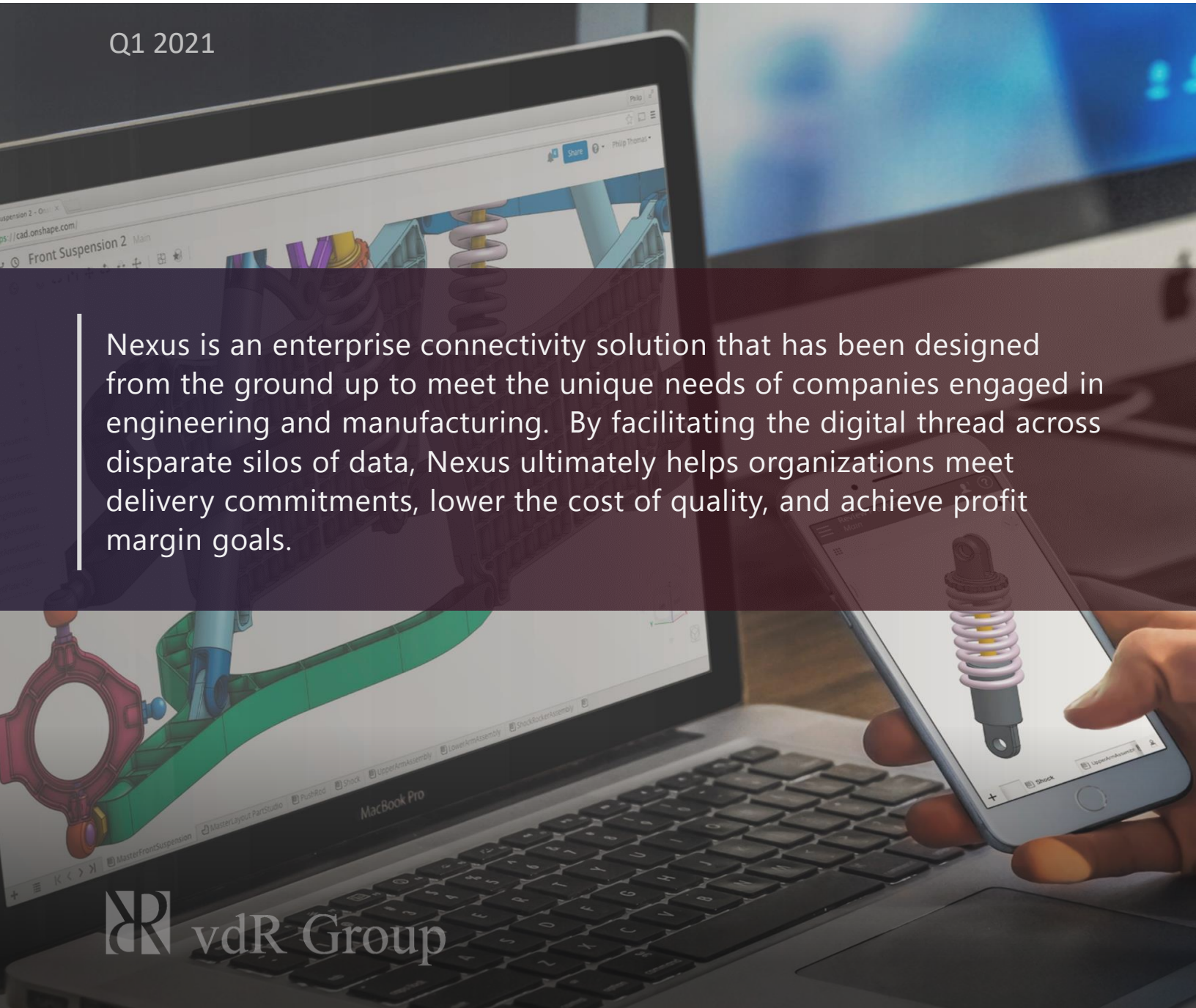
vdR whitepaper

nexus

Enabling Enterprise Application Connectivity for Engineering and Manufacturing

Q1 2021



Nexus is an enterprise connectivity solution that has been designed from the ground up to meet the unique needs of companies engaged in engineering and manufacturing. By facilitating the digital thread across disparate silos of data, Nexus ultimately helps organizations meet delivery commitments, lower the cost of quality, and achieve profit margin goals.

vdR Group

Executive Summary

Disconnected silos of data are the bane of business. The more silos there are, the more work required to meet delivery schedules, keep the cost of quality in check, and achieve profitability. These are all direct hits to the bottom line.

