

ISO19650 CDEs and Information Exchanges

Managing and Sharing Construction Data
 Computing in Construction
 Metropolia

ISO 19650 – CDE and Information Exchange



ISO 19650-1 – Part 1: Concepts and principles (2018)

- The concepts and principles of the information management process.

ISO 19650-2 – Part 2: Delivery phase of assets (2018)

- The process for the management and collaborative production of information during the delivery phase of assets.

ISO 19650-3 – Part 3: Operational phase of assets (2020)

- The process for the management and collaborative production of information during the operational phase of assets.

ISO 19650-4 – Part 4: Information exchange (2022)

- Recommended concepts and principles for the exchange of information between parties throughout the lifecycle of an asset.

ISO 19650-5 – Part 5: Security-minded approach to IM (2020)

- A framework for a security-minded approach to managing information relating to sensitive assets.

ISO 19650-6 – Part 6: Health and safety (work in progress)

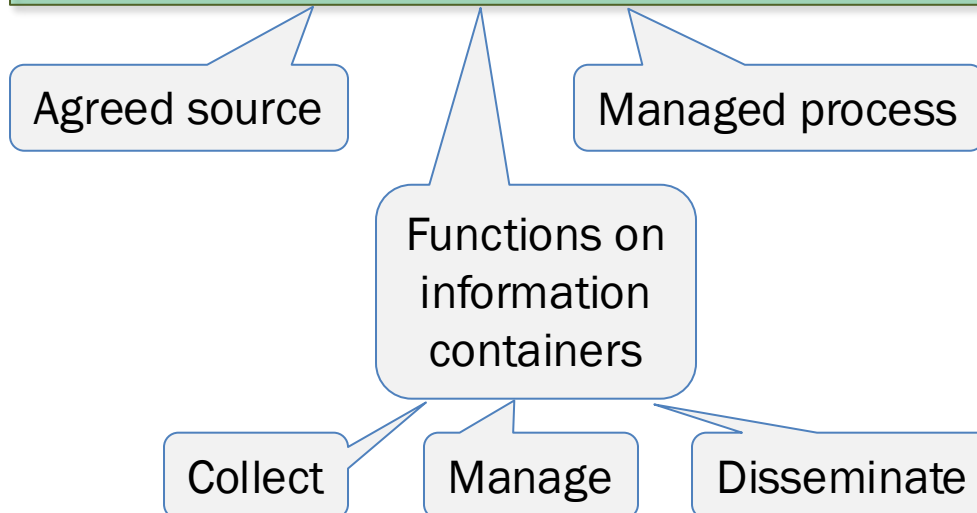
- Expected to concern the production and management of health and safety information on built environment projects.

openCDE buildingSmart (2021)

- Specification of an open API for Common Data Environments

common data environment CDE

agreed source of *information* for any given project or *asset* for collecting, managing and disseminating each *information container* through a managed process



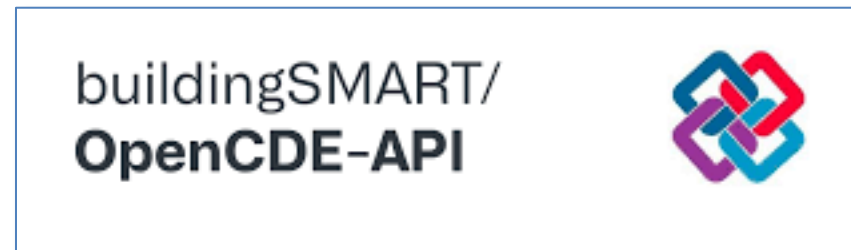
A CDE can be implemented in different ways - the definition provides just the requirements

A CDE can provide the access to information for all important actors and stakeholders but with different access rights

A CDE is composed of

- technology: the CDE solution →
- process: the CDE workflow →

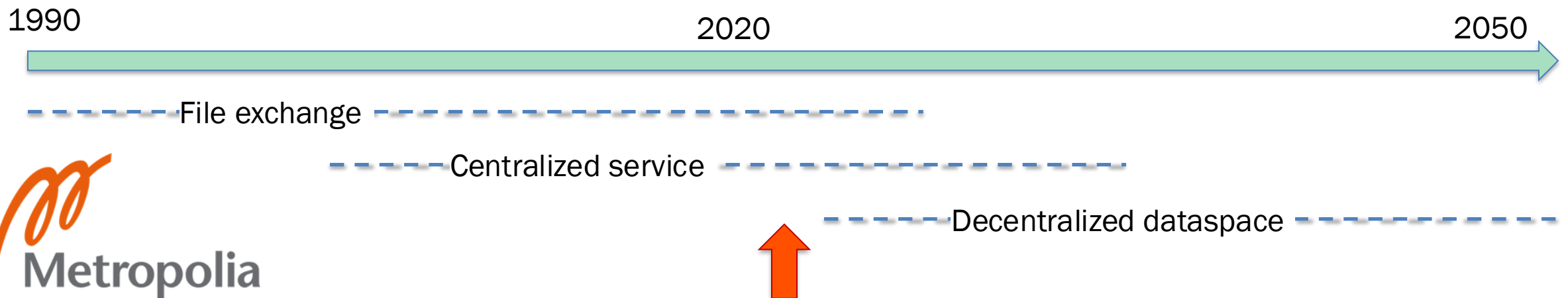
Existing CDE solutions



Evolution of CDE solutions – Exchange

Approaches to share BIM data

1. File exchange
 - point-to-point transfer of BIM files
 - problem: disorganized, ad hoc, a confusion with versions
2. Centralized service
 - a file server, project bank, cloud folder, **cloud-based CDE with BIM functions**
 - problem: who controls, data security, trust, rights
3. Decentralized dataspace
 - interoperation of multiple CDEs
 - data sovereignty: clear ownership, each party decides with whom to share their data
 - technologies: Linked Data, decentralized identifiers (w3c DID), International Dataspace, GAIA-X, ...
 - problem: requires complex technical infrastructure and interoperability between systems

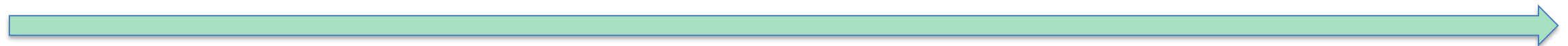


Evolution of CDE solutions – Granularity

Granularity of shared data

1. Model level
 - whole model is exchanged
 - traditional concept: model ~ file
 - support for grand BIM software tools
2. Updates/fragments
 - goal of more transactional updates of models
3. Objects
 - individual objects, sets of objects
 - queries to the relevant models
 - support for smaller, use-case-based tools

1990



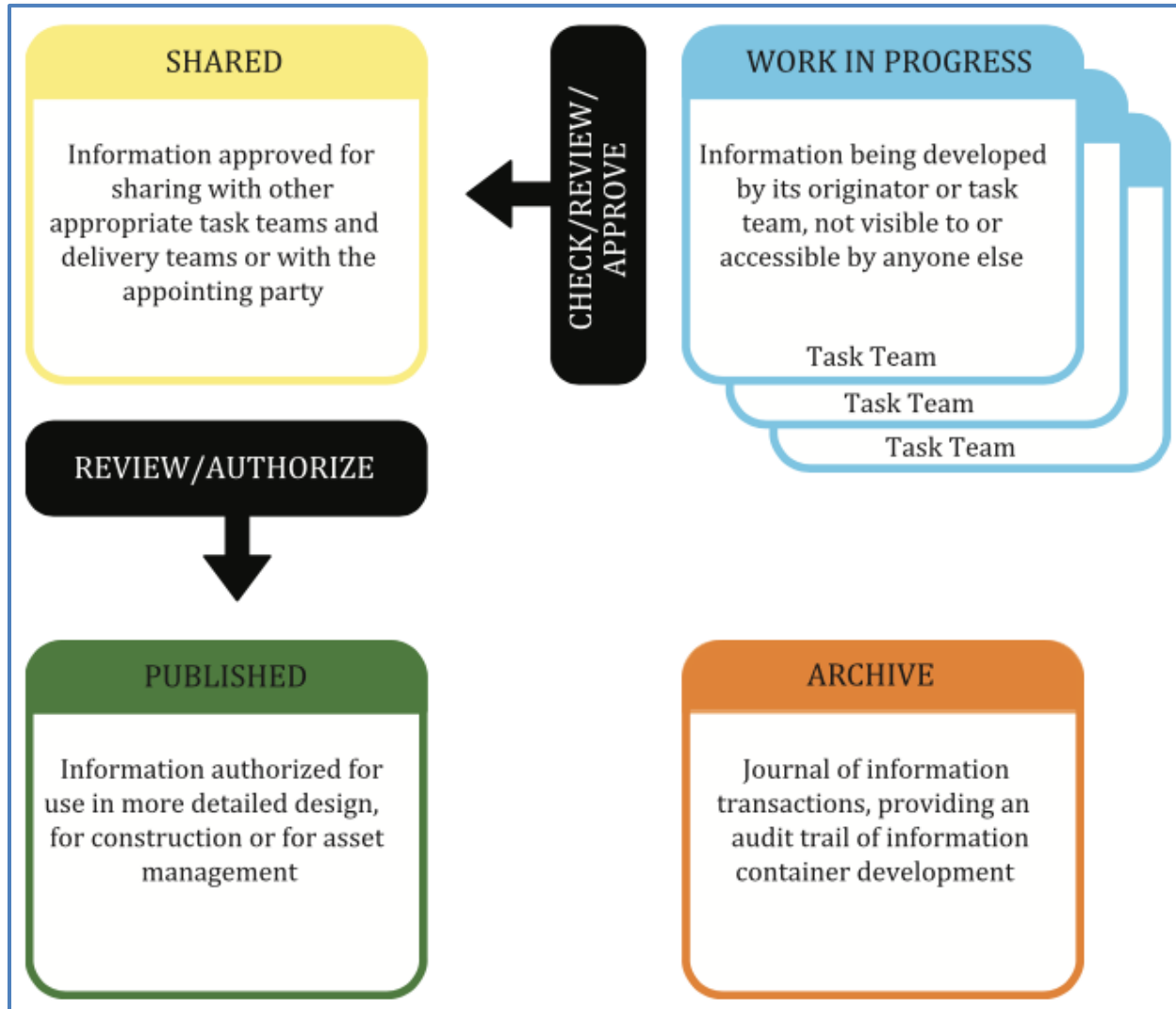
Model level

Fragments/changes

Objects

ISO19650 CDE workflow

CDE workflow



Status of an information container managed in a CDE:

1. Work in Progress
2. Shared
3. Published
4. Archive

- Coordination with other related appointed parties (clash checking, ...)
- Sharing is subject to security-related restrictions
- Information containers are visible and accessible but not editable
- Return to work-in-progress if changes are needed

- The originating task team compares the information container against the
 - information delivery plan and
 - agreed standards, methods and procedures

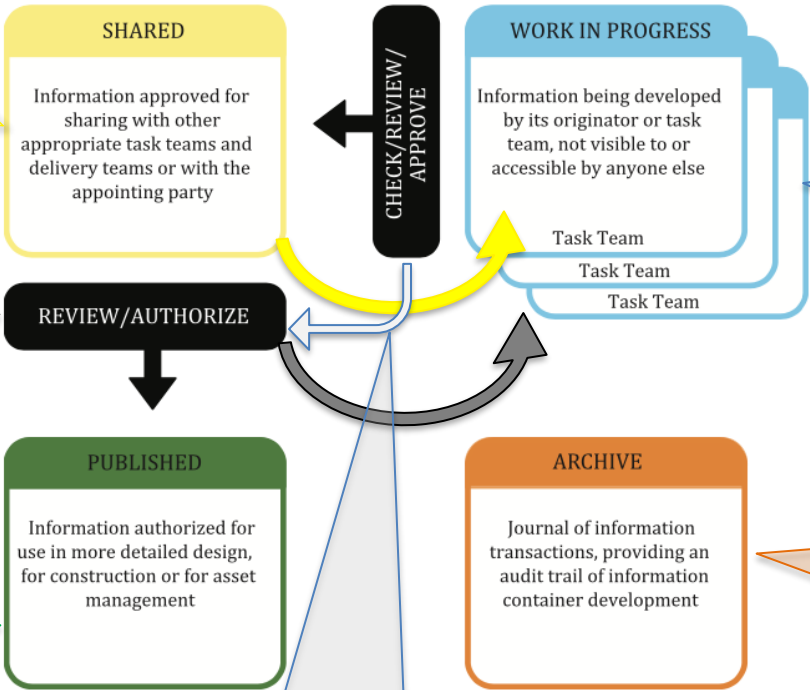
- Information is
 - editable
 - visible to the task team only
- All information development happens at this stage

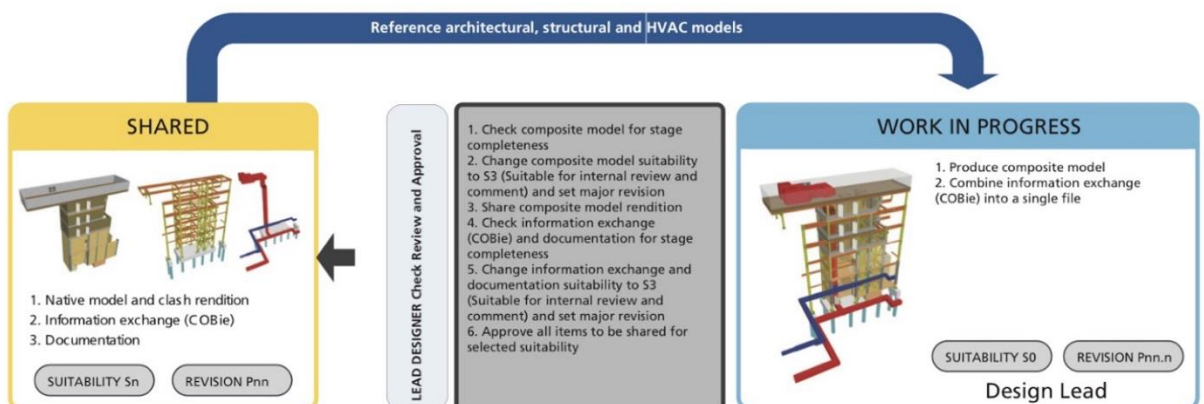
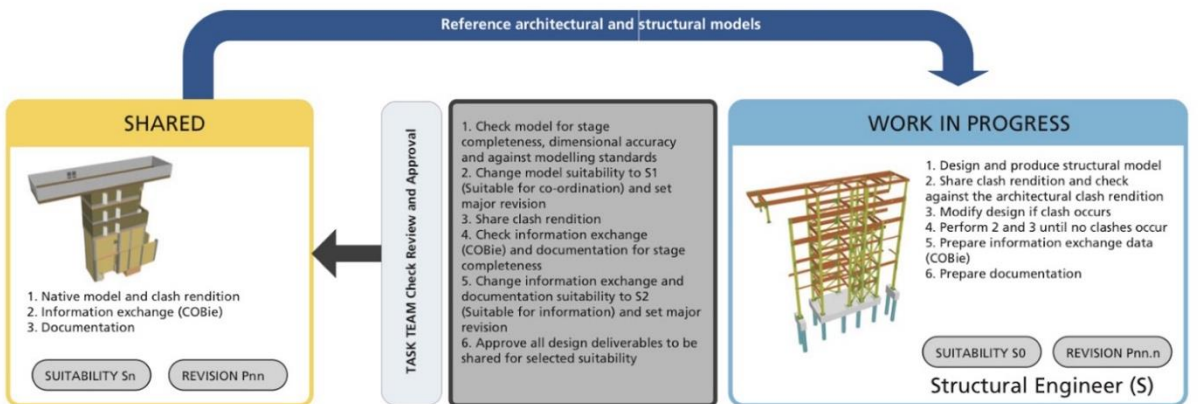
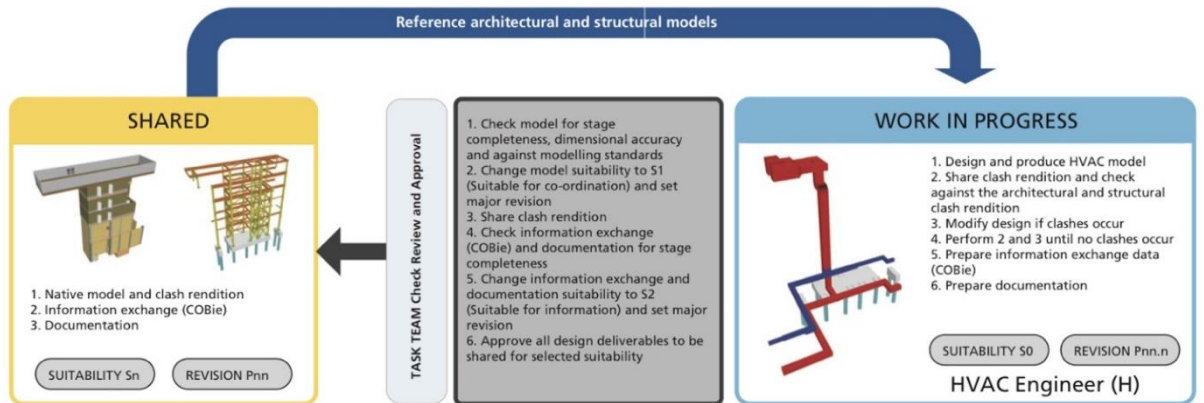
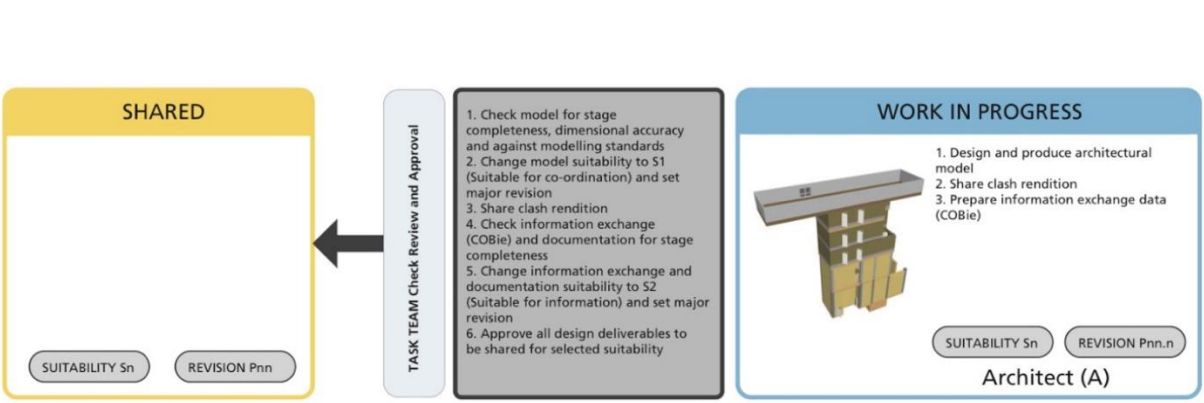
- Compare information containers against the information requirements for coordination, completeness and accuracy
 - If ok, the information container is frozen
 - If issues, return to work-in-progress

- Frozen information
- Satisfies the identified information requirements

- Information that
 - has been utilized for all its planned purposes
 - may be used for other purposes identified later

- Static information
 - Images, videos, signed documents, ...





CDE and information models

The result of the ISO 19650 information management process is

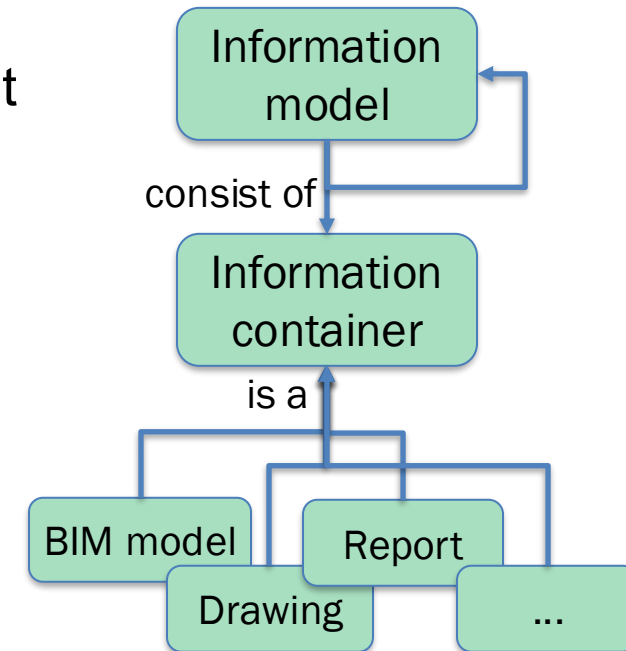
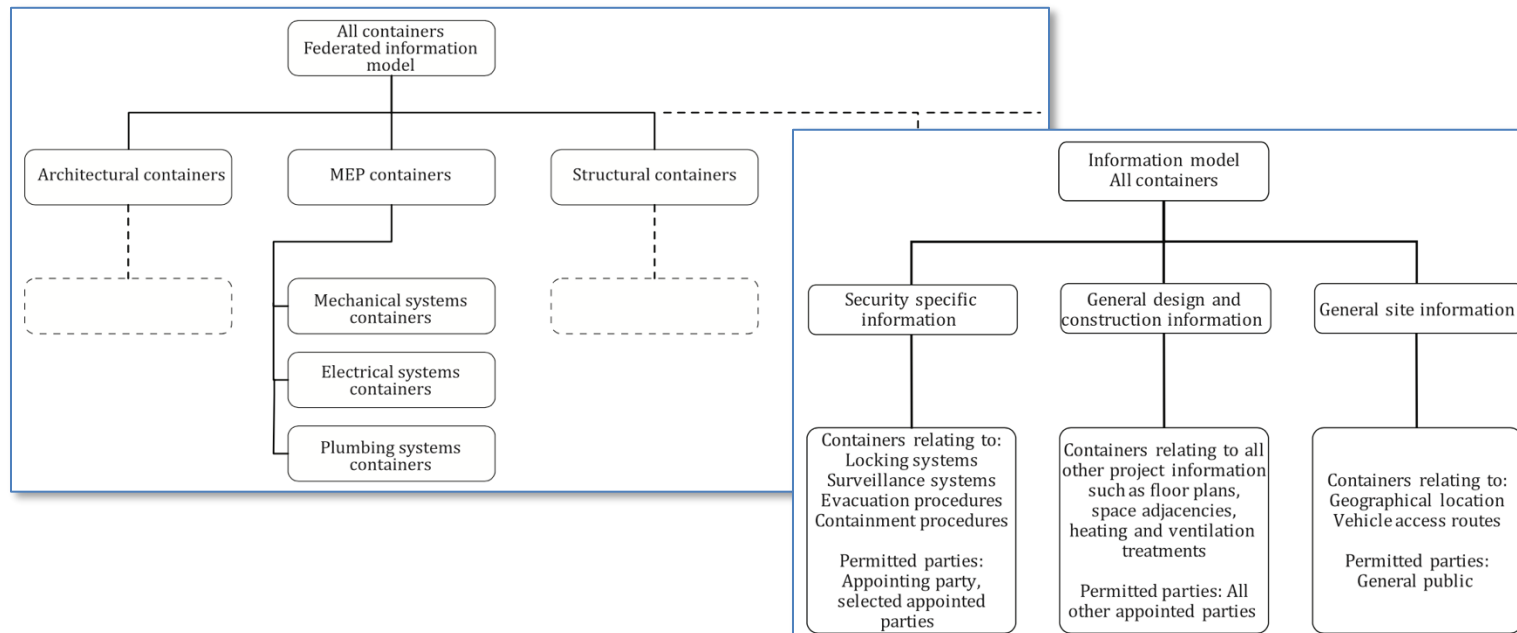
- the creation of an information model: PIM or AIM

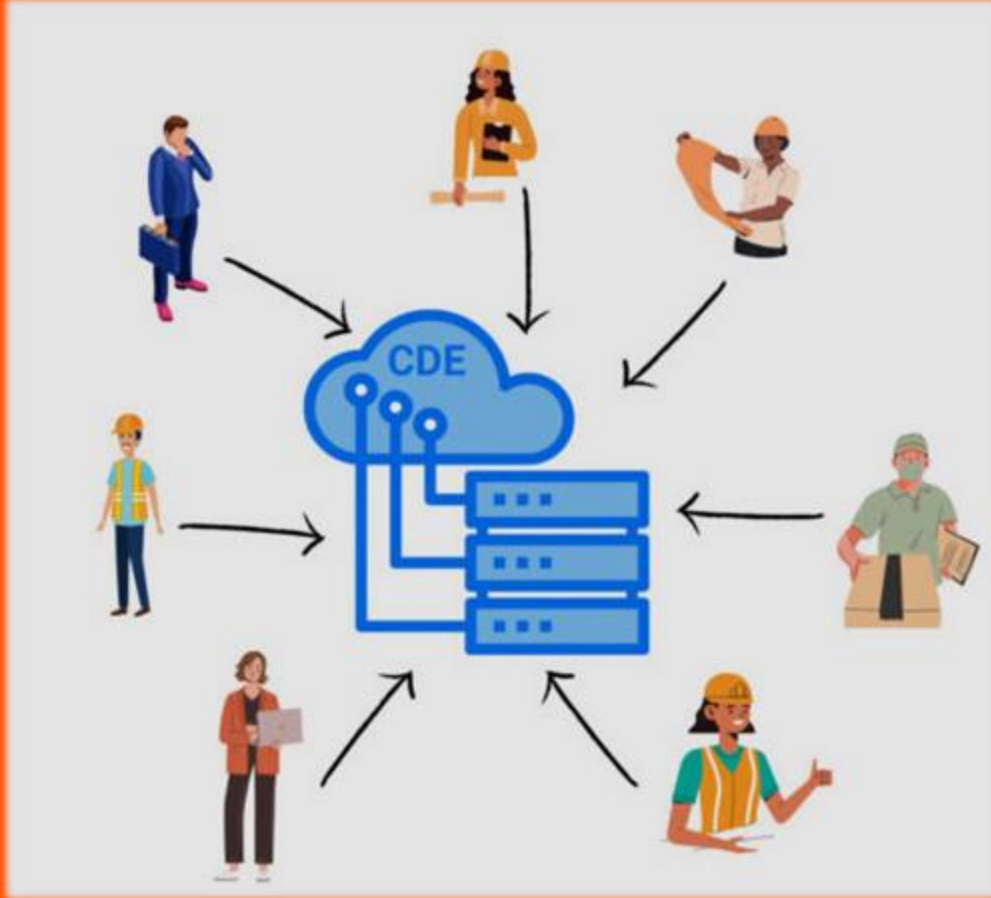
PIM and AIM are repositories of published (or archived) information

- accepted by the appointing party and in accordance with the EIR
- purpose is to inform decision making concerning the project or asset

CDE can contain also information containers in other states

- work in progress or shared
- part of PIM or AIM eventually, when fully developed and accepted





CDE and Information Exchange (ISO 19650-4)

Mobilization for information production

- Information providers
 - Select appropriate software
 - Confirm the support for the agreed exchange schemas and data formats
 - both import and export, as needed
 - Test the methods and procedures for information exchange
 - ensure the information flow between systems
 - should be verified before finalizing the requirements
- Information receivers
 - Check and confirm the selected review and integration software
 - Importing into persistent container
 - Appropriate handling of linking, between container or to the semantic web
- Implementation
 - All work executed under the security management plan
 - Aim at frequent exchange of of information to support collaboration
 - whenever in a coherent state

Decision points in the CDE workflow

Decision A: Approve for sharing

- The information provider itself reviews the information containers they have developed whether they can approved for sharing based on the decision criteria

Decision B: Authorize and accept for publication

- The information receiver reviews an information container based on the decision criteria
- Decision to publish can be made in two steps:
 1. authorization by the lead appointed party
 2. acceptance by the appointing party

Decision criteria ...

1. Common Data Environment

- Correct naming
- Correctly provided metadata
 - Information to support the workflow
 - Metadata about the information within the container
- That security and handling requirements have not been breached
 - e.g., visibility to outsiders
- In case of multiple CDEs,
 - naming and metadata are retained and
 - legally significant archival is maintained

Enable correct structuring of information

Make information discoverable and enable essential queries

Include only uncompromised information

Aim to retain the benefits of a CDE in a multi-CDE setting

... Decision criteria ...

2. Conformance

- exchange schema (e.g., IFC4.0.2.1)
- data format (e.g., Step Physical File Format)

Automatic checking with an
IDS

Table A.1 Open schema

Name	ISO standard	Data format	File suffixes
IFC	ISO 16739-1 ^[6]	spf xml rdf/owl	.ifc .ifcxml
GML	ISO 19136 (all parts) ^[9]	xml	.gml
Posc/Cesar	ISO 15926 (all parts) ^[10]	.spf	

BCF schema
COBie

Table A.2 Open data formats

Use	ISO standard	Data format	File suffixes
Spreadsheet document	ISO 29500 (all parts) ^[15]	xml, text	.docx .xlsx .csv
Portable document	ISO 19005 ^[16]		.pdf
Office document	ISO/IEC 26300 (all parts) ^[17]	xml	.odt .ods .odp
RDBMS	ISO 9075-1 ^[18]	text	.sql .gql
Image	ISO/IEC 10918 ^[19] (all parts)		.jpg
Image	ISO/IEC 15948 ^[20]		.png
Multi container package	ISO 21597 ^[21] (all parts)	zip, rdf-xml	.icdd

XML
JSON
SPFF
BCF format

... Decision criteria ...

3. Continuity

- The information container is checked for continuity against
 - other information containers;
 - previous versions of the current information container;
 - previous status changes;
 - previous delivery stages and operational trigger events;
 - previous delivery or operational phases;
- Aspects to check:
 - geospatial co-location, including geo-location, site location and asset location;
 - calendar coordination;
 - spatial, physical, and process entity identifiers and names
 - process, site, facility, storey/region, types and
 - systems and zones, packages and method statements;
 - space/location, component and task entity naming;
 - attribute, property, material and shape/profile naming.

For example, maintaining GUIDs of entities

Enables linking, integration and comparison with other containers (e.g., BIM models)

Enables identification of differences between versions

Enables progress tracking

Can be partially broken, e.g. 5% of GUIDs – what to do?

Continuity can be checked but it is difficult to fix after it has been broken.

Continuity should be actively considered and maintained through the whole information development process

... Decision criteria ...

4. Communication

- Check that quality of information has not suffered from poor or erroneous conversion or other exchange issues due to changes of
 - date format or calendar assumptions;
 - units of measure;
 - character sets or encoding.
- Checking methods that can be used:
 - visual inspection;
 - reports; and
 - file size and checksums.

Exchange issues are likely to be revealed only at the receiver end (where system settings can be different) and should be checked there

... Decision criteria ...

5. Consistency

- Check the internal consistency with any referenced information containers
 - spatial, physical and process consistency including the absence of duplication and conflicts such as overlaps or gaps;
 - attribute and property consistency such as contradictions;
 - gaps or overlaps with adjacent information containers within the federation strategy;
 - incorrect allocation with other information containers within the federation strategy;
 - appropriate accuracy including quantitative accuracy of locational and property values and thematic accuracy of classification and text properties.

Interfaces between division of design according to

- disciplines
- systems
- building sections
- ...

Gaps? Overlaps?

PropertySets with overlapping properties: duplicates or contradictions? Garbage properties?

Different levels of accuracy used in different properties

- quantitative values
- classification levels

... Decision criteria ...

6. Completeness

- Check for the presence and adequacy of the information against the LOIN specified by the EIR and any additional expectations, concerning the representations and description of
 - entities,
 - relationships,
 - properties and
 - shape;
- Three kinds of purposes:
 - immediate purposes – to satisfy the needs of the immediate delivery stage or operational trigger event;
 - oversight and coordination purposes – to support coordination of spatial, physical and process aspects;
 - long-term management and societal requirements – such as using standard naming and classification, and open standards

Check with IDS

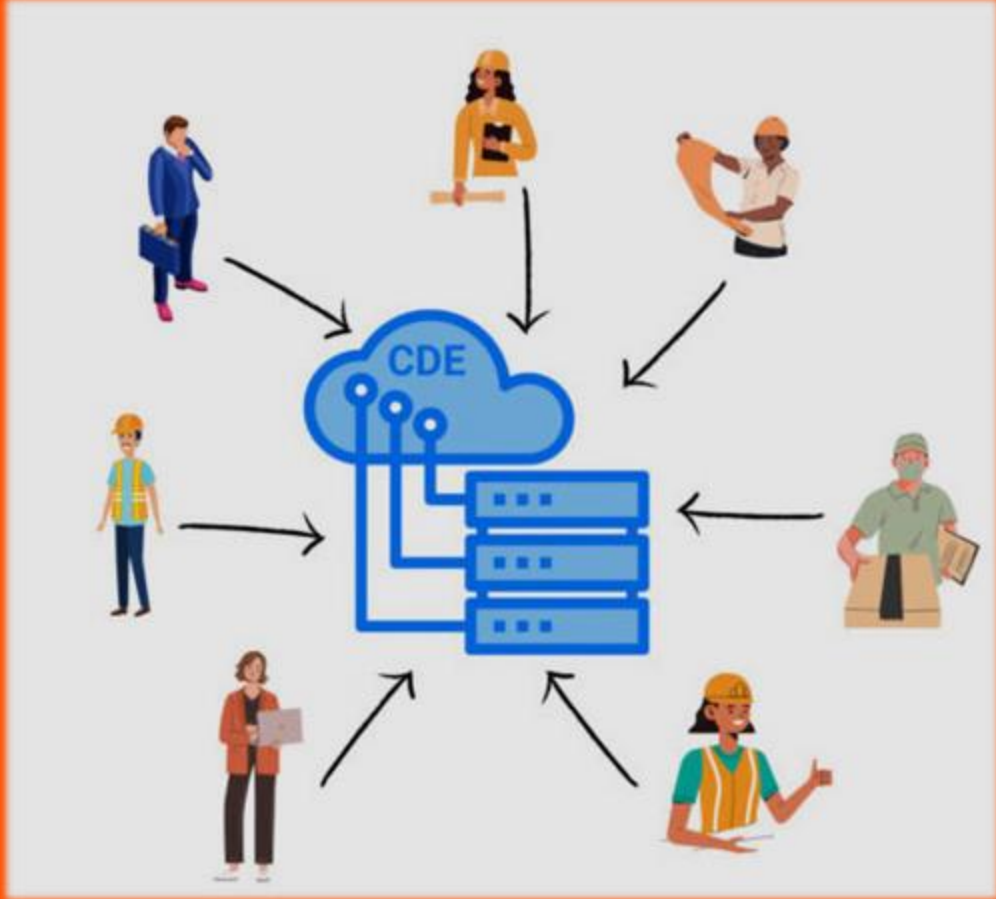
Check by hand?

... Decision criteria

7. Other

- For example
 - capacity and performance criteria;
 - technical standards;
 - commercial and legal requirements;
 - health and safety considerations.

Particularly significant at the end of each delivery stage or operational trigger event.



Current CDEs

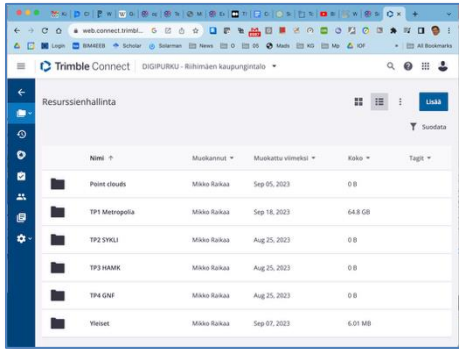
Benefits of a CDE

- Access to the latest, up-to-date information
- Controlled and secure environment
 - right people have the right kind of access to the right information at the right time
- Easy access to information
 - information is readily accessible to appropriate teams
 - independent of location or device (both desktop and mobile devices)
- Managed process for progressive development of information
 - using appropriate permissions control
 - audit trail of information development and exchange
- Coordinated production and consumption of information
 - facilitates collaboration across disciplines and teams
 - reduce clashes, rework, and duplication
- Information is clearly identifiable
 - common standards
 - meta-data

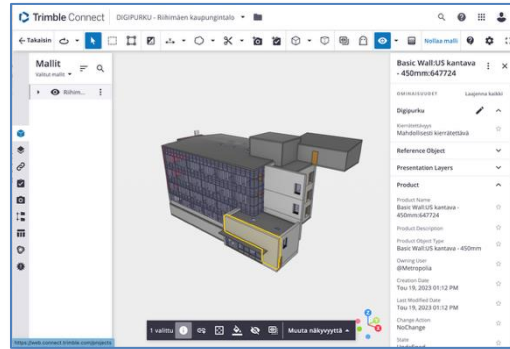
Faster, easier, and more accurate decisions across the asset lifecycle



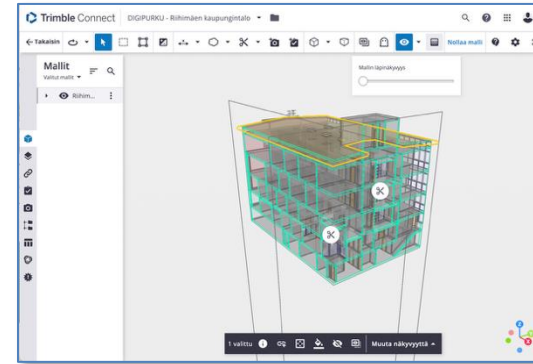
Additional functionalities of current CDEs



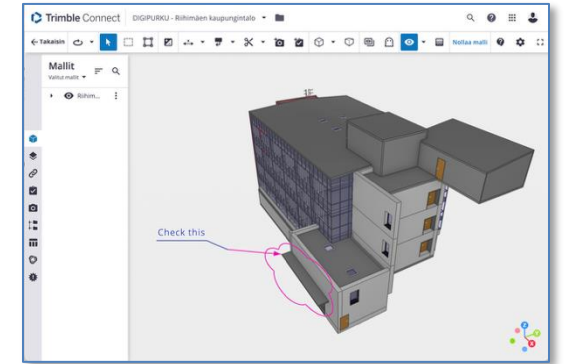
Works in a browser, cloud-based (no installation)



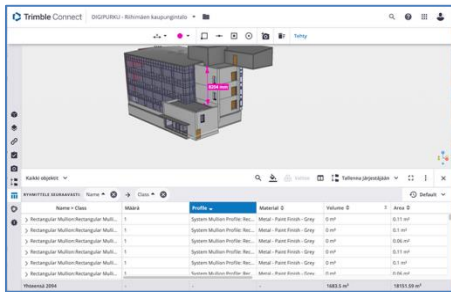
Visualization and viewing entity properties



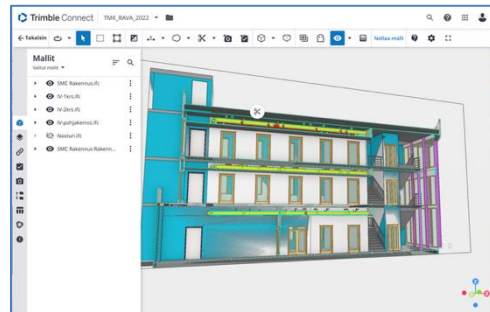
Transparency and cutting planes



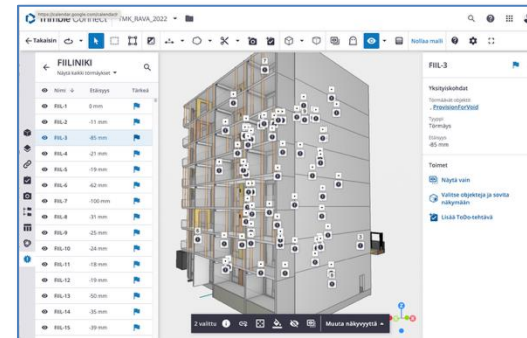
Markings and annotations



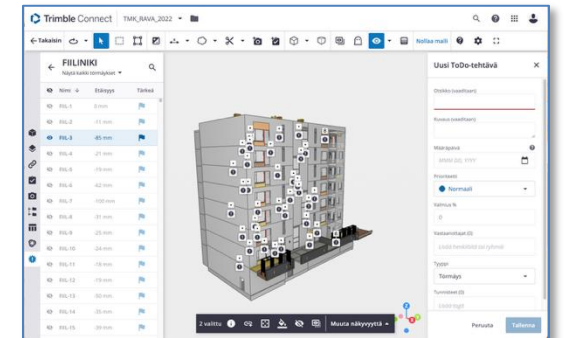
Quantity takeoffs and measurements



Combine multiple BIM-models



Check collisions



Create issues

BCF – BIM Collaboration Format

- Issue management for BIM
 - to facilitate collaboration and communication among stakeholders in a BIM-based project
 - for documenting and managing issues, comments, and discussions related to BIM models (in IFC)
- Creation of issues detected in a BIM tool
 - for instance, a collision, misalignment, accessibility problem, ...
 - an issue often must be resolved by a different party from the one who identified it
 - issue resolutions process can be tracked
- An issue can contain
 - identifiers of the relevant entities (GUIDs)
 - visualization of the issue: camera position in the model, with a static preview
 - annotations made to the model
 - other attachments (files, documents, or images to provide additional context)
- Interoperable
 - BCF is compatible with various BIM software and platforms
 - issues created in BIM tool can be easily shared, reviewed, and resolved in another BIM tool
- Two implementation approaches
 - An open file format (bcfXML) – file-based, original specification
 - Communication protocol (bcf API) – server-based, supports discussion
- Origin
 - Originally developed in a collaborative initiative of Tekla and Solibri in 2009

Software implementations

- bcfXML – 65
- bcf API – 34





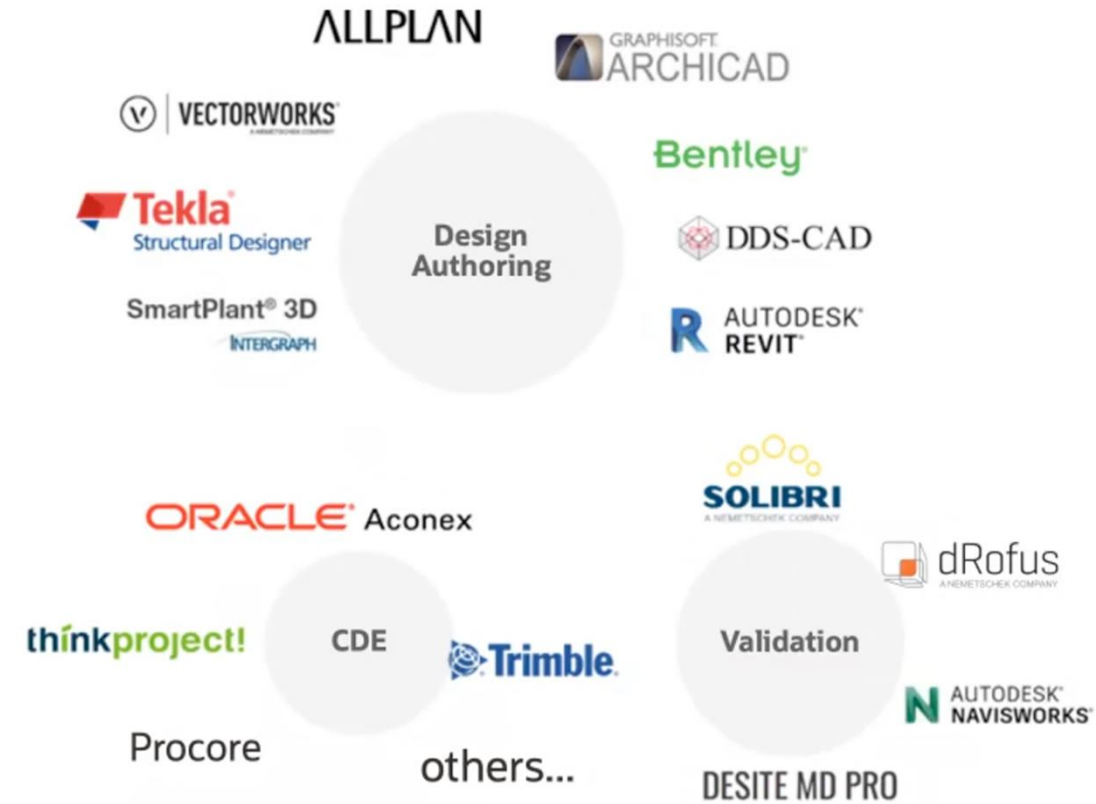
openCDE API

Working with multiple CDEs

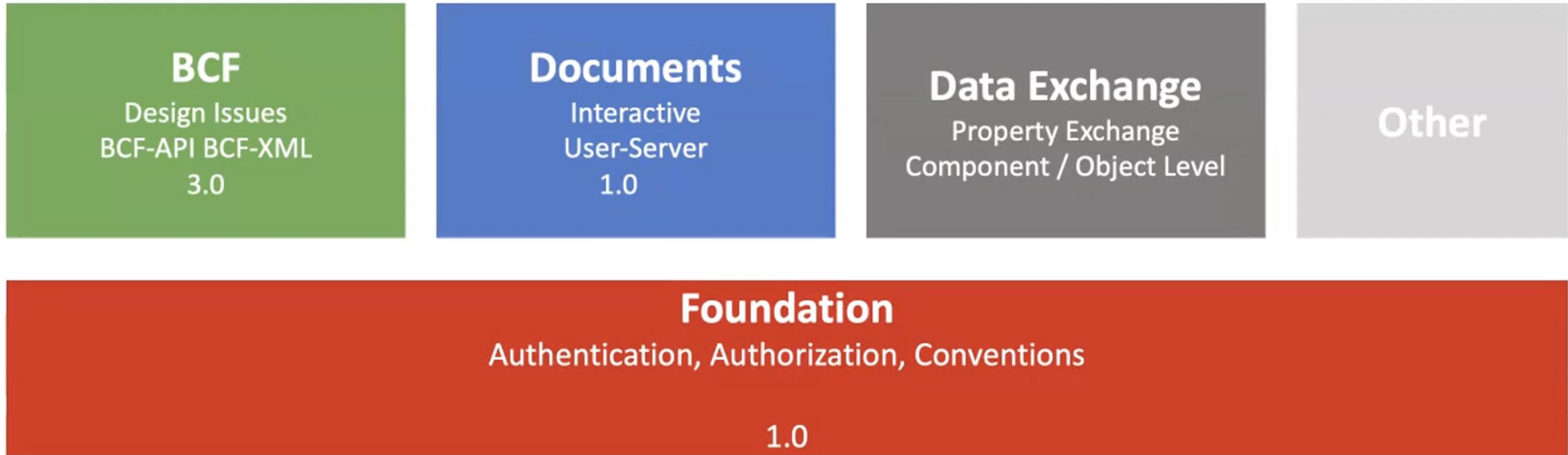
- Multiple CDEs in practice
 - Optimally, a single CDE is used throughout the lifecycle of a project
 - However, due to practical and technical challenges, multiple CDEs are often employed and managed concurrently, leading to issues such as
 - data inconsistencies
 - duplications
 - missing information
- Maintaining flexibility with CDEs
 - Companies should be prepared to work with different CDEs in different projects
 - Client, lead designer, constructor may require the use of a specific CDE
 - Vendor-specific CDEs may favor integration with their own BIM tools
 - For instance, Autodesk Construction Cloud with Revit
 - Can limit functionality or support for third-party authoring tools
 - Vendor lock-in should be avoided for technical and economic reasons
- How do different BIM applications interact with the CDE?
 - many CDEs support or have plugins to popular BIM tools
 - facilitate data exchange, versioning, and other collaborative features
 - still, there can be restrictions and compatibility issues
 - may affect seamless integration
 - will some data loss or fidelity issues remain

OpenCDE interface

- Main functions of CDEs are relatively similar
 - Authentication and authorization
 - Storing documents
 - Managing issues
- How programs can connect to and access data in different CDEs in a similar way?
- OpenCDE is an interface based on a family of standards
 1. to provide open connectivity and communication
 2. between CDE platforms and BIM tools
 3. for the building and infrastructure domains in the built asset industry
- OpenCDE includes
 - Foundations API
 - Documents API
 - BIM Collaboration Format (BCF)
 - Property / Data Exchange API (upcoming)



OpenCDE APIs



buildingSmart – openCDE API

An open API specification for CDEs

- RESTful web interface: data is exchanged via
 - HTTP query parameters
 - JSON payloads
- Main API
 - Foundation API: <https://github.com/buildingSMART/foundation-API>
 - Authentication and user services
- Feature-based additions
 - BCF API: <https://github.com/buildingSMART/bcf-API>
 - Issue management for BIM
 - Documents API: <https://github.com/buildingSMART/documents-API>
 - Uploading and downloading models, drawings, pdfs, ...
 - Dictionary API: <https://app.swaggerhub.com/apis/buildingSMART/Dictionary/v1>
 - Access to the buildingSmart Data Dictionary for classifications

Thank you!

