

AP233

An Information Model for Systems Engineering

11th NASA/ESA Workshop on Product Data Exchange 2009

Georg Siebes

Agenda

- Introduction
- Context
 - Information Models
 - Organizations Relevant to AP233 Development
 - STEP
- AP233
 - System Engineering Model History
 - AP233 Capabilities
 - AP233 Development Status
- Resources

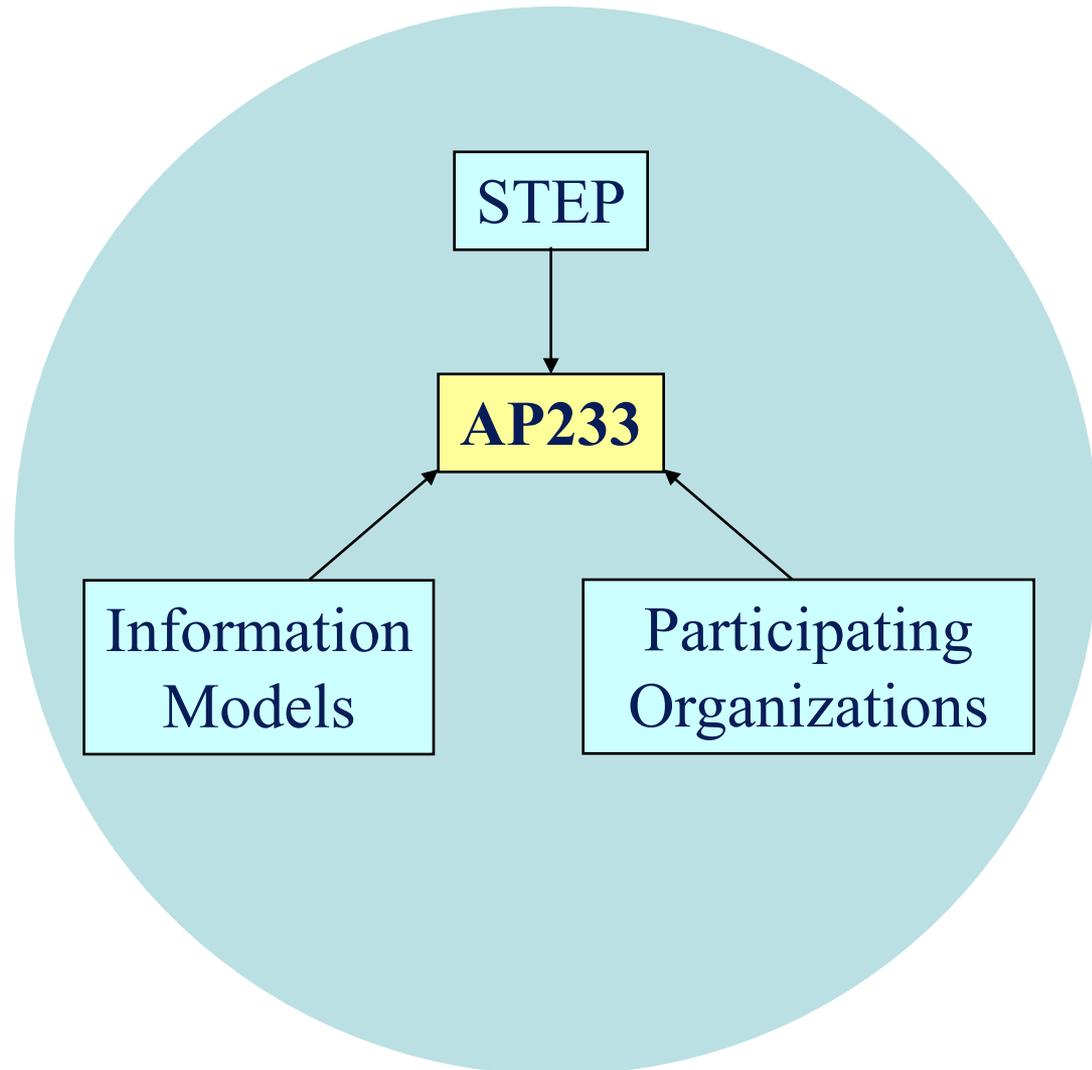
Introduction

- In today's world, information is abundant. We have no problems generating it. But we are challenged to find, organize, and exchange information.
- A standardized model of information can help. Such a model nearly completed its development for Systems Engineering. It is referred to as AP233 (AP = Application Protocol).

A Roadmap For This Talk

We will approach
AP233 from 3
different
directions.

But first a little
more on
“Information”



Information

- What is information?
 - We are surrounded, immersed, awash, bombarded by it
 - It doubles every 3 years (at least)
 - It exists in the natural world; it exists in cyber space
 - It becomes relevant through communication
- Definitions may help (from Oxford English Dictionary):
 - **Fact**
Something that has really occurred or is actually the case
 - **Data**
Facts, esp. numerical facts, collected together for reference or information.
 - **Knowledge**
The fact, state, or condition of understanding
 - **Information**
Knowledge communicated concerning some particular fact, subject, or event
- ...and for good measure:
 - **Semantics**
The relationships between linguistic symbols and their meanings

Information, cont.

