IMPLEMENTING A FEDERATED ARCHITECTURE TO SUPPORT SUPPLY CHAINS

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ABSTRACT

This paper presents an update to a previous paper [4] that laid out requirements for federating enterprise systems and an implementation strategy for vendors of PLM (Product Lifecycle Management) software as well as organizations using such software. The original paper presented a concept. Since then several new technologies have emerged and several organizations have embraced and implemented federated architectures. While tool vendors have made progress in this direction by providing homogeneous federation capabilities, economic reasons have prevented them from achieving true heterogeneous federation. This paper presents an updated architecture, describes how some vendors are supporting a federated architecture, and explains how some organizations have implemented these concepts.

A *federation* implies a loosely coupled system distributed across the Internet or an intranet, where the participants can join in and leave the federation without breaking the federation. It also implies that participants are autonomous independent entities that can function on their own when they are not a part of a federation. An entity can participate in many federations at the same time and membership in a federation is not static. This represents the reality of the supply chain member organizations that are independent businesses. While organizations operate in this fashion for various programs, software systems that can operate this way have emerged only recently. Each organization typically maintains its own software systems (PLM, ERP, Workflow, etc.) that cannot be dependent on systems of other organizations. In order to achieve the reduced cost and cycle time, organizations need the capability to efficiently participate in multiple supply chains on an ongoing basis.

The federated approach is inline with these business trends, provides a low risk alternative to existing technology investment strategies, and enables organizations to bring new technologies in a modular fashion as opposed to implementation using a "big bang" approach. The federation approach leverages software solutions available from several vendors to support multiple, geographically distributed companies collaborating on programs. Furthermore, a federated architecture enables programs to implement a total systems view and optimize their supply chains at a global level and unlock the supply chain's inherent value.

KEY WORDS

Federated Architecture, Virtual Companies, Product Lifecycle Management (PLM), Workflow, Planning and Scheduling, Supply Chains, Agents, Business Case, Implementation Strategy.

INTRODUCTION

Over 60 percent of a product's cost is in its supply chain. To be more efficient each organization needs to look at how it interacts with its customers and suppliers for multiple programs. The rapid consolidation and reorganization of the defense industry means a business unit cannot rely on centralized corporate systems for mission critical needs. The design and manufacturing processes have significant inefficiencies built into them, due to lack of collaboration between primes and their supply chains. The causes of these inefficiencies range from very little involvement of suppliers in design process to limited supplier visibility into primes' manufacturing plans and schedules. Multiple, intensive iterations are involved in the exchange of technical data during design. These iterations are exacerbated by a lack of seamless and managed data exchange between each organization's data management system. The processes for managing designs and approvals are ad-hoc and typically are not synchronized with the information requirements of a design. The process tools currently in use provide limited support to users in relieving them of their data management burden.

Suppliers are typically not made aware of the prime's plans and schedules in detail. So they stack up their inventory at each point in the supply chain to hedge against unexpected demands. The delivery schedules are artificially constrained leading to sub-optimal production rates and supply/demand oscillations. The severe impact of information delays on inventory levels has been well documented [27]. Most PLM software tools and architectures focus on enterprise level capabilities as opposed to the virtual enterprise capability. The enterprise is seen as a stable entity made up of distributed sites. The tools cannot easily handle organizational changes, they assume a homogeneous environment, and they provide limited support for interoperability standards.

A proposed remedy for these inefficiencies caused by the use of uncoordinated PLM tools is the implementation of a technology solution based upon the concept of federation.

A *federation* implies a loosely coupled system distributed across the Internet or an intranet, where the participants can join in and leave the federation without breaking the federation. It also implies that participants are autonomous independent entities that can function on their own when they are not a part of a federation [12]. Each participant can support different schemas and their implementations can also be different. All participants do need to understand a common subset, which is represented by models such as those proposed by OMG (Object Management Group) PDM Enablers [16]. That level of common understanding should suffice to create a federated architecture. An entity can participate in many federations at the same time and membership in a federation is not static. This represents the reality of the supply chain member organizations that are independent businesses. While organizations operate in this fashion for various programs, software systems that can operate this way have emerged only recently. Each organization typically maintains its own software systems (PLM, ERP, Workflow, etc.) that cannot be dependent on systems of other organizations. These features make the federated architecture scalable and practical for organizations.

BUSINESS CASE FOR FEDERATION

In order to achieve the reduced cost and cycle time, organizations need the capability to efficiently participate in multiple supply chains on an ongoing basis. It can be argued that information linkages between organizations follow Metcalf's Law of networks that states the value of a network increases in proportion to the square of the number of nodes connecting it [6]. Figure 1 shows the typical business architecture for large programs where systems need to overcome the barriers of firewalls, business practices, data structures, and corporate cultures to realize the value of the networked information.

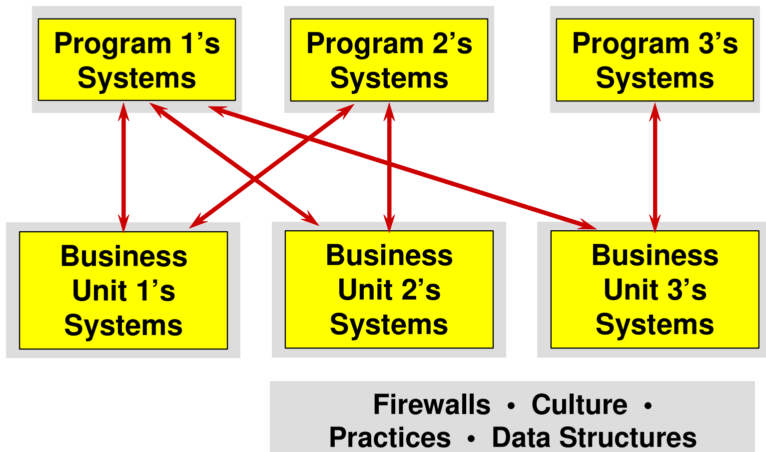

Figure 1. Business Architecture for Programs

The current trend in organizations is towards common systems, tools, and processes. While that is a trend away from disjointed systems; it is unrealistic to assume that there will ever be a single process or tool that can satisfy every need in a large organization with multiple business units and supply chain members.

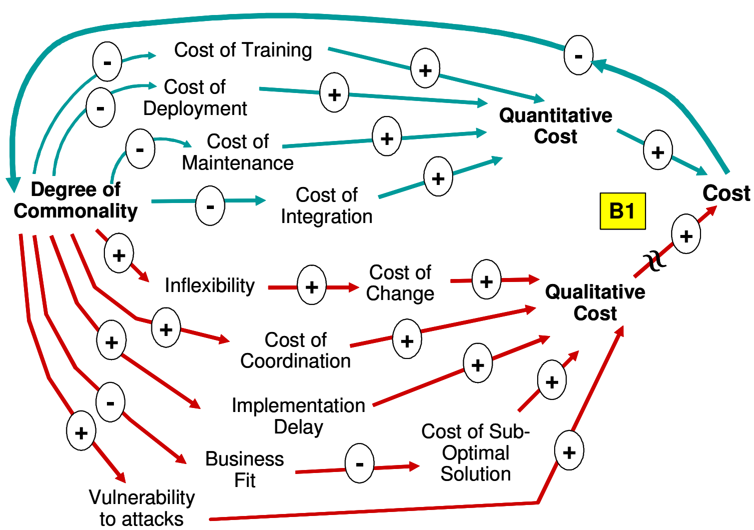

Figure 2. Degree of Commonality Model

Figure 2 shows a model of the impact of common tools on cost. It shows some very well known and understood impacts on cost (quantitative factors) as well as some impacts that are often ignored (qualitative factors). The model illustrates that as the degree of commonality increases, there is a reduced cost of training, which in turn reduces the quantitative costs. The upper half of the model includes factors that result in reducing the overall cost. In contrast, as the degree of commonality increases, there is increased inflexibility. This is because the same solution has to be applied to all organizations that are implementing a common solution, thus leading to more constraints on the solution. This results in an increase in the cost of modifying the solution or even changing the solution. For example moving from one PLM technology to another is harder when multiple organizations are collectively using a solution. This results in an increase in the qualitative cost. The lower half of the model includes factors that tend to increase the overall cost as the degree of commonality goes up, thus negating the gains from the top half of the model.

Another interesting aspect is that the qualitative factors also have a delay built into them before their impacts become evident. For example, cost impacts of increased vulnerability to cyber attacks might not become evident till the system is attacked. The two sets of factors tend to balance one another. Since the commonality tends to provide savings in the short term, it creates a feedback effect resulting in motivation to increase the degree of commonality.

