

# STEP Implementation

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# Outline

- Overview of PDES & STEP modular standards
- Update on STEP for 3D CAD
- STEP for CAE, Electromechanical
- Systems Engineering and PLCS

# PDES, Inc. Members

## Norway

JOTNE EPM  
TECHNOLOGY

## Sweden

EUROSTEP

## UK

THEOREM  
SOLUTIONS

BAE SYSTEMS

## Germany

LKSOFT

## France

AIRBUS

## Belgium

CAPVIDIA

## United States

THE BOEING COMPANY

ADOBE

SANDIA NATIONAL LABORATORIES/  
KCP

COSTVISION

MECHDYNE

ROCKWELL  
COLLINS

PURDUE

INTERNATIONAL  
TECHNEGROUP

GEORGIA TECH

LOCKHEED MARTIN

DSN INNOVATIONS

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INTERNATIONAL  
TECHNEGROUP

GEORGIA TECH

LOCKHEED MARTIN

IBM

PTC  
CCAT

NARA  
NASA  
NIST

SCRA  
HOST CONTRACTOR



# PDES, Inc. Members as of Oct. 2010

Industry	Large Vendor	Small Vendor	Government	University	Non-Profit
Airbus	Adobe	CostVision	NARA	Georgia Tech	CCAT
BAE Systems	IBM	Eurostep	NASA	Purdue	DSN Innovations
Boeing	PTC	ITI	NIST		
Honeywell					
Lockheed Martin		JOTNE EPM Technology	Sandia Nat'l Labs		
Rockwell Collins		Mechdyne			
		LKSoft			
		Theorem			
		Capvidia			

# Intro to Modular STEP AP's

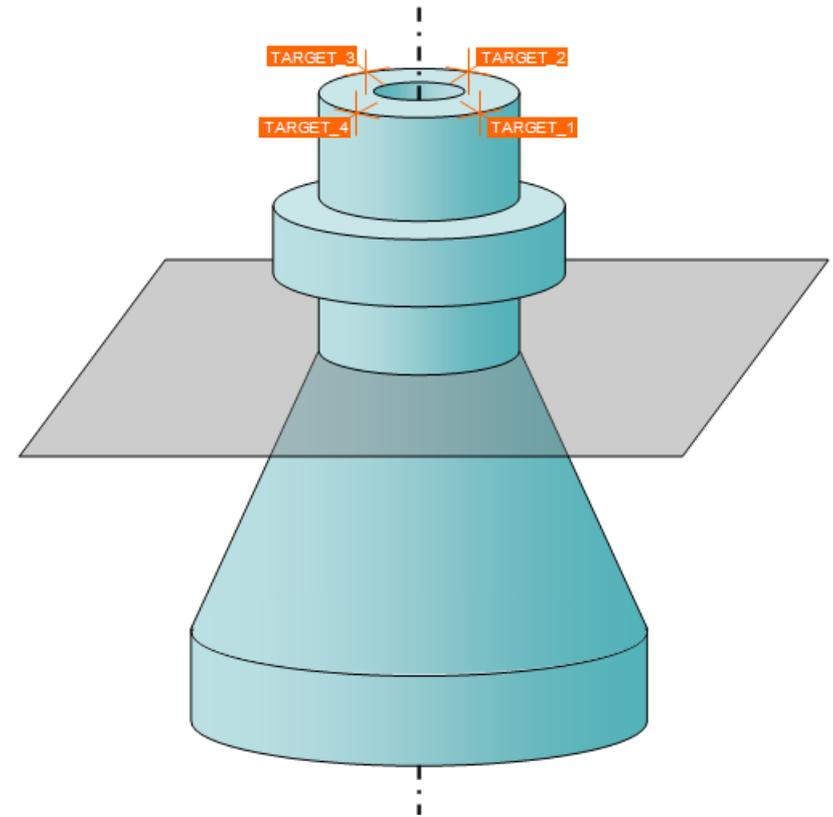
- Application Protocol (AP) Modularization Benefits
  - Standards as a Database
    - Faster revision process (months rather than years)
  - Interoperability of implementations through module reuse
    - Requirements, structure, etc.
- Modular AP Domains
  - AP203 Mechanical CAD (parts & assemblies)
  - AP209 CAE (FEA and CFD)
  - AP210 EDA/MCAD (electrical and mechanical assemblies)
  - AP233 Systems Engineering
  - AP239 Product Life Cycle Support (PLCS)

# Mandates for ISO 10303 (STEP)

- requirement for **Computer-Aided Engineering, Design and Manufacturing** systems used by NASA to have **interchange tools that support ISO 10303**
  - NASA-STD-2817 Chief Information Officer (1999)
- “procure **all product/technical data** in attachment (1) digital formats and ensure product model data meets ISO/STEP requirements specified in attachment (1).”
  - ASN RDA Memo by John Young, Oct. 23, 2004, **STEP for 2-D and 3-D CAD**
- “**implement a similar approach** that adopts ISO 10303 to enhance interoperability” as described in Young memo above
  - OSD ATL Memo by Ken Krieg, June 21, 2005, **STEP for UID**
- “Ratifying nations agree to apply **ISO 10303-239 for product data management** in cooperative NATO acquisition programs.”
  - NATO STANAG 4661, ratified by US
- “The PM shall require the use of International Standards Organization (ISO) 10303, Standard for Exchange of Product (STEP) Model Data, **AP239, Product Life Cycle Support, for engineering data** “
  - AFI 63-101 , April 17, 2009, PLCS for engineering data

# What's New in AP203ed2?

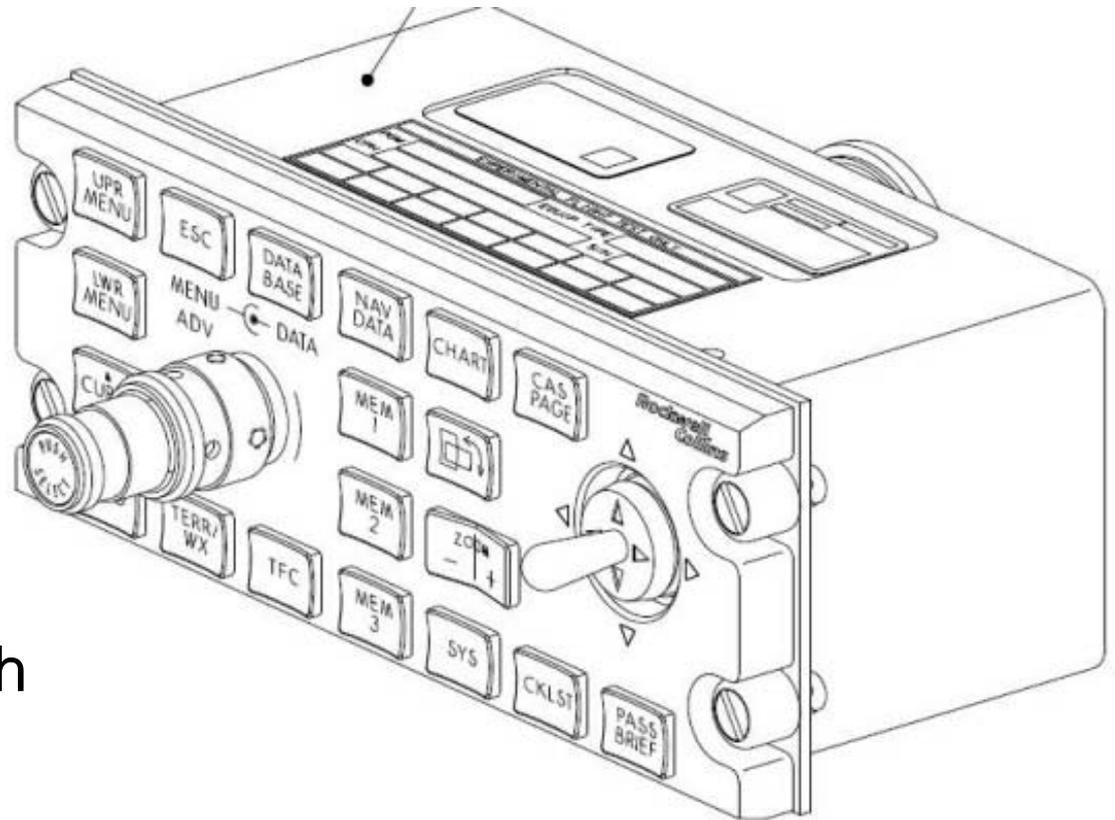
- Published by ISO in 2009
- New capabilities
  - Catalog Data
  - Composite Structure & Shape
  - GD&T
  - Validation Properties
  - Draughting
  - 3D Camera Views
  - External Libraries
  - ...



**Test Model for  
Supplemental Geometry**

# Been in 203, but little used

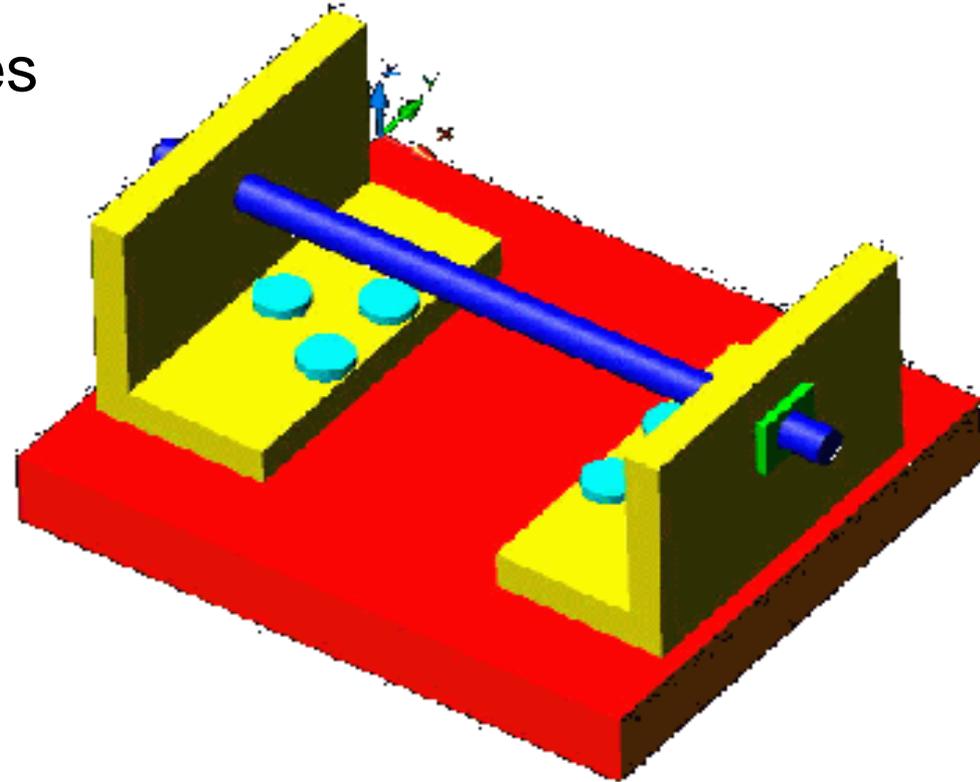
- Beyond Geometry
  - Requirements
  - Functional Breakdowns
  - Activity, Work Order
  - Project, Contract
  - Information Rights
  - Approvals
  - Security Classification
  - Product Concept
- Can associate these with other model entities
- Future use in CAD-PDM



**Test Production Model**

# Conformance to AP203ed2

- Only 2 Conformance Classes
  - Part and Version ID
  - Part View Definition
- 77 Conformance Options
  - Advanced B-Rep.
  - Colors and Layers
  - Construction Geometry
  - Edge Based Wireframe
  - Enhanced Assembly
  - Materials
  - Person and Organization
  - Product Configuration
  - ...



**Test Model for User Defined Attributes**

# Convergence of AP203 (Aero) and AP214 (Auto)

- Create single superset standard for MCAD
  - 203 x 214 = 242 and upwardly compatible
  - Modularization for interoperability across domains
  - Already harmonized for geometry (translators handle both)
- 214 adds the following capabilities
  - Manufacturing process planning
    - Relate plans, operations, tools, raw/in-process/finished, projects, other activities, etc.
  - Kinematics
  - Machining Features
  - OMG PLM Services (web services API) for Engineering Change
- Enable association with 203 unique capabilities
  - Catalog, Composites, Construction History, Requirements

# Proposed New Functionality for AP 242

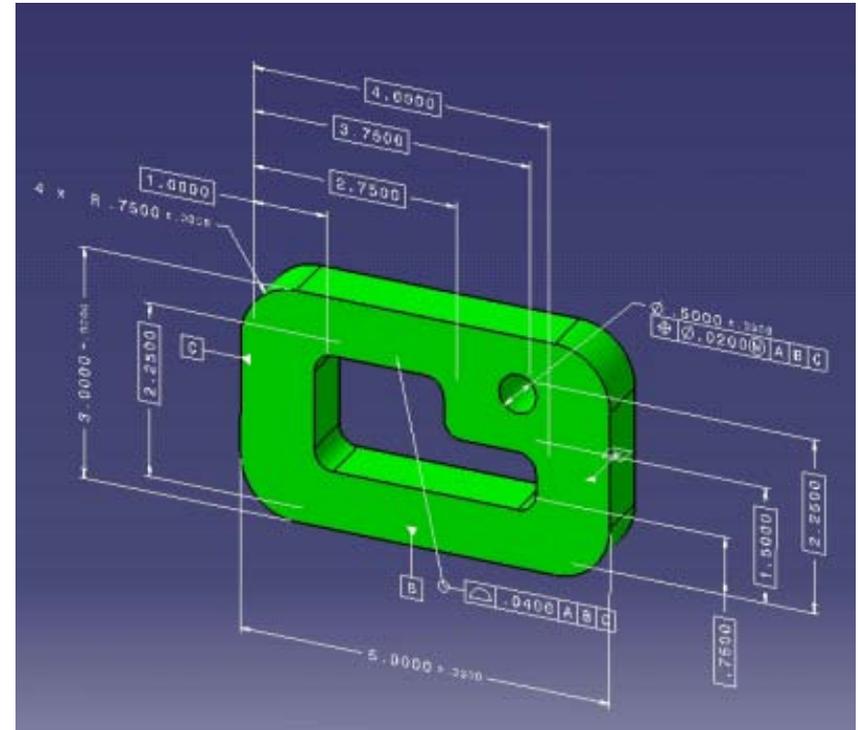
- 3D shape quality
- 3D parametric / geometric constraints design
- 3D kinematics assembly
- 3D GD&T at assembly level
- Sustainability information
- Access rights / Digital Rights Management
- Software / mechatronics
- 3D electrical harness
- 3D piping

# Benefits of 242 For

- **Standards Developers**
  - Eliminates overlapping development and maintenance
  - Eliminates time consuming harmonization
- **Software Vendors**
  - Upward compatibility for existing implementations
  - Single standard so reduced cost and time to conform
  - Combination of 203- and 214-unique capabilities can lead to new software capabilities
- **End Users**
  - Potential for unified approach to PDM exchange
  - Interoperability with other domains such as CAE, PLCS, SE

# CAX-Implementer Forum

- Joint testing effort of PDES Inc. & ProSTEP iViP
  - Participants: Adobe, AutoDesk, CostVision, Dassault Systemes, DataKit, Eurostep, ITI TranscenData, Kubotek, PTC, Siemens, T-Systems, Theorem Solutions
- Bi-annual rounds of testing of CAD data exchange
  - Cooperate on implementing STEP
  - Accelerate translator development
  - Promote interoperability
  - Scope is AP203 and AP214
- [www.cax-if.org](http://www.cax-if.org)

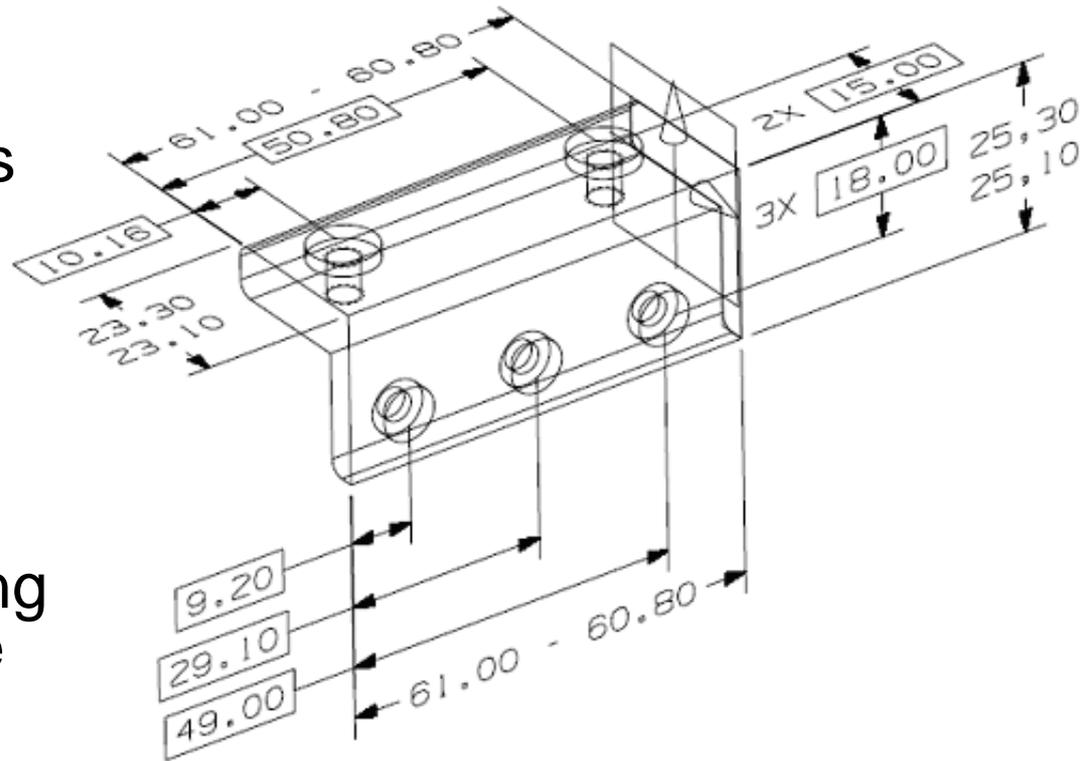


**Test Model for PMI Semantic Presentation and Representation**

# CAX-IF Benefits

- Individual results covered by non-disclosure
  - Publish only aggregate results
- Regular conference calls to discuss test rounds
- Draft Recommended Practices documents to guide implementation
- Alternate meetings Spring in US and Fall in Europe

## Test Model for PMI Polyline Presentation



# CAX-IF Test Cases

## Past Functionalities Tested

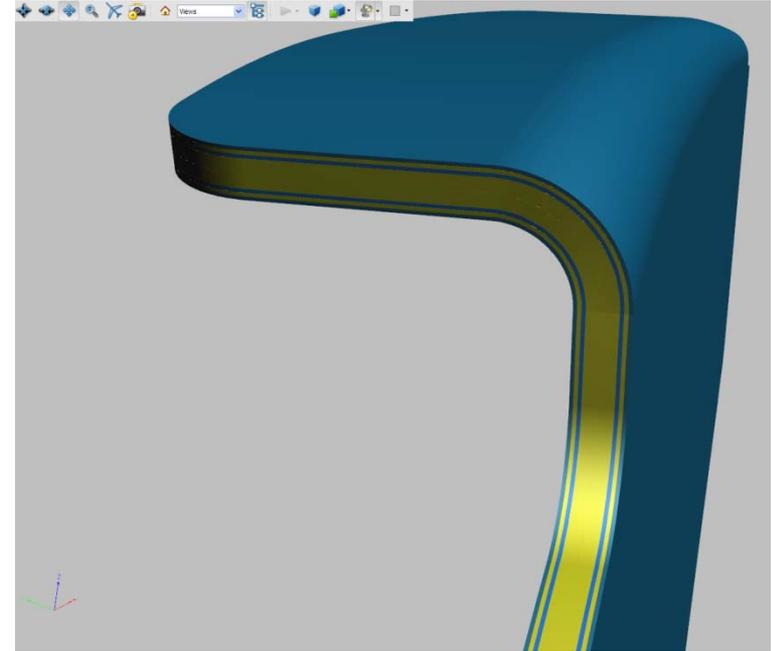
- Density and Material Name
- Supplemental Geometry
- Wireframe Geometry
- External References
- Colors, Layers & Groups
- Cloud of Points
- AP Interoperability

## Current Test Cases

- Geometric Validation Properties
- PMI Polyline Presentation
- PMI Representation and Presentation
- User Defined Attributes
- Problematic production models
- **Composites**

# Composites

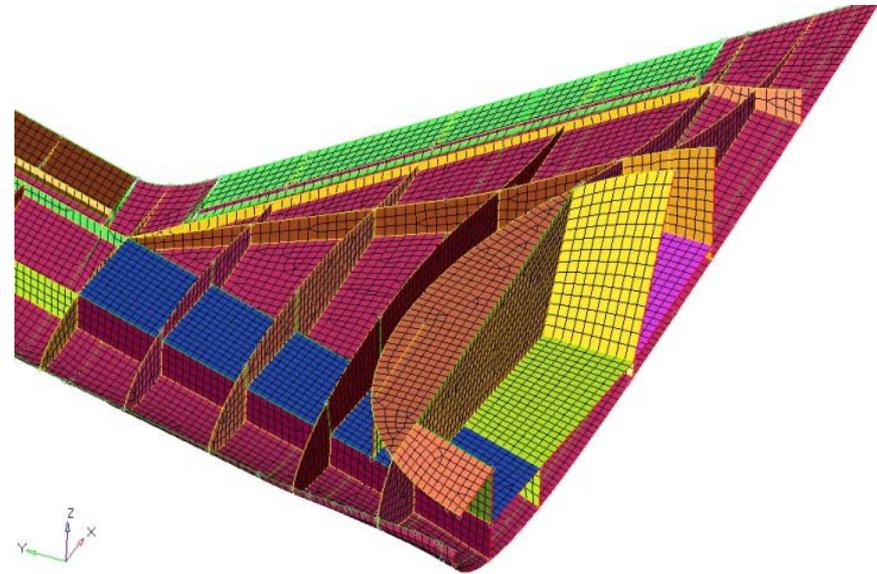
- Composite meta-data
  - Ply orientation angle and thickness
  - Material specification
- Shape
  - 2 ½ D wireframe and surfaces
  - Explicit solids
- Shared between
  - AP203ed2 for CAD
  - AP209ed2 for CAE



**Composite Plies & Core Structure**

# AP209ed2 Multidisciplinary Analysis and Design

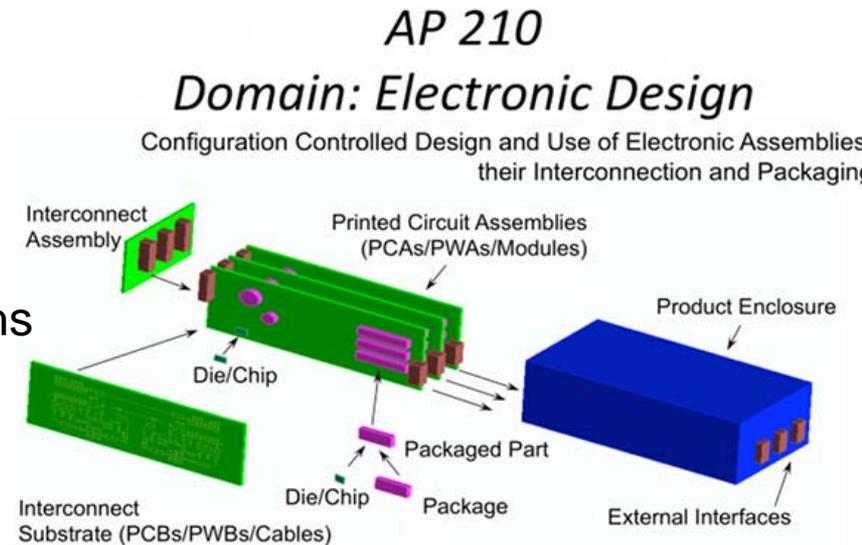
- Combines CAD, CAE, PDM capabilities
  - Superset of AP203ed2
  - Finite Element Analysis (FEA)
  - Computational Fluid Dynamics (CFD)
  - General numerical analysis
  - Shares base analysis models with AP233 Systems Engineering
- Developing binary API
  - Based on open source HDF5 toolkit
- Simulation Data Management (SimDM) project
  - Analysis data management
  - Repository for archiving
  - Interfaces to commercial and proprietary simulation tools



**Publicly sharable  
Finite Element Model  
for testing**

# AP210ed2 Electro-Mechanical Projects

- Current projects
  - 3D multi-domain component models and central repository
  - Schematics data exchange model with IPC
- Existing implementations
  - DFM and DFT Rule Checkers
  - Gerber to AP210 translator
  - Visualization/virtual product walkthroughs
  - ECAD-MCAD data exchange
- Previous implementations
  - PCB stackup design and warpage analysis



# Enterprise-Class STEP

## Product Life Cycle Support

- **AP239 PLCS**
- **US Army TACOM**
  - Requiring on contracts
- **US Army LOGSA**
  - Logistics Support Analysis
  - DEX's based on MIL-STD-1388
- **US NAVAIR**
  - UH-60 pilot
- **NAVSEA**
  - Requiring on contracts
- **OSD for UIUD**

## Systems Engineering

- **AP233 SE**
- **INCOSE Professional Society**
  - Product of the Year 2009 Working Group Award (Model Driven System Design )

# What Does AP233 Enable?

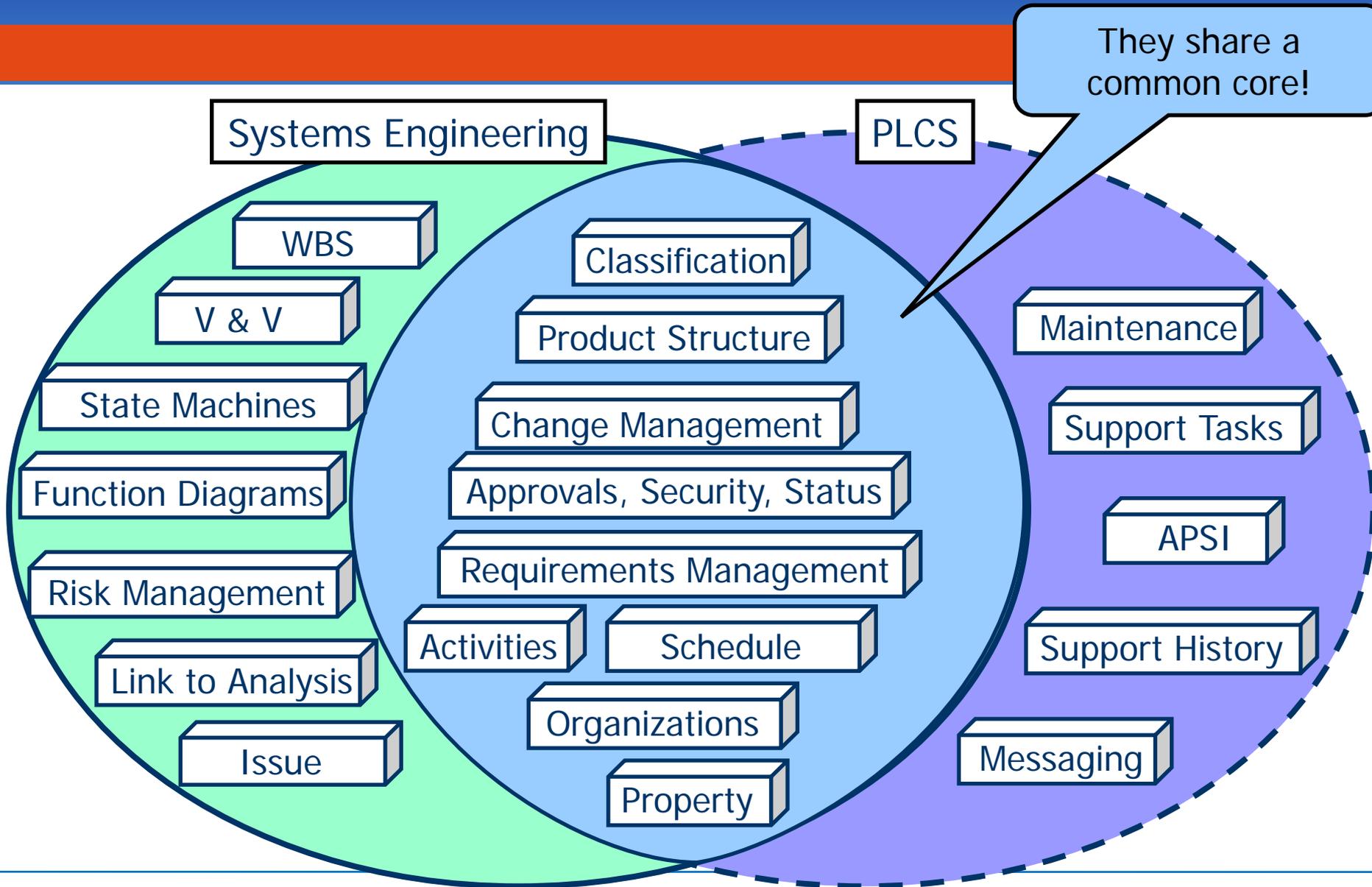
- Program management
  - Issue
    - Activities
    - Approvals
  - Risk
    - Probability & Consequence
    - Source & Impact
    - Contingency plans
  - Project
    - Organizational structure
    - Project breakdown
    - Schedule
    - Work structure
    - Management information resources
- System modeling
  - Decision support
    - Requirements management
    - Measures of effectiveness
    - Analysis interface
    - Verification & Analysis
    - Justification
  - System structure
    - Product data management
    - Breakdown
    - Interface
  - System behavior
    - Function based behavior
    - State based behavior