Information

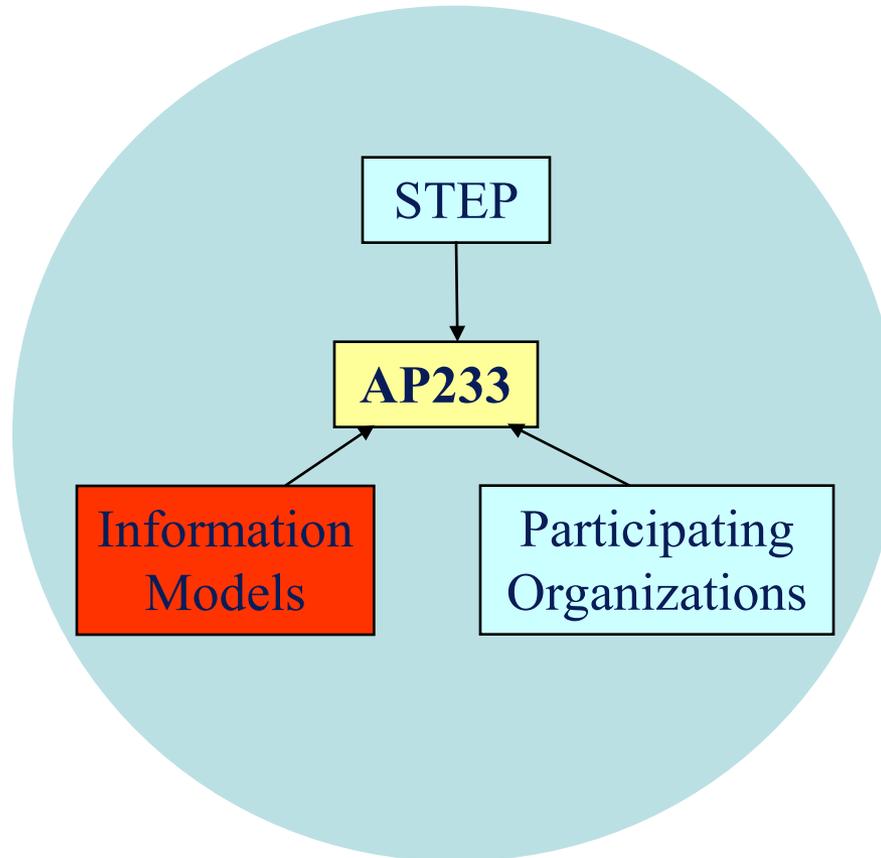
*A communicated
understanding of
data*

Pi = 3.14159

Re-used from "Information" by Hans Christian von Baeyer

In a nutshell, this is what AP233 does for Systems Engineering

Information Models



Information Models

- Information Models abound. Just a small, random sample:
 - **Common Information Model (CIM) Standards**
Distributed Management Task Force
 - **A Taxonomic Information Model for Botanical Databases**
International Organization for Plant Information
 - **Geo-Information Models**
Netherlands Geodetic Commission
 - **Core Model Of The Electronics Domain**
IEC 62016

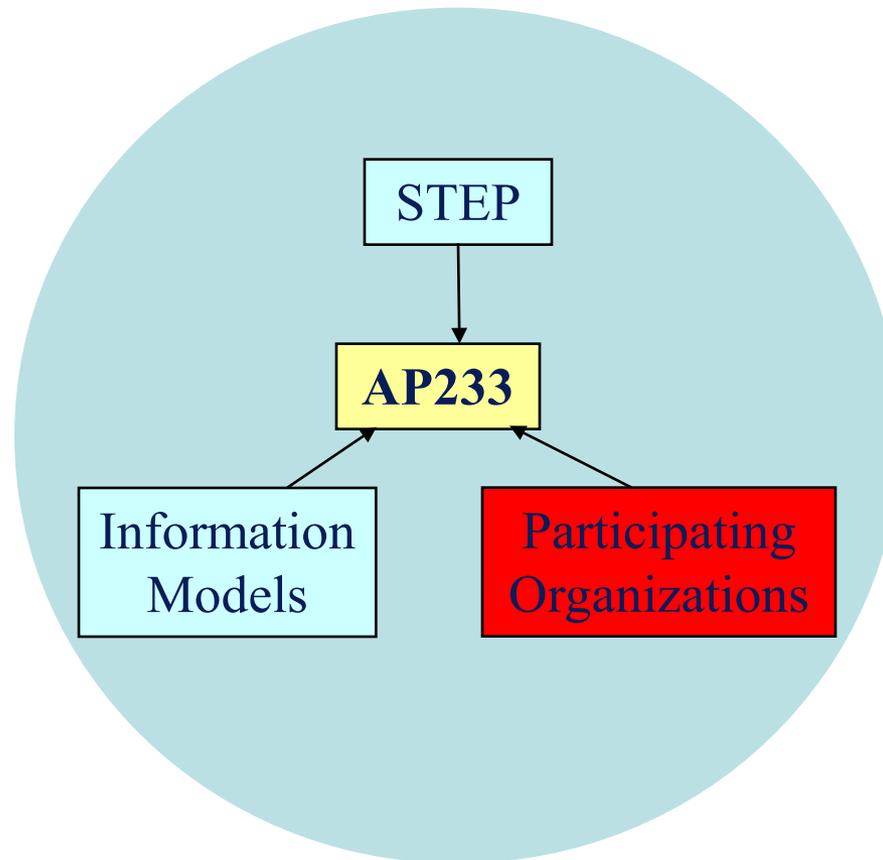
Others:

- **Soil Erosion**
 - **Chemistry**
 - **Economic**
- What is characteristic about information models?

Characteristics of Information Models

- An information model is a formal description of an area of interest, a domain.
- It specifies the *objects* within the domain, the *relationships* between the objects, the *attributes* of the objects and the *constraints* upon the objects and their relationships.
- Many information models are international standards (often overlapping)
- Languages exist to unambiguously express information models.
Some examples:
 - Business Process Modeling Language (BPML)
 - Unified Modeling Language (UML)
 - SysML is a domain-specific visual modeling language for systems engineering applications
 - EXPRESS (ISO 10303 – 11)

Participating Organizations



Organizations

- OMG (Object Management Group)
 - is an open membership, not-for-profit consortium that produces and maintains computer industry specifications for interoperable enterprise applications
- OASIS (Organization for the Advancement of Structured Information Standards)
 - is a not-for-profit, international consortium that drives the development, convergence, and adoption of e-business standards
- INCOSE (International Council on Systems Engineering)
 - not-for-profit membership organization with the mission is to advance the state of the art and practice of systems engineering
- ISO (International Organization for Standardization)
 - is a network of the national standards institutes of 156 countries, with a Central Secretariat in Geneva, Switzerland, that coordinates the system.
- PDES, Inc.
 - the mission of PDES, Inc. is to accelerate the development and implementation of STEP.

PDES, Inc. Members

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

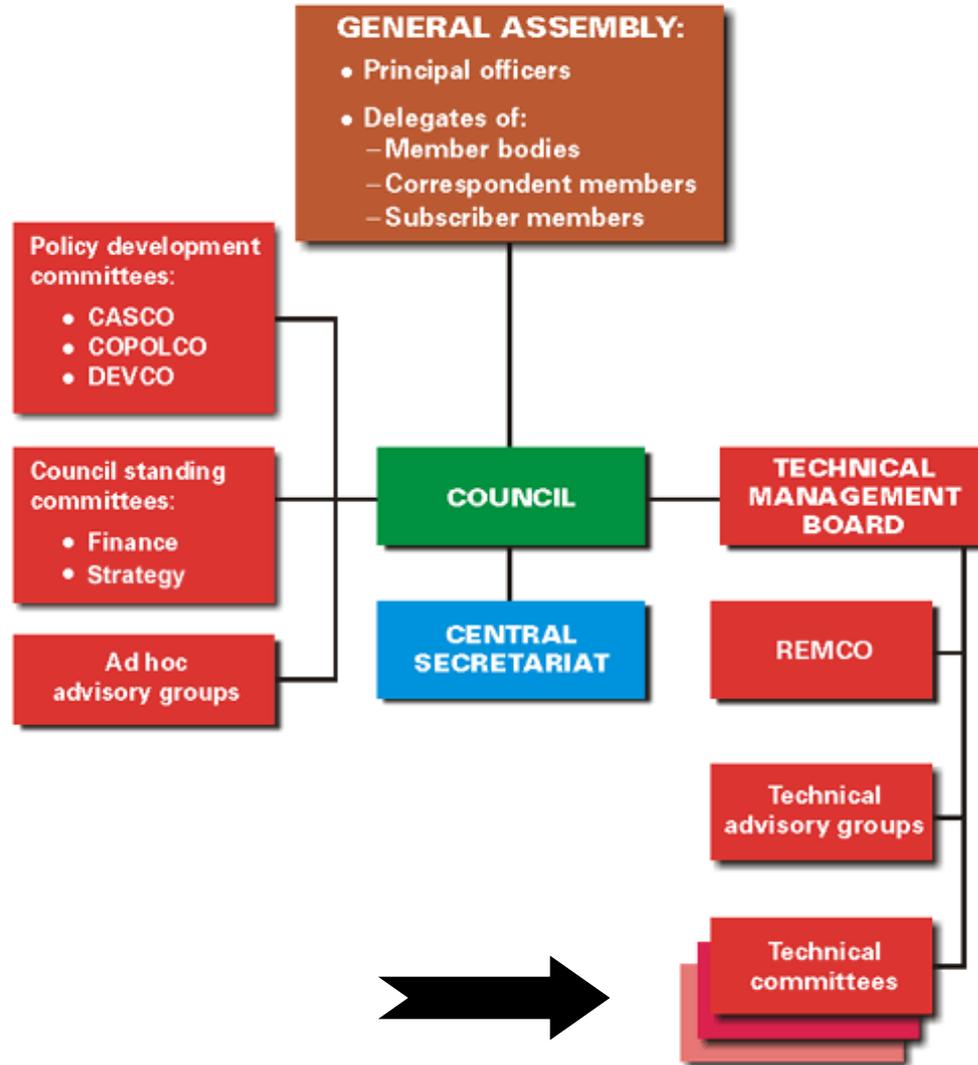
AP233 Participants

Over the course of the project, numerous organizations have helped with AP233

- ATI
- BAE SYSTEMS
- BOEING
- ESA
- EADS
- EDS
- EuroStep
- Georgia Tech
- IBM
- I-Logix
- INCOSE
- John Deere
- Motorola
- MOD
- NASA/GSFC
- NASA/JPL
- NAVSEA
- NDIA
- NIST
- Northrup Gruman
- OMG
- PDES Inc.
- Raytheon
- Rockwell Collins
- Vitech
- Volvo Aero

ISO

ISO STRUCTURE



ISO Technical Committee's

JTC 1 Information technology

TC 1 Screw threads

•

TC 19 Preferred numbers

TC 20 **Aircraft and space vehicles**

TC 21 Equipment for fire protection and fire fighting

•

TC 182 Geotechnics

TC 183 Copper, lead, zinc and nickel ores and concentrates



TC 184 **Industrial automation systems and integration**

TC 185 Safety devices for protection against excessive pressure

TC 186 Cutlery and table and decorative metal hollow-ware

•

TC 228 Tourism and related services

TC 229 Nanotechnologies

TC184

Industrial automation systems and integration

*Total number of published ISO standards
related to the TC and its SCs:*

420

Participating countries:

21

Observer countries:

22

Committee

Title

TC 184/AG

Advisory group

TC 184/SC 1

Physical device control

TC 184/SC 2

Robots for industrial environments



TC 184/SC 4

Industrial data (home of STEP – ISO 10303)

TC 184/SC 5

Architecture, communications and integration frameworks

TC184/SC4

Industrial data

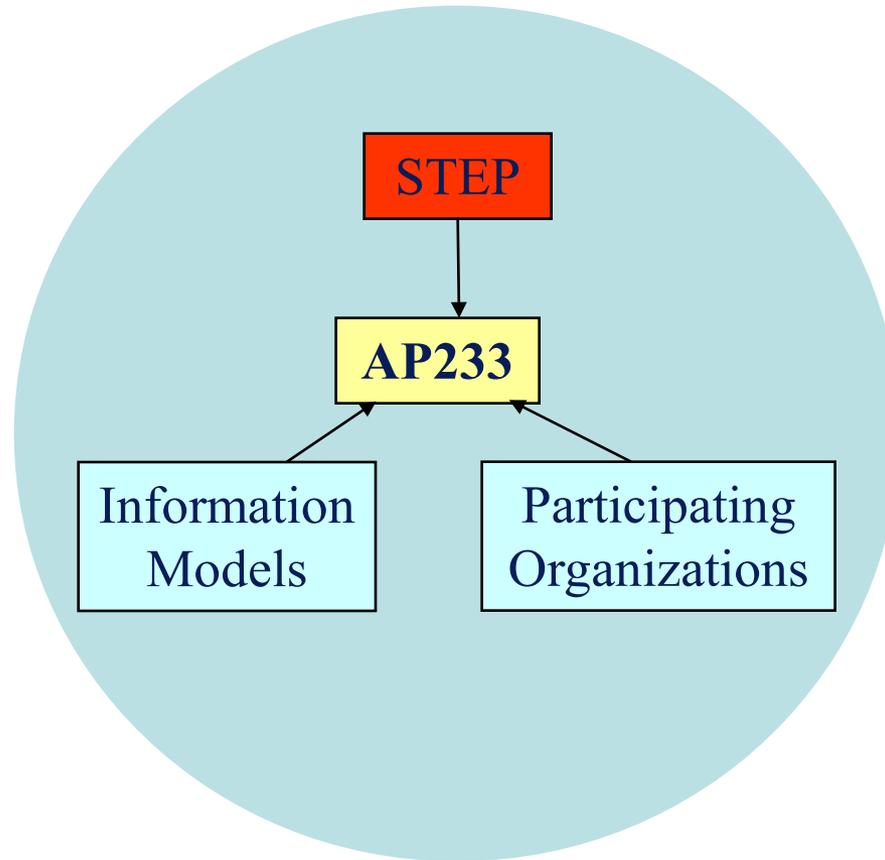
<i>Number of published ISO standards under the direct responsibility of the TC 184/SC 4 Secretariat:</i>	<u>367</u>
<i>Participating countries:</i>	<u>20</u>
<i>Observer countries:</i>	<u>12</u>

Committee

Title

<i>TC 184/SC 4/QC</i>	<i>Quality committee</i>
<i>TC 184/SC 4/PPC</i>	<i>Policy and planning committee</i>
<i>TC 184/SC 4/AG</i>	<i>Change management advisory group</i>
<i>TC 184/SC 4/WG 2</i>	<i>Standard for the neutral representation of standard parts</i>
 <i>TC 184/SC 4/WG 3</i>	<i>Product modeling</i> (home of AP233)
<i>TC 184/SC 4/WG 8</i>	<i>Joint SC 4 - SC 5 WG : Manufacturing process and management information</i>
<i>TC 184/SC 4/WG 11</i>	<i>EXPRESS language, implementation methods and conformance methods</i>
<i>TC 184/SC 4/WG 12</i>	<i>Common resources</i>

STEP



What is STEP ?

- The STEP project was initiated in 1984 by ISO.
- STEP is a synonym, sometimes interpreted as

*Standard for the Exchange of Product Model
Data*

- The actual designation of the STEP standard is

*ISO 10303 Industrial Automation Systems -
Product Data Representation and Exchange.*

STEP Application

- STEP
 - provides a mechanism that is capable of describing product data throughout the life cycle of a product,
 - the description is independent from any particular system.
 - it is suitable not only for neutral file exchange, but also as a basis for implementing and sharing product databases and archiving
- STEP standards are developed for specific application domains and referred to as Application Protocols (APs)
- An effort to modularize APs is underway for the benefit of reuse.

What is an AP

An Application Protocol (AP) is a standardized representation of product data in a specific application context.

It includes:

- The description of the functionality (AAM, Application Activity Model)
- An application-oriented reference model from a user's point of view (ARM, Application Reference Model)
- Representation of the reference model through objects from the Integrated Resources as implementation view (AIM, Application Interpreted Model)
- Implementation guidelines and conformance conditions for implementations

STEP APs

AP202 Associative Draughting

AP203 Configuration Controlled 3D Designs of Mechanical Piece Parts and Assemblies

AP207 Sheet Metal Die Planning and Design

AP209 Composite and Metallic Structural Analysis and Related Design

AP210 Electronic Assembly, Interconnect, and Packaging Design

AP213 Numerical Control (NC) Process Plans for Machined Parts

AP232 Technical Data Packaging - Core Information and Exchange

 **AP233 Systems Engineering**

AP212 Electrotechnical Design and Installation

AP214 Core Data For Automotive Design Processes

AP215 Ship Arrangement

AP216 Ship Moulded Forms

AP218 Ship Structures

AP221 Functional Data and their Schematic Representation for Process Plant

AP224 Mechanical Product Definition for Process Planning Using Machining Features

AP225 Building Elements Using Explicit Shape Representation

AP227 Plant Spatial Configuration

...more

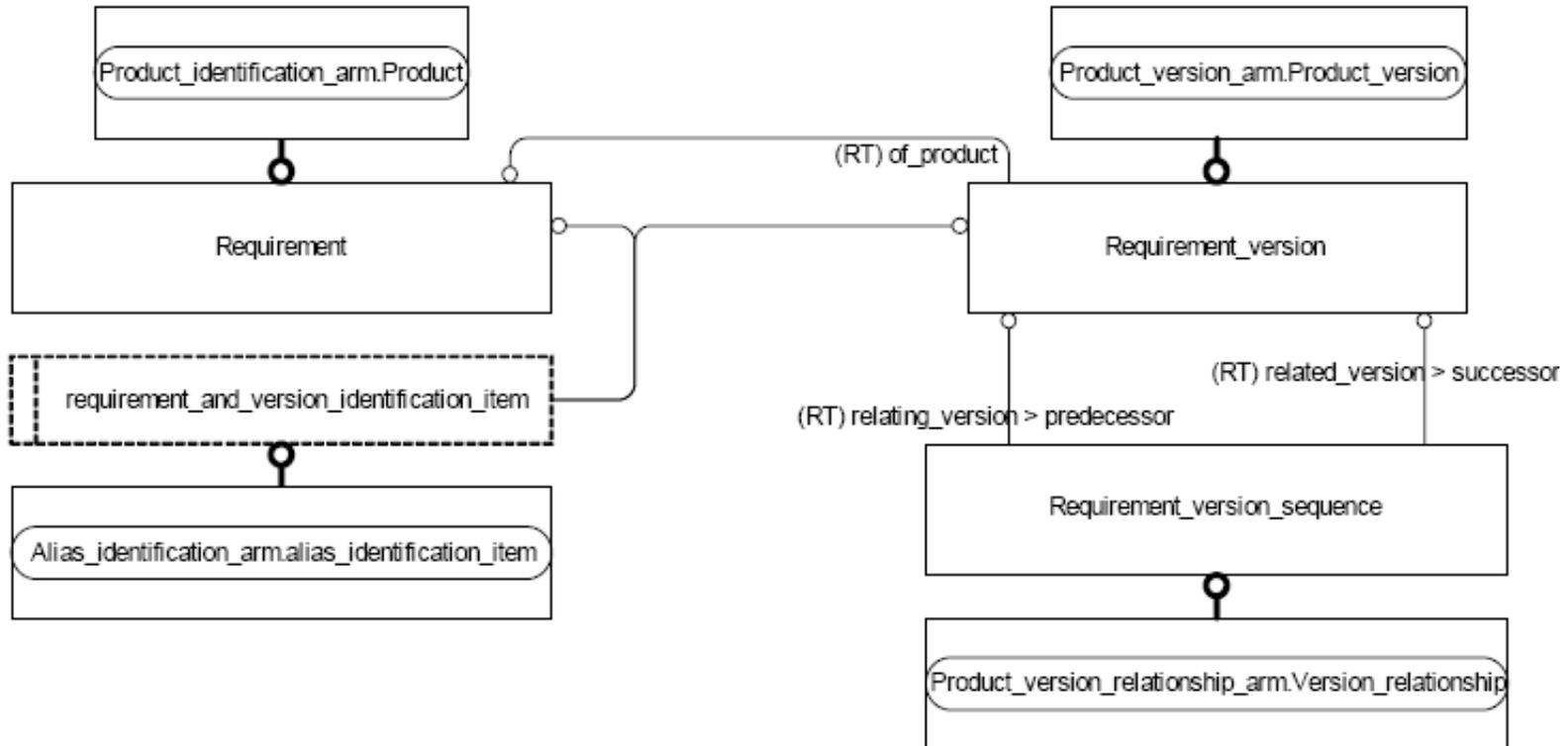
What is Express?

