

CDBB

Research Agenda and Landscape

Post-Workshop Notes

Hosted by BEIS

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Centre for Digital Built Britain
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Contents of this note

This note replicates the content of the briefing note circulated before the workshop, augmented with notes from the workshop

Notes captured from the discussions and the working sessions are highlighted

- Introduction to the Workshop
- Introduction to the vision for digital built Britain
- The purpose of the Research Agenda and the Research Landscape
- History to date and the context of the Workshop
- Introduction to the framework by which the capabilities are organised
- Detailed exploration of the capabilities
 - “Value”, “Governance”, “Learning” and “Context”
 - “Services”, “Built Environment” and “Data and Information”

CDBB will use the insights from the workshop to further develop the Agenda and Landscape

Components of the Vision: Digital built Britain envisages asset lifecycles based upon ubiquitous data and information ...

Design

- Deploy digital techniques to design better performing buildings, homes and infrastructure
- Use good practice, secure by default, information management to get data right from the start



... that adopts new tools and techniques across organisations and supply chains ...

Design

Build

- Exploit new and emerging digital construction and manufacturing technologies and techniques
- Secure, shared information, enabling clients, design teams, construction teams and the supply chain to work more closely together to improve safety, quality and productivity during construction



... to develop and improve the intelligence and performance of new and legacy assets and services ...

Design

Build

Operate

- Use real time information to transform the performance of the built environment and its social and economic infrastructure
- Smart asset management to predict and avoid disruption of services
- Digitising existing assets



The vision for digital built Britain is extremely inclusive, requiring an equivalently broad research agenda

Design

Build

Operate

Integrate

A digital built Britain:

- understanding what information is needed right from the start
- ensuring feedback loops are in place throughout an asset's lifecycle
- information enabling better whole life value and optimising services to improve socio-economic outcomes for citizens
- exploit new and emerging skills and technology to increase productivity.



The CDBB Research Programme is developing a Research Agenda and a Research Landscape for digital built Britain

- The Research Agenda

- will provide a suggested and structured portfolio of the **capabilities needed** within the UK to achieve and enjoy the potential of digital built Britain
- will be structured to allow different funding bodies to 'mix and match' as appropriate for their interests and perspectives
- Will be a 'live document' that continues to evolve as progress is made and insights emerge

- The Research Landscape

- Will identify centres of competence that could be called upon to contribute to research, to demonstrators or to problem solving
- Will also be a 'live document'

The workshop clarified that this is perhaps better labelled a “**Capability Framework**”, providing a tool from which others can craft research calls to pursue their specific agendas. The range of capabilities discussed here is, deliberately, extremely wide. This makes it possible for funding bodies to choose and define a particular scope within this range. That chosen scope enables them to tighten the focus onto particular sets of capabilities needed and for which research can be sought

