

C4C: Clouds for Coordination

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The logo for BRE (Building Research Establishment) consists of the lowercase letters 'bre' in a bold, yellow-green, sans-serif font.The logo for RIBA (Royal Institute of British Architects) features the word 'RIBA' in a black serif font, followed by a black heraldic crest.The logo for lee wakemans features the name 'lee wakemans' in a white sans-serif font on a blue and green background with a wavy pattern.The logo for AEC3 features a blue circular graphic with a white swoosh, followed by the text 'AEC3' in a grey sans-serif font.The logo for IBM consists of the letters 'IBM' in a blue, horizontally-striped, sans-serif font.The logo for COSTAIN features the word 'COSTAIN' in a white, bold, sans-serif font centered within a blue square.

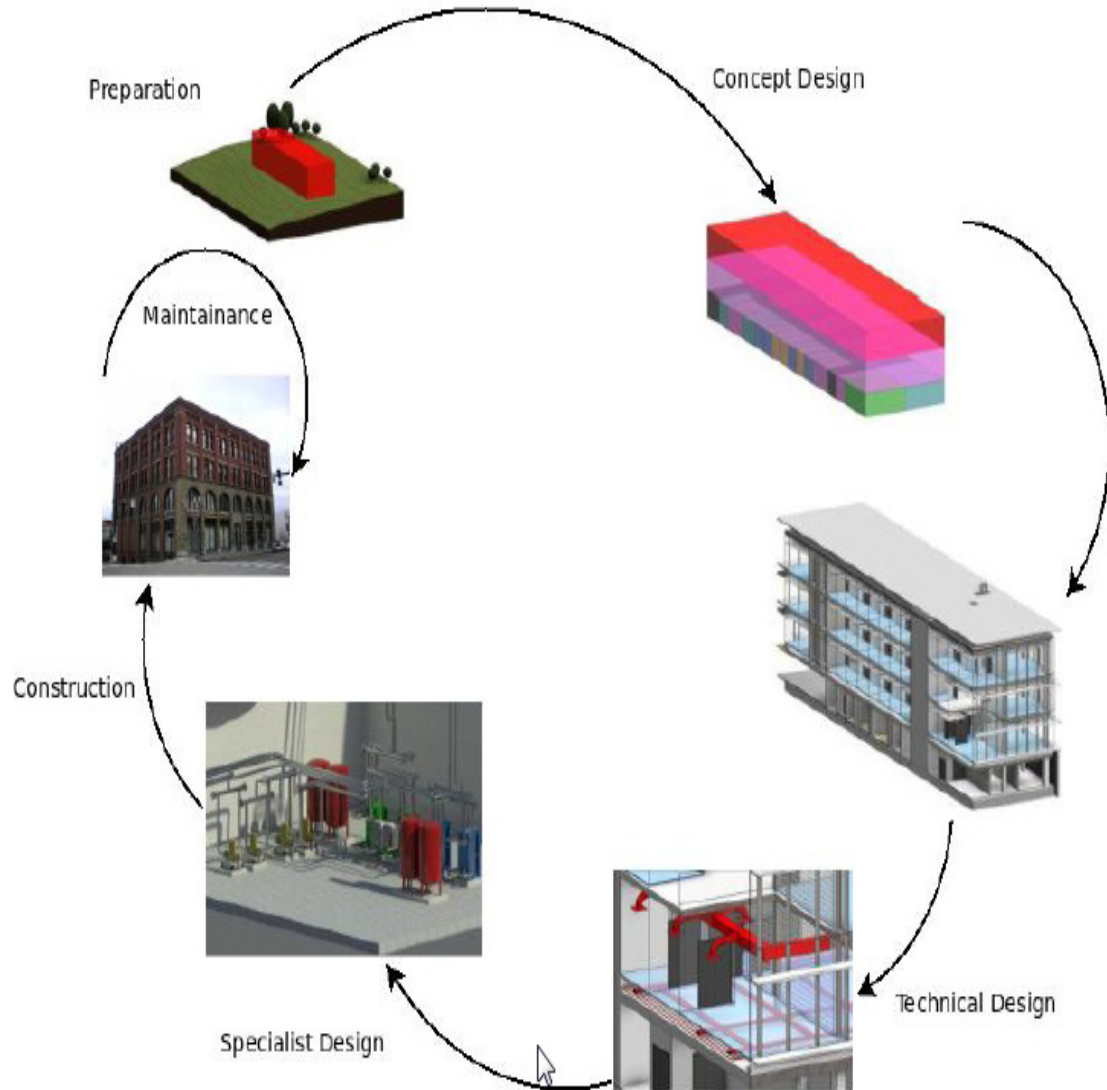
BRE lead:
Andy Sutton

The logo for Cardiff University consists of two red rectangular boxes. The top box contains the text 'CARDIFF UNIVERSITY' in white, serif, all-caps font. The bottom box contains the text 'PRIFYSGOL CAERDYDD' in white, serif, all-caps font.

“The market for cloud computing services is growing by 26 percent each year. It is an area with exceptional potential for growth. Finding the correct balance between trust and flexibility, without compromising security, is vital. Through this support we aim to help UK suppliers of cloud infrastructure and outsourced IT services to work together on the challenges that are holding-back the adoption of cloud computing, in order to capture a bigger share of this expanding market.”

– Ian Gray (Chief Executive, Technology Strategy Board)

Construction “Stages”



Construction is a data rich environment

Data sizes & types can vary: images, text documents, animations, spreadsheets, 3D models

Data storage lifetimes can vary

Often complex supply chains

C4C Objectives

The C4C Project investigates how Cloud computing can be used to support:

- Data sharing and interoperability on a multi-platform cloud environment.
 - No single pre-agreed storage technology
- Data and process coordination between organisations utilising a multi-platform cloud environment.
 - PAS 1192-2 (WIP, Shared, Published Archived), RIBA “Plan of Works”
- Mechanisms to allow embedding of industry specific processes and policies.
 - Particular focus on BIM/IFC

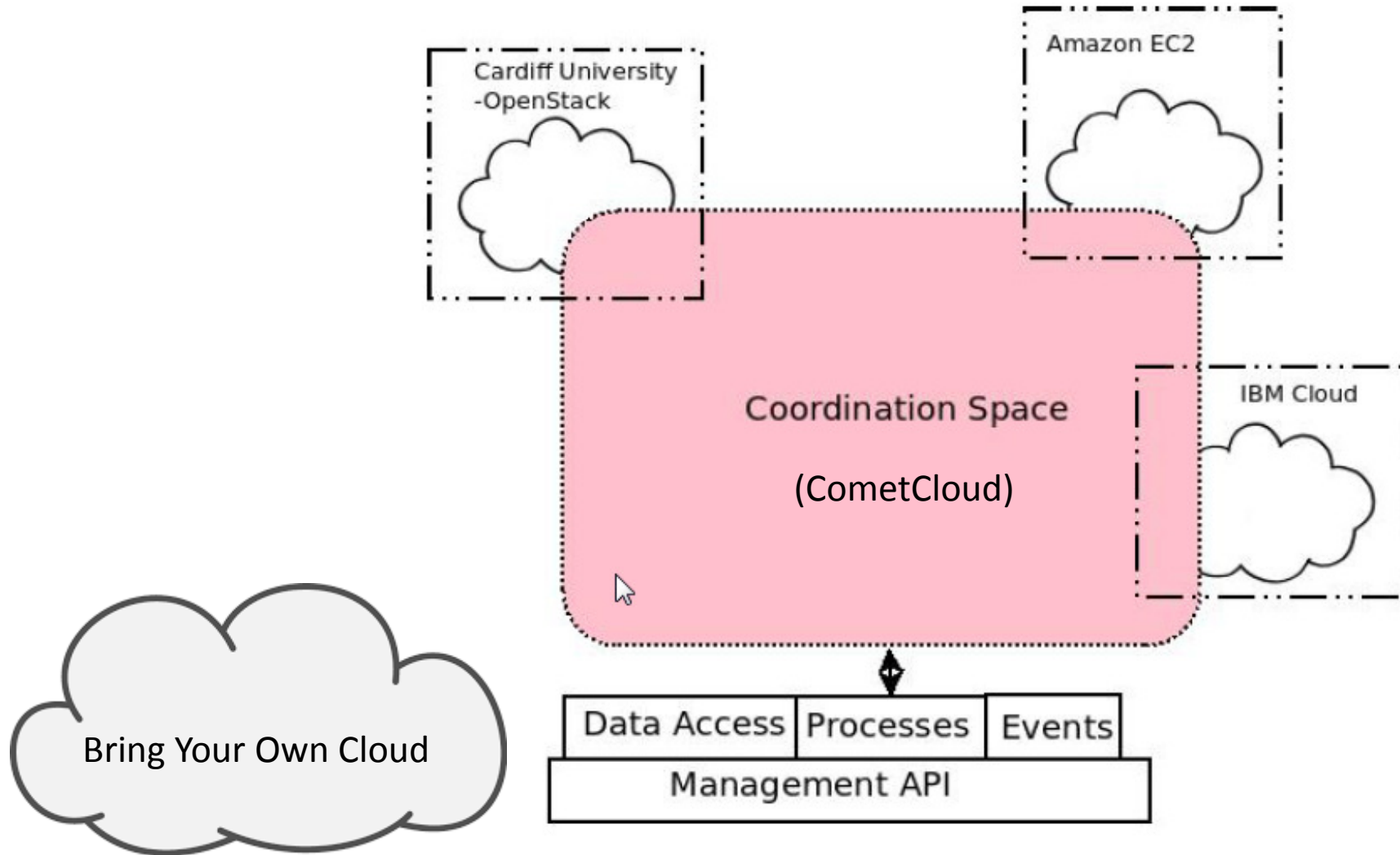
Construction data requirements

Within a construction project many companies will have their own data storage solutions:

- At various stages of a buildings lifecycle the Building Information Model (BIM) will be spread across these
- Each organisation will not wish to release all information that they utilise/create into the wider project:
 - For protection of IP.
 - For quality reasons i.e. draft documents, models evaluating different options – **dependency issues**
- Data artefacts may be released to only certain participants with varying abilities to access them
 - **Alert participants when objects change**

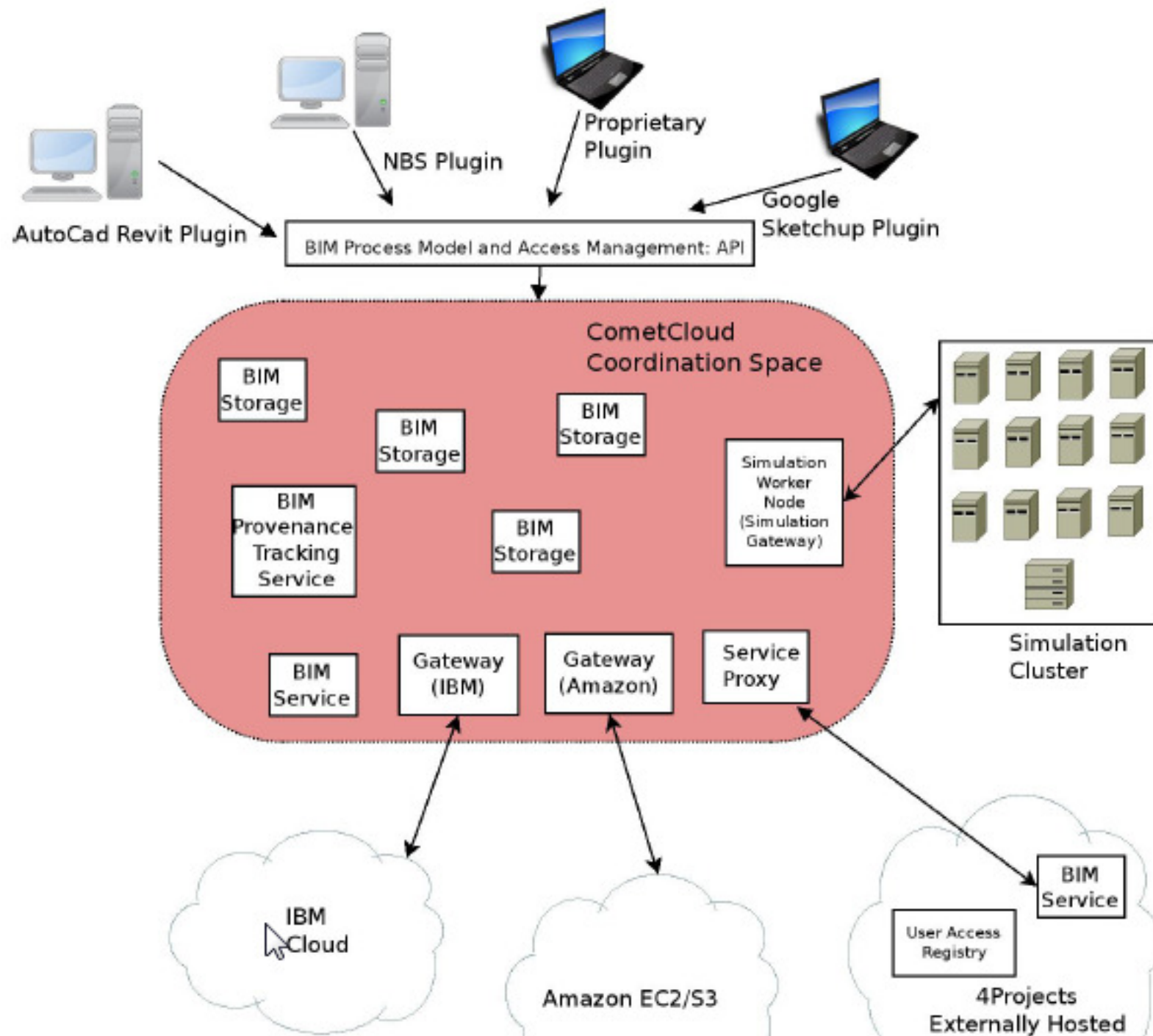
CometCloud-based multi-Cloud infrastructure

(<http://nsfcac.rutgers.edu/CometCloud/>)

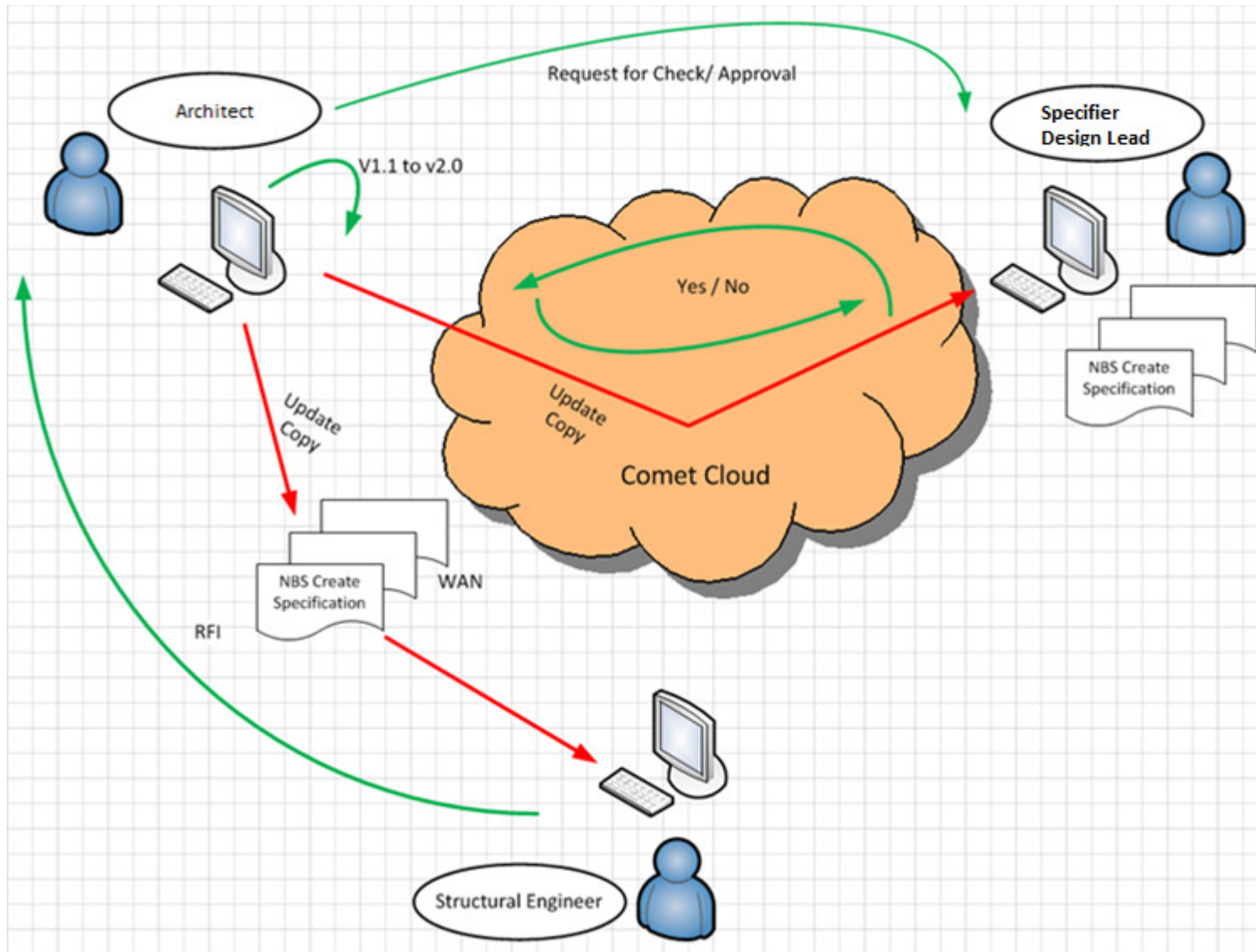


Cloud Interoperability

- Common Commands and APIs: a common set of commands are supported across different Cloud environments
- Specialist gateways: use of specialist translation gateways that convert commands from one Cloud environment to another.
- Wrapping: adding a software layer around an entire Cloud system -- so that the internal workings of the system are never exposed to an external user
- Messaging: converting output generated from one Cloud system into potential input for another



Workflow



C4C Workflow

Each site is associate with a discipline(role):
Architect, Structural Engineer, Specified Design Lead.

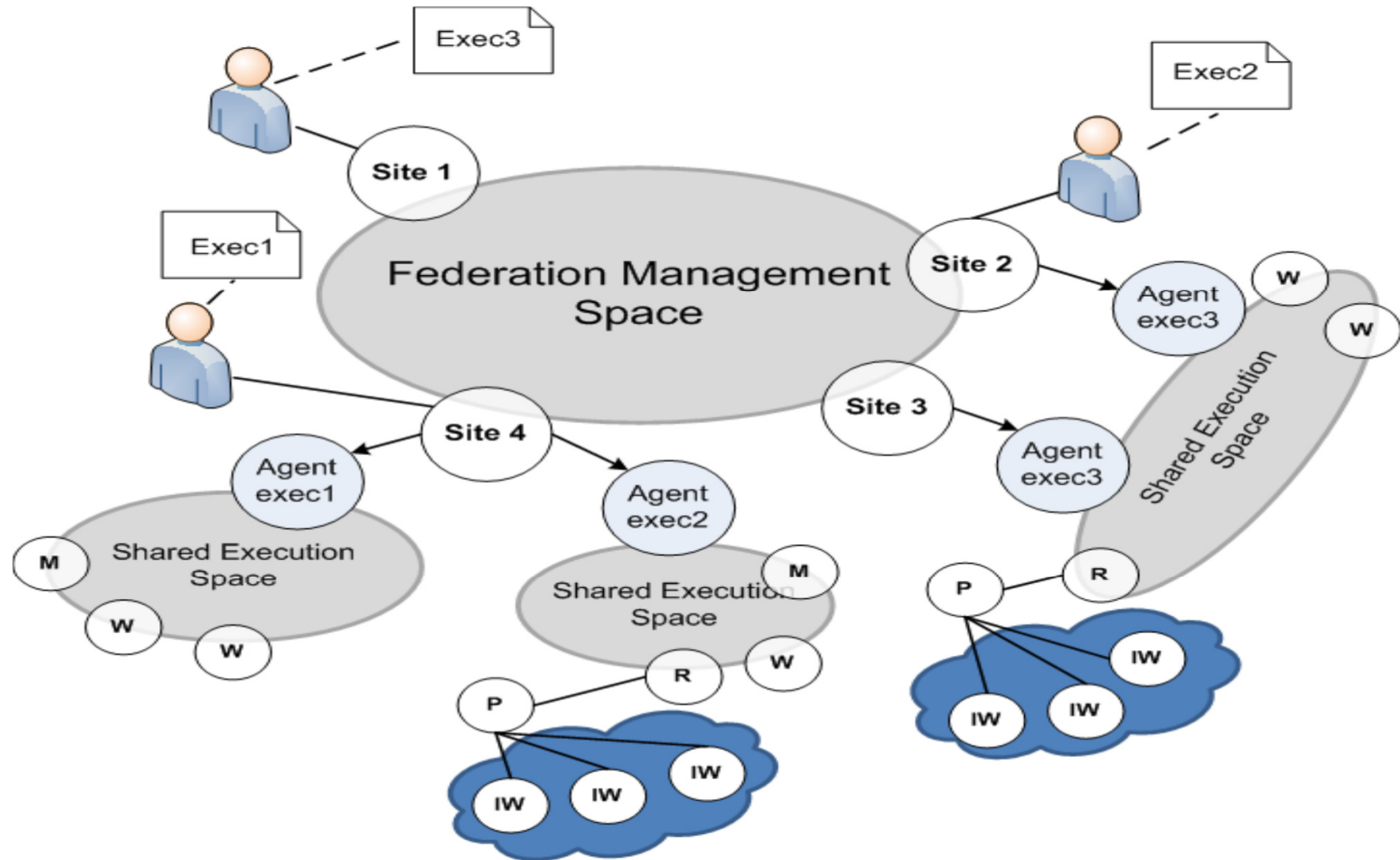
Projects are represented in an IFC format

Each project has a stage: in-progress, shared internal, shared, approved, handed-over.

Sites can access the IFC objects based on their roles

When an object is added/updated/modified
corresponding disciplines are notified

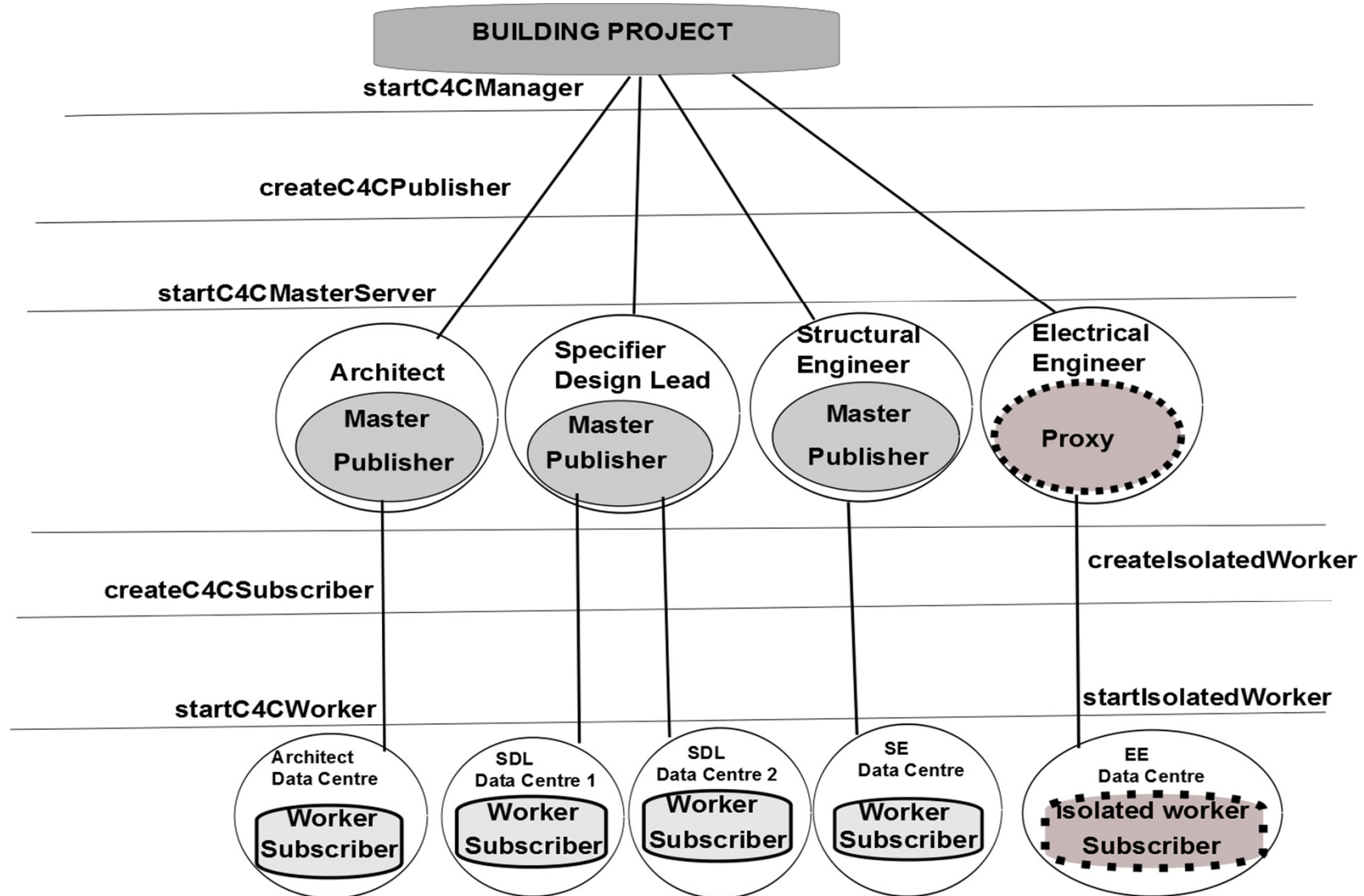
Data Sharing "Federation"



Federation Management Space

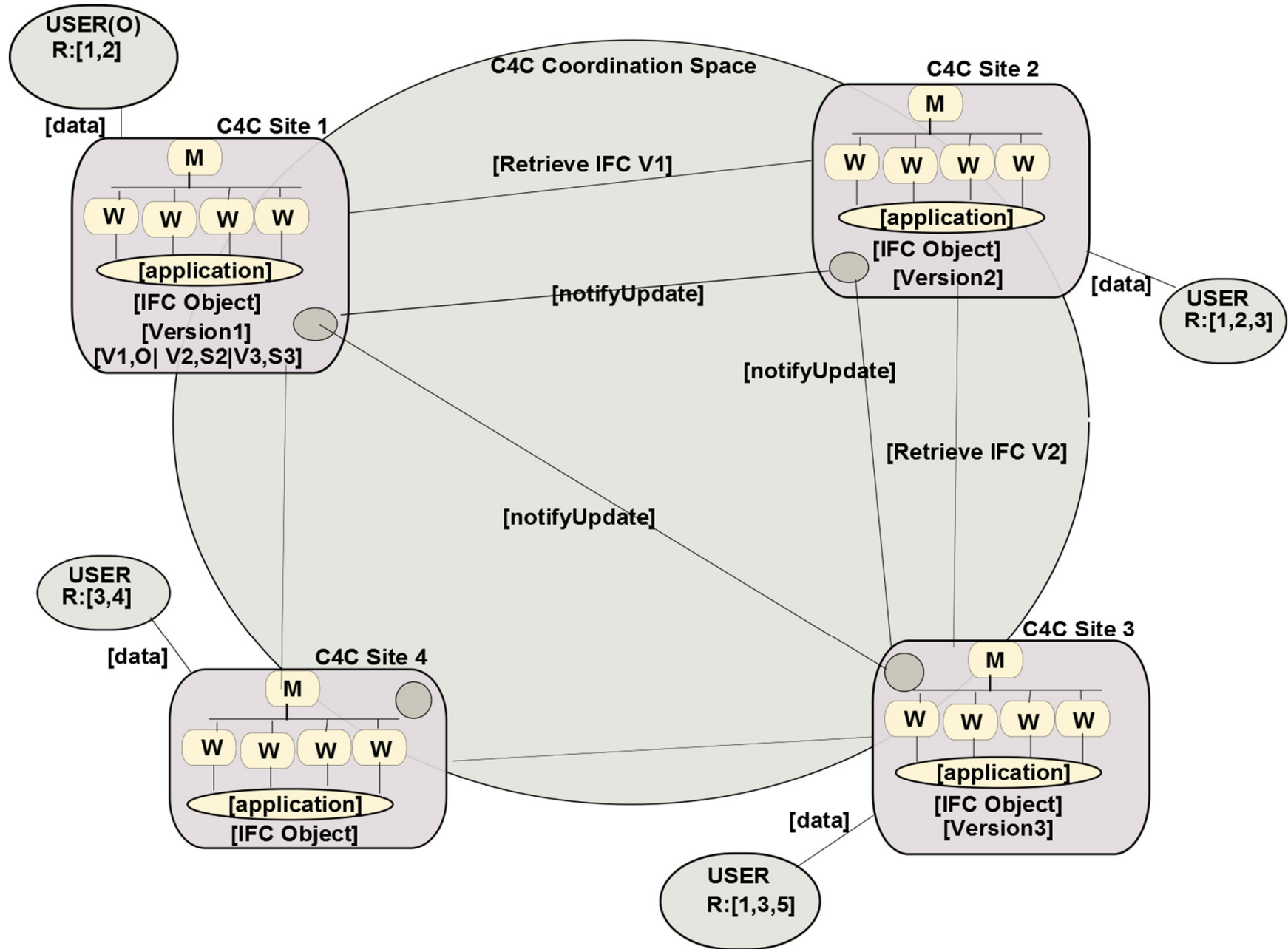
- (M) denotes a master - creates tasks (operations on the IFC objects such as: add,update,delete), submits them into the coordination space, and collects results.
- (W) is a worker – provides a storing space and can have computing capabilities (for storing IFC objects)
 - (IW) an isolated worker
 - (P) a proxy
 - (R) is a request handler.

Multi-cloud Implementation



Implementation

- Each of these disciplines can have their own data centres(SDL Data Centre 1 and SDL Data Centre 2 where fragments of the building model can be dispersed (IFC Objects))
- For each company(site) we deploy a master-worker (publisher-subscriber) model
- Disciplines can be added dynamically during the project development



C4C coordination

- Disciplines
 - Architect
 - Specifier Design Lead
 - Structural Engineer
- Object
 - Object modified
 - Object retrieved from CometCloud
 - IFC model reconstructed
- Event
 - Object modified
 - From Structural Engineer to CometCloud
 - Architect visibility

Project Outcomes

- Multi-Cloud & BIM API
 - Enables management of objects making up an IFC implementation
 - Objects can be retrieved from different Cloud systems
- Deliver a service-based governance infrastructure for hosting and managing data within a multi-cloud environment.
- Demonstrate the deployment of services over the multi-cloud environment:
 - Provenance-tracking service;
 - A Building Data Compliance testing service;
 - Building data artefact availability certification service.
- Investigate the usage of a multi-cloud environment from the view of process management and coordination.