- The modeling language for STEP is EXPRESS
- EXPRESS is a lexical, object flavored information modeling language and is defined in ISO 10303-11:1994.
- EXPRESS-G is an iconic language that provides a subset of the lexical modeling capabilities; this is defined in Annex D of ISO 10303-11:1994.

Sample Express

```
1 SCHEMA Bank;
2 ENTITY Branch;
3     SortCode : STRING;
4     BranchManager : Manager;
5     Tellers : SET[1:20] OF Teller;
6     Customers : SET[0:?] OF AccountHolder;
7 DERIVE
8     Staff : SET[2:21] OF Employee := BranchManager + Tellers;
9 END_ENTITY;
10
11 ENTITY Person
12     ABSTRACT SUPERTYPE OF (ONEOF (Male, Female) AND
13                               (Employee ANDOR AccountHolder));
14     Age : INTEGER;
15 WHERE
16     age_cannot_be_negative : Age >= 0;
17 END_ENTITY;
.
N END_SCHEMA;
```

Sample Express-G

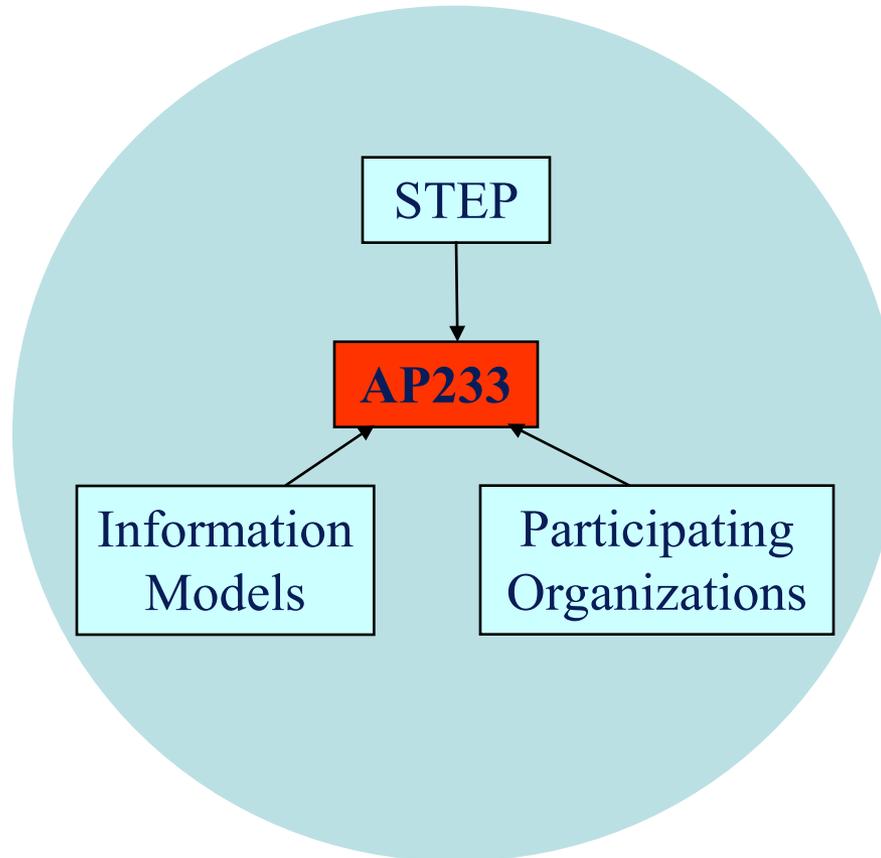


The **Requirement** entity is used to uniquely identify a requirement. There may be many versions of that requirement (**requirement_version**).

The **Requirement_version** entity represents a version of a requirement. This entity is used to record the different versions of a requirement.

The **Requirement_version_sequence** entity is used to relate a previous version (**predecessor**) of a requirement to the version that replaces it (**successor**).

AP233



AP233 History

- Systems Engineering Data Representation and Exchange Standardization ([SEDRES](#))
 - the Root of AP233
- ESPRIT Project 20496
 - January 96 – March 99
 - ~45 work years
 - jointly European Commission and industrial partner funded
- An initiative to produce a tool-neutral solution to the lack of tool interoperability for the systems engineering domain
- Used specific tools and exchanges for validation

AP233 History, cont.