# AP233 Implementations

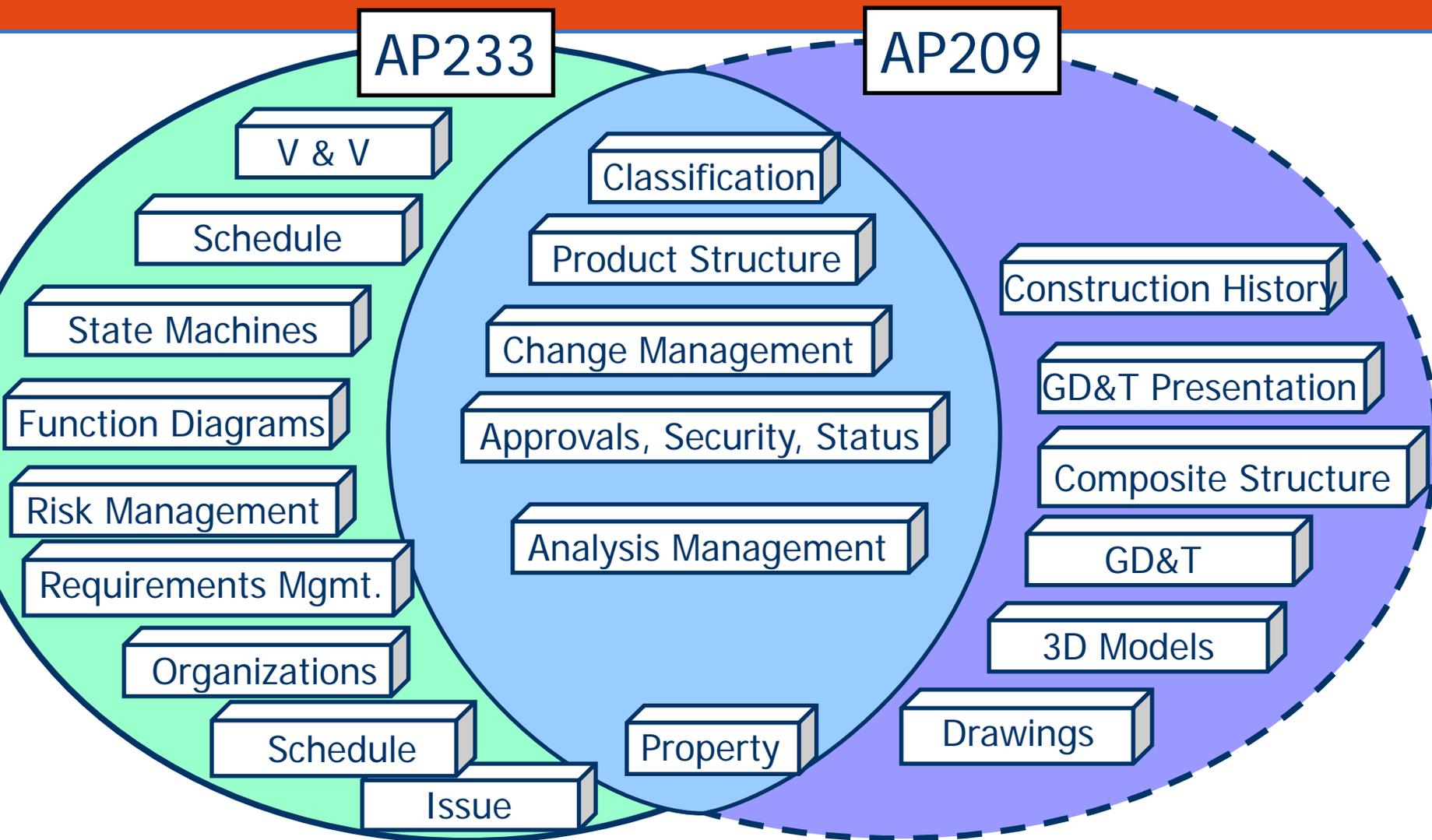
- Migration between versions of SE tools
  - UGS Slate to UGS Systems Engineering
- Exchange between Requirements Management tools
  - IBM Requisite Pro and Telelogic DOORS
- Model management of SysML and interoperability with other domains
  - i.e. Risk, Program/Project, downstream CAD/CAE/CAM, PLCS
- DoDAF to AP233 for exchange and archive
  - CADM representation of views
- Multi-domain simulation management
  - Requirements through analysis – EU Vivace & Crescendo
- Earned Value Management XML Schema mapping into 233 reference data
  - Associate cost & schedule with systems engineering

.. And remember PLCS implementations are AP233 implementations where they overlap

