

Open product lifecycle data sharing using XML

SIEMENS

White Paper

The manufacturing industry is demanding unprecedented levels of interoperability between product lifecycle management (PLM) application software in order to accelerate the execution of critical business process threads to achieve significant cost savings and an important time to market advantage.

PLM XML is a protocol created by Siemens PLM Software to boost PLM interoperability by defining a set of XML schemas and associated services that facilitate open, high-content product lifecycle data sharing.

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Executive summary

Efforts to achieve interoperability among software applications used in product conception, development, engineering, manufacturing and maintenance cost the global manufacturing industry billions of dollars annually. In order to achieve significant cost savings and an important time to market advantage, the global market is now demanding unprecedented levels of interoperability among PLM software applications to help accelerate the execution of product development process threads. Initiatives to improve interoperability in heterogeneous application environments are therefore vitally important.

PLM XML is a format created by Siemens PLM Software for facilitating product lifecycle interoperability using XML. It is open, published and is

compliant with the World Wide Web Consortium (W3C) XML schema recommendation.

Representing a variety of product data both explicitly and via references, PLM XML provides a lightweight, flexible mechanism for transporting high-content product data over the internet. PLM XML schemas are the basis of a rich interoperability pipeline connecting Siemens PLM Software products and third party adopter applications. PLM XML is complementary to existing and emerging XML-based standards; it supports work flows requiring application integration, interoperability and data sharing by improving collaboration efficiency throughout the product lifecycle.

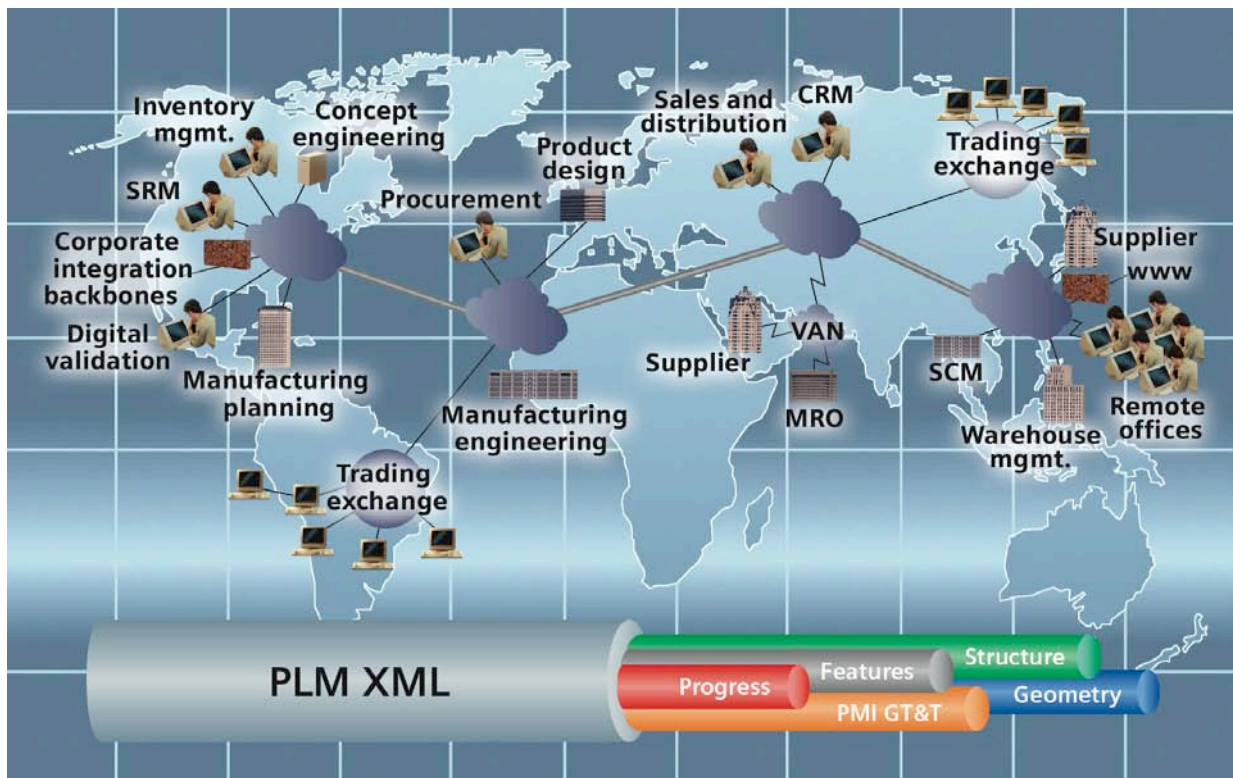


Figure 1: The PLM XML vision – high-content data flow between application domains.