What if you could establish an environment whereby standalone applications work together to look and behave as one integrated solution? As a result:

- users would not need to switch between applications to get the information they need,
- parts, bills of materials, their documents and drawings could be automatically shared and/or exchanged at the right time to ensure everyone is on the same page,
- solutions could be left as-is

Seamlessly connecting disparate silos of data is what Nexus achieves.

This white paper characterizes the Nexus solution, the challenges it overcomes, how it works, along with implementation considerations.

What is Nexus?

Nexus is an enterprise connectivity solution that has been designed from the ground up to meet the unique needs of companies engaged in engineering and manufacturing. By facilitating the digital thread across disparate silos of data, Nexus ultimately helps organizations meet delivery commitments, lower the cost of quality, and achieve margin goals.

The illustration below highlights Nexus working with a myriad of application categories common to the product lifecycle of activities.

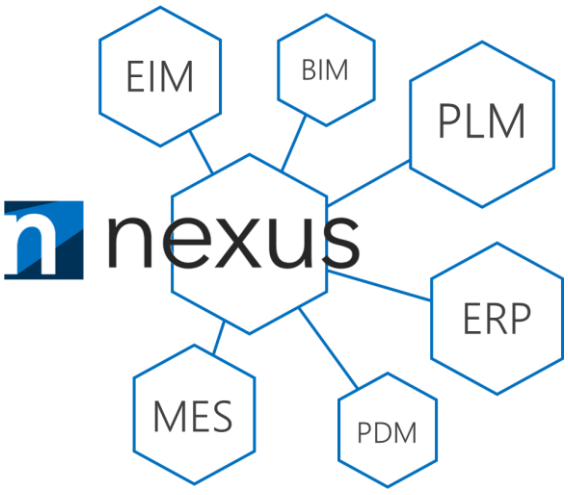


Figure 1. Nexus, an Environment Bonding Solution

"The more silos there are, the more work required to meet delivery schedules, keep the cost of quality in check, and achieve profitability."

The categories represented in this figure include enterprise information management (EIM), building information management (BIM), product lifecycle management (PLM), enterprise resource planning (ERP), product data management (PDM), and manufacturing execution systems (MES). Of course, there are others. Each of these play a role and support and contribute to the product lifecycle.

Simplify Enterprise Integrations

Nexus represents the next generation in application integration technology. By combining application-ready connectors, workflow concepts, and preconfigured transaction templates, connecting various applications has never been easier.

Faster Time-to-Value

As previously noted in Figure 1, product lifecycle activities involve a broad spectrum of applications. Nexus has anticipated their operational characteristics, infrastructure conditions, and access considerations to aid in significantly accelerating integration deployments.

Lower Cost of Ownership

By adhering to the industry-standard REST (REpresentational State Transfer) application programming interface (API) conventions, Nexus ensures organizations can quickly adjust yet remain resilient to the inevitable downstream changes in technology trends and business climates.

Challenges

The product lifecycle of activities for engineering and manufacturing organizations touches a wide range of functional disciplines. For manufacturing strategies such as build-to-stock (BTS) and configure-to-order (CTO), the internal process often starts with product marketing and new product development cycles. For build-to-order (BTO) and engineering-to-order (ETO) operations, product-related activities typically start during the sales process.

Regardless, the disciplines of project management, engineering, purchasing, quality, manufacturing, and customer support all touch product data in one way or another. The figure below illustrates and highlights these various activities.

"Research shows an exponential relationship between the number of silos of data and the downstream challenges that are created."

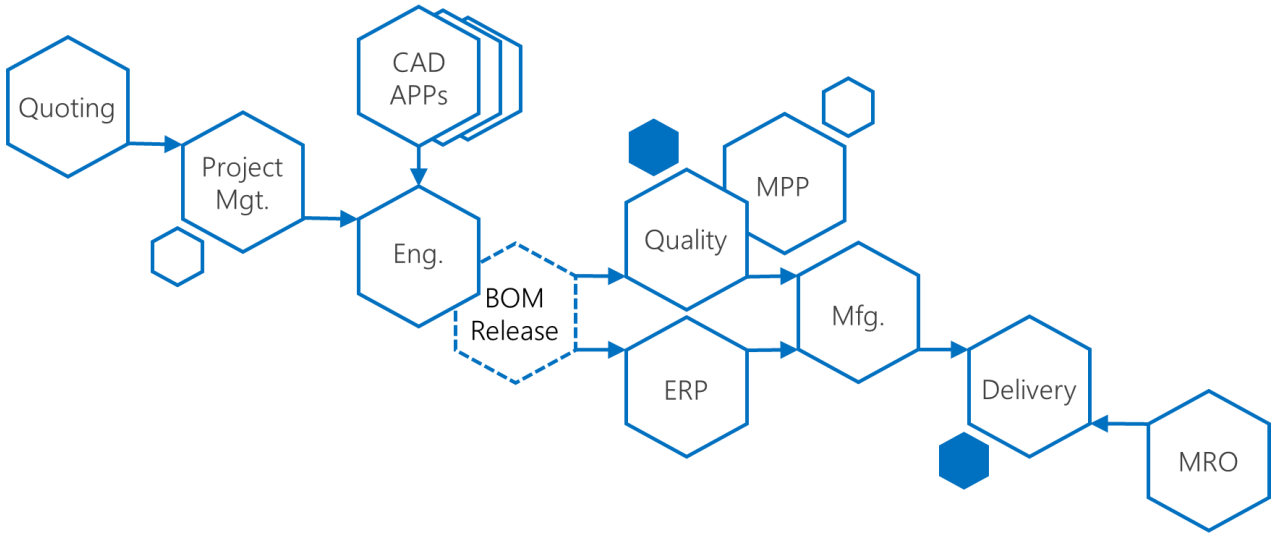


Figure 2. The Product Lifecycle of Activities and Operational Disciplines

To support these lifecycle stages, organizations have long recognized the value of acquiring and implementing "best of breed" applications. There is no one-size-fits-all for handling the ERP requirements for a manufacturer. Companies with multiple manufacturing facilities and distribution channels will have ERP needs far different from a single facility/single product manufacturer. Moreover, if organizations cannot find an off-the-shelf option, they will build-out their own platforms to meet their unique business requirements. The reality of standalone applications or "silos of data" is inescapable.

Research shows an exponential relationship between the number of silos of data and the downstream challenges that are created. It is easy to see why. Silos of data inherently impair information reuse, collaboration, process repeatability, change controls, and confident decision making. Users spend non-productive time searching, resolving data and document version discrepancies, and assembling context. These "intervention-based-tasks" are prone to transcription and/or interpretation errors and are often performed devoid of a broader understanding of other vital factors.

Of course, organizations and software vendors have sought various remedies. Over the past couple of decades, we have seen numerous "unifying" and/or "aggregating" concepts. Techniques have included data warehousing, data virtualization, big data and analytics, and more recently, the concept of data lakes. These attempts yield yet another data silo, requiring its own support and maintenance.

"Silos of data inherently impair information reuse, collaboration, process repeatability, change controls, and confident decision making."

An important counterpart to the unifying theme has been enterprise application integration (EAI) solutions. Earlier "hub and spoke" or middleware configurations treated the exchange, manipulation, and mapping of metadata between on-premise applications. As cloud-based software-as-a-service (SaaS) solutions emerged, EAI platforms have also migrated to the cloud. The latter is often referred to as platform-as-a-service (PaaS). However, the meta data-centric theme has persisted.

Product data extends far beyond simple metadata characteristics. There are BOM structures, versions, relationships, and associated documents and drawings. Hence, moving product-oriented data from one application to another is much more involved. Historically, these product-oriented integrations have been noted for their expense, lengthy implementation schedules, and rigidity. This may explain why silos of data still prevail.

Solution

Eliminating silos is disruptive and often impractical, and the above noted "unifying efforts" produce yet another silo to manage and maintain, what is left? The solution is to establish an "environment bonding" platform. Leave applications as-is, connect and/or bind the various applications together, and orchestrate the exchange of data and files.

Nexus is an environment bonding solution and is comprised of:

- application ready connectors
- workflow architecture
- ready-to-use transaction templates
- support for cloud-based or on-premise operations
- synchronous and asynchronous operations
- monitoring and visibility tools

Application Ready Connectors

Preconfigured functionality required within each connected application and linked to Nexus are available for a growing list of applications, as highlighted in Appendix A. The functionality includes application embedded processes (i.e., workflow nodes that affect various release operations), data federation capabilities (application dependent), and process activation triggers.

Workflows

Nexus is based on a workflow-centric architecture used to orchestrate the exchange and transfer of parts, bills of materials, metadata, relationships, and associated documents, drawings, and renditions. The workflow process incorporates traditional workflow steps or "nodes." Each node can have its own "if-then-else" logic, programmatic processes, mappings, hooks to native application program interfaces (APIs), messaging, and other options.

"A workflow-centric architecture is used to orchestrate the exchange and transfer of parts, bills of materials, metadata, and artifacts."

Ready-to-use Transaction Templates

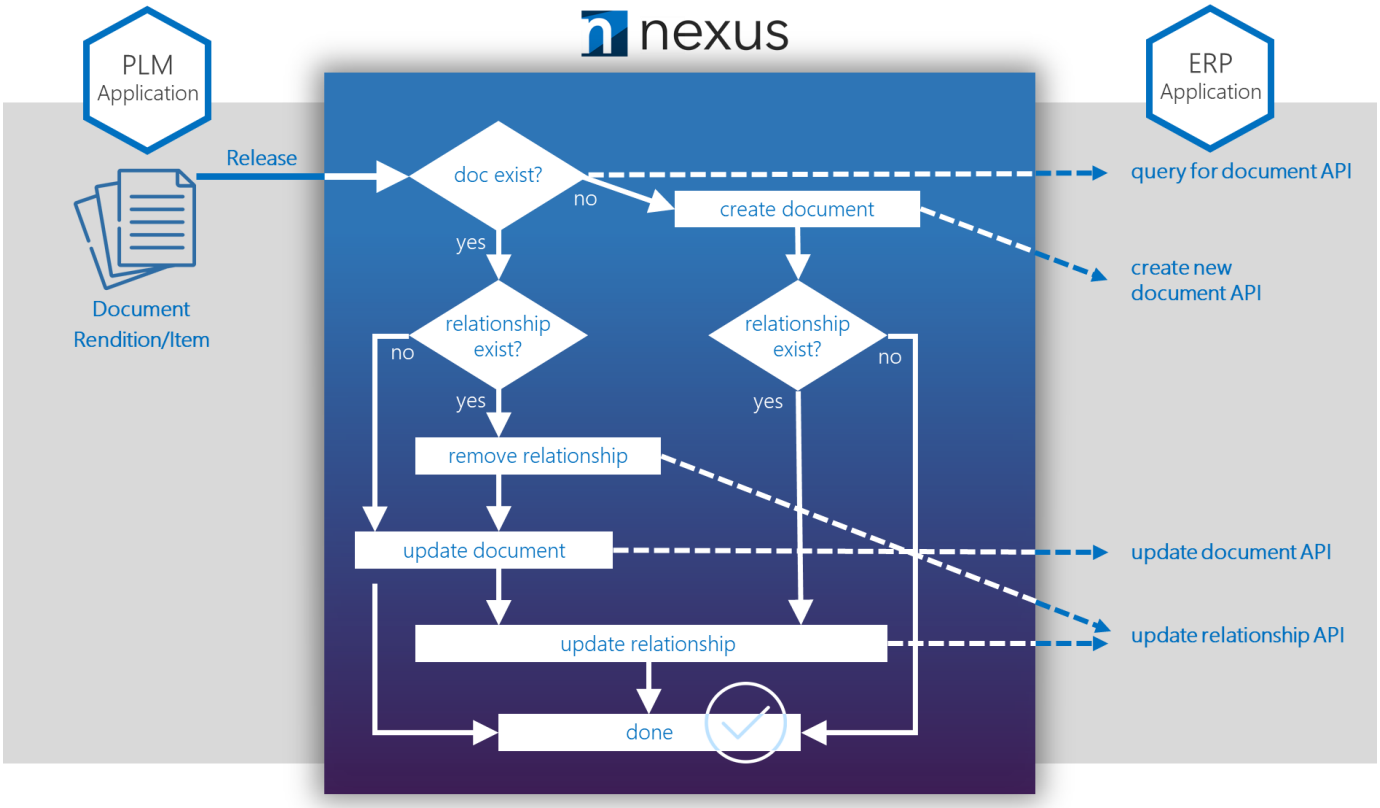
To accelerate time-to-value and minimize endpoint customizing, Nexus provides preconfigured transaction templates for common use cases. Templates serve as place holders to leverage the create, read, update, and delete (CRUD) operations required to support the exchange of data and files between various applications.

