Aspects on Systems Engineering Tool Integration

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Readers notes are available in notes page view.

Outline

- Motivation
- Requirements on a systems engineering data exchange mechanism
- Outline and status of the AP-233 data exchange standard
- The STEP standard framework
- Summary

System specification - Preliminaries

- Project problems can often be traced to the specification
  - Specification may be ambiguous
  - Specification may be incomplete
  - Specification may be complete but misinterpreted
- Tools for improving specification quality are becoming commonplace
  - A number of SE tools are available
  - Tool data exchange capabilities are often limited

Current trends 1

- System complexity is increasing
  - So is development cost
- Increased competition - global market
  - Failure could be devastating
- Accents the importance of a correct system specification

- Merger rally
  - Need to integrate heterogeneous processes and environments

Current trends 2

- Requirement management tools replaces word processor based specifications
- System modelling and verification tools are introduced
  - E.g., Statemate, CORE, Doors, Prover
- Introduction of PDM systems

- Paradigm shift
  - Allows for fine granularity traceability in the engineering process

Consequences

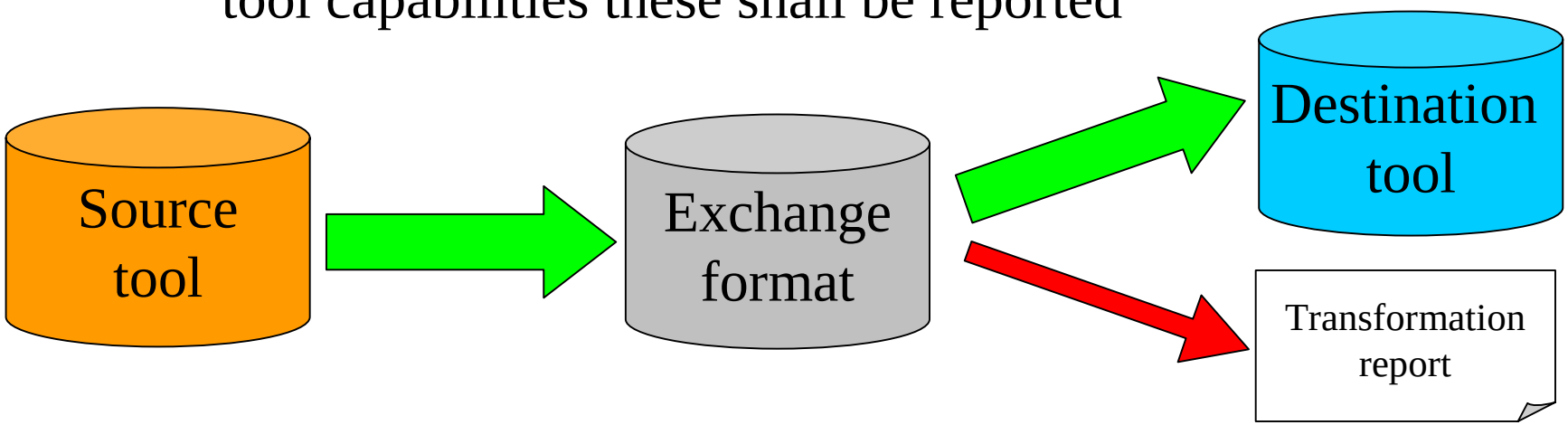
- A system specification is no longer a homogeneous document
  - Specification fragments may be available in multiple tool formats
    - Some representations allow for simulation and formal verification
- All parts of the specification must be kept under configuration management and traceability must be maintained
  - Over all partners involved in a project!

Intermediate conclusion

- No single tool cover all aspects of the systems engineering process
  - Beneficial to use multiple tools in the process
- Heterogeneous systems
  - Need to flow information down to multiple engineering disciplines
- Heterogeneous environments
  - Different tools in use in different departments or organisations involved in systems engineering
- Reliable and economical data exchange capabilities are required!

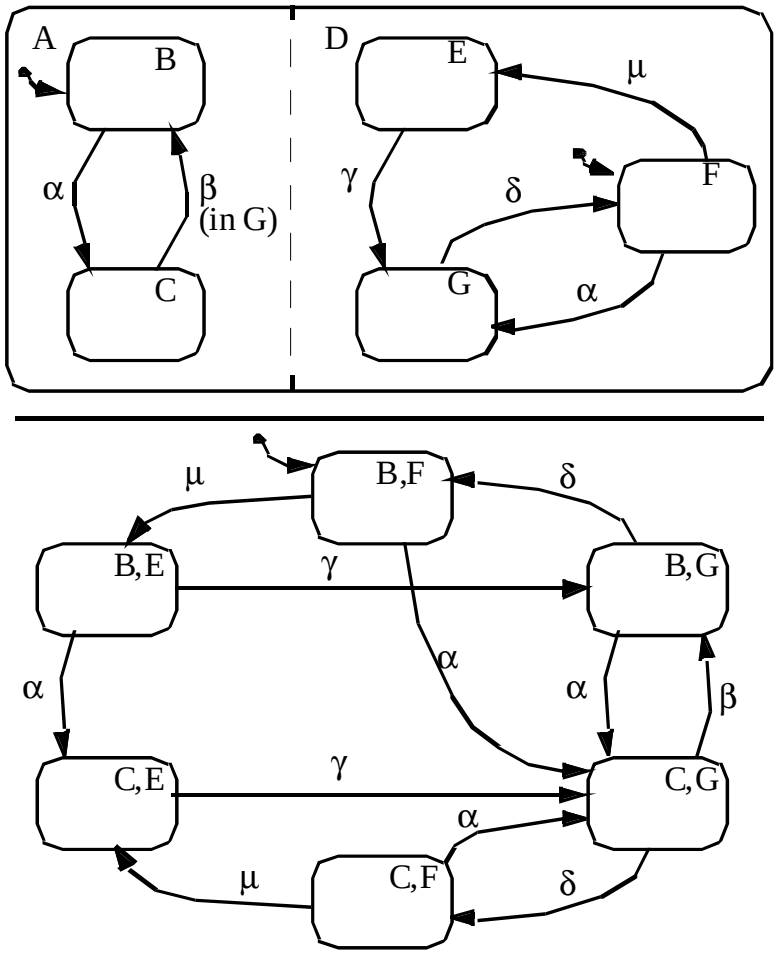
Data exchange requirements 1

- The semantics of a specification exchanged shall be maintained
  - The data exchange format shall be rich enough to maintain semantics
  - If alternations to a specification is introduced due to tool capabilities these shall be reported



Data exchange requirements 2

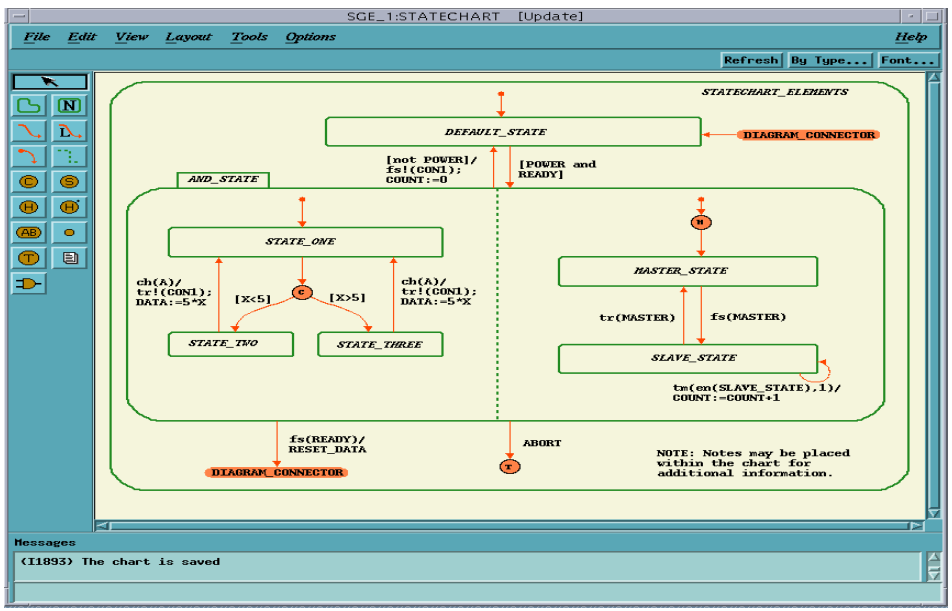
- The structure of a specification shall be maintained in a data exchange
  - Whenever possible
  - It is not obvious that the two models to the right are equivalent!



A state chart (top) and its equivalent basic state machine

Data exchange requirements 3

- A data exchange format shall preserve layout of a specification
  - preservation of visual layout of a specification is important to maintain readability of a specification

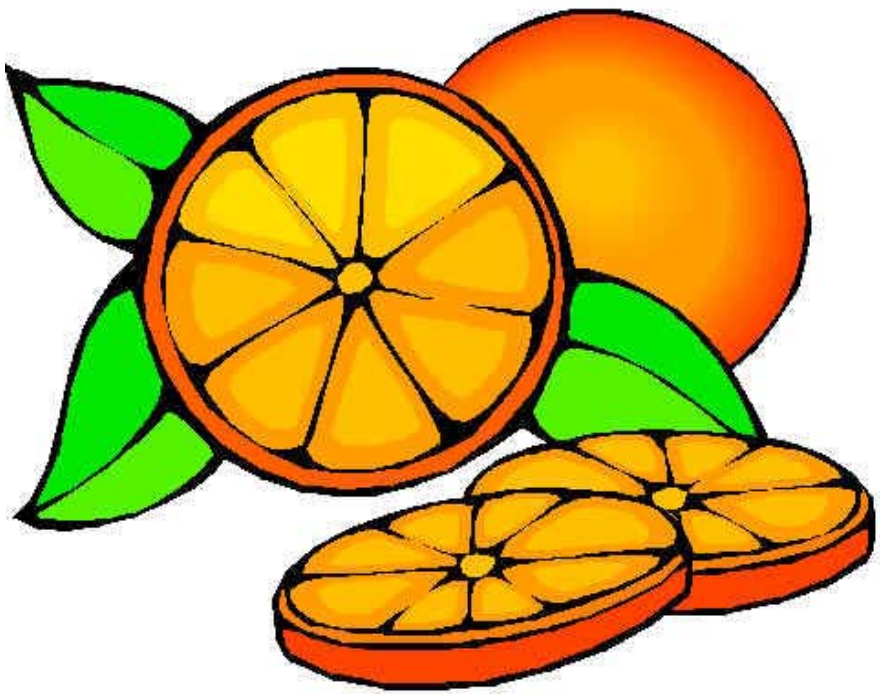


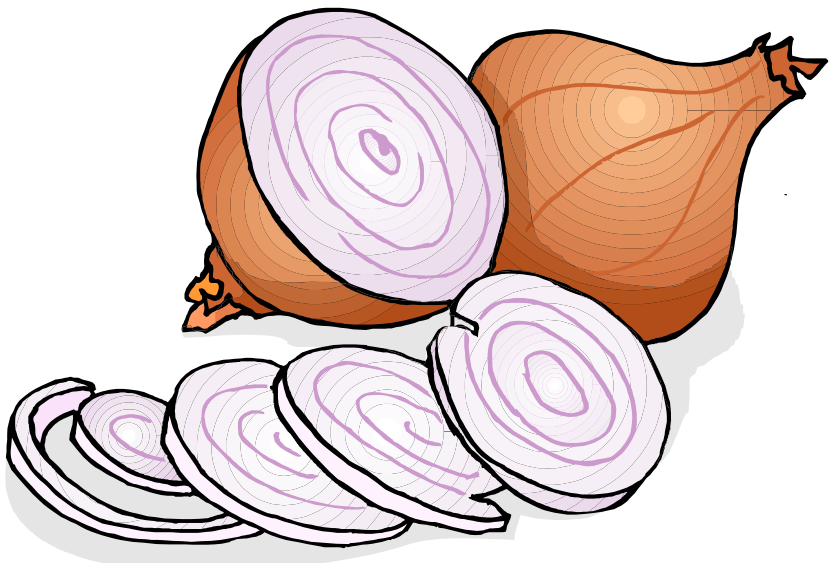
Data exchange requirements 4

- A data exchange format shall be independent of
  - Tool
  - Method
    - But shall support relevant methods and tools
  - Process
    - But shall support recording of activities in a project to maintain traceability
- No assumptions on what a ‘complete’ or ‘good’ system specification shall look like
  - Multiple views on the system under specification shall be supported

Data exchange requirements 5

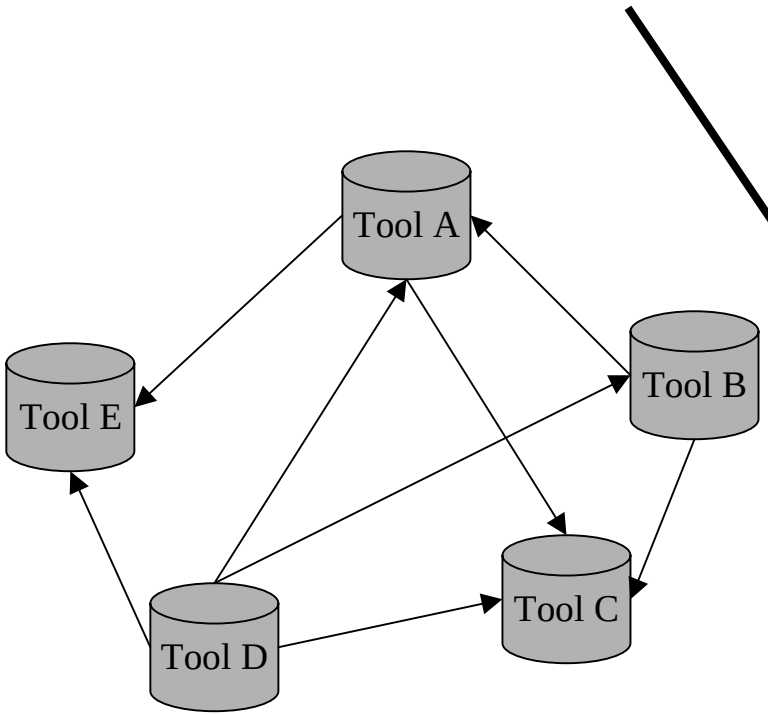
- Structured according to the ‘orange-onion’ principle

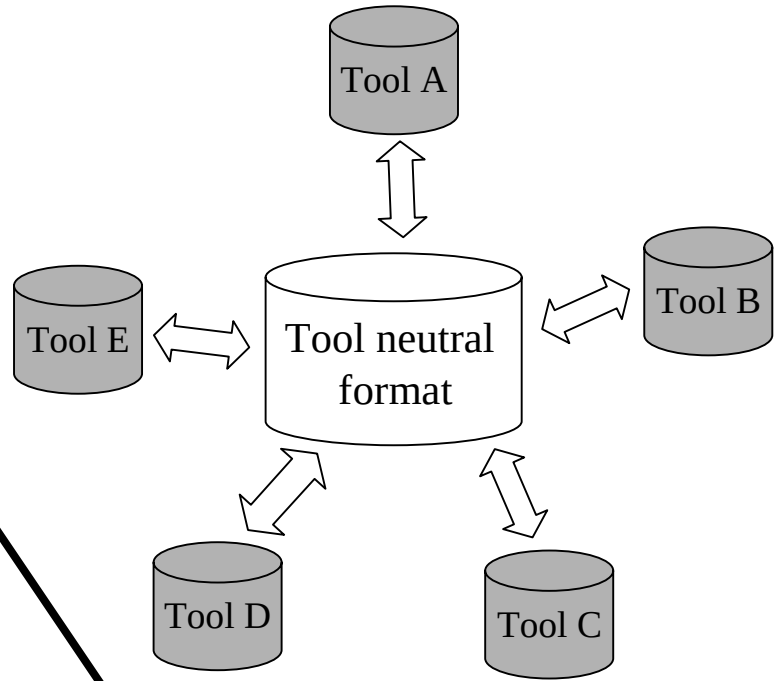




Data exchange approaches

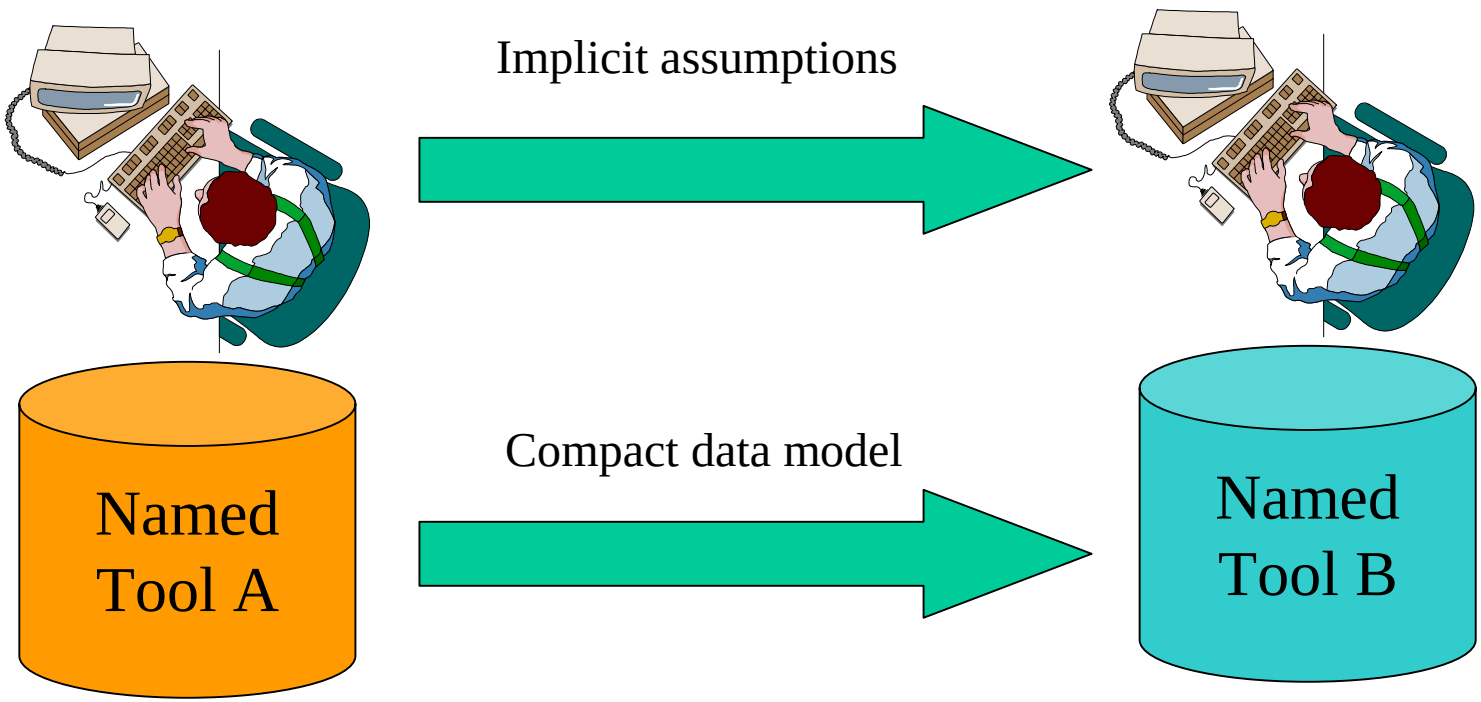
Direct translation



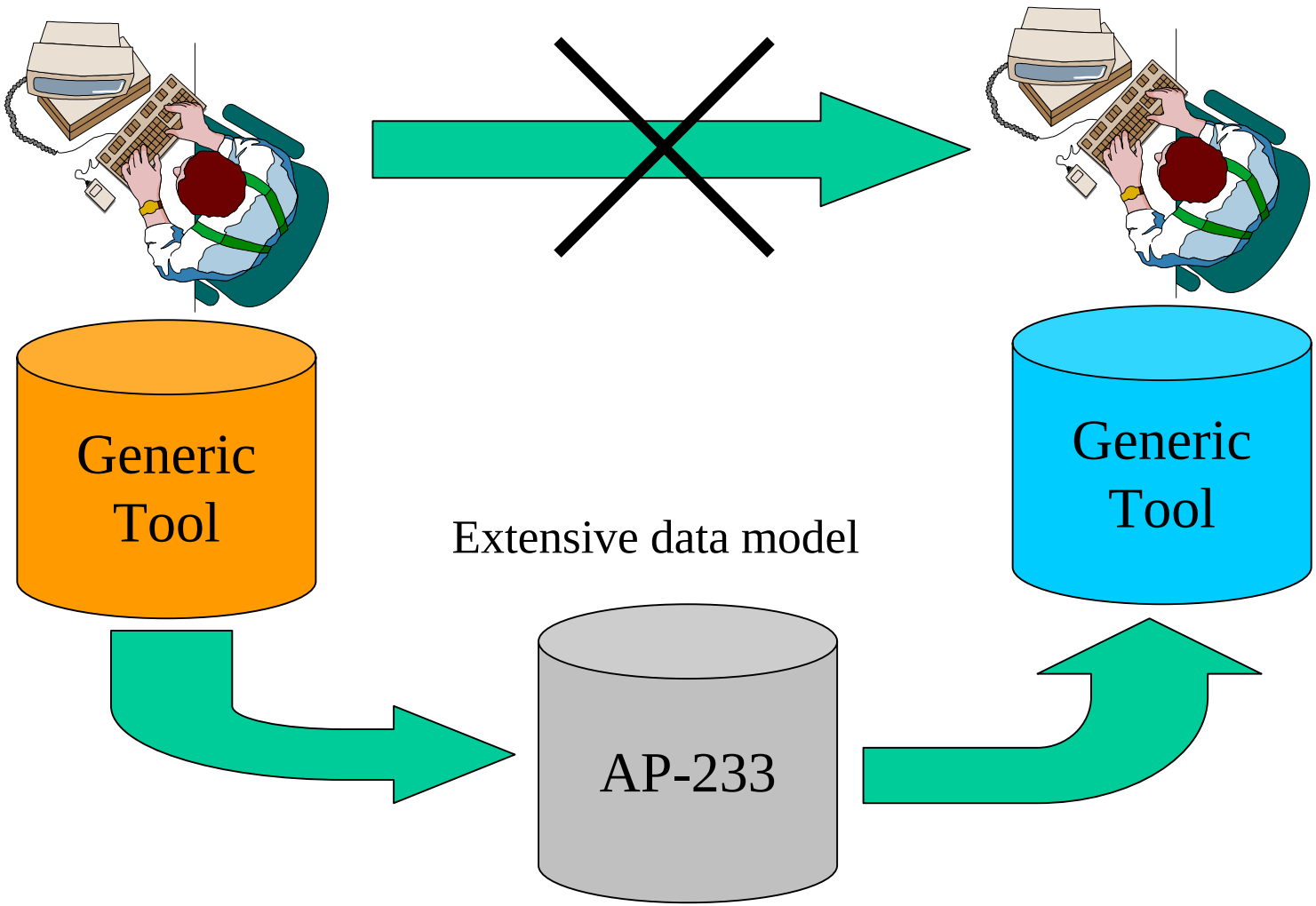


Intermediate format

Tool specific data exchange



Generic data exchange



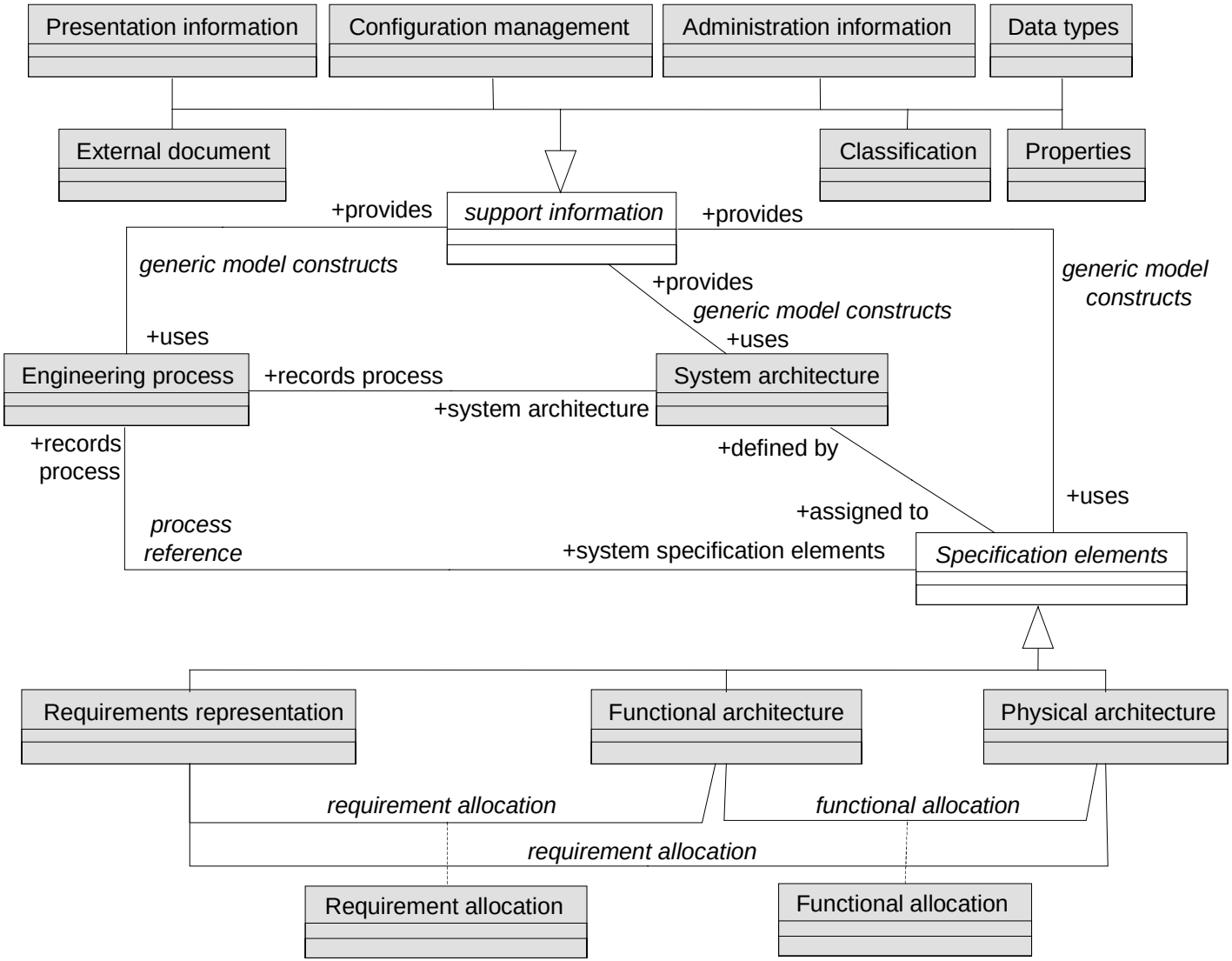
AP-233

- Systems engineering data exchange standard under development
  - Generic data model
  - Developed using the EXPRESS language
- Within the STEP standards framework
  - ISO 10303
- Active standardisation working group
  - with active INCOSE liaison

AP-233 keywords

- Supports data exchange
  - Across tool boundaries
  - Across domain boundaries
  - Across organisational boundaries
  - Independent of system life cycle
- While maintaining
  - specification semantics
  - specification readability
- And promoting
  - reuse of existing specification fragments
  - traceability and configuration management

AP-233 Scope



What is STEP?

- The scope of STEP (ISO 10303) is product data exchange standardisation.
  - Initiated in the ‘80’ies The root and main momentum is in mechanical engineering
- STEP is highly market driven
  - Standardisation is based industry initiative
  - Voluntary contribution
- Defines data exchange infrastructure
  - File format
  - Repository access
  - Information modelling language
  - Test methodology & certification
- Voting on standardisation is made on country basis
  - All countries active in ISO 10303 have ONE vote