Defining PLM XML

PLM XML is defined by a set of XML schemas that are compliant with the W3C XML schema recommendation. It is a transport protocol for exchanging product lifecycle data. PLM XML is designed to support interoperability in a collaborative environment by representing a payload of rich product lifecycle data in XML form. The schema definitions include structures that allow access to top-level metadata as well as detailed model data. An example PLM XML document fragment is shown in Figure 2.

By taking advantage of the web-friendly nature of XML and by concentrating the top-level data in a format that can be emailed or downloaded depending on security settings and requirements, PLM XML enables collaborating teams to work in ways that adapt to real-world situations, whether it means addressing firewall issues, accessing central web servers or working across an intranet.

```
<?xml version="1.0" standalone="no"?>
<PLMXML xmlns="http://www.plmxml.org/Schemas/PLMXMLSchema" schema
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance"
time="14:49:12" language="en" date="2001-12-19">
  <ProductDef id="id1" name="assembly" revision="1">
    <InstanceGraph id="id2" rootInstanceRef="id3">
      <Description>
        Product hierarchy for sample car, distributed over two fil
      </Description>
      <Instance id="id3" partRef="#id4"/>
      <Instance id="id6" partRef="#id7"/>
      <Instance id="id10" partRef="car_axle_assembly.plmxml#id11"/>
      <Instance id="id24" partRef="car_axle_assembly.plmxml#id11"/>
      <Part id="id4" type="assembly" instanceRefs="id6 id10 id24"/>
      </Part>
      <Part id="id7" type="solid" representationRefs="id9">
      </Part>
      <Transform id="id23">1 0 0 0 0 1 0 0 0 0 1 0 0 1 0 1</Trans
      <Transform id="id25">1 0 0 0 0 1 0 0 0 0 1 0 0 -1 0 1</Tran
      </InstanceGraph>
      <Representation id="id9" name="car_id7" format="XT" revision=
      <Description>
        Chassis of Car assembly
      </Description>
      </Representation>
    </ProductView id="id26" primaryOccurrenceRef="id27"/>
  </ProductDef>
</PLMXML>
```

Figure 2: A PLM XML document fragment.

PLM XML schemas

PLM XML schemas define a generalized data model in a framework focused on product lifecycle data. This framework consists of various elements as illustrated in Figure 3. This section provides information on the type of data supported in PLM XML schemas.

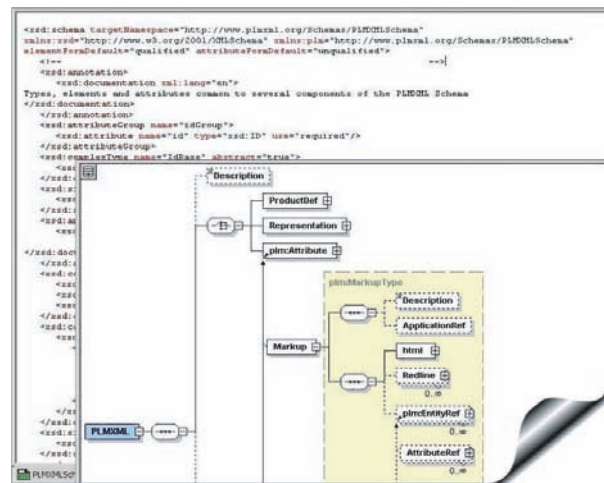


Figure 3: A PLM XML schema fragment and tree hierarchy.

Product structure

PLM XML supports both configured product structure, as required for computer-aided design (CAD) and visualization applications and bill of material (BOM) exchange, and unconfigured product structure, as required for the exchange of more complex data by product data management (PDM) systems.

Configured product structure is represented as an instance graph, together with occurrence trees known as “product views.” The instance graph models the basic assembly structure, while the product view allows particular display configurations or sub-groupings to be specified, or default properties (like color) to be modified on particular occurrences.

Unconfigured product structure introduces the concepts of options and variants, as well as revisions and effectivity. Variants can be defined and options selected or deselected by means of a simple Boolean expression; all major constructs can be revised, allowing the product history to be tracked.

Metadata

PLM XML provides the means to associate a variety of PLM metadata with the product structure. The general design element (GDE), is the basis from which other metadata can be derived. The GDE element represents an internal constituent of a structure object, such as a design feature, port and annotation. Among the defined metadata, dimensions and tolerances can be attached to the model, as well as notes, balloons, welds and fasteners.

Geometric representation data

Generic elements are provided to support a full range of geometric information including points, curves, composite curves, surfaces and coordinate systems. PLM XML also can represent construction geometry. Construction geometry can include the point representing the center of gravity of a part, or a set of sample points that can be used to check the fidelity of a model after it has been imported into a different system. Geometric representation data can be stored in multiple files and referenced through pointers, enabling reduced file sizes for collaborative activities. Representation data is not required to be stored using PLM XML geometric elements.

Data ownership

PLM XML facilitates access control, tracking data ownership on the basis of an individual person, role or organization.

Visualization properties

PLM XML supports visualization properties that can be exchanged in the form of view controls (view directions, view ports, view characteristics) and display controls (backgrounds and other attributes).

Features

PLM XML feature description contains basic information including attributes for feature hierarchy and status. Additionally, elements such as type and parameters, as well as information to link the feature to the originating application or multiple representations, are provided (see references above). Parameter descriptions can also be included in the feature description. PLM XML feature support is suitable for visualization and feature browser applications.

A data type that describes feature trees is provided to support feature based modeling systems.

Application associativity

A PLM XML document created by a sending application need not explicitly represent all the data to be communicated. PLM XML defines elements to enable associativity back to the sending application. These elements can be contained in any elements that refer to an originating entity not represented directly in a PLM XML document. Data for name, location via uniform resource identifiers (URI) and related attributes are available.

Delta

In order to support a more dynamic exchange of data, PLM XML provides a delta schema, which enables applications to define a difference between two product structures. Deltas provide a mechanism to manage change in BOM interoperability scenarios.

Extensibility

One of the key advantages of an XML schema-based format is its inherent extensibility. The PLM XML schema allows extensions to derive new elements from existing ones. These can be included, explicitly or by reference in document headers. This facilitates ad-hoc data sharing, so that the receiving application can interpret the newly defined elements.

PLM XML currently supports schema extensions for maintenance repair overhaul (MRO) and mechatronics (routing). A brief list of elements includes facilities, inventory and product status for MRO and cable type, length and harness properties or routing.

PLM XML characteristics

PLM XML has three important characteristics that are beneficial to adopters and make it suitable for collaborative interoperability applications. Specifically it is open, lightweight and extensible.

Open

PLM XML schemas are published at www.plmxml.com. They can be freely downloaded and used as the basis for collaborative applications that are interoperable with Siemens PLM Software products or with other PLM XML enabled applications. Developed and maintained by Siemens PLM Software, PLM XML schemas will extend to encompass additional product information, including extensions proposed by the adopter community.

Lightweight

PLM XML is by design an efficient, effective and lightweight embodiment of structured product data geared towards moving essential information between PLM processes. Using built-in URI and PLM XML pointer mechanisms diverse CAD representations, PLM XML documents and general data streams can be related to the product structure and referenced.

Applications that consume PLM XML can selectively access portions of the additional data, depending on need, network capacity and other scenario constraints.

The ability for any element at an extremity of the product structure hierarchy (i.e. "leaf node") to point to several representations enables the consuming application to choose which ones are appropriate. For example, the users of a CAD authoring system and of a browser-based visualization system can view respectively the detailed Parasolid® data or "XT" file and the lightweight facet file representing the same component of an assembly, and collaborate on that basis. This flexibility also makes it possible to view the lightweight representations of components before deciding to download the more complete representation if it is available.

Extensible

The extensible nature of PLM XML allows additional data to be transported simply by building on the published schemas. This flexibility enables adopters to describe in extended schemas data that may be highly specialized or commercially sensitive. In this way it becomes possible to transport as much of a data model as is required without breaking away from the core of PLM XML. Additional or extended schemas can be shared between groups participating in a particular collaborative scenario, and where appropriate considered for inclusion in the published PLM XML schema set.

PLM XML in action – pipeline, toolkits and services

PLM XML pipeline

The primary benefit of adopting PLM XML is the ability to share high content product data with a community of adopters and enabled applications, including both Siemens PLM Software adopters and other external adopters, via the PLM XML pipeline. The PLM XML pipeline can be extended as more areas of the product lifecycle are reached and more data sources come online. This growth is fueled as the PLM enterprise is able to flexibly share information

authored in any area, and as PLM application suppliers create programs whose interoperability is built in using PLM XML.

There are several software services mechanisms that together bring the PLM XML specification to life and enable the PLM XML data pipeline to be populated and exploited, as shown in Figure 4. These include a read/write capability provided in toolkit form, which enables adapters to access referenced data and representation handlers to consume referenced data.

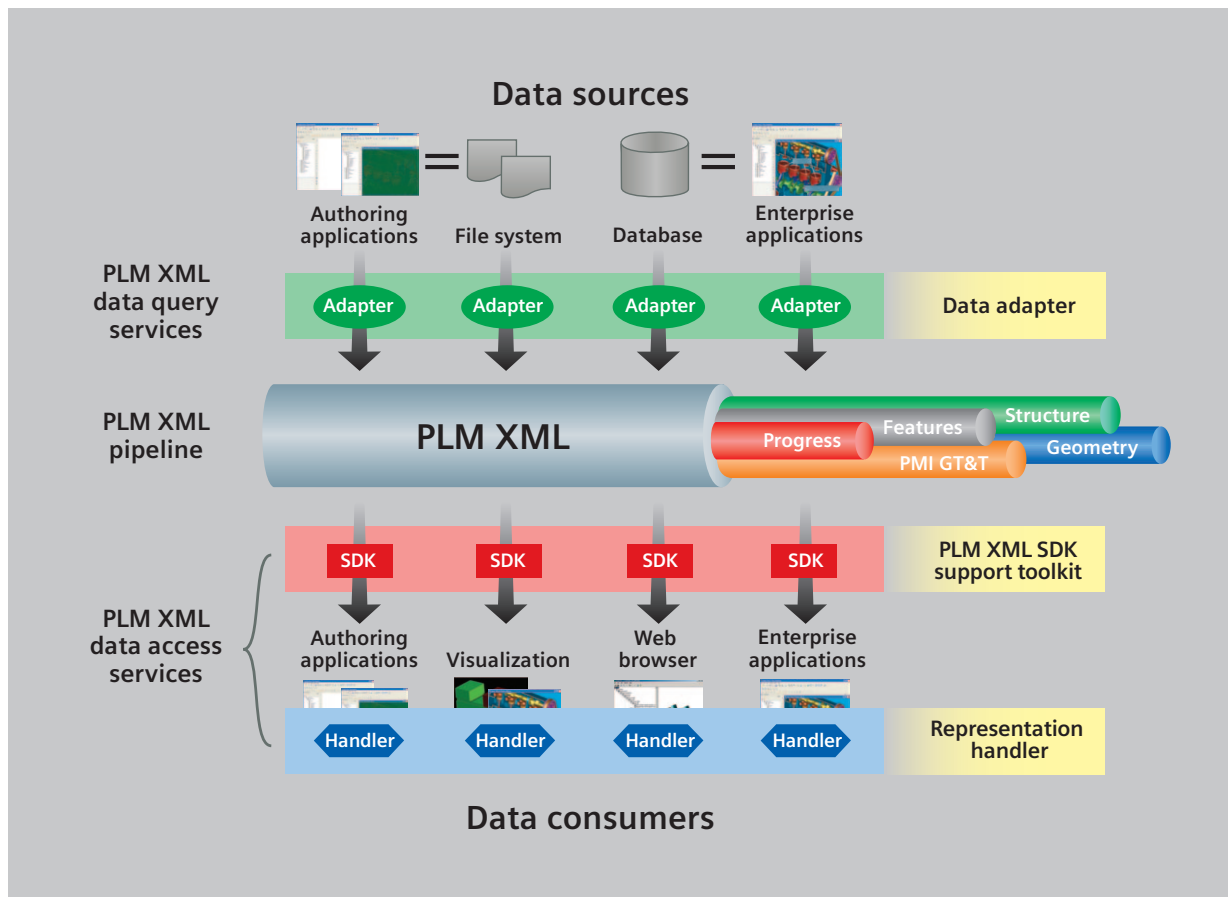


Figure 4 : PLM XML services populate and exploit the PLM XML pipeline.

PLM XML toolkits

PLM XML support can be built into an application by enabling read, write and interrogation of PLM XML documents and data structures. This can be done directly from the PLM XML schema definitions and documentation. Taking a toolkit approach to implementation can make the integration of PLM XML support modular and the maintenance and extension of PLM XML support easier.