The impacts of the degree of commonality model are shown in the graphic below (Figure 3). As the degree of commonality increases, it provides initial cost savings, thus providing incentive to increase the commonality. When there is no commonality, each participant operates independently. We call this a disjointed architecture. As the degree of commonality increases beyond a certain limit, there are diminishing returns. While easily quantifiable and visible metrics show reducing costs, qualitative factors that are often hidden (or ignored) show increasing costs. The qualitative factors become very important as the degree of commonality approaches 100% (centralized architecture) and are typically ignored by most architectural approaches. Existing architectures only take into account the technical aspects, and ignore the cultural and organizational aspects.

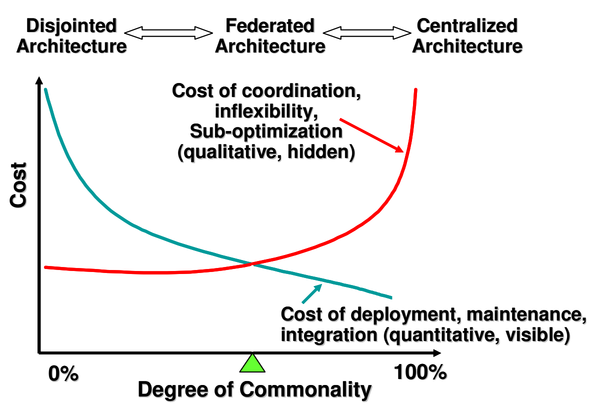

Figure 3. Hidden Cost of Commonality

A federated architecture emerges as the architecture that can overcome the problems traditionally addressed, and exacerbated, by increasing commonality. Here are some of the factors and scenarios that are driving the need for a federated architecture:

- **Cost**. Federation can lead to a lower cost implementation as outlined by the tradeoffs in previous sections, but the true benefit derived from federation is the resulting ability of diverse teams to interact with each other and to have visibility into other team's work and design decisions. This reduction in time delay is a key factor in reducing design cycle time and cost.
- **Schedule**. As discussed in the previous paragraph, a federated architecture can facilitate the reduction of cycle times.
- **Agility**. Federation offers more flexibility and agility as organizations change and tools change over the product life-cycle. Federation offers a more practical way to absorb these changes without catastrophic impact to the program.
- **Organizational issues**. Often organizational issues are the primary reason for selecting a federated architecture since the other architectures clearly do not resolve these issues. For example, it is impractical to assume that all organizations will switch over to a common tool for every program.
- **Autonomy**. A federated architecture enables members to have more autonomous control over their infrastructure. Many organizations feel uncomfortable letting go of this control and fear the loss of responsiveness and agility that accompanies a centralized architecture.
- **Regulations**. Issues like ITAR (International Traffic in Arms Regulations) regulations could force separation of information into two systems that then need to be federated for the local users.
- **Classified and unclassified environments**. Classified and unclassified environments need to be physically separate. Federation can enable the classified system to be able to access the total information set. This issue is similar to the ITAR issue, so one can foresee a program requiring three or four separate systems to address ITAR and Classification issues. Other architectures simply don't address this situation.
- **Scalability**. A federated architecture is inherently more scalable than a centralized architecture.
- **Latency**. A federated architecture enables faster response to users by positioning often used and relatively stable information closer to the end users. This can result in significant reduction in latency and bandwidth utilization.
- **Robustness**. A federated architecture is inherently more robust, since there is no single point of failure for the entire system. Even when many parts of the system have failed, or if the connections have failed, other nodes can continue to function.
- **Systems operating in autonomous mode**. DoD (Department of Defense) platforms that have a requirement to access PLM systems need to be able to operate in autonomous mode without disrupting access to critical information. This situation again calls for a

federated architecture as opposed to a centralized architecture that will not meet this requirement.

It is clear that to fully leverage the inherent value of the supply chain, the information systems need to be connected via a federated architecture. A federated architecture is a better fit for the dynamic nature of today's value chains and their participating organizations. As the cost of federating any two objects in the enterprise goes down, it is expected that inter-organizational and intra-organizational systems will be federated to gain efficiencies as well as enable innovation by connecting previously disconnected networks of information, processes, and people [11].

FEDERATION STRATEGY

The efforts of the commercial vendors must be leveraged to ensure that the results are quickly deployable throughout the industry without disruption of the existing and planned information technology strategies of the primes and their suppliers. The solutions need to be developed in an collaborative fashion with key vendors as part of the team. There is a significant distinction between concepts of federation versus integration. While there are several programs aimed at developing enterprise-wide infrastructures, what is needed is a commercially available federated enterprise capability that lets the enterprise systems of primes and their suppliers form program specific federations. Federation is preferable across cultural and organizational boundaries, whereas integration is preferable within those boundaries. The development of the architecture is guided by several principles that have been found useful in information technology and other domains:

- Provide Information (and resources) only when needed.
- Provide only the needed information (no more, no less).
- Do not carry Information "defects" to the next step.
- Put in place a process that discourages generation of defects.
- Information should be owned by the entity that is most suited to keep it current/accurate.
- Information accessible by all those who have a need or who may have a need.
- Take soft/qualitative factors into account.