Nexus templates include:

- part/assembly releases
- document releases
- metadata federation
- change activation triggers

Transaction templates can be combined and customized or created from scratch. The diagram below illustrates the document/artifact release transaction process from a PLM application to an ERP application. Note that because the transaction template handles all document transfer logic, only four (4) APIs of the target applications are required in this example.

Figure 3. Document Artifacts Transaction Template



"Nexus can support applications operating on-premise and/or in the cloud."

Deploy on Cloud, On-Premise, or Hybrid

Nexus has been architected to recognize the reality of varying IT strategies and policies. Whether the applications to be connected, operate on-premise, or in the cloud, Nexus can be configured to operate securely in all possible configurations.

Given the trends for cloud-based hosting applications such as Salesforce for CRM, Microsoft Dynamics 365 Business Central for ERP, and Upchain for PLM, Nexus has been designed to likewise operate as a full "platform as a service" or PaaS. As a PaaS platform, Nexus supports multiple organizations and multiple users and requires no IT and infrastructure support. Since Nexus is fundamentally a data conduit, no customer data is ever saved within Nexus.

As an alternative to the PaaS approach, Nexus can also operate on-premise. Operating on-premise will require a minimum infrastructure. See Appendix B for details.

Synchronous and Asynchronous Operations

The very nature of product data is that BOM structures and associated files can be enormous. Hence, Nexus supports both asynchronous and synchronous data exchange capabilities. Ultimately the value of this data transmission feature enhances the user experience.

Synchronous exchanges are common when pushing or requesting metadata. The function might also support the concept of a federated link, whereby data is simply retrieved from one environment and presented in the requesting environment. The requested data is only for display and information/manipulation purposes and is not saved. This operation is real-time, dynamic, and synchronous. There are no workstation and/or client user interface delays.

Asynchronous exchanges recognize that some transactions require additional time to process. For example, Nexus currently supports an integration with Autodesk Revit. Revit project files can easily exceed 100 MB in file size. Processing these can take several minutes. Hence, an asynchronous process is activated within Nexus - the options of which can be defined in the workflows.

Monitoring and Visibility Tools

The sixth key feature of Nexus are provisions for operational monitoring and visibility. Functionality includes:

- application ready connectors
- workflow architecture
- ready-to-use transaction templates

Nexus records all transactions, including operations at each node in a workflow sequence. As a minimum, the transaction event log identifies the source and the target applications, the transaction's characteristics, and status. The actual data and/or files exchanged between applications are never saved in Nexus.

Nexus supports a range of error recovery processes, including authentication access, connectivity service disruption, and error flags experienced in the handshaking between the source and target application. Upon encountering an error condition, a retry process is activated.

"Leave data silos in place, allowing them to look and behave as one integrated solution."

Retry processes are configurable, including specifying the number of retry attempts, activating selected retry processes that can include custom routines, and messaging.

Messaging is available at any stage in the transaction and error recovery process. The messaging setup is configurable and can identify the activating event, the individual and/or service to be messaged, coupled with underlying error recovery options as previously noted.

Implementing Nexus

The primary implementation considerations for Nexus are as follows:

- infrastructure
- use cases
- API availability
- Minimum Viable Product (MVP) exercise
- implementation

Infrastructure

As indicated earlier, Nexus can operate in the cloud and on-premise. The Nexus cloud solution is a true PaaS solution. It is a multi-user, multi-tenant environment. Some organizations may wish to maintain their infrastructure on-premise.

Hybrid configurations can be supported, including a cloud application like Salesforce operating against an on-premise PLM solution. If the applications to be connected operate in the cloud, it is recommended that the PaaS instance of Nexus be used.

Use Cases

The second implementation consideration is to define the use cases for the integration. For example, use cases can be as simple as creating new and/or update parts and/or bills of material from PLM to ERP. Of course, many other use cases exist and depend on the applications to be connected. A sampling of these use cases are as follows:

- federating data back from ERP to PLM
- releasing a document from PLM to an EIM platform such as SharePoint or OpenText Content Suite
- push part purchase order information back to PLM from ERP
- activate an investigation request from EIM to PLM

API Availability

The previous exercise will help dictate the needed APIs required to facilitate the use cases. As previously discussed, each API is mapped to a task in the Nexus workflow. For example, in the part release process, one of the nodes in the workflow would check to see if a part exits in the target application. As such, Nexus would rely on a simple query API associated with the target application.

Interestingly enough, because of the workflow paradigm in Nexus, many of the transfer operations rely on just a handful of APIs. As noted earlier, Nexus leverages REST APIs. If this convention is not available for an application,

"Nexus is designed from the ground up to support enterprise engineering and manufacturing applications."

additional work may be required to establish a so-called "wrapper" to support REST API conventions. This may be the case for older legacy solutions.

Minimum Viable Product (MVP)

The growing trend in implementation methodologies have been to leverage Agile and Lean concepts. Conducting a minimum viable product (MVP) exercise is one of the cornerstones of their philosophies. MVPs are low risk and a quick mechanism to demonstrate the functionality and feasibility of any implementation effort. In the case of Nexus, the MVP approach is highly recommended.

The MVP approach can still follow the standard Agile method of incorporating sprints. For a Nexus integration, three sprints are typical.

- application ready connectors
- workflow architecture
- ready-to-use transaction templates

Of course, variations on the MVP can be established. However, ultimately, the intent is to confirm the needed infrastructure, availability and functionality of the necessary APIs, and understanding the scope of a full implementation. Rarely is the work done during an MVP discarded in the subsequent implementation.

In some cases, the application to be included in an integration may have been configured for use with Nexus. Appendix B provides a list of applications that have been completed and/or in process. If a "preconfigured" application is available, the sprint cycle may be shortened as needed.

Implementation

The last step in the process is the actual implementation work. Although Nexus has built-in workflow capabilities, there will be some configuration required within each application, depending on the function of the use cases desired. For example, if a part is to be released from PLM to ERP, the activating trigger within the PLM release workflow process will be required. Another example is the use of federation. For example, a use case provides a user within OpenText Content Suite visibility into the status of a change workflow within a connected PLM solution. However, not all applications support federation.

Typically, these programmatic embedded capabilities are geared to triggering events. As previously suggested, these would be completed at the various stages of the implementation sprint process.

In practice, integrations can be accomplished with 10 to 30 days of services conducted over one (1) to two (2) months, depending on the use cases.

Summary

A wide range of applications support the product lifecycle activities for engineering and manufacturing organizations. Some of these so-called “point solutions” fulfill specific needs such as a CAD design and simulations. Others are enterprise-oriented, supporting content management and various accounting disciplines, for example.

Studies have shown that silos of data hinder an organization’s ability to share effectively, collaborate, and support informed decision making. These, in turn, negatively impact delivery schedules, cost of quality, and ultimately profitability.

Companies and software vendors have sought to break down these barriers. Efforts such as unifying and aggregating data from multiple sources and leveraging EAI techniques have been used. Unifying approaches create yet another silo that incurs its own challenges for data synchronization and long-term maintenance and support. EAI is ideal for exchanging metadata but has been characterized by long implementation cycles, cost, and rigidity when used in engineering/manufacturing environments.

Nexus was designed to leave data silos in place, allowing them to look and behave as one integrated solution. Logic operations needed to transfer parts and related data are embedded in Nexus, thereby removing the risks and burden of customizing connected applications. Hence, silos are virtually unified, integration efforts are dramatically shorter, and the longer-term cost-of-ownership is kept to a minimum.

Nexus represents the latest in technology and architecture. It is a digital transformation enabling platform. More importantly, it is a “business solution” that helps engineering and manufacturing organizations meet delivery commitments, lower their cost of quality, and ultimately achieve profitability.

Appendix A - Nexus Application Connectors

Summary

Provided in the table below are the various applications for which a connector with Nexus is released, in process, planned, or requested.

Application	Class	Status	Comments
Autodesk Fusion Lifecycle	PLM	In Process	Scheduled for release in Q1 2021
Aras Innovator	PLM	Available	Released Q3 2020
Arena	PLM	In Process	Scheduled for release in Q1 2021
Autodesk Revit	CAD	Available	Released Q3 2020
Autodesk Vault	PLM	In Planning	
CADnection	Utility	In Process	Scheduled for release in Q1 2021
Dassault Enovia	PLM	In Process	Customer-specific and scheduled for Q1 2021
Microsoft ERP D365	ERP	Available	Released Q3 2020
Microsoft Excel	Productivity	Planned	Initial user stories are being developed
Microsoft SharePoint	EIM	Planned	Initial user stories are being developed
Open Text Content Suite	EIM	In Process	Scheduled for release in Q1 2021
OnBase	EIM	Requested	
Oracle EBS	ERP	Requested	
Oracle JD Edwards	ERP	Requested	
Oracle NetSuite	ERP	In Process	Scheduled for release in Q1 2021
Plex	ERP	Requested	
PTC Windchill	PLM	Requested	
QAD	ERP	Planned	
SAP PLM	PLM	Requested	
Siemens Teamcenter	PLM	Requested	
Sinequa	SBA	Planned	Search-Based Application (SBA)
Upchain	PLM	Available	Released Q4 2020

