

Construction Innovation Hub and D-COM Network Briefing Note: The Digital Compliance Ecosystem

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1. Foreword

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

This makes the collaboration between the Construction Innovation Hub and the Digital Compliance (D-COM) Network especially important. Together, these two key players are seeking to develop a new 'Digital Compliance Ecosystem' to support construction firms in navigating the complex regulatory landscape with greater ease and certainty.

The Digital Compliance Ecosystem will build on the groundwork laid by the D-COM Network in 2018, and directly supports the ambitions of the Construction Leadership Council (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 in the DLUHC 'Final report of the expert group on structure of guidance to the Building Regulations' (released formerly under MHCLG).

This briefing note signifies a first stage in industry engagement that is key to enabling the success of this project. The project team have already held an introductory briefing event and have more events planned. They are also keen to hear from members of the industry working in related domains to ensure that the developed Digital Compliance Ecosystem is fit for purpose and industry applicable.

Dr Steven Yeomans

Head of Research & Programme Lead
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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 from BRE, the Manufacturing Technology Centre (MTC) and the Centre for Digital Built Britain (CDBB) 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. Why do we need digitised and automated regulatory compliance?

The entire lifecycle of the built environment is governed by a variety of regulations, requirements and standards. The checking of compliance against these is a complex task, which is currently performed manually, thus becoming highly resource intensive.

There has been a significant rise in interest from government expert groups to address some of these challenges. However, so far there has been no adequate suggestion or adoption of either the digitisation of regulations or compliance systems.

The 'Building a Safer Future' consultation is an example of this. It covers a broad spectrum of relevant issues. However, the consultation suggests adding further layers of regulatory compliance to an already broken system.

The D-COM Network agrees that concerns raised in the Hackitt review show that departures from ongoing compliance and monitoring has become a systemic problem in the construction industry. This project proposes a transformation of the regulatory compliance system. Digitising and automating this system will improve transparency and assist in supporting the 'Golden Thread'.

The recent increase in information and data maturity due to the adoption of processes such as Building Information Modelling (BIM) and supporting standards, means automation of compliance checking is becoming feasible. This is an opportunity to start overhauling the system. Why? Because the current system is extremely difficult to manage. Building Control Bodies lack resources, there are too many ambiguous regulations and competing requirements, as well as un-auditable decision-making processes.

The concept of automated compliance checking can bring tangible advantages including:

- Reduction in time and costs associated with achieving compliance,
- Increased accuracy and allowing for more consistent compliance checking across the built environment,
- Ability to utilise regulations/requirements in a creative and assistive manner, prior to compliance checking,
- Ability to apply compliance checking throughout the asset lifecycle,
- Support the creation of the 'Golden Thread' of information.

5. Why a Digital Compliance Ecosystem?

Our 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.

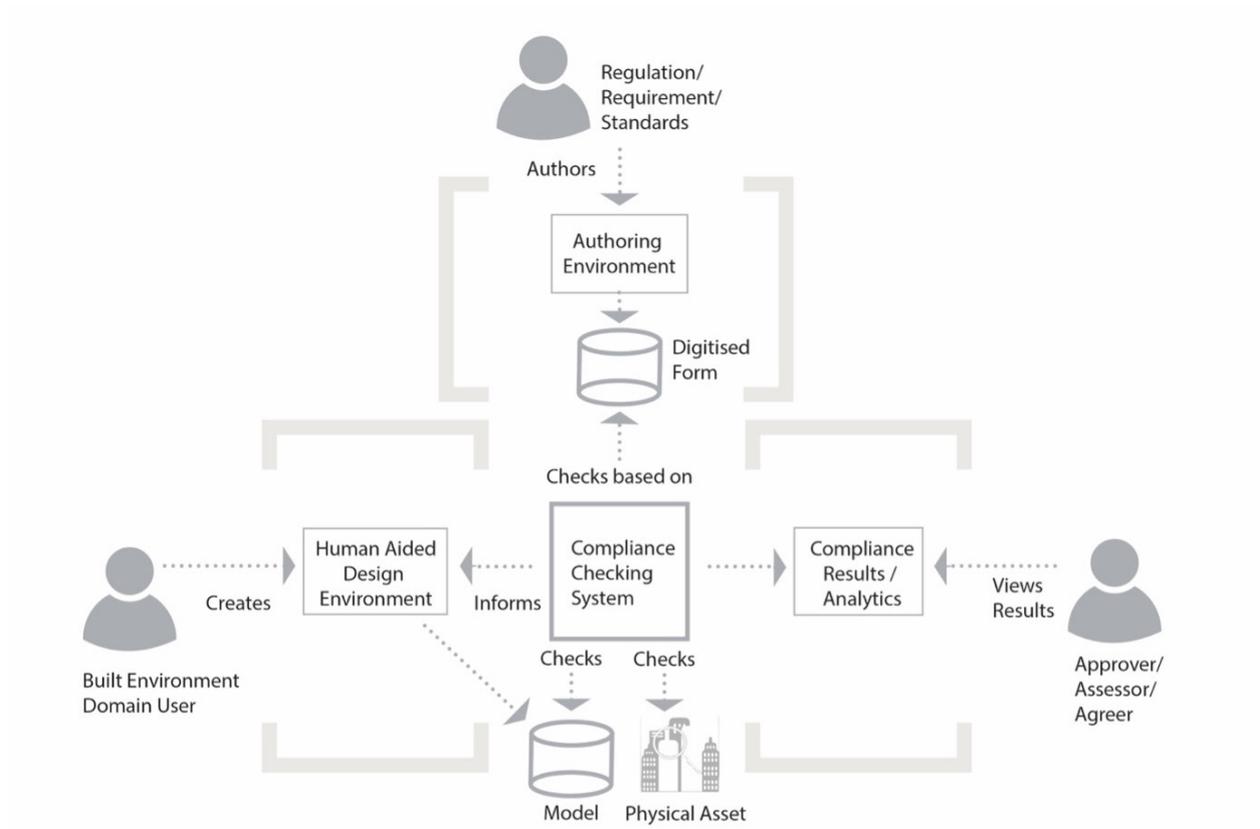
Firstly, many D-COM Network partners were previously involved in the RegBIM project which explored the technical challenges around the digitisation and automation of compliance checking in the UK construction sector. This project confirmed the technical feasibility of automating compliance checking based on the source regulations. It also determined that any future compliance checking system should be made up of many different services and should not attempt to centralise all required functionality. Essentially, this has identified that an 'open' approach philosophy is essential in terms of the system structure and interfaces. It was further made clear in this project that any future system should integrate the variety of tools and data sources currently available.

The D-COM Network was also funded by the Centre for Digital Built Britain (CDBB) to understand and ascertain the appetite for a Digital Compliance Ecosystem focusing on themes of political willingness, technical capability, and commercial inclination. This identified key obstacles including a lack of shared open standards for representing compliance clauses and that there is no ability or right for the public to see compliance assessments of the buildings they live and work in, except in some specific circumstances such as energy related compliance assessments.

In addition, work from the wider industry has contributed significantly to identify the need for a Digital Compliance Ecosystem. The 'Final report of the expert group on structure of guidance to the Building Regulations' recommends that

the government should explore how the current information in Approved Documents can be transferred into a digital platform, specifically the Approved Documents should be made searchable with ability to read-across the Approved Documents (in a topic-centric way). The 'Independent Review of Building Regulations and Fire Safety: final report' recommends; the establishment of a digital record (the intent of a golden thread of information) for high rise buildings and to provide regulations and guidance that are simpler to navigate but that genuinely reflect the level of complexity of the building work.

This paints a picture of the current built environment landscape, in which there are many stakeholders, many tools, many data sources and many routes to compliance. The knowledge base from academia and industry describes a present situation lacking in open standards and access, with key recommendations focussing on accessibility and transparency. In this context, it is clear, that only an open "ecosystem" can integrate the requirements efficiently and accurately because a central monolithic system will not be able to meet these requirements.



Digital Compliance Ecosystem - Conceptual process

The key principles for a Digital Compliance Ecosystem are:

- Built on open standards where possible and using open Application Programming Interfaces (APIs),
- Loosely coupled components and systems distributed in nature to reflect the Building Control system,
- Non-monolithic: Concentrating on integrating different data sources/simulation/processing tools as opposed to centralizing all aspects.

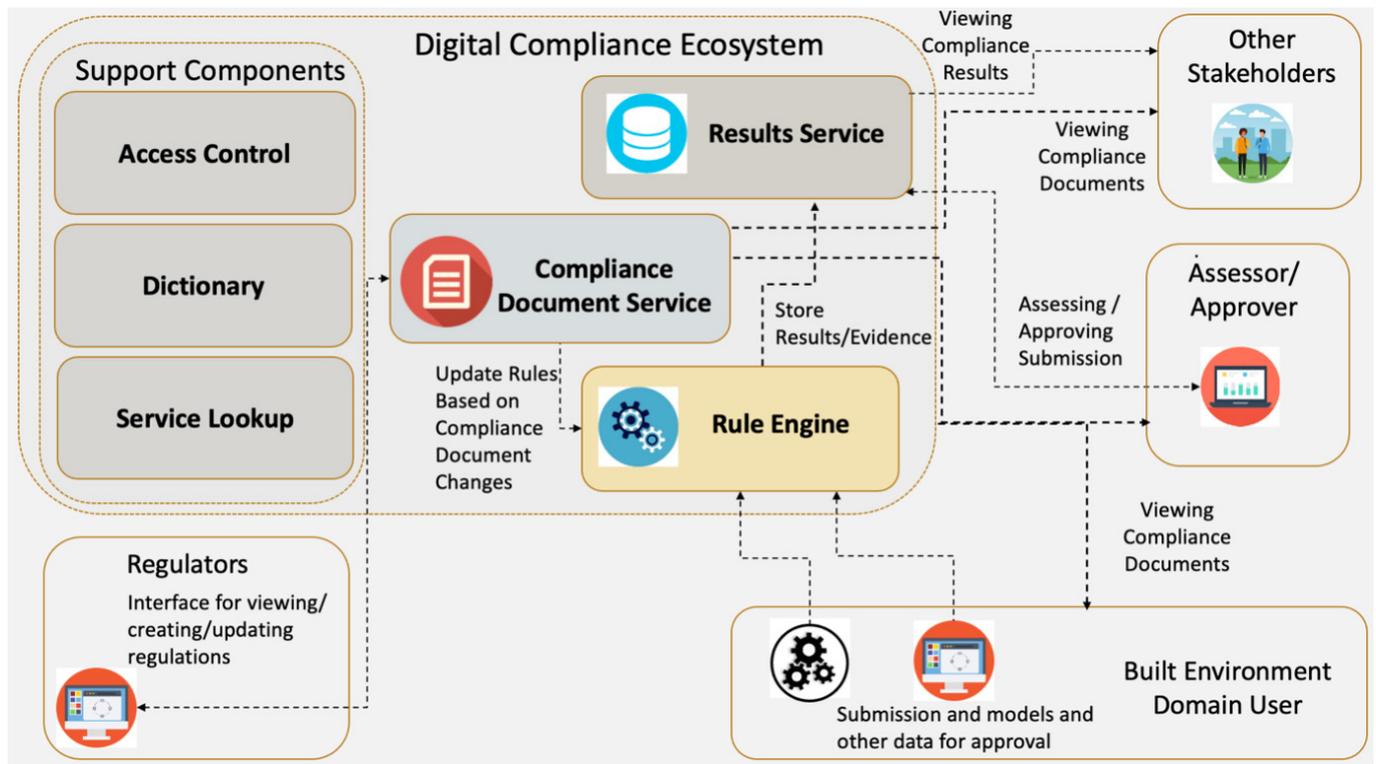
6. The Digital Compliance Ecosystem at a glance

Our Digital Compliance Ecosystem is a set of software services that interact using openly defined APIs, integrating both new and existing compliance checking tools to digitise and automate the compliance processes from design, build and throughout an asset's lifecycle.

Descriptions for each component of this Ecosystem are as follows:

- **Compliance Document Service:** A software service that provides the storage, retrieval, querying updating, and management of digitised compliance documents stored in a machine-readable format each of which applies within any given jurisdiction.
- **Rule Engine:** A software service that provides a compliance checking engine. It can execute a compliance check against any given Compliance Document by receiving and retrieving data from a set of sources, including Building Information Model data.
- **Results Service:** A software service that provides the storage, management and retrieval of results of compliance checking.
- **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.
- **Compliance Simulation and Analytical Tools:** A tool (i.e., energy analysis) that performs a specialised task, but whose result data is required as part of the compliance checking process.
- **Asset Model Source:** A service that can provide asset model data (i.e., BIM). Examples of this could include a model server, or a common data environment.
- **Other Data Sources:** Other Data Sources that can provide other types of data (such as product data and geolocation data) to contribute towards the compliance checking process.
- **Compliance Document Viewer:** A viewer that can render a Digitised Compliance Document in a human readable form. This could include tools to interactively navigate the document, or, for example, produce a PDF document output.
- **Digitised Compliance Document Editor:** An editor designed to allow the user to create and update Digitised Compliance Documents, their content and embedded logic, thereby, digitising, requirements, standards, or guidance clauses.
- **Case Management Tool:** A tool (or set of tools) designed to initiate and manage the process of submission and assessment of automated compliance checking.
- **Result Viewer and Analytics Tools:** A result viewer and analytics tool that can provide an interface for displaying and analysing the results of compliance checking.

It is our vision that a variety of external tools, data sources and user interfaces will also be able to interface with the Digital Compliance Ecosystem through our open APIs.



Digital Compliance Ecosystem - Components at a glance

7. What should a Digital Compliance Ecosystem do?

The project team have performed a requirements engineering exercise to inform the future development of the Digital Compliance Ecosystem. The requirements for the Digital Compliance Ecosystem are as follows:

- Provide the automated checking of regulations, requirements, standards and guidance in a timely manner while maintaining human review and oversight.
- Make regulations, requirements, standards and guidance available (in both human and machine-readable forms) in a navigable, searchable, query-able digital form to enable:
 - (a) understanding of changes,
 - (b) provision of an aspect-based view on regulations, requirements, standards and guidance (read-across), i.e., viewing all particular clauses that correspond to a specific aspect of a building.
- Enable easier updating and management of regulations, requirements, standards and guidance.
- Enable the formation of persistent links between the variety of tools and data sources (including BIM data, calculation tools, Other Data Sources) that feature in current compliance processes, without the need to transmit data to one centralized repository.
- Retain the ability for manual submission of information.
- Provide an audit trail of the decisions and results of a building's compliance with clauses (the intent of a Golden Thread of information).

- Provide consistent and structured data (for asset descriptions, compliance documents, and results and requests for information) and open standards for interfacing with Digital Compliance Ecosystem.
- Provide ability for users to query and access compliance results and evidence as appropriate to their role.
- Provide definitions and mappings across contexts of terms and measures required for compliance processes.
- Provide APIs for each system component that are openly specified so external parties can easily develop software that interacts with the Digital Compliance Ecosystem.
- Provide appropriate information security provisions to ensure the secure execution of all the above, including the enforcement of access rights.

The following paragraphs describe the list of requirements for each component of the Digital Compliance Ecosystem.

7.1. Compliance Document Service

The Compliance Document Service component will allow for the access and updating of Compliance Documents in a machine-readable format. It will also allow for searching of and performing change management of Compliance Documents. It will do this by maintaining compliance clauses in a structured database, along with explicit relationships between clauses. It will also be maintaining an explicit audit trail of all modifications to the compliance clauses, as well as a means for managing the published history of each document. Finally, it will also include the capability of enforcing user access rights to view and/or modify compliance clauses.

7.2. Rule Engine

The Rule Engine service will perform the main processing of the compliance checking process. It will be able to retrieve compliance clauses from the Compliance Document Service and generate executable rules and use these to perform automated compliance checking. To perform these checks, it will retrieve and receive data from Other Data Sources including model servers, compliance tools, compliance data sources, and data translators. It will also accept the manual submission of data where no automated methods of checking are available. Once completed, these results will be transmitted to the Result Service. Throughout this process the Rule Engine will include the ability to enforce user access rights in conducting compliance checking and submitting information.

7.3. Result Service

The Result Service will enable the storage and management of results of the compliance checking process. It will do this by, enabling the unique identification of a building using a unique ID, to enable correlation between compliance checking on multiple Compliance Documents and wider integration with future 'Golden Thread' efforts. It will store, for each building; (a) the result of each element of a compliance check, (b) a link to the element of the Compliance Document (i.e., clause) that generated the results, (d) a timestamp, (e) the source of the data on which the answer was based (i.e., calculation tool, BIM data, manual submission). It will also provide the ability to retrieve and query the stored results of compliance checking and enforce appropriate access rights in retrieving compliance checking results.

7.4. Service Lookup

The Service Lookup component will provide a means for other system components to query and retrieve endpoint details for other components. It will also provide the ability to query components for details based on role, compliance clauses supported and jurisdiction.

7.5. Dictionary

The Dictionary will provide key data translation capabilities of the Digital Compliance Ecosystem. Specifically, it will, support retrieval of concepts for a given language and context and then support translation and mapping of concepts. An example of this is the translation between human readable terminology found in documents and a machine-readable location within BIM data where the data may be located.

8. Users and Stories

We have defined a set of four categories of users:

- **Built Environment Domain User:** A user that is performing some role related to a built asset and its data.
- **Assessor/Approver:** A user responsible for performing compliance checking of a built asset against requirements, regulations, standards or guidance, such as Building Control Bodies.
- **Regulator:** A user responsible for authoring and updating requirements, regulations, standards or guidance.
- **Other Users:** Any other user not covered by the above, from the public, local and central government, to occupants and residents.

Each of the users identified above will be associated with certain tools and use cases. User stories have been defined to illustrate what components users will utilise.

8.1. Creating/editing a new Compliance Document

Users with the correct level of authorisation can create a new Compliance Document. To do this, a supporting software tool (a Digital Compliance Document editing tool), will need to be used. This tool will first verify that the user has the correct level of authorization, before using the Service Lookup to submit the updated/new Compliance Document to the Compliance Document Server.

8.2. Viewing Compliance Documents

Any user of the system can view a digitised construction regulation/guidance document. A software tool will be used to load the document, by using the Service Lookup, to retrieve a list of Compliance Documents. Once the user selects a document its structure and content are then retrieved from the Compliance Document Service. Then, individual parts of it can be viewed. The document could also be searched (i.e., for keywords or paragraph/section numbers).

8.3. Conducting a compliance check

To conduct a compliance check, a member of the project team must first use a Case Management Tool to request that a Rule Engine Service (located via the Service Lookup) begin assessment of a given asset, against a given Compliance Document. The Rule Engine Service will then compile into rules the requested clauses from a Compliance Document Service (located using the Service Lookup).

The Rule Engine will use the Dictionary to determine from which data source each item of data can be sourced from. The Rule Engine can acquire data, either from this data source, or if no data source is available, then the data can be provided by human input. In all three cases, the origin of all data is always logged.

Once results are calculated and approved by an Assessor/Approver, they are passed to the Result Service (located using the Service Lookup) for long term storage.

8.4. Viewing Compliance Results

To view compliance results users can use a Result Viewer tool, the user must first specify the asset and the clauses they wish to review the results of. The Service Lookup will then locate the Results Service. Once the user's level of authorisation has been verified, they are then able to retrieve result information from the Result Service. These results can then be viewed in the context of the clauses concerned, by retrieving clause details from the Compliance Document Service.

8.5. An Assessor/Approver reviewing an automated compliance check

This tool will retrieve the results from an automated compliance check from a Rule Engine (located via the Service Lookup). These results will have been previously generated by a Built Environment Domain User, such as a design team. An Assessor/Approver will view these results in the context of the clause being checked (as retrieved from the Compliance Document Service). Their authorisation to assess will also be verified.

As part of their assessment process, they will be able to review the automated decisions made, along with their audit trails.

An Assessor/Approver will be required to assess any manual assessments made by the Built Environment Domain User, such as a design team, by submitting their assessment of these to the Rule Engine (located via the Service Locator). Additionally, the Assessor/Approver will be able to manually override any automatically generated decisions. All these actions will be logged, and an audit trail formed.

They also can request access to further information or access to applicable data via the Rule Engine.

9. Your feedback

On 1st of July 2021, we held an 'Initial Consultation Event', at this event we engaged with professionals active in the built environment. We presented our progress in the specification and design of the Digital Compliance Ecosystem.

We posed several important questions to attendees that would inform the development of the Digital Compliance Ecosystem going forwards. Overall, this workshop garnered many varied perspectives. We received a large amount of positive feedback – but also gathered some key recommendations.

Regarding the most important outcome from the adoption of such a Digital Compliance Ecosystem, participants suggested numerous and wide-ranging outcomes. Many outcomes directly benefit the compliance process, while indirect outcomes were discussed in length, with participants in agreement that sectors such as the insurance industry could benefit greatly from the adoption of this ecosystem. This benefit was described from both the perspectives of the insurer and the consumer, in this sense it would be useful for the project team [to consult and determine how the adoption of such an ecosystem could benefit these specific stakeholders](#). Beyond this, many outcomes described the human at the centre of the process (a perception which

is reflective of the wider construction industry and aligned with previous D-COM Network work and our continual commitment to this aim). For the designer in particular, many positive outcomes were described. Participants described how they could see the Digital Compliance Ecosystem educating the designer, indirectly and without extra burden.

Though many positive outcomes for humans were discussed, participants warned of potential risks. Participants indicated worries that the Digital Compliance Ecosystem could “dumb down” the design process and suggested only competent professionals should use it. This presents an interesting point of discussion as closing off the Digital Compliance Ecosystem to only “competent professionals” would counter the open nature of it. It would be useful for the project team to give consideration as to the level of authorisation made available to different stakeholders, in order to alleviate the problem described.

Participants largely agreed on what “[an Audit Trail of Results](#)” should be – a flow of information forming a historical record. Participants also agreed that varying stakeholders would need varying levels of details, though for different reasons. Many cited security/privacy concerns whilst others raised concerns around an information overload. It is an interesting point for discussion that most participants arrived at the same conclusion that unfettered access was undesirable, but for very different reasons. It was indicated that there was some level of confusion around the line between result and the evidence to support results and so, greater distinguishment may be needed.

Whilst there were reservations in specifying the level of detail available to various stakeholders, participants did indicate potential third parties that should have access to relevant data, such as; [Local Councils](#), [Building Control Bodies](#), [Fire Services](#) and [Utility providers](#). In these instances, participants held a clear view as to why and were able to identify

the benefits. In this sense, it may be necessary for the project team to consult specific potential stakeholders to identify their desired outcomes.

Finally, regarding how the overall compliance process should change with the adoption of digitisation, there was some sentiment that the Digital Compliance Ecosystem should allow Building Control Bodies to choose which sections to process manually and to allow the bodies to choose trade-offs. Thus, [it would be a worthwhile exercise for the project team to consult with Building Control Bodies and designers/specifiers on this aspect, specifically to establish firstly, the level of desire from both groups and, secondly, any potential pitfalls that such a mechanism may lead to.](#)

10. Next steps & conclusion

This briefing paper has described our progress so far in specifying and defining the requirements for our Digital Compliance Ecosystem. Now that we have defined the architecture and gathered feedback, the next stage of the project will be to develop and define:

- Specification of the open format for representing digitised Requirement clauses.
- Specification and development of the APIs, to be released openly at the conclusion of the project.
- Design various exemplar user interfaces.
- Implementation and testing proof of concept software prototypes.

We welcome feedback from across the construction industry to help inform the future work in our project. So, if you have any feedback on our progress so far – please contact the project leads [Dr Thomas Beach](#) and [Lee Tuffnell](#).



D-COM Network

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**UK Research
and Innovation**

The Construction Innovation Hub is a consortium between:

