Overview of Product Information Interoperability Using STEP (ISO 10303)

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5/98 Updates - M. C. Ramesh
11/00 Updates - R. Peak

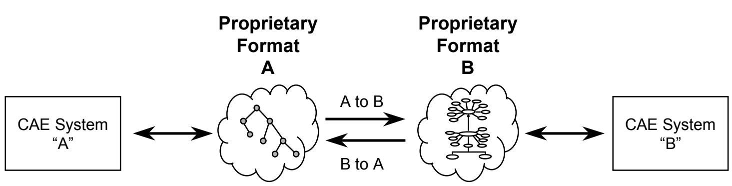
Product Information Interoperability (PII) & Product Data Exchange (PDE)

- "The ability to describe and exchange in a digital or computerized format all useful information about a given product." (US Product Data Association).
- Intent: Enable those involved in the development of a product (designers, analysts, manufacturers, support personnel) to define, access, and exchange all useful information via computer (electronically).
- PDE - tends to imply file exchange
- PII - tends to imply more dynamic interaction in-memory or via databases
  - See STEP implementation levels

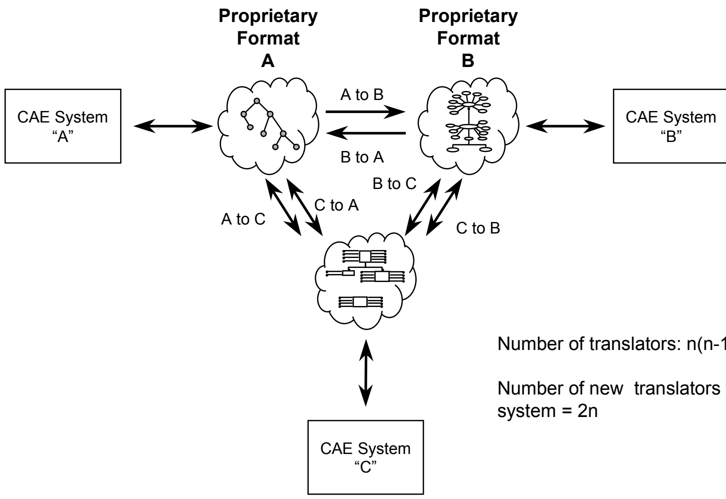
PDE Scenarios

- Internal communication (within the organization).
- External communication (clients, contractors, suppliers, partners).
- Make engineering data generated by one application program readable by other application programs.
- Long-term archiving.

PDE Approaches: Direct Translation



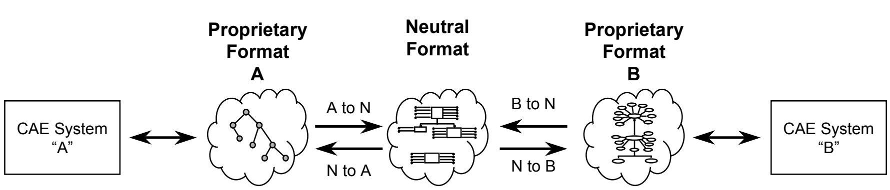
PDE Approaches: Direct Translation



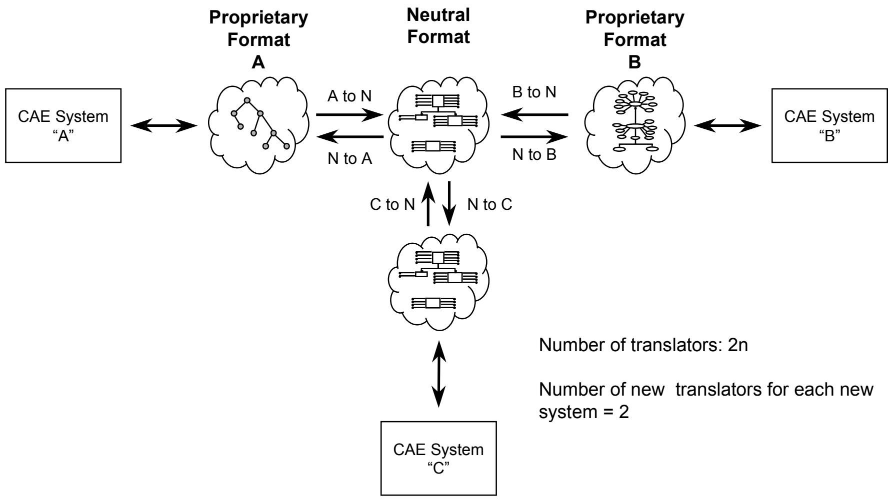
Number of translators: n(n-1)

Number of new translators for each new system = 2n

PDE Approaches: Neutral Format



PDE Approaches: Neutral Format



Number of translators: 2n

Number of new translators for each new system = 2

PDE Approaches: Shortcomings

- Direct translation:
  – Two translators for each pair of applications exchanging data.
  – Maintenance is a nightmare:
    » Requires knowledge of both proprietary formats.
    » Each new release requires changes in many translators.
- De facto standards:
  – Not well supported by all vendors (e.g., DXF).

PDE Approaches: Shortcomings

- Formal Standards:
  - Too narrow in scope (e.g., EDIF for integrated circuit design data only).
  - Ambiguity (e.g., IGES different interpretation of the same generic entities).
  - Different vendors support different subsets (e.g., IGES).
  - Lack of conformance methods.
  - Data mixed with information (comments, scoping rules) intended for human interpretation.

PDE Approaches: Shortcomings

- Proposed solution: a new generation neutral standard:
  - Computer-interpretable.
  - Unambiguous.
  - Represents product data throughout its entire life cycle (design, analysis, manufacture, production, support and disposal).
  - Specifies conformance testing.

STEP (ISO 10303)

- Mid 1980s: IGES/PDES Organization (IPO) initiated the development of a second generation of PDE standard called Product Data Exchange Specification (PDES).
- 1988: IPO submitted this standard to the International Organization for Standardization (ISO), which adopted it as the basis for STEP (Standard for the Exchange of Product Model Data).
- March 1994: Initial release of the International Standard.
- Today, PDES = Product Data Exchange using STEP (U.S. STEP effort).

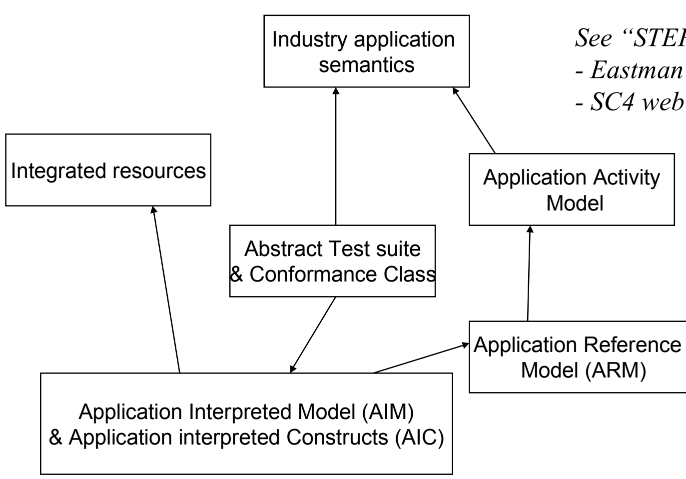
STEP (ISO 10303)

- STEP is not just a STANDARD it is a METHODOLOGY for the development of product data specification.
- Requirements
  - Long term Storage and retention of product information
  - Reduction of ‘islands of automation’
  - Independence of data from software tools
  - Communication of product information within and across enterprise

STEP (ISO 10303)

- STEP Principles
  - Define Architecture for product data
  - Support standardization of industry application semantics
  - Define requirements for implementation of product data exchange
  - Define requirements for the assessment of PDE implementations

STEP (ISO 10303)-STEP Architecture



See "STEP On A Page"
- Eastman Figure 5.3
- SC4 web site

See also more recent work on modules

STEP Application Protocols

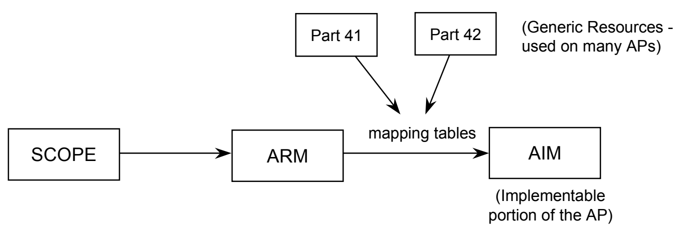
- Define standard schema (entities, etc.) to support a particular set of industry activities
- Main sections:

  1.- Scope.

  2.- Information Requirements (Application Reference Model - ARM).

  3.- Application Interpreted Model (AIM).

  4.- Conformance Requirements.



STEP (ISO 10303)

- STEP Architecture
  - Application Protocols - e.g AP214 excerpts
    - » Data specification that satisfy the product data needs of a given industrial application
- specifies an application protocol (AP) for automotive mechanical design processes. This application protocol defines the context, scope, and information requirements for various development stages during the design of a vehicle and specifies the integrated resources necessary to satisfy these requirements. This application protocol addresses the requirements of the automotive industry covering cars, trucks, busses, and motorcycles.

  - Integrated Resources - e.g Part 47 (IS): Shape variation tolerances
    - » Generic data specification that support the consistent development of AP across many application areas

STEP (ISO 10303)

- STEP Architecture
  - Application Protocols - e.g AP214
- EXAMPLE 1 -- Typical constituents of the body are frame, doors, roof, engine hood, windshield, or bumpers. The power train includes the engine, transmission, and drive line.
- EXAMPLE 2 -- Typical constituents of the power train are gear box, pistons, and exhaust pipe. The chassis includes all parts which are responsible for the vehicles handling.
- EXAMPLE 3 -- Typical constituents of the chassis are the front axle, rear axle, steering, suspension, wheels, shock absorbers, and brakes. Interior parts include parts that are built into the interior of the vehicle and not related to the power train.
- EXAMPLE 4 -- Typical interior parts are seats, instrument panel, door panels, the mechanism for power windows, air conditioning system, or stereo equipment. Only the mechanical aspects of a vehicle and its components are covered by this AP; the functional aspects, such as electronic, hydraulic, and pneumatic, are not covered.
- EXAMPLE 5 -- For a battery or a switch, product characteristics such as shape, material, or mass are covered but the electrical functionality is not covered.
- Finite element analysis (FEA) is not supported by this AP.

STEP (ISO 10303)

- STEP Architecture
  - Application Protocols - e.g. AP214

EXAMPLE 6 -- Typical technologies for primary shaping are molding or casting, for transforming are bending or stamping, for separating are milling or lathing, for coating are painting or surface coating, and for fitting are welding or riveting. b) process plan information to manage the relationships between parts and the tools used to manufacture them and to manage the relationships between intermediate stages of parts or tools, referred to as in-process parts;

c) product definition data and configuration control data pertaining to the design phase of a product's development;

d) changes of a design, including tracking of the versions of a product and data related to the documentation of the change process;

e) identification of alternate representations of parts and tools during the design phase;

f) identification of standard parts, based on international, national, or industrial standards, and of library parts, based on company or project conventions;

g) release and approval data for various kinds of product data;

h) data that identify the supplier of a product and any related contract information;

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- AP214 - Example 6 (continued)

i) any of eight types of representation of the shape of a part or tool:

1) 2D--wireframe representation;
2) 3D--wireframe representation;
3) geometrically bounded surface representation;
4) topologically bounded surface representation;
5) faceted--boundary representation;
6) boundary representation;
7) compound shape representation;
8) constructive solid geometry representation. j) shape representation of parts or tools that is a combination of any two or more of these eight types of shape representation;

k) data that pertains to the presentation of the shape of the product;
l) representation of portions of the shape of a part or a tool by form features;
m) product documentation represented by explicit and associative draughting;
n) references to product documentation represented in a form or format other than that specified by ISO 10303; (SGML) [8].
o) simulation data for the description of kinematic structures and configurations of discrete tasks;
EXAMPLE 8 -- The simulation data for a windshield wiper includes the geometry of the windshield as well as the kinematic structure of the wiper including all necessary links and joints.
p) properties of parts or tools;
q) surface conditions;
r) dimensional and geometrical tolerance data.

The following are **outside the scope** of this part of ISO 10303:

a) product definition data pertaining to any life cycle phase of a product not related to design;
b) business or financial data for the management of a design project;

STEP Implementation Levels

- Level 1: File Exchange
- Level 2: Working Form
- Level 3: Shared Database
- Level 4: Knowledge Base

STEP Resources

- Web:
  - ISO SC4 Home Page: http://www.nist.gov/sc4/
  - PDES Inc. (US consortium) http://pdesinc.aticorp.org/
    - » Industry usage examples
  - Other links via EIS Lab http://www.eislab.gatech.edu/step/

- Suggested Reading:
  - STEP: Towards Open Standards - Al-Timimi & MacKrell, 1996
  - STEP: The Grand Experience - Kemmerer ed. (NIST), 1999
  - Information Modeling the EXPRESS Way - Schenk & Wilson, 1994
  - Developing High Quality Data Models - West & Fowler, 1996
    http://www.stepcom.ncl.ac.uk/epistle/data/mdlgdocs.htm
  - Building Product Models - Eastman, 1999
    - » Esp. Chapter 5 (Overview; Express); Chapter 6 (Integrated Resources)