Information Technology
for Engineering & Manufacturing

XML for Manufacturing Systems Integration

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Overview of presentation

- Introductory material on XML
- NIST's participation in XML activities
- XML and manufacturing systems integration
- Discussion of selected XML/MSI activities at NIST
- Plans for the future

What is XML?

- E**X**tensible **M**arkup **L**anguage
- Standard being developed under the auspices of the World Wide Web Consortium (W3C)
- A format for structured data interchange over the Internet
- XML documents are tagged ASCII text; vendor and platform-neutral

Most Internet browser vendors will support XML; some already do

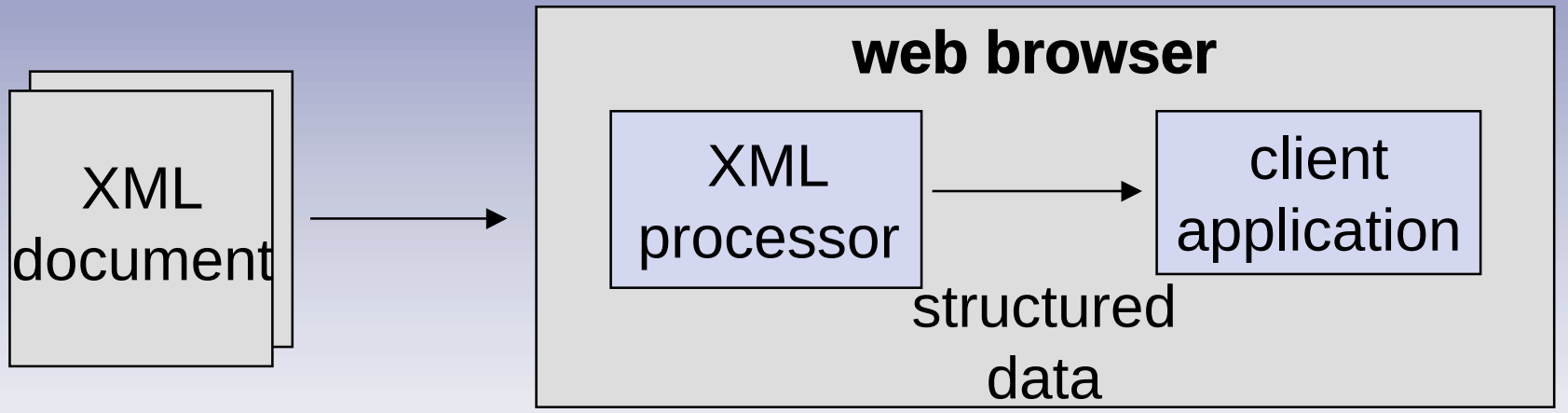
Why is XML important?

- Supports data exchange between heterogeneous systems
  - Data sharing between manufacturing applications and common business software tools
- Facilitates electronic commerce
  - Reduces start up costs
  - Enables interoperability between different transaction processing systems
- Enables seamless integration between Internet and desktop

Who is using XML?

- Answer: just about everybody
- Numerous XML initiatives are underway in manufacturing, financial services, publishing, health care, aerospace, automotive, government, and many other industrial sectors
- For listings of current applications, see the following:
  - http://www.oasis-open.org/cover/gen-apps.html
  - http://www.oasis-open.org/cover/gov-apps.html

An XML application scenario



XML versus HTML

- XML is extensible (content providers can develop their own tag sets); HTML is not
- XML documents must be either valid with respect to a **document type definition**, or they must be **well-formed**; HTML documents may contain tagging errors
- XML is designed for representing structure; HTML is designed mainly for presentation
- XML documents are intended to be interpreted by applications (style sheets needed if human readability required); HTML documents are intended to be read by humans

Side-by-side comparison

XML

```
<?xml version="1.0"?>
<!DOCTYPE order SYSTEM
    "order.dtd">
<order>
    <customer id="234666">Smith,
John</customer>
    <item id="417" price="19.50"
quantity="3">deluxe widget</item>
    <item id="892" price="100.00"
quantity="1">custom
    doohickey</item>
</order>
```

HTML

```
<html>
    <head>
        <title>order</title>
    </head>
    <body>
Name: Smith, John<br>
ID: 234666<br>
Items:<br><ul>
        <li>ID: 417, Price: 19.50,
Quantity: 3, deluxe widget</li>
        <li>ID: 892, Price: 100.00,
Quantity: 1, custom doohickey</li>
        </ul>
    </body>
</html>
```

To learn more about XML

- World Wide Web Consortium's XML home page
  - http://www.w3.org/XML/
- XML Cover Pages
  - http://www.oasis-open.org/cover/
- Another good place to look
  - http://www.xml.com (contains annotated version of standard plus numerous articles)

XML at NIST

- Emphasis is on activities in line with NIST's traditional measurement and standards role as well as some projects with potential for big economic payoff
  - Conformance testing
  - Standards development
  - Interfaces to standard reference databases
  - Business-to-business e-commerce
- Also, several information-based manufacturing engineering projects are using XML as a data exchange syntax

Some current and recent NIST projects

- Conformance testing
  - Test suites for W3C standards
- Standards development
  - XML schema repositories
    - using the Organization for the Advancement of Structured Information Standards (OASIS) spec
  - XML repositories for product data standards
  - Mapping/transformation of legacy standards into XML
- Standard reference database interfaces
  - MatML (XML vocabulary for materials data)
- B2B e-commerce
  - Member of RosettaNet consortium
  - Internet Commerce for Manufacturing
  - CommerceNet (funded by ATP to develop XML e-business vocabularies)

XML and Manufacturing

- Web is evolving into the de facto delivery environment for distributed software systems
  - Manufacturing software systems are following this trend (example: recent proliferation of CAD vendor portals)
  - “The network is the computer.”
- But XML syntax alone is insufficient for capturing manufacturing application data semantics
  - Need information modeling language plus XML serialization/deserialization algorithms
  - Other presentations in this session will touch on this issue

Manufacturing projects at NIST using XML

- Intelligent Manufacturing Systems Modeling and Simulation Environments for Design, Planning and Operation of Globally Distributed Enterprises (IMS MISSION)
- NIST Design Repository
- ***Process Specification Language***
- ***Modularization of STEP (ISO 10303)***
- ***XML for Machine Tool Performance Data***
- ISO 10303-28, XML representation of EXPRESS schemas and data (will be mentioned in Martin Hardwick's talk)

Presenting PSL concepts as XML

- Advantages
  - Leverages XML's popularity, support in mainstream software apps
  - XML's hierarchical syntax a good fit for certain PSL concepts
- Disadvantage
  - XML not as rich a representation language as first order logic
- Advantages outweigh disadvantages, particularly when full power of PSL ontology not required

PSL/XML accomplishments

- Initial set of guidelines for mapping PSL concepts to XML
- Promising results using the Resource Description Framework (RDF) schemas to represent instances of objects used in processes
- XML architectural forms used to achieve transformations from other XML process vocabularies to PSL

Additional PSL/XML references

- PSL/XML web page
  - http://www.nist.gov/psl/xml/
- PSL Overview and Version 1.0 specification
  - http://www.nist.gov/msidlibrary/doc/nistir6459.pdf
- Lubell and Schlenoff, *Process Representation Using Architectural Forms: Accentuating the Positive*, Markup Technologies ’99 conference
  - http://www.nist.gov/msidlibrary/doc/mt99new.pdf

More on modularization of STEP (ISO 10303)

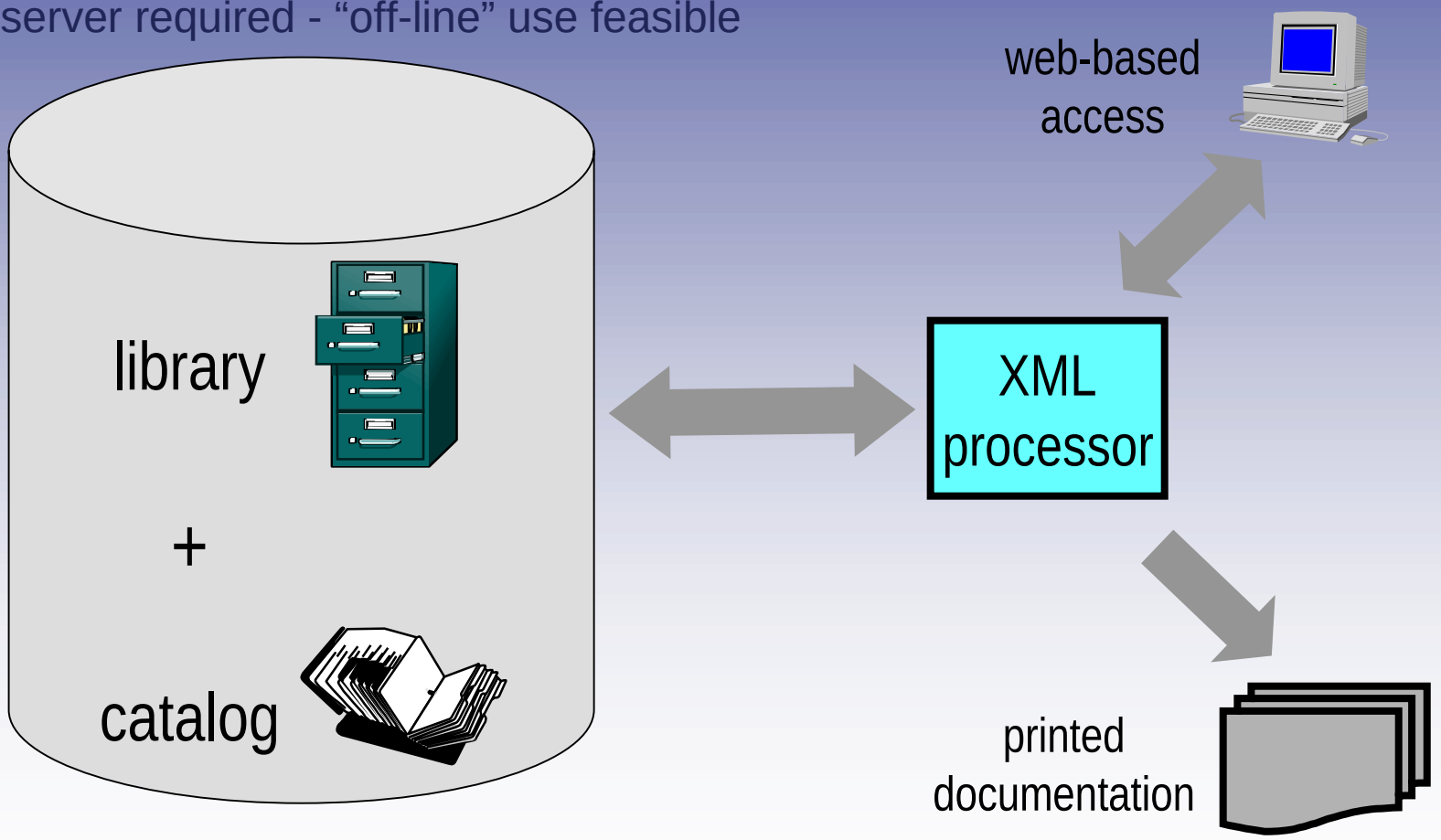
- STEP (Standard for the exchange of product model data) is a family of standards for product data exchange
- A modular strategy has been adopted for STEP in order to:
  - Reduce development costs
  - Allow implementations to contain subsets or extensions of a STEP specification
  - Improve interoperability
- Objective: provide infrastructural technologies necessary for STEP development and implementation using modules
- NIST is collaborating with PDES, Inc., an industry/government consortium working to develop and deploy STEP

Technical approach

- Modules are currently specified using HTML – eventually will be migrated into an XML repository
- Modules have a dual nature
  - Behave like documentation as well as software components
- Represent modules as XML in order to take full advantage of their dual nature
- Manage module development like a distributed software project
  - Use source code versioning tools to track changes to module XML documents
  - Enable Web-based read/write access

Repository architecture

No Web server required - “off-line” use feasible



STEP module repository references

- STEP Modularization HTML Repository demonstrator available at http://wg10step.aticorp.org/Modules/index.htm
- XML repository information and links to publications available at http://www.nist.gov/stepmod/

Future of XML for manufacturing applications

- Increasing need in manufacturing systems integration for mapping languages
  - Create data views on the fly
  - Resolve terminology clashes between different industries
  - Hide information from applications that don't know how to process it
- XML has two technologies for transformation/mapping
  - Extensible Style Language for Transformations(XSLT)
  - Architectural forms

At a glance

Architectural forms

- Technique for *declaring* a mapping between XML documents
- ISO standard
- Supported in few tools, but not too hard to implement

XSLT

- *Procedural* language for transforming an XML document
- W3C Recommendation
- Supported in many tools
- Can be used to implement arch. forms

XML architectures and manufacturing

- Architectural forms and XSLT likely to play an important role in future XML applications
  - Architectural forms have already been successfully used with PSL
  - ISO 10303-28 is using both XSLT and arch. forms in order to support multiple STEP/XML mapping methods without burdening STEP implementors
- XML transformation tools will be useful for coping with multiple manufacturing ontologies

XSLT and architectural forms references

- Architectural Forms
  - ISO/IEC 10744:1977 **Information processing -- Hypermedia/Time-based Structuring Language (HyTime) - 2d edition (Annex A.3 Architectural Form Definition Requirements)**
    - http://www.ornl.gov/sgml/wg8/docs/n1920/
  - ISO/IEC 10744 Amendment 1, ISO/IEC JTC 1/WG4 N1957
    - http://www.ornl.gov/sgml/wg4/document/1957.htm
  - David Megginson *Structuring XML Documents* Prentice Hall (1998) (Chapters 9-11)
- XSLT
  - W3C Recommendation
    - http://www.w3.org/TR/xslt
  - For other references, see http://www.w3.org/Style/XSL/#learn