

Construction Innovation Hub + D-COM Network Briefing Note: Digital Compliance Driven by Open Standards and Open APIs

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1. Foreword

The construction industry is currently undergoing a step change in both the regulatory requirements placed upon it and the ever-increasing need for improved transparency and auditability.

There is also an increasing desire from the wider construction industry, and an increasing adoption amongst both data producers and consumers for the use of open standards and APIs (Application Programming Interface) to become the default position within the sector.

The Construction Innovation Hub and the Digital Compliance (D-COM) Network are seeking to develop a new 'Digital Compliance Ecosystem' to support construction firms in navigating the complex regulatory landscape with greater ease and certainty. Both are committed to the principle that this Ecosystem will be built on top of existing standards where possible and where new APIs or standards must be developed, they are open and freely available.

The Digital Compliance Ecosystem will build on the groundwork laid by the D-COM Network in 2018 and directly supports the ambitions of the CLC 'Roadmap to Recovery' by developing a digital ecosystem that assists in the delivery of high-quality, better-performing buildings, as well as addressing the need identified by the MHCLG Expert Group on Structure of Guidance to the Building Regulations.

This briefing note represents the continuing industry engagement that the product team are conducting, aiming to disseminate their intentions and direction regarding the use of open APIs by the Digital Compliance Ecosystem. Following this, the project team are keen to hear from members of the industry working in related fields to ensure that the developed Ecosystem is fit for purpose.

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2. About the D-COM Network

The Digital Compliance (D-COM) Network is led by Cardiff University and was formed to meet the clear need for research, insight, and leadership in the digitisation of regulatory processes and automated compliance checking. The D-COM Network is highly rated for its help in creating the landscape and agenda around digital transformation of regulations and compliance processes in the UK.

The D-COM Network is formed from a balance of industrial and academic capabilities. It has a multi-institutional and multi-themed approach focusing on transparency and openness, which we consider significant factors in this journey. The wider D-COM Network consists of 14 primary contributors, with expertise across multiple built environment sectors. 5 building focussed partners are participating in this project.

3. About the Construction Innovation Hub

The Construction Innovation Hub brings together world-class expertise to transform the UK construction industry.

The Hub is developing solutions that will help drive the transformation of the sector. We're pioneering ways in which buildings and infrastructure are procured, designed, delivered and operated to deliver market-ready products and processes that will shape our future built environment, ensuring safety, quality and value.

In close collaboration with government, academia, industry and partners across the Transforming Construction Challenge, we are guiding a collaborative programme, using world-leading processes and technologies, to create a market with the capability and capacity needed to deliver the UK's construction and infrastructure needs.

This collective innovation will drive adoption of manufacturing-led approaches to construction, digital tools and secure, connected data that support sector growth and open export opportunities, accelerating recovery and the transformation to a future-ready sector.

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4. What is our Digital Compliance Ecosystem?

The concept of a Digital Compliance Ecosystem has culminated from the combined expertise of the D-COM Network from many previous projects. Key lessons learnt from these projects have informed the architecture of this Ecosystem.

Two key principles have been adopted when developing the Digital Compliance Ecosystem. Firstly, that it will be built on open standards, where possible, and will use open APIs. Secondly, that it will also concentrate on integrating different compliance data sources/simulation/processing tools, as opposed to centralizing all aspects in one “compliance checking service”.

Industry users will utilize the Digital Compliance Ecosystem through a series of software tools, these include:

- **Document Viewer:** Will allow a user to view a document within the Digital Compliance Ecosystem. It includes tools to navigate the document interactively and search.

