment. Service-oriented architectures offer long-term benefits to both solution developers and to those companies that adopt SOA within their IT infrastructure and environments – faster development of applications and industry/user/company tailored solutions, faster and less costly deployment, and less dependency on a given set of technology.

UGS has been incorporating an SOA within their product suite for the past several years, expanding the use of SOA with each release. With the release of Teamcenter 2007, UGS will complete this process. This updated architecture will enable UGS to rapidly expand their product suite to meet the needs of their users and help those users more quickly upgrade their PLM environment to take full advantage of UGS' offerings.

About CIMdata

CIMdata, an independent worldwide firm, provides strategic consulting to maximize an enterprise's ability to design and deliver innovative products and services through the application of Product Lifecycle Management (PLM) solutions. CIMdata offers world-class knowledge, expertise, and best-practice methods on PLM solutions. These solutions incorporate both business processes and a wide-ranging set of PLM enabling technologies.

CIMdata works with both industrial organizations and suppliers of technologies and services seeking competitive advantage in the global economy by providing world-class knowledge, expertise, and best-practice methods on PLM solutions.

In addition to consulting, CIMdata conducts research, provides PLM-focused subscription services, and produces several commercial publications. The company also provides industry education through international conferences in the US, Europe, and Japan that focus on PLM. CIMdata serves clients worldwide from locations in North America, Europe, and Asia Pacific.

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