STEP Infrastructure

Test cases - ATS

Test process - Part 3x

Domain data exchange standards - Application protocols

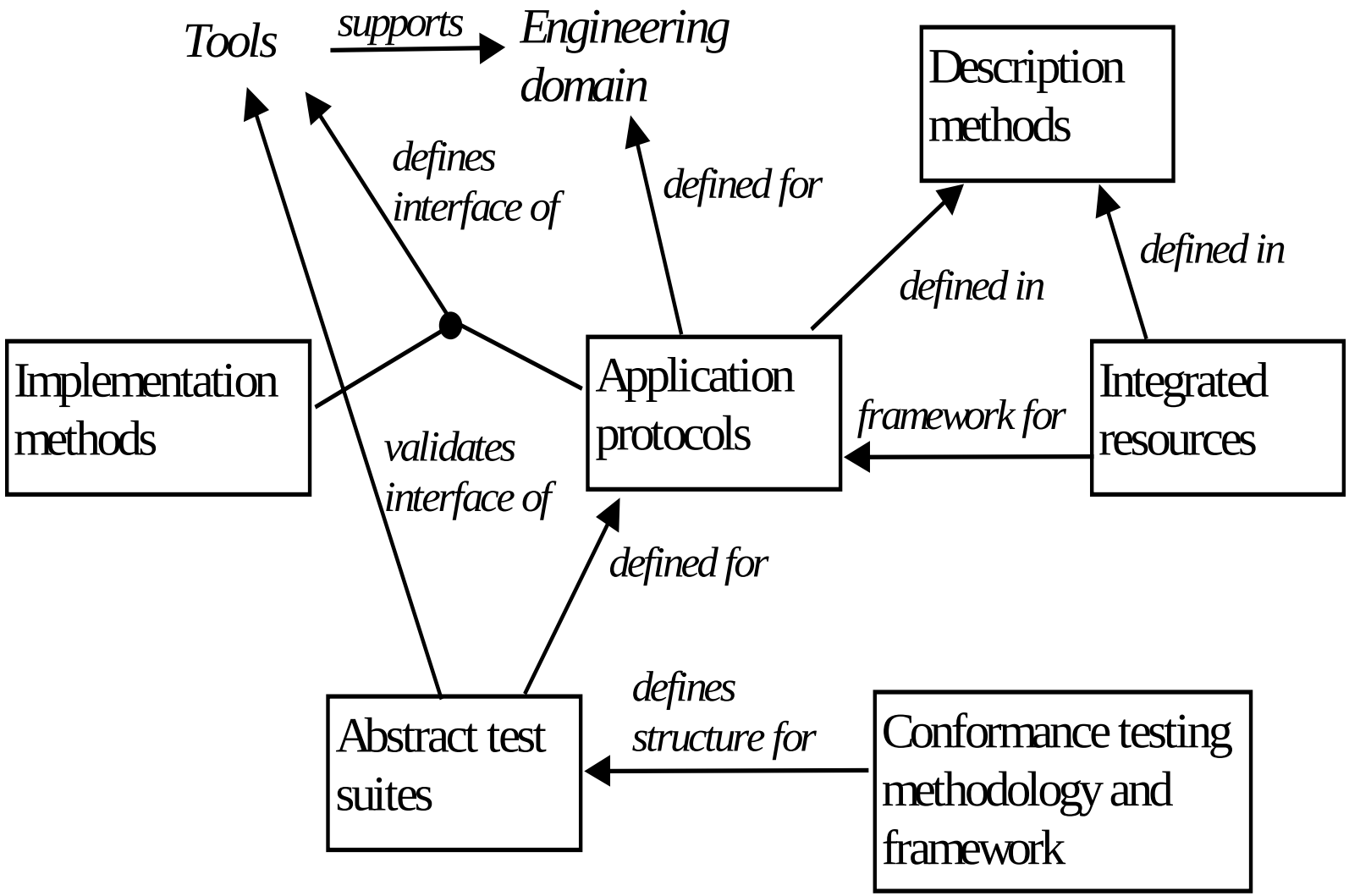
Reusable data exchange schemas - Application modules

Reusable schema components - Integrated resources

Modelling Languages

Data and API formats - implementation methods

STEP Infrastructure - Relationships



Existing Application Protocols

+AP201: Explicit Draughting

+AP202: Associative Draughting

+AP203: Configuration Controlled 3D Designs of Mechanical Parts and Assemblies

AP204: Mechanical Design using boundary representation

AP205: Mechanical Design using Surface Representation

+AP207: Sheet Metal Die Planning and Design

+AP209: Composite & Metallic Analysis & Related Design

+AP210: Electronic Assembly, Interconnect and Packaging Design

+AP212: Electrotechnical Design and Installation

+AP213: Numerical Control (NC) Process Plans for Machined Parts

+AP214: Core Data for Automotive Mechanical Design Processes

+ indicate at DIS, FDIS or IS

AP215-218: Ship Arrangement, Moulded Forms, Piping, Structures

AP220 PCA Process Planning

AP221: Functional Data and their Schematic Representation for Process Plant

AP222: Design to Manufacturing for Composite Structures

AP223: Exchange of Design and Manufacturing Product Information for Cast Parts

+AP224 Mechanical Product Definition for Process Planning Using Machining Features

+AP225 : Building Elements Using Explicit Shape Representation

AP226: Ship Mechanical Systems

+AP227: Plant Spatial Configuration

AP231: Process Design and Process Specifications of Major Equipment

AP232: Technical Data Packaging Core Information and Exchange

AP233 Systems Engineering Data Representation

Standardisation activities and progress

- Five working drafts has been developed
- Tool interfaces will be implemented in the SEDRES2 project
  - Validation of the data model
  - Results will be available by mid 2001
- AP-233 standardisation delayed by STEP transition to a modular application protocol structure
  - Further information is available at www.sedres.com

Summary

- Review of requirements on a data exchange format
  - Focus on maintaining specification semantics
  - Thus limiting the risk introduced by data exchange
- Outline of the scope of AP-233
- Overview of the STEP standards framework
- Summary of the standardisation process status

Supported by the SEDRES2 project