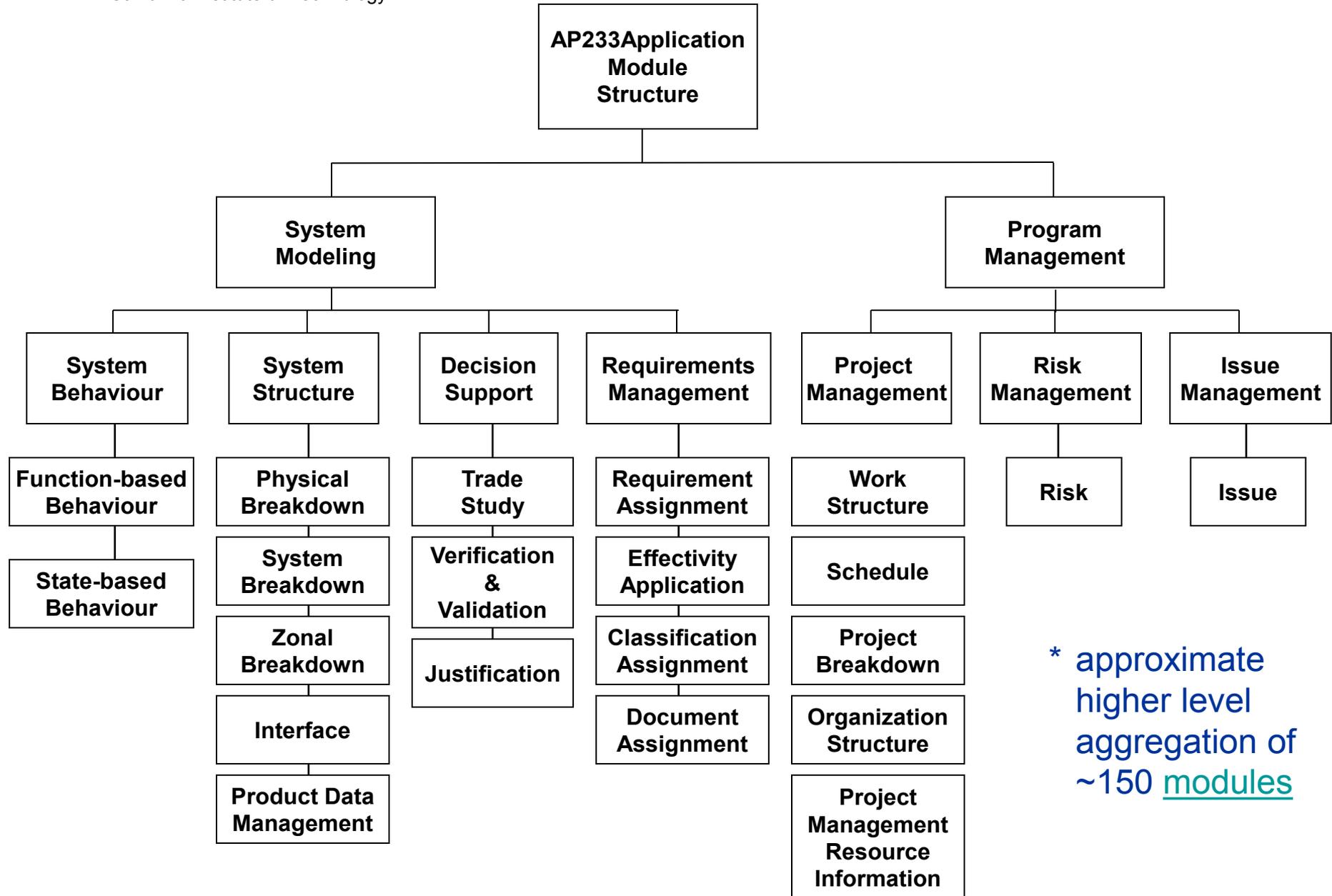
- SEDRES-2 (January 2000 - December 2001)
 - The SEDRES-2 mission extended, validated and standardized the Systems Engineering (SE) data model and nurtured its practical implementation and multi-sector exploitation as a key enabler for the competitiveness of European industry.
- Final Draft data model #5 being reworked as PAS 20542
 - PAS = Publicly Available Standard (ISO terminology)
- A number of prototype tool interfaces demonstrate capability
 - SEDRES Project Final Event - December 2001 at BAE SYSTEMS (Warton, UK)
 - Included demonstrations

Overview of AP233

- Application Protocol 233 (AP233) is a modular, STEP-based data exchange standard, targeted to support the needs of the systems engineering community.
- The AP233 Project is collaborating with the Object Management Group (OMG) that has developed SYSMML, a systems engineering extensions to UML and INCOSE (International Council on Systems Engineering), a systems engineering professional society.

AP233 Scope

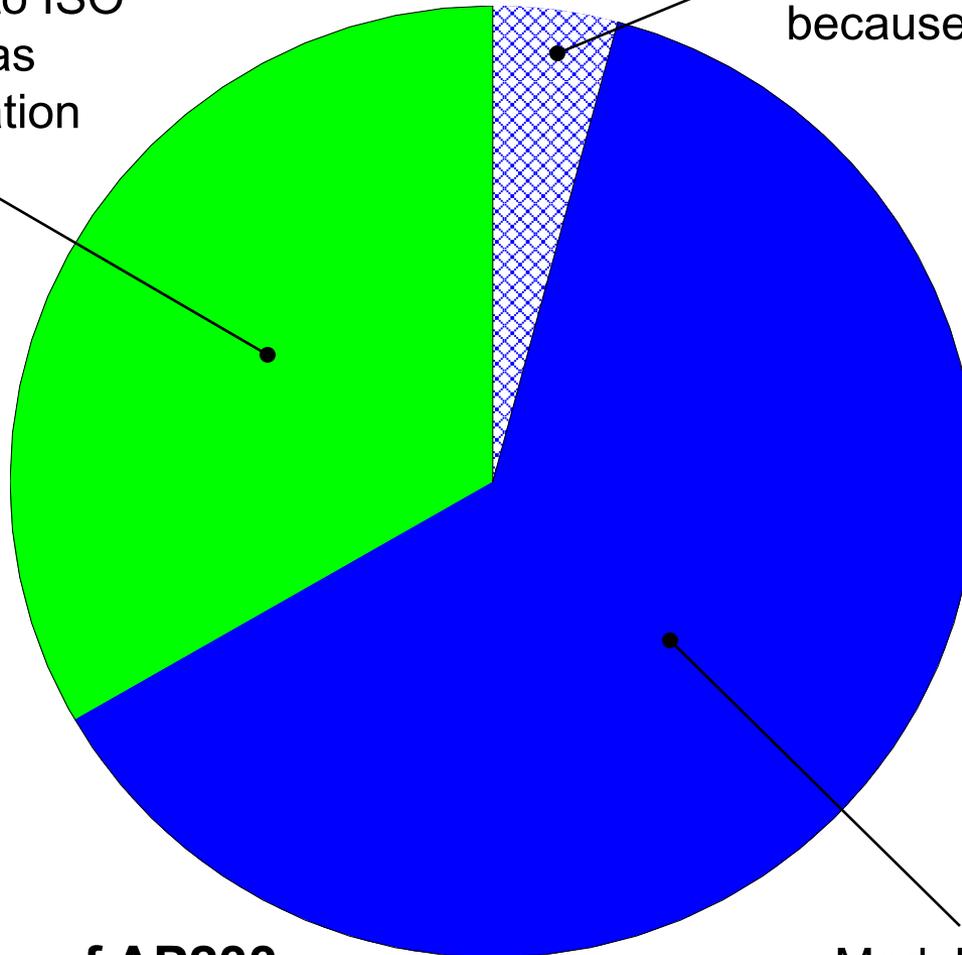
- Using the STEP modular develop approach, AP233's scope includes:
 - requirements (functional, architectural, property)
 - verification and validation
 - product functionality
 - architecture
 - (evaluation of) alternative solutions
 - traceability
 - product data management
 - project management information (cost, schedule, etc.)



* approximate higher level aggregation of ~150 modules

Modules released to ISO
by AP233 in 2008 as
Technical Specification

Modules in need of rework
because AP239 e2 updates



**Complete release of AP233 as
Draft International Standard (DIS)
expected in 2009**

Modules published
by PLCS (AP239) in 2004
and reused by AP233

AP233 Role

- ***Capture, Exchange and Archive Systems Engineering Information across Disciplines and Organizations. AP233 enables***
 - communication between similar tools in Systems engineering usage
 - communication between different tools both within and external to Systems engineering functions
 - holistic approaches to data sharing
 - fine grain configuration management to Systems engineering data
 - sharing of management data currently locked up in proprietary formats and tools
 - supports MBSE

Additional Information

References

[EXFF](#) - Engineering Exchange For Free

[EuroStep's AP233 Website](#)



AP-233

Welcome to Eurostep's AP233 website. Eurostep is a consulting and software development company specialising in sharing and exchanging engineering information. We have a team dedicated to AP233 who are leading the technical development of the Standard. We are also developing prototype applications and interfaces which enable data sharing and exchange of systems engineering data.

This website is intended to be an information resource for those companies wanting to contribute to the AP233 standard, or even for those who just want to use the standard. AP233 is still under development, but there are trial implementations under way (see software section)

[The Future of System Engineering Tools](#), Steve Jenkins, JPL

[NASA/ESA Product Data Exchange](#) Workshop at NASA's STEP site

[AP233.ORG](#) public site

[Step Module Repository Project](#)

Sample of implementations

Microsoft Excel - LIST_AP233-Implementations-2006-04-24-b

Type a question for help

File Edit View Insert Format Tools Data Window Help

Arial 10 B I U

H1

	A	B	C	D	E	F	G
1	LIST_AP233-Implementations-2006-04-24-b						
2	Implementations of AP233						
3	Application Names	Module Set	Type	Date	Status	Contact(s)	Comments
4	AP233 Demonstrator Tool	Requirements	Prototype	2001	Legacy	Ian Bailey	A freely available tool developed by Eurostep and funded by NASA and UK MoD to generate requirements test data.
5	SLATE	Requirements	Commercial	2001	Legacy	Mark Sampson, John Nallon	Early adopters of AP233 Requirements in a commercial tool; SAVE AS feature built-in to the SLATE
6	UGS TeamCenter SE	Requirements	Commercial	2003	Active	Mark Sampson, John Nallon	UGS TeamCenter SE is a follow-on product to SLATE after UGS acquisition
7	DOORS	Requirements	Test	2001	Legacy	Ian Bailey	Interface developed within AP233 Requirements Demonstrator Tool
8	Excel	Requirements	Test	2001	Legacy	Ian Bailey	Interface developed within AP233 Requirements Demonstrator Tool
9	MS Word	Requirements	Test	2001	Legacy	Ian Bailey	Interface developed within AP233 Requirements Demonstrator Tool
10	Vitech CORE	Requirements	Test	2001	Inactive	Ian Bailey	Interface developed within AP233 Requirements Demonstrator Tool
11	VTT	Requirements	Commercial	2002	Active	Eurostep-Finland	VTT (Finnish Government R&D Centre) contracted with Eurostep-Finland to develop a dual-language (Finnish/English) requirements management tool for the building and construction industry using an early version of the AP233 Requirements data model.
	3SL CRADLE	Requirements	Prototype	2002	Active	Julian Johnson, Ian Bailey	UK MoD funded this prototype to demonstrate ability to move MoD's requirements in DOORS into and out of

Ready

Thank You

... and are there any question?