a history of product models for facilities

Prof. Jeffrey Wix Dip.Tech., FRSA,, MCMI
Nicholas Nisbet MA DipArch

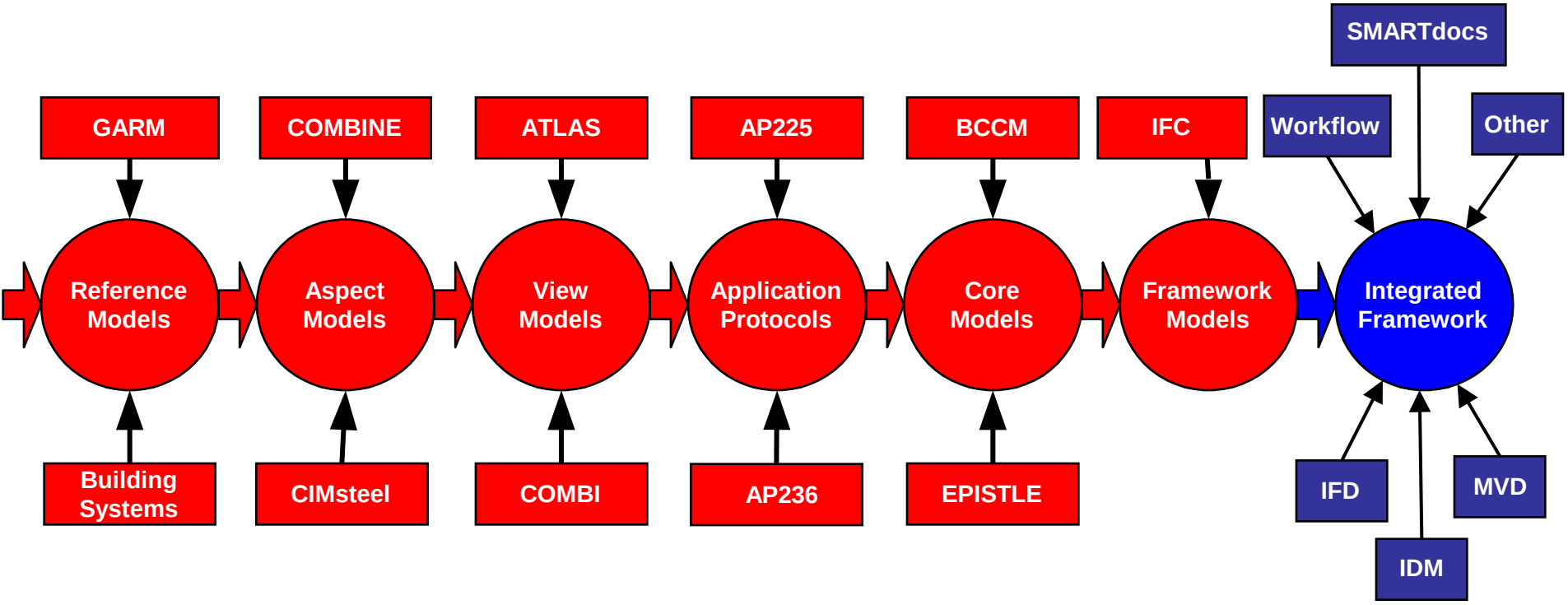
before models

- In the early days of CAD, there were lots of programs.
- Exchanging data between all of these programs was a problem!
- HPGL gave some relief using ‘pen up’, ‘pen down’ commands.
- In 1979, the need for data exchange in defense work initiated efforts on IGES (Initial Graphics Exchange Specification).
- This rapidly became a standard as ANSI Y14.26M.
- The last version (5.3) was published in 1996 but is still widely used in many industries.
- It was recommended in ‘*Data Exchange Between Computer Systems for the Construction Industry*’ (Jeffrey Wix and Colin McLelland, 1986) .
- …. but, with the advent of DXF, it never took off in construction.

STEP

- In 1984, work started on STEP which is the STandard for the Exchange of Product model data.
  - In the US, it was originally called PDES or Product Data Exchange Specification.
- STEP used the newly emerging ideas of information modelling and data definition developing from the relational database world.
  - EXPRESS as the data definition language.
  - IDEF1X, then NIAM and now EXPRESS-G for notation.
- In November 1986, at a STEP meeting in London, the AEC working group was formed.

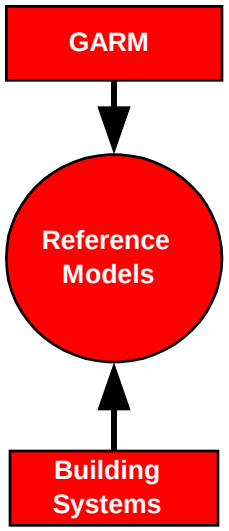
model development



Designations of model type reflect the authors opinion rather than a specific technical development. This diagram is not a timeline.

Jeffrey Wix: July 2008

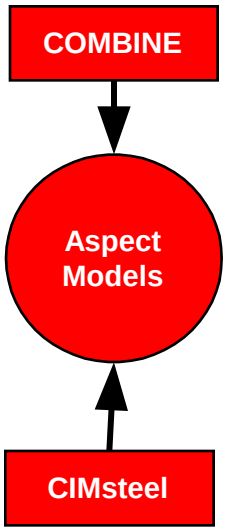
reference models



- General AEC Reference Model (GARM) emerged in 1986.
- Developed by Wim Gielingh at TNO (Netherlands).
- Key ideas were:
  - separation of functional units (requirements) and their technical solutions,
    - now being implemented through constraint based models such as SMARTcodes;
  - generic, specific and occurrence level requirements and solutions,
    - implemented through library, type and occurrence objects.
- GARM was the originator of many ideas in the IFC and ISO 15926.

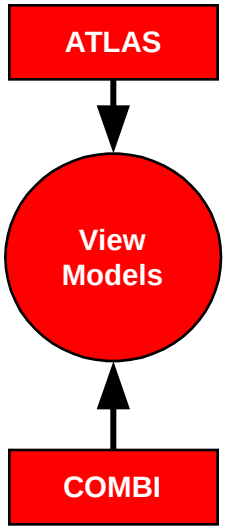
- Building Systems Model emerged in 1986.
- Developed by Prof. James Turner at University of Michigan (USA).
- It provided a system oriented description of the world.
- Key ideas were:
  - system taxonomy (separated into active and passive systems;
  - assignment of elements to multiple systems (multifunctionality);
  - arbitrary grouping on elements to systems;
  - port based connectivity.

aspect models



- Aspect models deal with the totality of one particular subject.
- They emerged around 1989/1990 to add topical requirements to reference models.
- The best known models are COMBINE and CIMsteel.
- COMBINE dealt with energy and HVAC and was led by Fried Augenbroe (TU Delft, now Georgia Tech).
- CIMsteel focussed on structural steel frameworks through design, modelling and fabrication.
- Originally led by Alastair Watson at University of Leeds, CIMsteel is now at version 2 and is widely supported and used in the US through AISC and work at Georgia Tech led by Chuck Eastman.

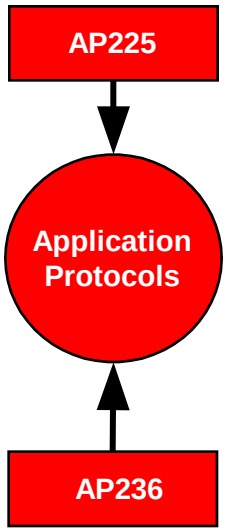
view models



- View models focussed on supporting the software implementation.
- The most significant developments were the EU funded projects ATLAS and COMBI.
- Development of these models was in the period 1992-1994
- Historically, these are significant.

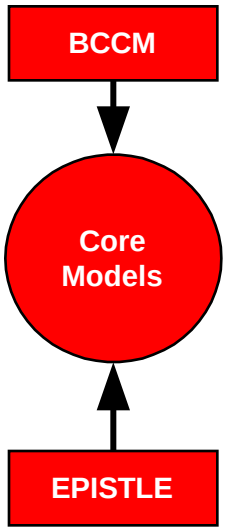
- More recently, the aecXML activity attempted to accelerate product model development.
- Two activities have become established from this initiative:
  - gbXML dealing with energy,
  - landXML dealing with road construction geometry.
- Both of these conform to the view model idea.

application protocols



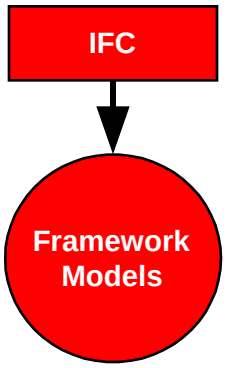
- In 1993, at an ISO STEP meeting in Berlin, plans were made for several application protocols for construction.
- The aim was to have an HVAC protocol based on an extension of the COMBINE work (ISO 10303:228) and a structural steel protocol based on CIMsteel (ISO 10303:230).
- Lack of funding killed these efforts.
- However, a German initiative led by Wolfgang Haas on ‘building elements using explicit shape representation’ did proceed. This became ISO 10303:225.
- Later work through the FunSTEP project on furniture led in Portugal/Spain by Ricardo Goncalves is driving ISO 10303:236.

core models



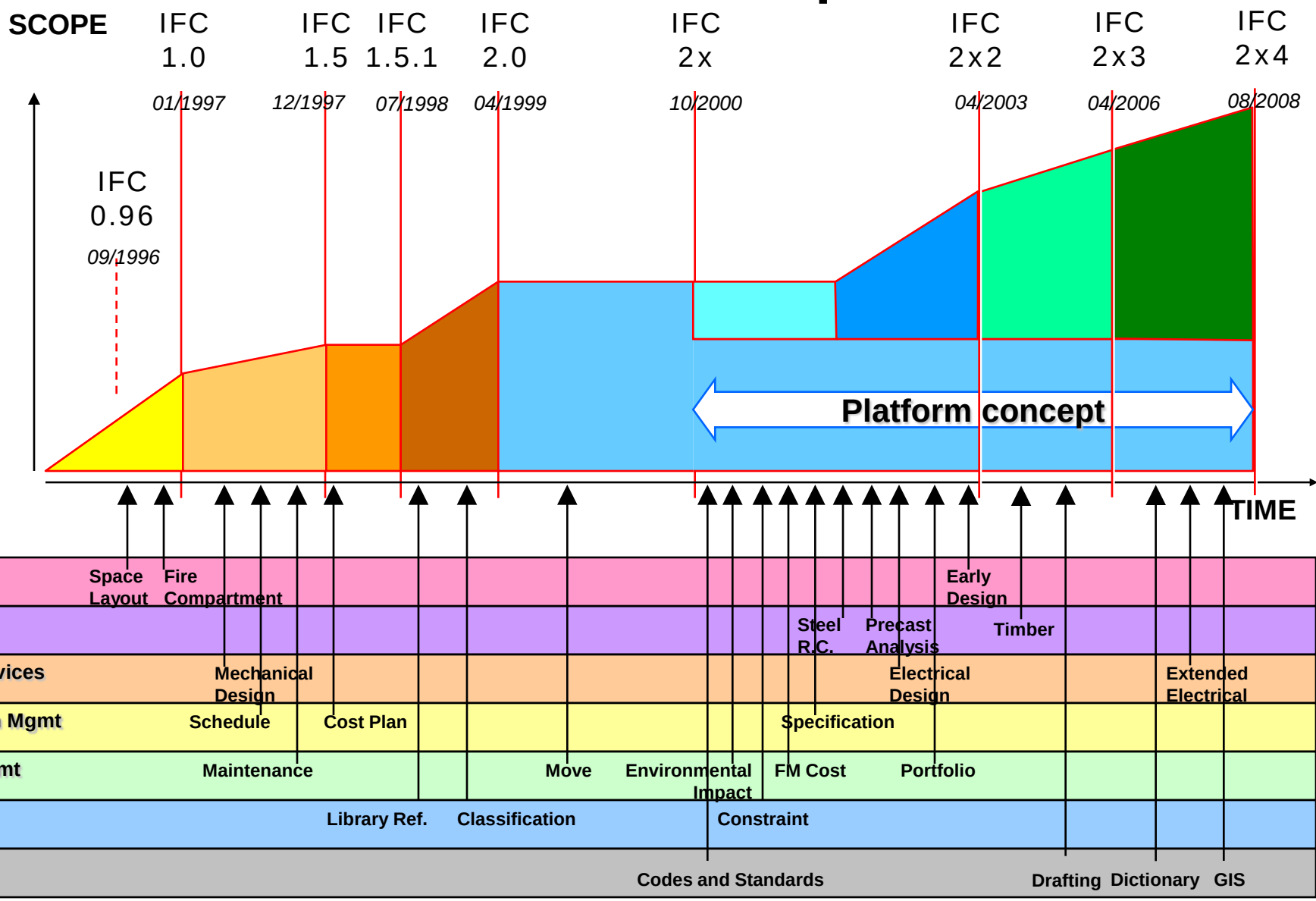
- In 1993, model development focus moved back to ISO where the idea of Core Models was emerging.
- This drew on ideas by Gielingh and Tolman reinforced by the development of ‘high quality data modelling’ at Shell by Matthew West
- The Epistle Core Model and the Building Construction Core Model (BCCM) built on this.
- BCCM was also able to build on the implementation success of the ATLAS project and merged ideas from COMBI.
- BCCM was developed as a resource part in STEP which became a problem as it could only be instantiated through application protocols (for which funding was an issue)

framework models



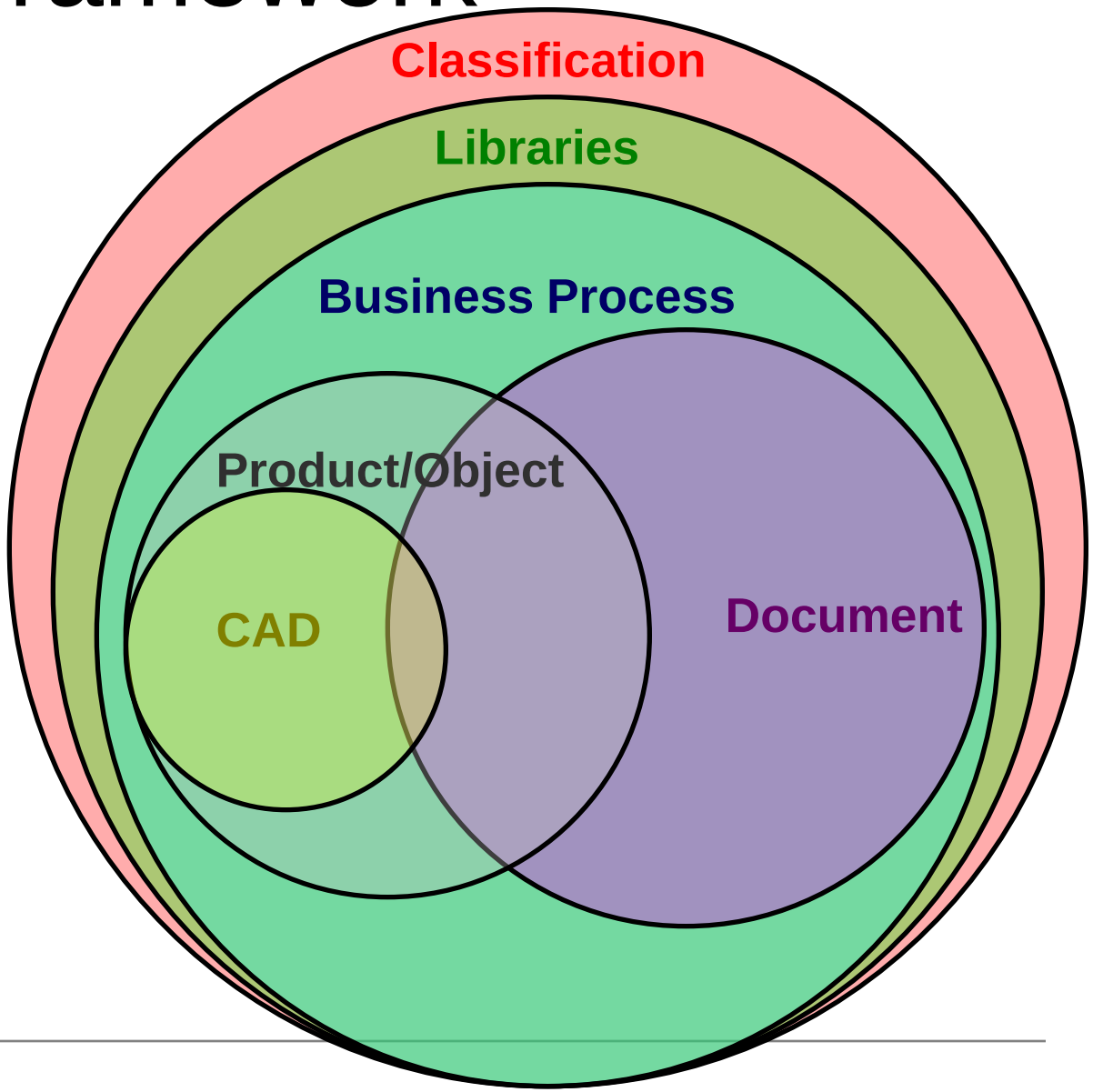
- In 1994, Autodesk brought together 8 developers from around the world to test their new ARX development for an intensive 2 weeks (with some success).
- 12 companies then came together to further test interoperability ideas around AutoCAD Release 13.
- In 1995 they demonstrated success and opened out to industry as a whole. This was the International Alliance for Interoperability (IAI), now called buildingSMART.
- At the heart of IAI was the IFC product data model.

IFC model development

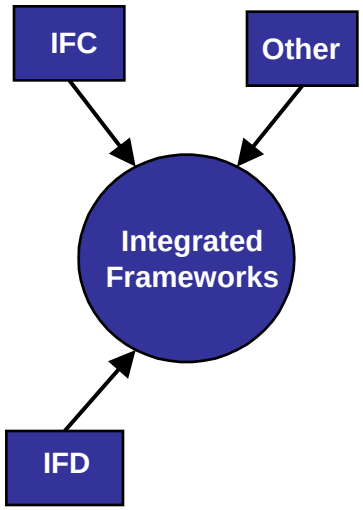


integrated framework

- The vision of an integrated framework emerged at a meeting in Vancouver in 1999.
- It looked at areas of ICT development and how they connected.
- A conclusion was that terms and their meanings must be standardized through a dictionary.
- Provided the ‘kick-off’ for what is now the IFDinitiative.

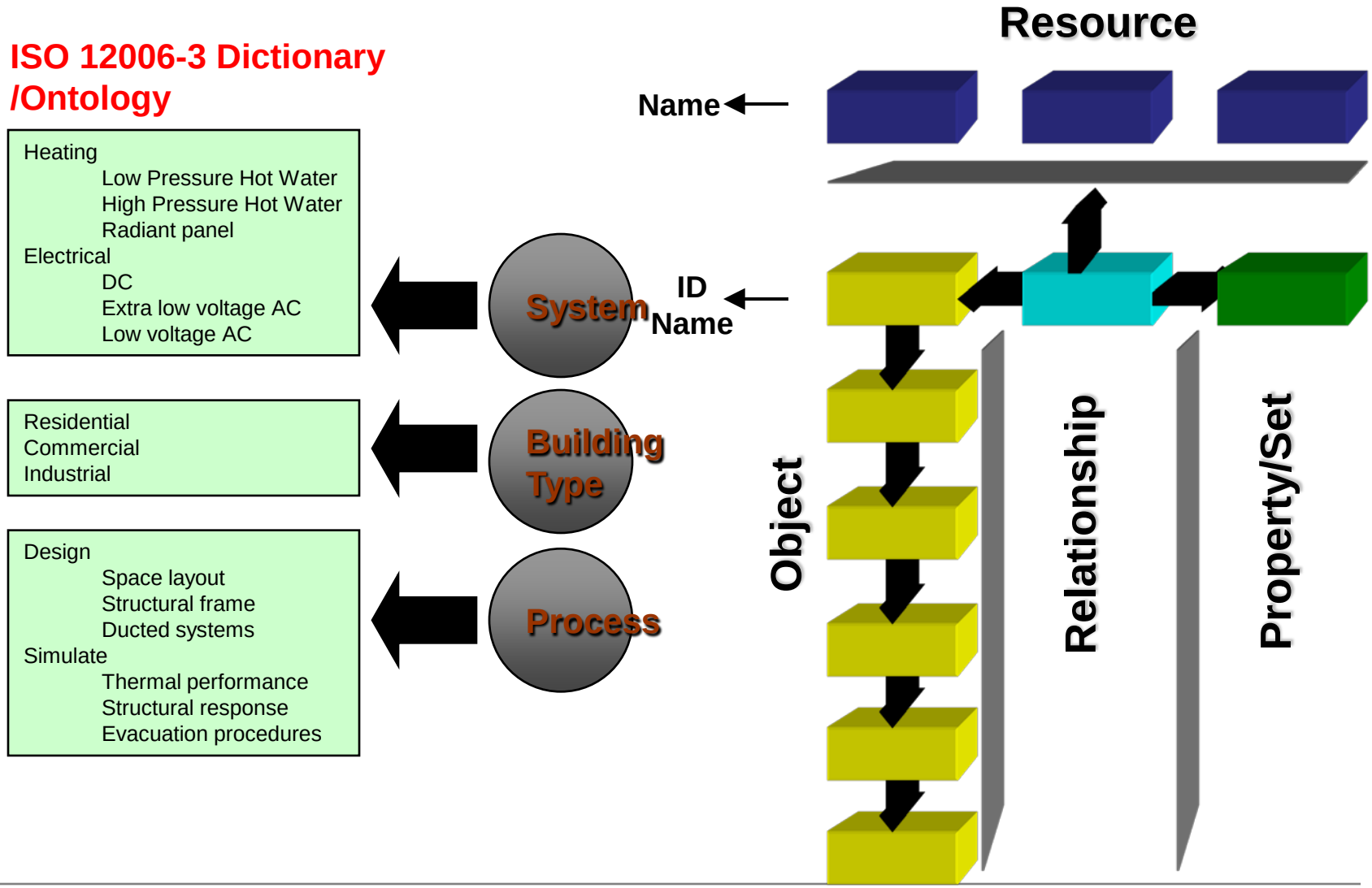


dictionary

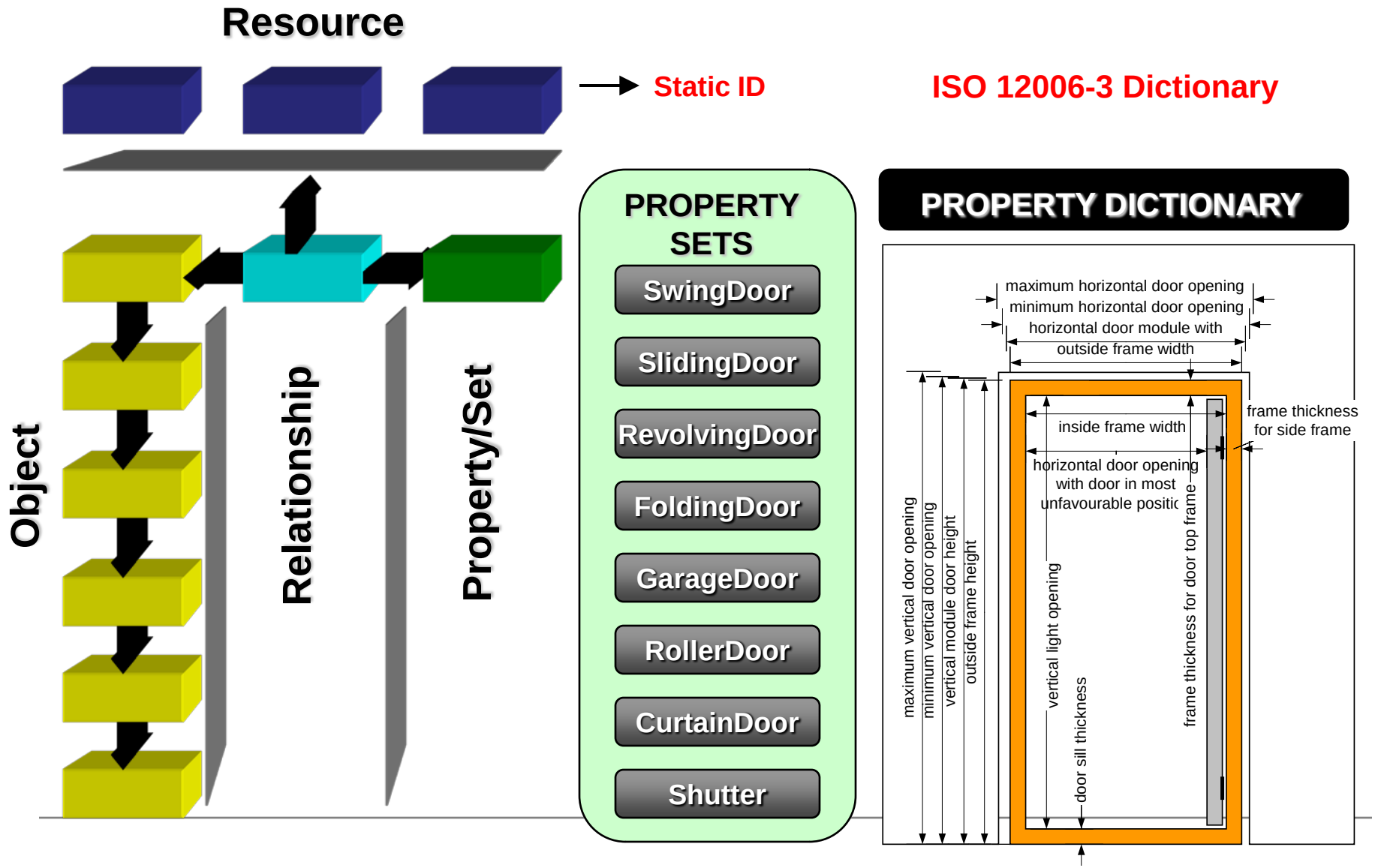


- In June 1999, the need for a dictionary of user defined properties in multiple languages was defined.
- Translation would be via a globally unique identified concept rather than just a word translation.
- This became ISO 12006:3 in 2007.
- It is better known as IFD,
  - International Framework for Dictionaries.
- IFD is being further developed by a consortium comprising Norway, Netherlands, USA, Canada.
- Provision for its use is in the IFC 2x4 model release.
- IFD is now being tested as a means to map between classification systems; something not previously achieved.

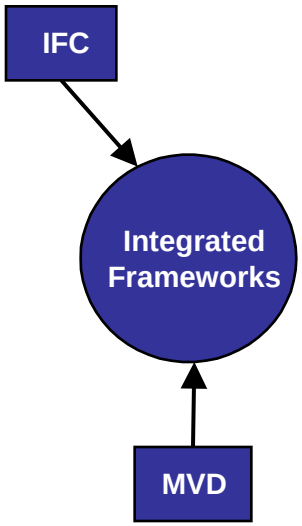
object name services



property name services

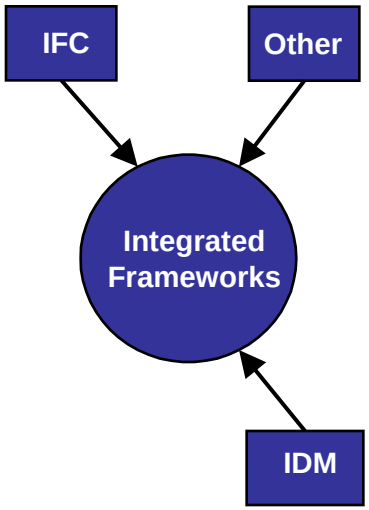


views



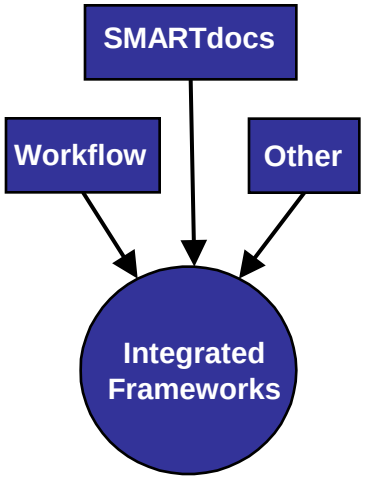
- No-one implements the whole of the IFC model,
  - except model server and viewer providers.
- Views provide a focus for software implementation.
- Principally, this is the coordination view at present.
- Now expanding to QTO, FM, HVAC and Structural.
- In 2003, Jiri Hietanen from Finland developed a more diagrammatic approach to model view development (MVD).
- Approved by buildingSMART as the ‘official’ method.
- Views provide the basis for certification which tests support by software for required entities, attributes, property sets.
- It does not test that the data shared is valid.

information delivery manual



- In 2005, the ‘Information Delivery Manual (IDM) was developed by Jeffrey Wix, Bjorn Stangeland and Lars Christensen.
- It’s aim is to support users in the construction process.
- It specifies exchange requirements and business rules.
- This allows for model use to be extended:
  - allows acceptable data values to be specified;
  - information shared can be configured to local or project needs without having to vary the model;
  - supports the use of models in the construction process;
  - enables shared building information to be validated.
- IDM is currently being developed as ISO 29481:1 and is harmonized with buildingSMART view development.

‘other’ key ideas



- The technology used for the ICC SMARTcodes project is also being adapted to provide validation of data exchange.
- It can also be extended to become a SMARTdocuments knowledge capture capability.
- IFC will need to work in conjunction with other data exchange specifications including:
  - GML/CityGML/KML (geographic information and city maps);
  - landXML (roads);
  - TransML (transportation systems generally);
  - gbXML (energy);
  - ISO 15926 (process plant).
- IDM will extend to define workflow provisions using a process execution standard such as BPEL.

what next?

- IFC is a result of continuous development that started 20+ years ago.
- What can we expect in the next few years?
  - Model stability;
    - the policy of maintaining the 2x model series will continue for several years since buildingSMART is committed to a full ISO release of IFC in 2010.
  - Extension of the ‘ontology’ support from IFD;
    - this will include much more terminology and more language support
  - Growth in view and exchange requirement provision.
  - Introduction of data validation methods to quality assure exchanges.
  - Development of object libraries that will allow information delivery via the web.
  - Executable process workflows.
  - Enhanced implementations through services oriented provisions.
  - ….. and more