CONCEPT OF OPERATIONS

The concept of operation surrounding the federated environment is centered on the concept of open, but managed, communication through the Internet. It begins with a system established within the prime contractor organization. The prime sets up a federation of organizations that participate in the program, including the customers. Federations will be setup by different primes for their programs and will block out the organizations they do not want to involve in their federation. The federation setup will involve defining who the members are, what are their roles, and what information and functionality they can access. The business relationships with suppliers will be long term strategic relationships built on trust and cooperation, not competing suppliers against each other every time or searching databases for low cost suppliers. These partnerships (federations) will essentially drive the configuration of their respective business tools (PLM, Workflow, MRP, etc). Once the business tools are configured to act as a federation they will be ready to support the supply chain throughout the life cycle.

In our envisioned scenario, the entire program team will be involved in the development of the high level requirements. They will collaborate with each other in a structured and ad-hoc manner to perform trade-off analysis to make the most cost-effective decisions. High-level requirements are broken down into design requirements. The design effort will also be collaborative. Members will develop more robust designs that are less susceptible to design changes. The designers will search through part catalogs based on their requirements and find parts based on cost and delivery criteria. Design changes will be immediately percolated throughout the supply chain to assess impacts.

The federated workflow manager (FWM) will provide automated set-up of the design collaboration process throughout the supply chain through an integrated methodology with the federated PLM (FPLM) system. The integrated FWM and FPLM system will significantly reduce the cost and cycle time through the inclusion of best-practice processes for collaborative system requirements breakdown, systems partitioning, and detailed design. Concepts like commonality, reuse and collaboration will be built into the design processes.

The production operations across the supply chain and programs will be globally optimized for efficient production rates and resource utilization. Different manufacturing sites will be coordinated. The results will be significantly lower inventories, faster customer response, and agile operations.

Federation impacts several processes in an enterprise. Some of the key processes impacted are:

- Requirements management and development across the supply chain.
- Program management processes for assessing program status in terms of schedule, cost, and risks.
- Program reviews.
- System level concept evaluation and collaboration.

FEDERATED ARCHITECTURE

The federated architecture will enable the primes and their suppliers to function as a federated supply chain (Figure 4). The federated architecture supports primes, large suppliers, as well as small suppliers who have limited resources. A federation implies a loosely coupled system where the participants can join in and leave the federation without breaking the federation. It also implies that the participants can function on their own when they are not a part of the federation. This represents the reality of the supply chain member organizations that are independent businesses. These businesses have their own business systems (PLM, ERP, Workflow, Schedulers, etc.) that cannot be dependent on other systems. In order to achieve the cost and cycle time benefits the participating businesses need the capability to participate in multiple supply chains on an ongoing basis. The federation concept fits with these needs.

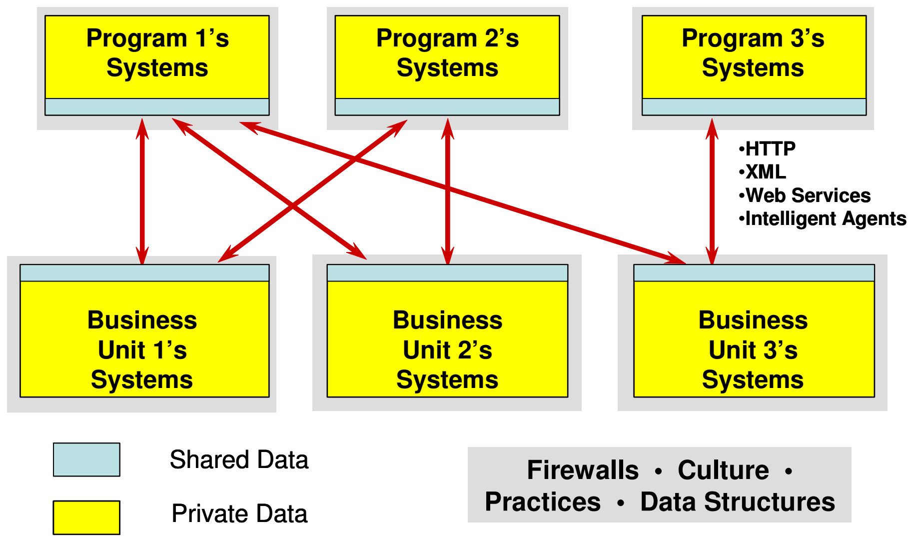

Figure 4. Federated Architecture Enables Computer Systems of Multiple Organizations to Act as a Team

Federation implies selective replication of information between federation members. Federation allows for a range of replication strategies of data from no replication of data to complete replication of data. The extent of replication depends on a number of factors such as: bandwidth, amount of information to be exchanged, frequency of exchange, volatility of information being exchanged, and information availability requirements. To achieve true federation between instances of an application, the application needs to be enhanced so it is aware of other instances and has the capability to interact with other instances.

Most integration techniques assume that a normative "business object model" is available. This has proven to be a challenging task. Federated architecture assumes that only some key concepts are normative and followed by all. Detailed object models and their implementations can be different. All participants need to understand a common subset, which is represented by models such as those proposed by OMG PDM Enablers [16]. That level of common understanding should suffice to create a federated architecture since it is not dependent on achieving a common schema across all participants.

The federated architecture represents the sweet spot between excessive disorder and excessive order, where the system is maximally responsive to the variety of its environment but sufficiently structured that it can act and exist [6]. A federated approach [5] provides the flexibility to deal with these current trend factors. Federation implies that one has established a degree of interoperability among business systems. Interoperability enables a shared-information area and provides a set of operations that can be initiated in a controlled fashion by one system operating on information in the shared/private area of another system. Members can join a federation to share information and functionality on a program and they can leave the federation when the effort is finished. Federation provides a low-risk alternative to existing technology investment strategies, and it enables organizations to bring new technologies in a modular fashion instead of requiring a total upgrade of the internal business-system architecture (“big bang” approach). A federated architecture enables programs to implement a total-systems view and it also provides the ability to optimize supply chains at a global level.

While this represents a qualitative tradeoff, an informal review of most aerospace organizations would show that the “centralized architecture” approach is not working as organizations and their supply chains have not been able to consolidate to a single enterprise system. These organizations/supply chains while striving for a “centralized” architecture currently are operating on a “disjointed” architecture. Other organizations are beginning to adopt a federated architecture and are reporting promising results. The following paragraphs describe some of the types of systems that can be federated.

FEDERATED PLM

The Federated Product Lifecycle Manager enables commercial PLM systems to be able to create federations among themselves, providing access to authorized information across the organizations from the local environment. This will greatly enhance information sharing and communication among the design team members without having to deploy and learn multiple PLM systems.

A key concept used in the architecture is a “Proxy” object that provides a surrogate or placeholder for another object to control access to it [9]. A proxy object resides in the local PLM environment and represents an object residing in a remote PLM environment. Requests made to the proxy are handled by the proxy and are forwarded to the real object for further processing. The results are returned to the proxy object. The proxy then forwards the results to the requester. Clients only work with the proxy object in the local PLM environment and are insulated from the details and how-to of dealing with the objects in remote PLMs. Some of the enabling technologies are described in the following sections.

FEDERATED WORKFLOW MANAGEMENT

Federated Workflow Manager enables commercially available workflow managers to create federations among them-selves, thereby providing workflow support for the entire project that spans multiple organizations. This will greatly enhance communication among IPPD team members, and will provide project status visibility and metrics collection for the entire program.

In this approach, the workflow is physically distributed between the prime and subcontractor sites. The federated control engine handles updates to the prime workflow and subflows. This architecture requires:

- The workflow builder to support the linking of workflow segments that are developed and owned by the various participants in a program.
- The ability to support multiple control engines communicating across the Internet. This will allow hierarchical workflows that have links to remotely located subflows to be executed across the Internet.
- Capabilities to allow designated program authorities to view global process status.

The emerging technologies of intelligent agents [13] and Wf-XML [21] hold a lot of promise in enabling federated workflows across organizations.

FEDERATED PRODUCTION PLANNING AND SCHEDULING

Federated Production Planning and Scheduling Systems enable MRP and ERP systems to create federations by allowing planning and scheduling information to be shared. This globally optimizes production across the supply chain for the entire program, and inventory and capacity visibility across the entire program. Federated planning and scheduling is one of the key mechanisms to coordinate production along the supply chain. Management of the day-to-day operations planning can impact the ability to execute production programs as the number of partners increases.