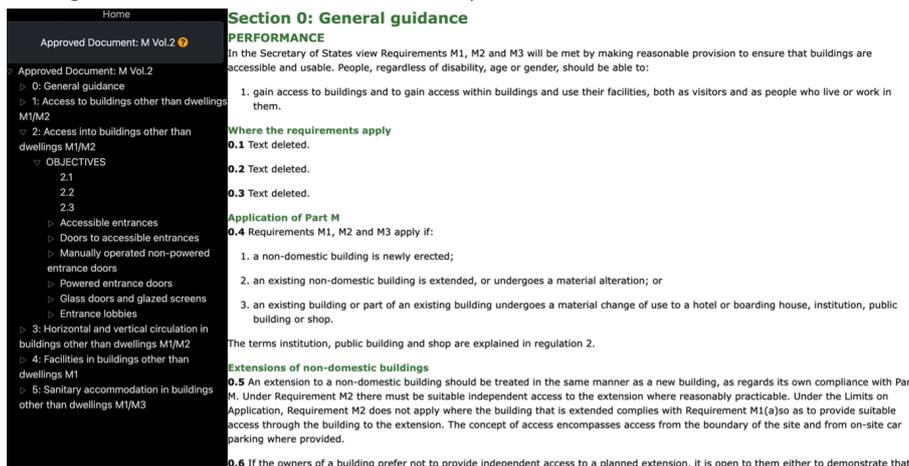


Figure 1: A Compliance Document Viewer

- **Document Editor:** Will allow the user to create and update documents in the Digital Compliance Ecosystem. This includes editing their content and embedded logic, thereby, digitising, Requirements, Standards or Guidance clauses.

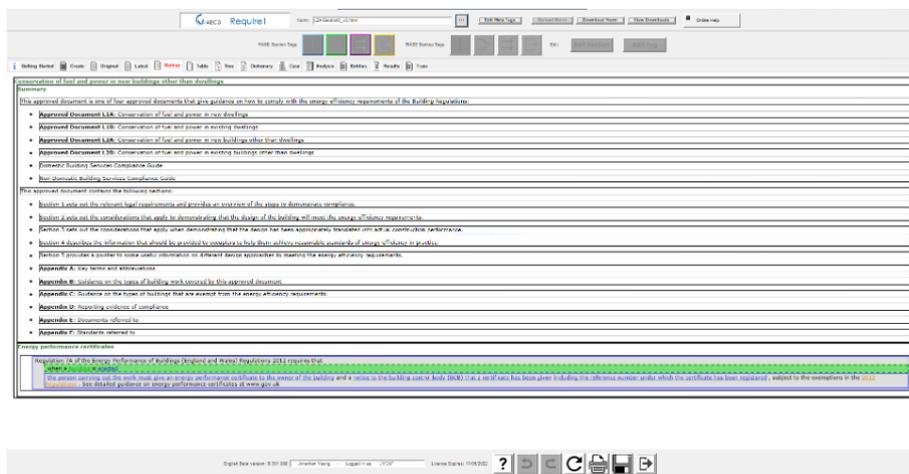


Figure 2: AEC3 Require1 - A Compliance Document Editor

- **Compliance Checking Management Tool:**

Will allow a project team to initiate and manage the process of submission and assessment of the automated compliance checking process

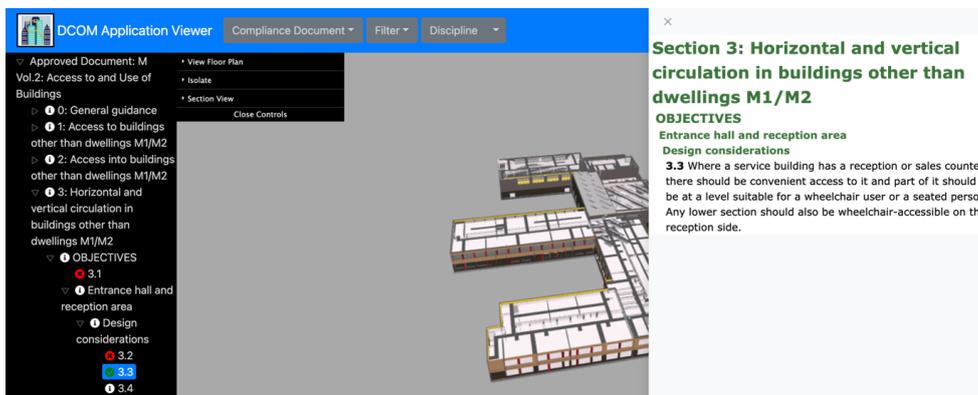


Figure 3: A Compliance Checking Management Tool Integrating Document Clauses into a Compliance Checking Tool

- **Building Control Management Tool:**

Will allow a building control professional to review and determine the outcome of a building control application submitted using the Digital Compliance Ecosystem.

Each of these software tools will be driven by data provided by the core components of the Digital Compliance Ecosystem, through a set of open APIs and using open standards.

One of the key open standards that is required for the Digital Compliance Ecosystem is the ability to represent, in a machine-readable way construction regulations, requirements, standards and guidance. To this end we defined the concept of a compliance document, which is:

A digitised form of a document containing construction industry, regulations, requirements, standards, and guidance. A compliance document contains both human readable text, figures/tables, a machine-readable structure, and logic to enable automated compliance checking.

The compliance document open standard adopted several guiding principles:

1. It should be open, and thus, should also depend only on other open standards and not utilise any closed formats.
2. It should be flexible enough to allow the embedding of multiple logic/rule formats to cater for the variety of use cases in the built environment.
3. It should re-use existing open standards as far as possible to avoid “re-inventing the wheel”. This enables software developers developing tools/services using the schema to leverage existing software libraries. This reduces both development time and costs.

Thus, the Digital Compliance Ecosystem utilises XML and JSON to represent a compliance document, allowing construction regulations and the rules needed to perform automated checking to be utilised across the components of the Ecosystem.

Descriptions for each of the core components of the Digital Compliance Ecosystem are as follows:

- **Compliance Document Service:** Provides the storage, retrieval, querying, updating, and management of documents stored in a machine-readable format.
- **Results Service:** Provides the storage, management, and retrieval of the results of compliance checking of a construction project.
- **Rule Engine:** The compliance checking engine. The rule engine executes compliance checks against a given document by utilising compliance data retrieved from a set of data sources, including BIM model data and data provided by other software tools such as geometry checking tools and energy simulation tools.
- **Service Lookup:** A software service that provides a directory of other services within the Digital Compliance Ecosystem.
- **Dictionary:** A software service that provides the ability to translate between the differing semantics of documents and industry data formats, including the ability to translate the terms that are commonly used inconsistently across languages and technical domains.

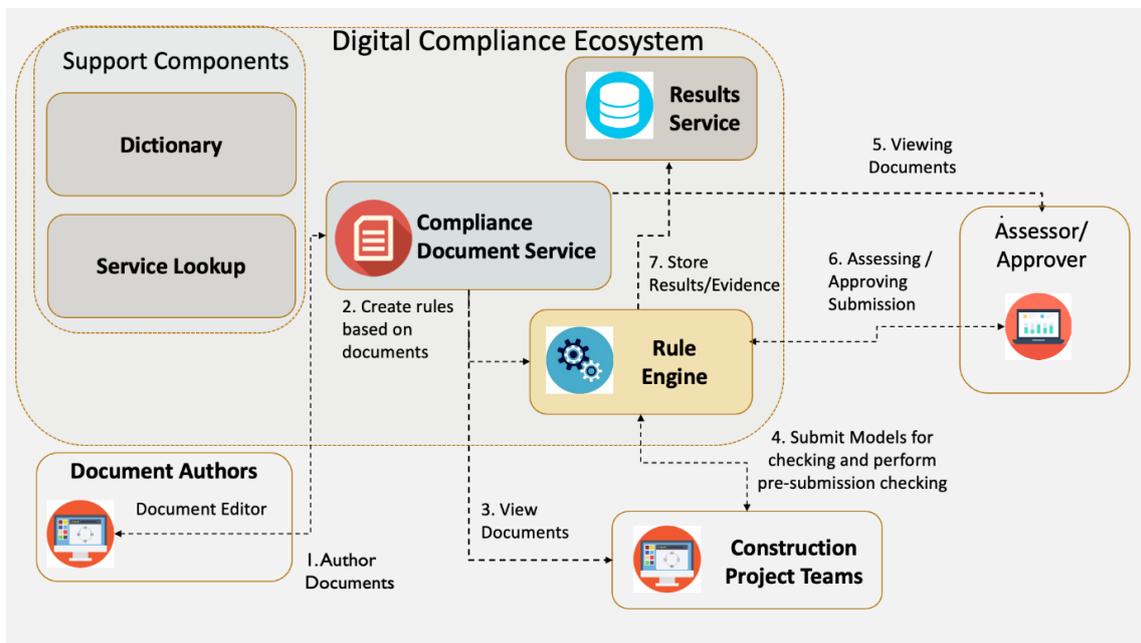


Figure 4: The architecture of the digital compliance ecosystem

5. The Digital Compliance Ecosystem Process

As part of the development of the Digital Compliance Ecosystem we have set out our vision of a digital building control process as supported by the Ecosystem.

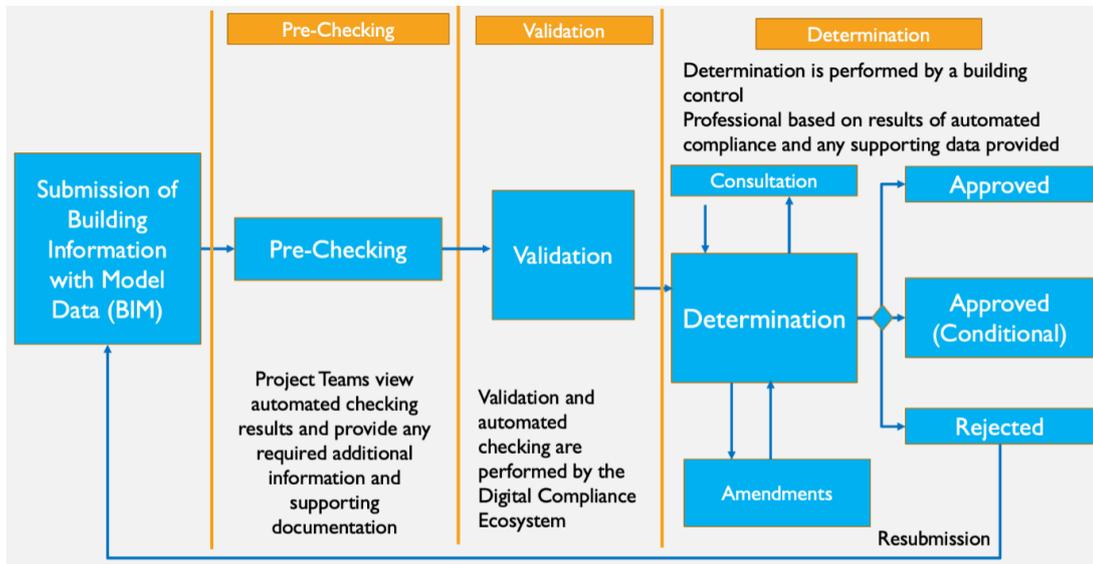


Figure 5: The new digitised building control process implemented by the Compliance Ecosystem

This process consists of the following stages:

- 1. Submission:** Where information about a project is submitted. As part of this process the project team will utilise the **compliance checking management tool** to submit a projects model data for compliance checking. This will result in the submission of this data to the rule engine using the **rule engine** component of the Digital Compliance Ecosystem.
- 2. Pre-Checking:** The project team utilises the **compliance checking management tool** to perform pre-checking. This consists of; (a) enabling the project team to ensure that all required information has been supplied, (b) enabling the project team to make amendments to their submission if the generated compliance results are not as expected. This will result in the submission of this data to the rule engine using the **rule engine** component of the Digital Compliance Ecosystem. As part of this process the **compliance checking management tool** will also provide users access to the text of the documents that are being referenced using the **compliance document service**.
- 3. Validation:** Validation of a compliance check could now be performed automatically by the Digital Compliance Ecosystem. This validates that all information is present and ensures payment has been made.
- 4. Determination:** Where a qualified building control professional examines the application using the **building control management tool**. This will result in the submission of any manual assessments performed by the building control professional to the **rule engine** and, finally, when the determination has been made, the storing of the results on the **result service**.

6. Digital Compliance Ecosystem API use cases

This section will present the three key APIs that have been developed and how they are used to allow external tools to interact with the Digital Compliance Ecosystem.

The four key APIs that form part of the Digital Compliance Ecosystem are:

Compliance Document API: Allows software applications to retrieve compliance documents at different levels of granularity from entire documents to individual clauses.

Result Service API: Allows software applications to retrieve compliance results from past building control applications.

Rule Engine API: Provided by the rule engine itself, this API allows software applications to submit compliance checking results to the rule engine.

Rule Engine Interface API: An API that software applications can implement to allow the rule engine to connect to them and retrieve compliance data.

The dual rule engine APIs are provided to allow more flexibility for users of the Digital Compliance Ecosystem, this allows the Rule Engine to have data sent to it and to request data from other software packages.

The remainder of this section will briefly document three exemplar use cases of utilising the Digital Compliance Ecosystem's APIs to perform commonly required tasks.

6.1. Using Compliance Data from Solibri Office

Solibri Office is a commercial BIM model checking tool. It provides an API that enables external software to execute geometric checks on elements within a BIM model. Within the Digital Compliance Ecosystem, Solibri Office has implemented the Rule Engine Interface API (See [Section 6.3](#)) to enable the rule engine to connect to Solibri Office to execute geometric checks (as shown in Figure 6). This enables the rule engine component to perform geometric checks. An example of this for testing if there is an adequate unobstructed space of at least 300mm on the pull side of a door between the leading edge and any wall return as detailed within Approved Document M Volume 2 is:

1. The Rule Engine queries Solibri Office asking "*Is the clear width at Door X's leading edge \geq 300 mm*" where X is the unique ID of a given door element in the BIM model.
2. Solibri Office then returns as a pass or fail response. In the case of a failure, it also returns evidence in the form of an image illustrating why the test has failed. This is illustrated in the figure.

This integration is an example of how, within the Digital Compliance Ecosystem, the rule engine can utilise the standard API provided by components that contribute data to the compliance checking process to retrieve answers to compliance questions.

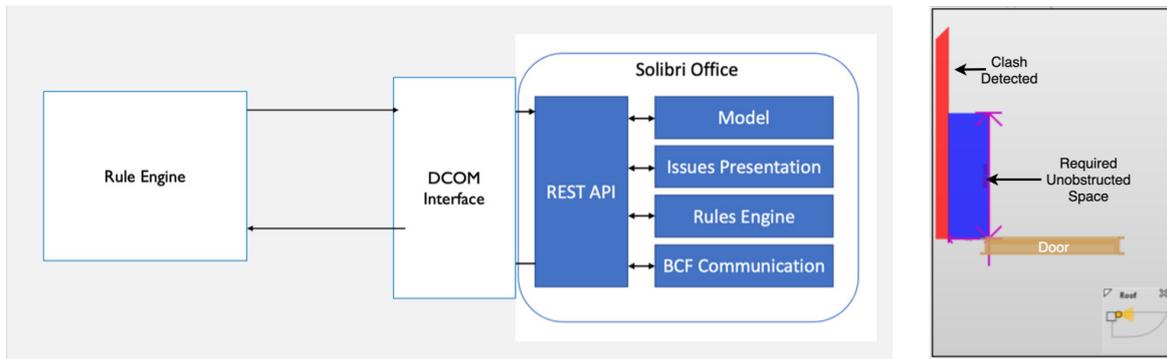


Figure 6: Using Compliance Data from Solibri Office

6.2. Authoring Documents in AEC3 Require1

Require1 is a digital compliance workbench which provides the ability to view/edit regulations, requirements, standards, and guidance documents. Require 1 also enables the “marking up” of regulatory documents with coloured highlights and metadata to make them executable by a computer. Require1 has been integrated with the Digital Compliance Ecosystem (as shown in Figure 7) enabling users to:

- download compliance documents using the compliance document API.
- edit and apply markup to compliance documents.
- authenticate and upload modified documents back to the compliance document service.

This use case illustrates how different software tools can utilise the regulation data stored within the Digital Compliance Ecosystem’s document service. It also illustrates how new regulations can be authored and updated.

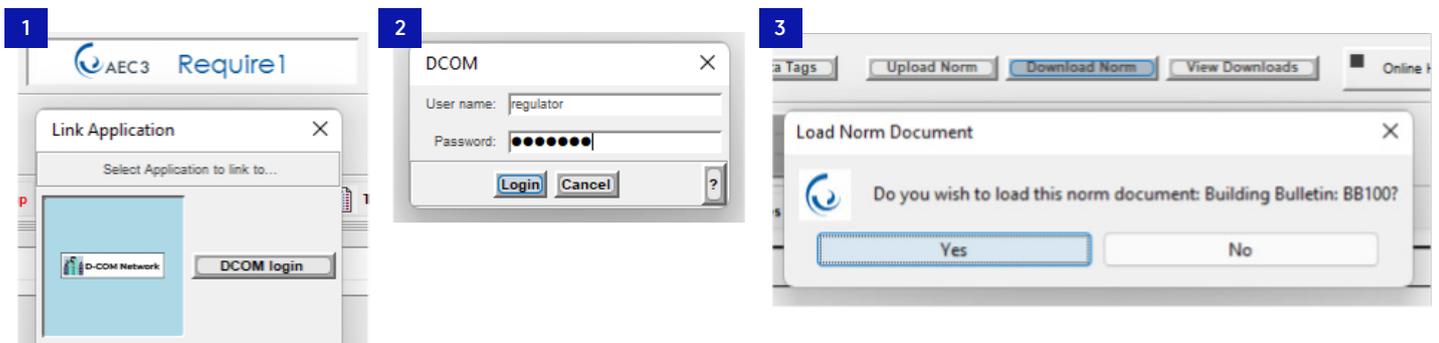


Figure 7: Using AEC3 Require1 to download/upload compliance document data.

(1) Connecting to Compliance Document API, (2) authentication, (3) Document download.

6.3. Integrating Document Clauses into a Compliance Checking Tool

The final use case illustrates how both the Rule Engine API, and the Compliance Document API can be utilised to create a tool to manage the process of compliance checking. The use case illustrates how multiple APIs from the Digital Compliance Ecosystem can be used to create richer tools.

In this use case the Compliance Document API is utilised to retrieve the clausal structure of the document being considered. Then, for each clause within this document, compliance results are retrieved from the rule engine and displayed as a series of icons next to each clause that indicate if the clause is passed, failed, or awaiting determination. When a clause is clicked on, the Compliance Document API is used to retrieve the text of the selected clause and display it. Finally, the Rule Engine Interface API is utilised to retrieve data from a model server and render it as a 3D display.

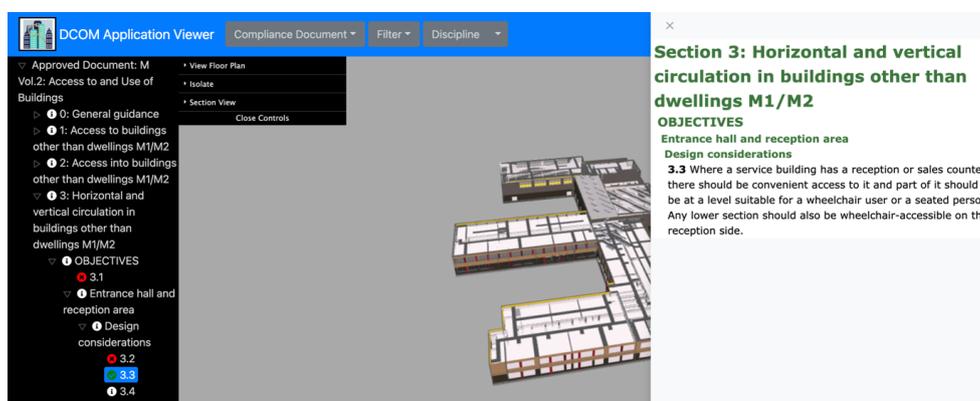


Figure 8: A Compliance Checking Management Tool Integrating Document Clauses into a Compliance Checking Tool

7. Next Steps & Conclusion

This briefing paper has described the intention and direction regarding our adoption of open standards and API. The project will now continue in producing prototype software implementations, designing, and implementing various exemplar user interfaces and, finally, implement and test proof of concept software prototypes.

We welcome feedback from across the construction industry to help inform the future work in our project. If you have any feedback on our progress so far – please contact the project leads [Dr Thomas Beach](#) or [Dr Ahmed Alnaggar](#).



D-COM Network

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**UK Research
and Innovation**

The Construction Innovation Hub is a consortium between:

