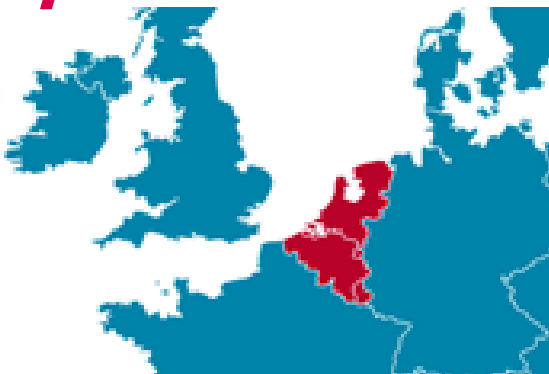
IFC Introductie

3D Pilot bijeenkomst
25.01.2012

Jakob Beetz

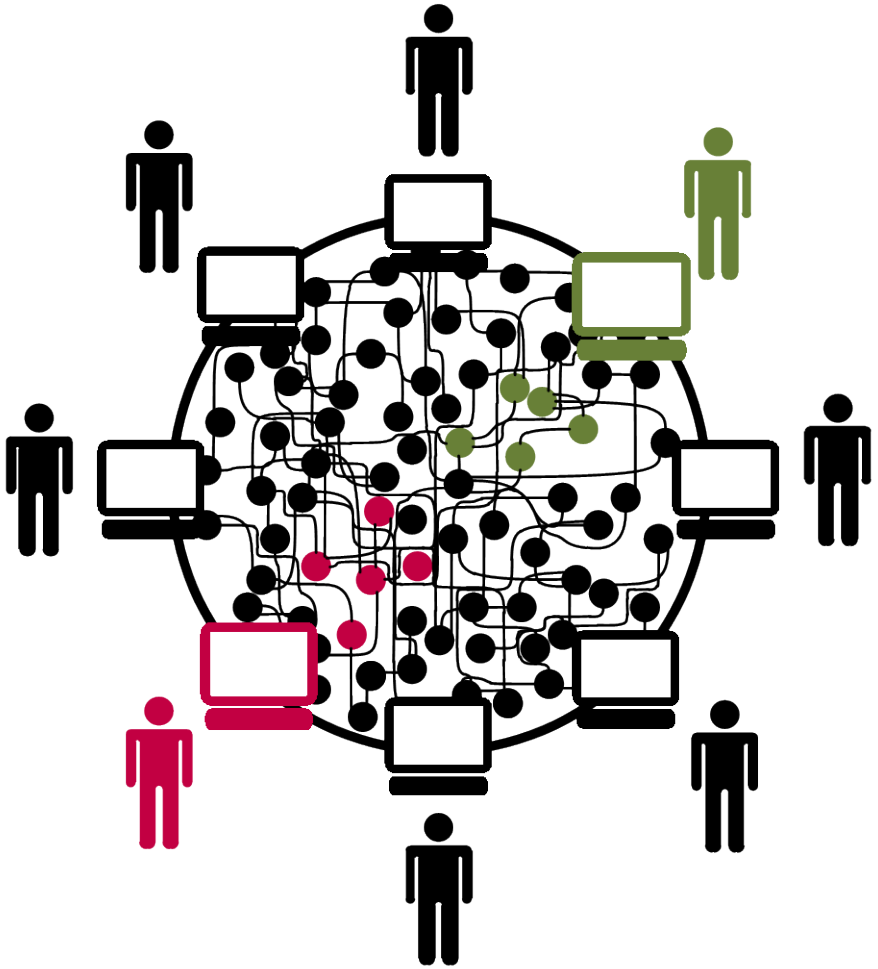
TU/e Technische Universiteit Eindhoven University of Technology

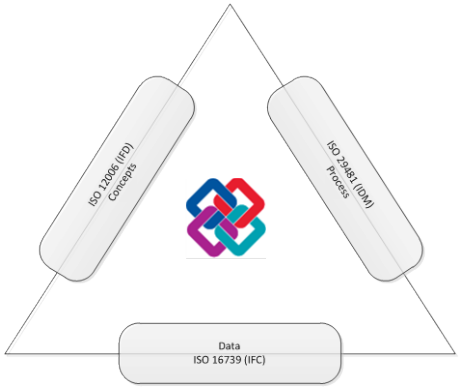
buildingSMART
International Alliance for Interoperability



Overzicht

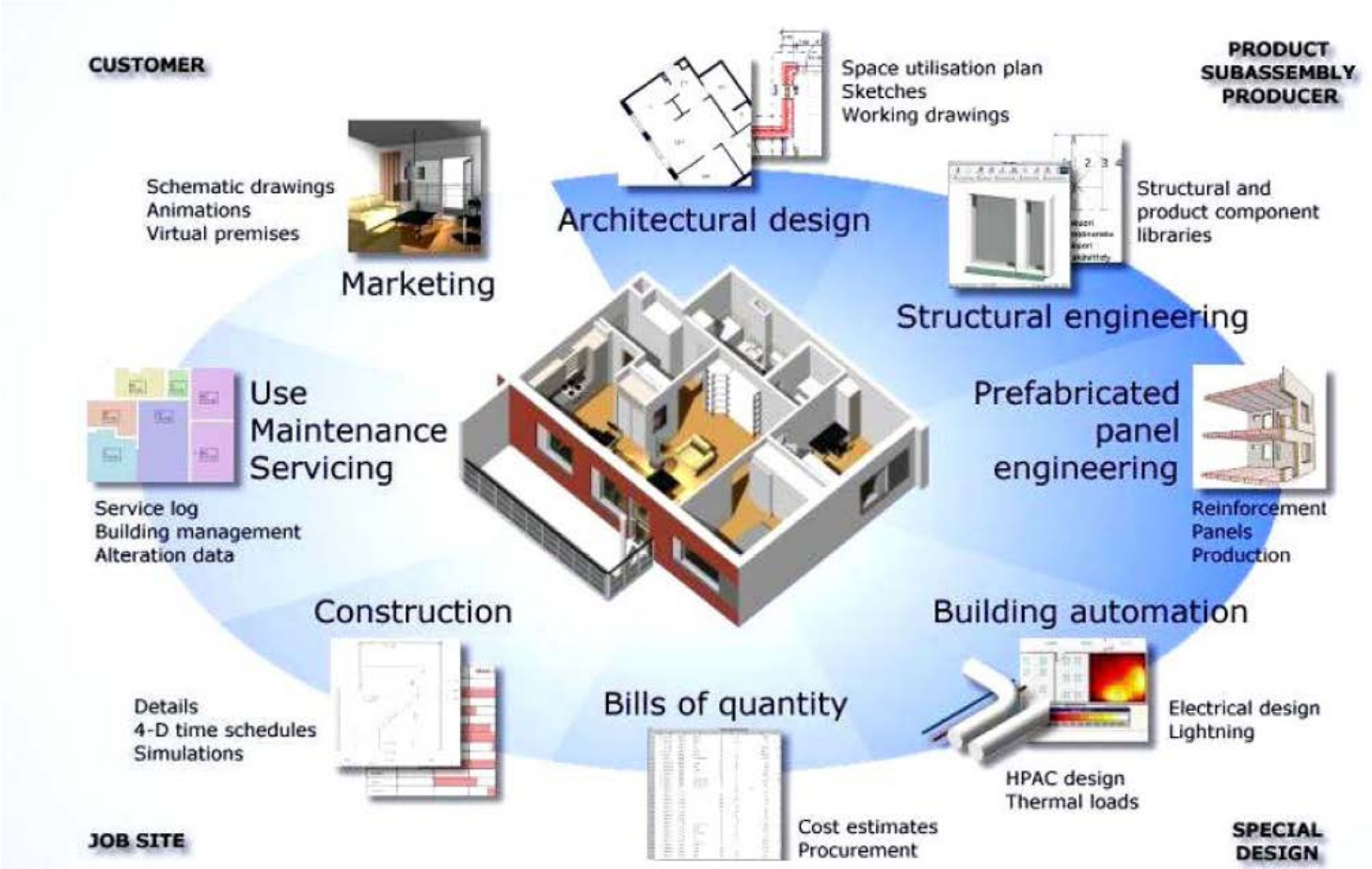
- IFC? Hoezo IFC?
- IFC? Wat is IFC?
- IFC? Hoe ziet het er uit?
- CityGML <-> IFC





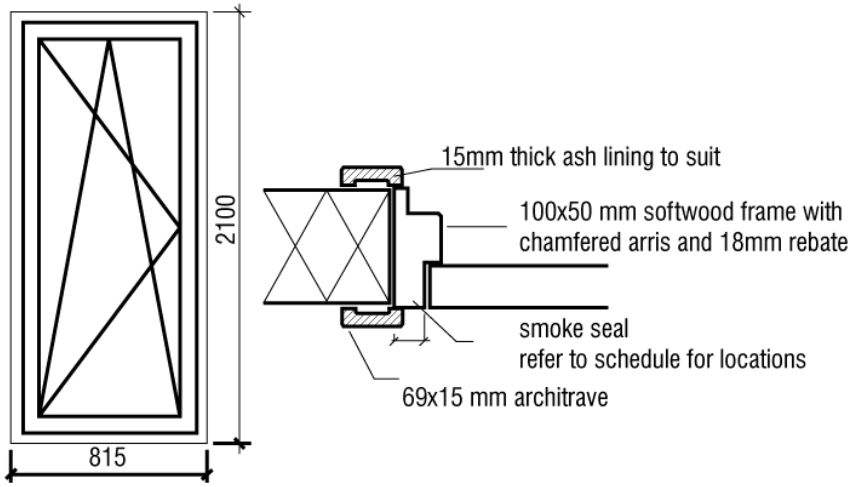
BIM in a nutshell

- Building Information Modeling (BIM) is method to integrate information from various stakeholders into a single model in order to enhance collaboration

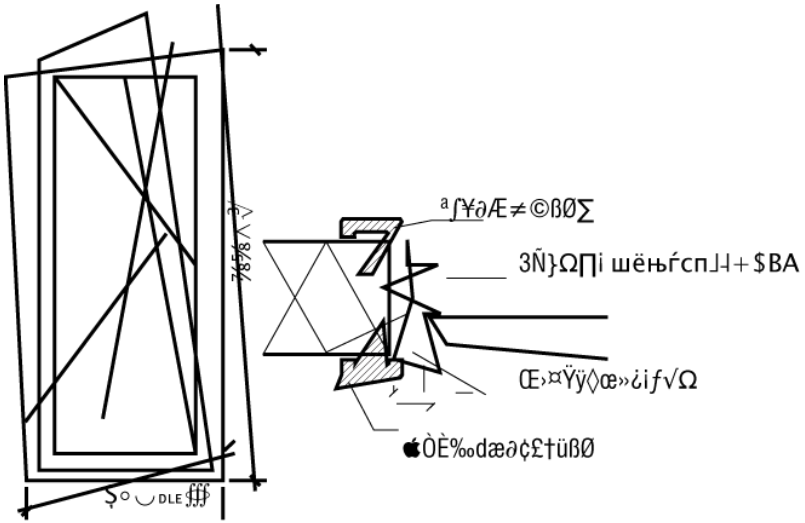


IFC? Hoezo IFC?

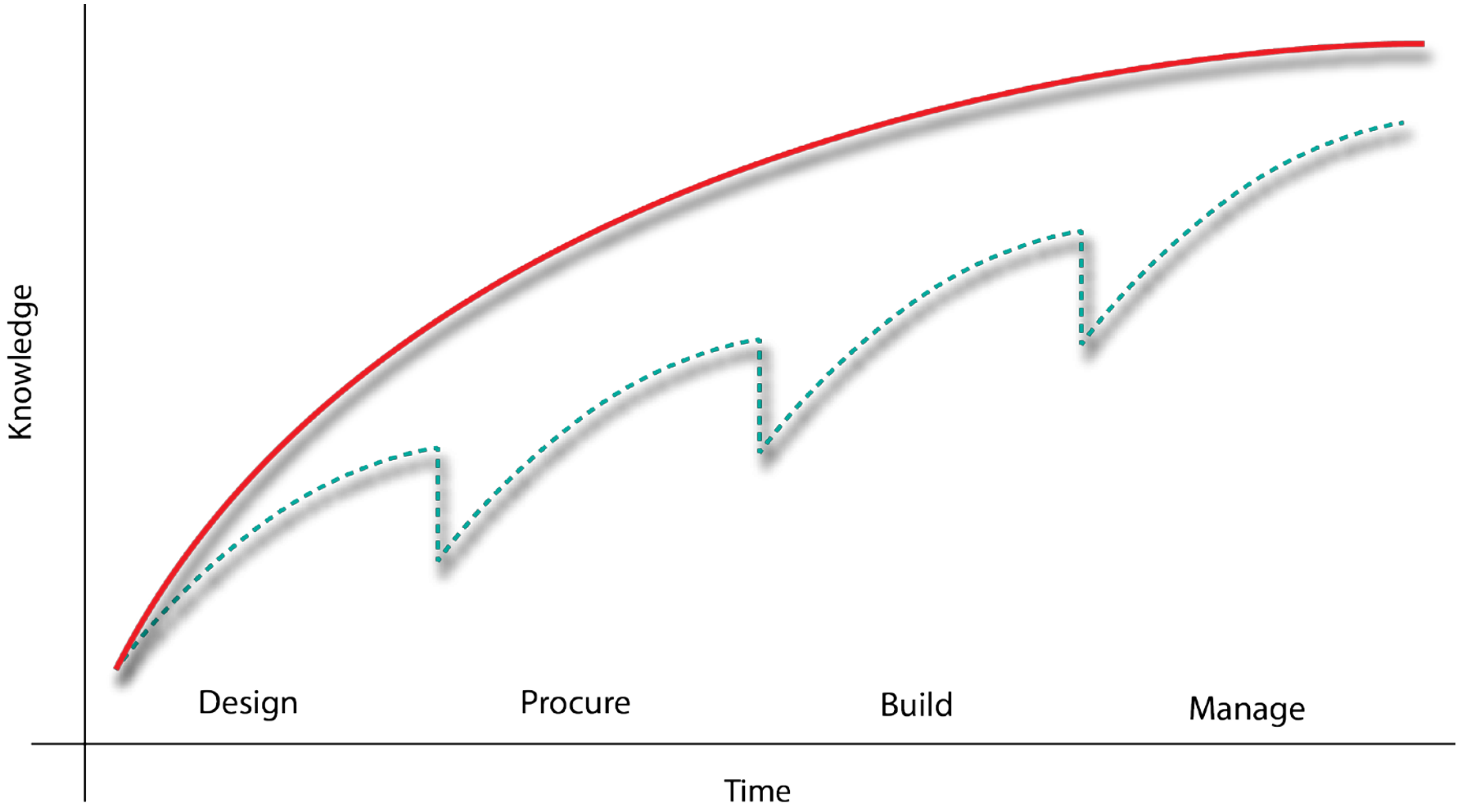
- Huidige situatie:
  - Samenwerking gebaseerd op tekeningen en natuurlijke taal



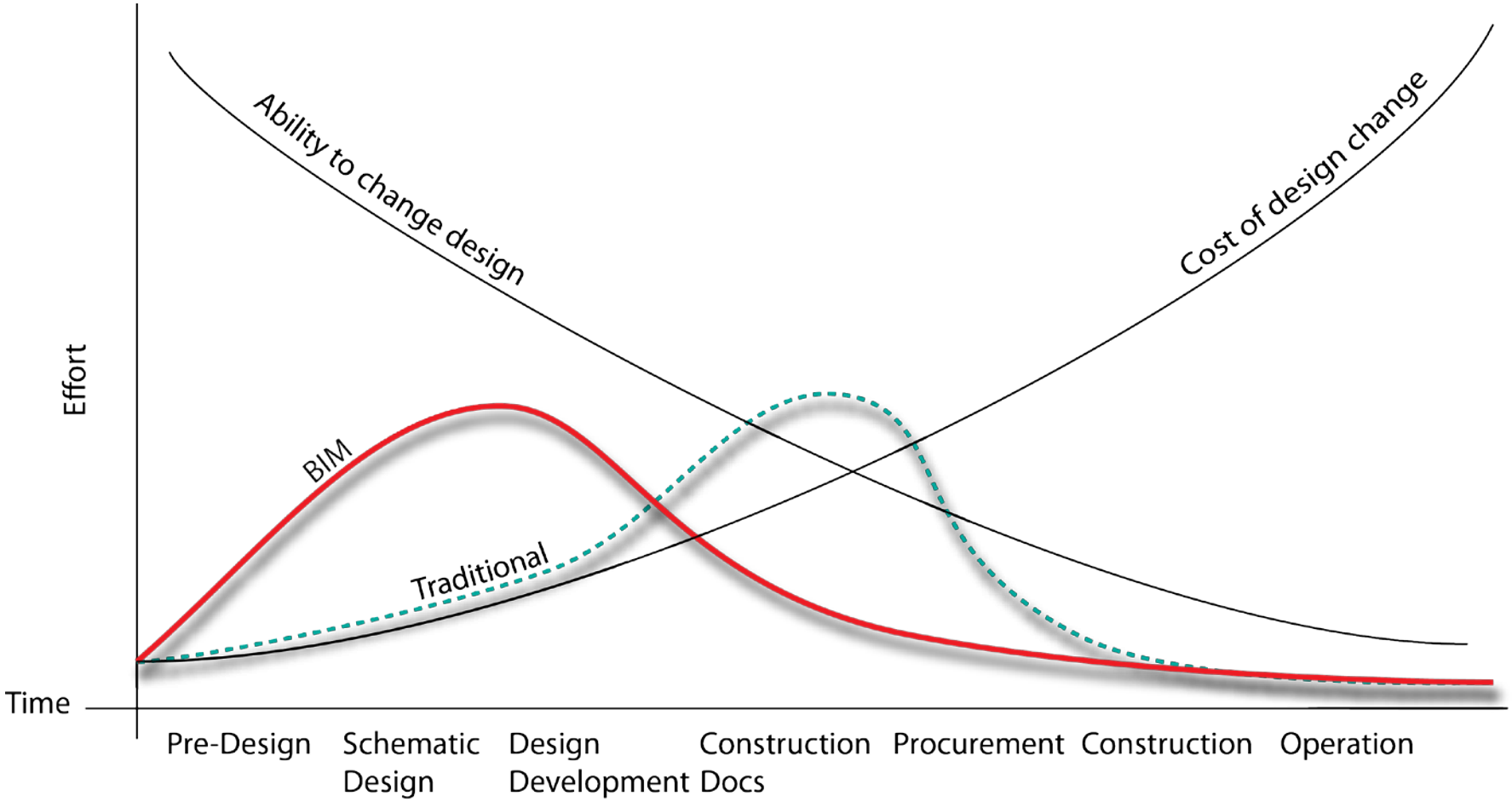
- **Probleem**:
  - **Betekenis** van tekeningen niet te verstaan door ICT tools
  - Interpretatie alleen door mensen mogelijk: arbeidsintensief, foutgevoelig
  - Automation ingewikkeld: **geen semantische interoperabiliteit**



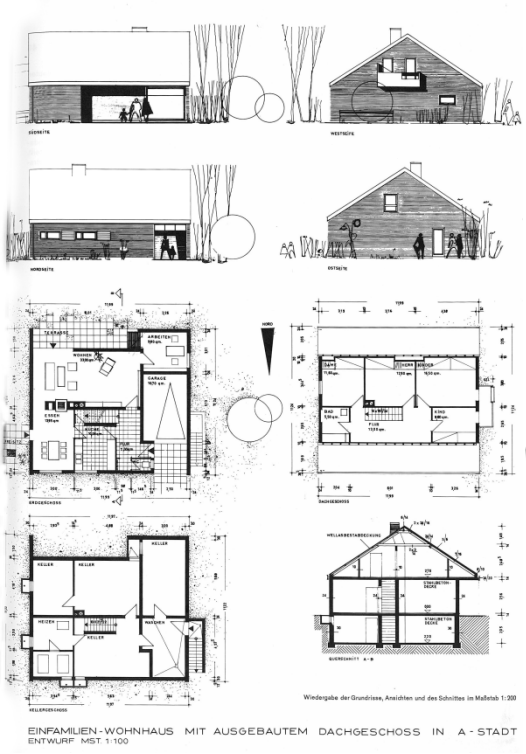
IFC? Hoezo IFC?

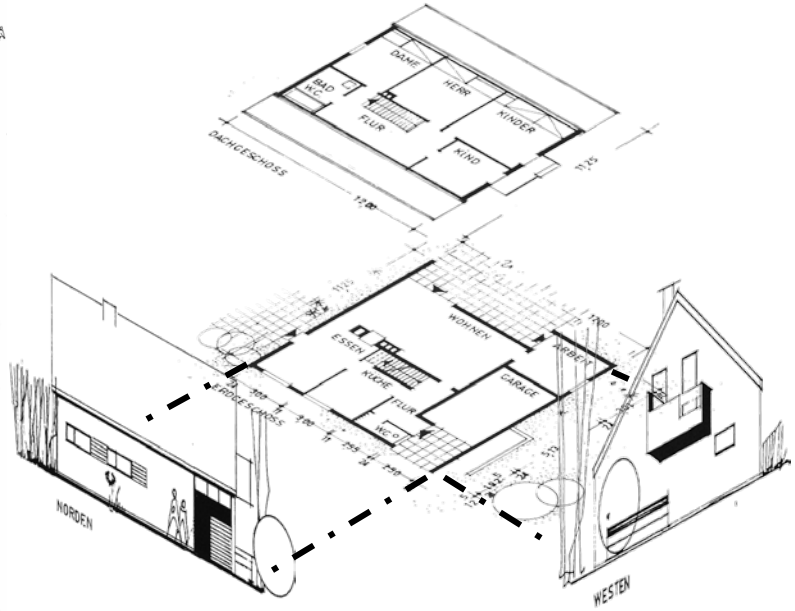


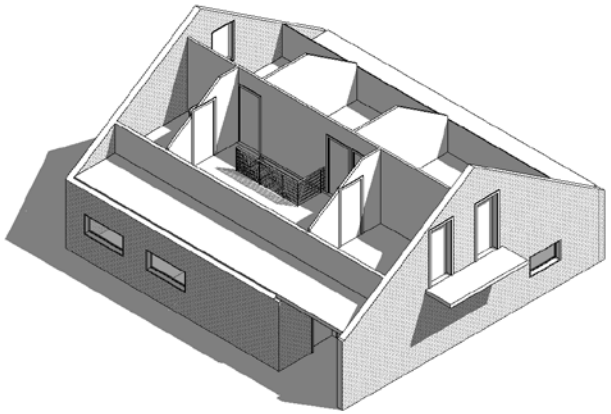
IFC? Hoezo IFC?



Traditioneel process







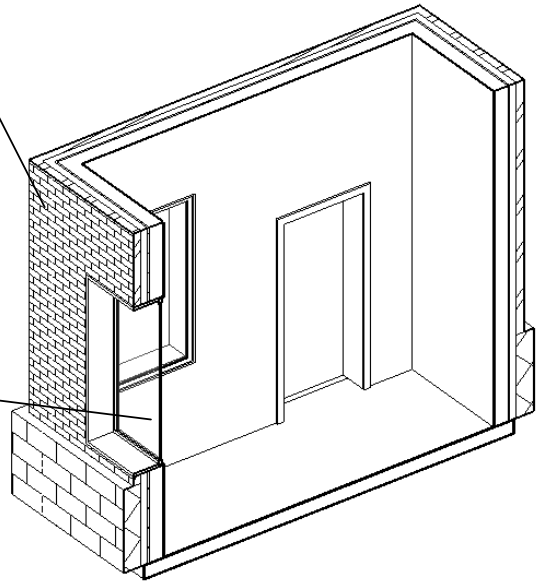
BIM process

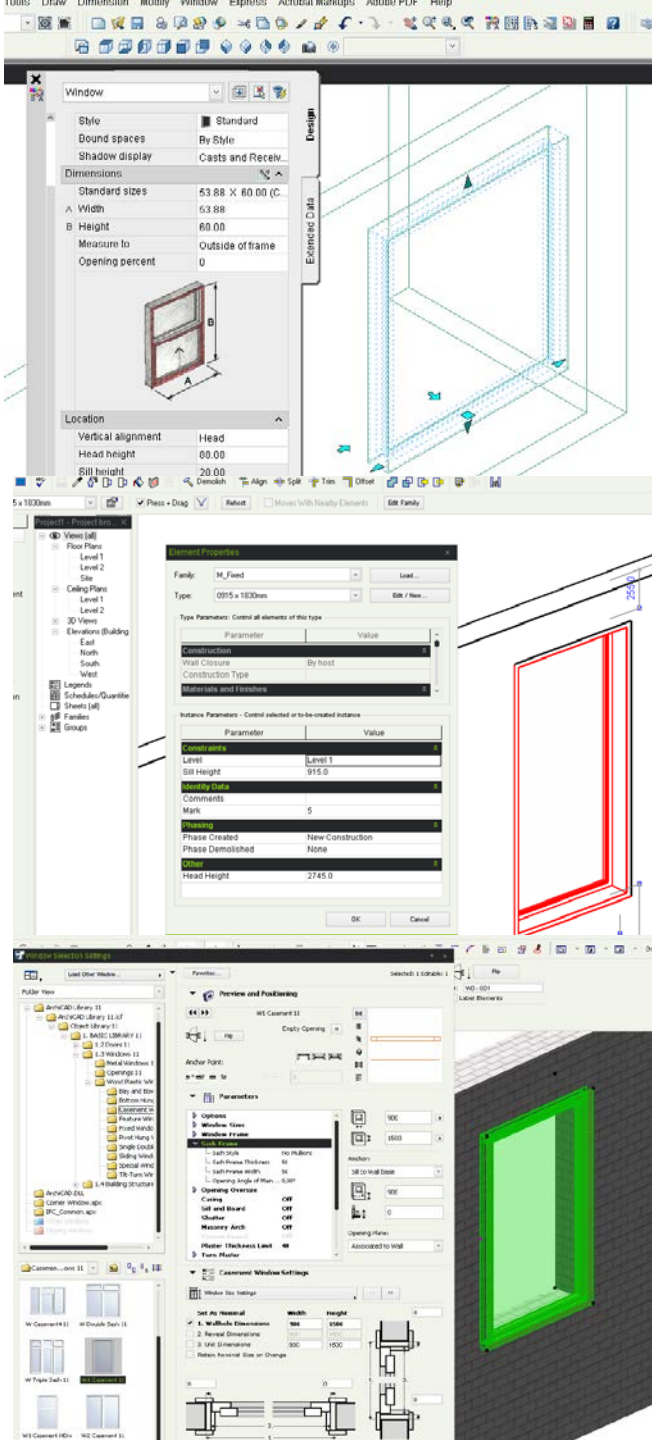
Van lijntjes en tekst naar objecten

Wall NS332	
Geometric Properties	
- Length	15.33
- Width	0.40 m
- Height	3.70 m
Material Properties	
- Mass	120 kg/m3
Construction Type	
- Insulation	No
- Load Bearing	Yes

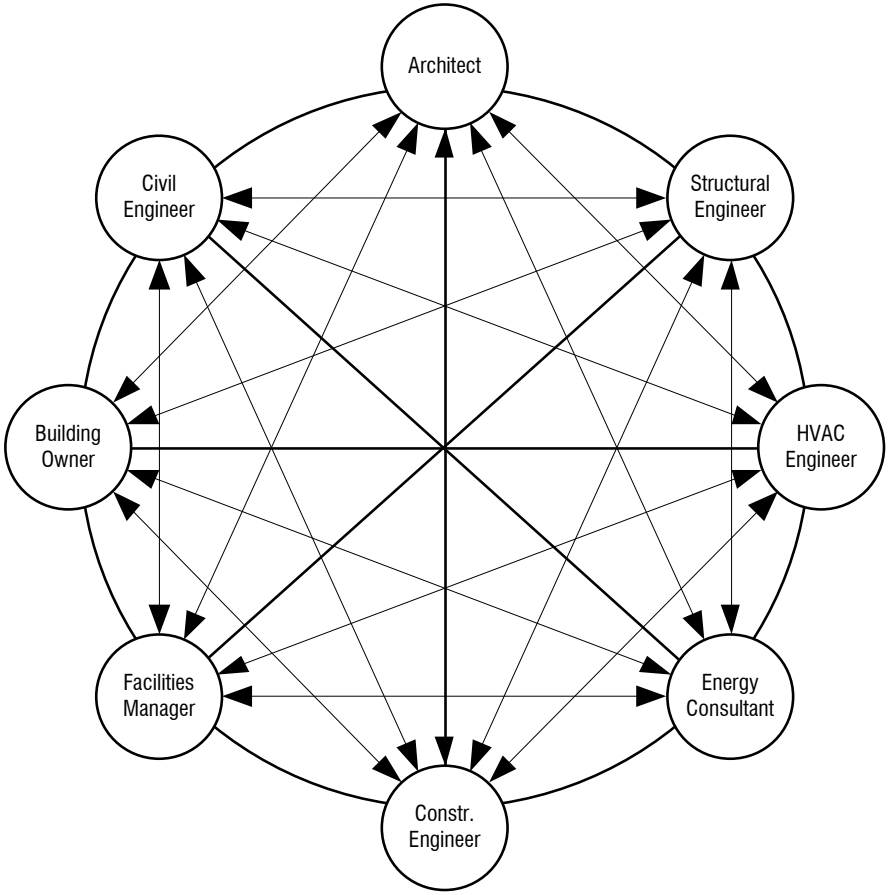
Is placed in

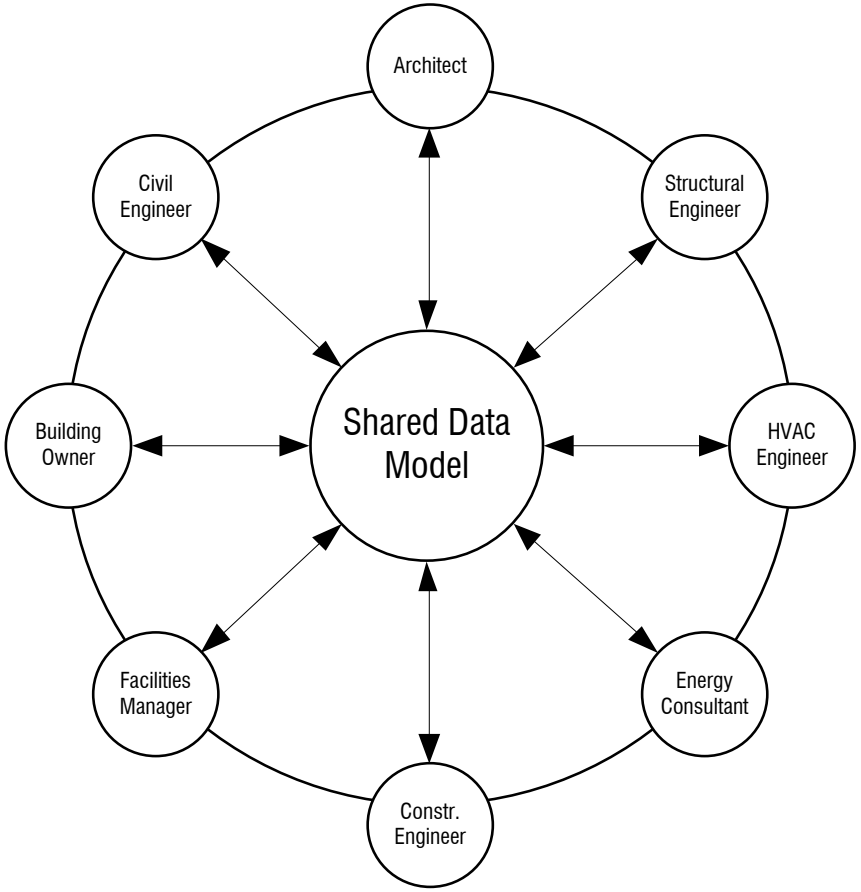
Window W2234	
Geometric Properties	
- Length	1.5 m
- Width	1.22 m
- Height	2.00 m
Material Properties	
- Mass	20 kg/m3
- Conductivity	0.84 J/s
Product	
- Manufacturer	Window Corp Inc.
- Price	2,500 EUR / piece
…	…



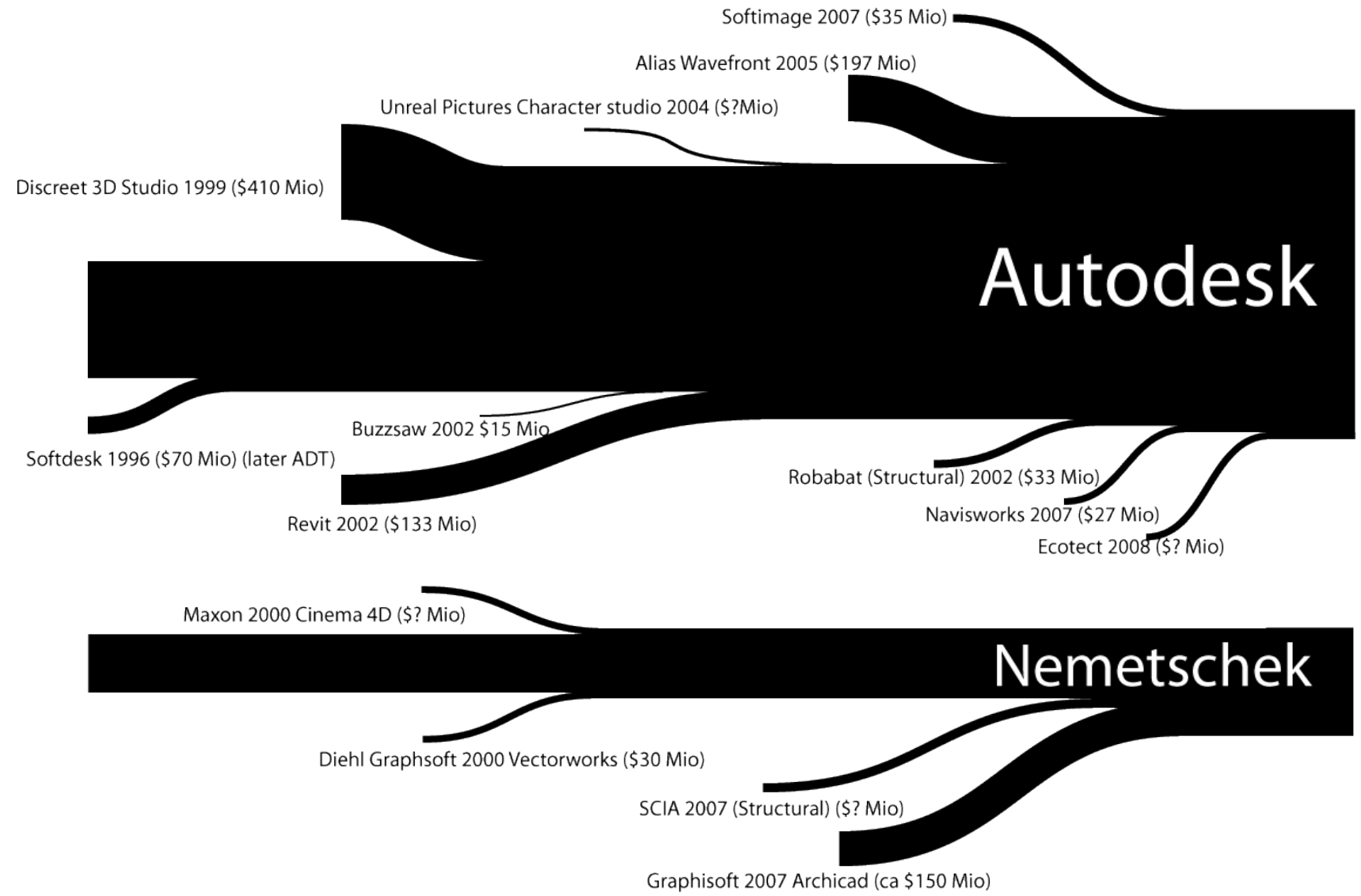


IFC? Hoezo IFC?

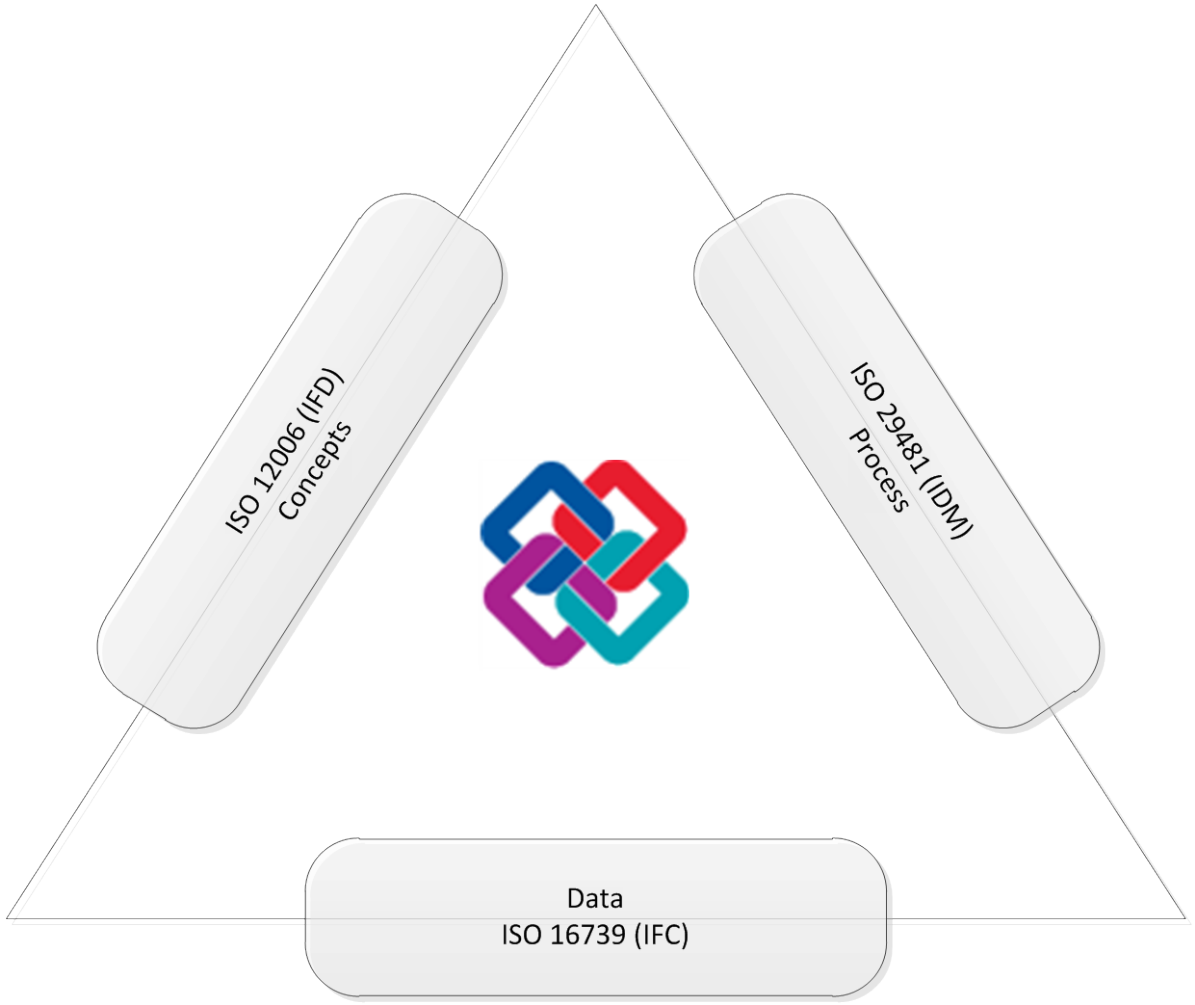




Shared Data model: Hoe sommige het willen



Het IFC Model: Overzicht buildingSMART standarden



Met IFC is het mogelijk…

- … sectorbreed interoperabiliteit tussen meer dan 130 tools te bereiken
- … over een uitgebreid, semantisch model met meer dan 600 classes voor bouw gerelateerde informatie te beschikken
- … doorstroom en integratie van informatie over de hele keten te faciliteren

Het is (nog) niet mogelijk…

- … informatie buiten B&U te verwerken
- … processen te bewaken (maar daarvoor hebben we IDM)
- … het model uit te breiden (maar daarvoor hebben we IFD)

Geschiedenis: Achtergrond

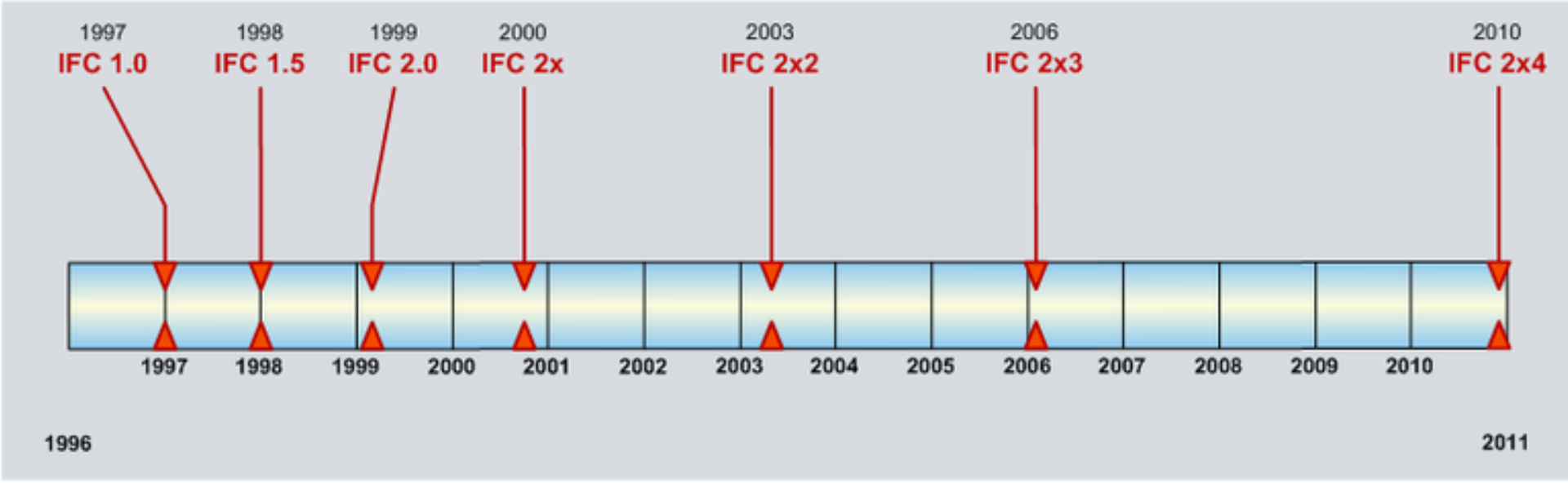
- Tot de jaren 80: DXF en IGES als niet-semantische standaarden alleen voor geometrie. Losse Domein modellen
- ISO richt Technical Committee 184, sub committee 4 ontwikkelt **ISO 10303** series van standaarden (TC184 SC4)
- Stanadard for the Exchange of Product Data: **STEP**

Geschiedenis: ISO 10303 series – STEP

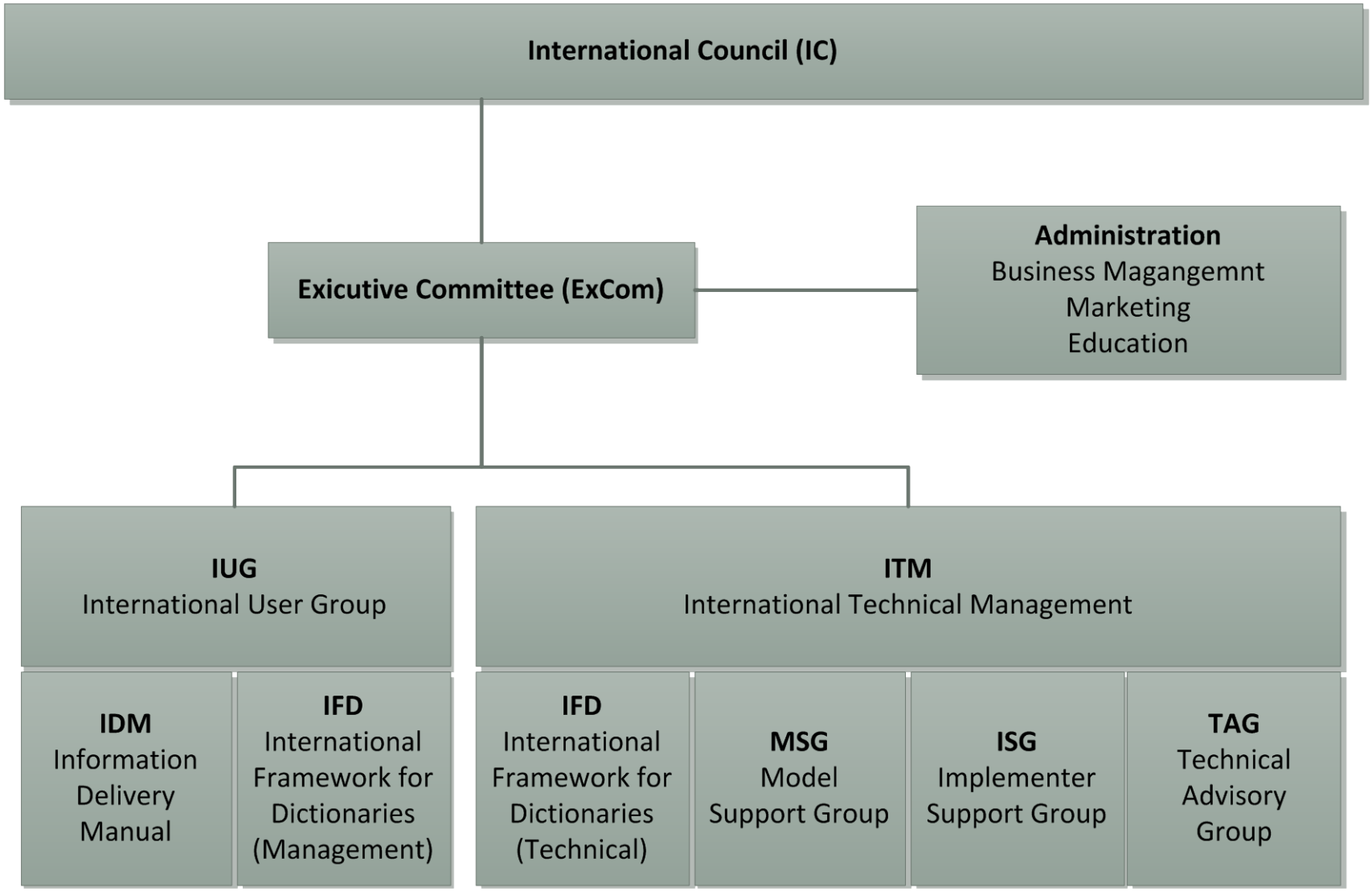
- Grootste ISO norm met honderden van specificaties, schema's, afspraken
- Belangrijke onderdelen:
  - Taal en data formaat:
    - Part 11 : STEP EXPRESS definitie taal (ziek ook Schenk en Wilson 1994)
    - Part 11 : EXPRESS-G grafisch diagramma van schemas
    - Part 21 : STEP Physical File Format (SPFF)
    - Part 28 : XML representatie
    - Part 22 : SDAI – gestandardeseert API voor STEP modellen
    - Anderen
  - Application Protocols
    - AP 225 bouw geometrie
    - Andere AP’s voor schepen, fabrieken, fluid dynamics, sheet metals, elektronica …

Geschiedenis: IAI, buildingSMART

- 1994: initiatief van Autodesk
- 1997: Industry Alliance for Interoperability – IAI
- Versnelling van ISO? (Eastman 1994)
- 2005: IAI -> buildingSMART
  - > 800 leden in > 32 landen georganiseerd in locaale “chapters”
- 2006: buildingSMART BeNeLux chapter
  - 50+ leden



Geschiedenis: buildingSMART organisatie



IFC Model: Schema definitie

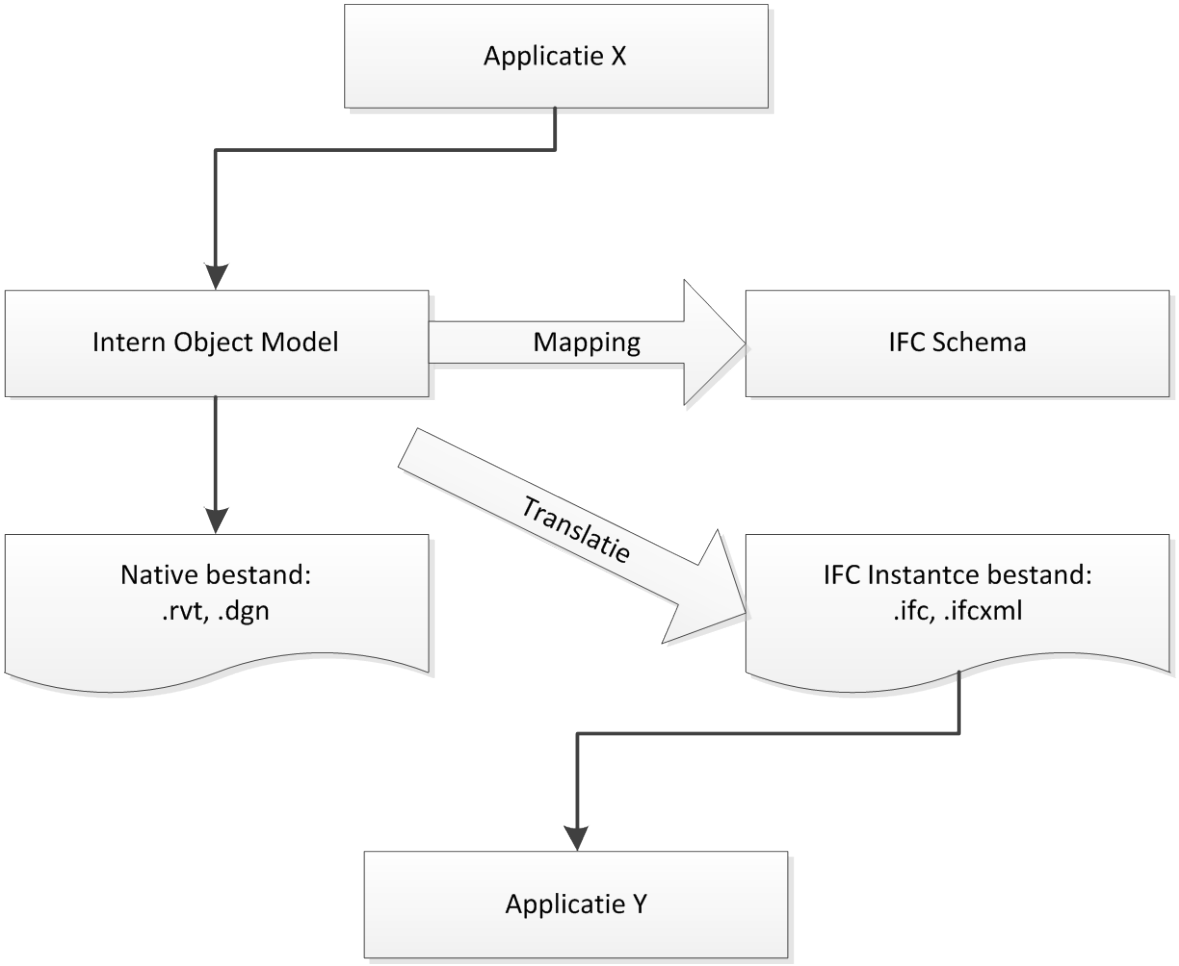
```
ENTITY IfcDoor
SUBTYPE OF (IfcBuildingElement);

        OverallHeight:      OPTIONAL IfcPositiveLengthMeasure;
        OverallWidth :      OPTIONAL IfcPositiveLengthMeasure;

END_ENTITY;
```

- Vastgelegd in een schema bestand (.exp)
- EXPRESS definitie taal
  - Types
  - Classes: Entities
  - Attributes:
    - Simple Types: float, string, integer, enum
    - Andere Entities
  - Regels: “Where Rules”
- Daarnaast: PropertySets (attributen niet in het model schema)

Implementatie door software



Bestandsformaten: Part 21 SPFF (.ifc)

```
ISO-10303-21;
HEADER;
FILE_DESCRIPTION(('ViewDefinition [CoordinationView]','Option [Filter: ]'),'2;1');
FILE_NAME('D:\\jakob\\projects\\buildingSmart\\BuildingSMART_BeNeLux\\Deur_archicad_14_voorbeldt.ifc','2011-06-
18T13:59:36',('Architect'),('Building Designer Office'),'PreProc - EDM 5.0','ArchiCAD 14.00 Release 1. 64-bit Windows Build Number of the Ifc 2x3
interface: 3018','The authorising person');
FILE_SCHEMA(('IFC2X3'));
ENDSEC;
DATA;

#1= IFCORGANIZATION('GS','Graphisoft','Graphisoft',$,$);
#5= IFCAPPLICATION(#1,'14.0','ArchiCAD 14.0','ArchiCAD');
#13= IFCOWNERHISTORY(#12,#5,$,.ADDED.,$,$,$,1308398376);
#14= IFCSIUNIT(*,.LENGTHUNIT.,.MILLI.,.METRE.);
#15= IFCSIUNIT(*,.AREAUNIT.,$,.SQUARE_METRE.);
#16= IFCSIUNIT(*,.VOLUMEUNIT.,$,.CUBIC_METRE.);
#17= IFCSIUNIT(*,.PLANEANGLEUNIT.,$,.RADIAN.);

...

#192= IFCWALLSTANDARDCASE('03f6qZ1Oz10xHShZ8a6ZrP',#13,'Wand-001',$,$,#189,#262,'03A46D23-058F-4103-B4-5C-AE32241A3D59');
…

#635= IFCFACETEDBREP(#631);
#638= IFCSURFACESTYLE('31 Buitenkozijn kader',.BOTH.,(#556));
#640= IFCPRESENTATIONSTYLEASSIGNMENT((#638));
#642= IFCSTYLEDITEM(#635,(#640),$);
#646= IFCSHAPEREPRESENTATION(#51,'Body','Brep',(#552,#635));
#652= IFCPRODUCTDEFINITIONSHAPE($,$,(#646));
#656= IFCDOOR('0jGNIOr61EIQGxAw1WCr1k',#13,'Merk-x',$,$,#339,#652,'2D417498-D460-4E49-A4-3B-2BA06033506E',2367.,1034.);
#675= IFCRELFILLSELEMENT('1toO7Eb5nAoAEkdP0vReSa',#13,$,$,#310,#656);
```

Bestandsformaten: Part 28 XML (.ifcxml)

```
<?xml version="1.0" encoding="UTF-8"?>
<doc:iso_10303_28 xmlns:exp="urn:oid:1.0.10303.28.2.1.1" xmlns:doc="urn:oid:1.0.10303.28.2.1.3"
xmlns:xsi="http://www.w3.org/2001/XMLSchema-instance" xsi:schemaLocation="urn:oid:1.0.10303.28.2.1.1 ex.xsd" version="2.0">
        <uos id="uos_1" description="" configuration="i-ifc2x3" edo="" xmlns="http://www.iai-tech.org/ifcXML/IFC2x3/FINAL"
xsi:schemaLocation="http://www.iai-tech.org/ifcXML/IFC2x3/FINAL ifc2x3.xsd">

                <IfcDoor id="i2193">
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                        <OwnerHistory>
                                <IfcOwnerHistory xsi:nil="true" ref="i1550"/>
                        </OwnerHistory>
                        <Name>Merk-x</Name>
                        <ObjectPlacement>
                                <IfcLocalPlacement xsi:nil="true" ref="i1876"/>
                        </ObjectPlacement>
                        <Representation>
                                <IfcProductDefinitionShape xsi:nil="true" ref="i2189"/>
                        </Representation>
                        <Tag>2D417498-D460-4E49-A4-3B-2BA06033506E</Tag>
                        <OverallHeight>2367.</OverallHeight>
                        <OverallWidth>1034.</OverallWidth>
                </IfcDoor>
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                        </Representations>
                </IfcProductDefinitionShape>


        </uos>
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```
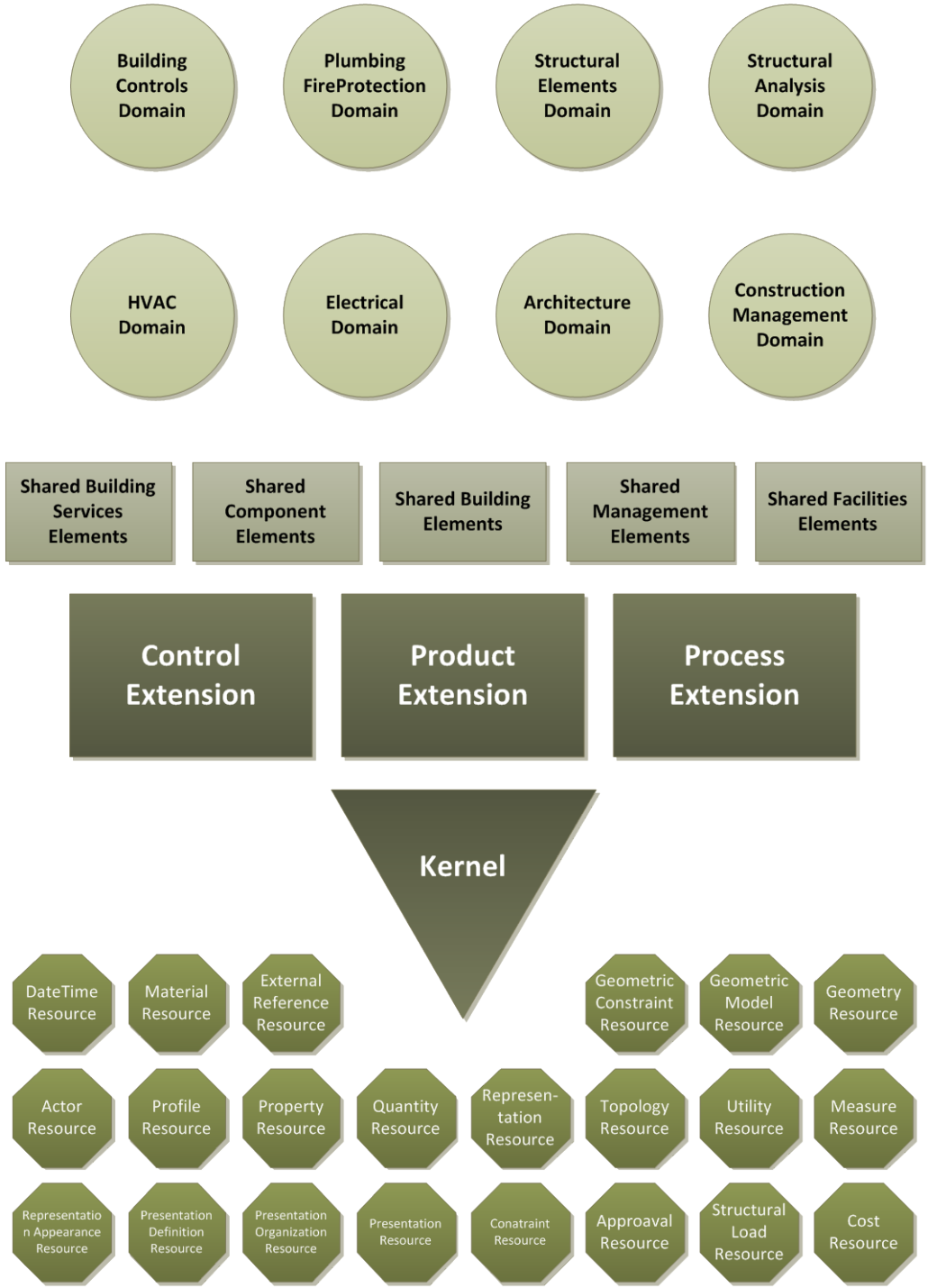
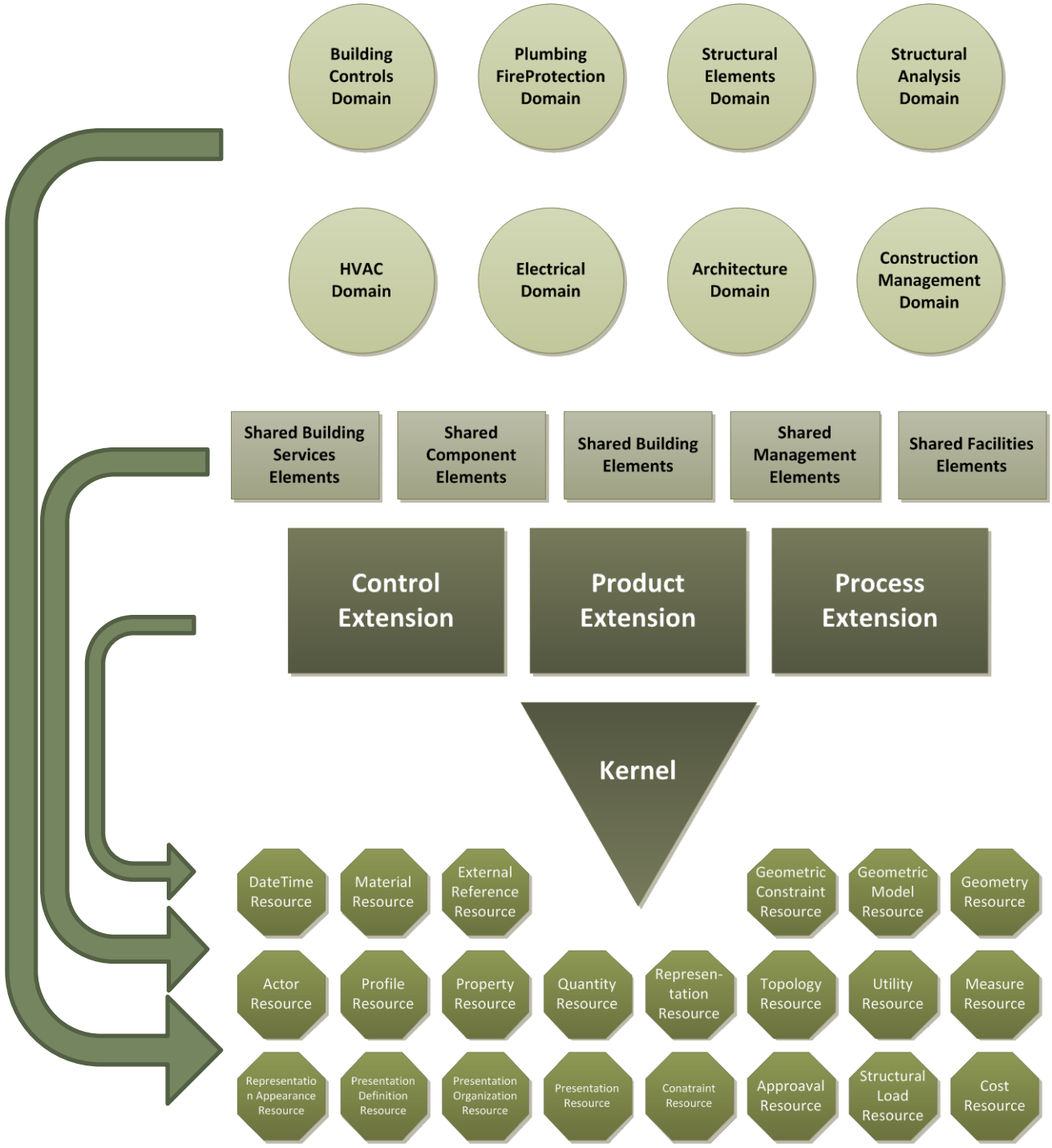
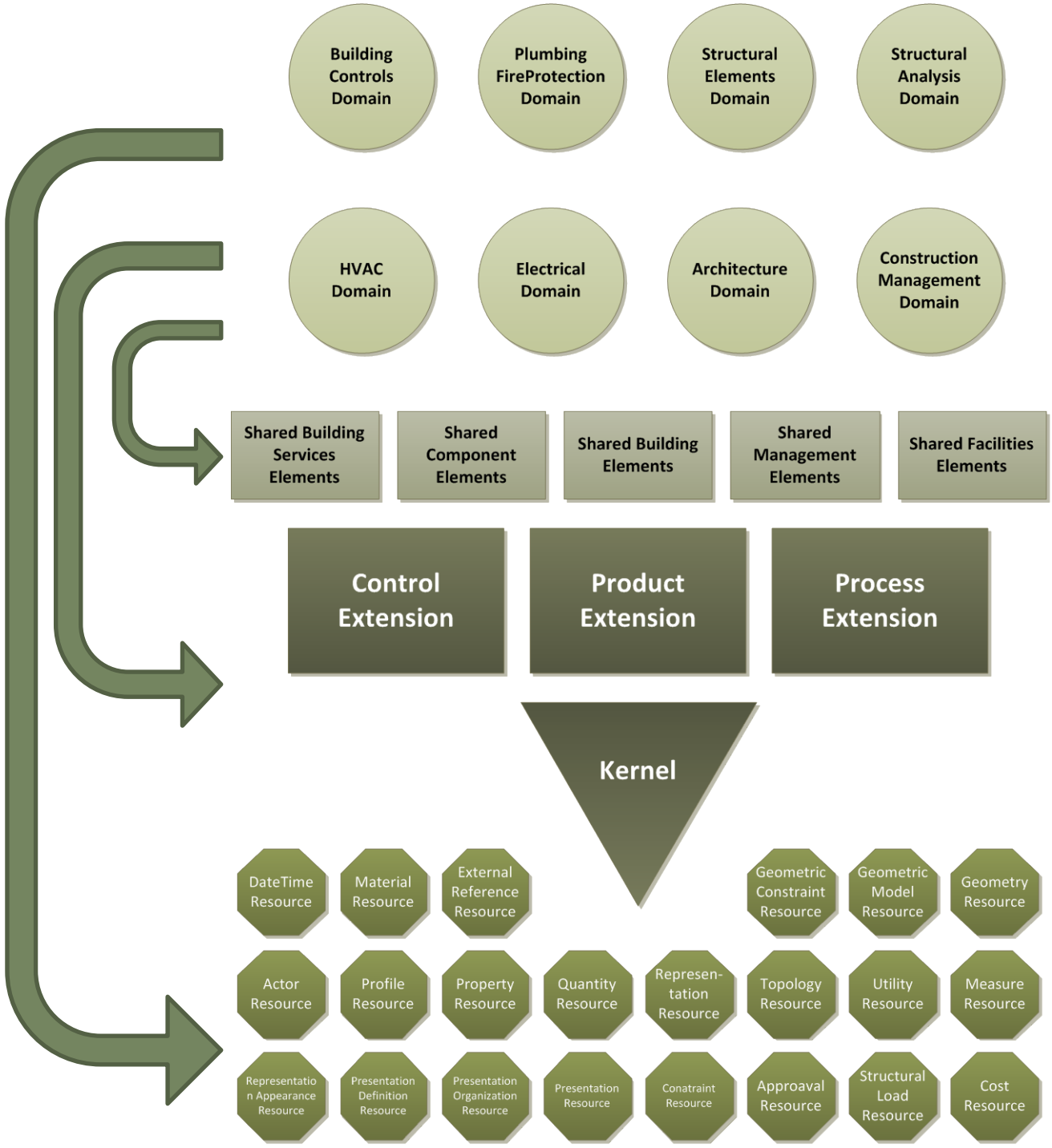

IFC Model: Lagen




Building Controls Domain
Plumbing FireProtection Domain
Structural Elements Domain
Structural Analysis Domain
HVAC Domain
Electrical Domain
Architecture Domain
Construction Management Domain
Shared Building Services Elements
Shared Component Elements
Shared Building Elements
Shared Management Elements
Shared Facilities Elements
Control Extension
Product Extension
Process Extension
Kernel
DateTime Resource
Material Resource
External Reference Resource
Geometric Constraint Resource
Geometric Model Resource
Geometry Resource
Actor Resource
Profile Resource
Property Resource
Quantity Resource
Represen-tation Resource
Topology Resource
Utility Resource
Measure Resource
Representatio n Appearance Resource
Presentation Definition Resource
Presentation Organization Resource
Presentation Resource
Conatraint Resource
Approaval Resource
Structural Load Resource
Cost Resource


Building Controls Domain
Plumbing FireProtection Domain
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Structural Analysis Domain
HVAC Domain
Electrical Domain
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Shared Building Services Elements
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Shared Building Elements
Shared Management Elements
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Geometry Resource
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Profile Resource
Property Resource
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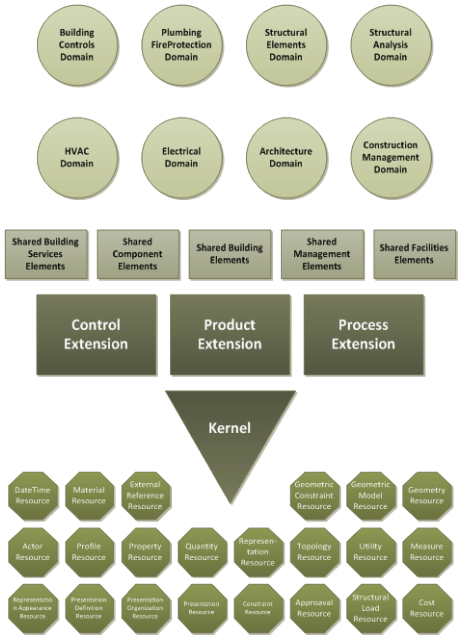
Represen-tation Resource
Topology Resource
Utility Resource
Measure Resource
Representatio n Appearance Resource
Presentation Definition Resource
Presentation Organization Resource
Presentation Resource
Conatraint Resource
Approaval Resource
Structural Load Resource
Cost Resource

IFC Model: Resources Layer



DateTime Resource

Material Resource

External Reference Resource

Geometric Constraint Resource

Geometric Model Resource

Geometry Resource

Actor Resource

Profile Resource

Property Resource

Quantity Resource

Represen-tation Resource

Topology Resource

Utility Resource

Measure Resource

Representation Appearance Resource

Presentation Definition Resource

Presentation Organization Resource

Presentation Resource

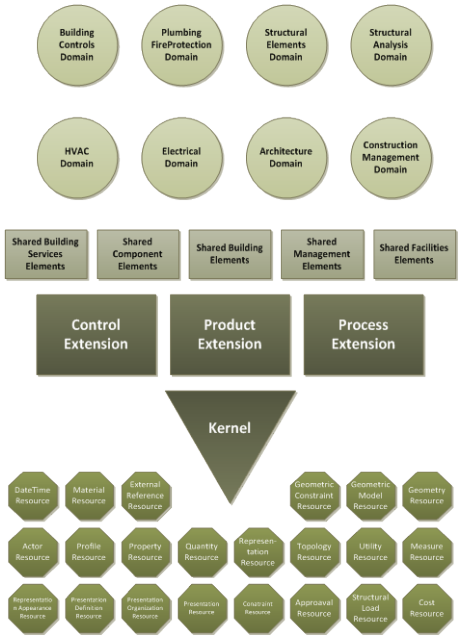
Conatraint Resource

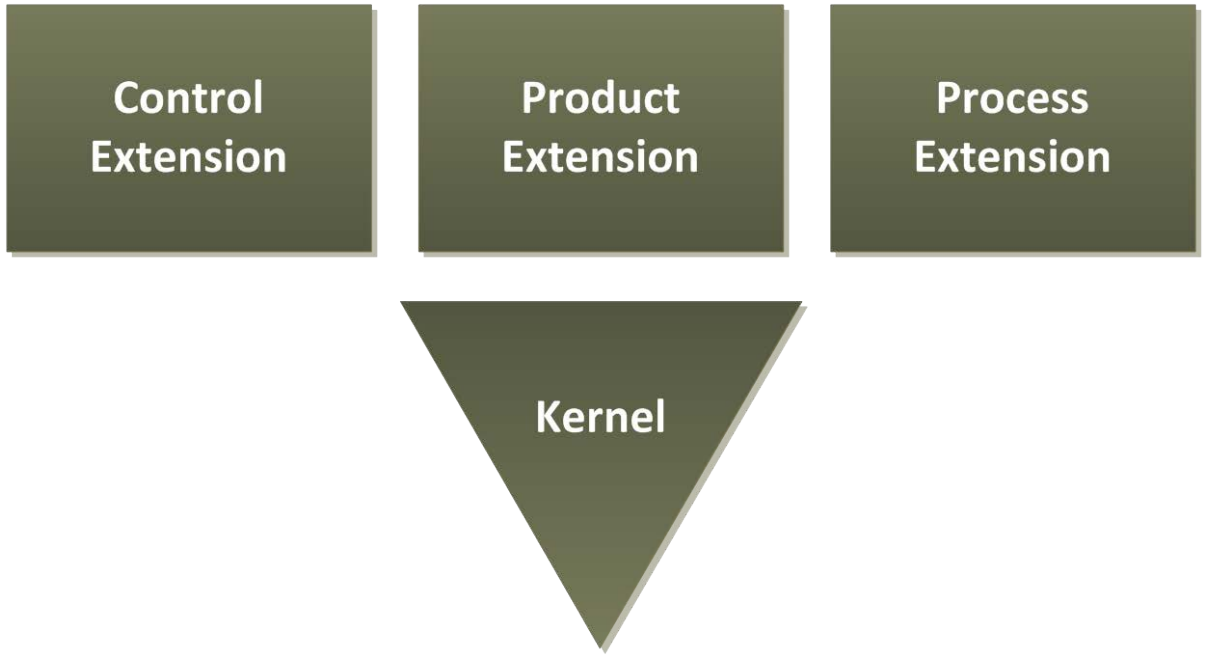
Approaval Resource

Structural Load Resource

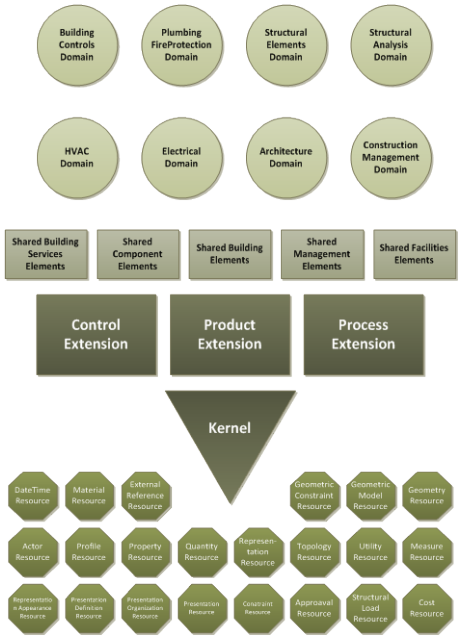
Cost Resource

IFC Model: Kernel Layer





IFC Model: Shared Layer



Shared Building Services Elements

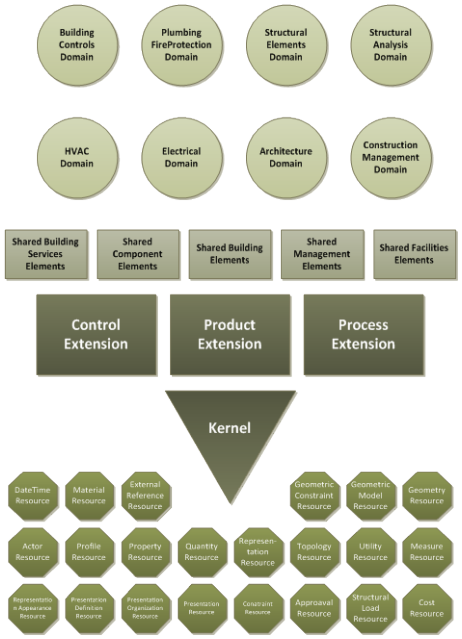
Shared Component Elements

Shared Building Elements

Shared Management Elements

Shared Facilities Elements

IFC Model: Domain Layer



Building Controls Domain

Plumbing FireProtection Domain

Structural Elements Domain

Structural Analysis Domain

HVAC Domain

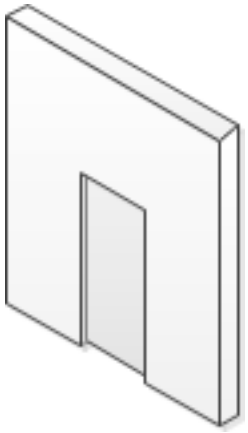
Electrical Domain

Architecture Domain

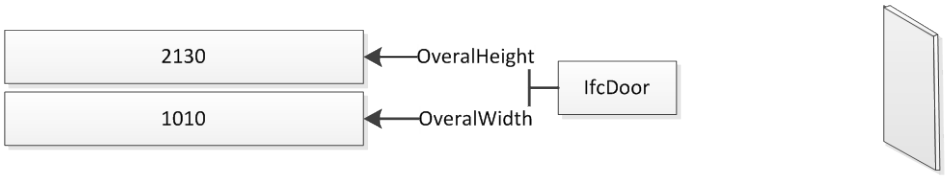
Construction Management Domain

Voorbeld: Deur

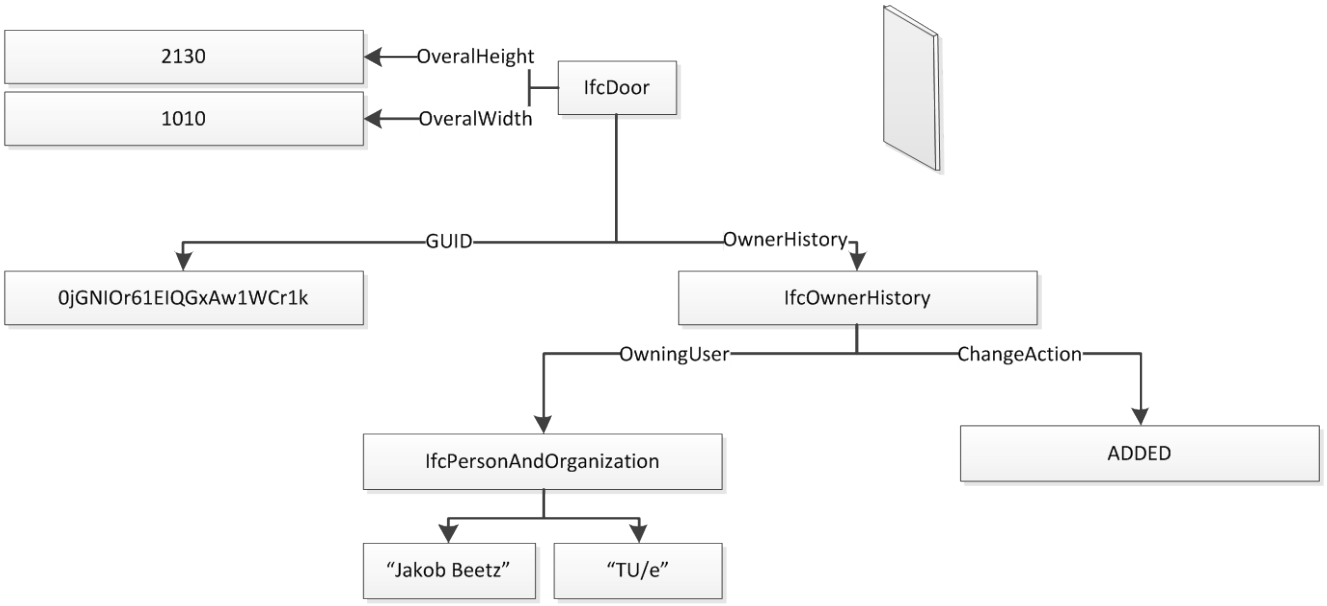
- **Aspecten**
  - **Eigenschappen**
  - **(geometrische) representatie**
  - **Sjablonen (object-type-occurence)**
  - **Aggregatie**
  - **Decompositie**



Definitie door eigenschappen



Definitie door eigenschappen



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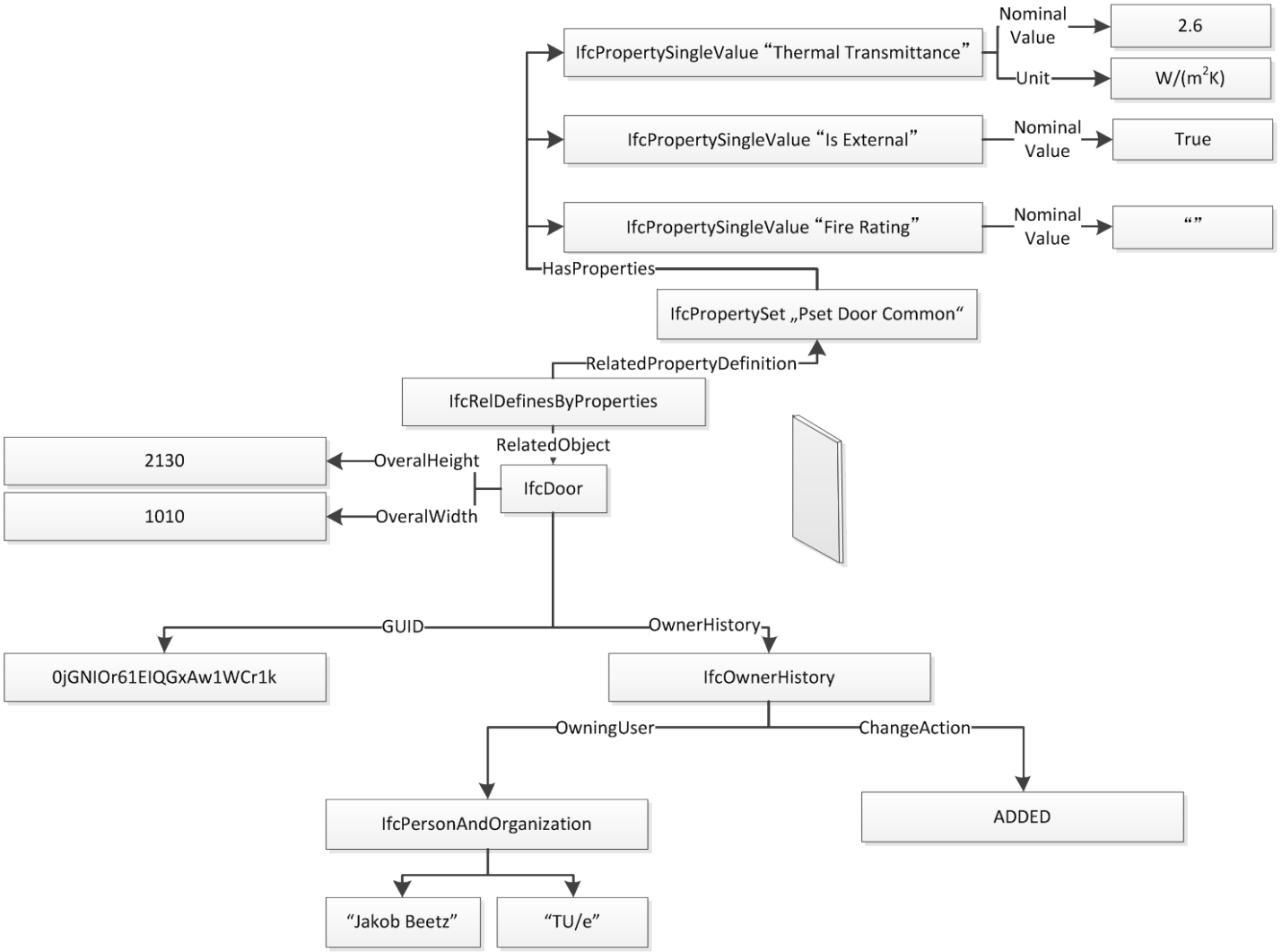

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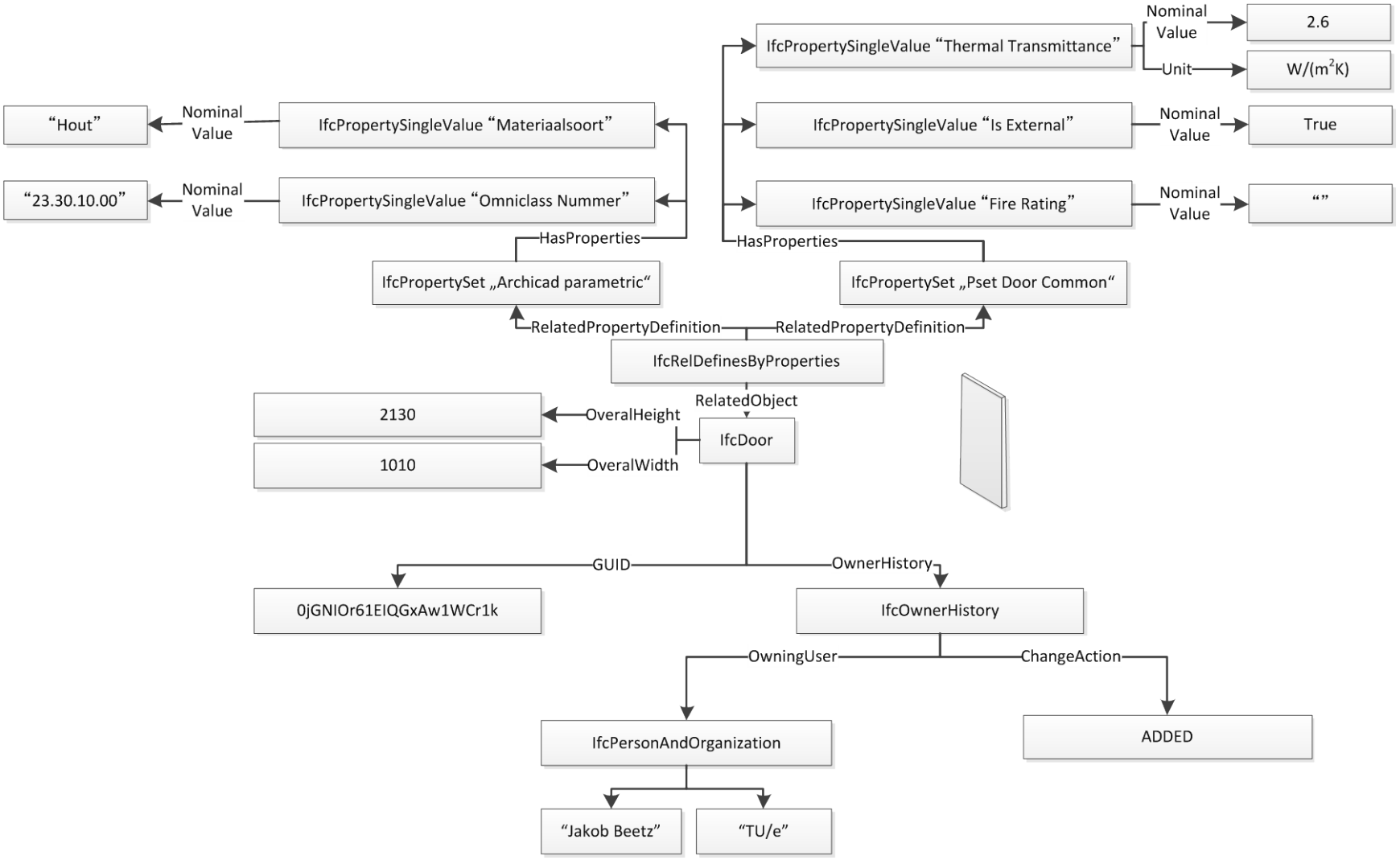
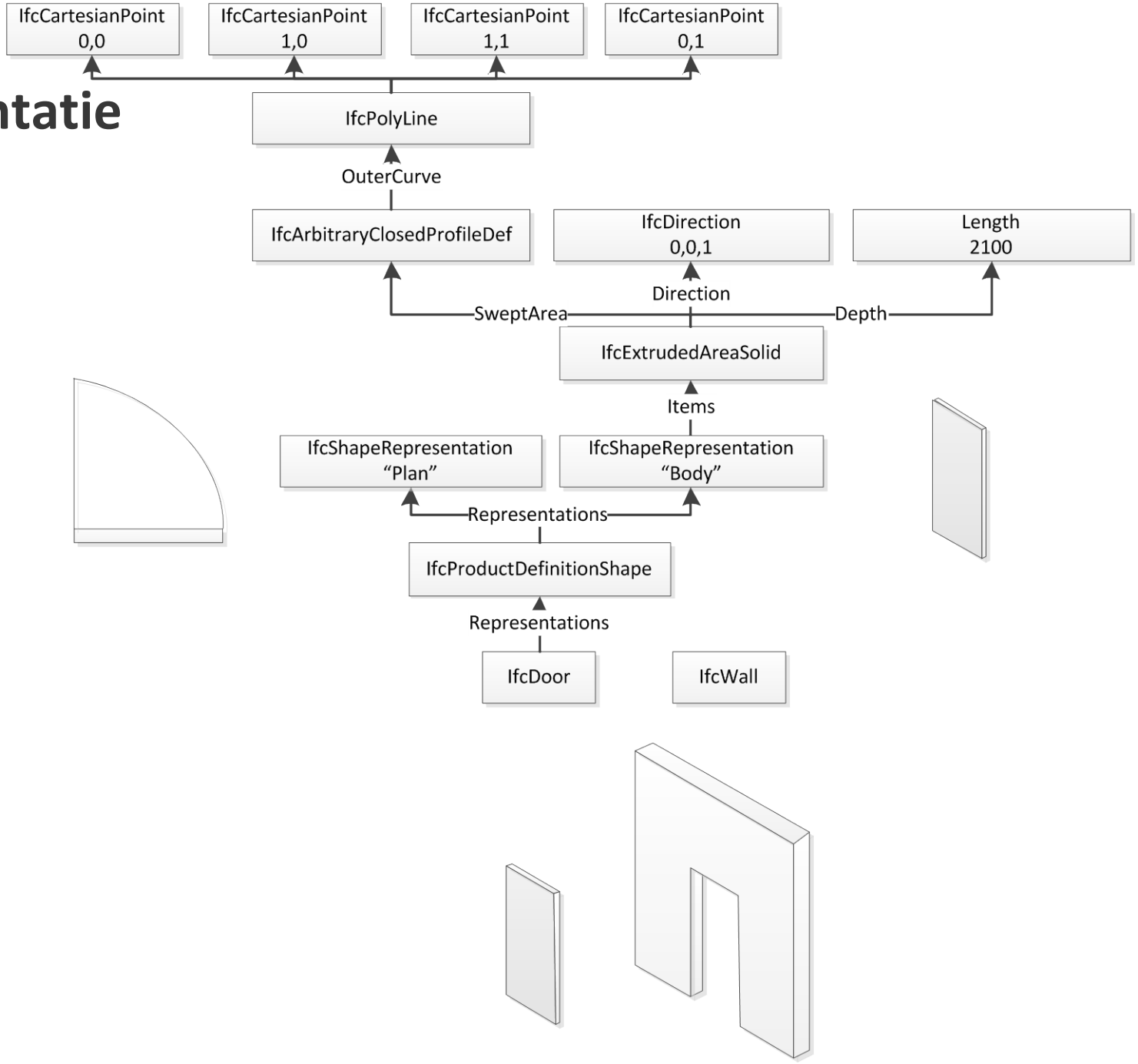
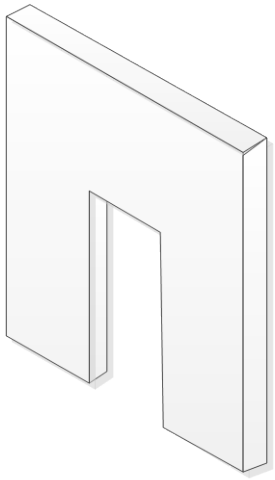
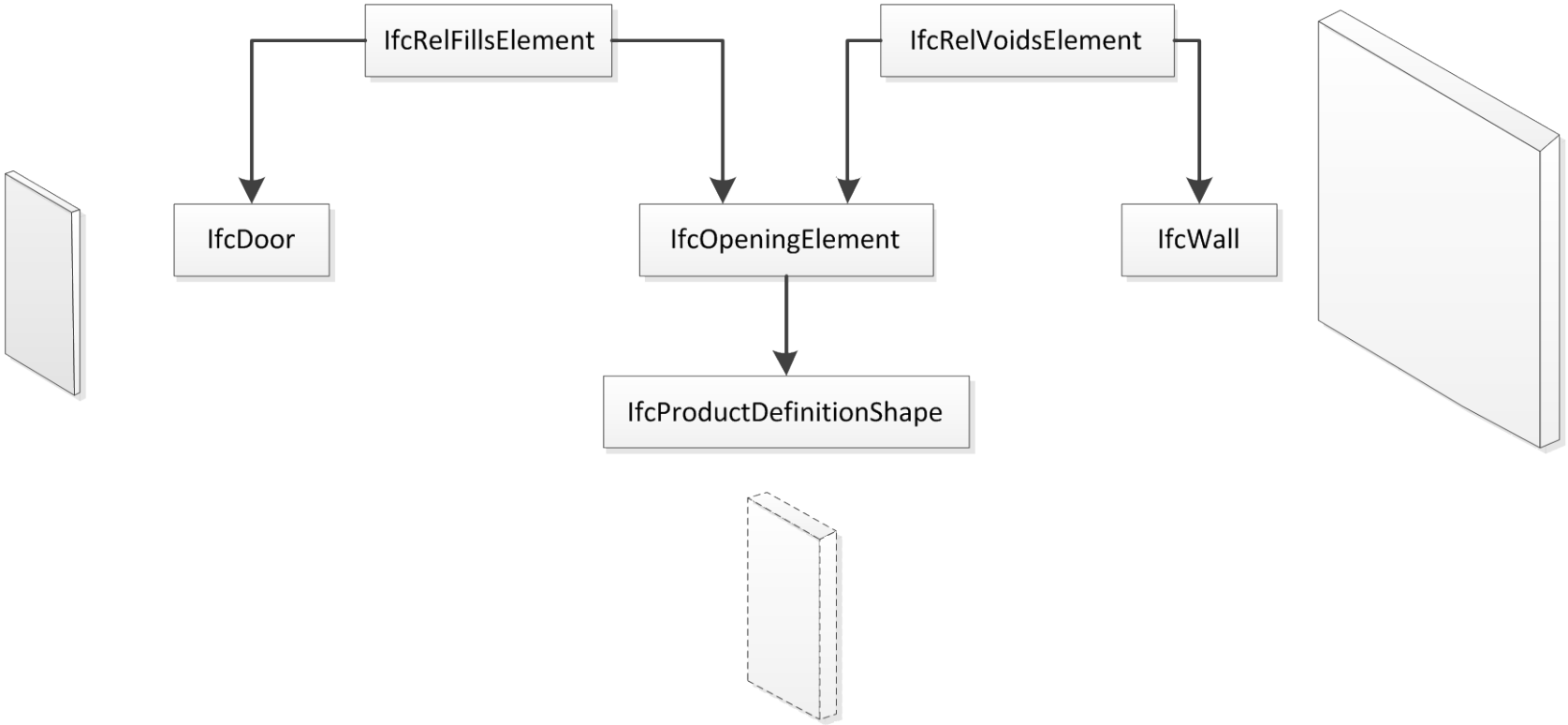


Representatie

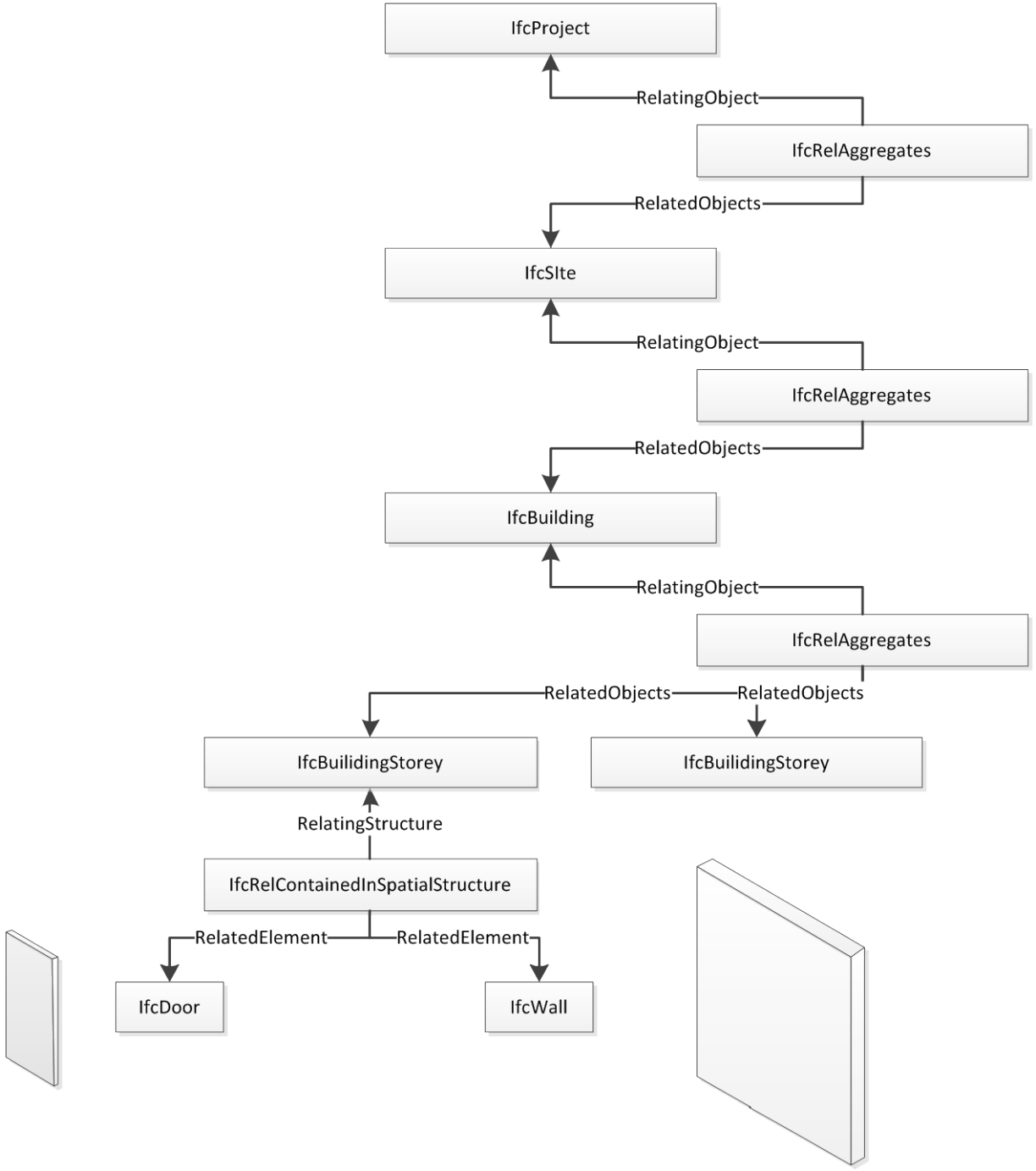


Decompositie en implicite geometrie





Aggregatie


IfcProject
RelatingObject
IfcRelAggregates
RelatedObjects
IfcSIte
RelatingObject
IfcRelAggregates
RelatedObjects
IfcBuilding
RelatingObject
IfcRelAggregates
RelatedObjects
RelatedObjects
IfcBuilidingStorey
IfcBuilidingStorey
RelatingStructure
IfcRelContainedInSpatialStructure
RelatedElement
RelatedElement
IfcDoor
IfcWall

Problemen

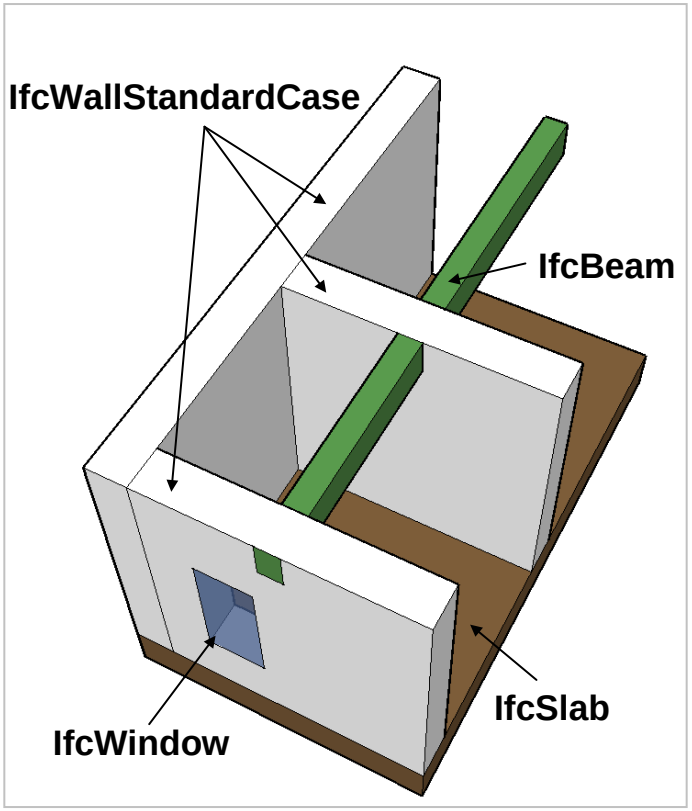
- Complex, groot model (600+ entiteiten)
- TMTOWTDI “There's more than one way to do it“:
  - Eigenschappen vastleggen op verschillende manieren mogelijk
  - Afspraken “Implementors Agreements” deels zwak
- Veel informatie optioneel
- GUIDs: niet voor alles, vaak niet bijgehouden maar vervangen

	IFC	CityGML
Geometrie	Impliciet: CSG, Sweep, NURBS, parametrisch Expliciet: , Brep, Surfaces, Polylines, Points	Impliciet: Geen Expliciet: Brep, Surfaces, Polylines, Points
Coordinaten	Cartesian World Coordinate System, Local/Relatief Coordinate Systems MAAR now also Projected Reference Systems, Transformations built-in (serveral different ones per Context possible) (IFC 4). Transformations noodzakelijk	Altijd in Projected systemen
Semantiek	Gebouwen: Complex, hoog detail niveau Omgeving: Weinig/niets Relaties: Aggregatie, decompositie, specialisatie op verschillende niveaus	Gebouwen: Beperkt tot enkele classes Omgeving: Uitgebreid (stadmeubels, water, tunnels, bruggen etc.) Relaties: eenvoudig
Uitbreidbaarheid	On-the-fly: Property Sets, externe classificaties en bibliotheken (IFD) koppelbaar aan generieke representaties (IfcProxy) Schema: Monolithisch	On-the-fly: Eigenschappen toevoegbaar, code lists (classifcatie maar geen eigenschappen (?)) Schema: XML schema's toevoegen via namespaces (ADE)

CityGML <-> IFC Differing Modeling Paradigms

BIM (e.g., IFC)

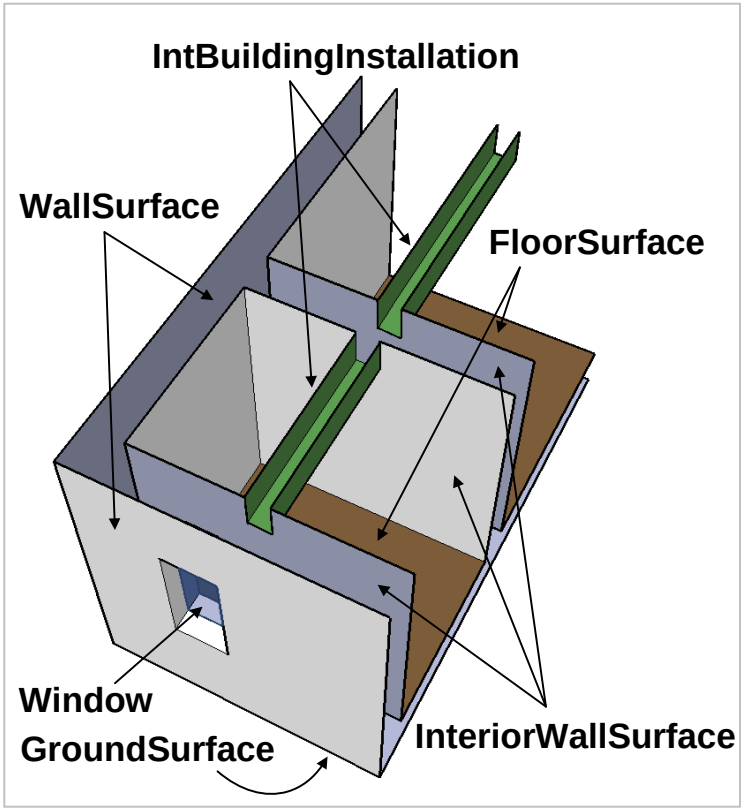
Constructive Solid Geometry



Volumetric, parametric primitives representing the structural components of buildings

3D GIS (e.g., CityGML)

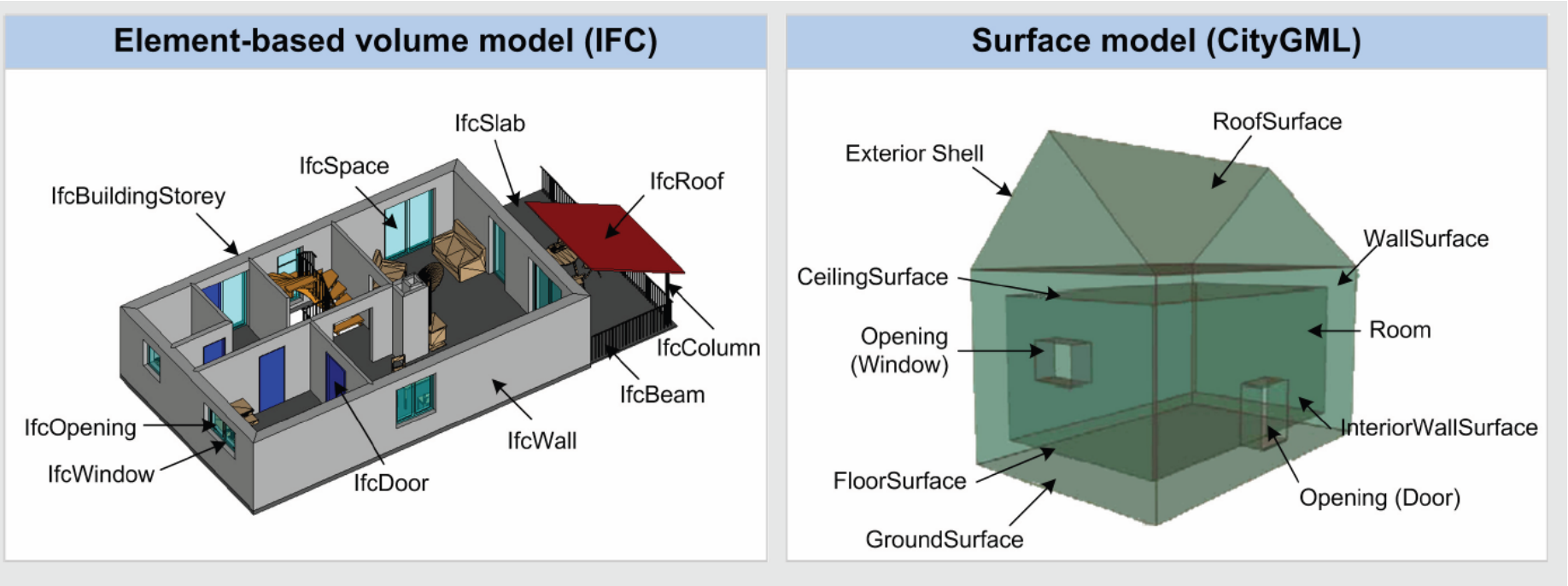
Boundary Representation



Accumulation of observable surfaces of topographic features

source: Thomas H. Kolbe - joint work with Claus Nagel & Alexandra Stadler

CityGML <-> Semantiek en geometrie

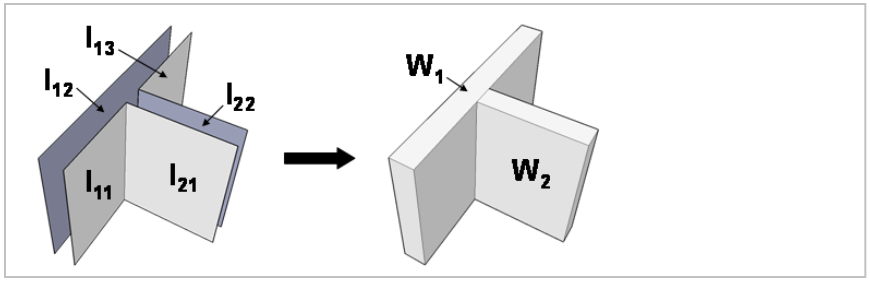


source: Claus Nagel

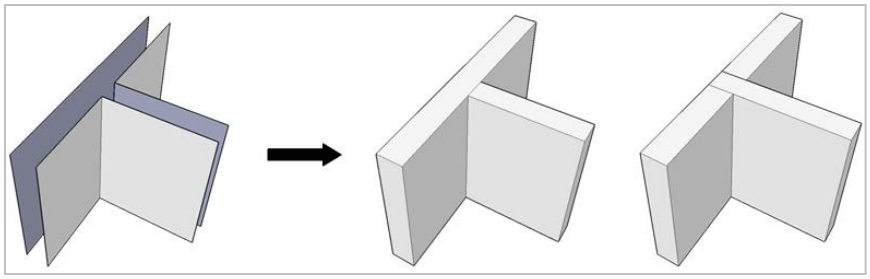
Matching between CityGML and IFC Entities

- Generation of IFC element hypotheses from CityGML entities
  - Semantic information as a priori knowledge
  - Evaluation of geometric-topological relations between CityGML entities

- ***n* CityGML entities may represent *one* IFC element**



- ***n*** CityGML entities may result in ***m*** competing IFC elements



- Further ***1:1*** and ***1:m*** relations possible
  → **High combinatorial complexity**

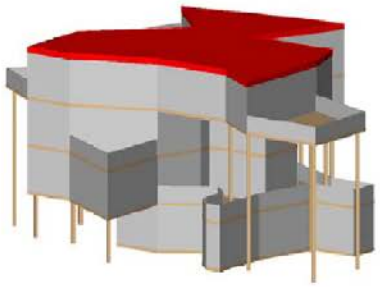
source: Thomas H. Kolbe - joint work with Claus Nagel & Alexandra Stadler

CityGML Conversion

Sources: [Nagel, Häfele, Kolbe]

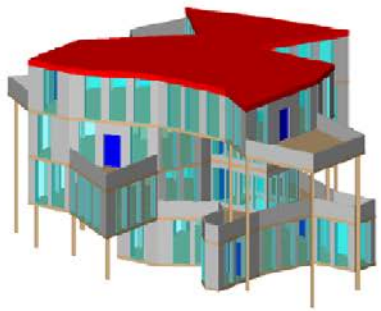
LoD 1 Model

File size: 0.02 MB



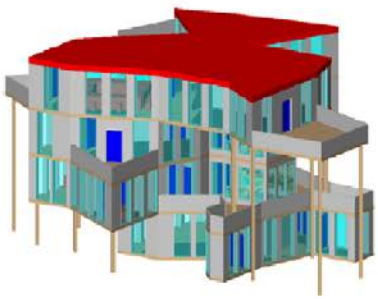
LoD 2 Model

File size: 0.7 MB



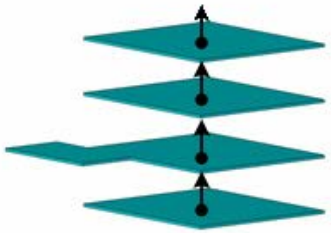
LoD 3 Model

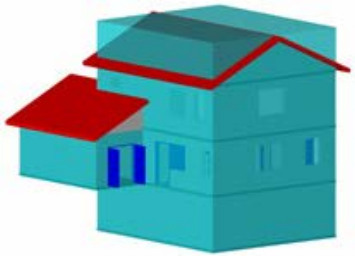
File size: 4.9 MB

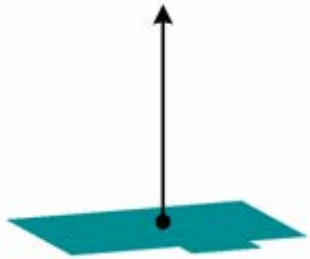


LoD 4 Model

File size: 8.7 MB







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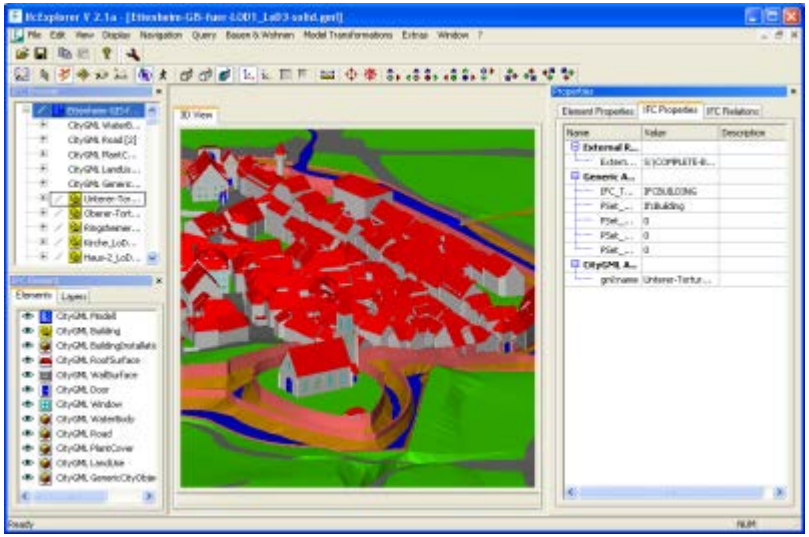
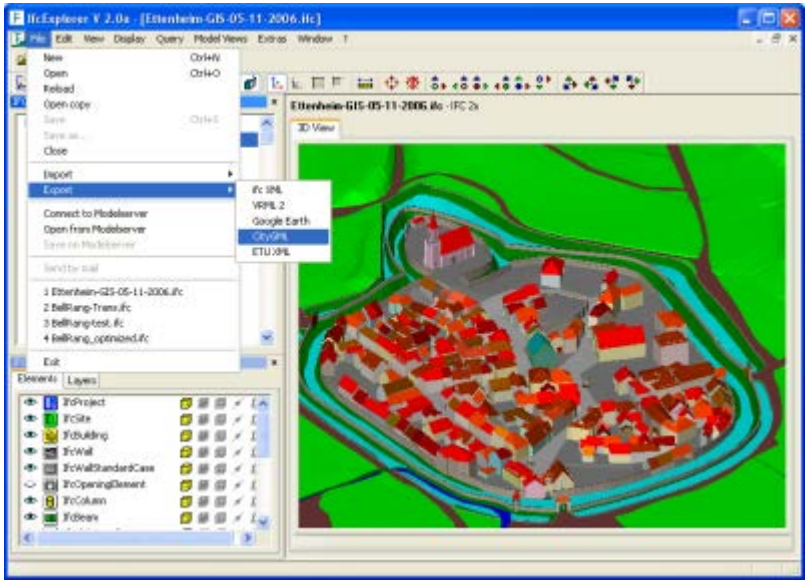
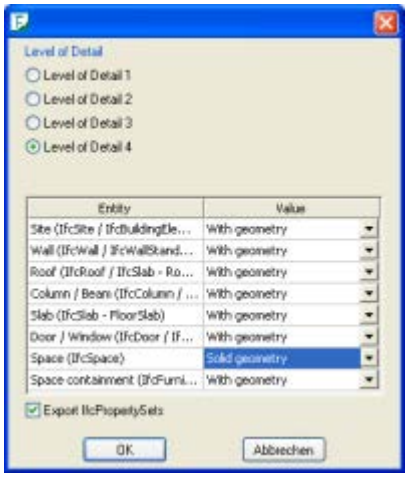
Implementaties: IfcExplorer
FZK/KIT Karlsruhe [Häfele et al]



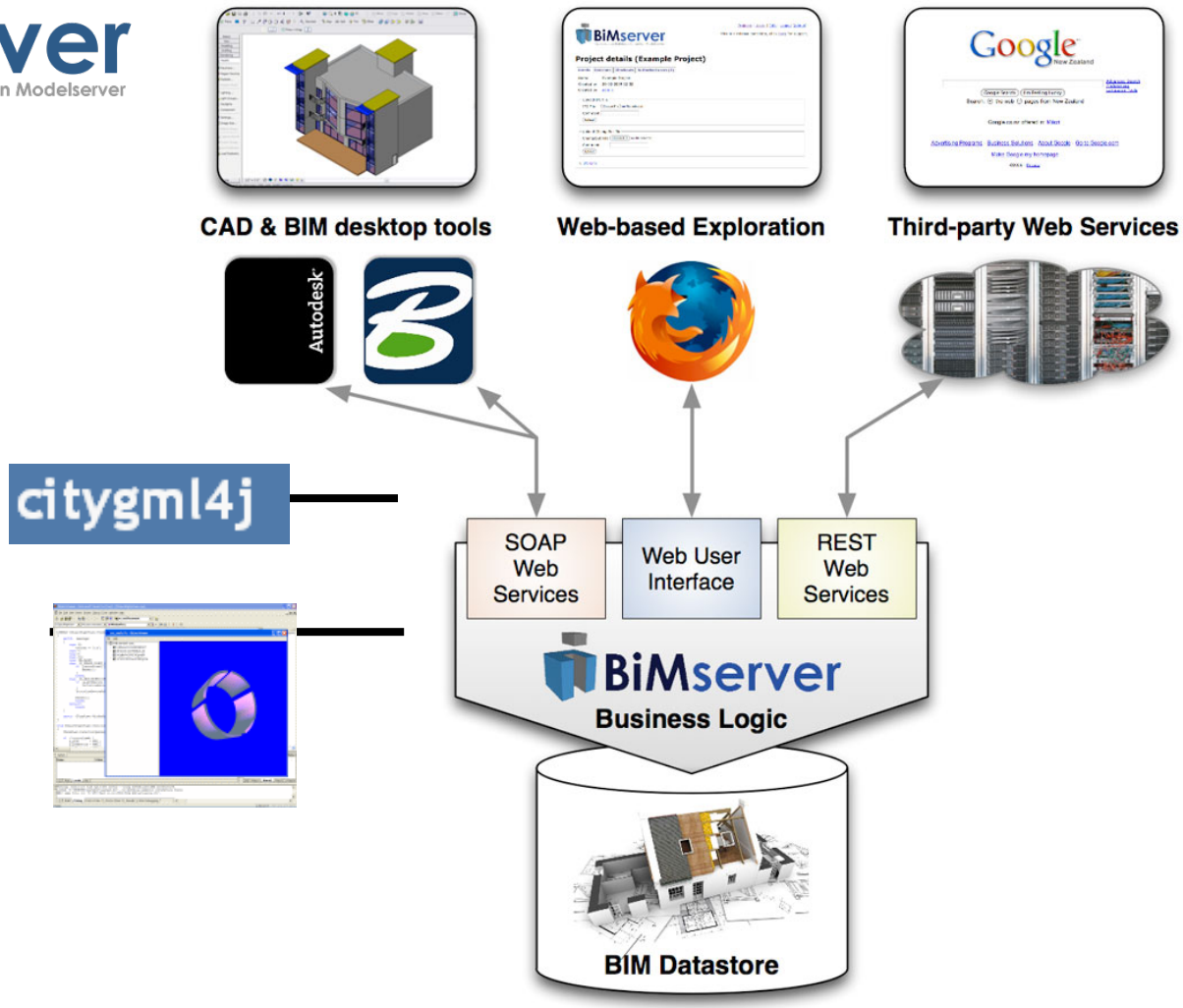




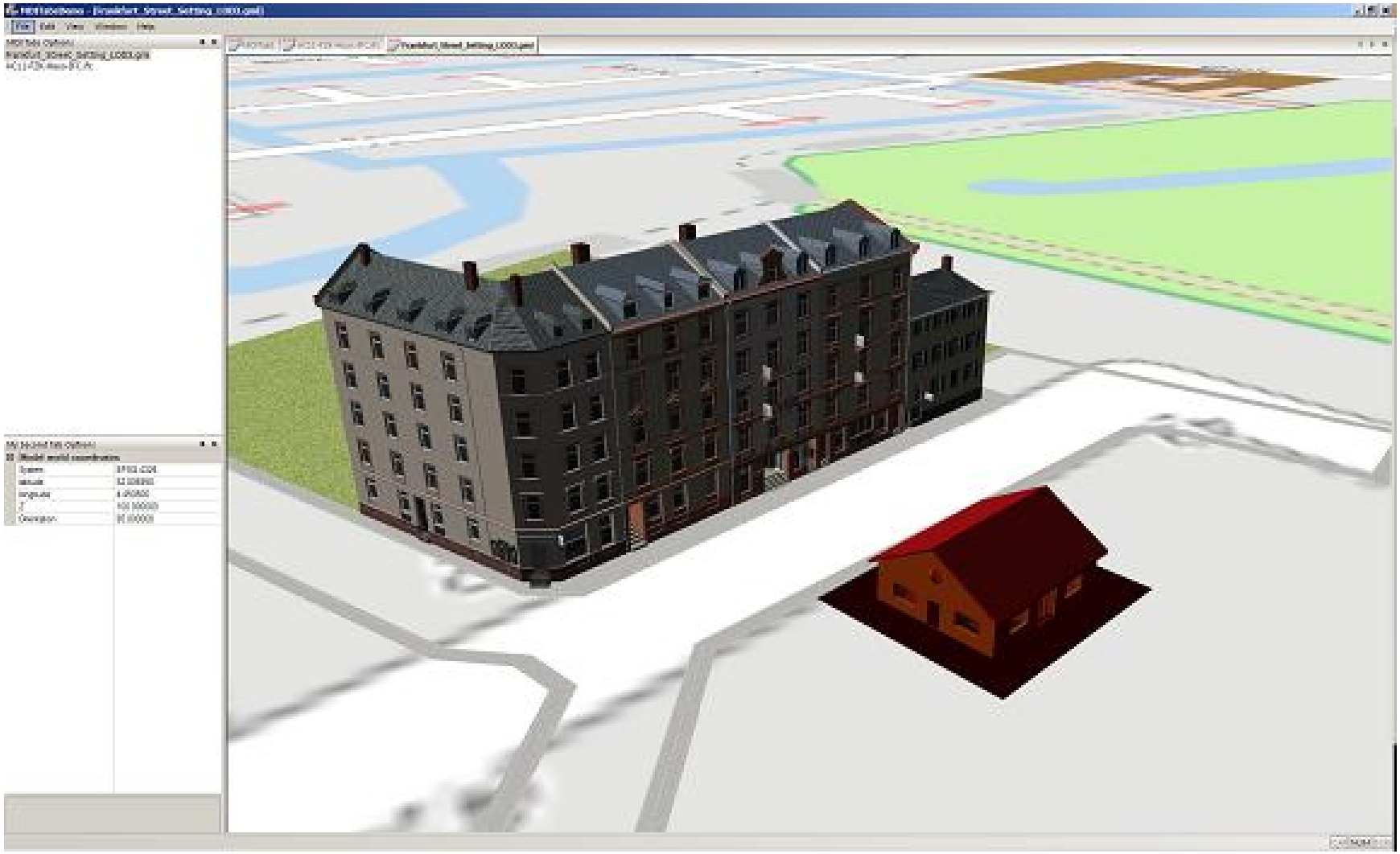
Implementaties: BIMServer

TNO & TU/e [de Laat, van Berlo, Beetz, Jessurun et al]

BiMserver
Open source Building Information Modelserver



Implementaties: Uberviewer
TNO [van den Helm et al]



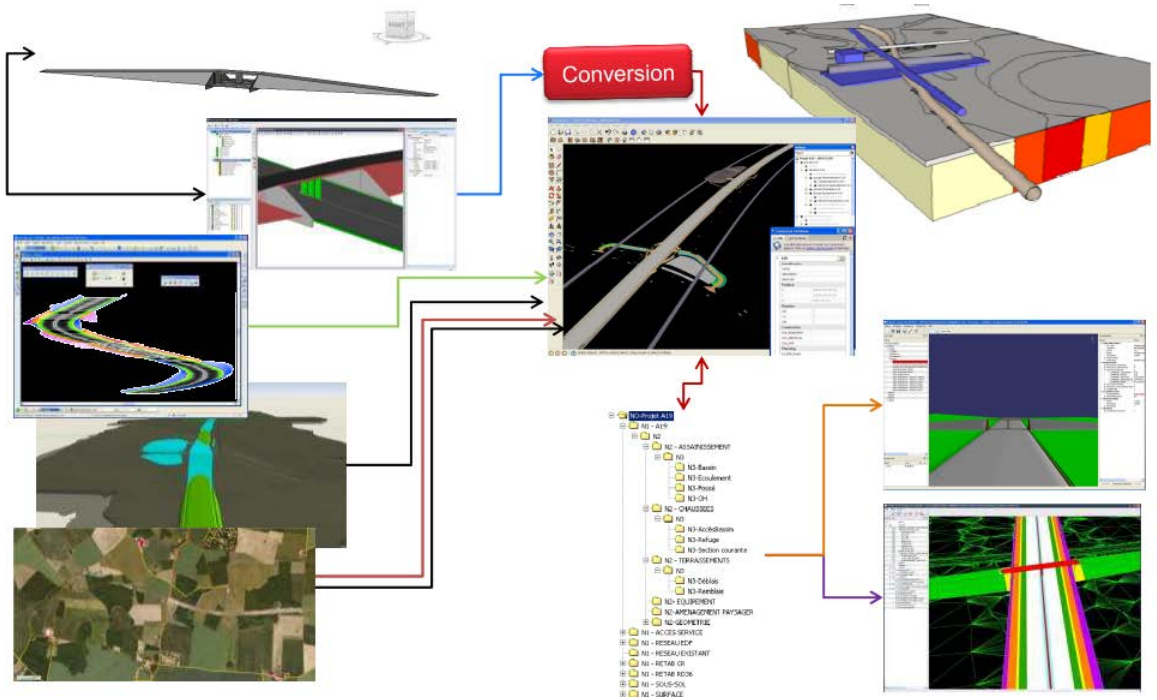
Ontwikkeling: Wertuigen

Citygml4j (Java)
Libcitygml (C++)

BIMServer (EMF, Java) ->IFC, Geom, Beheer
IFCEngine.dll (C) ->IFC, Geom
IFCGears (C++) -> IFC, Geom
OpenCascade (C++) -> Geom
Carve (C++) -> Geom
GDAL(veel talen) -> Geom

Initiativen: IFCInfra

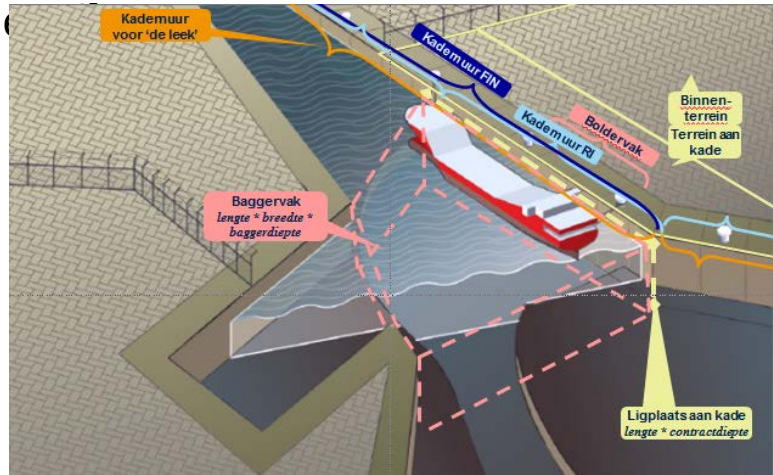
- **Initiated by “Club Communic” France [Pierre Benning, J.B. Vallette et al]**
- **Next week: Workshop Munich on parametric bridge design**



source: Club Communic, J.B. Valette demo 2010

Initiatives: NL

- RijksGebouwenDienst (RGD) BIM-norm (Nov. 1st): Dirk van Rillaer
- Buildingsmart.nl: validation of IFC for NL (Forum Standaardisatie endorsement =>GTDS.buildingsmart.com? RGD? WP 2?)
- Linda van den Brink (Geonovum) to map CityGML<->IFC
- RWS-BIM
- Taskforce Objecten-Bibliotheken (RWS/BIR)
- BIM Omgeving (CURNet)
- COINS
- Starting in January: Next Generation Infrastructures (NGI)
  - TU/Delft [Sisi Zlatanova et al]
  - TU/Eindhoven [Jakob Beetz et al]
  - Haven Bedrijv Rotterdam [Anne Jan Boersma
  - Gemeente Rotterdam [Joris Goos et al]



Bronnen CityGML<->IFC

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- El-Mekawy, M., and A. Östman. “Semantic Mapping: an Ontology Engineering Method for Integrating Building Models in IFC and CITYGML.” *Proceedings of the 3rd ISDE Digital Earth Summit* (2010): 12–14.
- Isikdag, U., and S. Zlatanova. “A SWOT analysis on the implementation of Building Information Models within the Geospatial Environment.” *Urban and Regional data Management, UDMS Annuals* (2009): 15–30.
- Laat, Ruben, and Léon Berlo. “Integration of BIM and GIS: The Development of the CityGML GeoBIM Extension.” In *Advances in 3D Geo-Information Sciences*, edited by Thomas H. Kolbe, Gerhard König, and Claus Nagel, 211-225. Berlin, Heidelberg: Springer Berlin Heidelberg, 2011. http://www.springerlink.com/content/jk21v46722433650/.
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- Nagel, C., and K.H. Häfele. “GENERIERUNG VON 3D-STADTMODELLEN AUF BASIS DES IFC-GEBAUDEMODELLS.” *Entwicklungsforum Geoinformationstechnik: Junge Wissenschaftler forschen, Berlin* 26 (2007): 27.
- Nagel, C., and T.H. Kolbe. “Conversion of IFC to CityGML.” In *Meeting of the OGC 3DIM Working Group at OGC TC/PC Meeting, Paris (Frankreich)*, 2007.
- Nagel, Claus. “Ableitung verschiedener Detallierungsstufen von IFC Gebäudemodellen”. Master Thesis, Karlsruhe University of Applied Science, 2007.

Bronnen IFC / BIM

- IFC Model specificatie:
  - IFC 2x3 http://buildingsmart-tech.org/specifications/ifc-releases/ifc2x3-tc1-release
  - IFC 2x4 http://buildingsmart-tech.org/specifications/ifc_specification/ifc-releases/ifc2x4-release/rc2-release/rc2-release-summary

- Eastman, Teichholz, Sacks, Liston:
  "BIM Handbook", 2008, John Wiley & Sons Inc.
- Eastman "Building Product Models" 1999 CRC Press Ltd.
- Jernigan "Big BIM, little bim" 2007, 4Site Press
- Gielingh, W.
  General AEC Reference Model, Gielingh WF (1988), TNO report BI-88-150,ISO TC 184/SC4/WG1 doc. 3.2. 2.1
  Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, 1988