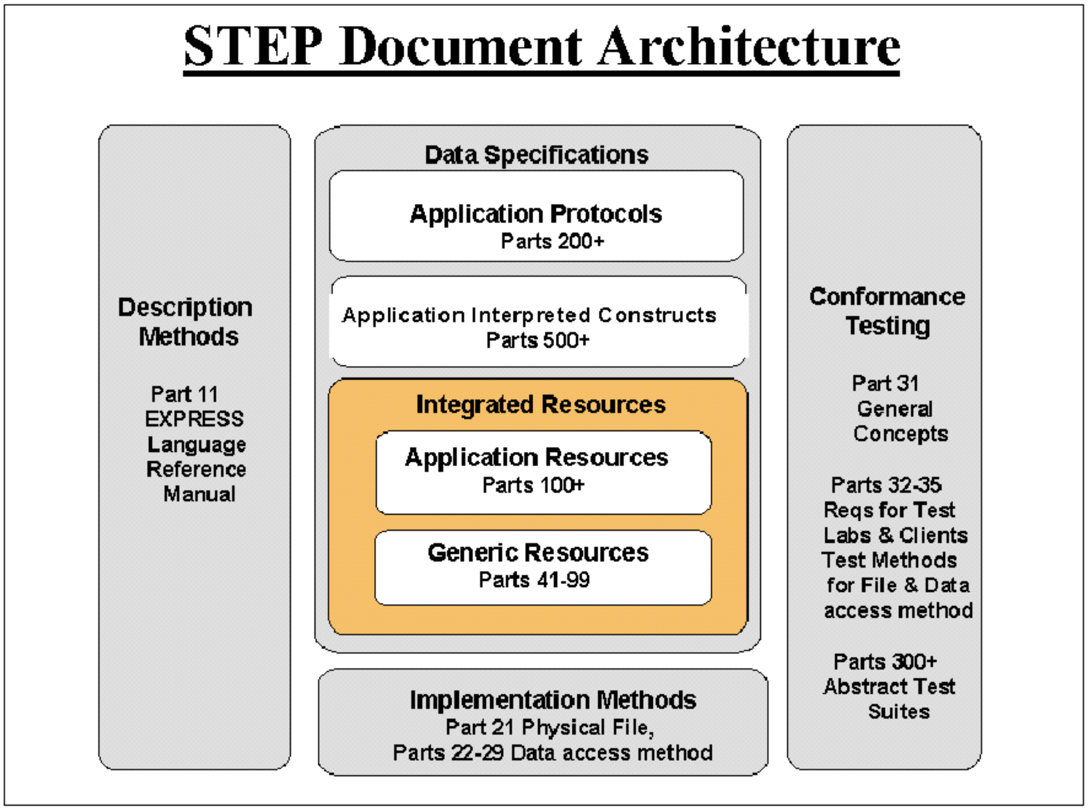


Fig. 7.1 : Overview of the STEP document architecture (Kemmerer 1999)

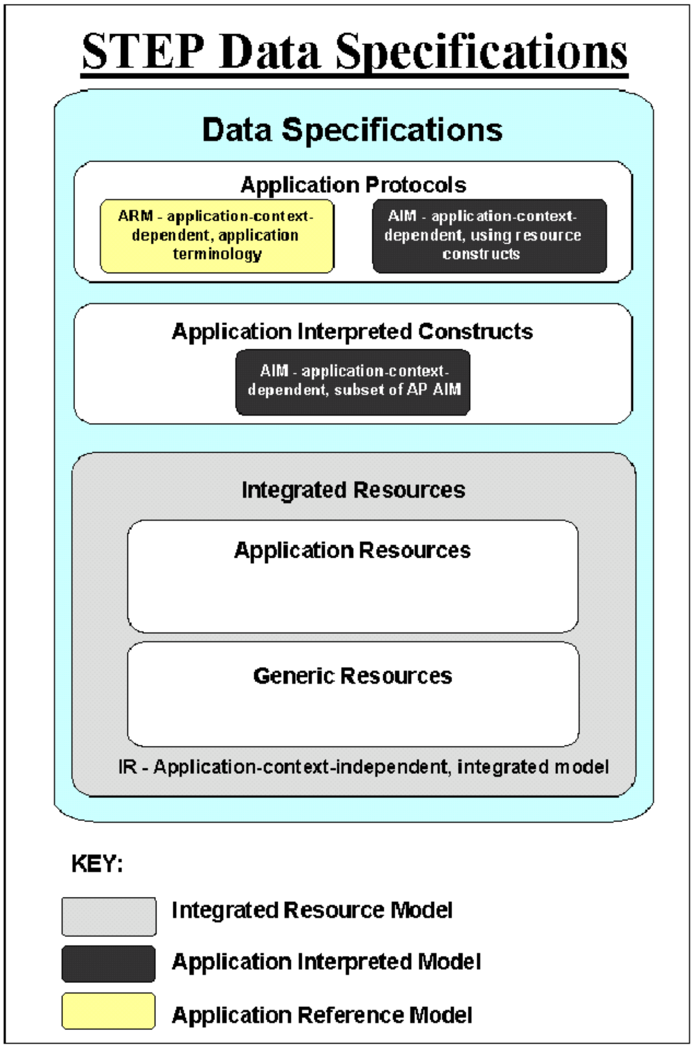


Fig. 7.2 : STEP data specification (Kemmerer 1999)

ISO TC184 SC4

STEP on a Page

ISO 10303

APPLICATION PROTOCOLS AND ASSOCIATED ABSTRACT-TEST SUITES

I 201 Explicit draughting [ATS 301 = X]
I 202 Associative draughting [X]
I 203 Configuration-controlled design (c2=I,a1=I)[X]
I 204 Mechanical design using boundary rep [I]
X 205 Mechanical design using surface rep [W]
X 206 Mechanical design using wireframe [X]
I 207 Sheet metal die planning and design [I]
X 208 Life-cycle product change process [X]
I 209 Composite & metal structural anal & related design[X]
I 210 Electronic assy, interconnection & packaging design [X]
X 211 Electronic P-C assy: test, diag, & remanuf[X]
I 212 Electrotechnical design and installation [C]
X 213 Num control (NC) process plans for mach'd parts [X]
I 214 Core data for automotive mech design processes (e2=E)[F]
E 215 Ship arrangement [X]
E 216 Ship moulded forms [X]
X 217 Ship piping [X]
E 218 Ship structures [X]
X 219 Dimension inspection [X]
O 220 Proc. plg, mfg, assy of layered electrical products [X]

C 221 Functional data & their schem rep for process plant [X]
X 222 Design-manuf for composite structures [W]
X 223 Exch of design & mfg product info for cast parts [@]
I 224 Mech pdt def for p. plg using mach'n'g feat (e2=X,e3=A)
I 225 Building elements using explicit shape rep [C] \[X,I]
X 226 Ship mechanical systems [C]
I 227 Plant spatial configuration(e2=C) [X]
X 228 Building services: HVAC [X]
X 229 Design & mfg product info for forged parts[X]
X 230 Building structural frame: steelwork [X]
X 231 Process-engineering data [X]
I 232 Technical data packaging: core info & exch [I]
W 233 Systems engineering data repr (to be PAS 20542)[X]
X 234 Ship operational logs, records, and messages[X]
W 235 Materials info for des and verif of products [X]
W 236 Furniture product and project data[W]
W 237 Computational Fluid Dynamics
A 238 Computer numerical controllers
W 239 Product life-cycle support
W 240 Process plans for machined products

jgnell, 89-Oct.-23; **rev. 03-04-07**. Origin: ISO 10303 Editing Committee. On-line: http://www.nist.gov/sc5/soap/

DESCRIPTION METHODS

I 1 Overview and fundamental principles
I 11 EXPRESS language ref man. (c1=I,c2=C e2=C e3=X(ISO 20303=X a1=X)
I 12 EXPRESS-I language ref man (Type 2 tech report, not a 10303 part)
X 13 Architecture and Methodology reference manual
E 14 EXPRESS X Language reference manual

COMMON RESOURCES (with 13584-20 logic. model of expr.(I) and 15531-42 Time (W))

APPLICATION MODULES (Technical specifications)

For status of the modules access the file via the SOAP home page.

Legend: TS Status
0-10 =O=prop-->apvl for ballot
10-20=A=NP blt circ-->NP apvl
20-60=D=DTS dev-->reg as TS
>60 =T=TS Published

INTEGRATED-APPLICATION RESOURCES

I 101 Draughting (c1=I)
X 102 Ship structures
X 103 E/E connectivity
I 104 Finite element analysis
I 105 Kinematics (c1=I, c2=I)

X 106 Building core model
C 107 Finite-element analysis definition relationships
C 108 Prmetizat'n&Constraints for expl geom prod mdls
C 109 Assembly model for products
W 110 Mesh-based computational fluid dynamics

INTEGRATED-GENERIC RESOURCES

I 41 Fund of prdct descr & spt (e2=I,c1=I)
I 42 Geom & top rep (c3=I,e2c1=I,e3=F)
I 43 Repres specialization (e2=I,c1=I,c2=I)
I 44 Product struct confg (e2=I,c1=I)
I 45 Materials (c1=I)
I 46 Visual presentation (c1=I, c2=I)
I 47 Tolerances (c1=I)
X 48 Form features
I 49 Process structure & properties

I 50 Mathematical constructs
E 51 Mathematical description
W 52 Mesh-based topology
W 53 Numerical Analysis
C 54 Classification Set theory
A 55 Procedural and hybrid represent.
W 56 State
W 57 Expression extensions
A 58 Risk

APPLICATION-INTERPRETED CONSTRUCTS

I 501 Edge-based wireframe
I 502 Shell-based wireframe
I 503 Geom-bounded 2D wireframe
I 504 Draughting annotation
I 505 Drawing structure & admin.
I 506 Draughting elements
I 507 Geom-bounded surface
I 508 Non-manifold surface
I 509 Manifold surface
I 510 Geom-bounded wireframe
I 511 Topological-bounded surface

I 512 Faceted B-representation
I 513 Elementary B-rep
I 514 Advanced B-rep
I 515 Constructive solid geometry
X 516 Mechanical-design context
I 517 Mech-design geom presentation(c1=I)
I 518 Mech-design shaded presentation
I 519 Geometric tolerances (c1=I)
I 520 Assoc draughting elements
@521 Manifold subsurfaces
E 522 Machining features
A 523 Curve swept solid

IMPLEMENTATION METHODS

I 21 Clear-text encoding exch str (c1=I,e2=I)
I 22 Standard data access interface
I 23 C++ language binding (to #22)
I 24 C language binding (to #22)

C 25 EXPRESS to OMG XMI
X 26 IDL language binding (to #22)
I 27 JAVA language binding (to #22)
@28 XML rep for EXPRESS-schemata & data
X 29 Ltwt Java binding (to #22) \(DTS)

CONFORMANCE TESTING METHODOLOGY & FRAMEWORK

I 31 General concepts
I 32 Requirements on testing labs and clients
X 33 Structure and use of abstract test suites
I 34 Abstract test methods for Part 21 implementation.
C 35 Abstract test methods for Part 22 implementation.

Legend: Part Status (E, F, I safe to implement)
0=O=Preliminary Stage (Proposal-->appr for NP ballot)
10=A =Proposal Stage (NP ballot circ-->NP approval)
20=W=Preparatory Stage (Wkg Draft devel.-->CD regis)
30=C =Committee Stage (CD circulation-->DIS regis)
40=E =Enquiry Stage (DIS circ.-->FDIS registration)
50=F =Approval Stage (FDIS circ-->Int'l Std regis)
@=At ISO, approved for publication (ISO status 40.95 or 50.99)
60=I =Publication Stage (Int'l Std published)
98=X=Project withdrawn

Fig. 7.3 : STEP On A Page : components of the standard (schema) (SOAP)

ISO TC184 SC4

STEP on a Page

ISO 10303

STEP on a Page provides a graphic summary of the progress of STEP, Standard for the Exchange of Product Model Data, the familiar name for ISO 10303. ISO TC184 SC4, Industrial-Automation Systems and Integration/Industrial Data develops the STEP standard.

Status of STEP Parts

Every part shown in the STEP on a Page has its status shown beside it. The status designators vary from "O" (the ISO preliminary stage) to "I" (International Standard--the stage in which the standard is published). Parts designated as "E, F" (levels of Draft International Standard) and "I" are considered advanced enough to allow software vendors to prepare implementations. The legend at the bottom of the page lists the corresponding ISO-project stage numbers next to the letter code.

Architecture of STEP

STEP on a Page attempts to show the STEP architecture by grouping the STEP parts into five main categories: description methods, implementation and conformance methodology, common resources, abstract-test suites, and application protocols.

Description Methods

From an architectural perspective, the description methods group forms the underpinning of the STEP standard. This includes part 1, Overview, which also contains definitions that are universal to the STEP. Also in that group, part 11, EXPRESS Language Reference Manual, describes the data-modeling language that is employed in STEP. Parts in the descriptive-methods group are numbered from 1 to 19.

Implementation & Conformance

The STEP implementation-methods group, the 20s series, describes the mapping from STEP formal specifications to a representation used to implement STEP.

The conformance-testing-methodology-framework group, the 30s series, provides information on methods to test software-product conformance to the STEP standard, guidance for creating abstract-test suites, and the responsibilities of testing laboratories. The STEP standard is unique in that it places a very high emphasis on testing, and actually includes these methods in the standard itself.

Common Resources (IR, AIC, and AM)

At the next level is the common-resources group, the parts that contain the generic-STEP-data models. The common resources were formerly called integrated-information resources. These data models can be considered the building blocks of STEP, and they can help AP integration and interoperability because entities in the common-resources group are shareable across the application protocols that need them.

Categories of common resources are generic resources, application resources, and application-interpreted constructs, application modules, plus the Logical model of ISO 13584-20 and the Time model of ISO 15531-42. Integrated-generic resources are generic entities that are used as needed by application protocols (AP below). Parts within generic resources have numbers between 40 and 60, and are used across the entire spectrum of STEP APs. The integrated-application resources contain entities that have slightly more context than the generic entities. The parts in the integrated-application resources are numbered in the 100s.

The 500 series are application-interpreted constructs, AICs. These are reusable groups of information-resource entities that make it easier to express identical semantics in more than one AP.

Application Modules are reusable groups of functional information requirements of applications that extend the AIC capability. The functional groups, defined in enterprise-application terms, are aligned with groups of integrated-generic resources. The application modules comprise the 1000 series of parts, which are technical specifications that achieve consensus at the Committee stage. AMs offer an opportunity to represent functional capability in multiple APs with a lower standards-development cost.

Abstract-Test Suites (ATS)

The 300 series of parts, abstract-test suites, consists of test data and criteria that are used to assess the conformance of a STEP software product to the associated AP. SC4 requires that every AP contain or be associated with an abstract-test suite. The numbers assigned to ATSs exceed the AP numbers by exactly 100. Therefore, ATS 303 applies to AP203. On the graphic, the ATS status is shown in brackets, [ ], following the AP name.

Application Protocols (AP)

At the top level of the STEP hierarchy are the more complex data models used to describe specific product-data applications. These parts are known as application protocols and describe not only what data is to be used in describing a product, but also how the data is to be used in the model. The APs use the integrated-information resources in well-defined combinations and configurations to represent a particular data model of some phase of product life. APs are numbered in the 200s. APs currently in use are the Explicit Draughting AP 201 and the Configuration Controlled Design AP 203.

ooOOoo

STEP on a Page was conceived and implemented by Jim Nell, National Institute of Standards and Technology. Updated 01-June-07

Fig. 7.4 : STEP On A Page : components of the standard (details) (SOAP)

ISO TC184 SC4 | **STEP on a Page** | **ISO 10303**

COMMON RESOURCES (with 13584-20 Logical model of expressions(I) and 15531-42 Time model(W))

APPLICATION MODULES (Technical specifications)

T 1001 Appearance assignment
T 1002 Colour
T 1003 Curve appearance
T 1004 Elemental shape
T 1005 Elemental topological shape
T 1006 Foundation representation
T 1007 General surface appearance
T 1008 Layer assignment
T 1009 Shape appearance and layers
D 1010 Date time

D 1011 Person organisation
D 1012 Approval
D 1013 Person organisation assignment
D 1014 Date time assignment
D 1015 Security classification
D 1016 Product categorisation
D 1017 Product identification
D 1018 Product version
D 1019 Product view definition
D 1020 Product version structure

D 1021 Identification assignment
D 1022 Part and version identification
D 1023 Part view definition
D 1024 Product structure
D 1025 Alias identification
D 1026 Part structure
D 1027 Part occurrence
D 1028 Geometric shape and topology
D 1029 Boundary representation model
D 1030 Property assignment

D 1031 Property representation
D 1032 Shape property assignment
D 1033 Shape property representation
D 1034 Product view definition properties
D 1035 Product view definition structure properties
D 1036 Independent property
D 1037 Independent property usage
D 1038 Independent property representation
D 1039 Geometric validation property representation
D 1040 Process property assignment

D 1041 Product view definition structure
D 1042 Work request
D 1043 Work order
D 1044 Certification
D 1045 Solid model
D 1046 Product replacement
D 1047 Activity
D 1049 Activity method

D 1054 Value with unit
D 1055 Part definition releationship
D 1056 End item identification
D 1057 Effectivity
D 1058 Configuration effectivity
D 1059 Effectivity application
D 1060 Product concept identification

D 1061 Project
D 1062 Contract
D 1064 Event
D 1065 Time Interval
D 1066 Constructive solid geometry
D 1068 Constructive solid geometry 3D
D 1069 Faceted boundary representation model

D 1118 Measure representation
D 1121 Document and version
D 1122 Document assignment
D 1123 Document definition
D 1124 Document structure
D 1125 File properties
D 1126 Document properties
D 1127 File identification
D 1128 External item identification assignment

D 1501 Edge based wireframe
D 1502 Shell based wireframe
D 1507 Geometrically bounded surface
D 1509 Manifold surface
D 1510 Geometrically bounded wireframe
D 1511 Topologically bounded surface
D 1512 Faceted boundary representation
D 1514 Advanced boundary representation

Legend: TS Status
0-10 =O=prop-->apvl for ballot
10-20=A=NP blt circ-->NP apvl
20-60=D=DTS dev-->reg as TS
>60 =T=TS Published

Fig. 7.5 : STEP On A Page : application modules (SOAP)

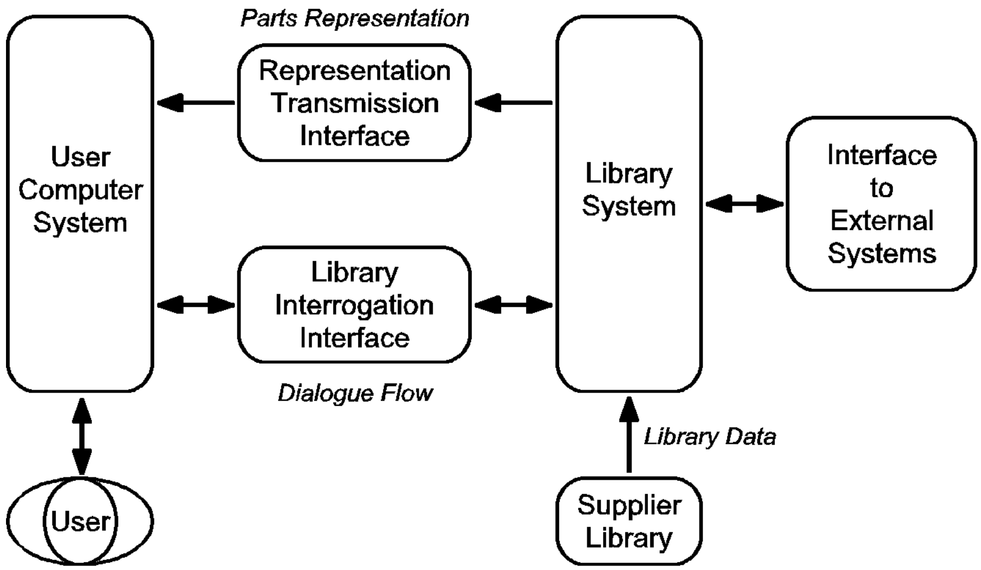


Figure 7.6 Functional areas of library usage

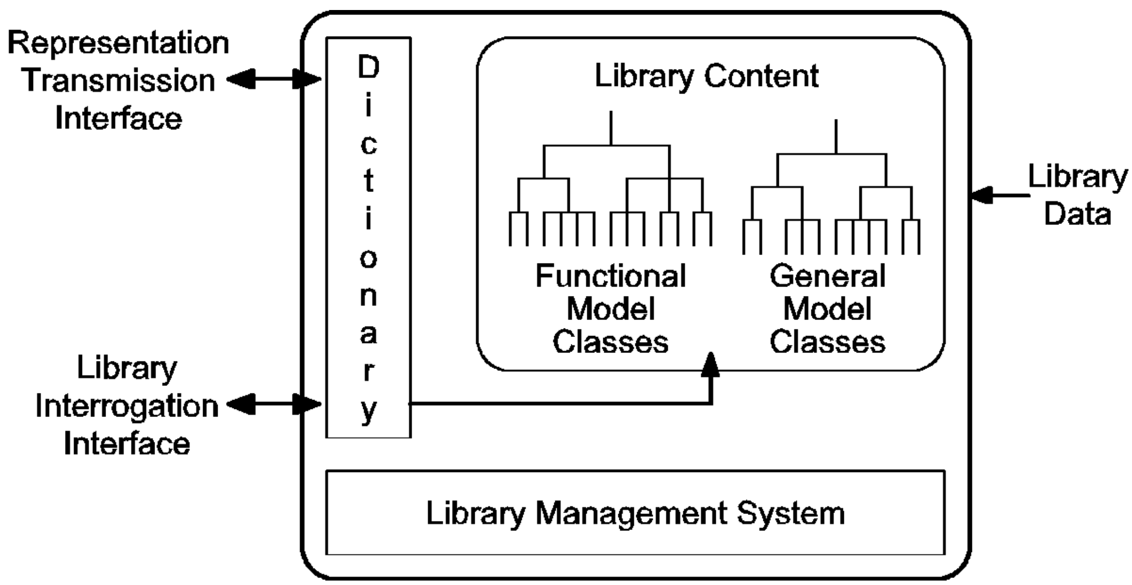


Figure 7.7 Library System

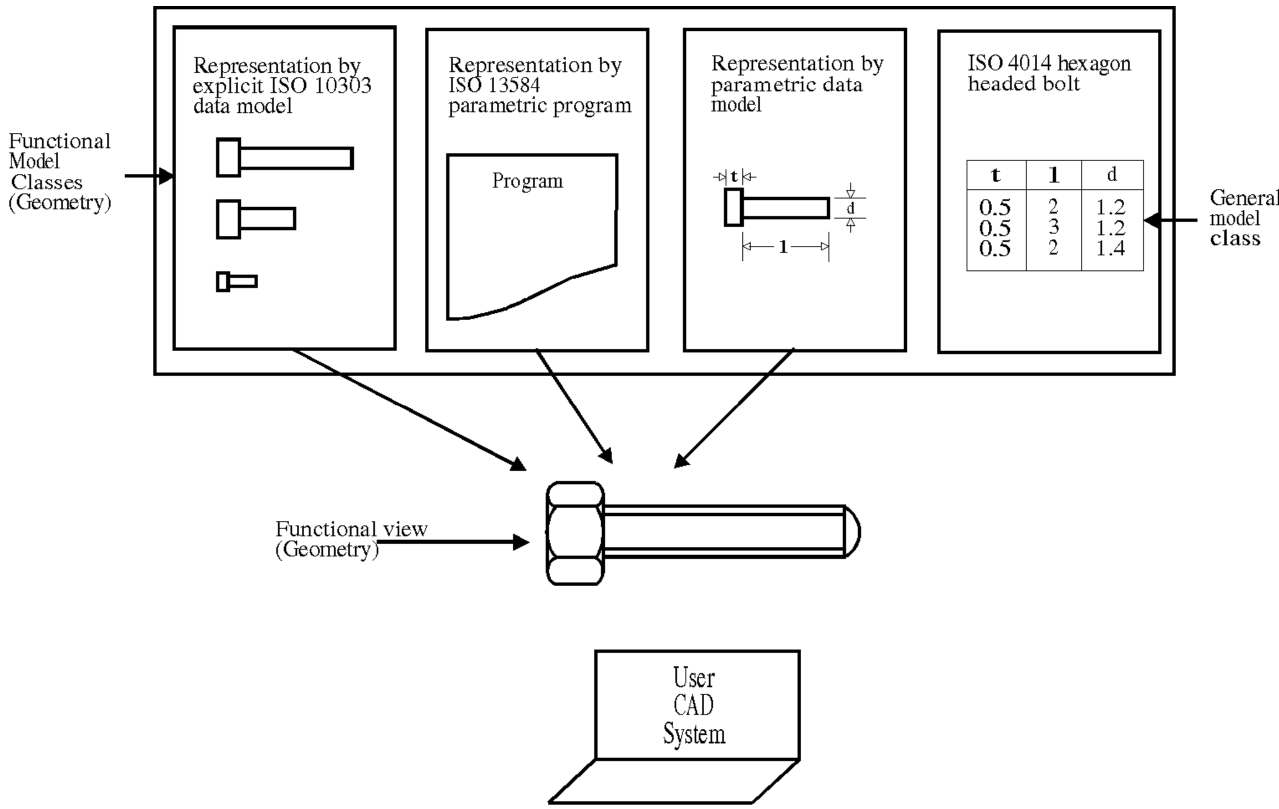


Figure 7.8 Structure of library contents

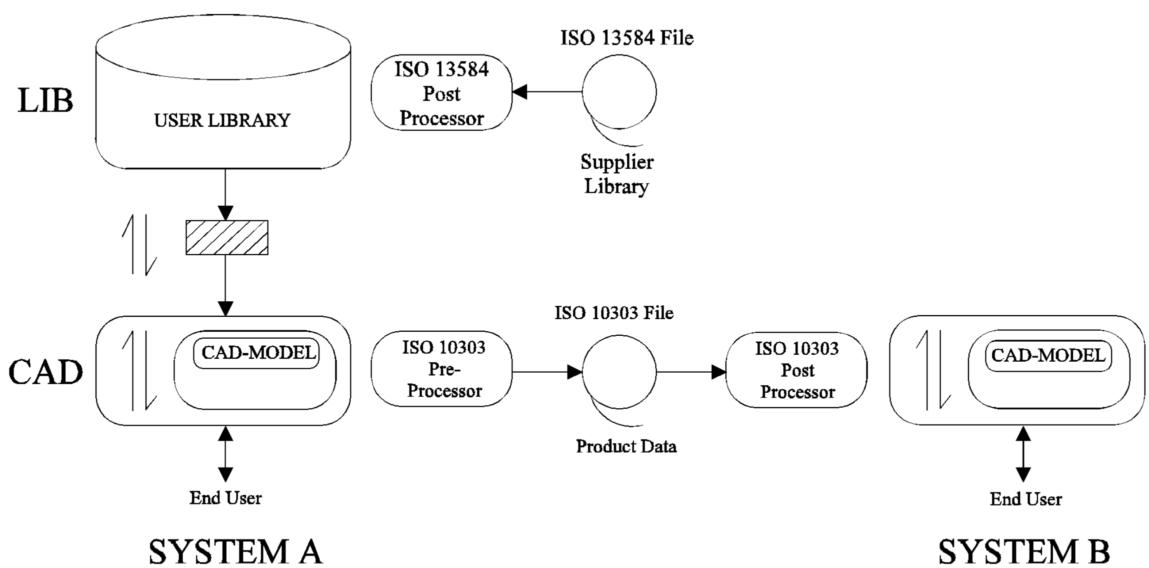


Figure 7.9 Libraries and product data exchange (level 1)

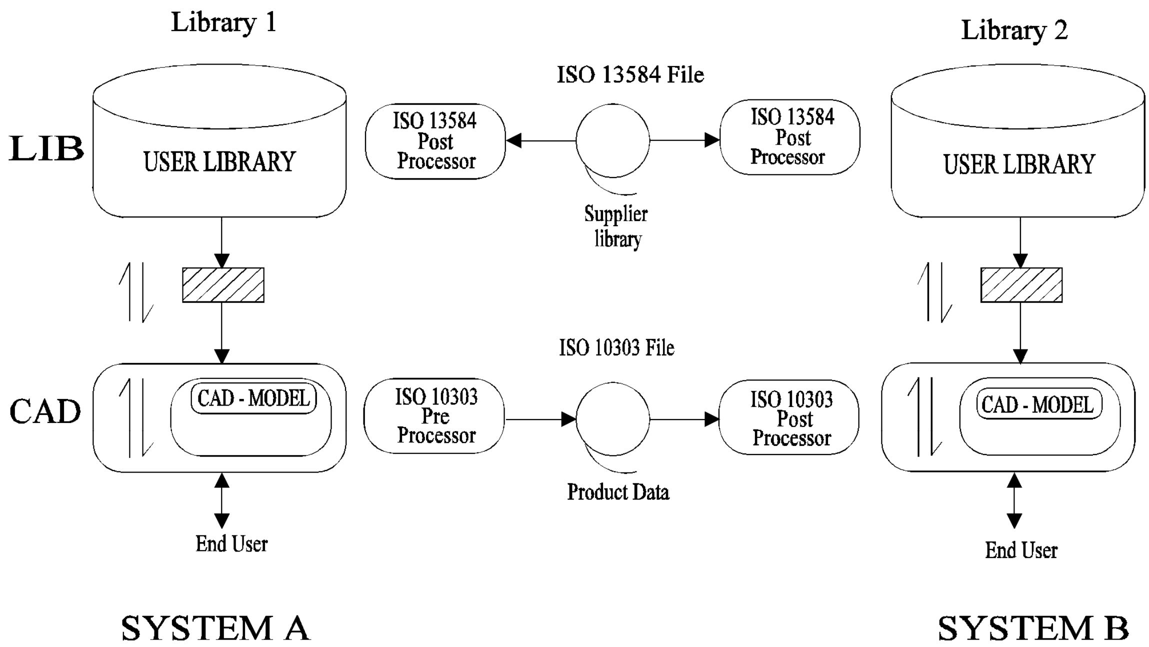


Figure 7.10 Libraries and product data exchange (level 2)

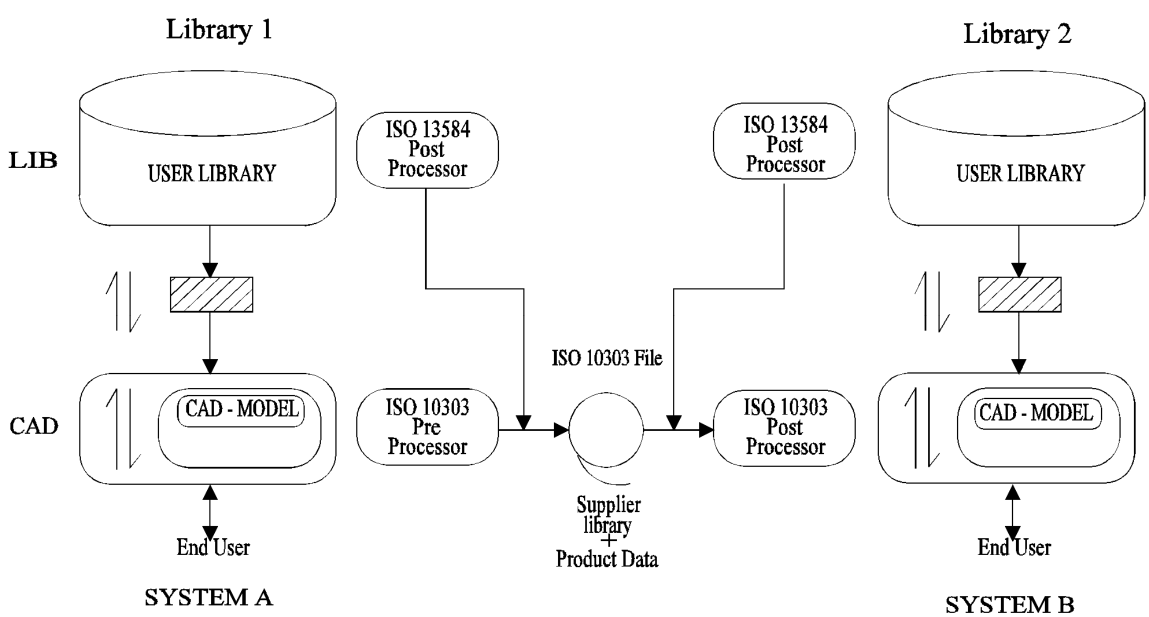


Figure 7.11 Libraries and product data exchange (level 3)

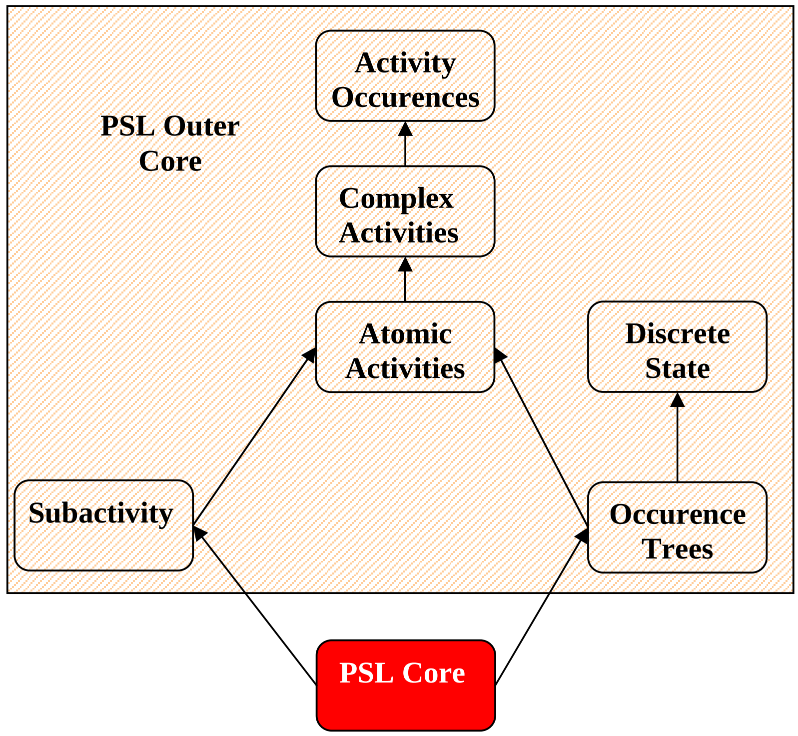


Figure 7.12 : PSL Outer Core definitions and their dependencies (ISO IS 18629-12)

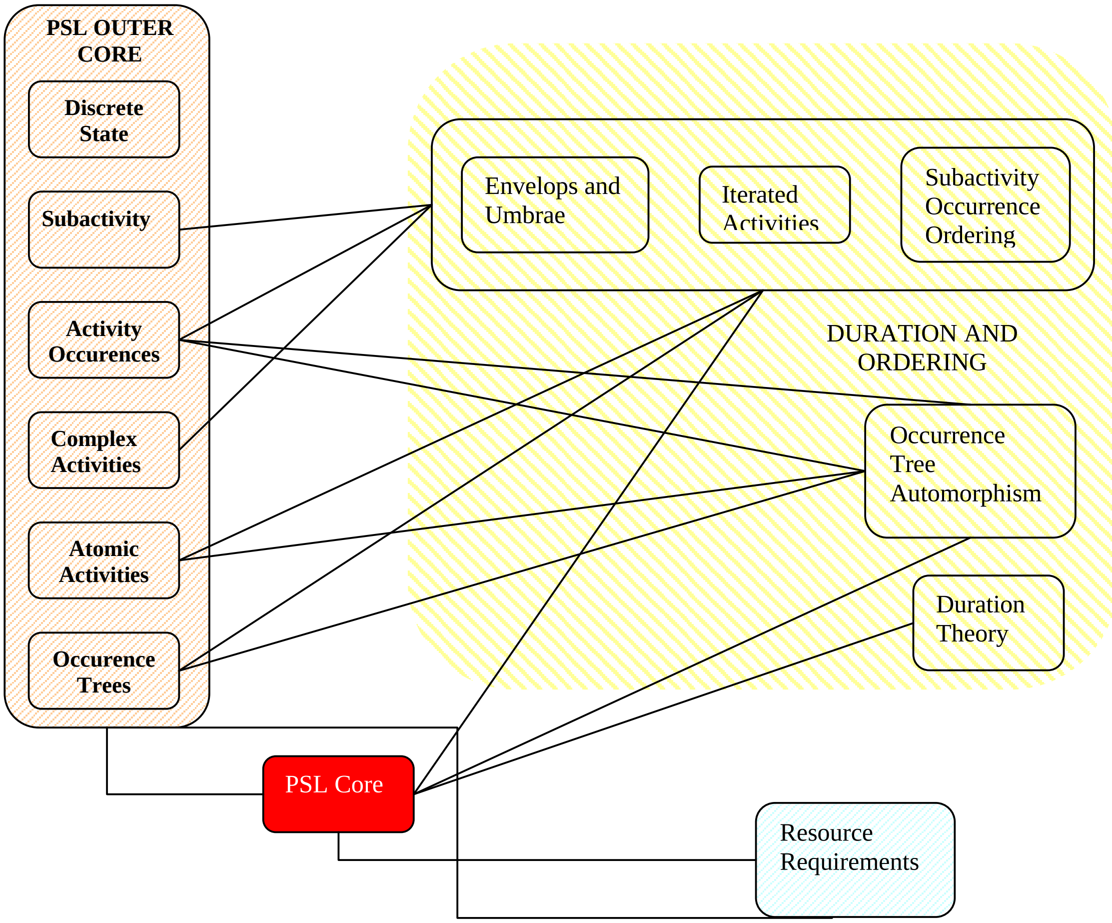


Figure 7.13 : Core and Outer Core Dependencies for Duration and Ordering, and Resource Requirements theories (ISO CD 18629-13), (ISO CD 18629-14)

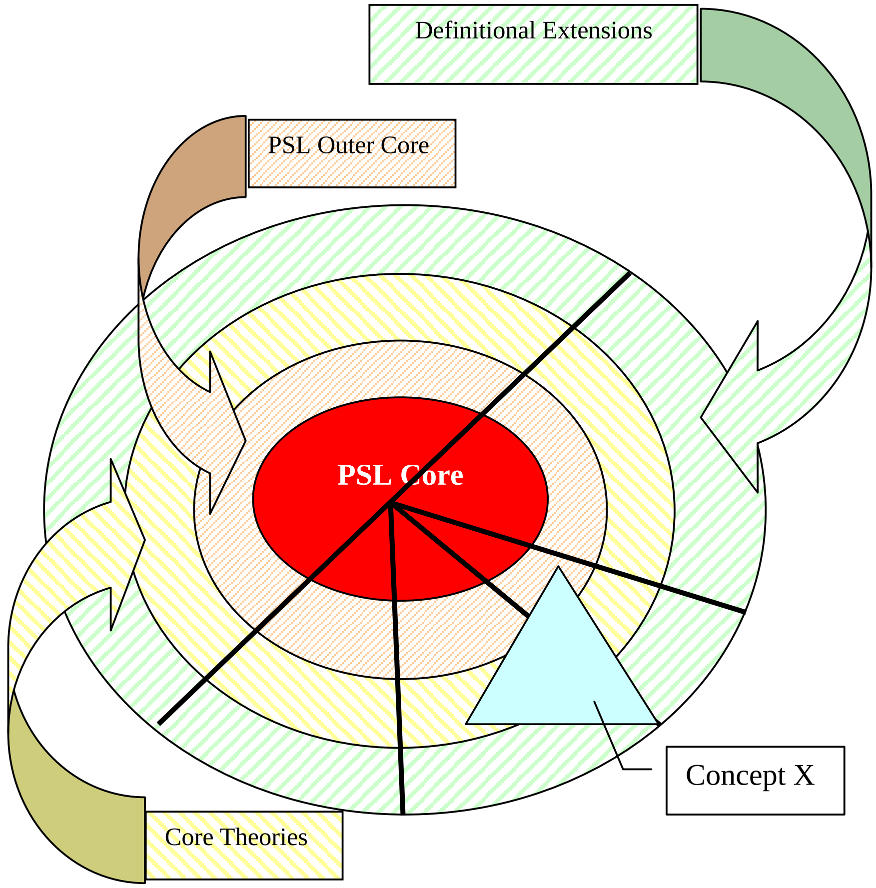
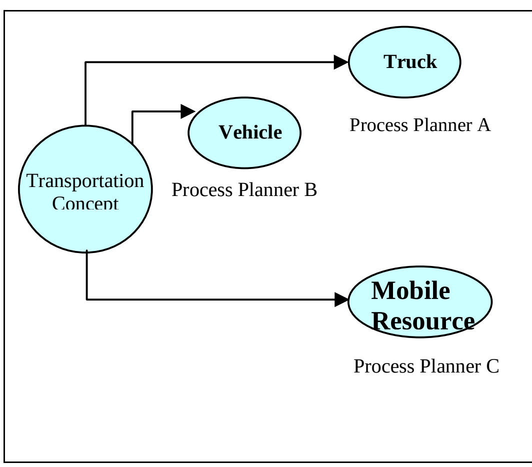


Figure 7.14 : Architecture of the PSL ontology



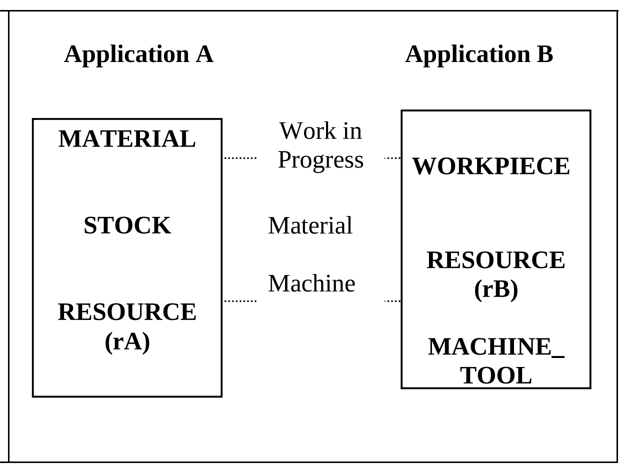


Figure 7.15 : Incompatible Content Representation

Figure 7.16 : Semantic conflict for resource

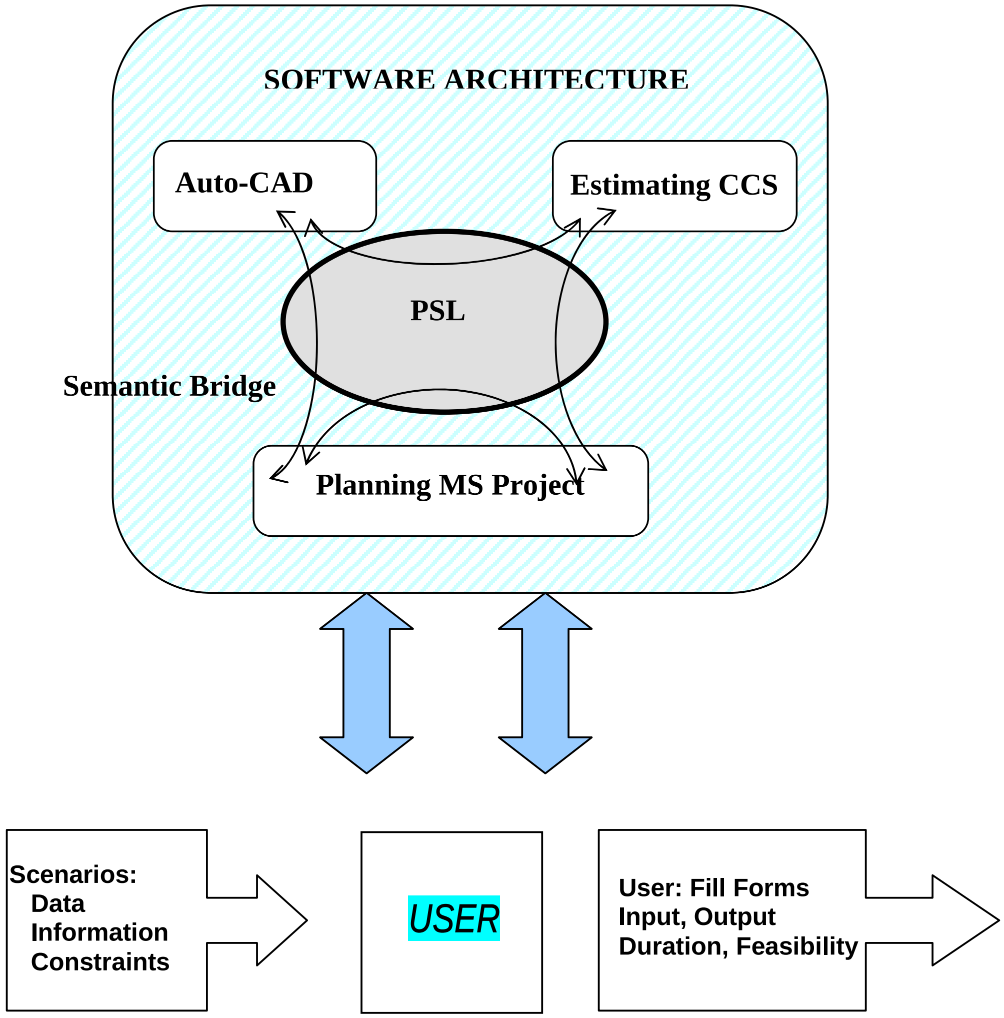


Figure 7.17 : Data and Information Exchange Scenario (Tesfagaber 2004)

```
(forall (?a)
     (iff(doorframe+assembly ?a)
       (and (activity ?a)
            (constrained ?a)
            (markov_precond ?a)
            (rigid_time ?a)
            (rigid_mixed ?a)
            (context_free ?a)
            (markov_effects ?a)
            (nontemporal ?a)
            (rigid_mixed_effects ?a))))
```

Figure 7.18 : Door-assembly process described with PSL.

```
(forall (?a)
     (iff(task ?a)
       (and (activity ?a)
            (constrained ?a)
            (markov_precond ?a)
            (time_precond ?a)
            (mixed_precond ?a)
            (context_free ?a)
            (rigid_state_effects ?a)
            (rigid_time_effects ?a)
            (rigid_mixed_effects ?a))))
```

Figure 7.19 : The MS-task described by PSL.

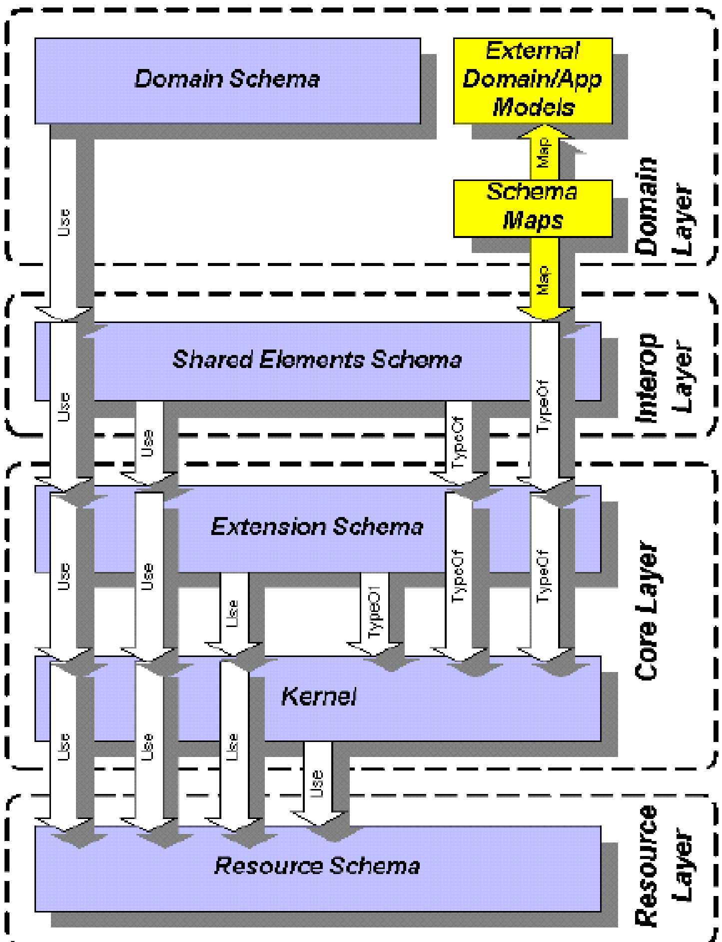


Fig. 7.20 : layering concepts of IFC architecture (IAI 2000)

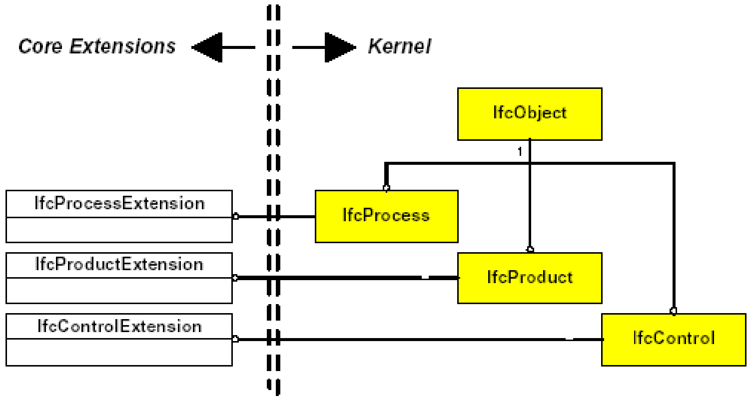


Fig. 7.21 : Core extensions from kernel classes (IAI 2000)

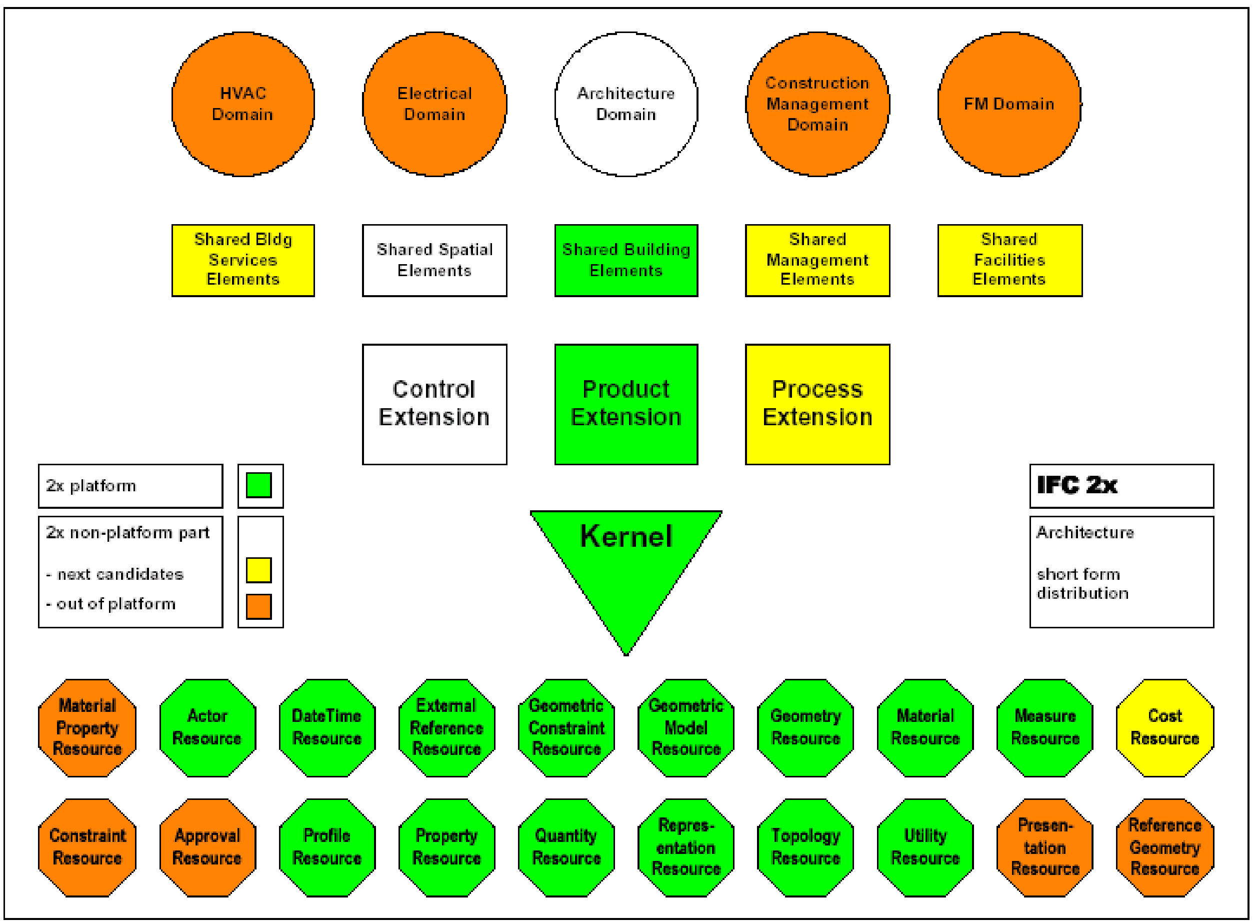


Fig. 7.22 : IFC 2x overall architecture (IAI 2000)

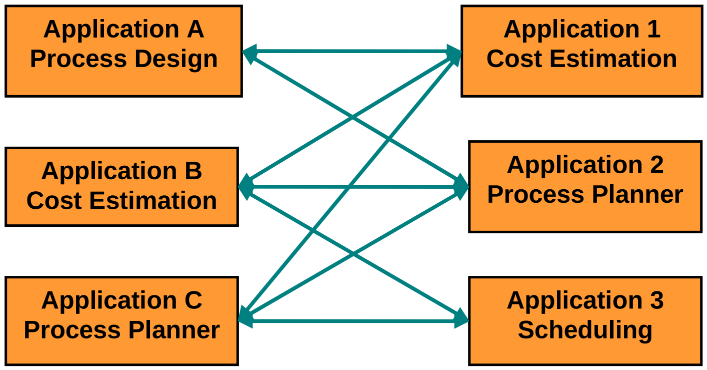


Figure 7.23 : Information exchange without PSL.

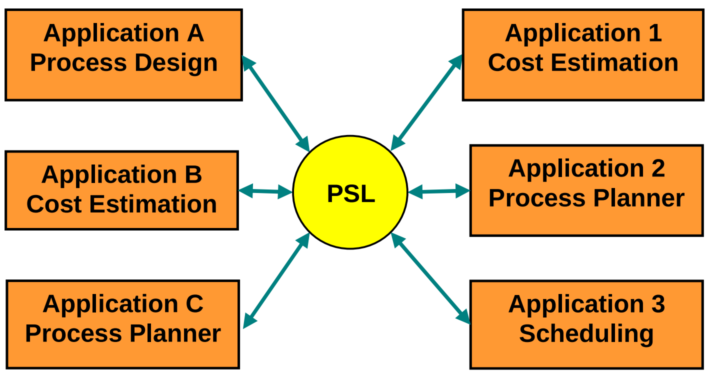


Figure 7.24 : Information exchange with PSL.