Federated Production Planning and Scheduling provides a set of tools and standards to bridge federated enterprise coordination for production and services. This architecture enables successful federated enterprise supply chain relationships. Examples of utilization include:

- A prime's sharing and collaboration of forecasts with suppliers;
- Better master production scheduling of components; and
- Just in time pull information relationships, etc.

As part of providing a set of standards to support decision making, certain functionality needs to be accommodated such as: creation of business policies, rules, and procedures; optimal supply chain design through model definition; supply chain inventory visibility; supply chain capacity visibility. The emerging ebXML standards [8, 29] are key enablers to achieving this capability.

KEY ENABLING TECHNOLOGIES

Several key technologies have emerged during the last five years that make federation more practical and affordable. The following technologies are some of the enablers to realize federated systems:

- ❖ **Web services**. Web services provide a standard means of interoperating between different software applications, running on a variety of platforms and/or frameworks on the web [25]. A Web service is a software system designed to support interoperable machine-to-machine interaction over a network. It has an interface described in a machine-processable format using WSDL (Web Services Description Language). Other systems interact with the Web service in a manner prescribed by its description using SOAP (Simple Object Access Protocol) messages, typically conveyed using HTTP with an XML serialization in conjunction with other Web-related standards. As applications and enterprise systems become web services compliant, it will become increasingly simpler to federate these systems. However, web services by themselves don't federate multiple systems, though they are a key enabler.

- **PDM Enablers**. PDM Enablers is an OMG Standard [16]. The goal of PDM Enablers is to establish standard interfaces for the services provided by Product Data Management (PDM) systems. These interfaces made available through ORBs (Object Request Brokers) will provide the standards needed to support a distributed product data management environment as well as providing standard interfaces to differing PDM systems. The focus of this standard is to allow standardized information to flow between PDM systems. At current time the standard does not address federation explicitly, even though this standard also provides infrastructure to enable a federated architecture.
- **STEP PDM Schema**. The STEP PDM (Product Data Management) Schema is a reference information model for the exchange of a central, common subset of the data being managed within a PDM system [22]. The STEP schema has had an enormous influence on the PDM Enablers described above. While the commercial adoption has been slow, the schema forms a critical enabler for achieving a federated solution.
- **XML**. XML (Extensible Markup Language) is a simple, very flexible text format derived from SGML [28]. XML based languages are emerging to standardize information in various domains. XML based languages to support PLM, E-commerce, and federation are emerging. XML is a key component of the web services set of standards and such is key to achieving practical implementation of federated architectures. Some of these languages are described below.
- **STEPml**. The STEPml is a XML based specification of the STEP PDM schema described above [19]. This represents the ongoing convergence between STEP and the emerging web services and XML standards.
- **ebXML**. ebXML (Electronic Business using eXtensible Markup Language), is a suite of XML based specifications that enables enterprises to conduct business over the Internet [8]. These specifications include the following topics: Requirements, Business Process and Information Meta Model, Core Components, Registry and Repository, Trading Partner Information, and Messaging Services. ebXML represents the next generation of EDI for e-business. ebXML provides a standard method to exchange business messages, conduct trading relationships, communicate data in common terms and define and register business processes.
- **Wf-XML**. Wf-XML is a XML and SOAP based protocol for run-time integration of process engines developed by Workflow Management Coalition [21]. Wf-XML, can be used to implement the three models of interoperability: chained workflows, nested workflows and parallel-synchronized workflows. Wf-XML supports these three types of interchanges both synchronously and asynchronously, and allows messages to be exchanged individually or in batch operations.

- **Federated Identity Management**. Federated Identity Management (FIM) is a system that allows individuals to use the same user name, password or other personal identification to sign on to the networks of more than one enterprise in order to conduct transactions [3]. This will enable companies to federate applications without needing to adopt the same technologies for directory services, security, and authentication.

IMPLEMENTATION CONSIDERATIONS

Implementing federation is a non-trivial task for technical and political reasons. It is necessary to follow a phased implementation approach to draw out technical issues and to instill user confidence and familiarity. Recent availability of commercial products from vendors like Federation, Inc. makes it much easier to implement a federated architecture. The following issues surface in implementing federated architectures.

PROCESS ISSUES

The federated approach requires that organizations rethink the processes that will design and manufacture the next generation products. Key issues to be addressed are: what processes should be used to involve customers and suppliers throughout the lifecycle; what information will be shared; and how will teams collaborate to perform work. The federated architecture opens up many new possibilities to redefine processes to improve productivity and cycle times. A good understanding of the "AS-IS" process and a vision of the "TO-BE" process are necessary to derive the benefits of this new architecture.

TOOL ISSUES

Effective implementation of the federated architecture requires examination of current tools and technology to see how much of this architecture is feasible and what new tools or tool capabilities are needed to realize and maintain this architecture for an organization. The tools and tool integrations should be evaluated and selected by considering maturity, availability, supportability, and cost. Many technology providers will claim to be able to do everything. The question to be answered is, what capabilities the currently available tools have to cost effectively support the business requirements.

ORGANIZATIONAL ISSUES

The new architecture and the process changes it forces will require cultural changes at the organizational level. Historically, design teams have not worked simultaneously with customers and suppliers. The process of involving customers in the design process, as opposed to getting approval at some later stage, may be difficult for customers and contractors to adopt. Use and acceptance of technologies such as PLM and Workflow themselves will be hard for design teams who are not accustomed to the discipline and rigor imposed by these tools. Benefits of these technologies come years later and therefore require strong management commitment and resolve. Performance and efficiency is likely to go down in the near term before it goes up. Therefore, it is better to not start unless you intend to follow through.

A further discussion of business issues surrounding these choices can be seen in [10]. Key factors identified are: annual sales of the organization, business driver, implementation timeline, political will, political will sustainability window, sponsorship level, budget, commonality of need, number of users, level of specific pain, continuity of specific pain, scale of pain, and politics of pain. The business reasons and driving forces are compelling and strong to start adopting these technologies. They will quickly become the differentiators in the coming years. Organizations must start the learning process now to become familiar with and to master these new technologies.

CASE STUDIES

The following are some examples of the use of federated architectures in industry:

Early Prototypes

To realize the federated architecture one organization developed prototypes that enable creation of proxy objects in one PDM system that can reference objects residing in another PDM system belonging to another organization. This enables the user to interact with information objects from multiple PDMs in a transparent fashion. The prototypes used Metaphase and Optegra PDM systems. Details of this implementation are available in [4, 5].

In the prototype's scenario, the user belongs to a subcontractor organization that builds a "black box" that fits in the "radar room" on a ship. User's organization uses Metaphase, while the organization responsible for the "radar room" uses Optegra. Key information that this user needs resides in Optegra and Metaphase (CAD data in "gaf" or VRML format for this demonstration). In the demonstration scenario, the user logs into the Metaphase system and starts work on the "black box". The user discovers its relationships to CAD models, documents, and assemblies. The user then discovers that the "black box" needs to fit into the "radar room". Further investigation reveals that CAD information for the "radar room" is not available locally, but a proxy object exists that points to the Optegra system (Figure 5).

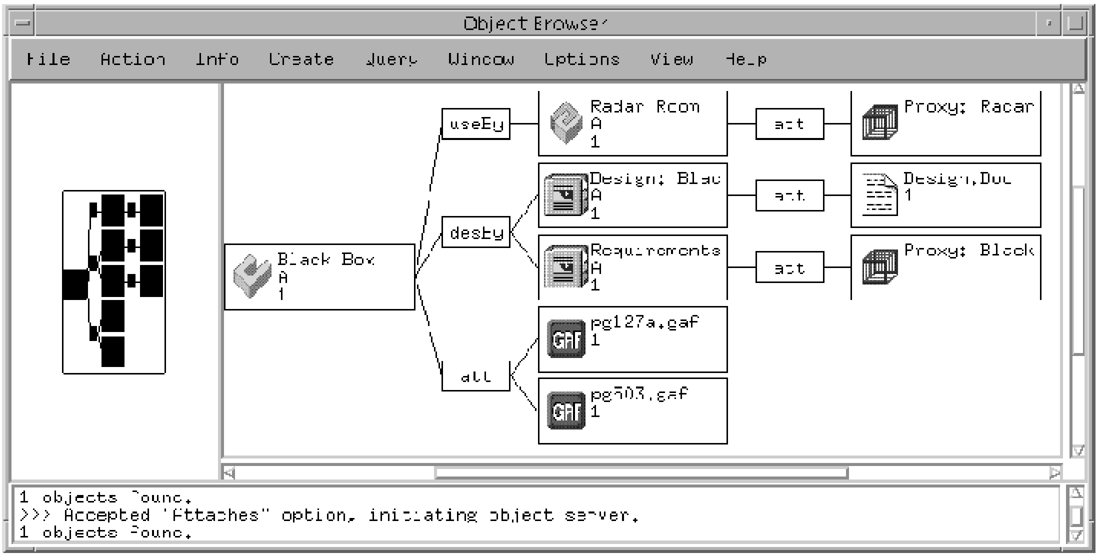

Figure 5. User Discovers a Proxy Object in Metaphase

The user requests the CAD data corresponding to the “radar room”. The proxy object initiates a request to Optegra for the appropriate CAD document. The document is “copied out” of Optegra using an Optegra API and transported to the Metaphase location. The document is then registered into Metaphase and appropriate relationships are created with Metaphase Objects (Figure 6). The user requests to view CAD documents for “black box” and “radar room”. The appropriate CAD tool is launched with the two CAD documents. The user can see how the two fit together and makes appropriate design changes.

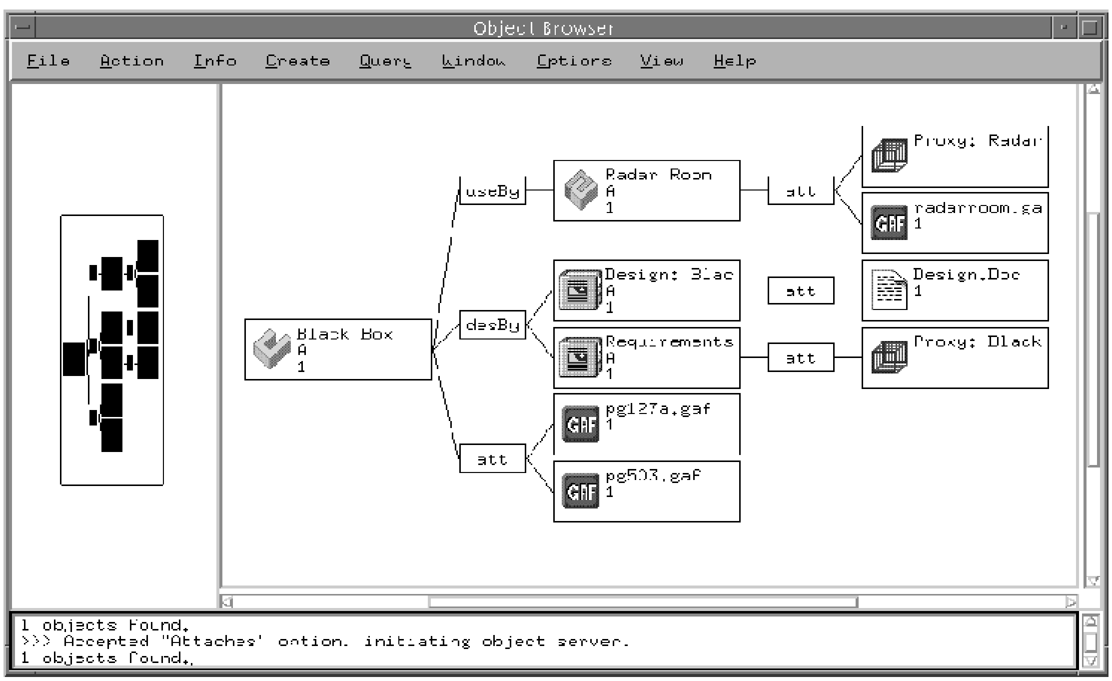

Figure 6. Object is copied from Optegra and Registered in Metaphase

This prototype essentially demonstrates a user interacting with the local PIM system while accessing information from multiple PIM systems. A similar prototype that lets Optegra users access Metaphase objects is being developed. The concepts described here can be applied to any PIM system.

DD-21

A federated architecture was also employed during the conceptual design phase of Navy's next generation destroyers, DD-21 [26]. In this implementation the organization responsible for systems engineering used a Windchill based PLM system that was federated to a Metaphase based PLM system employed by one of the subcontractors responsible for a major subsystem. The federation was used to keep the overall design synchronized with the evolving design of the subsystem by the subcontractor. The overall design was being continuously evaluated to see if it had achieved the key indicators of performance and cost. Using federation it was possible to ensure that at any given time the latest subsystem design was represented in the overall design of the system. The federation strategy used was very similar to the approach outlined in the previous example.

SUMMARY

The federated approach is inline with the current business trends and offers tremendous savings potential for organizations that are part of large supply chains. It provides a low risk alternative to existing technology investment strategies. It enables the organizations to bring new technologies in a modular spiral fashion as opposed to the "big bang" approach. It also provides the capability to protect an organization's current technology investments. Key vendors in these technology areas are investing in these technologies and solutions are emerging. Some organizations have already successfully deployed federated solutions and are beginning to realize their benefits.

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