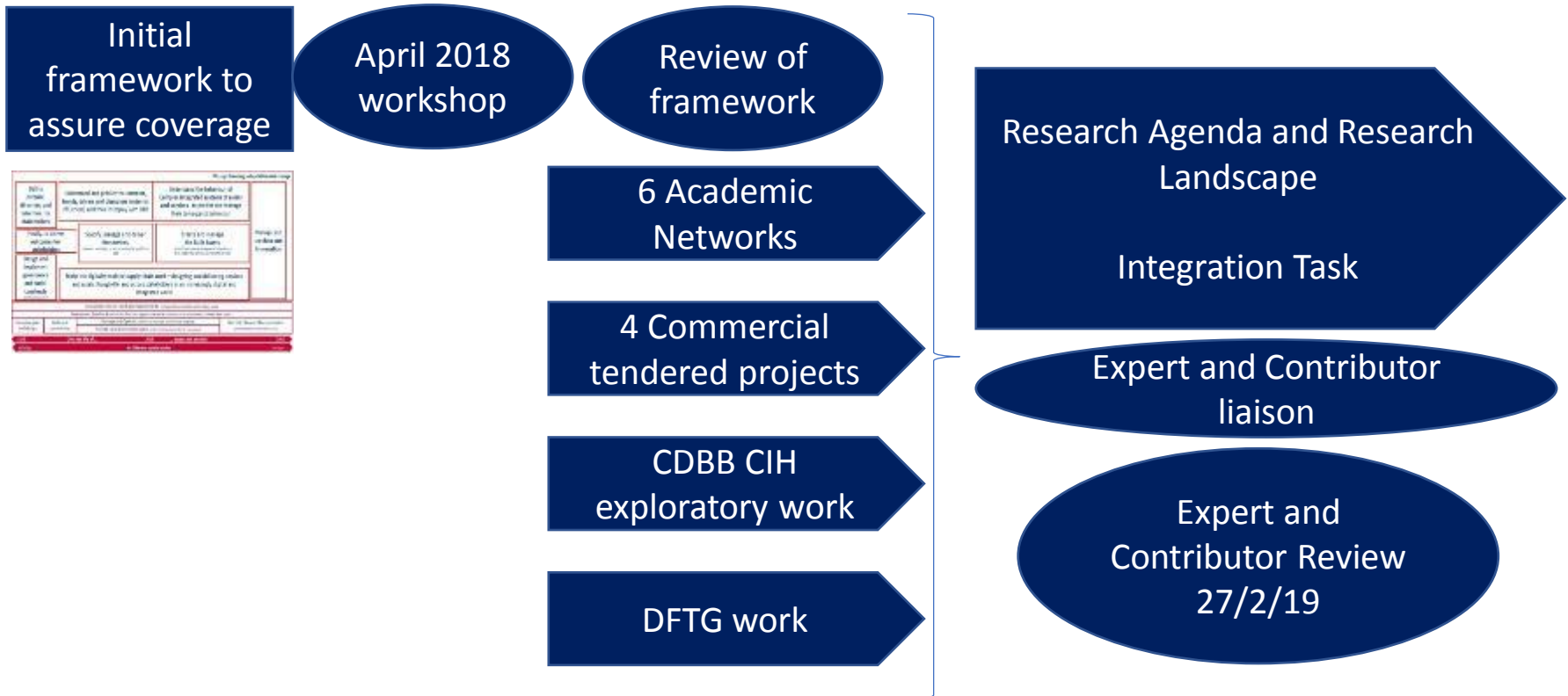
... and from which they can craft specific and more tightly defined research calls, seeking response from researchers across Britain

Recognising that the 'framework structure' may change as well as the more detailed content.

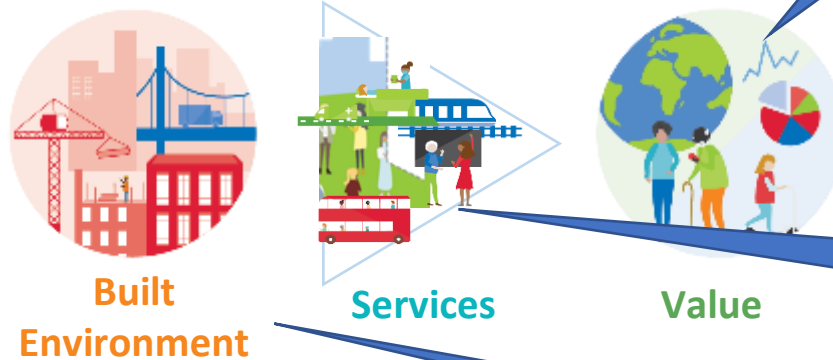
We expect that the Research Agenda and Research Landscape documents will evolve and mature

- This work is to identify the needed capabilities, focusing on those where there seems to be the greatest potential for research to help
- Bounded by
 - digitalisation
 - Integration
 - the built environment
- Problems needing capabilities
- Opportunities offering capabilities
- The agenda enables
 - funders with particular areas of attention to see what needs doing
 - researchers to define their proposals for how to contribute to the creation, dissemination and embodiment of capabilities

Both the Agenda and the Landscape are being assembled from many contributions, will go through considerable review, and we aim for a first draft early in the second quarter of 2019



The Research Agenda needs to cover every aspect of digital built Britain – how it's defined, developed, delivered and enhanced

