

# Building Information Modelling (BIM) Training

<https://ibse.hk/BIM-Training/>



## 2.1 BIM collaborations



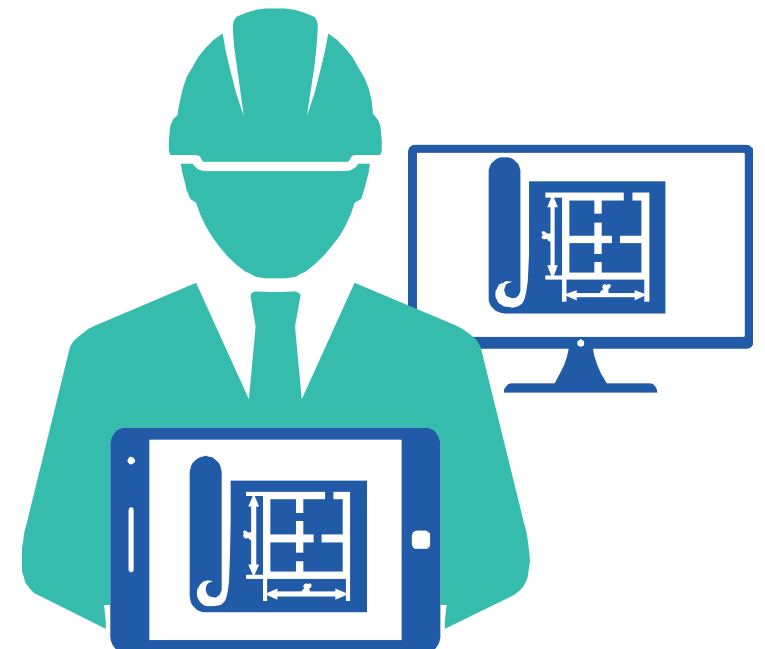
*Ir Dr. Sam C. M. Hui*  
Department of Mechanical Engineering  
The University of Hong Kong  
E-mail: cmhui@hku.hk

Jun 2024

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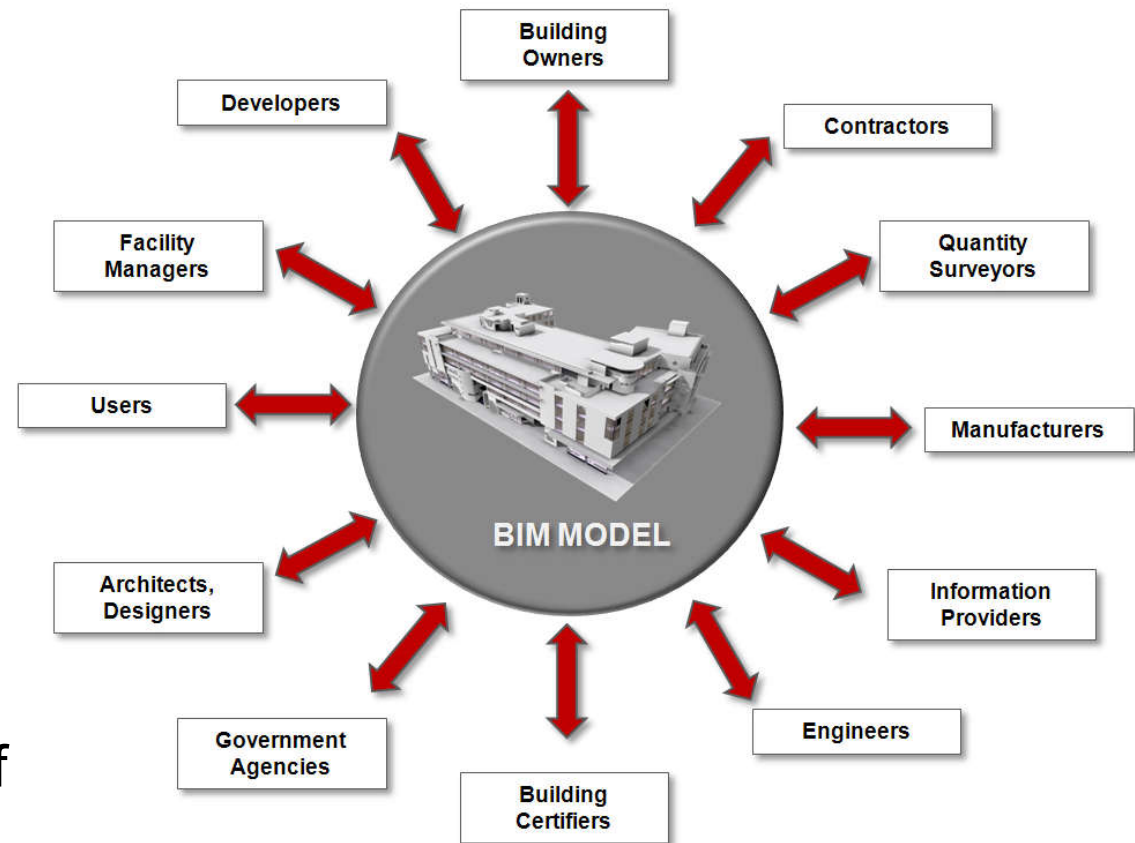


- External collaboration
- Industry Foundation Classes
- Sharing data and documents
- Reviewing and data exchange
- Cloud-based BIM



# 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.



# Project phases and stakeholders

PROJECT PHASES



The project team comes together at the earliest stage, improving accuracy of decisions. The rest of the process becomes more predictable, thus avoiding costly redesign work.



Collaboration between the architect, contractor, and engineers allows for better decision making, helping to improve quality and mitigate risk.



Precise virtual models are automatically part of the design, helping to reduce uncertainty in documents and interferences during construction.



Because of careful early planning, team members are able to use materials efficiently, creating less waste. Change orders are minimized, and no operational revenue is lost. Construction can be completed on schedule and on budget.



Owners can enjoy better quality assurance on their completed project and are provided with a complete virtual building for operational and renovation purposes.

## CONCEPTUALIZATION

## DESIGN

## IMPLEMENTATION DOCS

## CONSTRUCTION

## OWN / OPERATE

Architect: "Input from the extended project team enables me to make better design decisions early in the process."

Contractor: "I can foresee problems and reduce future delays."

Civil Engineer: "I can help with site selection so we won't run into environmental issues later."

Owner: "Careful planning will reduce waste and save money and time."

Architect: "We have a common understanding of design intent among the team. And, we can more effectively influence the sustainability performance of our designs."

MEP Engineer: "There are no conflicts in the field because we chose the best systems and sizing of the equipment during design."

Structural Engineer: "We were able to make the necessary analysis to a single model, saving us time and allowing us to fast track the structural design process and documentation."

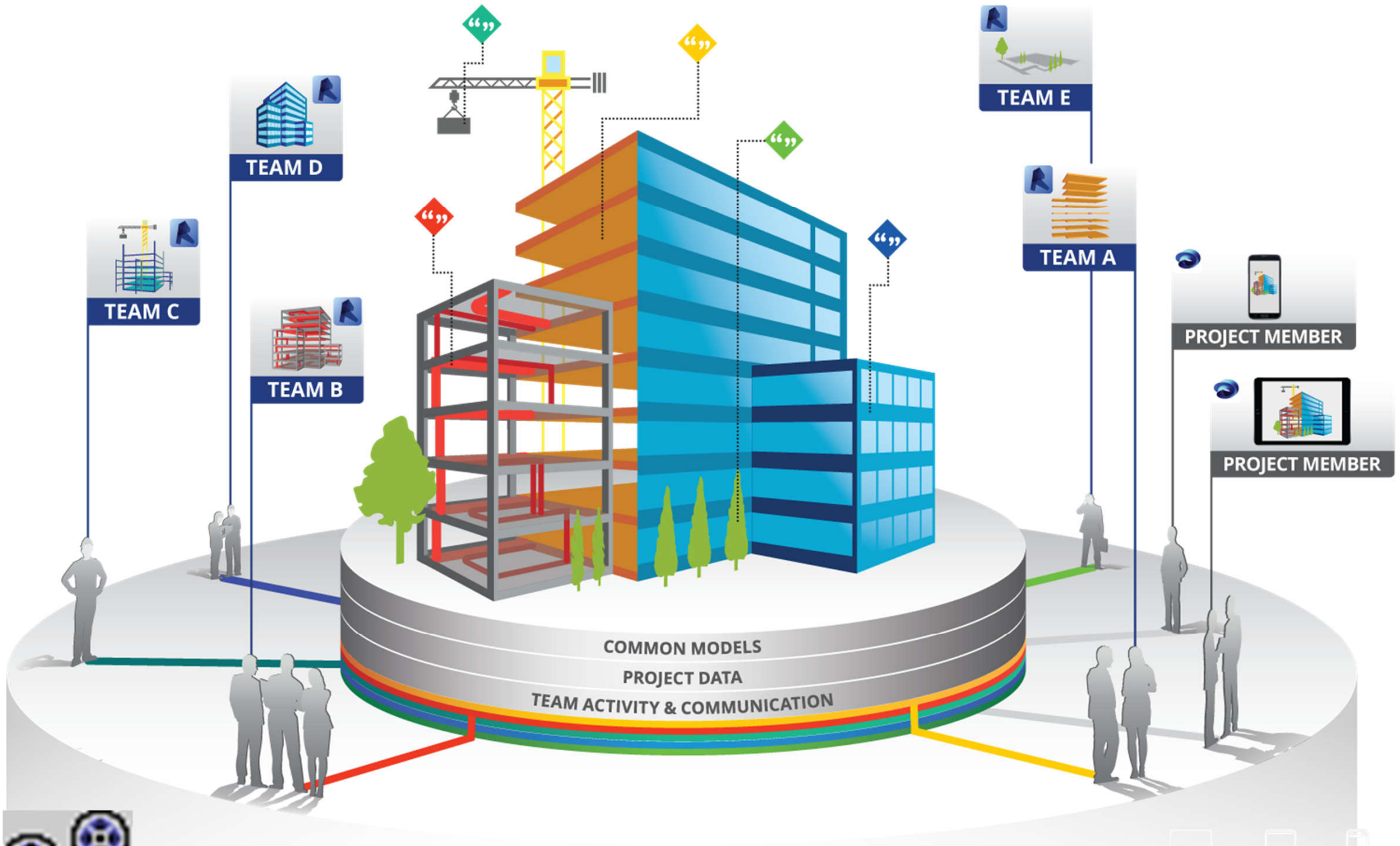
Fabricator: "Working with just one model to produce steel fabrication shop-drawings allowed us to begin fabrication early."

Contractor: "We've had zero interference on this project. RFI's were reduced significantly. I've never had construction go so smoothly."

Owner: "My building project was finished on time and on budget."

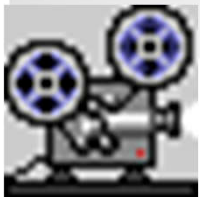
Tenant: "I can tell our needs were taken into account when the building was designed."

# 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

## Owner Team

Tools focused on the owner team:

- Capital planning software
- Financial software
- Operations software



### Web-based

- Hosted in the cloud

### Collaborative

- Designed for shared use

### Integrated

- All parties at the same table
- Equal access & accountability for all team members



## End Result

- Fewer delays
- Lower costs
- Greener project
- Higher quality building

## Design Team

Tools focused on the design team:

- Project Information Management (PIM) software
- Design software
- Office management software



## Construction Team

Tools focused on the construction team:

- Project management software
- Bid management software
- Estimating software



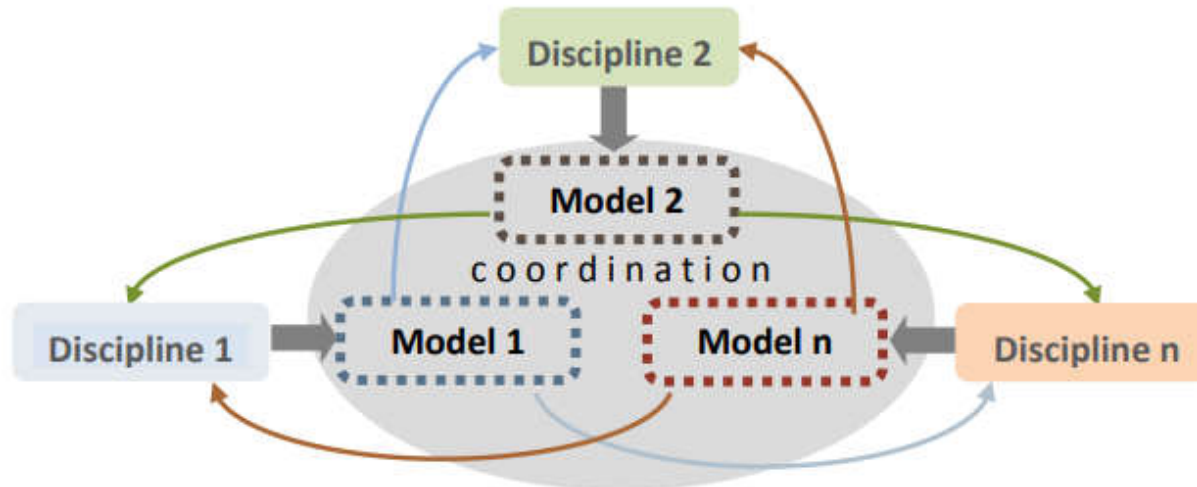
# BIM modelling and collaboration procedures

## (1) Model Creation by Respective Model Authors



Quality Checks

## (2) Model Coordination Involving Model Authors and Users

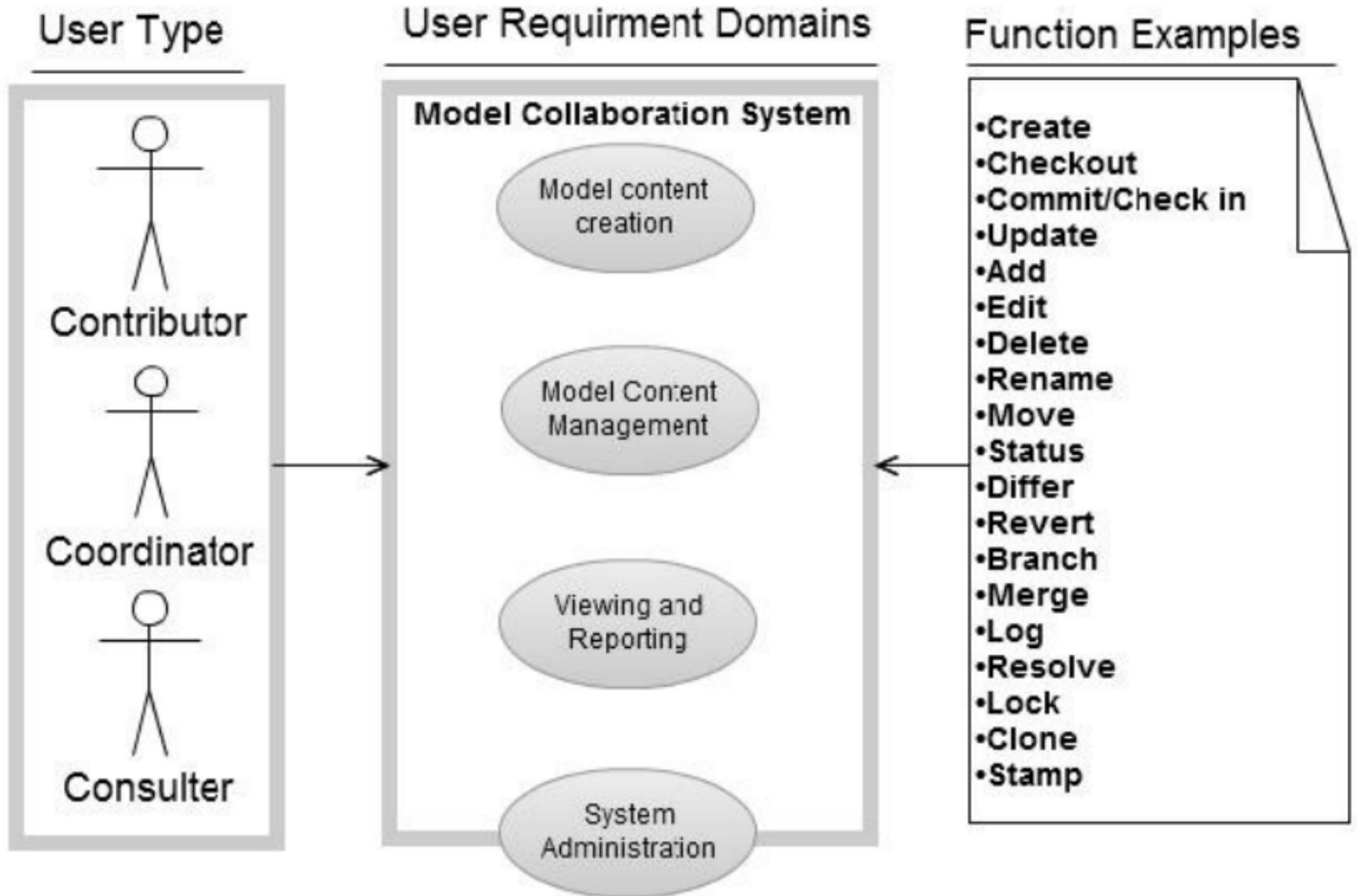


Authorised by BIM Manager

## (3) Models are Frozen and Released

- Co-ordinated and validated models can be released for use by model users.
- The models are also frozen as part of project history

# Users and requirement domains in a model collaboration system

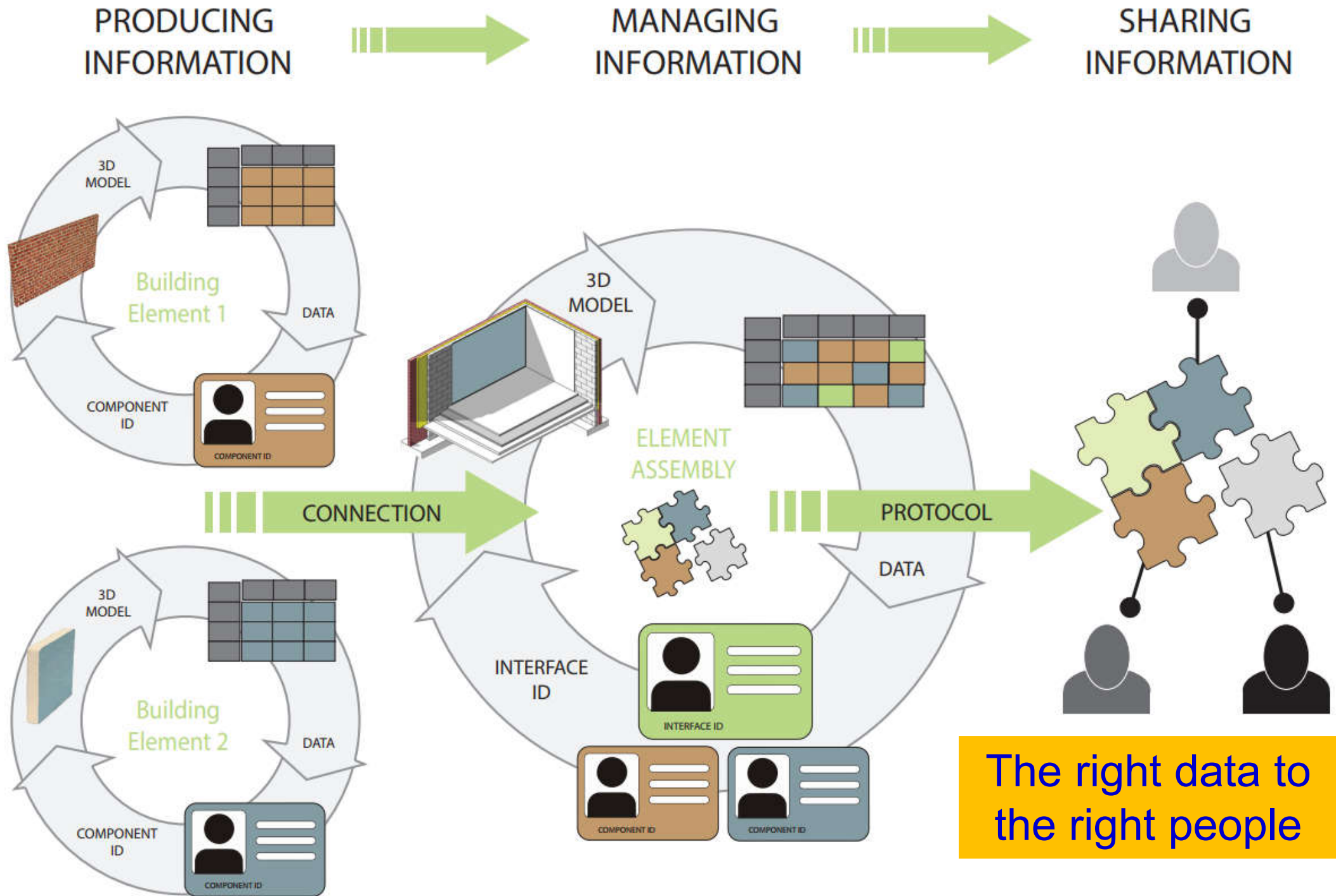




# Typical features of a model collaboration system

Model content creation	Model content management	Viewing and reporting	System administration
<ul style="list-style-type: none"> <li>• Model modifications</li> <li>• 2D data modelling</li> <li>• Data querying</li> <li>• Reference data linking</li> <li>• Product libraries</li> <li>• Support</li> <li>• Model checking</li> <li>• Rule-based modelling</li> <li>• Model comparison</li> <li>• Change management</li> </ul>	<ul style="list-style-type: none"> <li>• Model upload / download</li> <li>• Multiple data model formats</li> <li>• Partial model exchange</li> <li>• Versioning</li> <li>• Model merging</li> <li>• Data locking</li> <li>• Clash detection</li> <li>• Conflict resolution</li> <li>• Audit trail</li> <li>• Data publishing</li> <li>• Workflow management</li> </ul>	<ul style="list-style-type: none"> <li>• Remote model viewing</li> <li>• 3D navigation</li> <li>• Mark-up</li> <li>• Collaborative communication</li> <li>• Report generation</li> <li>• FM data support</li> <li>• Colour customization</li> <li>• Workflow reporting</li> <li>• Mobile computing support</li> </ul>	<ul style="list-style-type: none"> <li>• User profiling</li> <li>• Access control</li> <li>• Data handling</li> <li>• Interface customization</li> <li>• Security</li> <li>• Disaster protection</li> <li>• Data archiving</li> </ul>

# 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?

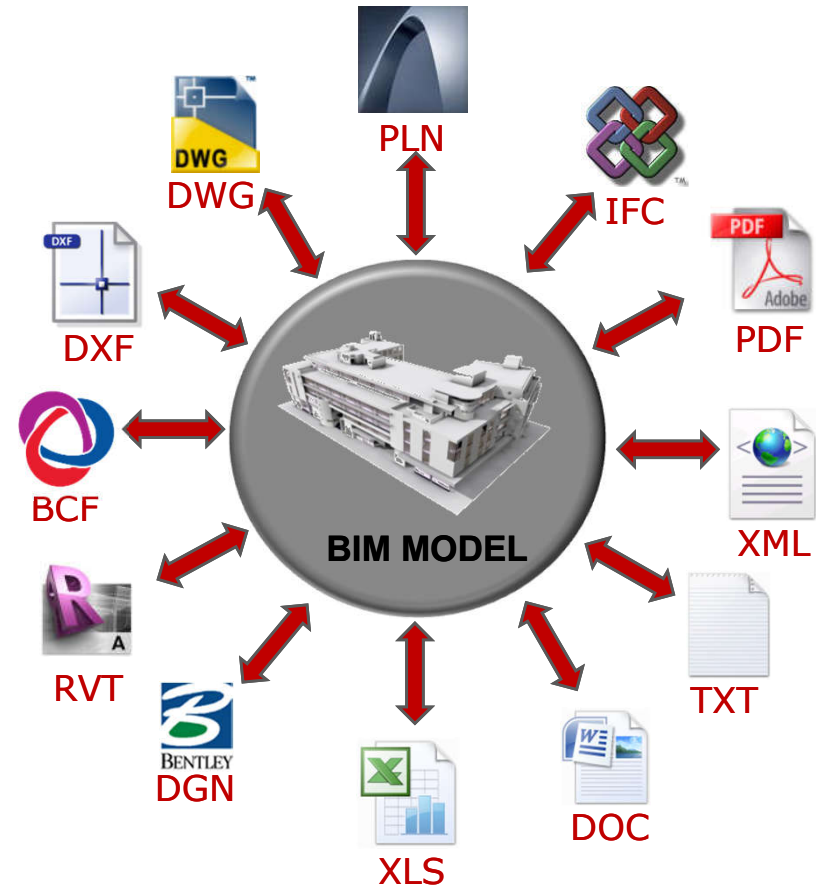


合作



# File Formats

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



# 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.

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A NEMETSCHKE COMPANY

AUTODESK.

BENTLEY

NEMETSCHKE

<http://www.buildingsmart.com/>

NEC

SOLIBRI

TIMBERLINE.

FUJITSU

GRANLUND

\* 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)



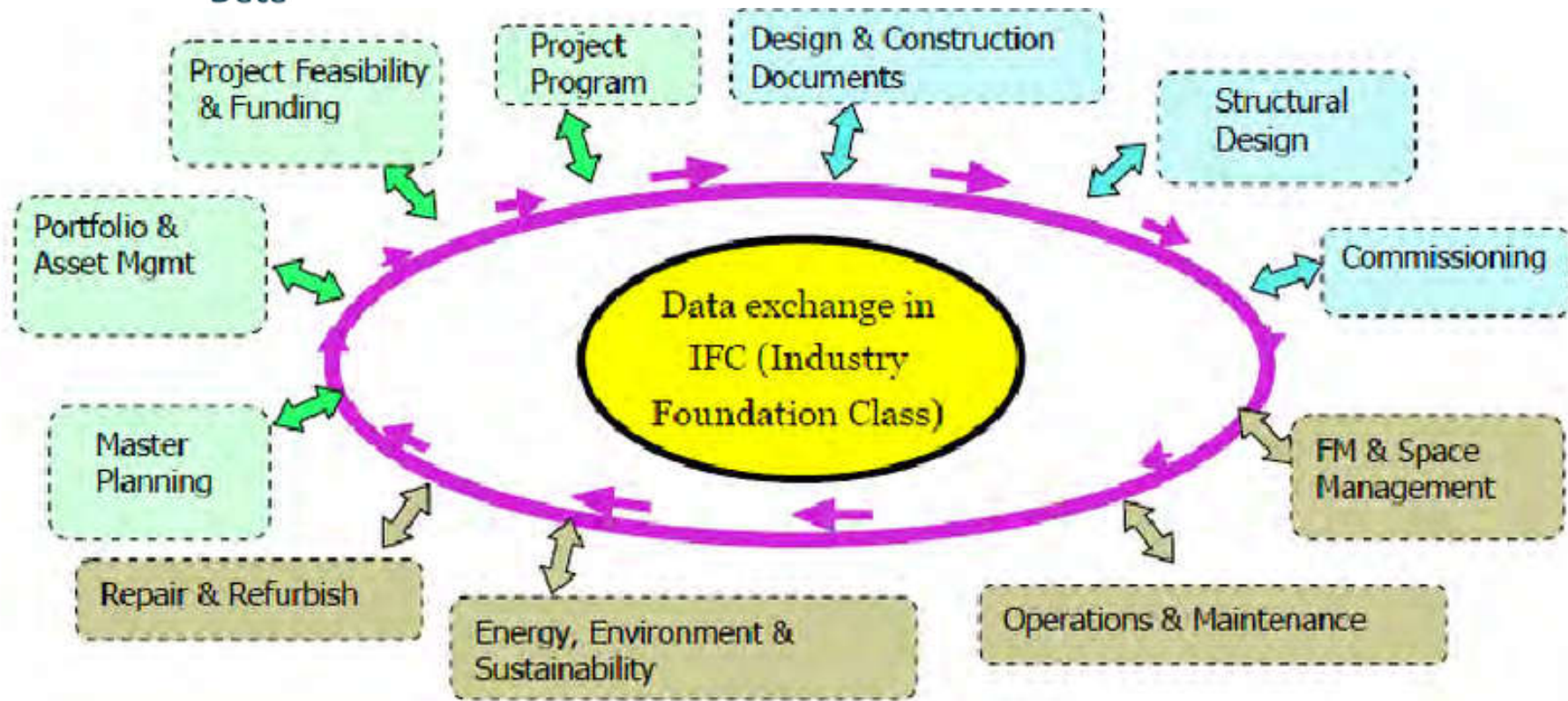
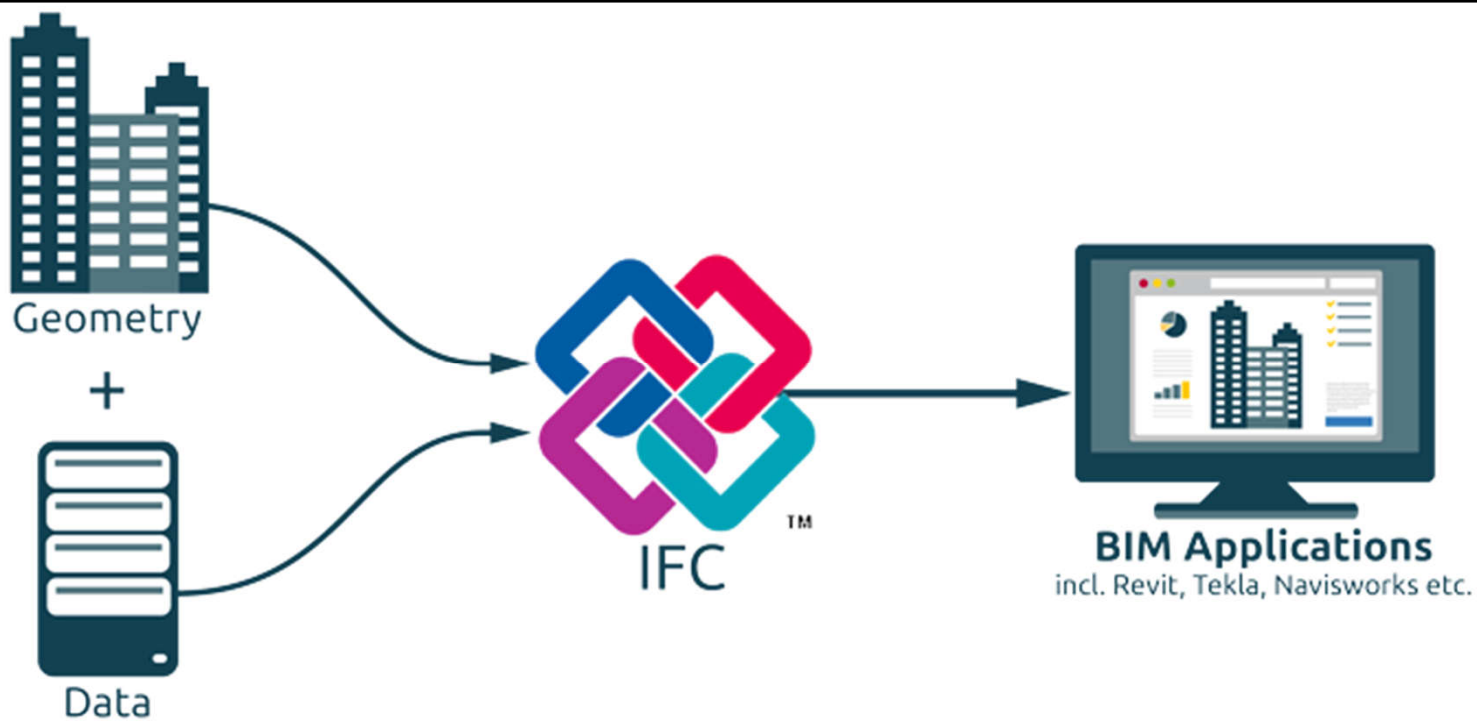
<http://buildingsmart.com/standards/buildingsmart-standards/ifc>

# Industry Foundation Classes



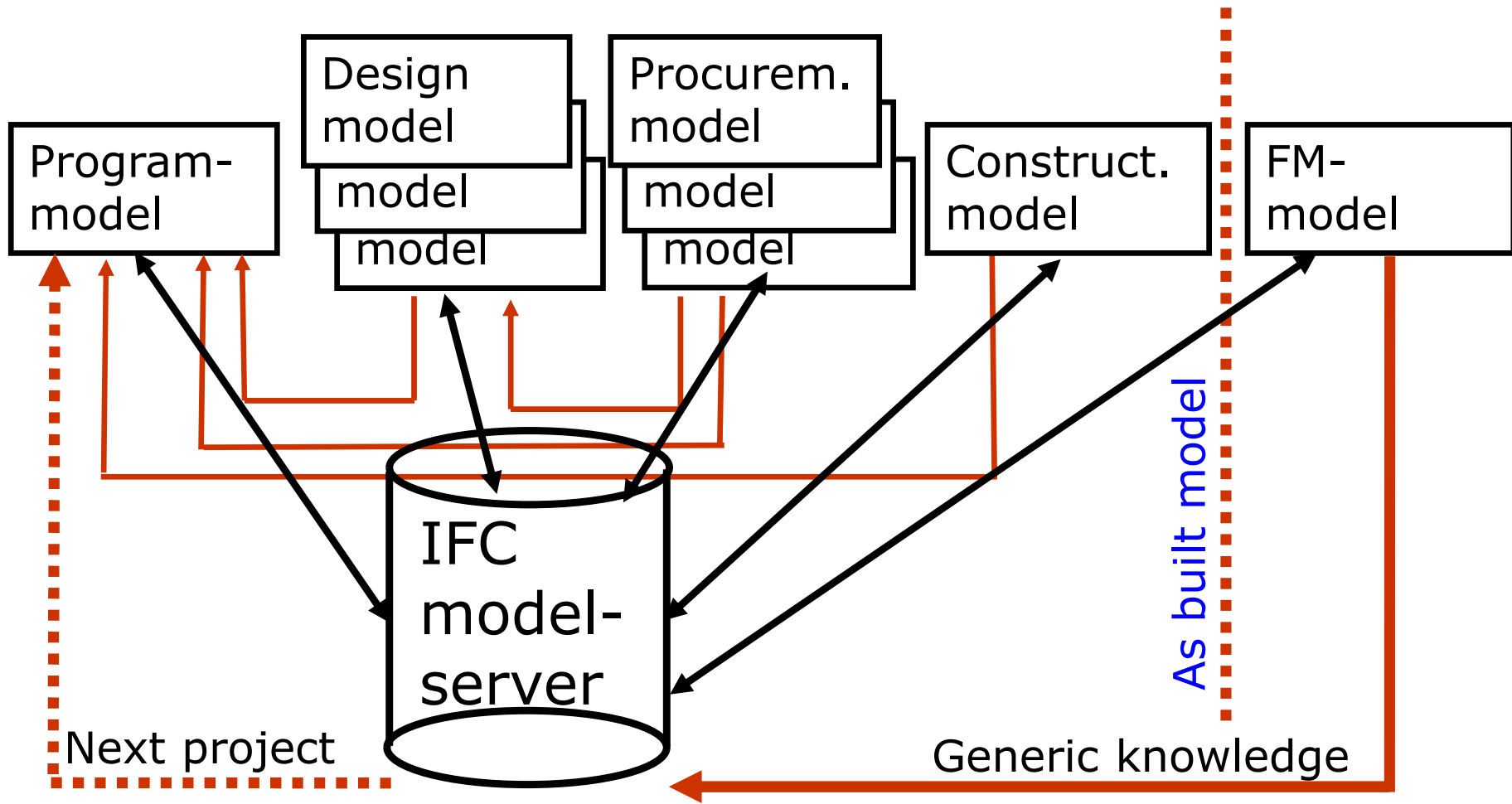
- IFC (Industry Foundation Classes)
  - A global standard for data exchange in the building industries; it is both a common data model and an open file format
    - Building industry professionals can use IFC to share data regardless of what software application they use to get their job done
    - Similarly 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



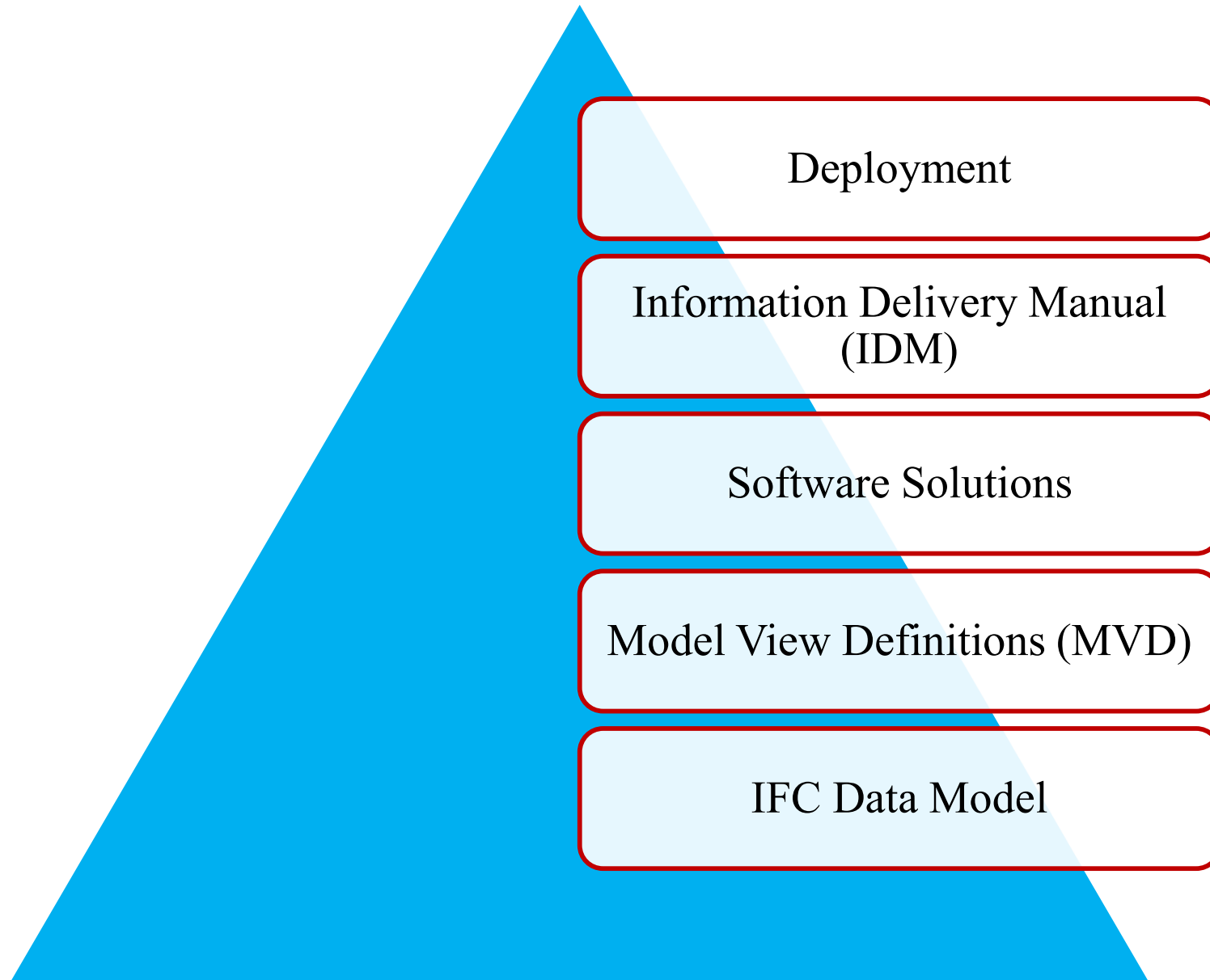


(See also: IFC Introduction <https://www.buildingsmart.org/about/what-is-openbim/ifc-introduction/>)

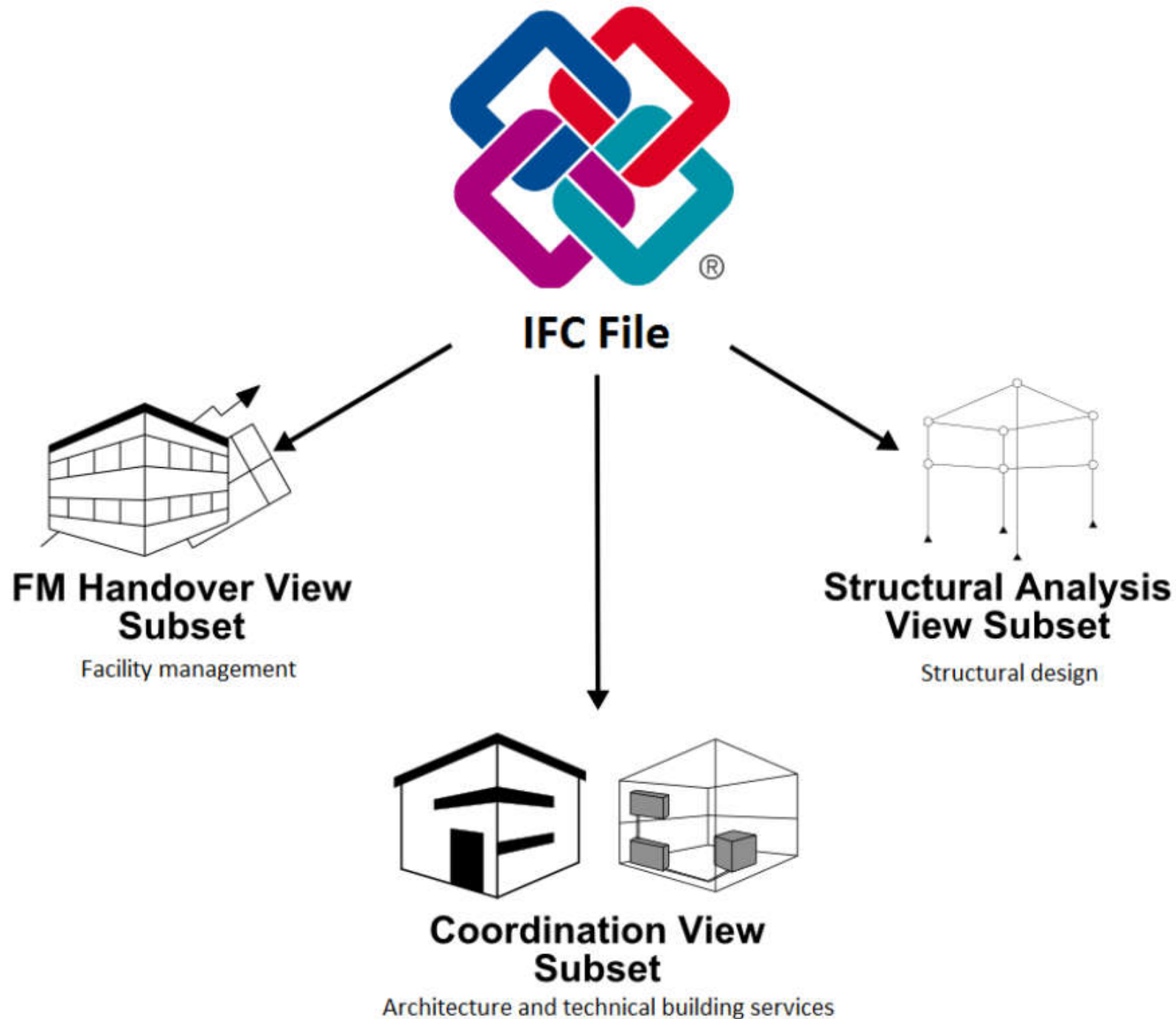
# Holistic view of Industry Foundation Classes (IFC)



# Layers of the information exchange framework for IFC

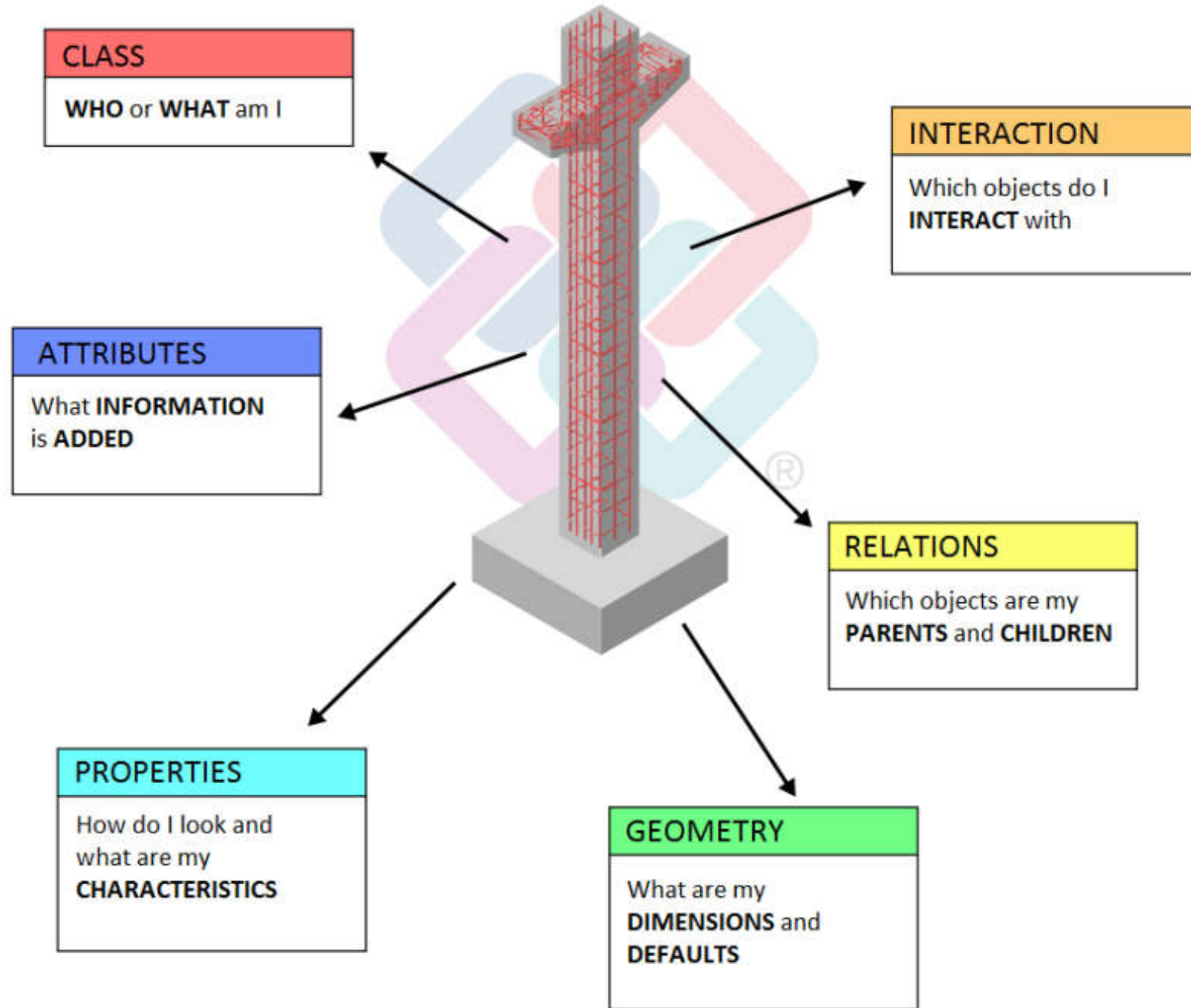


# Three subgroups of the Industry Foundation Classes (IFC) format



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

## Object



# Industry Foundation Classes



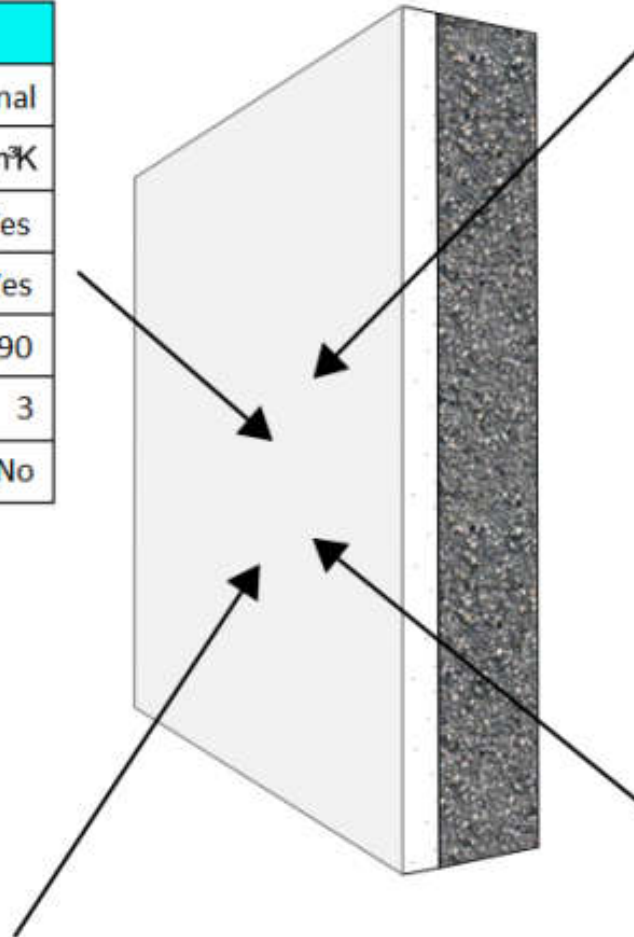
- Attributes of the IFC elements
  - Associations – Relations
    - Associated story, connecting elements
  - Geometric attributes – Base Quantities
    - Such as length, height, thickness, area, volume
  - Element properties (general and special)
    - Such as U-value, load-bearing, fire resistance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

# Example of component IFC element: A wall

Component  
IFC element

PSET COMMON	
Position	Internal
U-value	0.3 W/m <sup>2</sup> K
Recesses	Yes
Load-bearing	Yes
Fire resistance	F90
Sound insulation	3
Fire compartm.	No

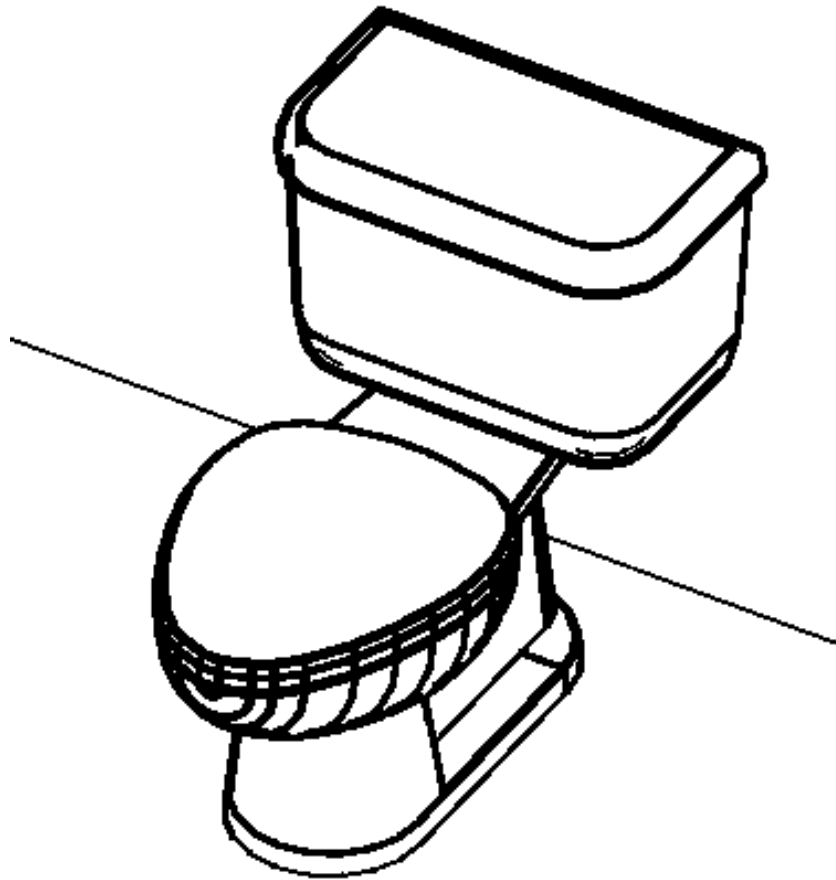
ADDITIONAL PROPERTIES	
Name	Wall
Function	AW01
Material	HICM
Flammability	A01



BASE QUANTITIES	
Thickn.	36.5 cm
Length	5.00 m
Height	2.50 m
Area	12.5 m <sup>2</sup>
Volume	4.56 m <sup>3</sup>

RELATIONS	
Story	GF
Openings	W01
Connection	-

# Example of BIM object: A toilet water closet



Parameter	Value
<b>Materials and Finishes</b> ⌄	
Toilet - Bowl/Basin Material	Porcelain - Linen
Toilet - Seat Material	Laminate - Linen, Matte
<b>Plumbing</b> ⌄	
Vent Connection	<input checked="" type="checkbox"/>
Waste Connection	<input checked="" type="checkbox"/>
CW Connection	<input checked="" type="checkbox"/>
HW Connection	<input checked="" type="checkbox"/>
<b>Identity Data</b> ⌄	
Assembly Code	D2010110
Keynote	
Model	
Manufacturer	
Type Comments	
URL	
Description	
Assembly Description	Water Closets - Single
Type Mark	
Cost	



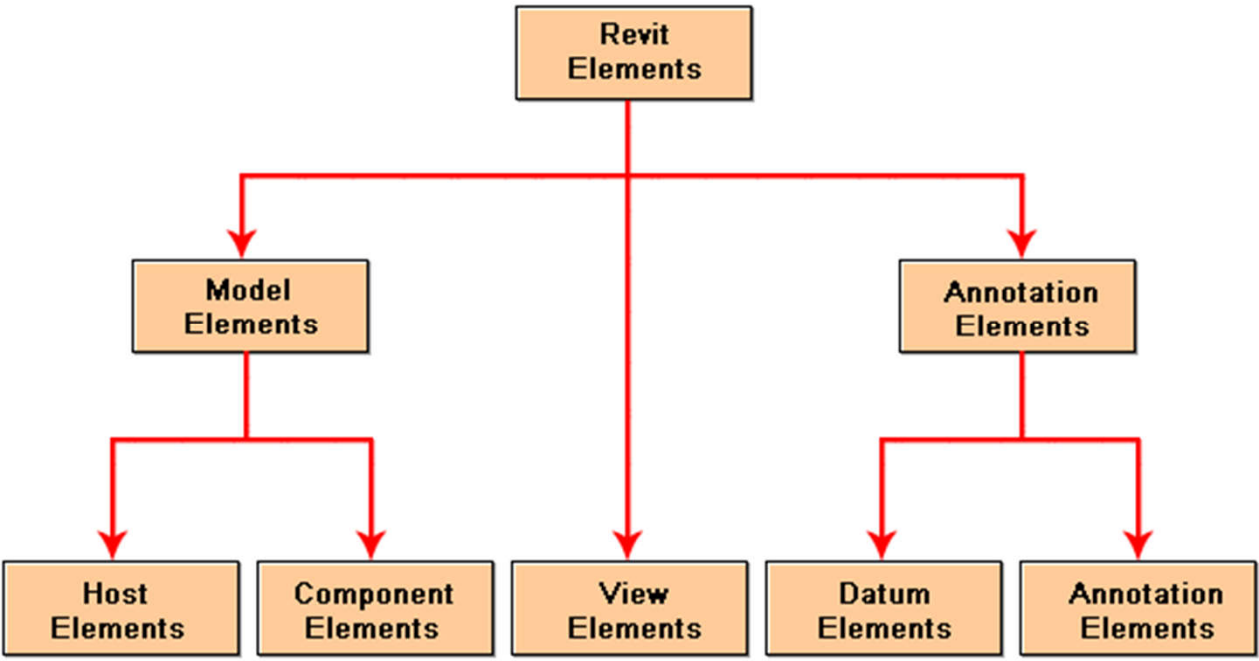
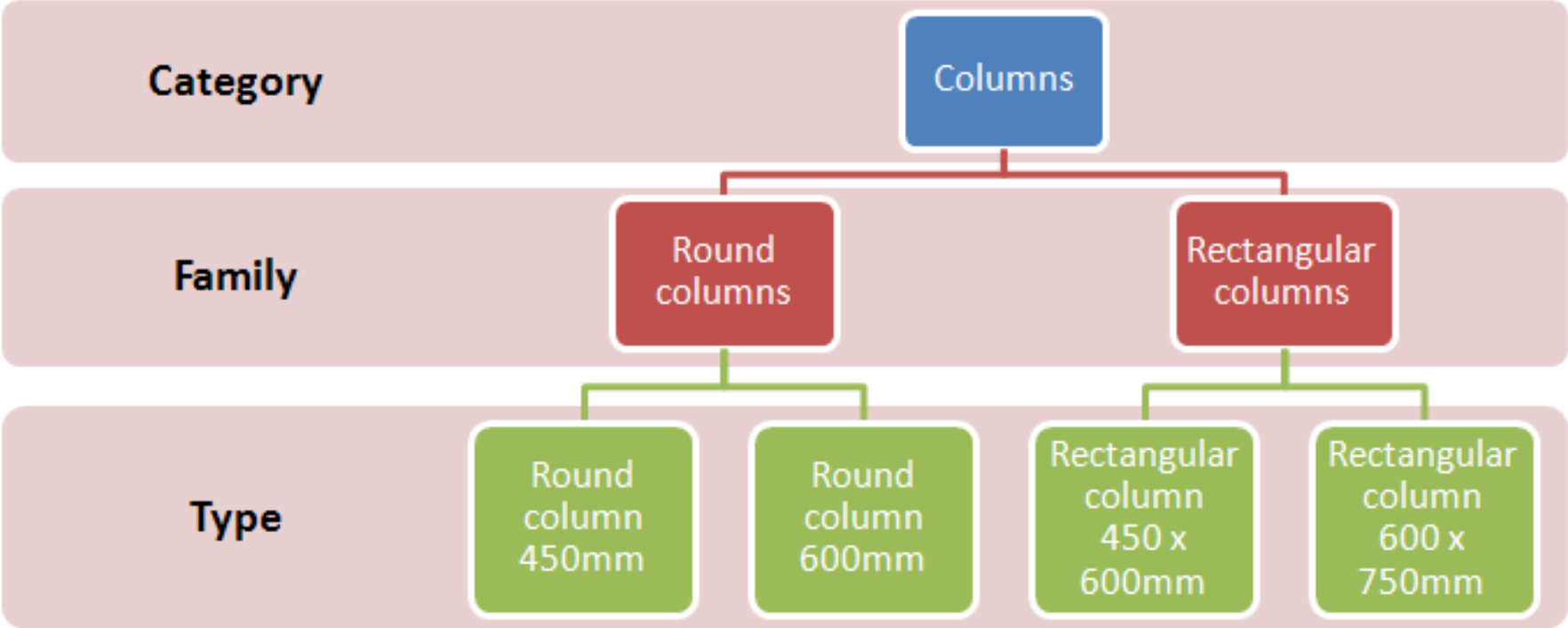
## Examples of terms used in Autodesk Revit

Key Term	Definition
<b>Parameter</b>	A detail that can be changed or adjusted – includes dimensions, materials, and off-sets.
<b>Parametric component</b>	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.
<b>Family</b>	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.
<b>Type properties</b>	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.
<b>Project views</b>	Different views of the model such as plan, elevation, section, and 3D views.

# Data structure and organization in Autodesk Revit

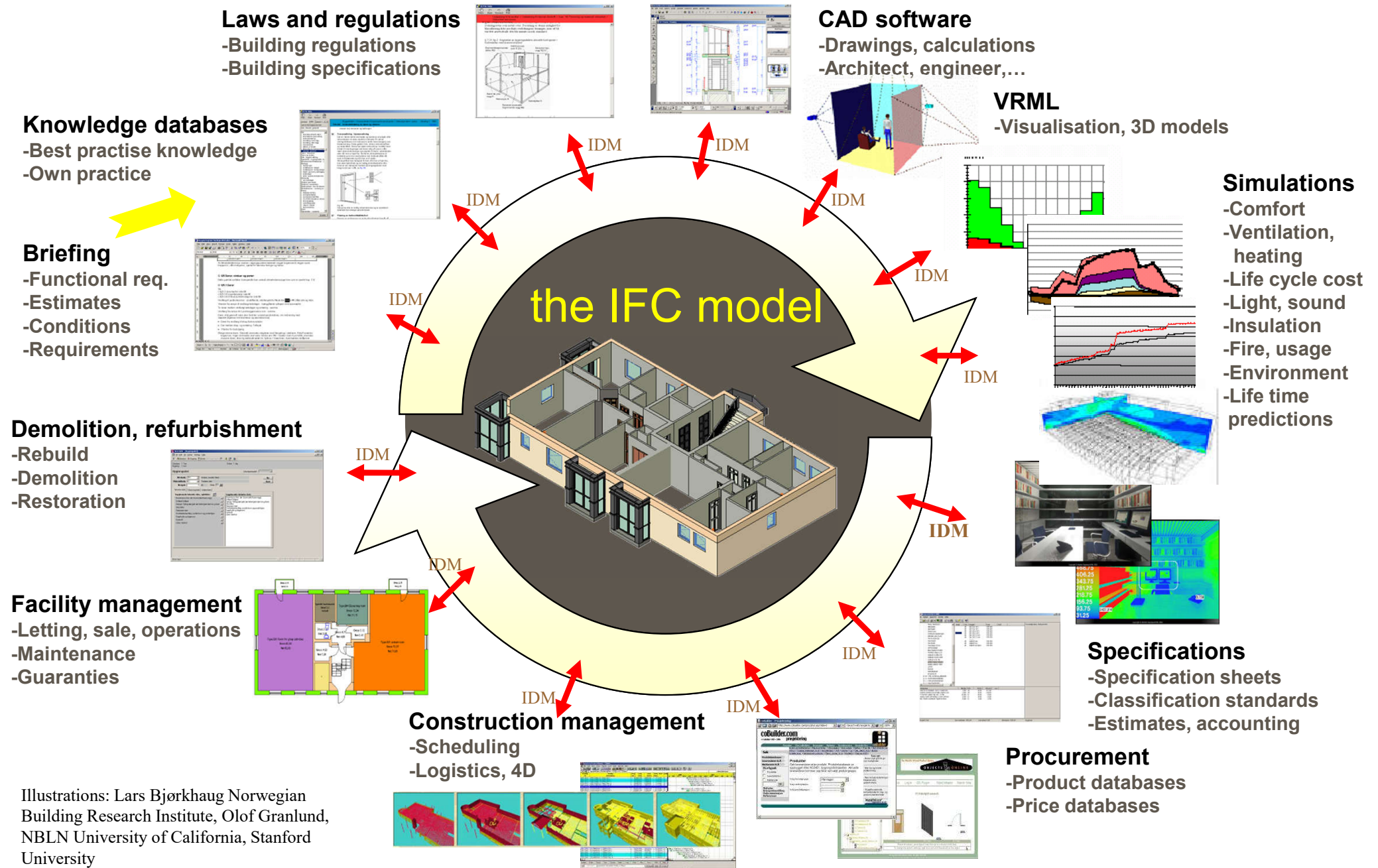
Key Term	Definition
<b>Categories</b>	All objects in the building model are assigned a category. All doors in a project belong to the <b>category Doors</b> . This broad category is further broken down into families.
<b>Families</b>	Families are groupings of <b>like geometry</b> . Continuing with the 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.
<b>Types</b>	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).
<b>Instances</b>	An instance is simply a single object of a type in the building model.

# 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

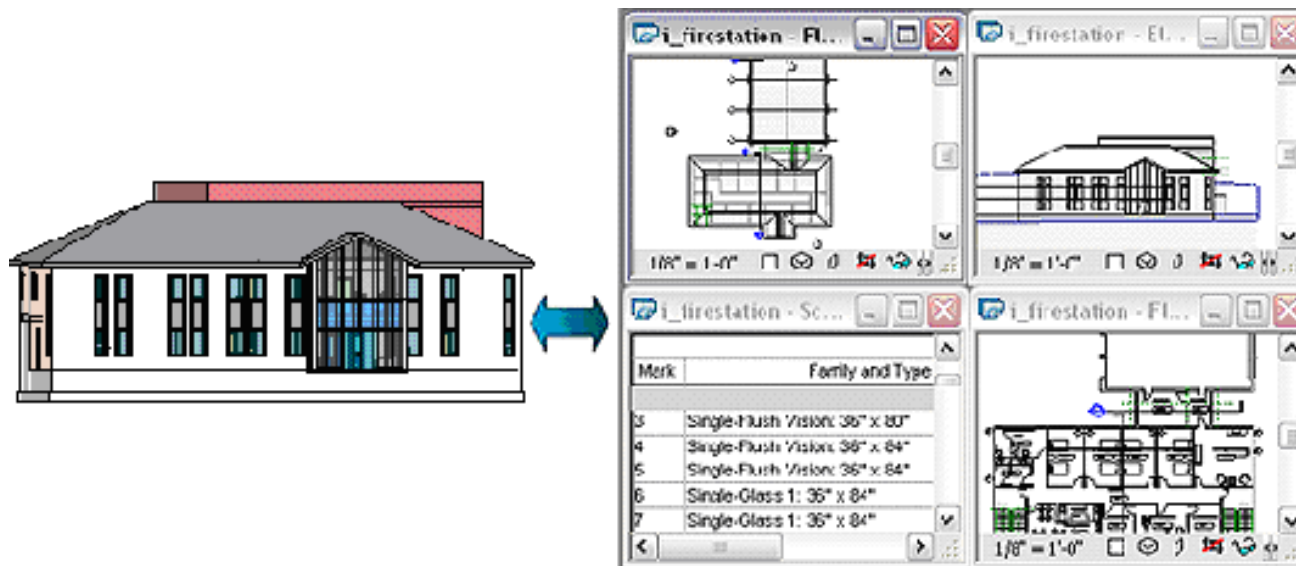


Illustrations: Lars Bjørkhaug Norwegian Building Research Institute, Olof Granlund, NBLN University of California, Stanford University

# 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

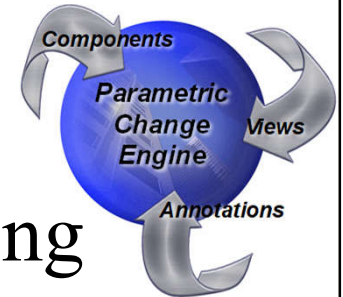


# Sharing data and documents



- 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



# 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.

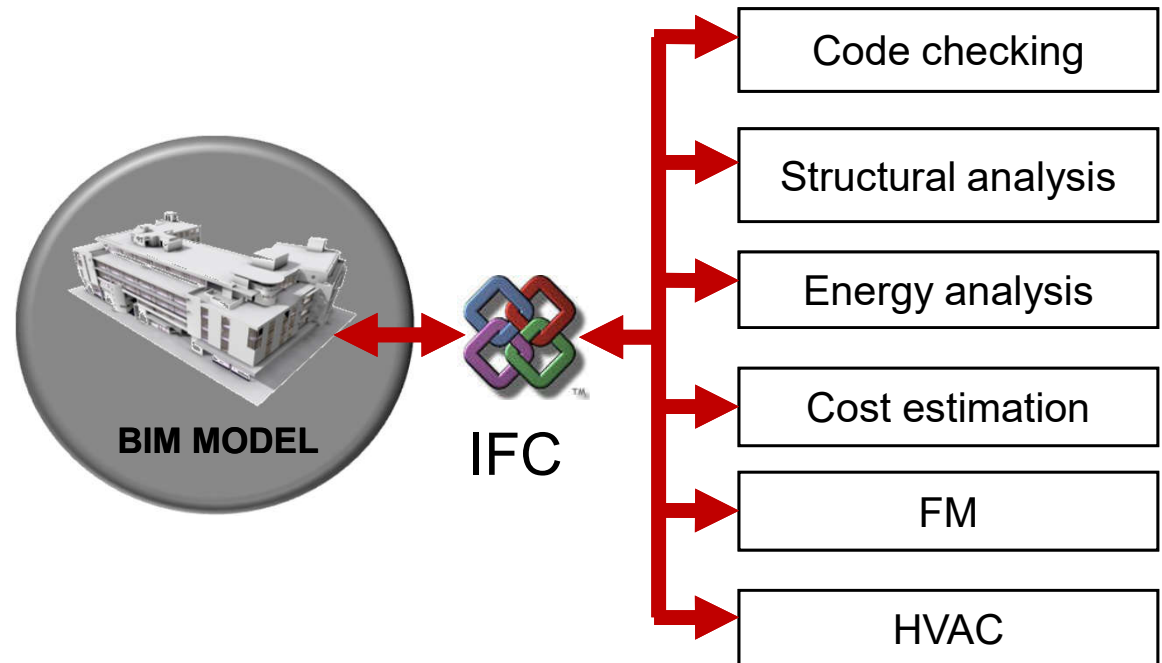


- More info:
- <http://www.buildingsmart-tech.org/specifications/specifications>

# Sharing the BIM Data: IFC

- **Benefits:**

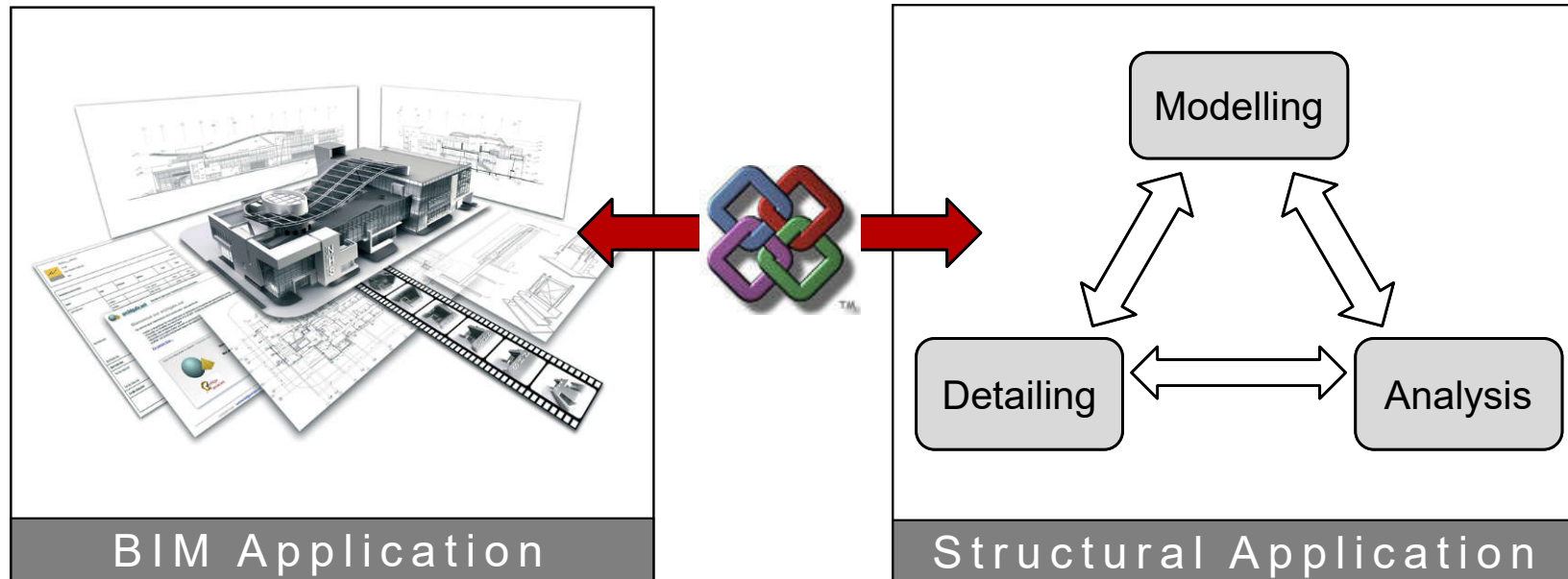
- Universal, industry standard data exchange format.
- Bi-directional connection between diverse applications
- Building elements preserve BIM information during data transfer





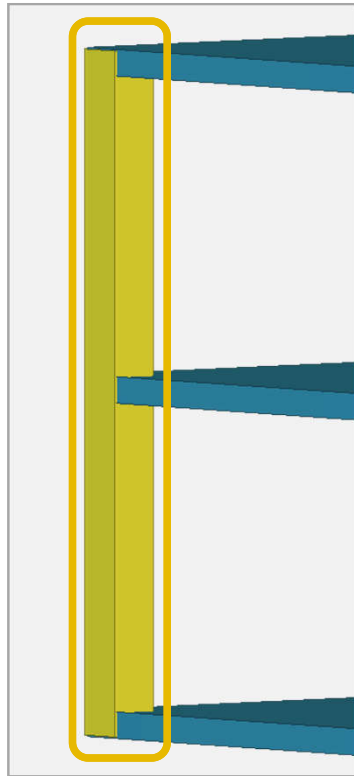
# IFC Based Structural Design Workflow

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

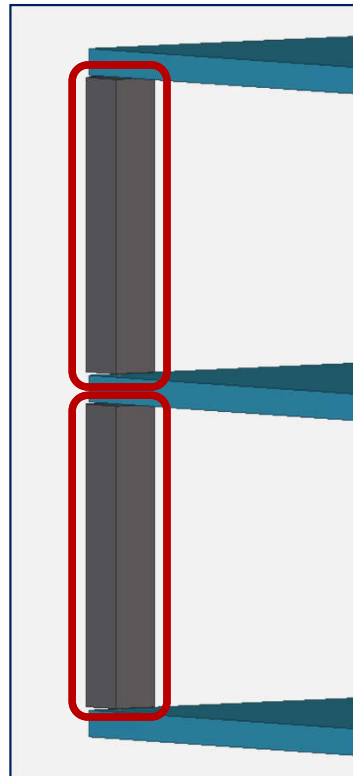


# Structural Modelling

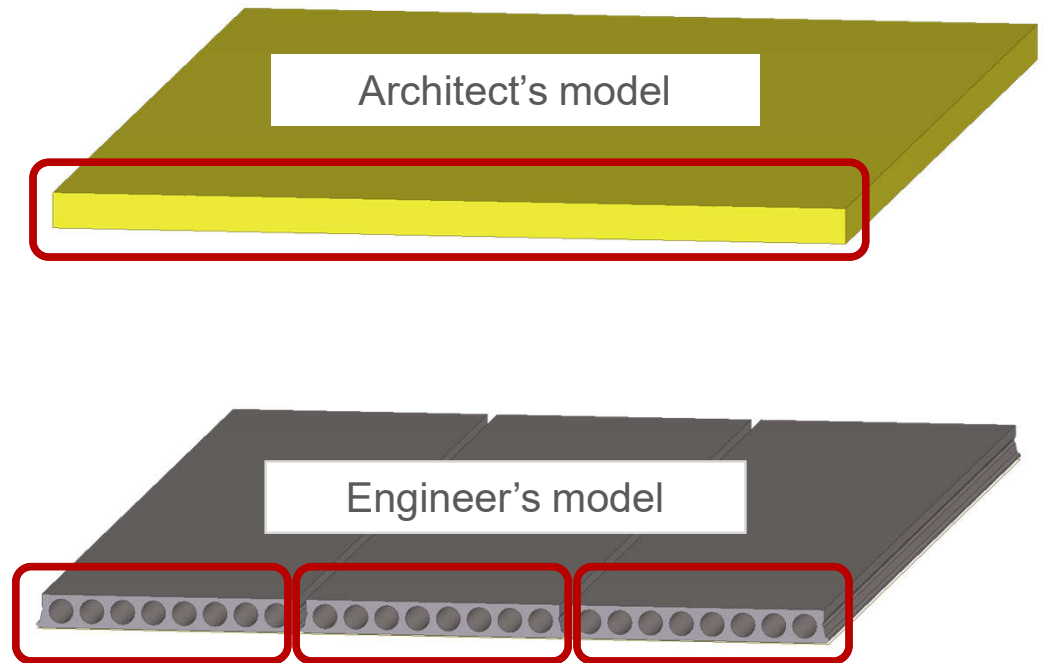
Different disciplines adopt different modelling concepts



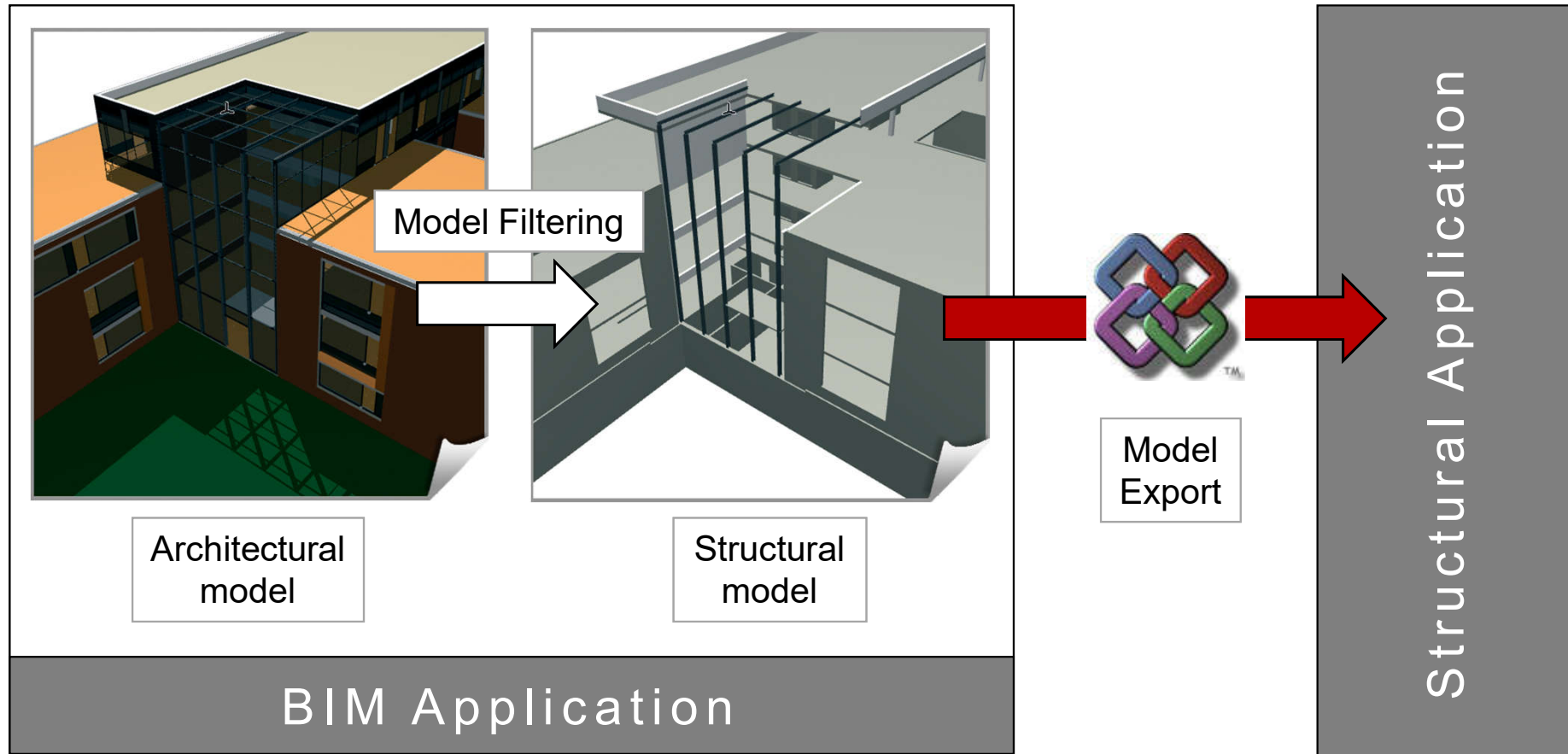
Architect's model



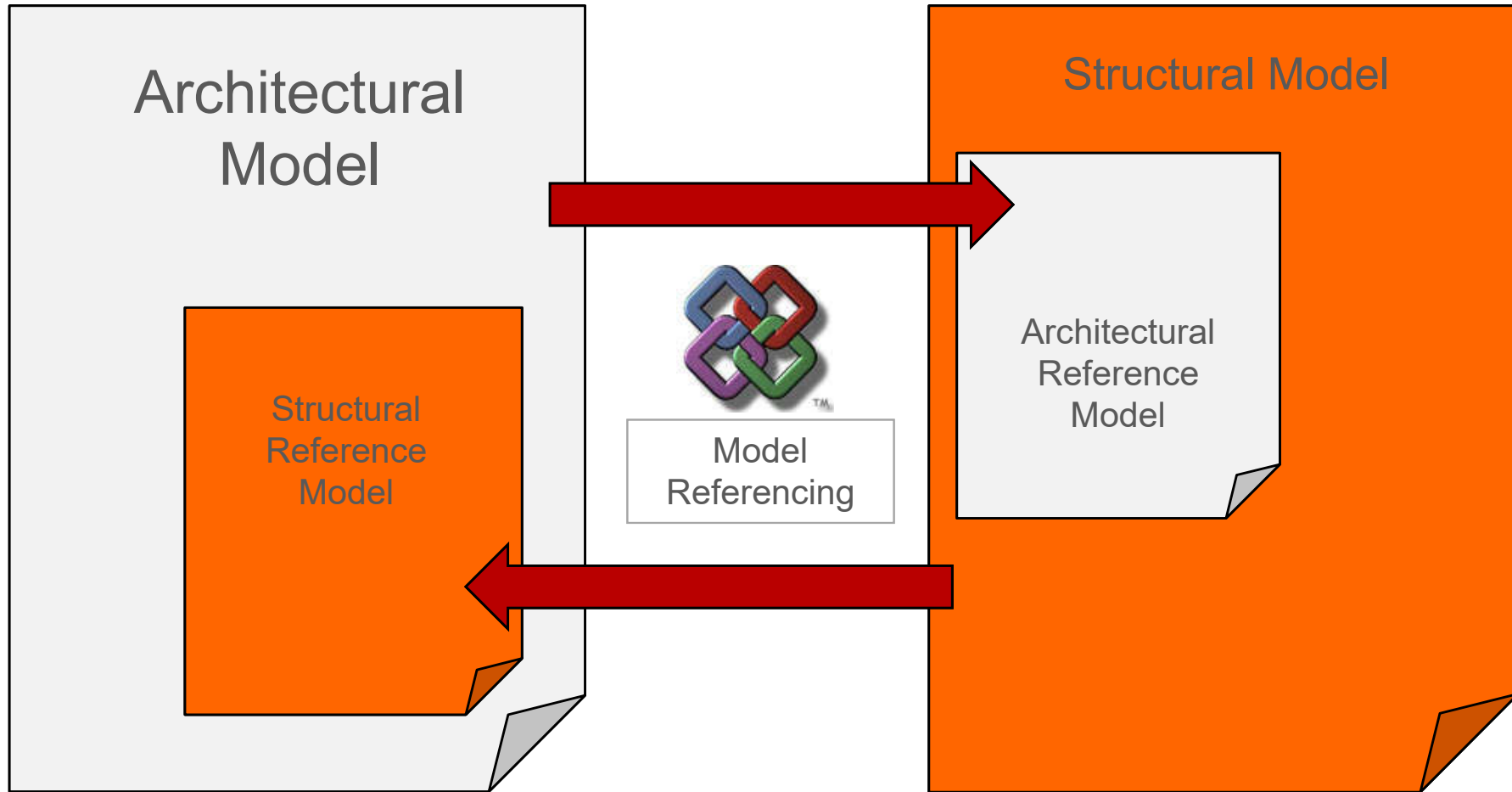
Engineer's model



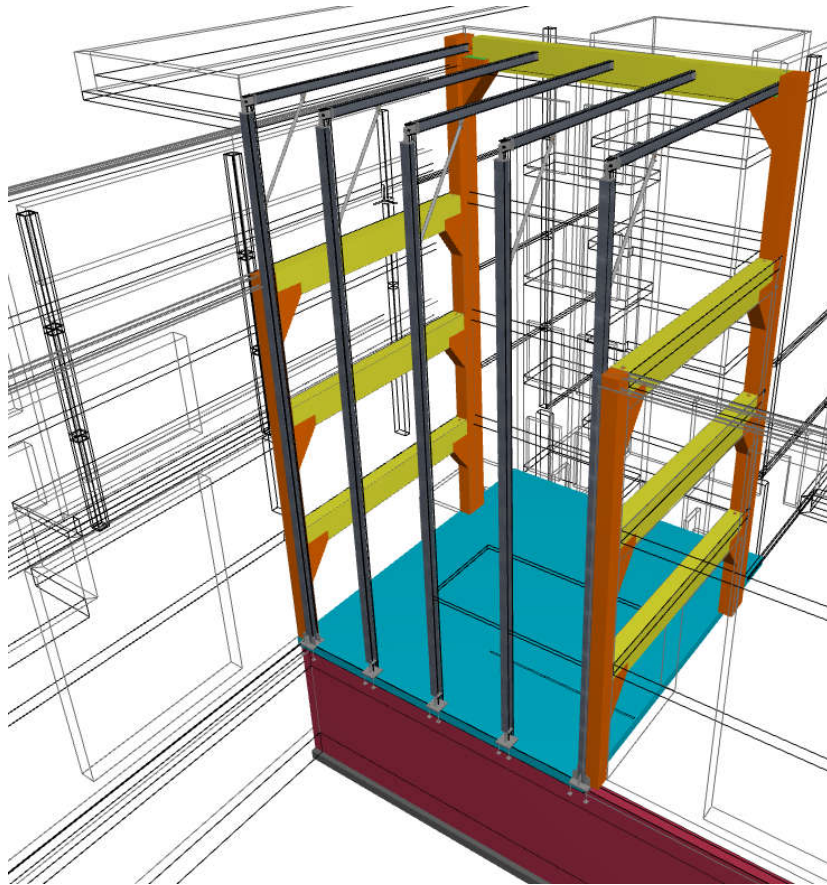
# Model Filtering



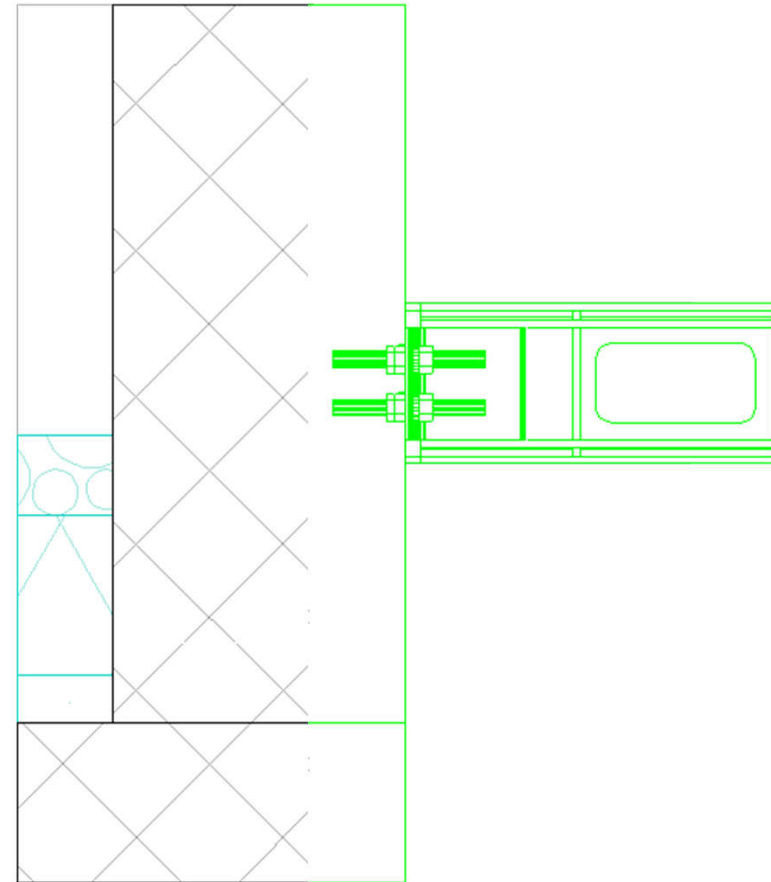
# Reference Model Concept



# Intelligent Model Referencing



Element Separation  
(Layering)



Visual Differentiation

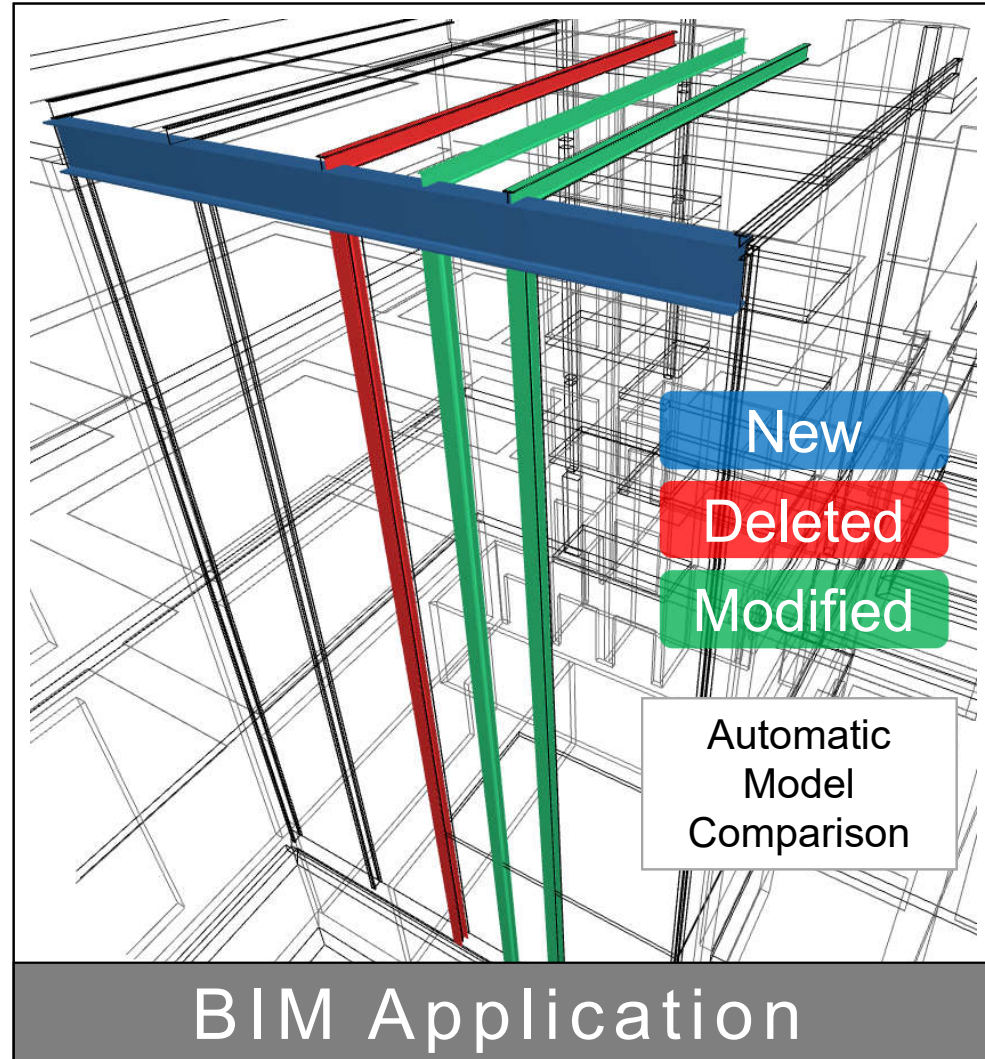
# Model Comparison

Structural Model Version 01

Structural Model Version 02



Model Referencing



# 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 transfer 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/>

# Sharing documents: PDF

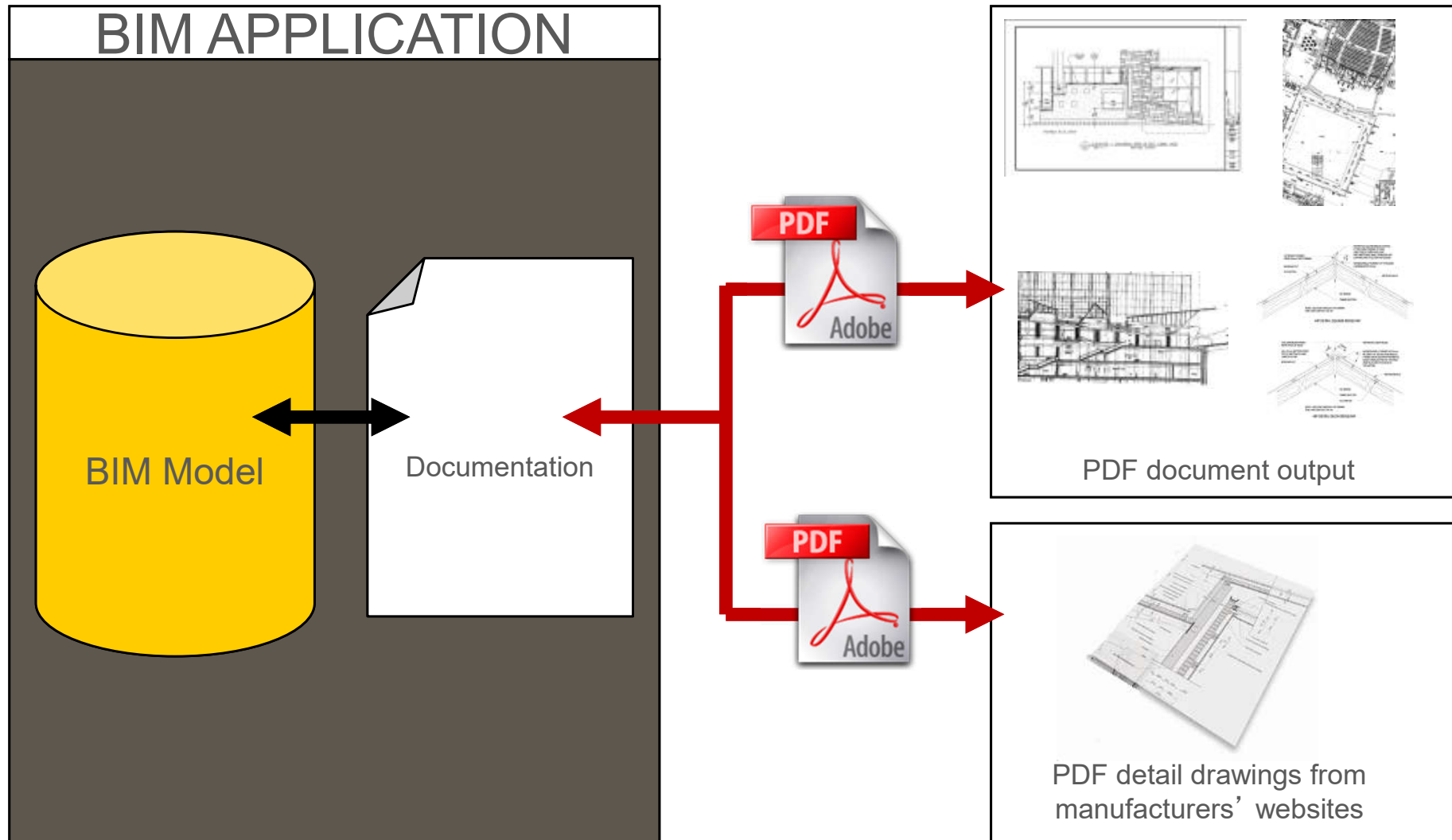


- PDF = **P**ortable **D**ocument **F**ormat
- PDF is a proprietary file format developed by Adobe Systems for representing **two dimensional documents** in a device independent and resolution independent format.
- Each PDF file encapsulates a complete description of a 2D document that includes texts, 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>



# Sharing documents: PDF



# 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

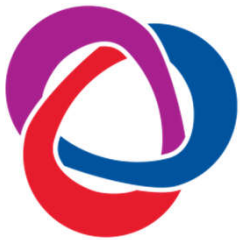


Source: <http://www.opendesign.com/>

(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

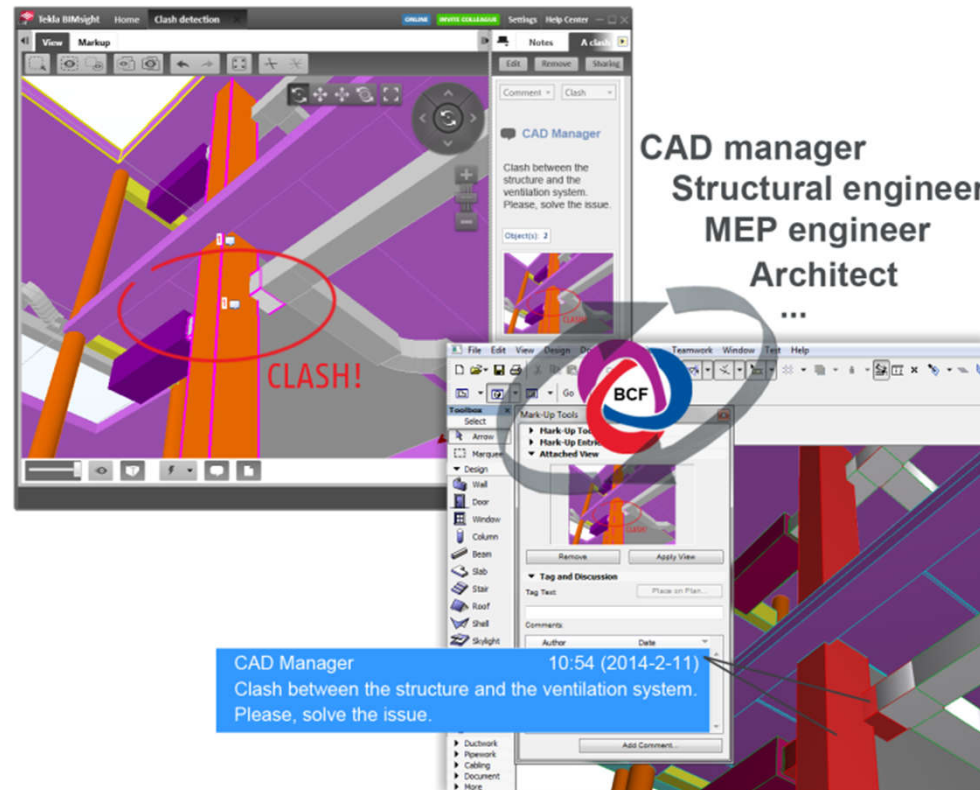


(Video: BIM Collaboration Format BCF explanation (2:13)

<https://youtu.be/yrm5SrEfSvE>)

# Reviewing: BCF

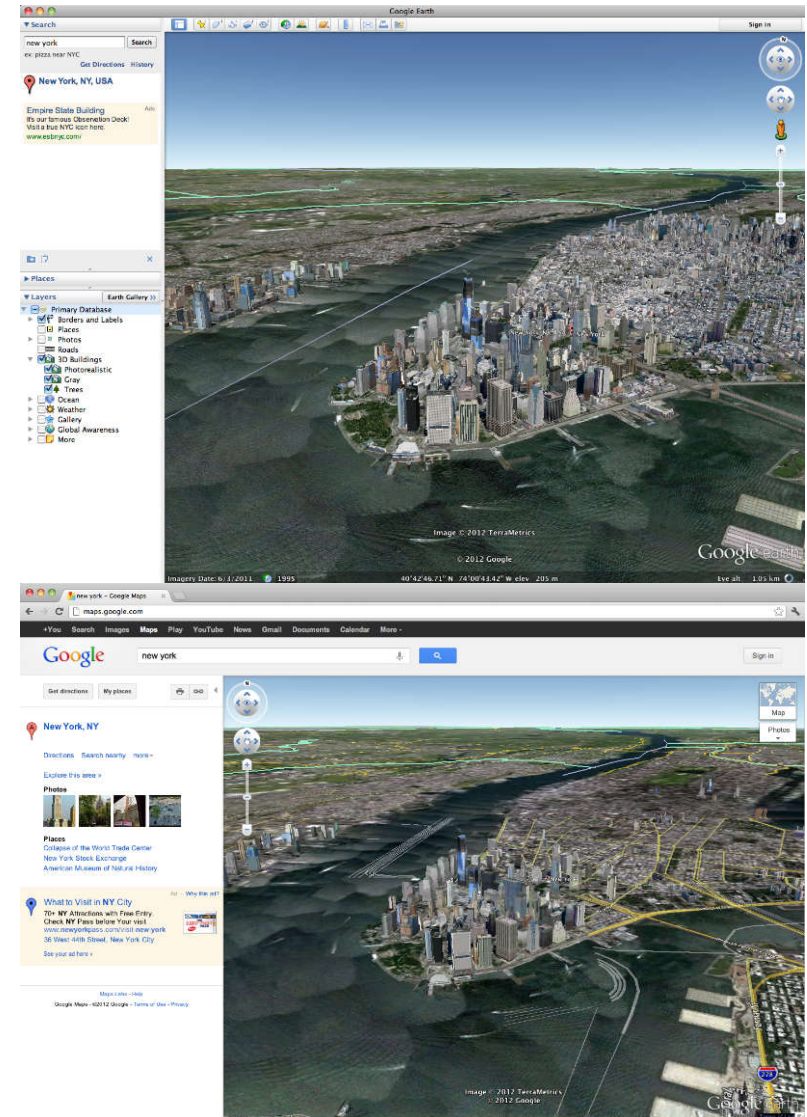
- IFC-based data exchange can be enhanced by using the so-called **BIM Collaboration Format (BCF)**-based communication.
- In combined IFC models, the BCF work flow enables participants to add comments to the overlapping issues (e.g. collisions).
- BCF comments include the referenced IFC elements and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



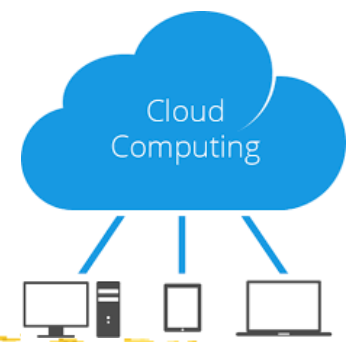
# Google Earth

- **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.

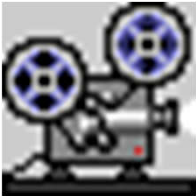
<http://earth.google.com/>



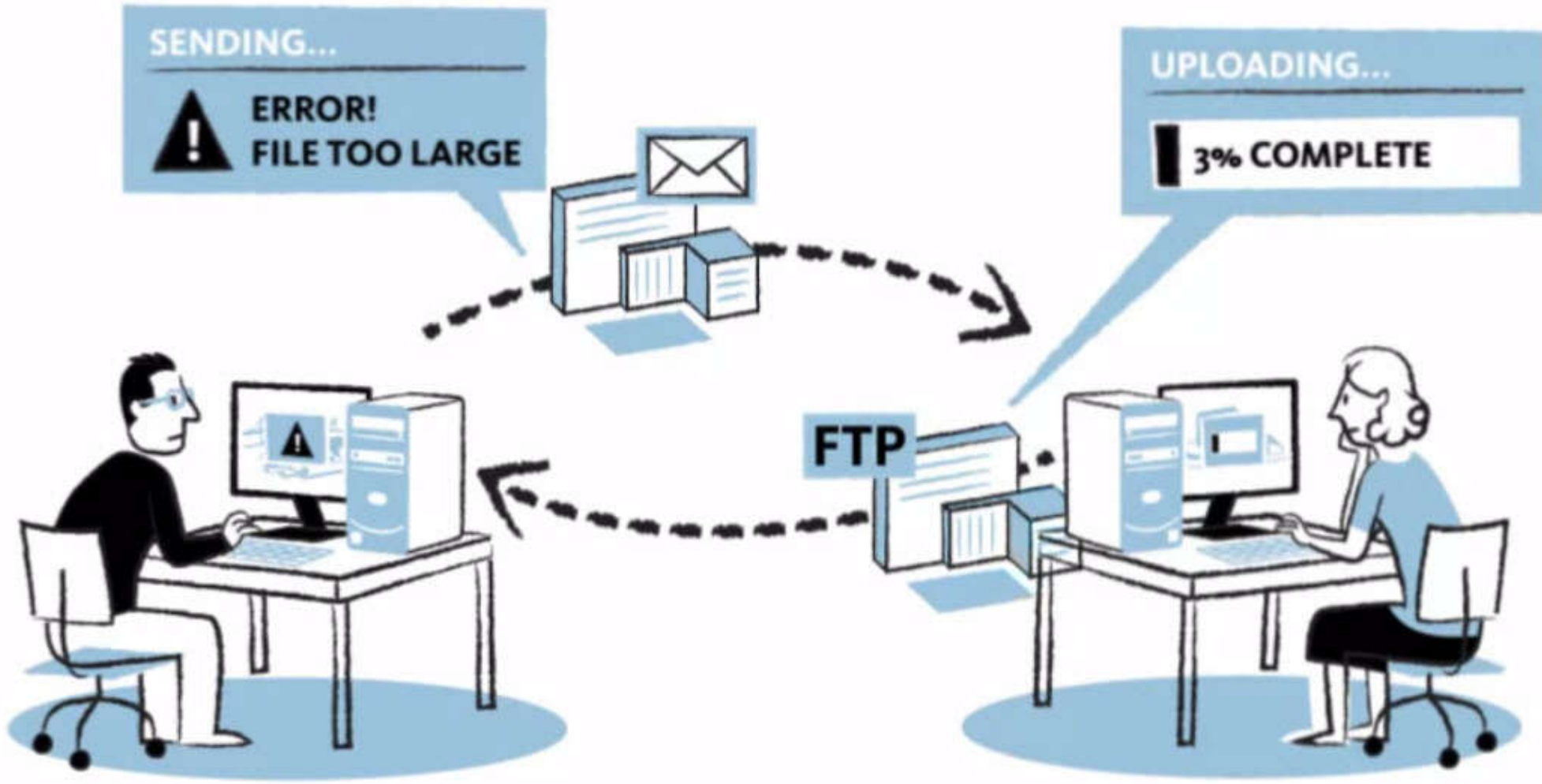
# Cloud-based BIM



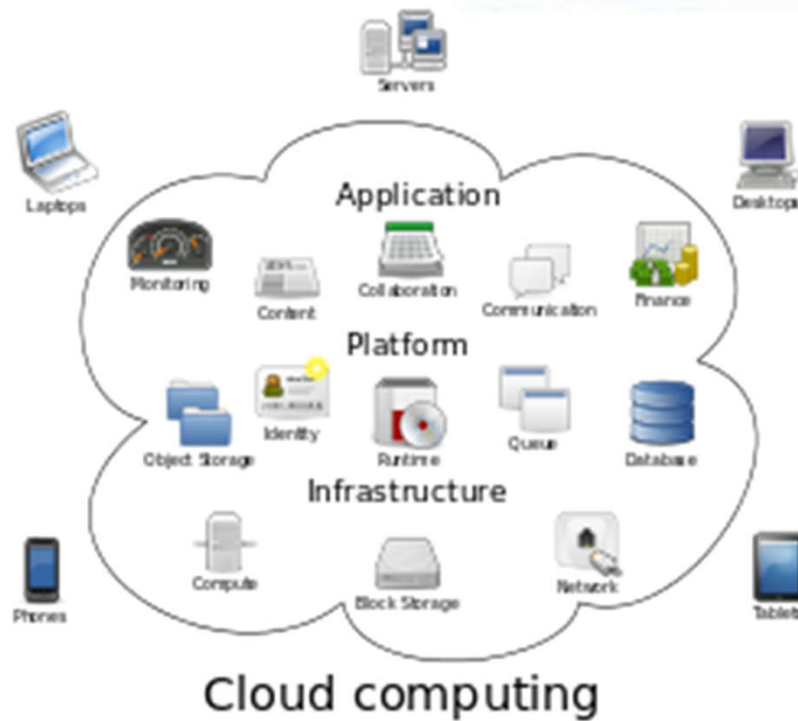
- Cloud computing 雲端運算
  - A concept for different methods of sharing resources over the Internet
- Cloud-based BIM collaboration:
  - Allplan Collaboration (EN) (4:21)  
<https://youtu.be/E5ZrwaWZtTk>
  - Autodesk® BIM 360™: The next generation of BIM is for anyone, anywhere, at any time (1:55)  
<https://youtu.be/3GJ7jvC71wA>



# This was “collaboration” before...



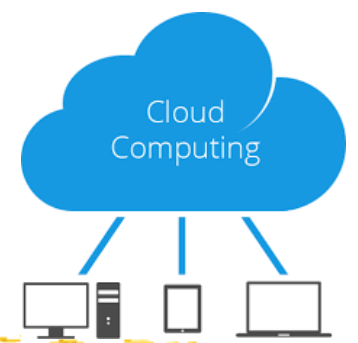
# Information flow of the BIM cloud



**Information  
anywhere,  
anytime**

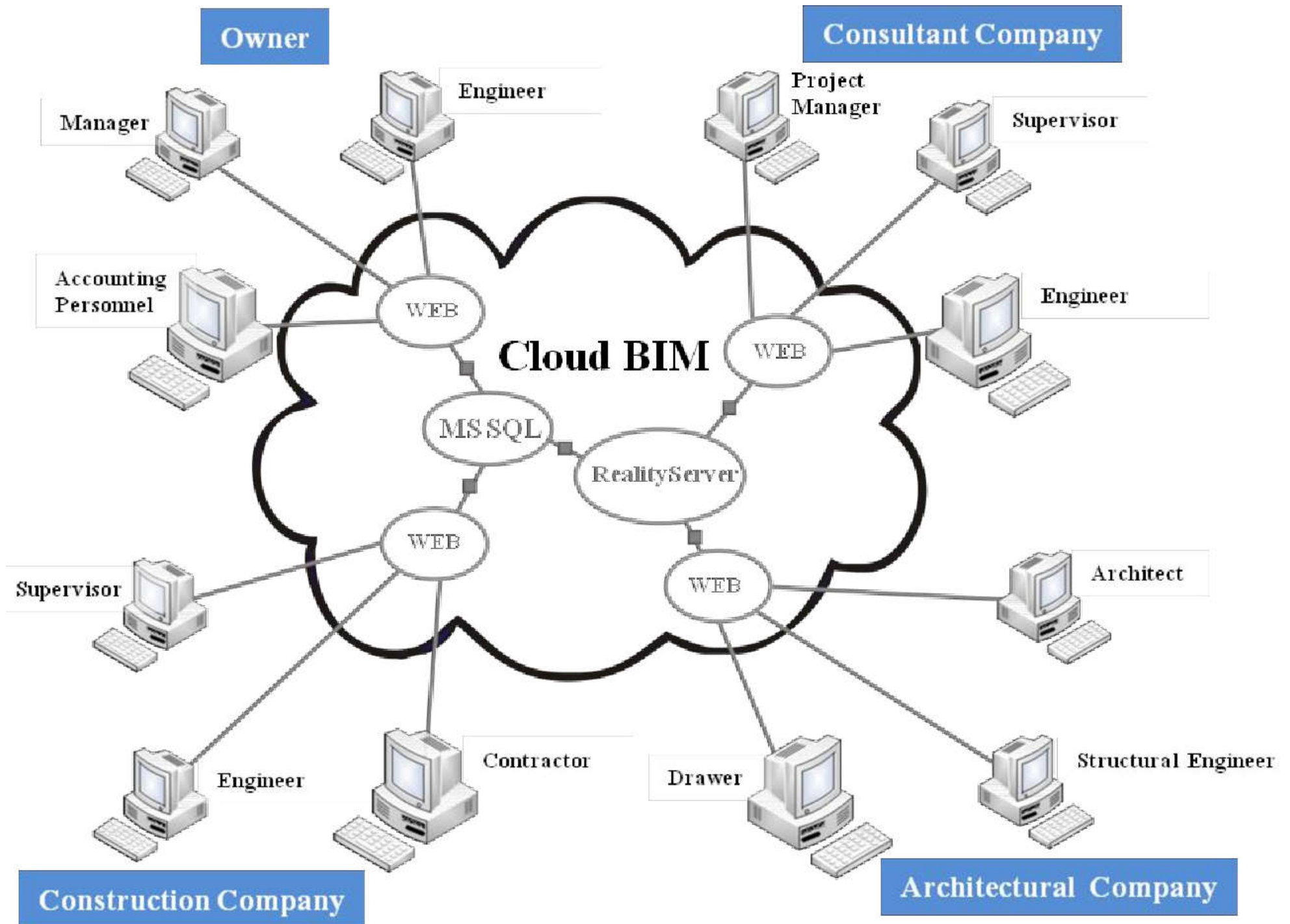


# Cloud-based BIM

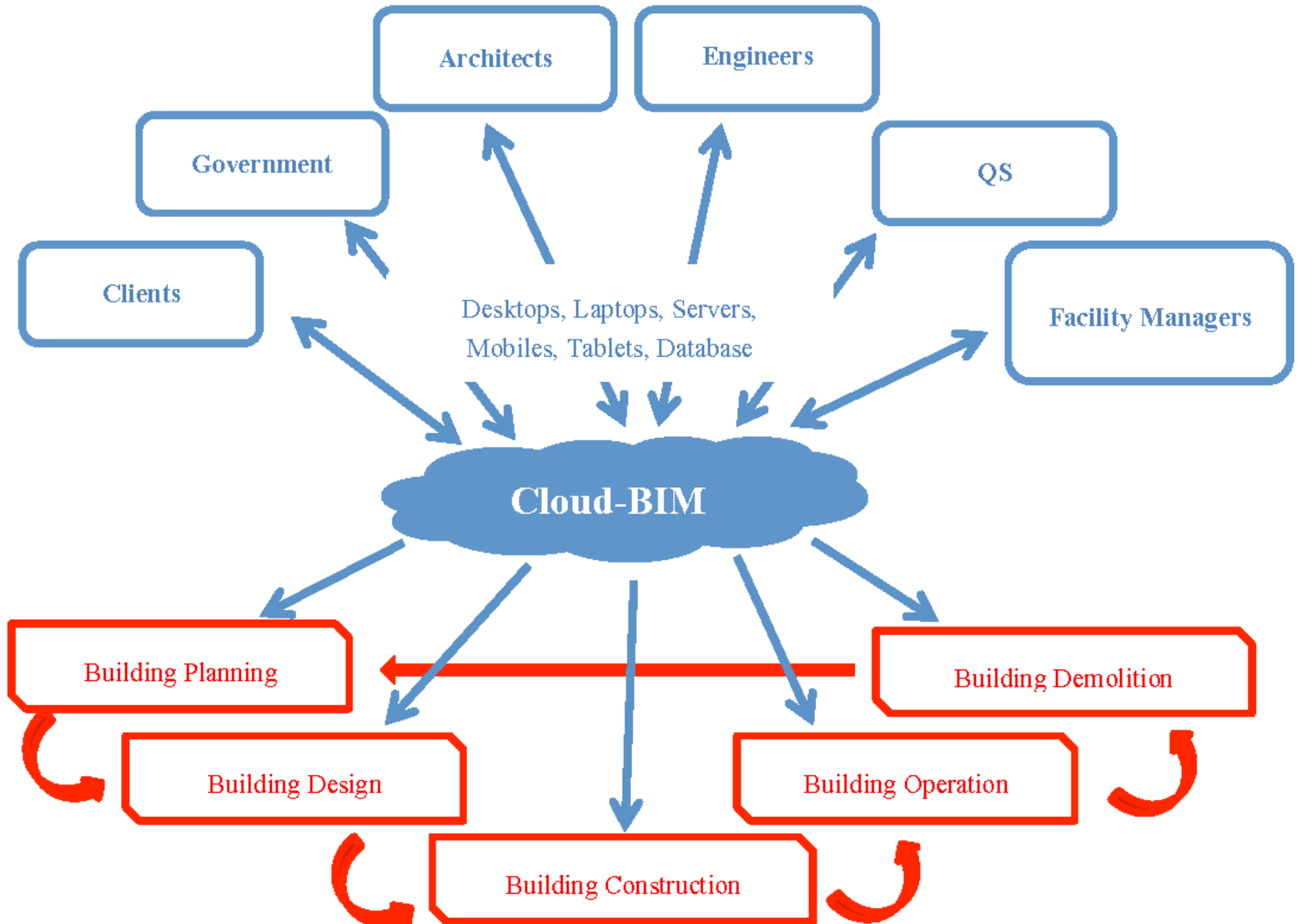


- Cloud-based platform for BIM
  - Can enhance the collaborative process to leverage web-based BIM capabilities and traditional document management to improve coordination
  - Four main aspects to consider:
    - 1. Model servers (to host the central BIM models)
    - 2. BIM software servers (shared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

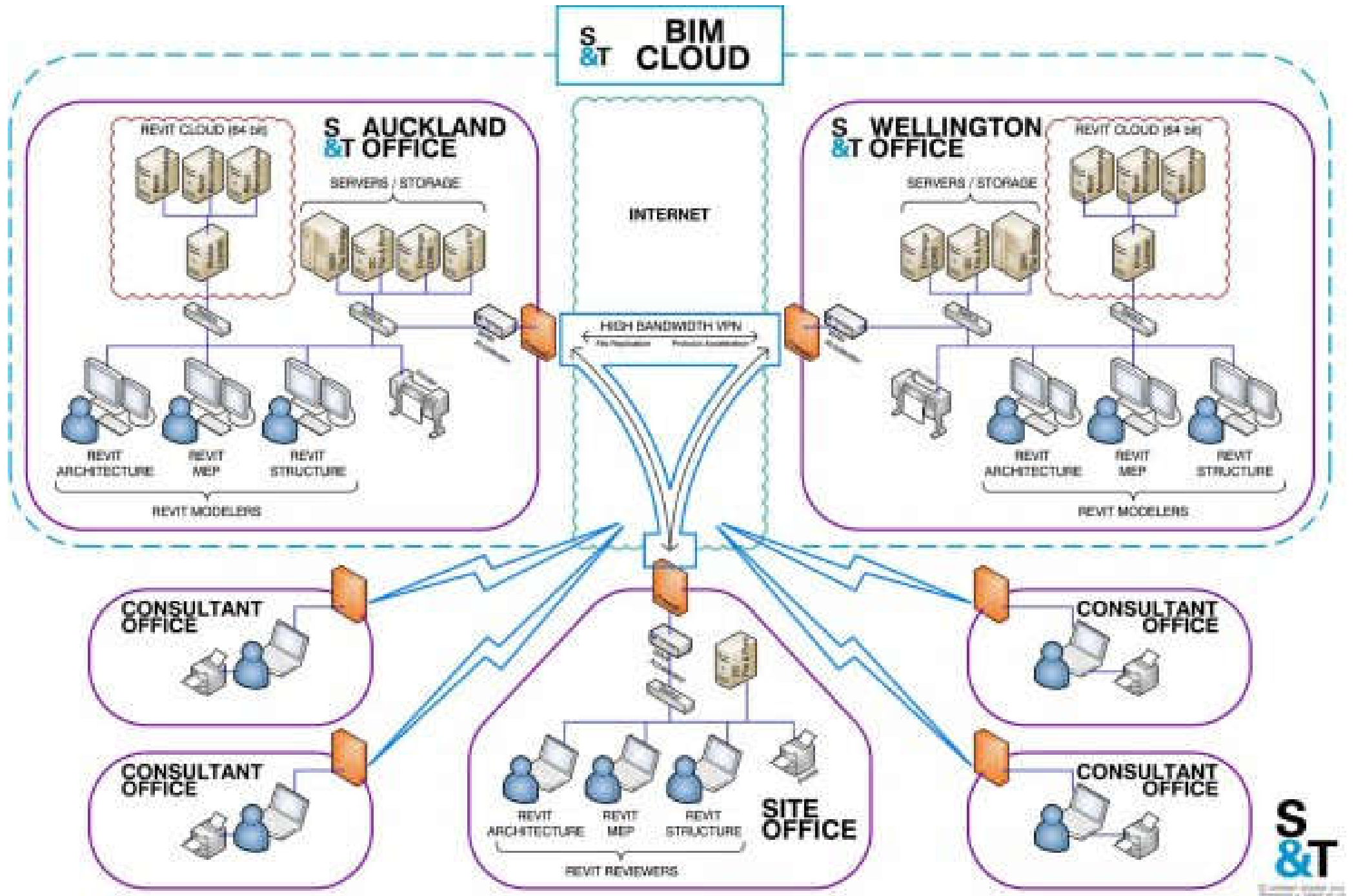
# The concept of Cloud-BIM



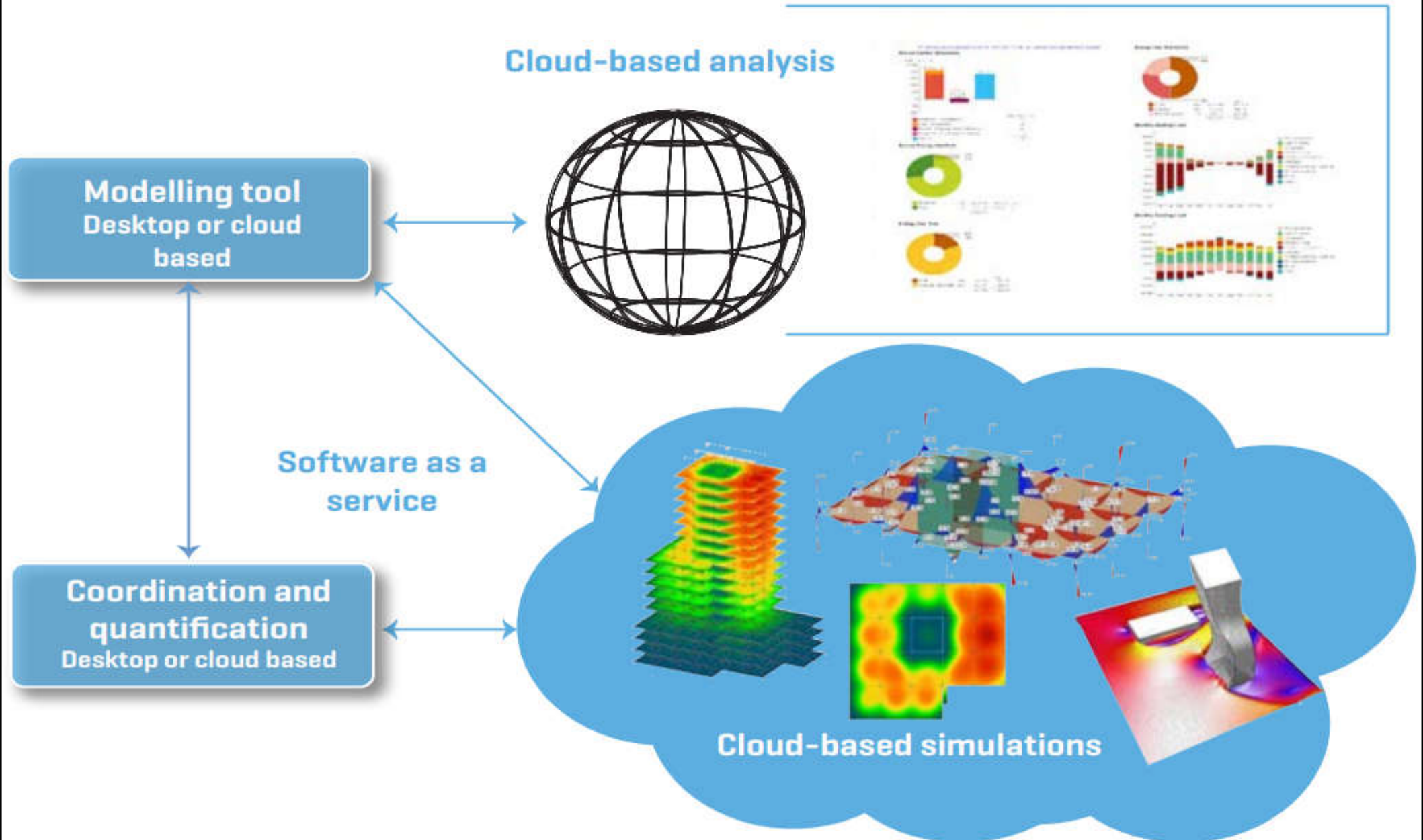
# Basic concept of cloud-based BIM



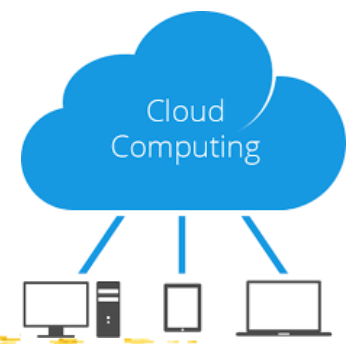
# Example of a Revit private cloud



# Cloud computing: Software as a service



# 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/>