Siemens PLM Software provides a software developer kit (PLM XML SDK) to enable application developers to build PLM XML support into their software products (see www.plmxml.com for details). The toolkit is able to author and consume any PLM XML documents that conform to the published schema definitions. The SDK is also object oriented and extensible, enabling an application to build in support for extensions; it includes a data adapter interface that provides a framework for resolving external references. The kit also provides example code and an example “Jumpstart” application that embodies the above capability (see a screenshot from the Jumpstart application in Figure 5).

The principal benefits of adopting the PLM XML SDK as the enabling software are (a) reduced time to bring PLM XML-enabled applications to market, and (b) ongoing compatibility with the published PLM XML schemas.

Data adapters

The data adapter is a run-time plug-in that enables an application to access externally referenced representations. It is required when an external reference from PLM XML resolves to a location within a part file or other proprietary location. The main functions of the data adapter are to eliminate the need for authoring applications to be present and to abstract the particular file format of the representation.

Representation handlers

As described above, PLM XML can reference a model representation using either URI or PLM XML pointer syntax. It can be retrieved via a data adapter to provide a stream of representation data to the receiving application. To consume this data in native form, the receiving application requires a representation handler, a piece of software that can directly interpret the stream of representation data. Representation handlers can be implicit in the receiving environment or accessed via web services, and can be full applications, embedded toolkits such as Parasolid, or simple plug-ins.

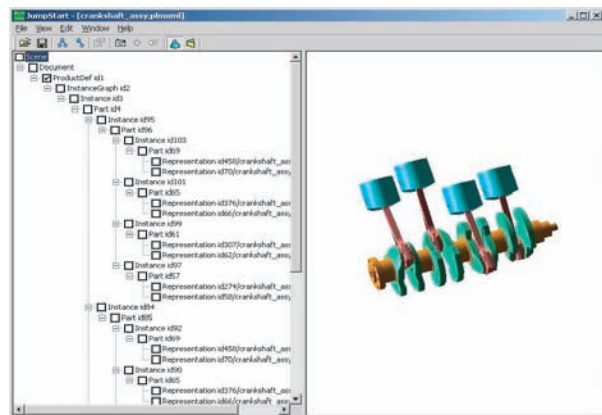


Figure 5: PLM XML Jumpstart application showing a crankshaft example.

PLM XML in the enterprise

As a flexible payload definition designed to support PLM interoperability scenarios, PLM XML has many potential applications. The following sections describe generic examples of where PLM XML can be deployed within the distributed enterprise.

PLM XML for interoperability

In certain application interoperability scenarios, for example part file or assembly data exchange, PLM XML can provide a vehicle for sharing product information, allowing common access to structure, attribute data and referenced representations.

Figure 6 shows PLM XML being used as a directly supported format for sending and receiving applications and as a tool for abstracting the native part file format to extract the essential product data via an adapter.

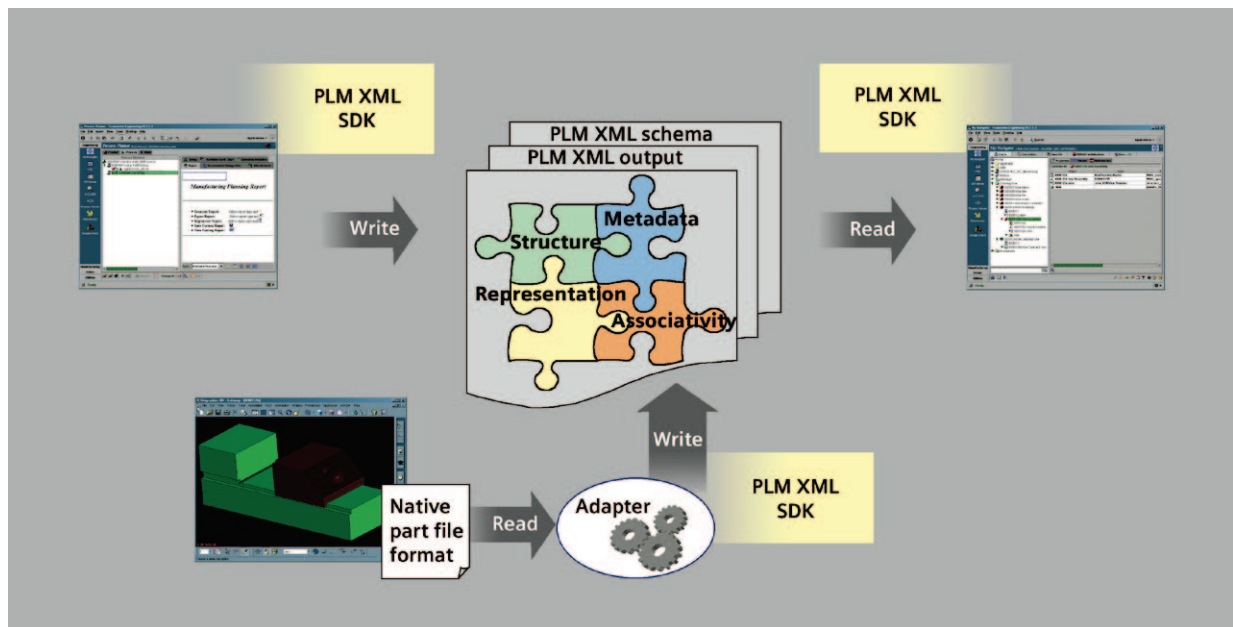


Figure 6: PLM XML facilitating interoperability between applications.

PLM XML for collaboration

PLM XML can be used to deliver a packet of information to a diverse collection of consumers for collaborative review. The receiving applications can identify and consume the data most appropriate to their application capabilities.

PLM XML allows receiving applications to selectively consume the contents of the PLM XML file, enabling the same payload to be used for collaboration with a variety of participants as illustrated in Figure 7.

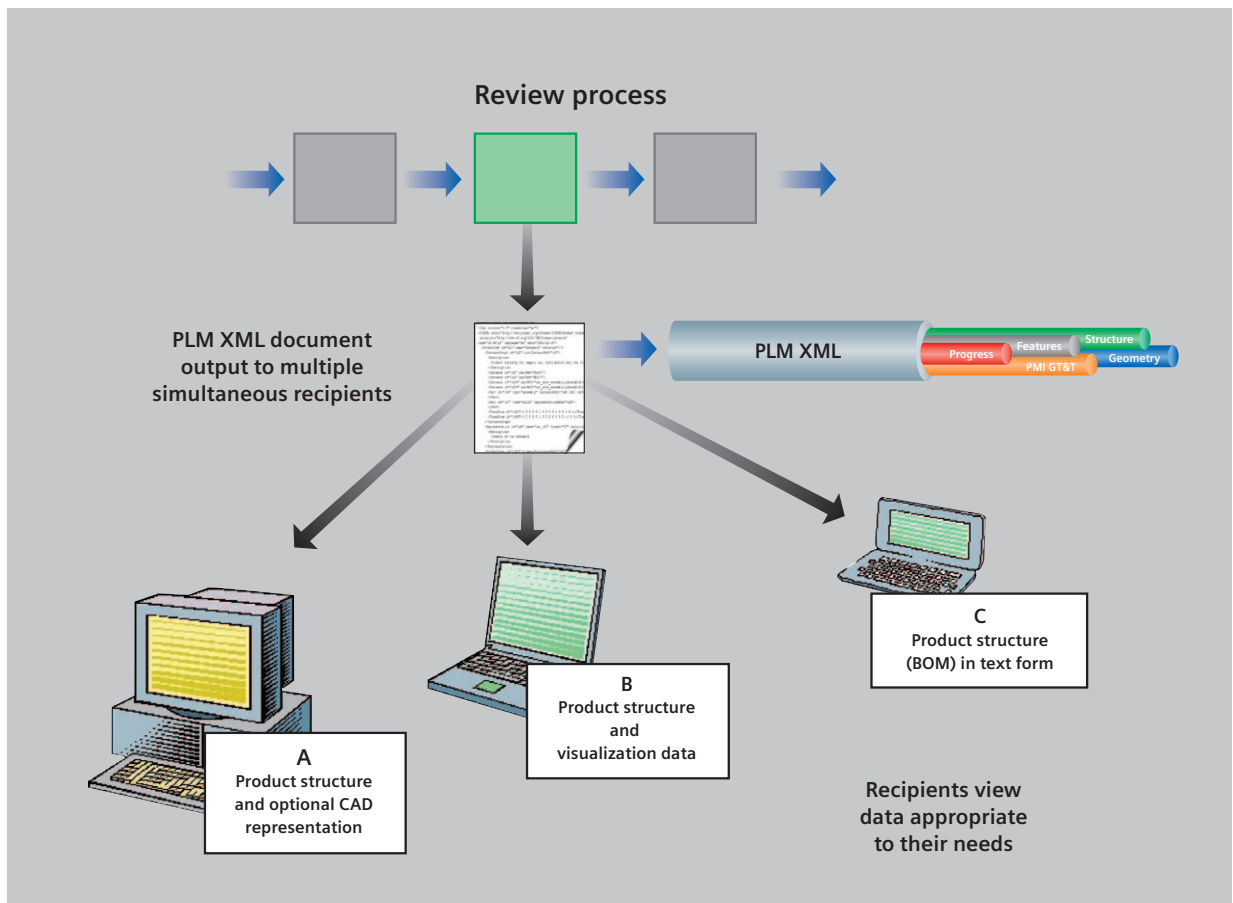


Figure 7: Flexible PLM XML payload provides appropriate levels of detail.

PLM XML for integration

PLM XML can embody the data payload in more formalized enterprise application integration scenarios, where there is a need to compose data payloads from multiple data sources and communicate to multiple recipients within a given transaction context. By using PLM XML, the payload can be high-level (for example, product structure as opposed to single objects) and can be received and processed in a variety of application environments to maintain consistency across an extended enterprise as displayed in Figure 8.

In this way, the PLM XML payload protocol can be used in formalized transactions between tightly integrated systems and at the same time be distributed to more loosely-coupled systems that need to be connected.

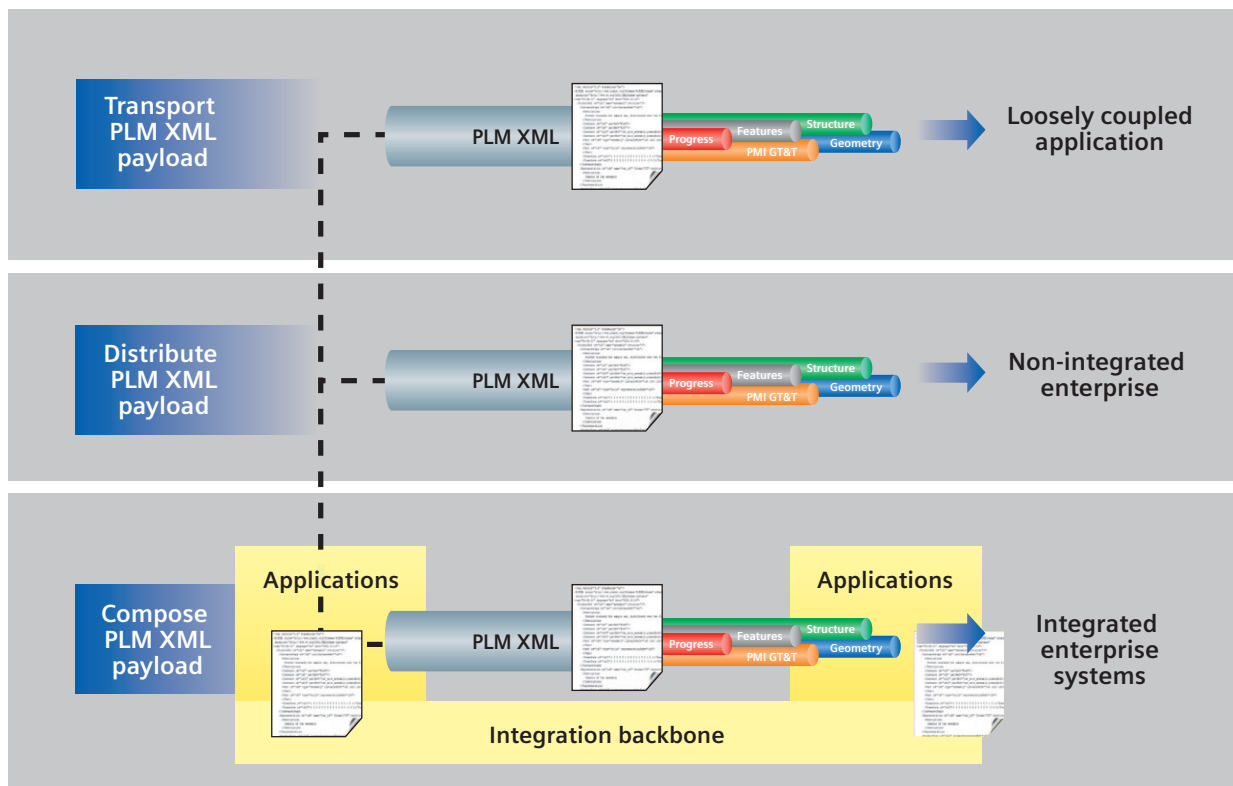


Figure 8: PLM XML in support of enterprise application integration.

PLM XML and standards

XML-based standards for data interoperability and exchange are becoming widespread and increasingly important in the PLM arena. These standards span a broad set of requirements across the supply chain and collaboration domains, and include initiatives that focus either on data content or payload, such as STEP(ml), or on the wider definition of frameworks for collaborative trading and e-business, such as RosettaNet and ebXML. Alongside these standards are efforts such as those of the Open Applications Group (OAG) to define general XML-based exchange protocols, combined with subsidiary developments to furnish content and context for particular vertical industries.

There is, however, no single definition for the complete PLM environment, and applications need to communicate before standards are solidified and fully available. PLM XML is targeted at providing a “working” solution and will leverage appropriate standards to complete the definition in given interoperability scenarios. In this respect, PLM XML aims to complement existing and emerging standards by providing appropriate consistency and compatibility, while at the same time providing added value in the particular context of product lifecycle data sharing.

The PLM data model is also constantly evolving, and there is a need to bring applications online quickly.

PLM XML allows new application data to be distributed and shared by providing an extensible mechanism that facilitates connectivity and associativity between disparate data models.

In general, the role of PLM XML can be summarized as follows:

- PLM XML is a collaboration/interoperability protocol designed to exchange pertinent PLM information between a range of data sources (PLM systems, data stores and part files) and a diverse set of applications (visualization/mockup, CAD, manufacturing, PDM and so on) in support of collaborative PLM scenarios.
- The data exchanged is not intended to represent the entire persistent data model of applications found within the PLM process – rather the data exchanged will often be a partial or canonical representation and will include/integrate/re-use other representations where appropriate.
- PLM XML enables Siemens PLM Software to respond to continuously evolving PLM processes and data models by quickly integrating new applications and data content into the collaborative PLM process.

Conclusion

PLM XML is an interoperability protocol – developed, promoted and supported by Siemens PLM Software – that defines XML schemas compliant with the World Wide Web Consortium (W3C) XML schema recommendation and associated services to facilitate high-content product lifecycle data sharing using XML. Siemens PLM Software is already demonstrating its ability to develop, promote and support highly successful open data formats within other sectors of the PLM industry. For example, Parasolid (which creates files in the “XT” data format) has become the most popular geometric kernel modeling software in the global CAD/CAM/CAE market due to its open “level playing field” business model. In addition, the JT™ data format for visualization and collaboration is proliferating rapidly in the global manufacturing and software vendor community through the efforts of an innovative global initiative called JT Open. More information about Parasolid and JT Open can be found at www.siemens.com/plmcomponents.

To enable broader, flexible interoperability across key PLM applications, PLM XML is designed to bring together product structure, part representations and metadata in a lightweight, web-friendly standard format, suitable for transferring high-content product data across the internet. Siemens PLM Software will develop, promote and support PLM XML using the same open principles that underpin the success of Parasolid and JT Open.

The functional objectives of PLM XML are to:

- Orchestrate product structure, geometric representation data and additional product metadata in an open, lightweight and extensible form
- Proliferate relevant information through the product lifecycle by offering a standardized protocol for data interoperability
- Integrate collaborative product lifecycle processes by providing a homogenous flow of data within a heterogeneous application environment

Siemens PLM Software is committed to the following set of guiding principles related to PLM XML.

- Siemens PLM Software will promote an open environment.

- The W3C XML compliant schemas will provide a basis for open content.
- PLM XML schemas will be published on the Internet at www.plmxml.com.
- By definition, PLM XML schemas are complementary to existing formats. Their evolution will take into account emerging formats and standards.
- Siemens PLM Software will provide implementation support.
- PLM XML Software Developer Kit (SDK) will be maintained to assist developers who implement PLM XML for read/write and data manipulation.
- Existing adapters and representation handlers will be maintained and developed to retrieve and consume referenced data.
- PLM XML will facilitate adoption by key applications throughout the product lifecycle.
- PLM XML will enable a rich pipeline of product data between PLM applications.
- The pipeline will address the needs of real-world collaborative scenarios.
- Adopters will operate effectively in a heterogeneous application environment.

To learn more about PLM XML, visit the PLM XML website www.plmxml.com.

About Siemens PLM Software

Siemens PLM Software, a business unit of the Siemens Industry Automation Division, is a leading global provider of product lifecycle management (PLM) software and services with 6.7 million licensed seats and more than 69,500 customers worldwide. Headquartered in Plano, Texas, Siemens PLM Software works collaboratively with companies to deliver open solutions that help them turn more ideas into successful products. For more information on Siemens PLM Software products and services, visit www.siemens.com/plm.

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