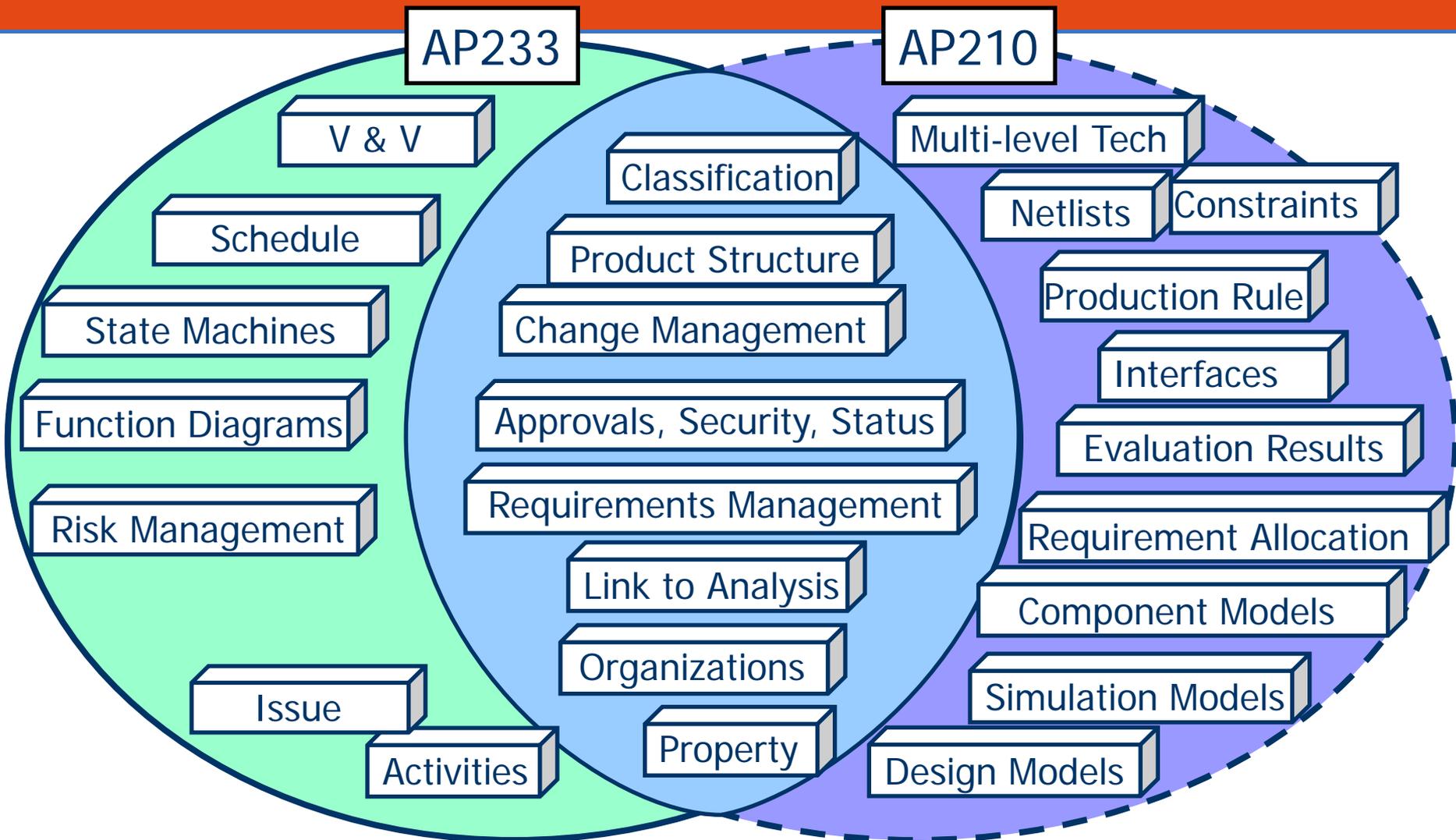
# Systems Engineering & PLCS



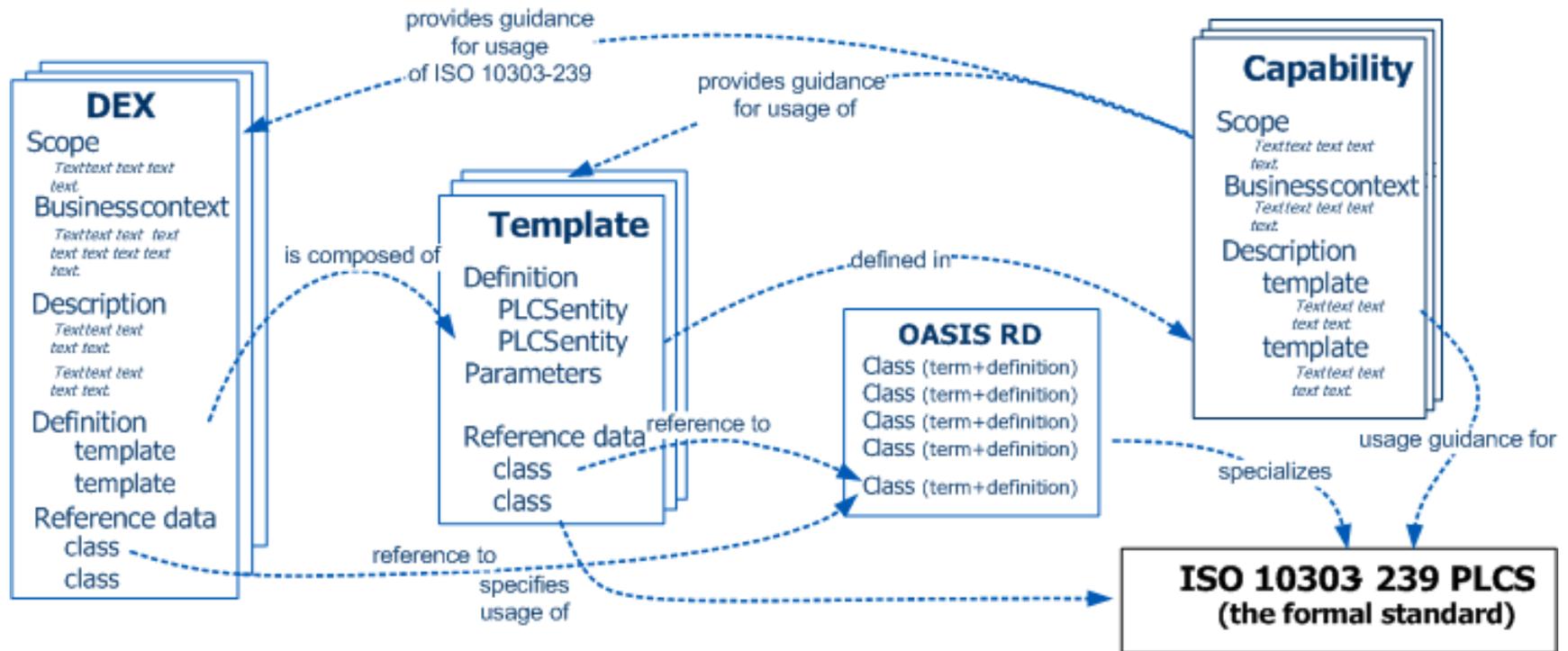
# Systems Engineering & CAE



# Systems Engineering and Electro-Mechanical CAD



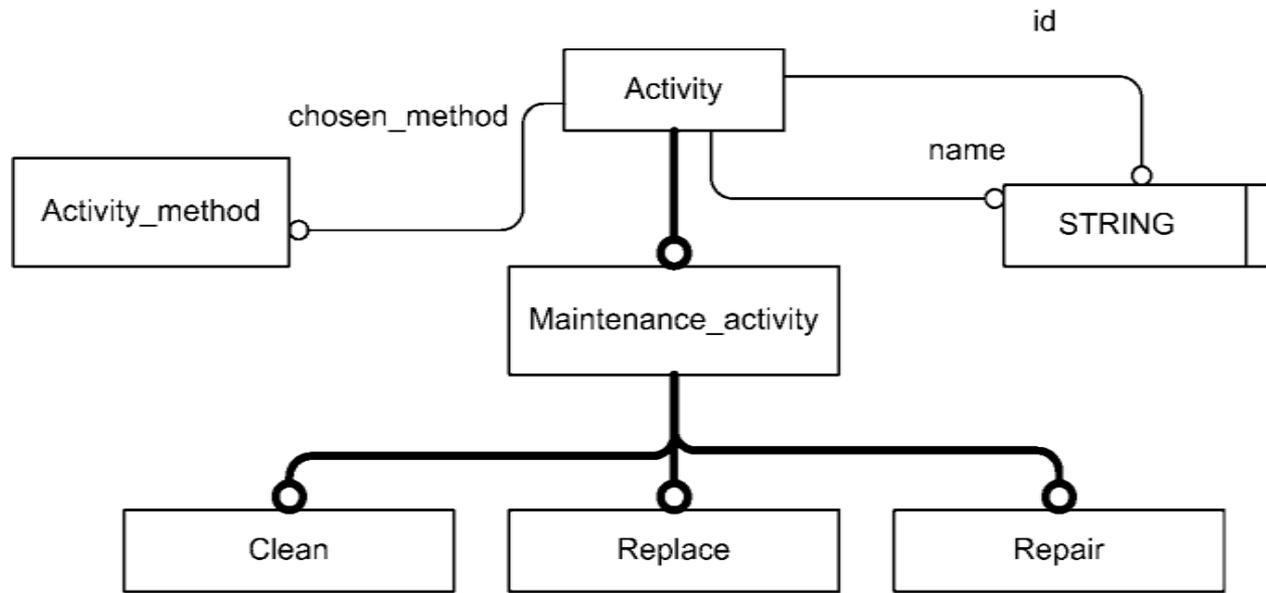
# OASIS PLCS DEX Architecture



- Reference data in Web Ontology Language (OWL) tailors to domain
- Templates are assembled into Data EXchange Specification (DEX)
- Open source infrastructure and free development tools

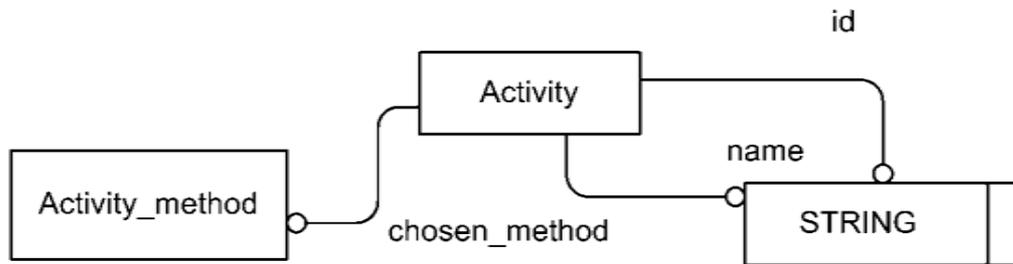
# Mapping with Reference Data

- Entities/relationships 233/239 are general
  - e.g. Product, Activity, Product\_relation
  - Most entities are subtypes of Product
    - e.g. Requirement, Part, Interface, ...
    - Inherit structure and relationships of Product
- Other subtyping is by classification assignment
  - Specialization of entities/relationships/attributes
  - External classes of reference data
  - e.g. INCOSE subtypes for requirement\_version
    - Functional, Performance, Reference, Validation, ...
  - Map to a domain by developing reference data

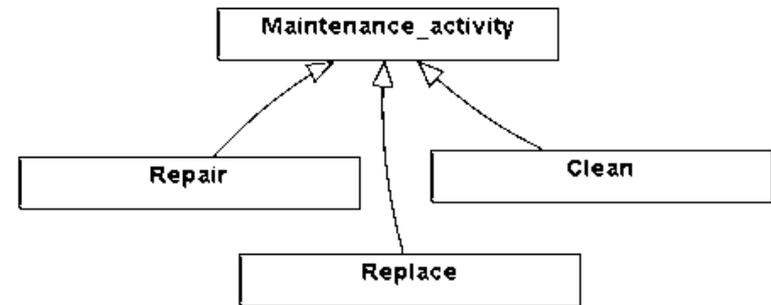


↙ Extension by Subtyping ↘

ISO Information Model



OASIS Taxonomy





# PLCS Edition 2

- Incorporate required changes identified from PLCS deployments
- New capabilities from 233 Systems Engineering
  - Risk, Decision Support, Verification & Validation
- Compatibility with 203ed2 through STEP modules as a database publication
- Information modeling complete and now moving through the ISO ballot process

# STEP is

- Mandated for government programs
- Interoperable with other engineering domains
- Usable across the life cycle
- Extendable with reference data and user defined attributes
- Harmonizing with other standards
- Supporting web services and SOA