Appendix B - Nexus On Premise Infrastructure Requirements

Hardware

- Windows Web Server
- Quad Core processor or better
- 8Gb of RAM minimum

Software

- Windows Server 2012 R2 or later
- SQL Server 2014 or later recommended, but SQL Server Express can also be used

Appendix C - Application and Use Cases

Introduction

As an environment bonding solution designed to support the unique needs of engineering and manufacturing environments, Nexus is ideally suited to the following applications integrations.

- PLM and ERP
- PLM and EIM
- Search-Based Applications

No doubt there are other applications such as product data management (PDM), yet it is typically viewed as a subset of PLM. Post ERP functionality to consider includes MES and even maintenance repair and operations (MRO). The three (3) primary application integrations are described below.

PLM and ERP

PLM is the platform of choice to design, engineer, and release parts and BOMs. PLM is workflow and process-oriented. A primary recipient of PLM data is ERP. ERP is a transactional environment that supports the purchasing, manufacturing, and delivering the items forecasted and/or ordered. To support this functionality, having an accurate and up-to-date part and BOM structure is of paramount importance.

The three most common use cases for a PLM/ERP integration are:

- release parts and/or BOMs to ERP
- federate part information such as inventory level and pricing back to PLM
- pushing purchasing information to PLM to support supplier/vendor activities

As previously discussed, Nexus is powered by a workflow process that ensures accurate part and BOM data is transferred and updated. With Nexus, data is updated immediately upon release and eliminates the need to conduct manual steps prone to time delays and transcription errors.

The second most common use case is the federation of data from ERP to PLM. The term federation in this discussion implies that data is dynamically retrieved, displayed, and/or processed. The data retrieved is not saved nor stored in the target application. In this use case, data federation from ERP is used for informational purposes in PLM.

For example, ERP maintains the part and/or item master information. Attached to the item master are purchasing data, inventory levels, production manufacturing dates, etc. This data is ideally suited for users of PLM and via federation services would eliminate the need to log in to yet another system to search and retrieve the data. Also, since the data is dynamically retrieved, the user will only see the latest and most current values.

The third use case considers the idea of pushing data unique to ERP back to PLM. This may include

purchasing data to support the following sub-use cases.

- understanding impact of a change on inventory and open purchase orders
- supporting supplier/vendor portal activities

Establishing a supplier/vendor portal in PLM is an emerging trend, for a good reason, since design and engineering work often requires supplier/vendor collaboration. This process occurs before the release of parts and even after release. It opens a level of access for suppliers/vendors to view the latest version of documents and/or drawings, along with the ability to participate in the change process. Ultimately, it is a catalyst for additional process efficiencies.

Establishing a supplier/vendor portal in PLM is an emerging trend, for a good reason, since design and engineering work often requires supplier/vendor collaboration. This process occurs before the release of parts and even after release. It opens a level of access for suppliers/vendors to view the latest version of documents and/or drawings, along with the ability to participate in the change process. Ultimately, it is a catalyst for additional process efficiencies.

Just before a purchase order is issued, ERP would retrieve portal access information from PLM. In the purchase order, this access information would be reflected. The supplier would then access the portal for released drawings and specifications and be assured the latest versions of information are being retrieved.

PLM and ERP

The discipline of managing enterprise content has come a long way. Early on, standalone systems would merely assign and link attributes to files. Those files would reside in file folders or be ingested. Today, these solutions are mature and are represented in products like Microsoft SharePoint and OpenText Content Suite. The Gartner Group labels this space as Enterprise Information Management (EIM).

EIM has evolved in its ability to manage multiple types of content. Rather than focusing on a select discipline the way Documentum did a couple of decades ago with the pharmaceutical industry, or Adept does today with engineering content, EIM platforms embrace content from across the enterprise. Moreover, these platforms are moving into the cloud. Given the pandemic of 2020, cloud access makes even more sense for companies.

EIM solutions are typically a repository for “released” content. This suggests that the creation, work-in-process, and release activities are executed in other platforms such as PLM or even technical documentation. For example, OpenText has recently initiated an effort to embrace “all things product” data and documents. OpenText Content Suite is already being used for other parts of the business. Since users are already accustomed to accessing content from within Content Suite, the natural progression is to extend it to product data, documents, and drawings.

As a part of this initiative, OpenText is viewing PLM as the work-in-process environment for product

development and manufacturing activities. However, rather than requiring users to sift through a PLM platform to find data, OpenText is establishing integrations with various PLM and even PDM solutions.

The three primary use cases for an integration between PLM and EIM are as follows:

- push all release content and artifacts from PLM to EIM
- federate content from PLM (and even other sources such as ERP) back to EIM
- initiate change from EIM that then triggers an engineering change process in PLM - which results in the first use case

The first use case is concerned with documents and not the traditional release of parts and assemblies we find with an ERP integration. In this case, the different stages of the product life cycle release artifacts such as quoting data, project management data, bill structures, manufacturing process plans, quality, acceptance criteria and certification, etc. The documents could be PDF files or rendered drawings being generated by various CAD users. As a result, users needing to find product data would simply go to the EIM platform as they currently do for other content types.

If EIM is now viewed as the repository for "all things product" data and documents, then why not bind data from other sources to support a "360 view" of the product data? For example, when a user reviews an acceptance criterion for products shipped by a vendor, additional related data is displayed. This information may reflect purchasing data, vendor details, and other supporting content being dynamically retrieved from various product data solutions. In this scenario, the use of federated data is an integral element to the integration use case.

The last use case builds on the theme that if EIM is the repository of all-things-product, why not give users the ability to initiate feedback concerning a product? For example, it might be an investigation request, problem report, or change request. Regardless, it is initiated from EIM, and depending on its workflow stages, it may be used to trigger a change request or change order process in PLM. In doing so, and upon release, an updated version of the released content is then pushed back into EIM repeating use case one.

Search-Based Applications

The inclusion of search engines or search-based applications (SBA) in this section emphasizes engineering/manufacturing environments.

According to the Gartner's Magic Quadrant report of 2019, Coveo, Lucidworks, Mindbreeze, Micro Focus, and Sinequa are rated as the top performers for a class of SBAs referred to as Insights Engines. According to Gartner, they combine search with AI to deliver actionable insights derived from the full spectrum of content and data sourced within and external to the enterprise. Additionally, the two-leading open-source players, Elasticsearch and Solr, continue to dominate use across various applications such as website search, ecommerce apps, and custom apps.

Appendix C - Application and Use Cases (continued)

SBAs are simply another way to store data. Traditional SQL tables are the platform of choice for PLM, ERP, and EIM solutions. The same data can be found in search engines but structured to optimize retrieval and analysis.

All these solutions operate by capturing existing data found in a wide array of file formats, web pages, and applications such as CRM, call centers, help desks, and other enterprise solutions. However, there is a growing trend to extend SBAs to engineering and manufacturing-oriented environments. Sinequa, for example, has an industry focus on manufacturers and now provides users with the ability to search and retrieve CAD model data based on its content.

CAD model data reflects intellectual property, design intent, spatial relationships, purchasing considerations, quality and inspection criteria, manufacturing processes, change history, and much more. Most anything that is manufactured and/or built today is described with CAD models. But this data is only part of a more significant collection of information. Product data also resides in ERP, EIM, and files, folders, spreadsheets, and more.

Given this wealth of data distributed about various repositories, Nexus can serve as a "collection" service whereby related data is retrieved, manipulated, and ingested by an SBA, offering an opportunity to establish a "360 view" of product information.

About vdR Group

Over the last three decades, The vdR Group has emerged as a leading engineering, manufacturing, and AEC solutions provider with a focus on driving digital transformation through product lifecycle management (PLM), enterprise application integration and search based application technologies. We do this with a consultative and solutions-based approach that includes strategic consulting, end-to-end implementations and application integrations. The vdR has helped 100s of companies ranging from Global Fortune 500 manufactures to cutting-edge start-ups. Today, over 220,000 users leverage vdR's solutions.

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