SBS5322 Basics of Building Information Modelling

http://ibse.hk/SBS5322/

BIM collaborations

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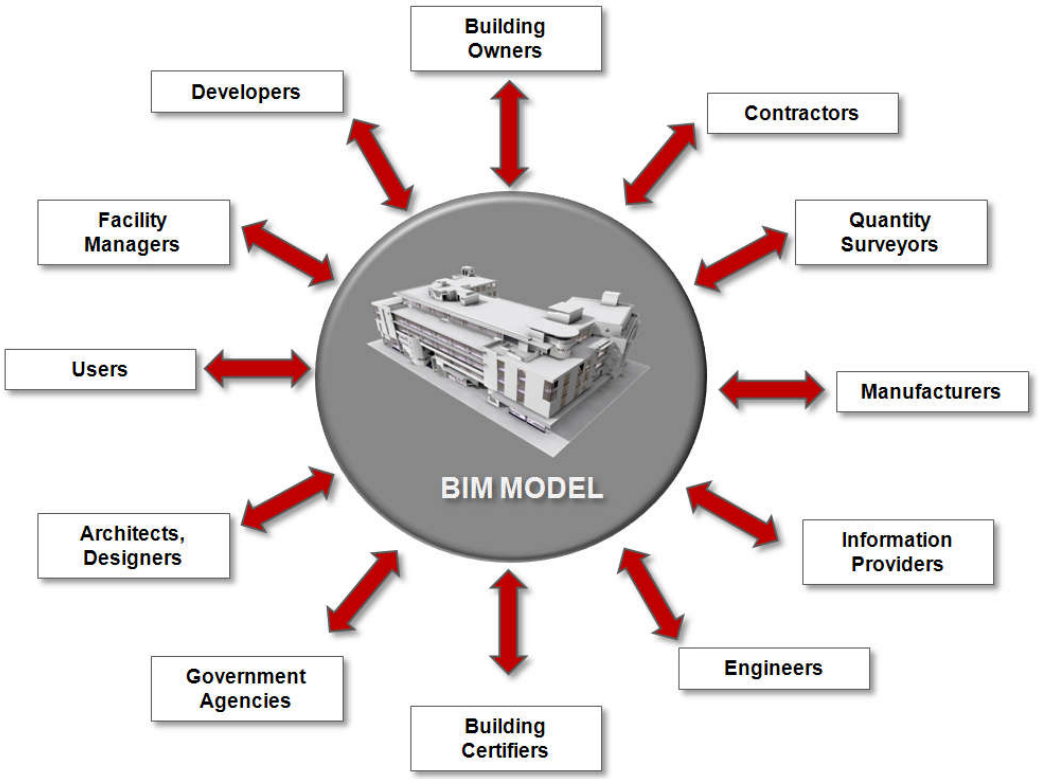
Contents

- External collaboration
- Industry Foundation Classes
- Sharing data and documents
- Reviewing and data exchange
- Cloud-based BIM

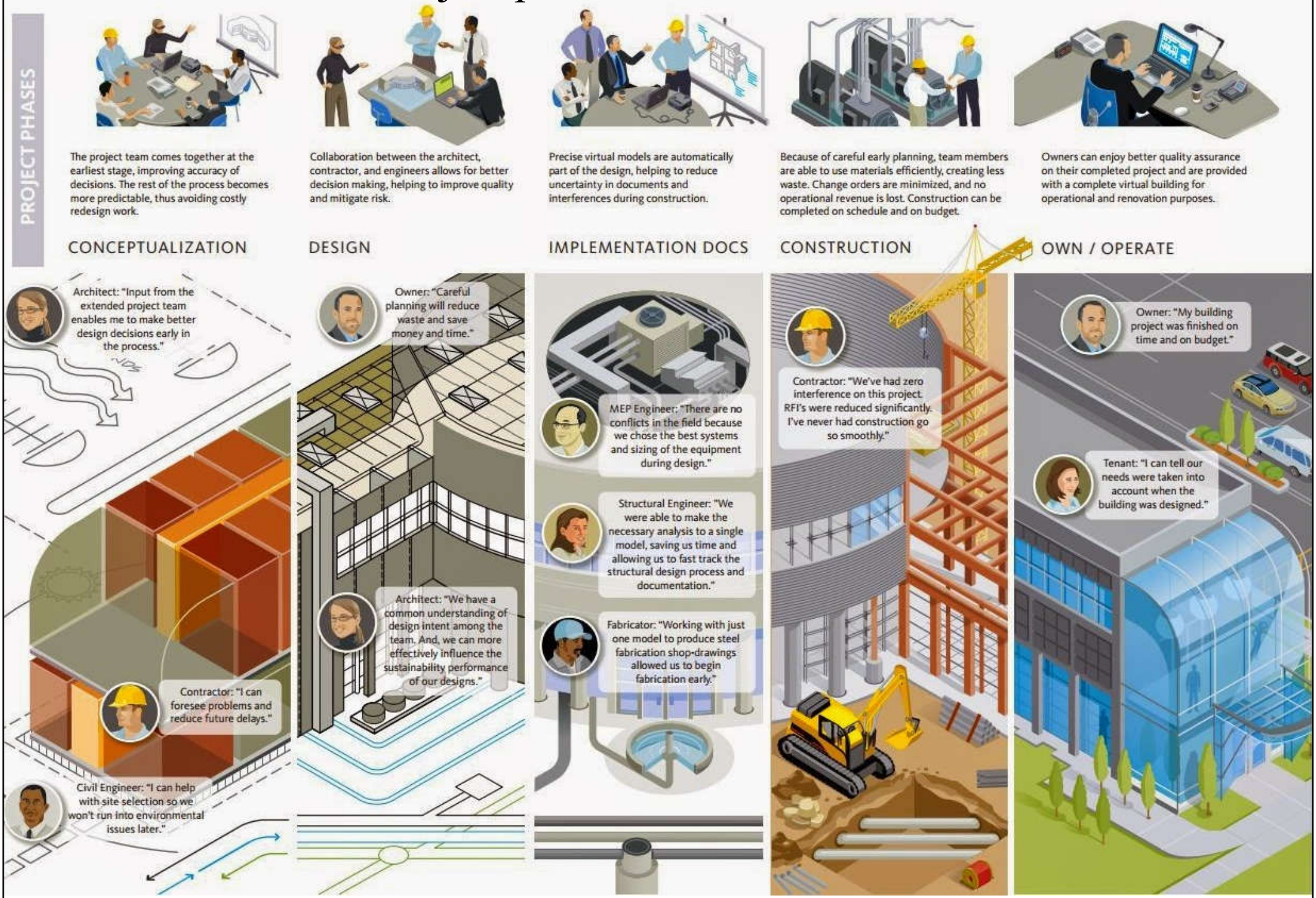
External Collaboration-BIM

- Collaboration of the project stakeholders are critical for the sake of successful project management.
- BIM applications support a wide range of data communication platforms.
- Automated collaboration solutions minimize the risk of project coordination errors.



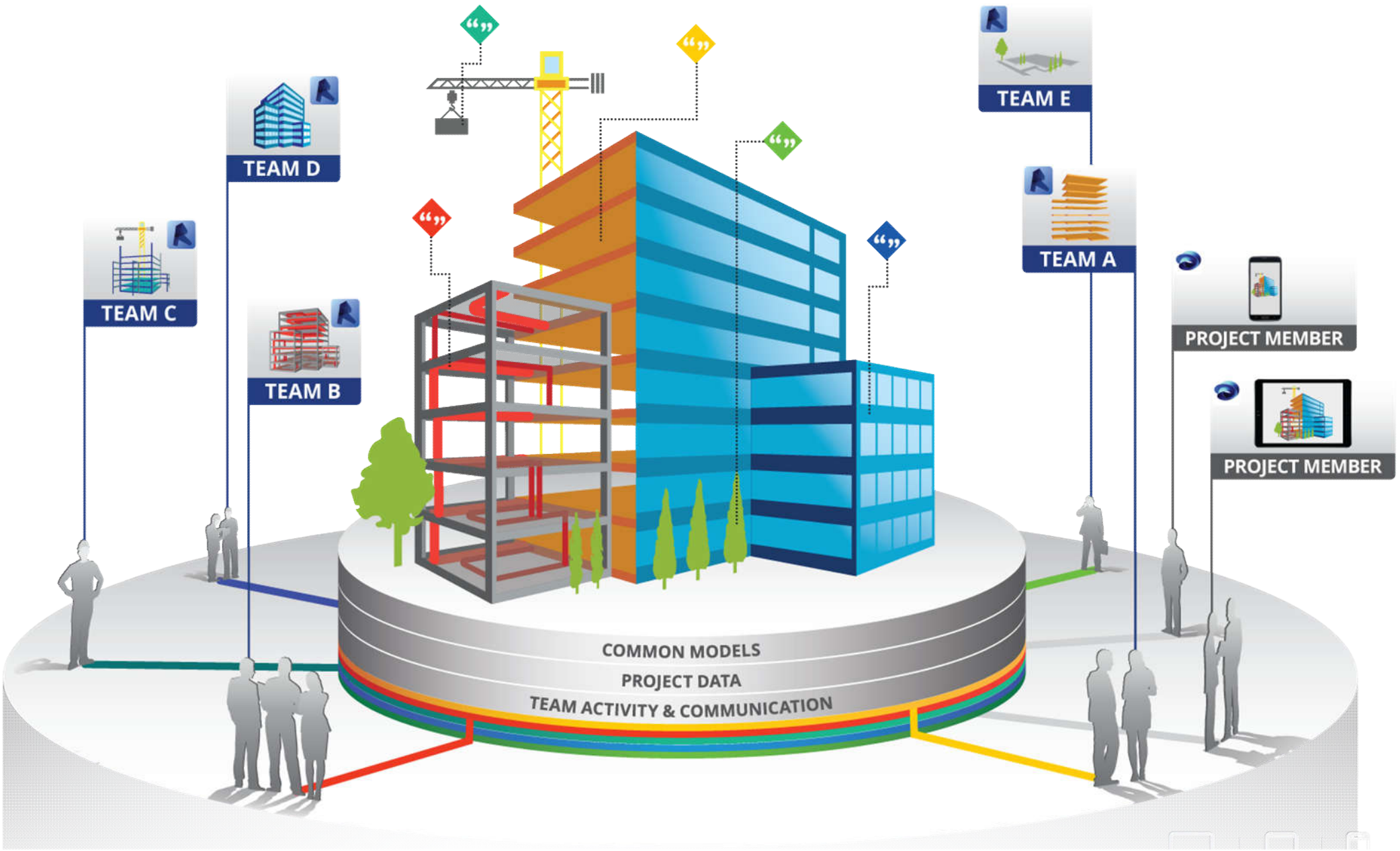
(Source: Graphifsoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Project phases and stakeholders



(Source: Autodesk)

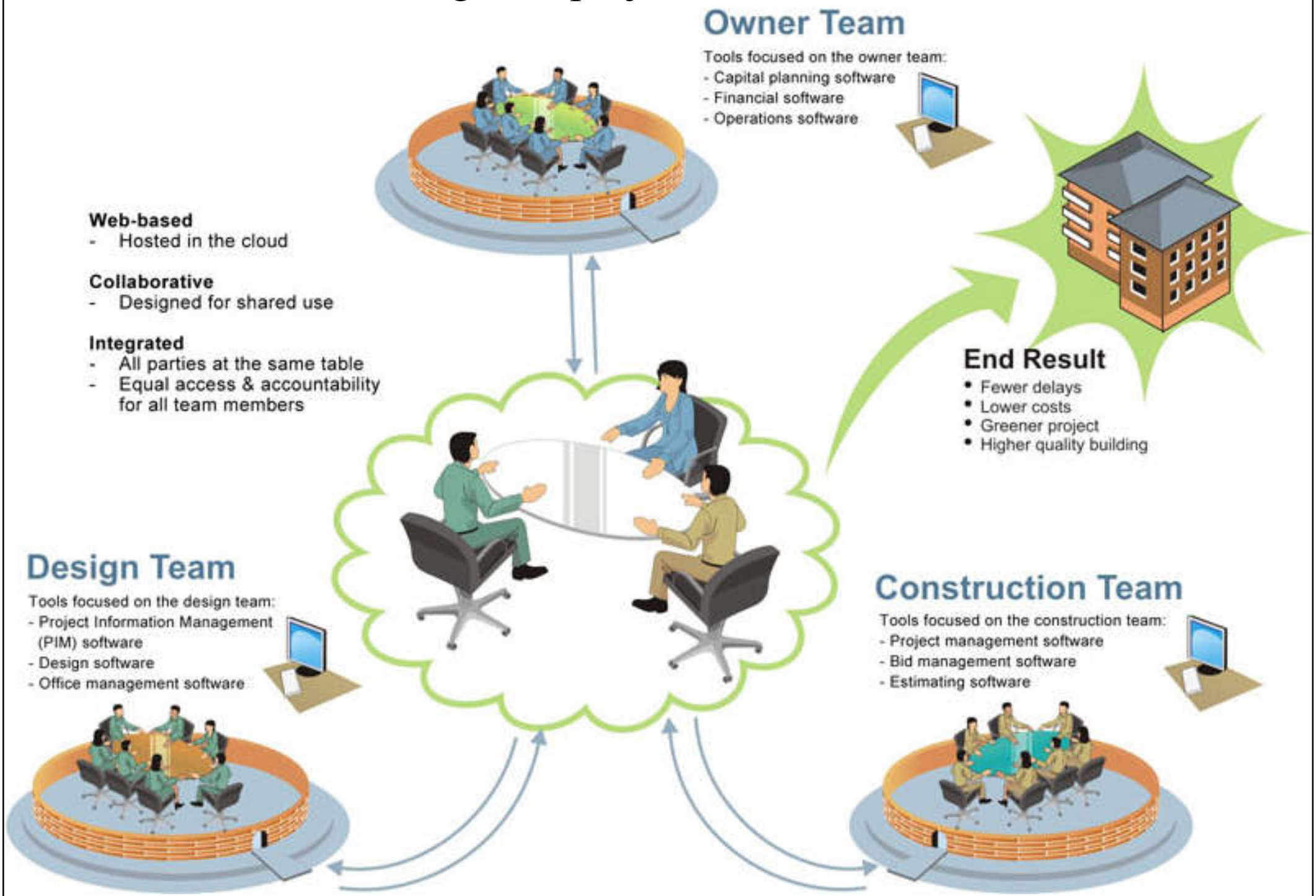
Project teams can work and collaborate better with BIM



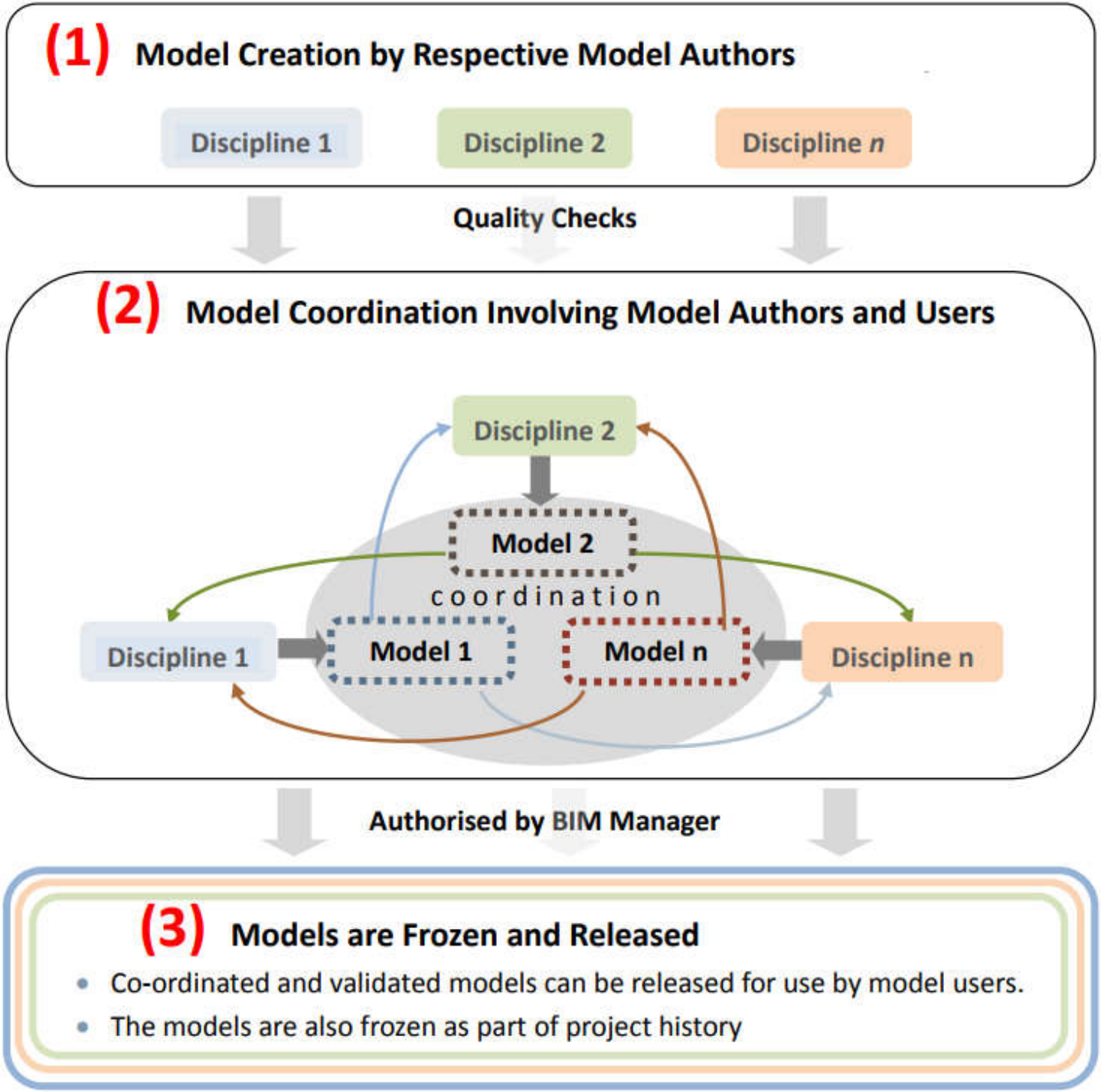
(Video: The Future of Project Delivery, by Autodesk BIM 360 (2:49) https://youtu.be/f4MyEHhPOpc)

(Source: Autodesk)

Integrated project collaboration

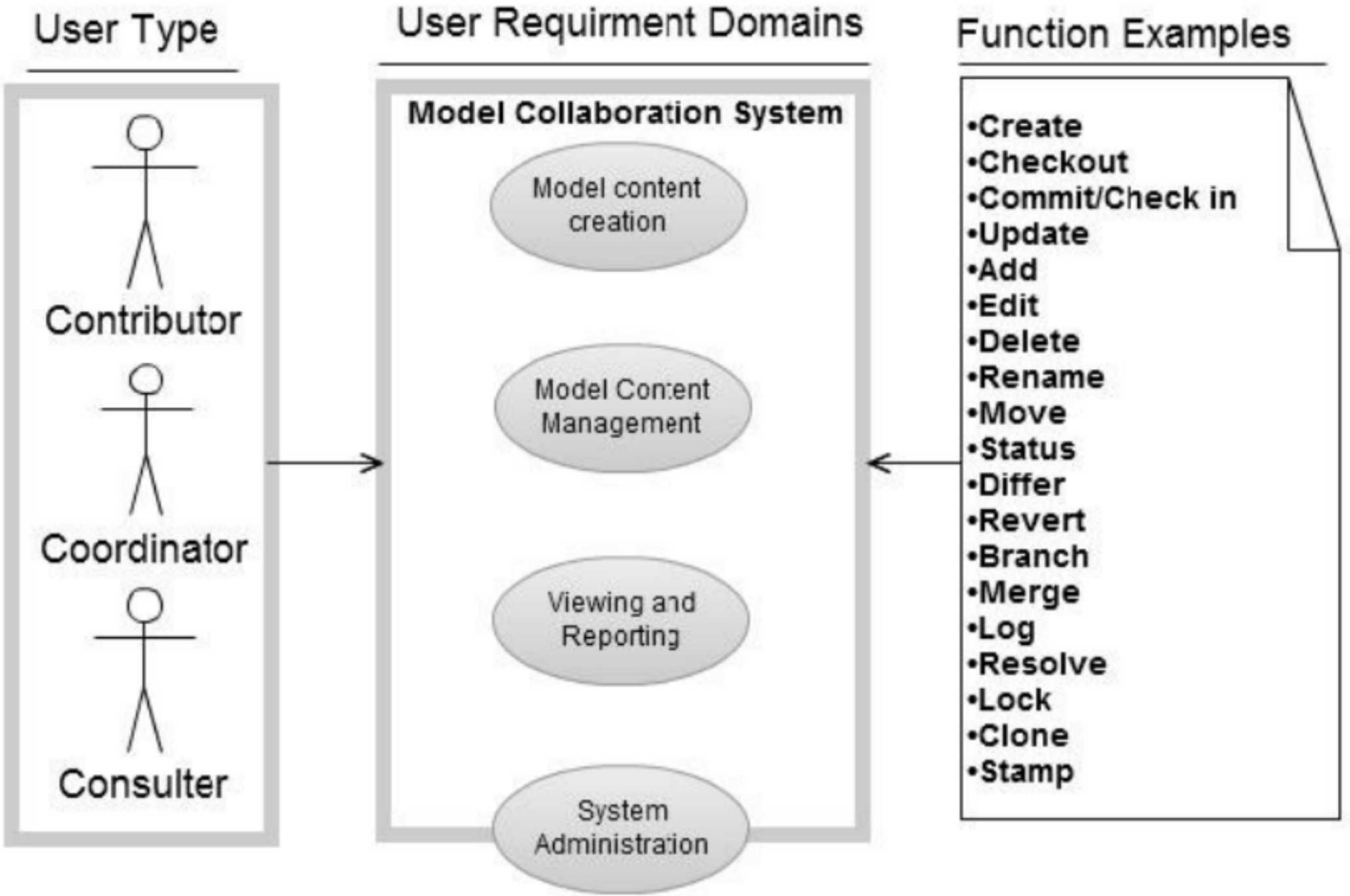


BIM modelling and collaboration procedures



(Source: Singapore BIM Guide Version 2)

Users and requirement domains in a model collaboration system



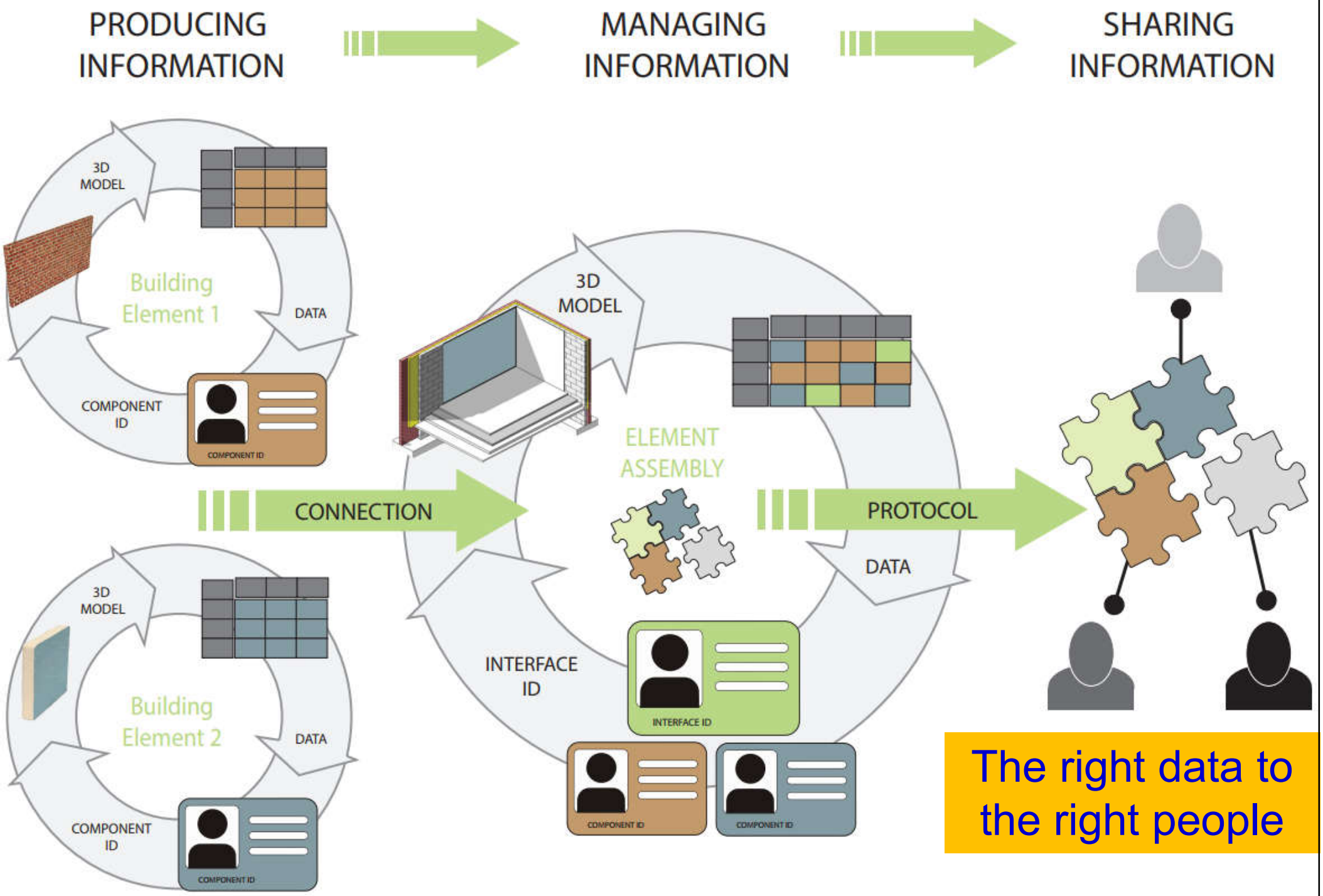
(Source: Shafiq, M. T., Matthews, J. and Lockley, S. R., 2013. A study of BIM collaboration requirements and available features in existing model collaboration systems, *Journal of Information Technology in Construction*, 18: 148-161. https://www.itcon.org/papers/2013_8.content.07723.pdf)

Typical features of a model collaboration system

Model content creation	Model content management	Viewing and reporting	System administration
• Model modifications • 2D data modelling • Data querying • Reference data linking • Product libraries • Support • Model checking • Rule-based modelling • Model comparison • Change management	• Model upload / download • Multiple data model formats • Partial model exchange • Versioning • Model merging • Data locking • Clash detection • Conflict resolution • Audit trail • Data publishing • Workflow management	• Remote model viewing • 3D navigation • Mark-up • Collaborative communication • Report generation • FM data support • Colour customization • Workflow reporting • Mobile computing support	• User profiling • Access control • Data handling • Interface customization • Security • Disaster protection • Data archiving

(Source: Shafiq, M. T., Matthews, J. and Lockley, S. R., 2013. A study of BIM collaboration requirements and available features in existing model collaboration systems, *Journal of Information Technology in Construction*, 18: 148-161. https://www.itcon.org/papers/2013_8.content.07723.pdf)

The key of BIM exchanges is the management of information



(Source: Denis, F., 2015. *Building Information Modelling – Belgian Guide for the Construction Industry*, ADEB-VBA, Brussel.)

External collaboration

- Current practices in the construction industry are document centric
- The BIM process can improve collaboration
- BIM applications and file formats
  - Wide variety of BIM applications for modelling and analysis of different aspects
  - No strong international standards yet
  - Exchange between BIM applications not always reliable

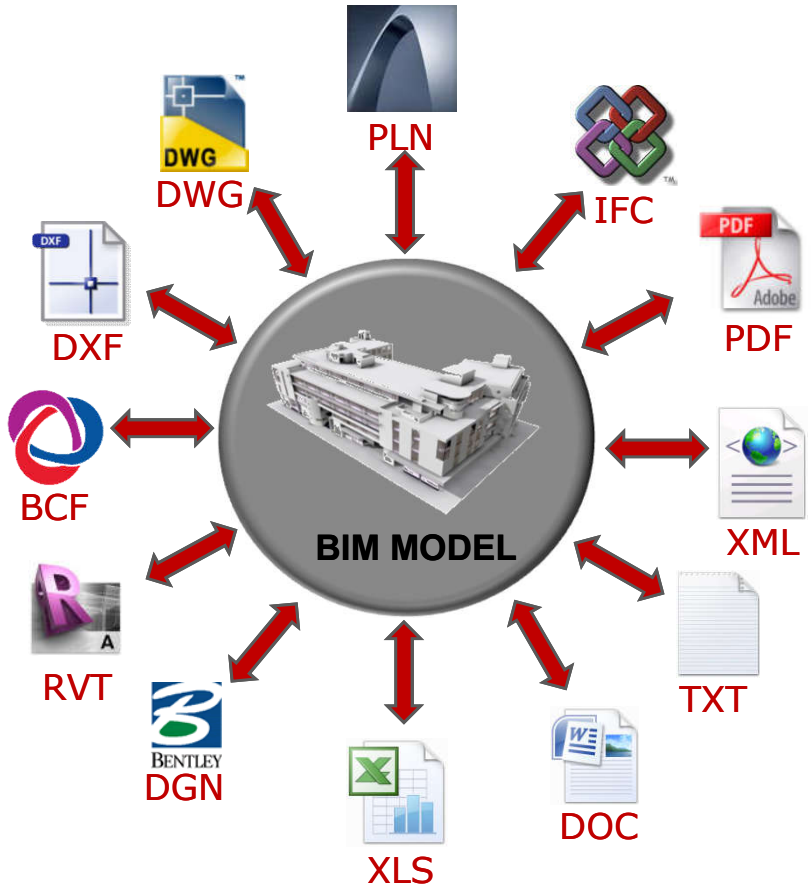
How to integrates with all major BIM tools for collaboration?

BIM Collaboration Format

合作

File Formats

- BIM applications allow the sharing of model data via several file formats:
  - IFC
  - DXF-DWG
  - PDF
  - XML
  - Native CAD/BIM file formats



(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

IAI

- The **International Alliance for Interoperability** (IAI) is a global standards-setting organization.*
- IAI is promoting effective means of exchanging information among all software platforms and applications serving the AEC+FM community by adopting a single Building Information Model (BIM).
- Major vendors of Building Information Model (BIM), Structural engineering, HVAC design, thermal analysis, code checking, quantity take-off and cost estimation applications have implemented support for **IFC** in their products.

http://www.buildingsmart.com/

* buildingSMART International, bSI, formally known as International Alliance for Interoperability, IAI

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

IFC

- **IFC** stands for Industry Foundation Classes.

- IFC is a standard universal framework that enables information sharing and interoperability throughout all phases of the whole building life cycle.
- Industry Foundation Classes (IFCs) are data elements that represent the parts of buildings, or elements of the process, and contain the relevant information about those parts.
-
- IFCs are used by computer applications to assemble a computer readable model of the facility that contains all the information of the parts and their relationships to be shared among project participants.
- IFC is developed by AIA (International alliance for Interoperability)

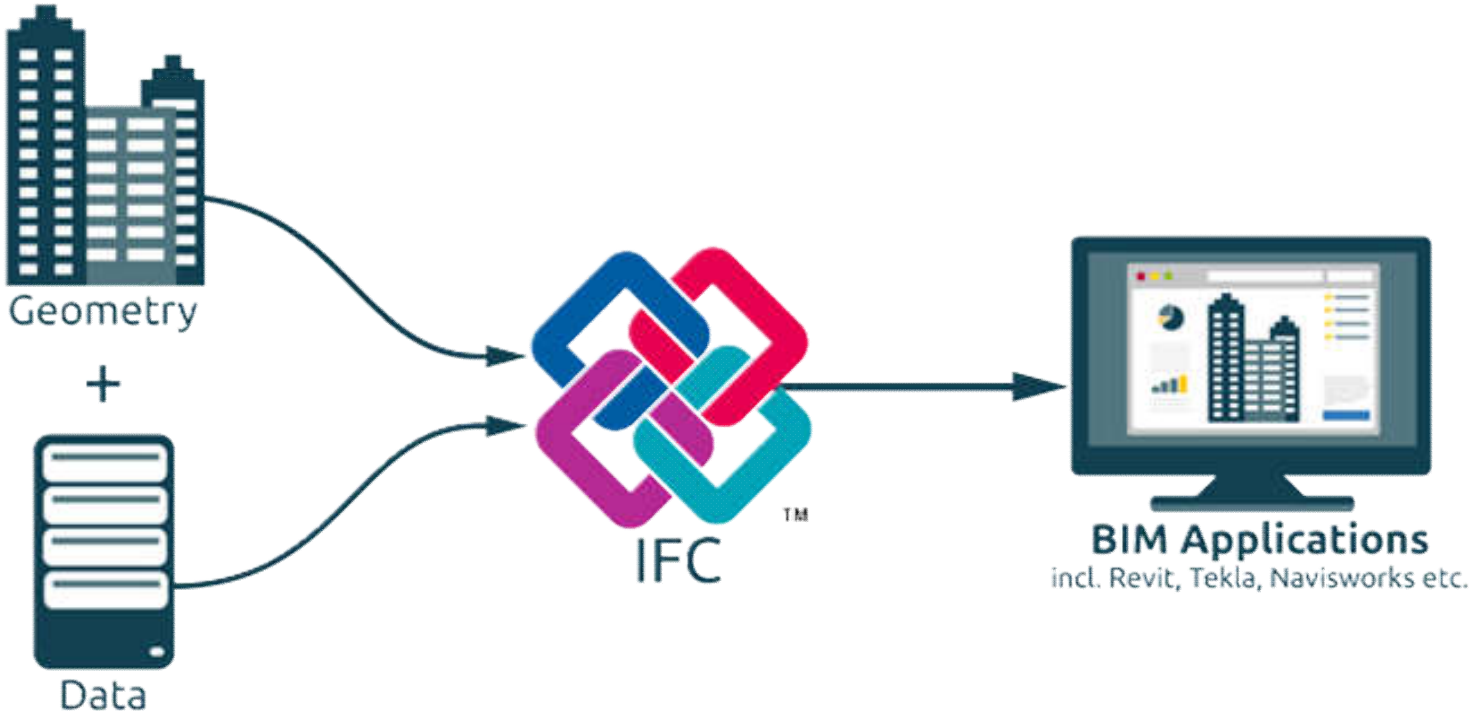
http://buildingsmart.com/standards/buildingsmart-standards/ifc

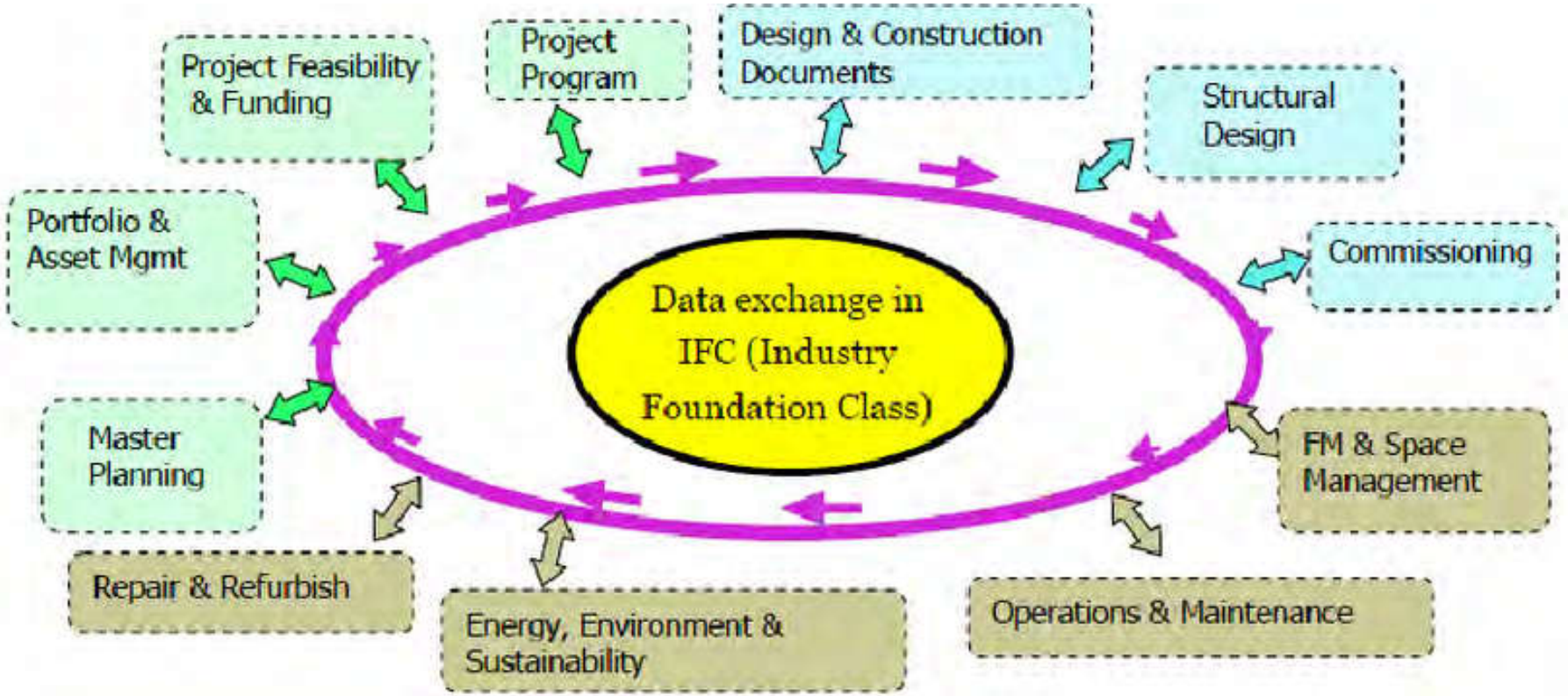
(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Industry Foundation Classes

- IFC (Industry Foundation Classes)
  - A global standard for data exchange in the building industries; it is both a common data model and an open file format
    - Building industry professionals can use IFC to share data regardless of what software application they use to get their job done
    - Similarly data from one phase of the building lifecycle can be utilised in a later stage without the need for data re-entry, custom import interfaces or proprietary plugins --- EXPORT and IMPORT

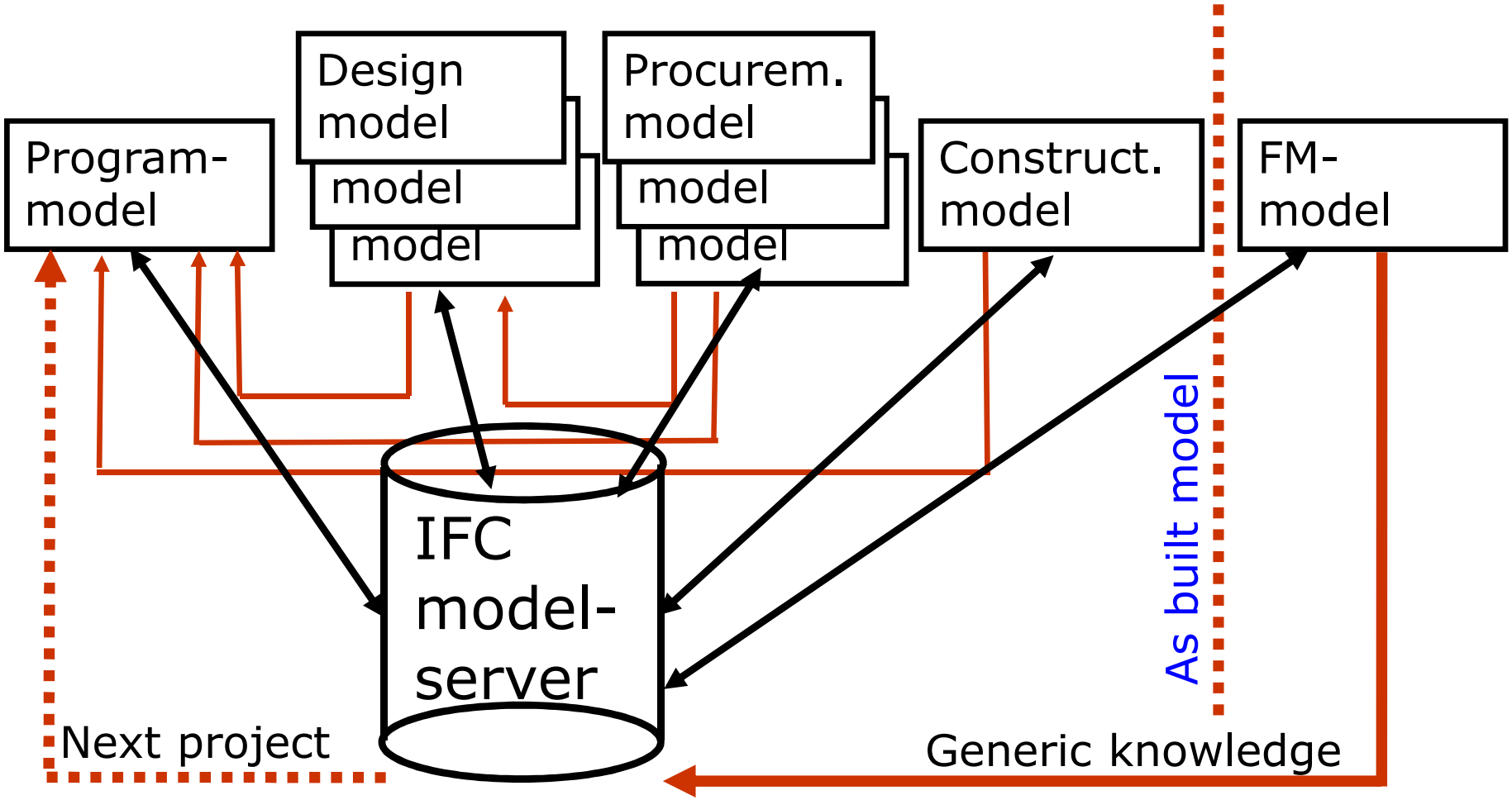
(See also: Industry Foundation Classes - Wikipedia https://en.wikipedia.org/wiki/Industry_Foundation_Classes)





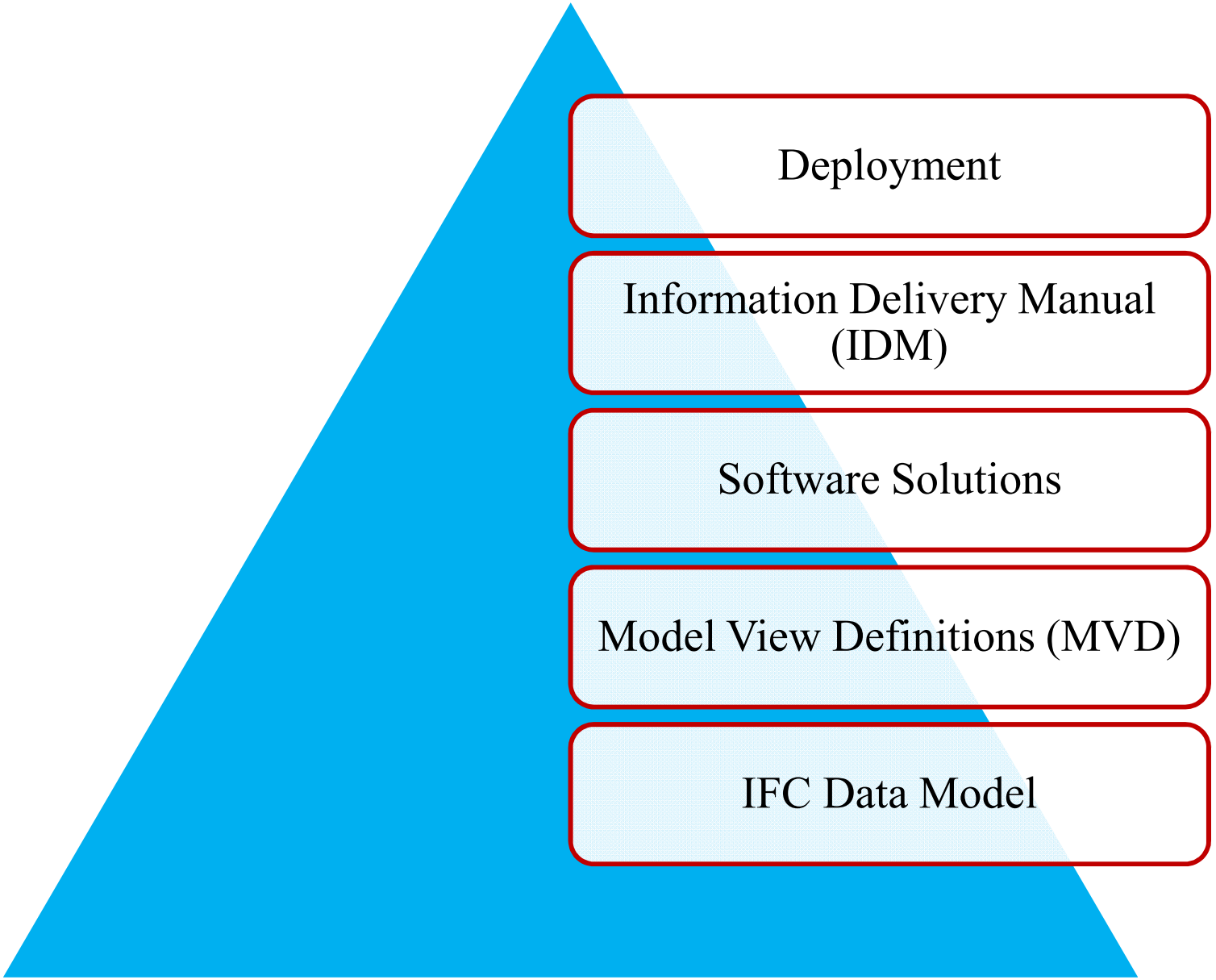
(See also: IFC Introduction https://www.buildingsmart.org/about/what-is-openbim/ifc-introduction/)

Holistic view of Industry Foundation Classes (IFC)



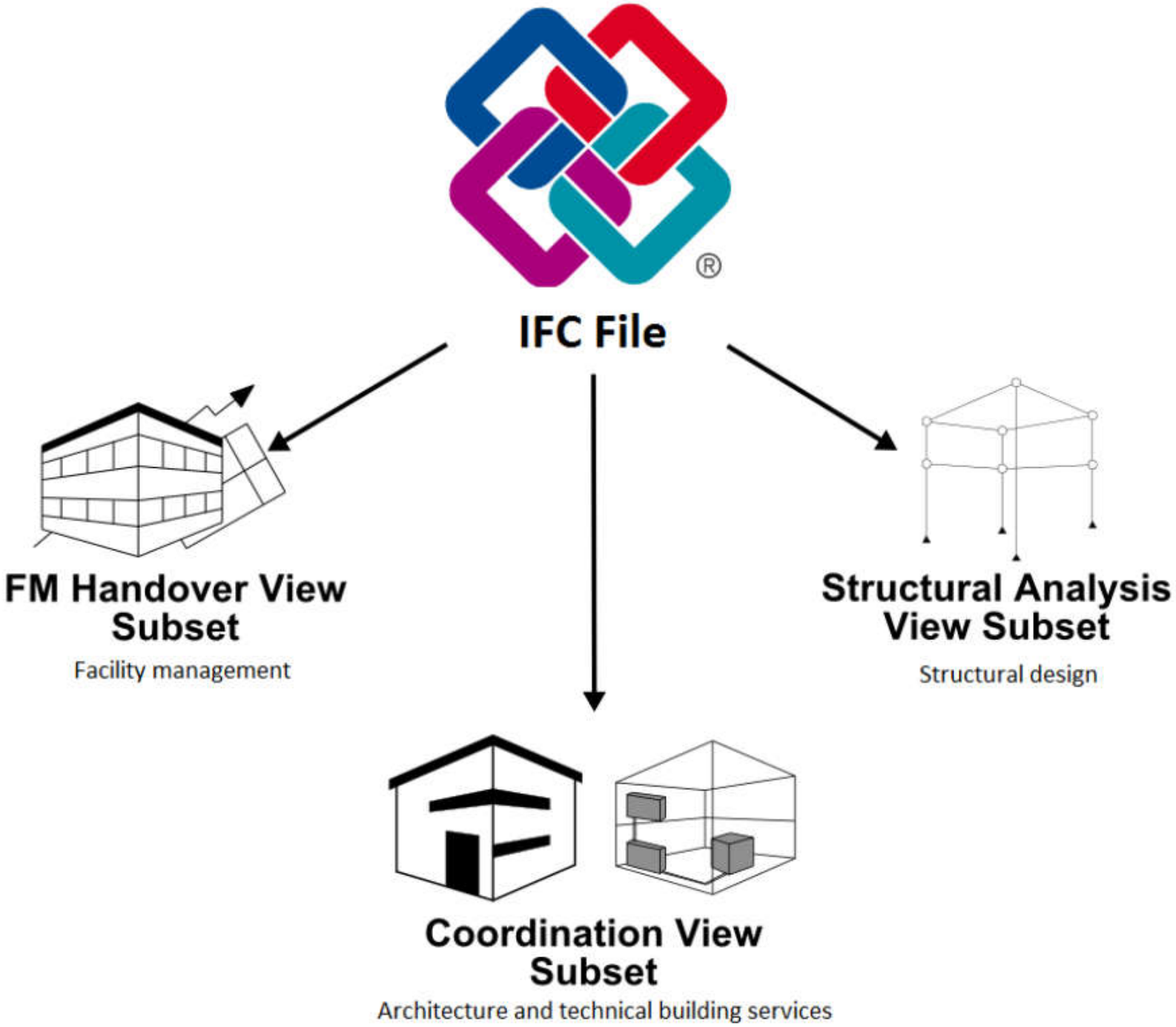
(Source: SINTEF Building and Infrastructure, Norway)

Layers of the information exchange framework for IFC



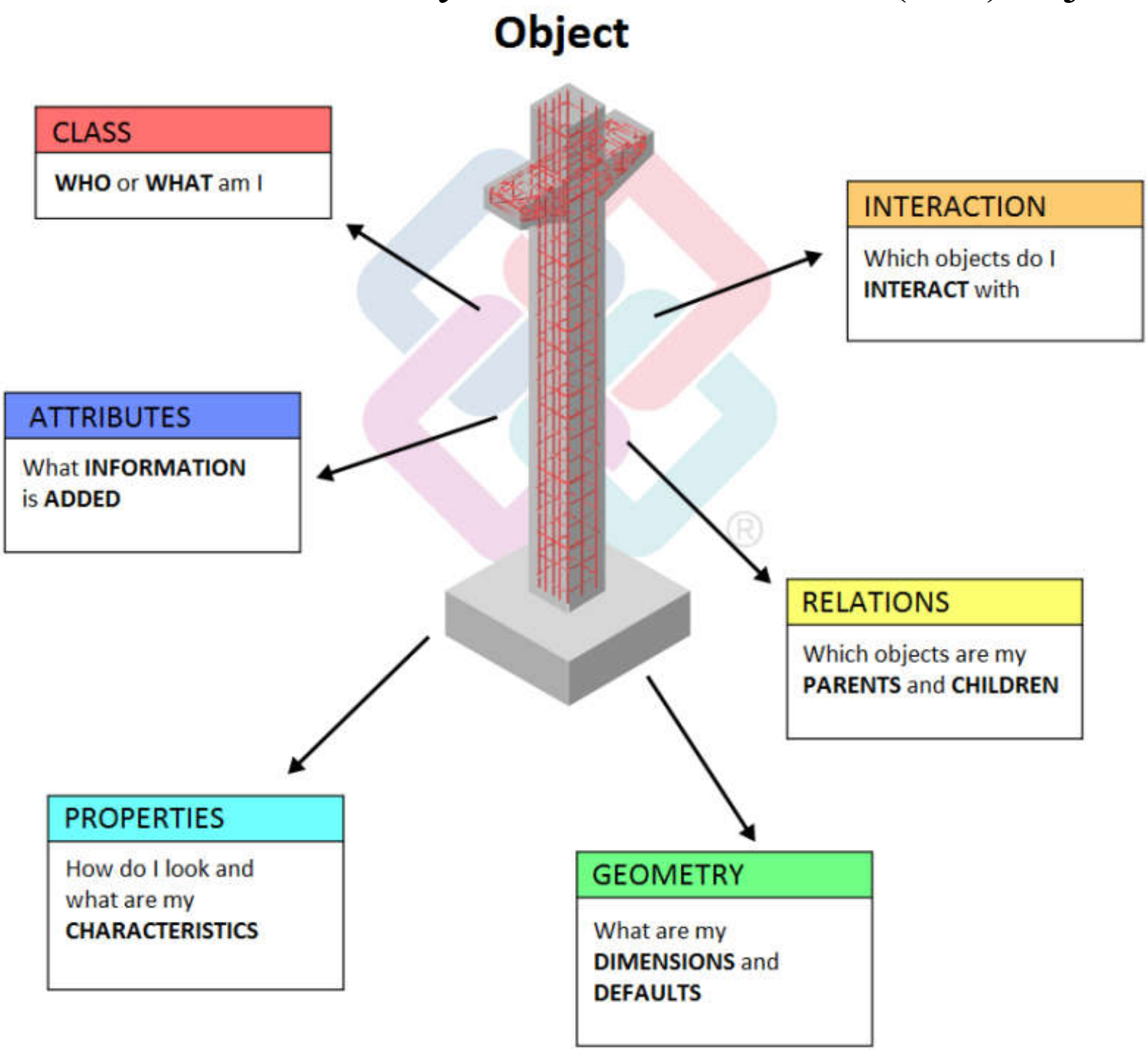
(See also: What is IFC? https://www.thenbs.com/knowledge/what-is-ifc)

Three subgroups of the Industry Foundation Classes (IFC) format



(Source: Allplan BIM Compendium http://iprostor.si/wp-content/uploads/2016/04/Allplan-BIM-Kompendij.pdf)

The structures of the Industry Foundation Classes (IFC) object format

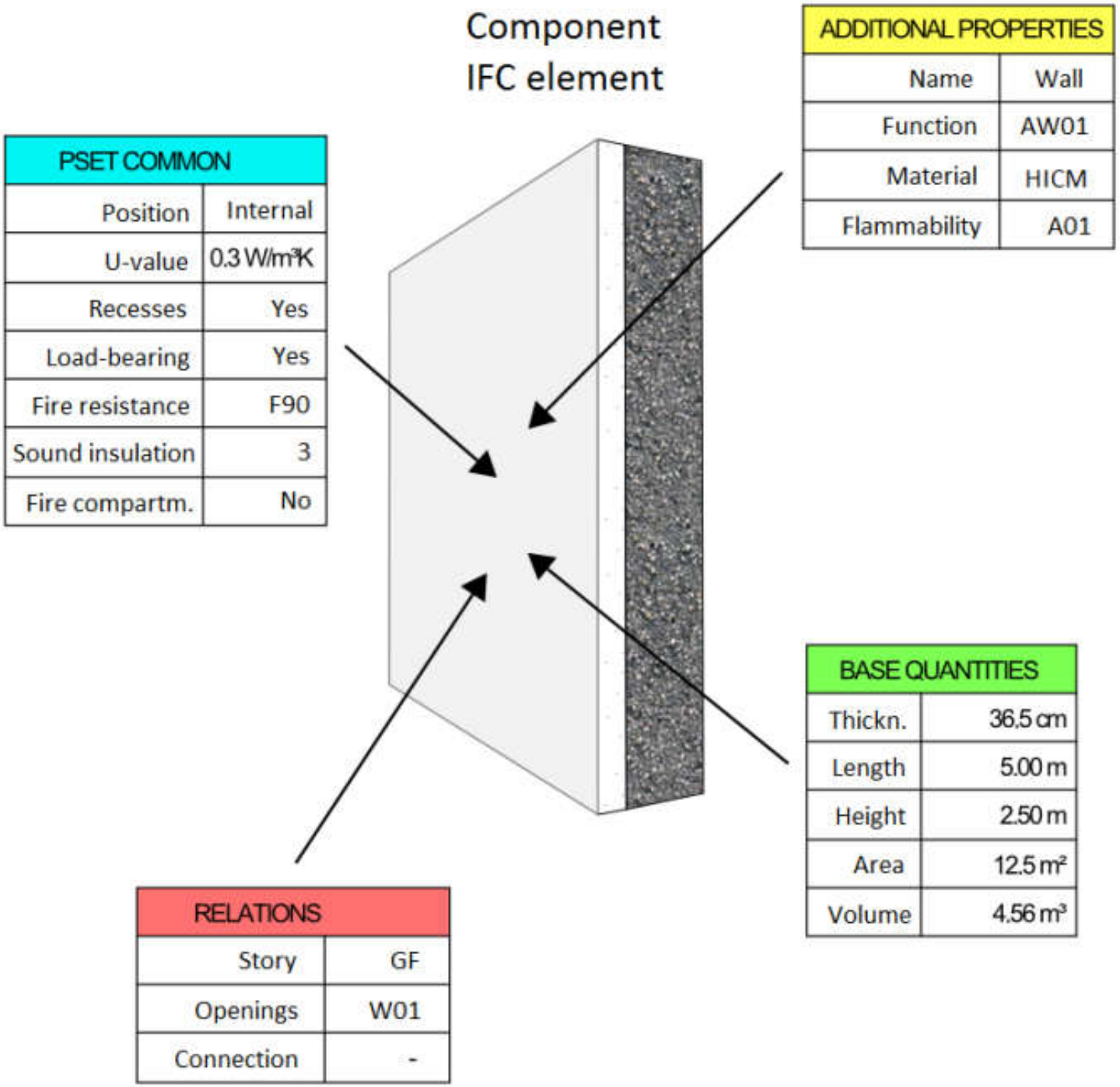


(Source: Allplan BIM Compendium http://iprostor.si/wp-content/uploads/2016/04/Allplan-BIM-Kompendij.pdf)

Industry Foundation Classes

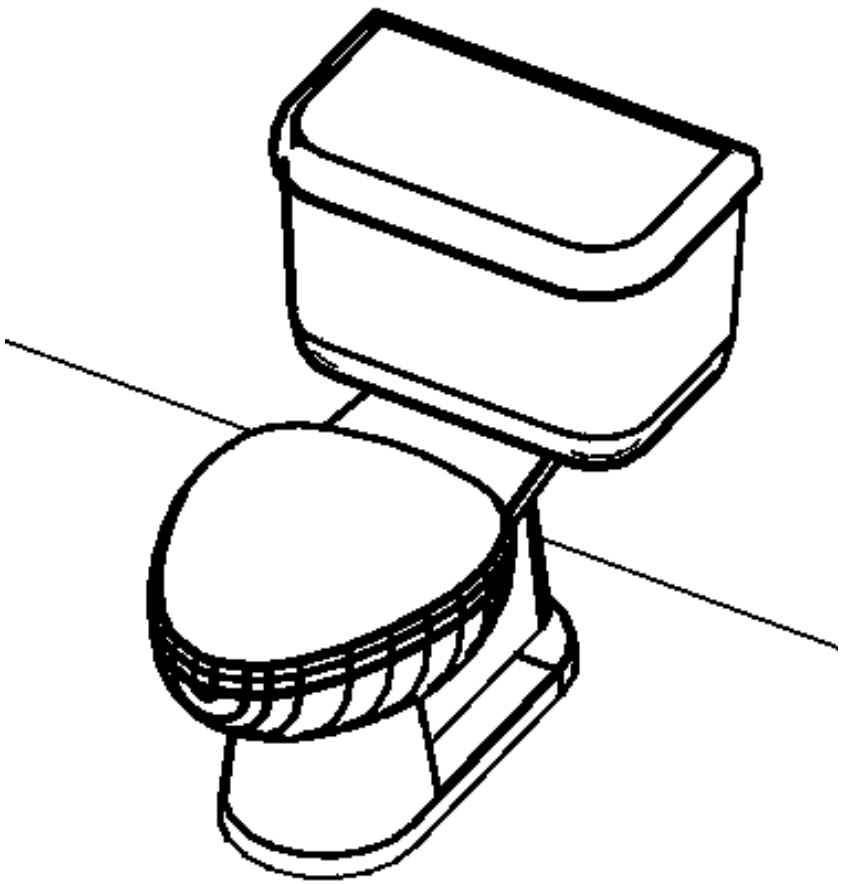
- Attributes of the IFC elements
  - Associations – Relations
    - Associated story, connecting elements
  - Geometric attributes – Base Quantities
    - Such as length, height, thickness, area, volume
  - Element properties (general and special)
    - Such as U-value, load-bearing, fire resistance
  - Additional properties
    - Such as name, function, material, flammability

Example of component IFC element: A wall



(Source: Allplan BIM Compendium http://iprostor.si/wp-content/uploads/2016/04/Allplan-BIM-Kompendij.pdf)

Example of BIM object: A toilet water closet



Parameter	Value
Materials and Finishes	
Toilet - Bowl/Basin Material	Porcelain - Linen
Toilet - Seat Material	Laminate - Linen, Matte
Plumbing	
Vent Connection	☑
Waste Connection	☑
CW Connection	☑
HW Connection	☑
Identity Data	
Assembly Code	D2010110
Keynote	
Model	
Manufacturer	
Type Comments	
URL	
Description	
Assembly Description	Water Closets - Single
Type Mark	
Cost	

Examples of terms used in Autodesk Revit

Key Term	Definition
Parameter	A detail that can be changed or adjusted – includes dimensions, materials, and off-sets.
Parametric component	A component – such as a piece of furniture, a door, or a window – that is comprised of adjustable parameters used to create variation within our model.
Family	A group of components with different settings for the same parameters. Each type is based on the same initial model but usually has different dimensions.
Type properties	Properties are common to many elements in a family. A type property affects all instances (individual elements) of that family in the project and any future instances that you place in the project.
Project views	Different views of the model such as plan, elevation, section, and 3D views.

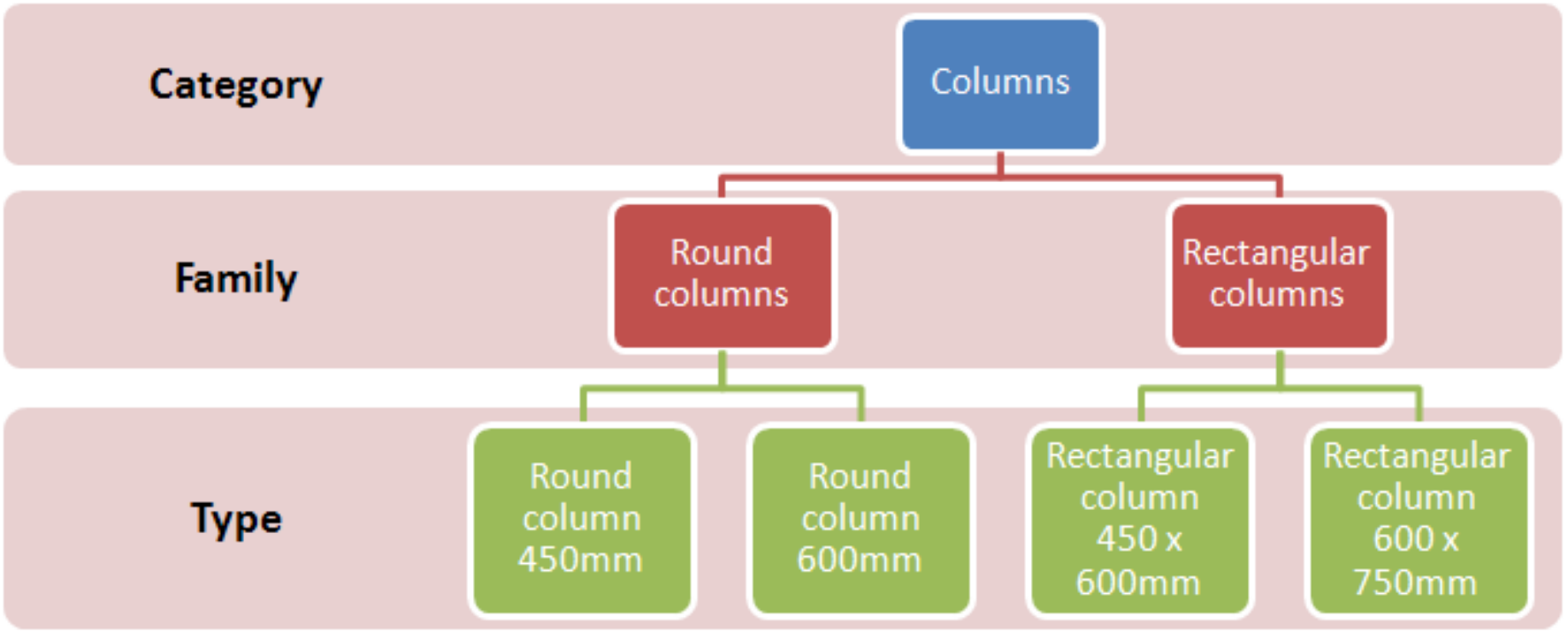
(Source: Autodesk Design Academy https://academy.autodesk.com/)

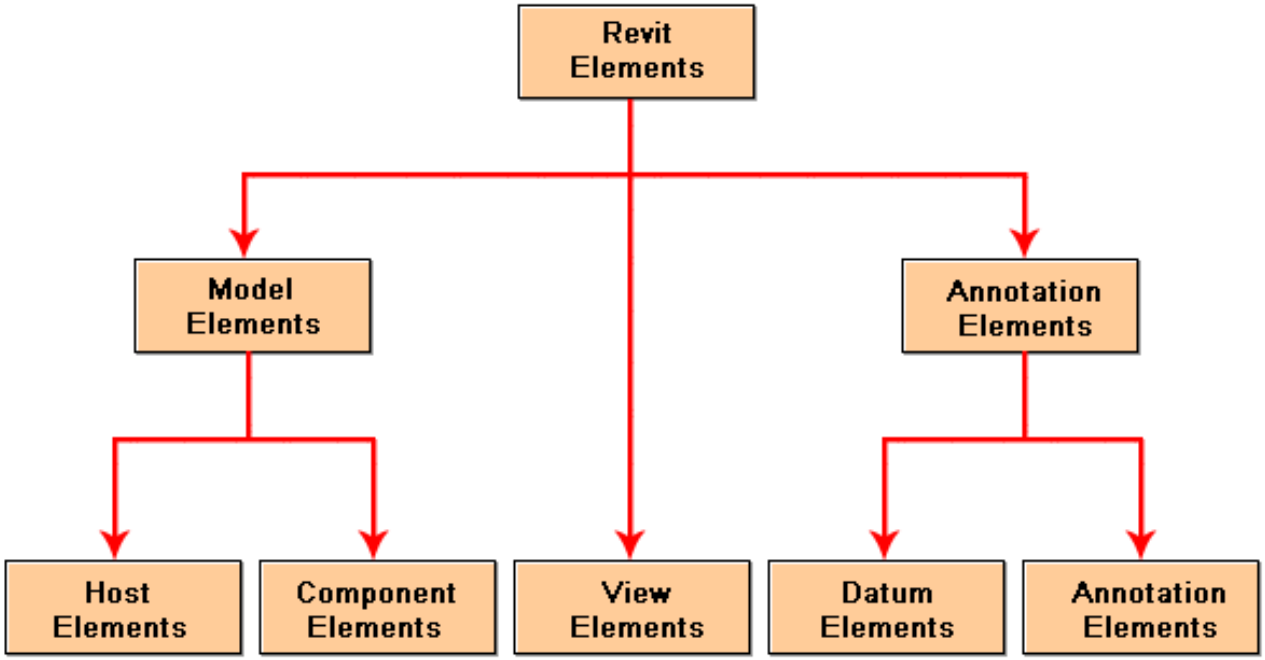
Data structure and organization in Autodesk Revit

Key Term	Definition
Categories	All objects in the building model are assigned a category. All doors in a project belong to the **category Doors**. This broad category is further broken down into families.
Families	Families are groupings of **like geometry**. Continuing with the door example, a single flush door belongs to a different family than a double door with glass in it because the geometry of the two types of doors is different.
Types	All design objects have a type. (A type is the same as a class.) The type defines what properties (values) an object has, how it interacts with other objects, and how it draws itself into each different kind of representation. (with a family, different types have the same set of parameters but different values).
Instances	An instance is simply a single object of a type in the building model.

(Source: Autodesk Design Academy https://academy.autodesk.com/)

Data structure and organization in Autodesk Revit: Examples

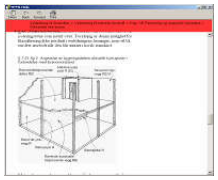


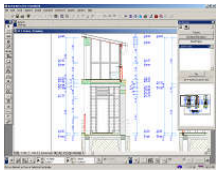


(Source: Autodesk Design Academy https://academy.autodesk.com/)

IFC is all about exchange and sharing of information

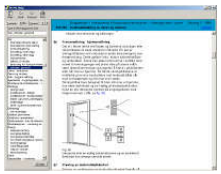
Laws and regulations
-Building regulations
-Building specifications



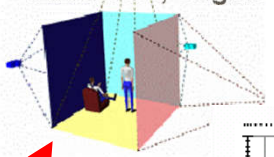


CAD software
-Drawings, calculations
-Architect, engineer,…

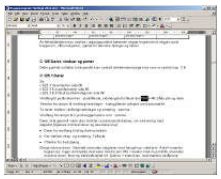
Knowledge databases
-Best practise knowledge
-Own practice



VRML
-Visualisation, 3D models



Briefing
-Functional req.
-Estimates
-Conditions
-Requirements



IDM

IDM

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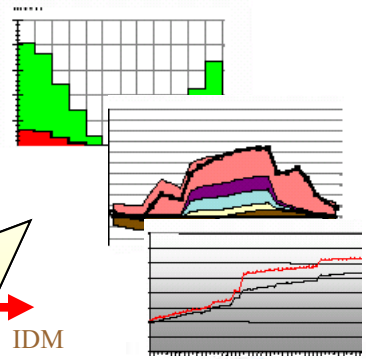
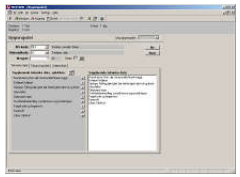
IDM

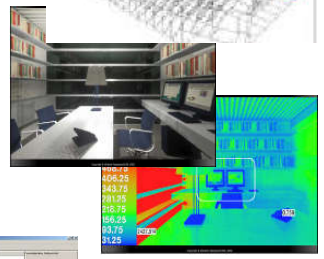
the IFC model

Simulations
-Comfort
-Ventilation, heating
-Life cycle cost
-Light, sound
-Insulation
-Fire, usage
-Environment
-Life time predictions

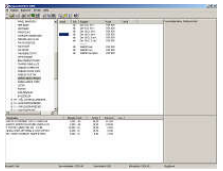


Demolition, refurbishment
-Rebuild
-Demolition
-Restoration



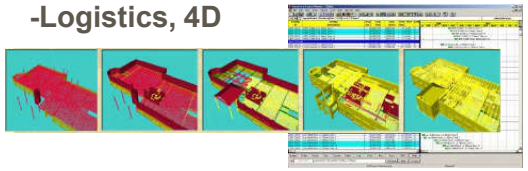


Facility management
-Letting, sale, operations
-Maintenance
-Guaranties



Specifications
-Specification sheets
-Classification standards
-Estimates, accounting

Construction management
-Scheduling
-Logistics, 4D



Procurement
-Product databases
-Price databases

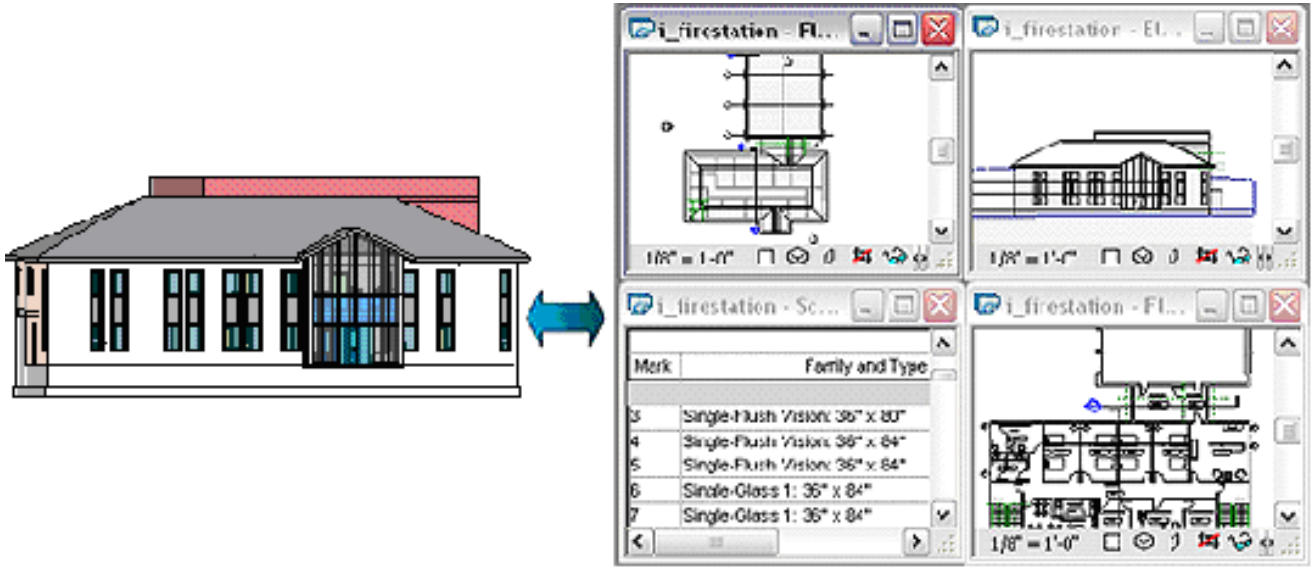
Illustrations: Lars Bjørkhaug Norwegian Building Research Institute, Olof Granlund, NBLN University of California, Stanford University

(Source: SINTEF Building and Infrastructure, Norway)

IDM = Information Delivery Manual = what, when, who

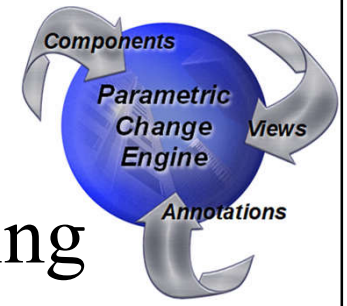
Sharing data and documents

- Bidirectional associativity
  - Changes to any part of the design are immediately reflected in all associated parts. It is applied automatically to every component, view, and annotation



(Source: Autodesk Design Academy https://academy.autodesk.com/)

Sharing data and documents



- Parametric relationships
  - Relationships among the elements in a building model
  - Enable the software to coordinate and manage the changes made to the building model
  - Created automatically by software, or created by the user
  - Parametric modelling
    - Maintains consistent relationships between elements as the model is manipulated

(Source: Autodesk Design Academy https://academy.autodesk.com/)

Open BIM

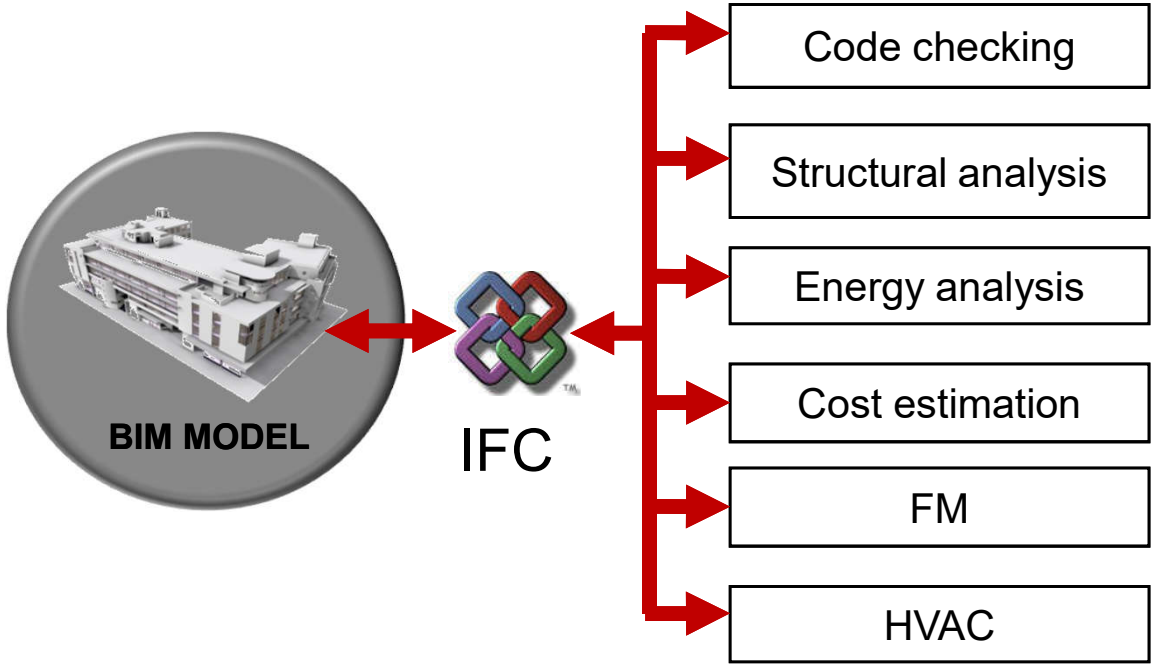
- Open BIM supports a transparent, open workflow, allowing project members to participate regardless of the software tools they use.
- Open BIM creates a common language for widely referenced processes, allowing industry and government to procure projects with transparent commercial engagement, comparable service evaluation and assured data quality.
- Open BIM provides enduring project data for use throughout the asset life-cycle, avoiding multiple input of the same data and consequential errors.

- More info:
- http://www.buildingsmart-tech.org/specifications/specifications

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Sharing the BIM Data: IFC

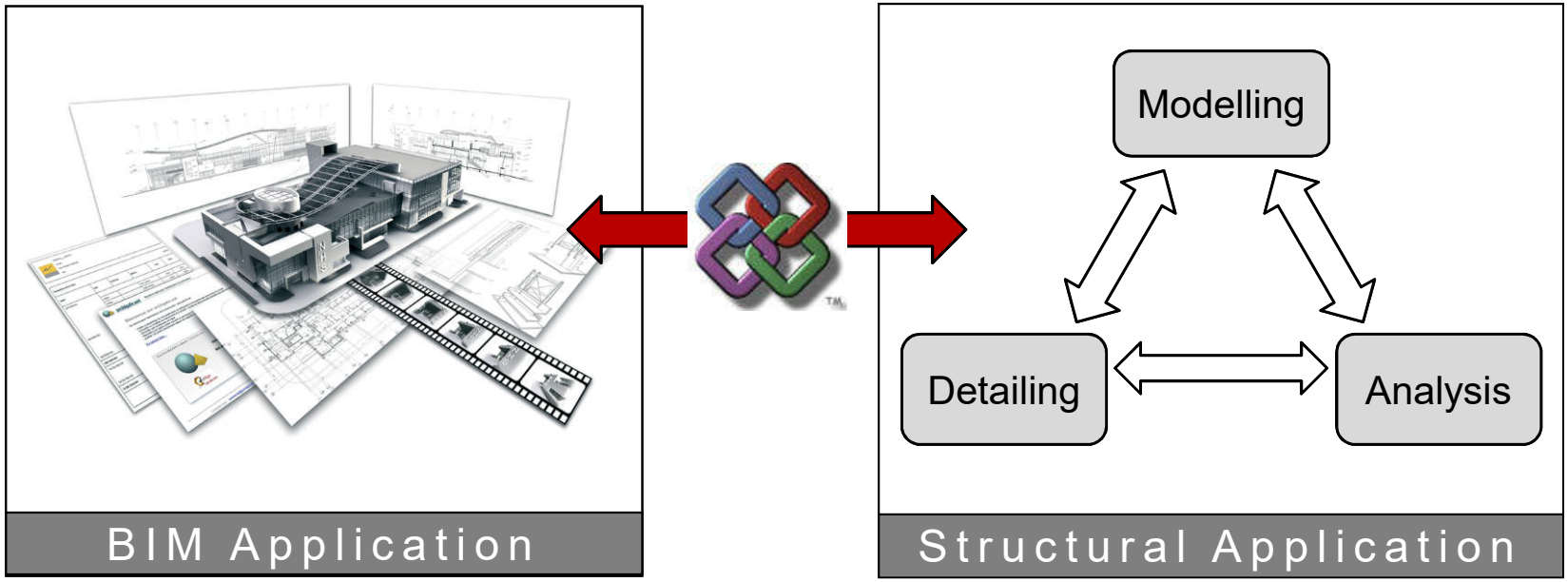
- **Benefits:**
- Universal, industry standard data exchange format.
- Bi-directional connection between diverse applications
- Building elements preserve BIM information during data transfer



(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

IFC Based Structural Design Workflow

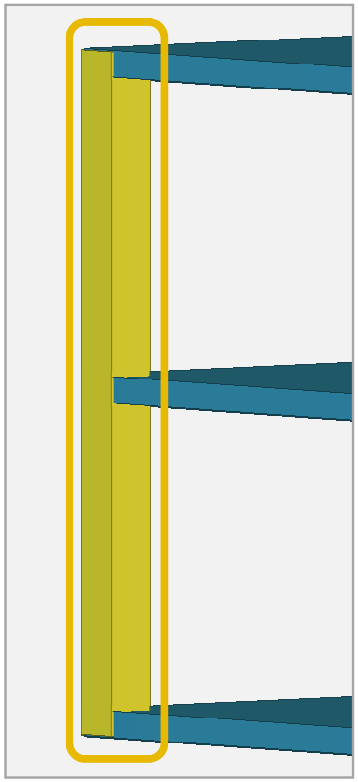
Modelling / Classification
Model Filtering
Model Export
Model Import / Referencing
Version Tracking



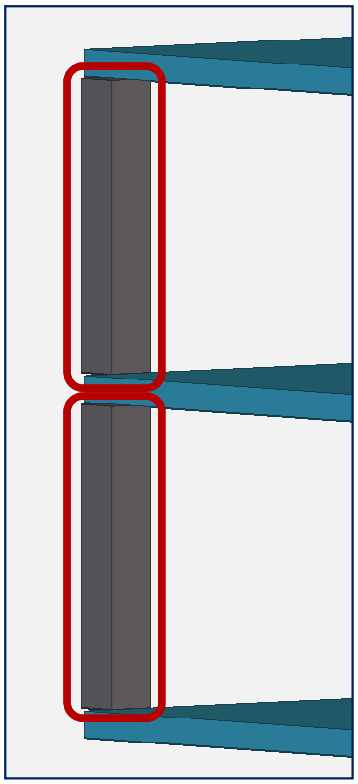
(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Structural Modelling

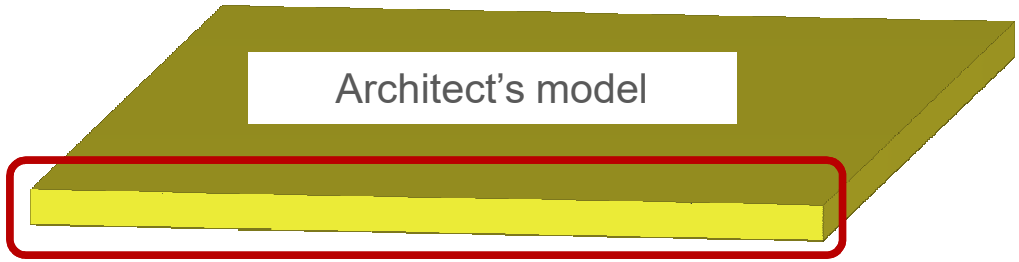
Different disciplines adopt different modelling concepts

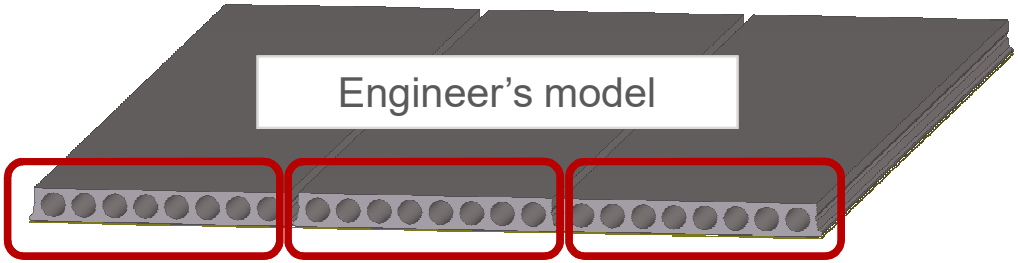


Architect's model



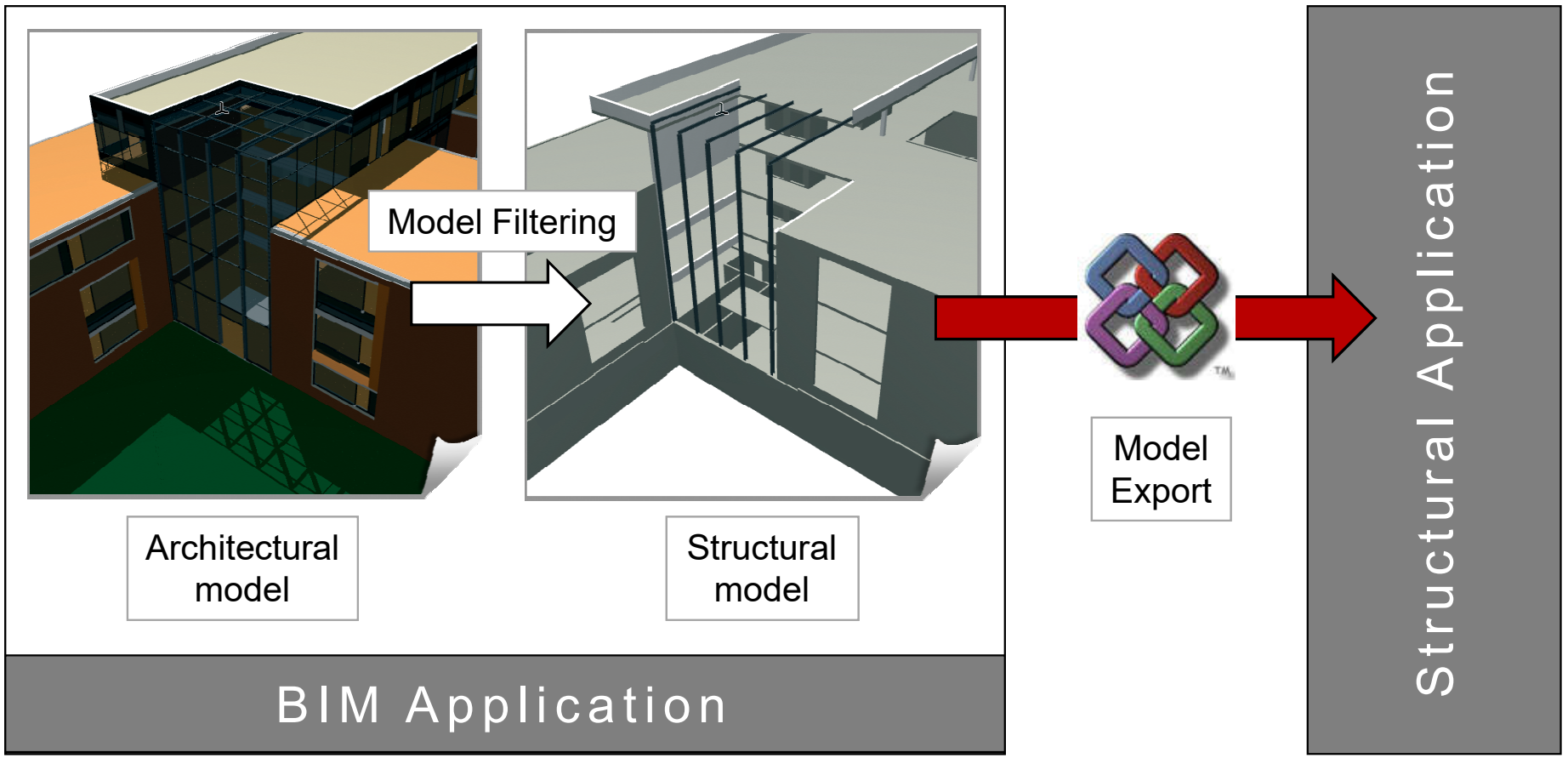
Engineer's model





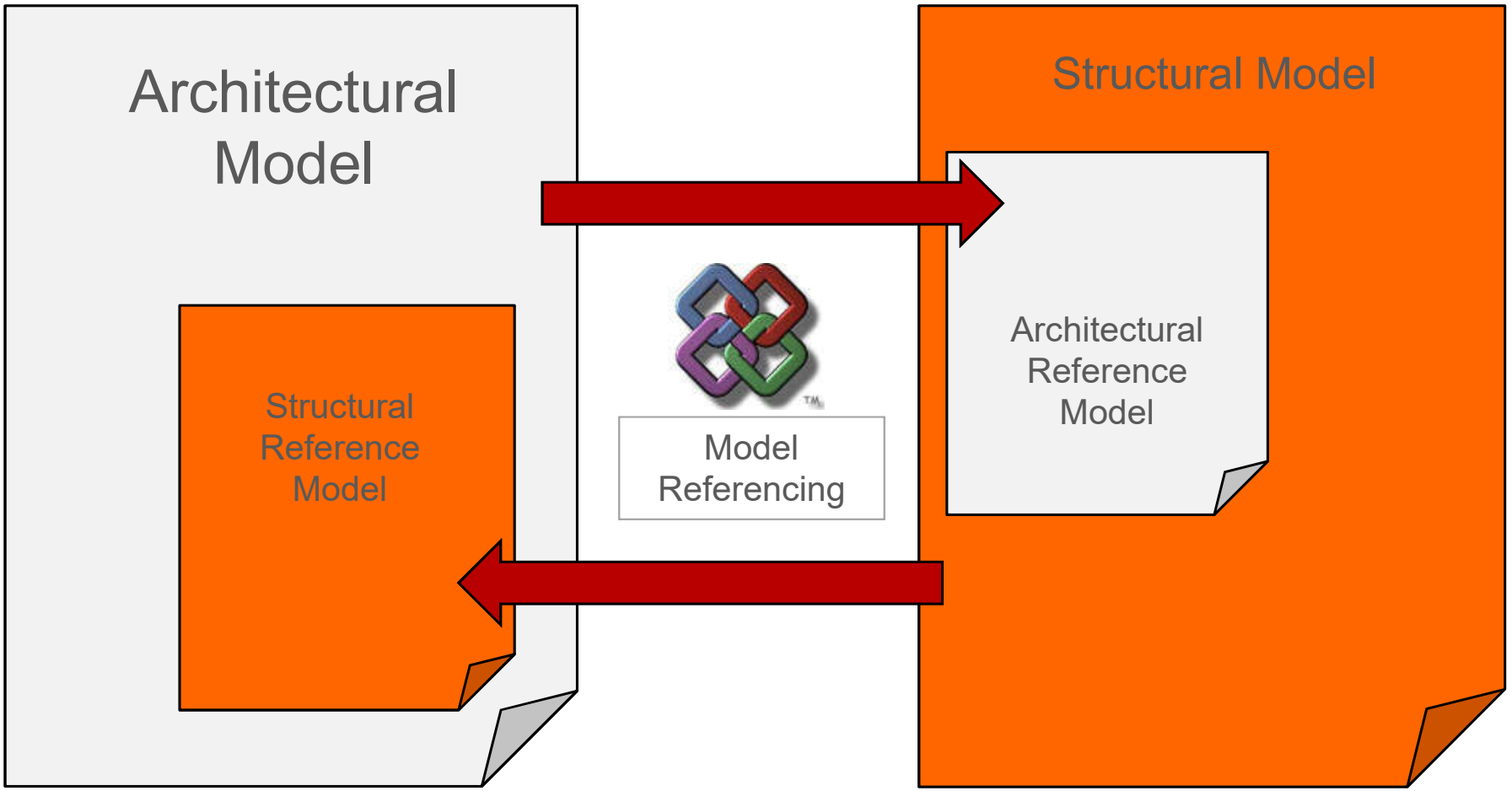
(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Model Filtering



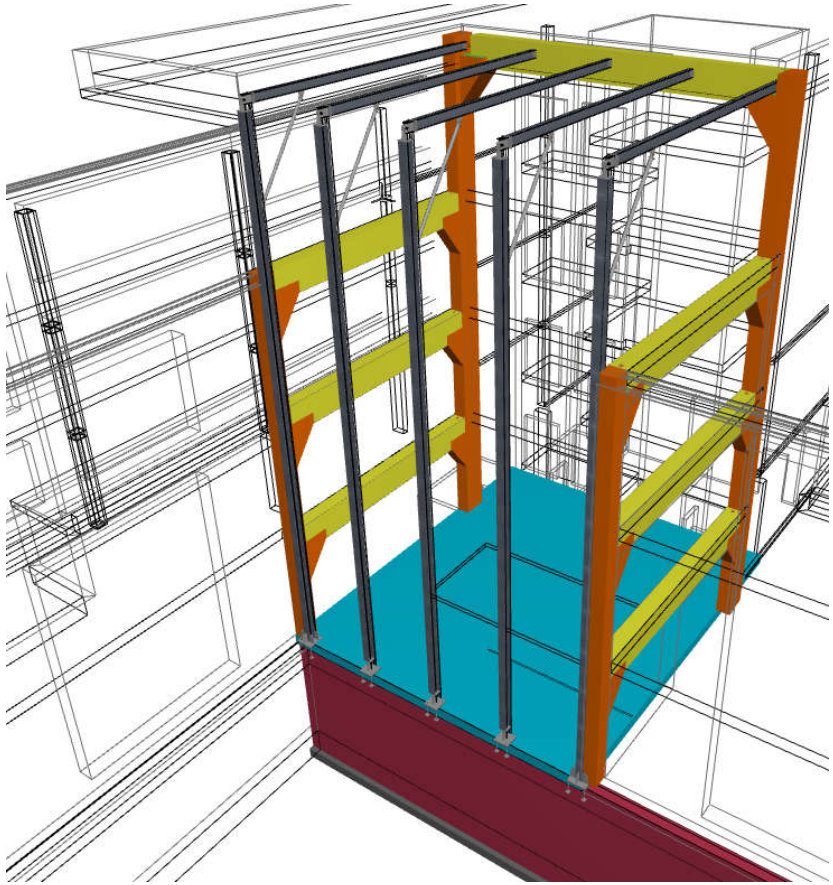
(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Reference Model Concept

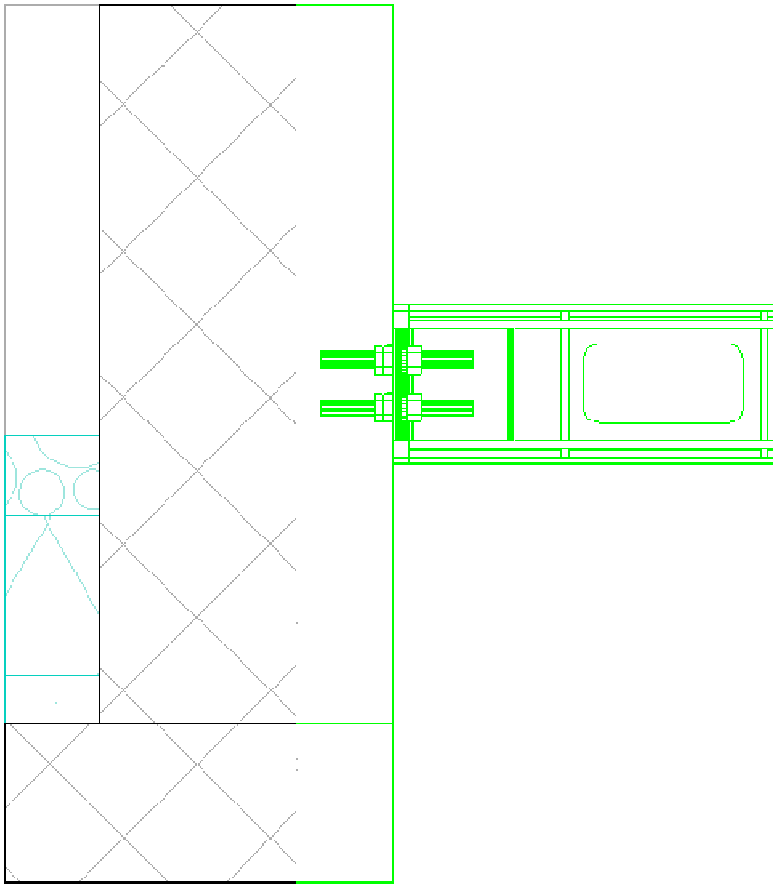


(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Intelligent Model Referencing



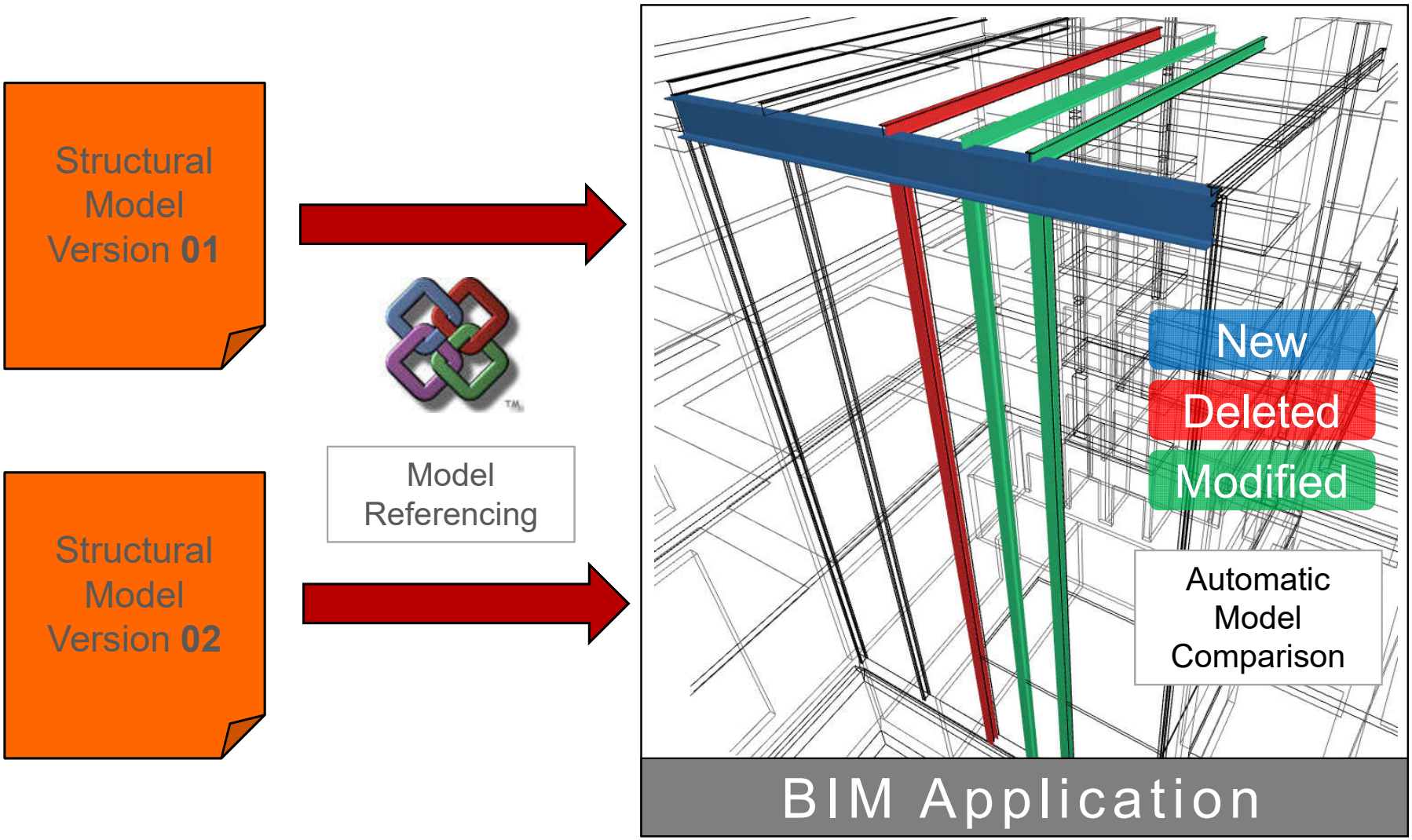
Element Separation
(Layering)



Visual Differentiation

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Model Comparison



(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Sharing model data: XML

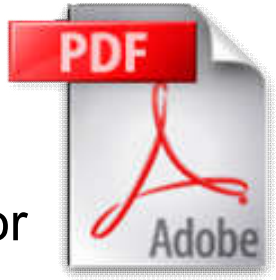
- XML = **Extensible Markup Language**

- General-purpose markup language capable of describing many different kinds of data.
-
- XML provides a text-based format to describe and apply a tree-based structure to information.
- XML can be used effectively to tranfer various data via the Internet.
- **aecXML** is a new framework for using the XML standard for communications in the AEC industry.
- The Green Building XML schema, referred to as "**gbXML**", was developed to facilitate the transfer of building information stored in CAD building information models, enabling integrated interoperability between building design models and a wide variety of engineering analysis tools

http://www.w3.org/XML/

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Sharing documents: PDF

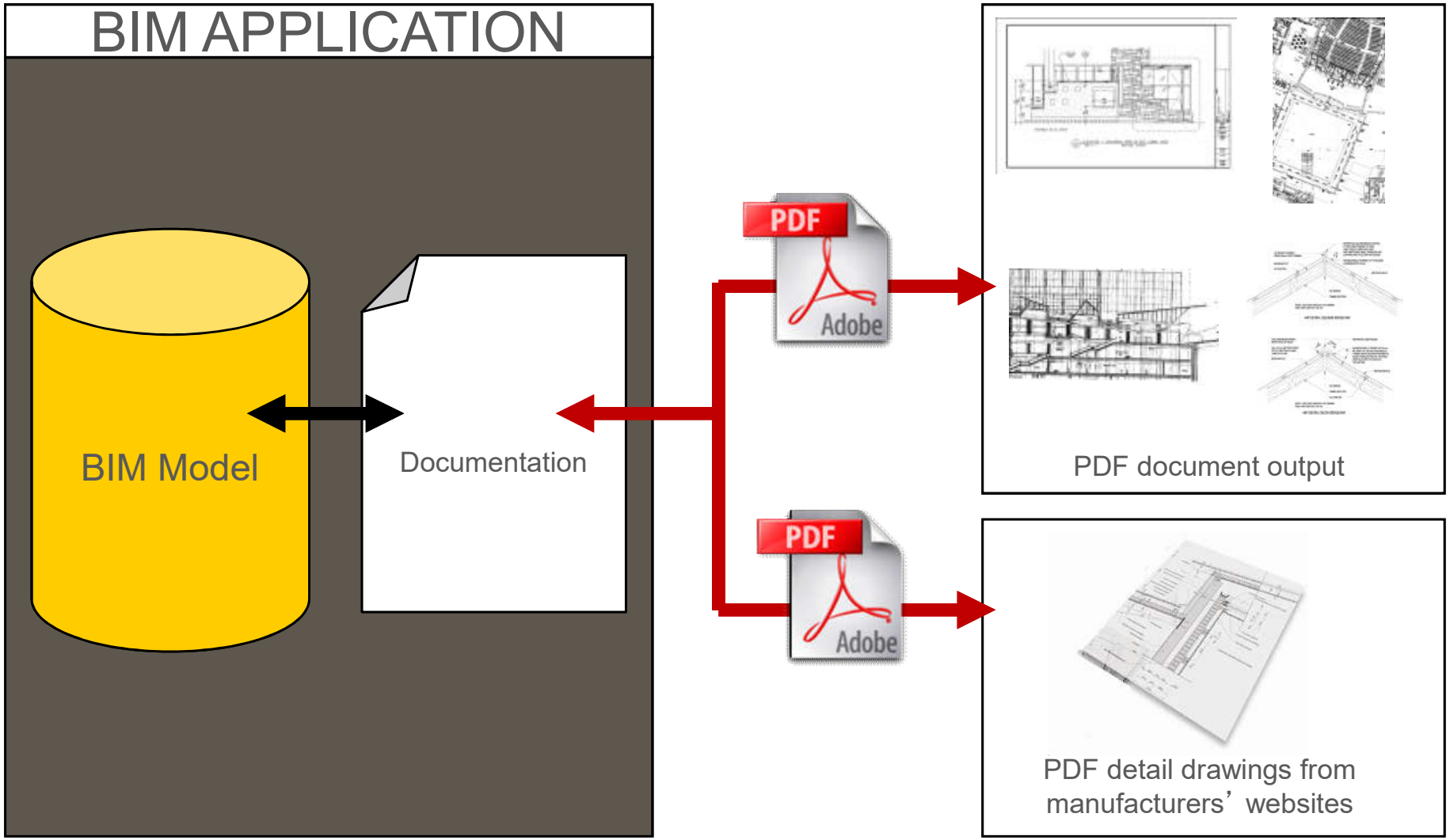


- PDF = **Portable Document Format**
- PDF is a proprietary file format developed by Adobe Systems for representing **two dimensional documents** in a device independent and resolution independent format.
- Each PDF file encapsulates a complete description of a 2D document that includes texts, fonts, images, and 2D vector graphics.
-
- PDF is currently the most common file format for sharing documents on the Internet-
- Most BIM applications can export to PDF format.
- Some BIM programs also allow the direct import of PDF documents into the architectural documentation.

Source: http://www.adobe.com/products/acrobat/adobepdf.html

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Sharing documents: PDF



(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Sharing drawings: DWG

- **DWG**, short for "drawing", is a file format for CAD drawings
- DWG is the native file format of Autodesk's AutoCAD program
- DWG has become the *de facto* standard file exchange format in the CAD industry for 2D drawings
- DWG is not capable of handling complete BIM data
- Most CAD programs reads and writes this format

Source: http://www.opendesign.com/

(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Reviewing and data exchange

- BIM Collaboration Format (BCF) is an open file format based on XML that allows the addition of comments to an IFC BIM model
  - BCF is intended to simplify collaboration between different parties working on a model by allowing them to raise issues, provide answers and make comments within an open file format that does not itself contain model elements
  - BCF provides a communication capability that is separated from the model itself

BIM Collaboration Format

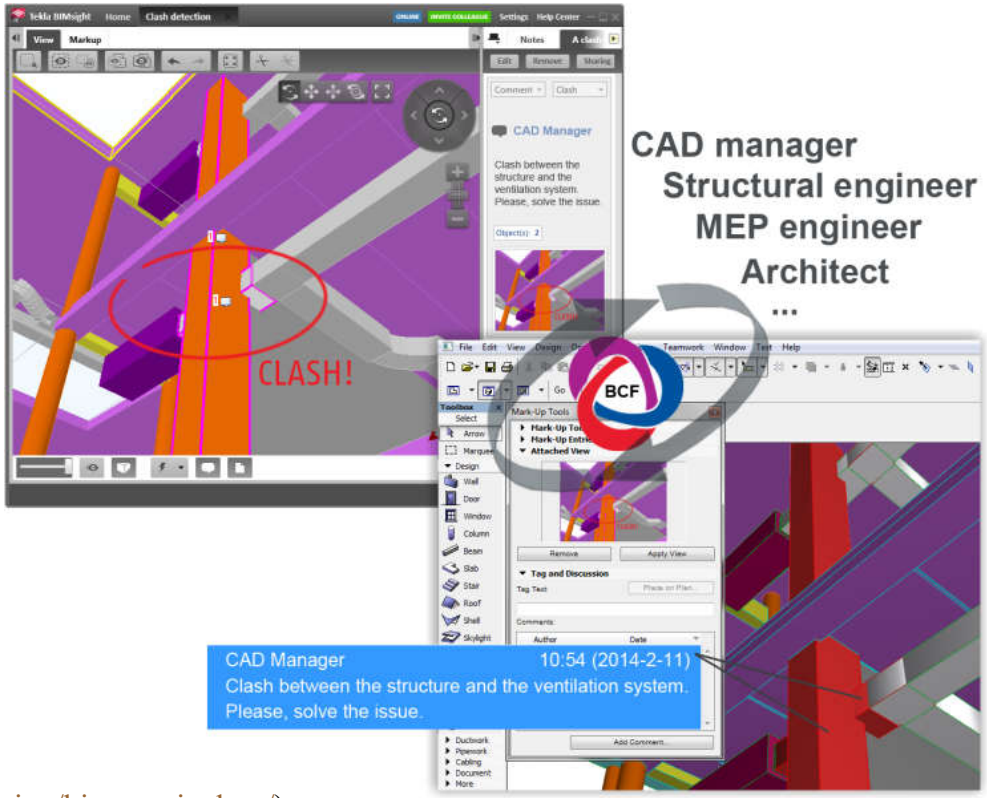
(Video: BIM Collaboration Format BCF explanation (2:13) https://youtu.be/yrm5SrEfSvE)

(Source: BIM collaboration format BCF https://www.designingbuildings.co.uk/wiki/BIM_collaboration_format_BCF)

Reviewing: BCF

- IFC-based data exchange can be enhanced by using the so-called **BIM Collaboration Format (BCF)**-based communication.
- In combined IFC models, the BCF work flow enables participants to add comments to the overlapping issues (e.g. collisions).
- BCF comments include the referenced IFC elements and an attached preview picture.

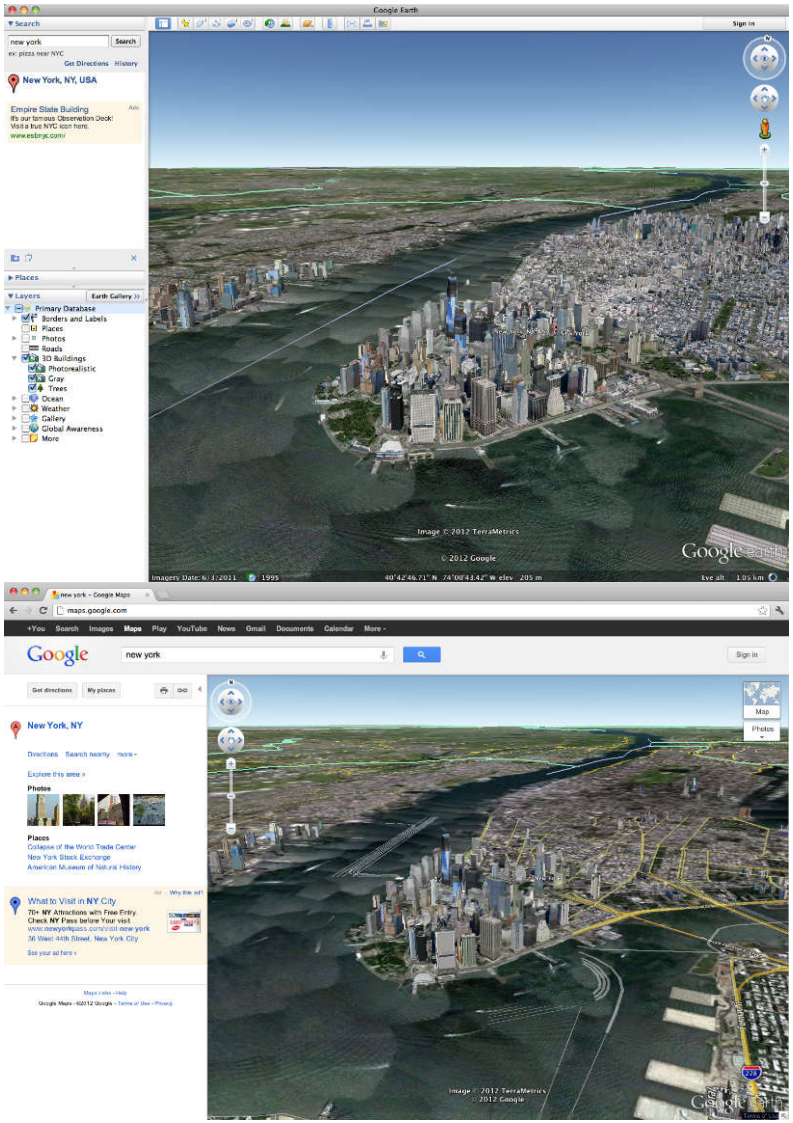
BIM Collaboration Format



(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Google Earth

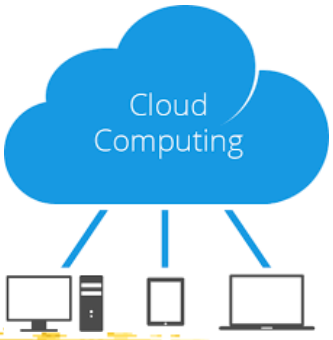
- **Google Earth** is a free, downloadable virtual globe program and web plug-in.
- Google Earth and SketchUp file formats (kmz, skp) allow to import 3D building models from CAD programs and insert them on the virtual Google Earth map.
- Google provides a layer showing virtual 3D buildings where they are present.
- Some BIM applications support the export of the 3D model in Google or SketchUp formats.



http://earth.google.com/

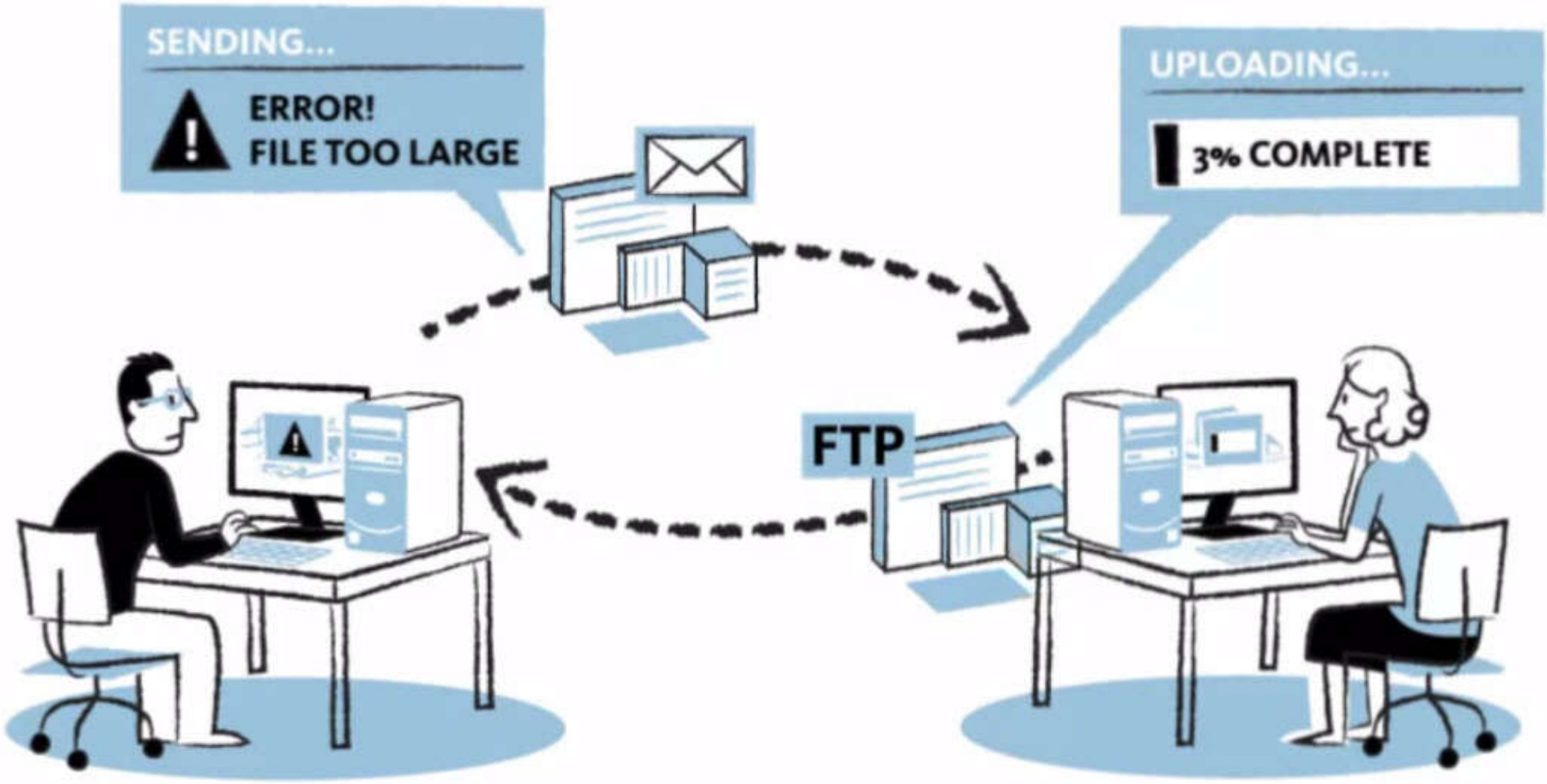
(Source: Graphisoft BIM Curriculum http://www.graphisoft.com/learning/bim-curriculum/)

Cloud-based BIM

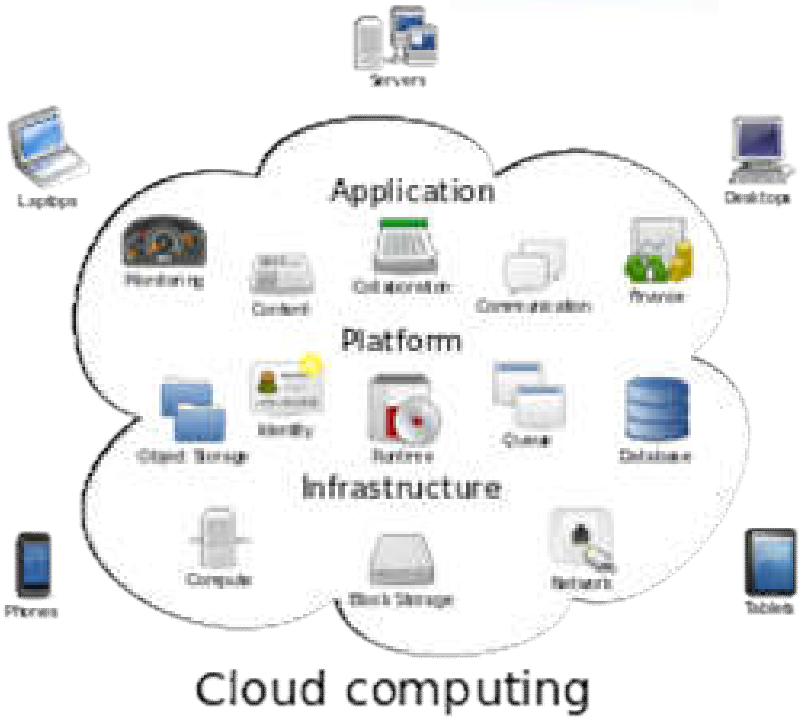


- Cloud computing 雲端運算
  - A concept for different methods of sharing resources over the Internet
- Cloud-based BIM collaboration:
  - Allplan Collaboration (EN) (4:21)
    https://youtu.be/E5ZrwaWZtTk
  - Autodesk® BIM 360™: The next generation of BIM is for anyone, anywhere, at any time (1:55)
    https://youtu.be/3GJ7jvC71wA

This was “collaboration” before...

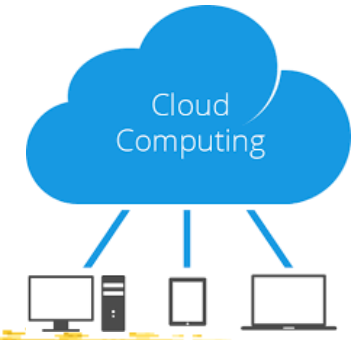


Information flow of the BIM cloud



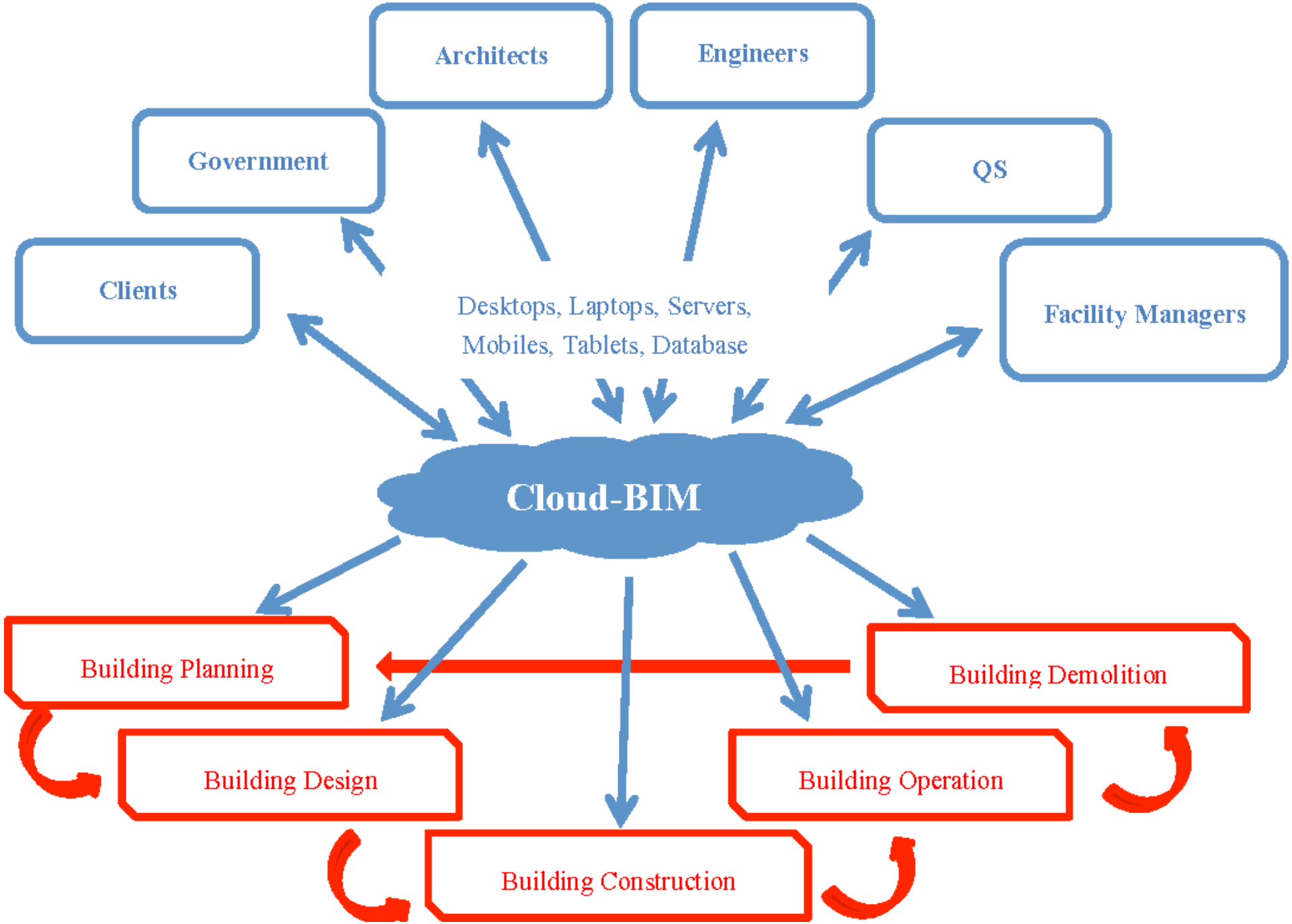
Information anywhere, anytime

Cloud-based BIM



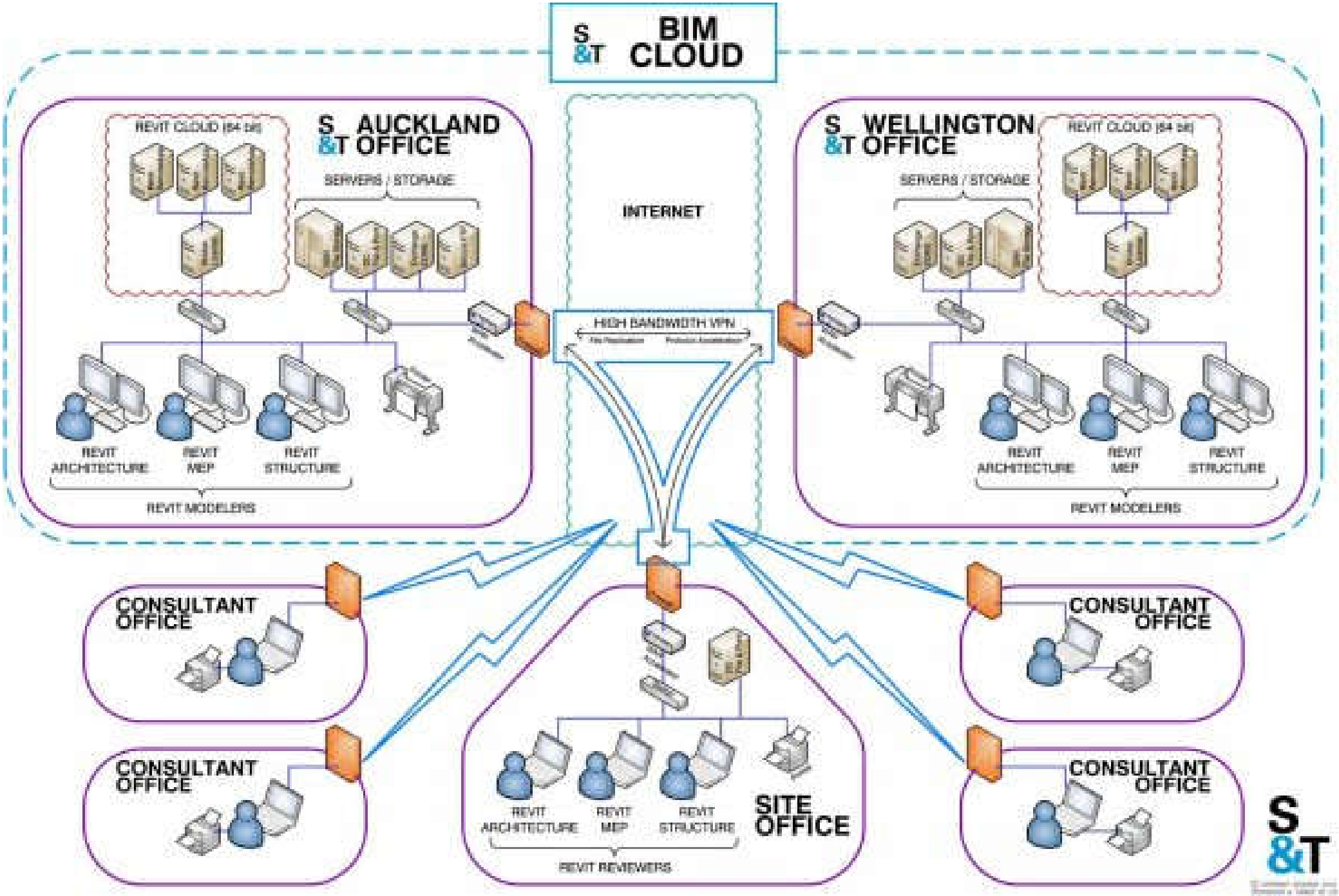
- Cloud-based platform for BIM
  - Can enhance the collaborative process to leverage web-based BIM capabilities and traditional document management to improve coordination
  - Four main aspects to consider:
    - 1. Model servers (to host the central BIM models)
    - 2. BIM software servers (shared software & hardware)
    - 3. Content management (centralised & secure hosting)
    - 4. Cloud-based collaboration (a new way of collaborating, coordinating and communicating within the project team)

Basic concept of cloud-based BIM



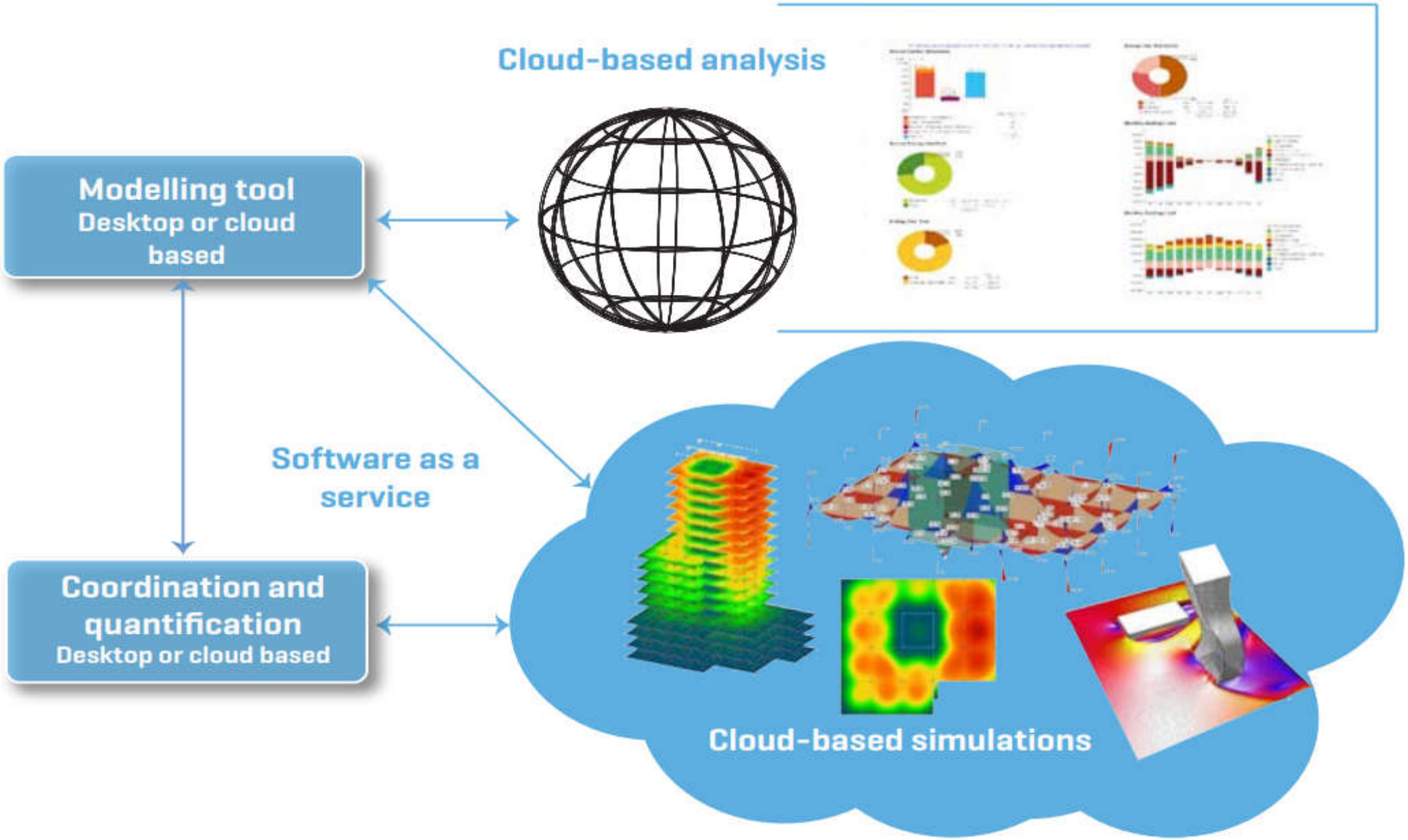
(Source: Wong, J., Wang, X., Li, H., Chan, G. and Li, H., 2014. A review of cloud-based BIM technology in the construction sector, Journal of Information Technology in Construction, 19: 281-291. https://www.itcon.org/papers/2014_16.content.06672.pdf)

Example of a Revit private cloud



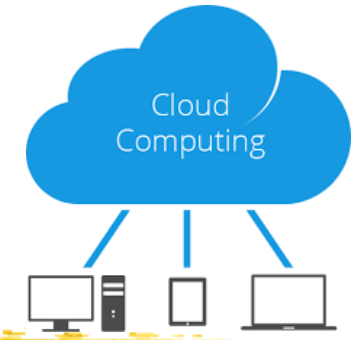
(Source: http://www.stephensonturner.com/news/2012/4/18/benefits-of-deploying-a-revit-private-cloud)

Cloud computing: Software as a service



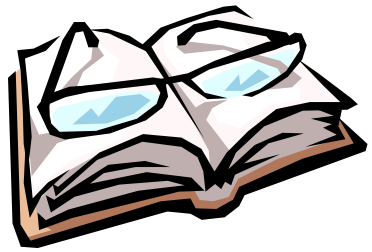
(Source: RICS, 2014. *International BIM Implementation Guide*)

Cloud-based BIM



- Examples of BIM collaboration software:
  - Aconex http://www.aconex.com/
  - Autodesk BIM 360: Construction Management Software https://bim360.autodesk.com/
  - BIMcloud http://www.graphisoft.com/bimcloud/
  - BIM Track https://bimtrack.co/
  - Revizto https://revizto.com
  - Trimble Connect (formerly GTeam) https://connect.trimble.com/

Further reading



- BIM glossary of terms
  - https://www.designingbuildings.co.uk/wiki/BIM_glossary_of_terms
- Industry Foundation Classes - Wikipedia
  - https://en.wikipedia.org/wiki/Industry_Foundation_Classes
- IFC Introduction
  - https://www.buildingsmart.org/about/what-is-openbim/ifc-introduction/
- What is IFC?
  - https://www.thenbs.com/knowledge/what-is-ifc