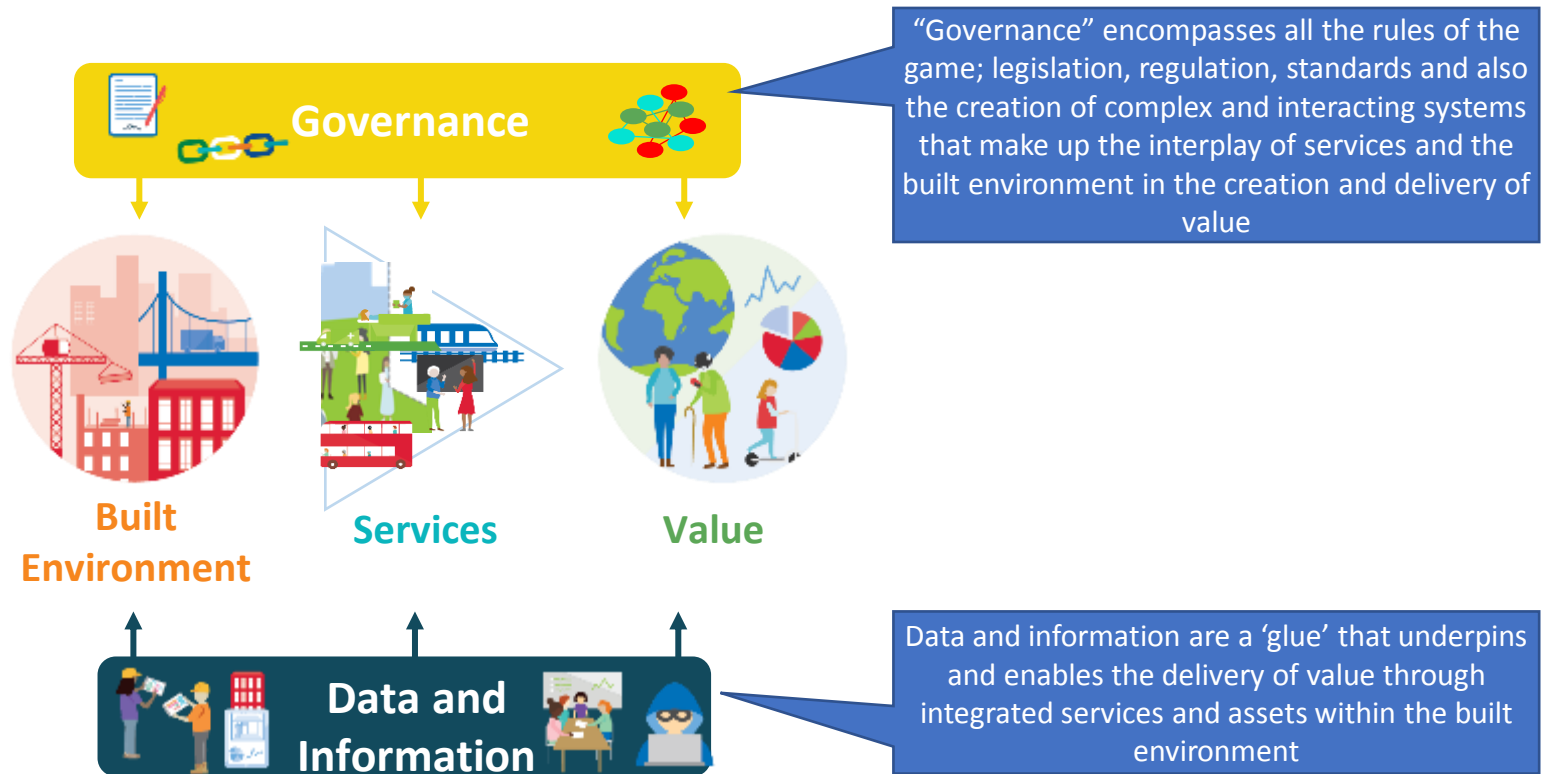


The framework of capabilities begins with the need to understand 'value' – its meaning for the UK and the myriad activities for its creation

A significant source of value for all in the UK are 'services', embedded in and delivered through the built environment

And the 'built environment' is at the core of digital built Britain

The Research Agenda needs to cover every aspect of digital built Britain – how it's defined, developed, delivered and enhanced



The Research Agenda needs to cover every aspect of digital built Britain – how it's defined, developed, delivered and enhanced

Learning

The framework of capabilities also includes those necessary for learning and adaptation – among the people and institutions of the UK

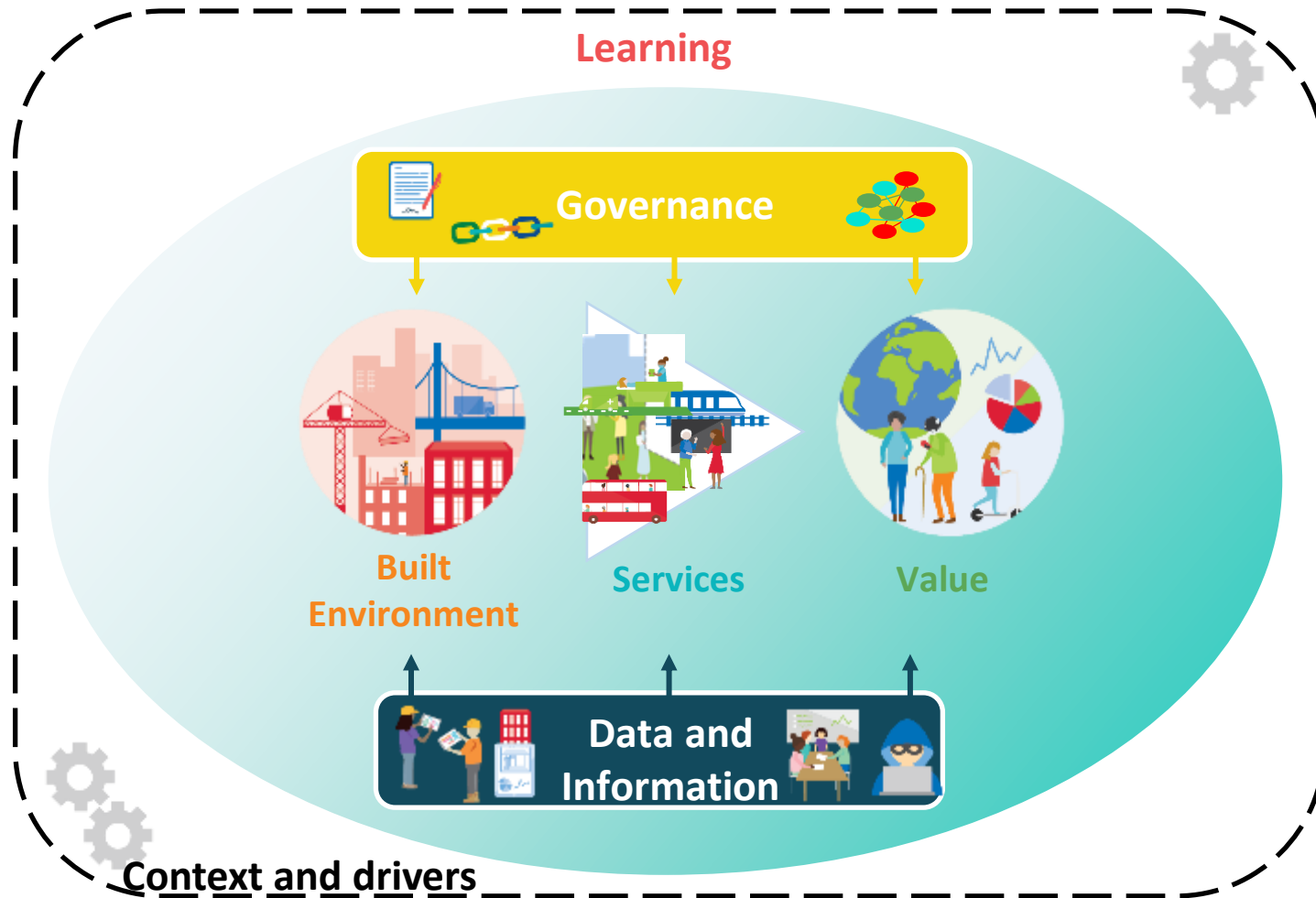


Digital built Britain will unfold within a context of external drivers, trends and events - so the UK needs capabilities to discern and manage accordingly

Context and drivers

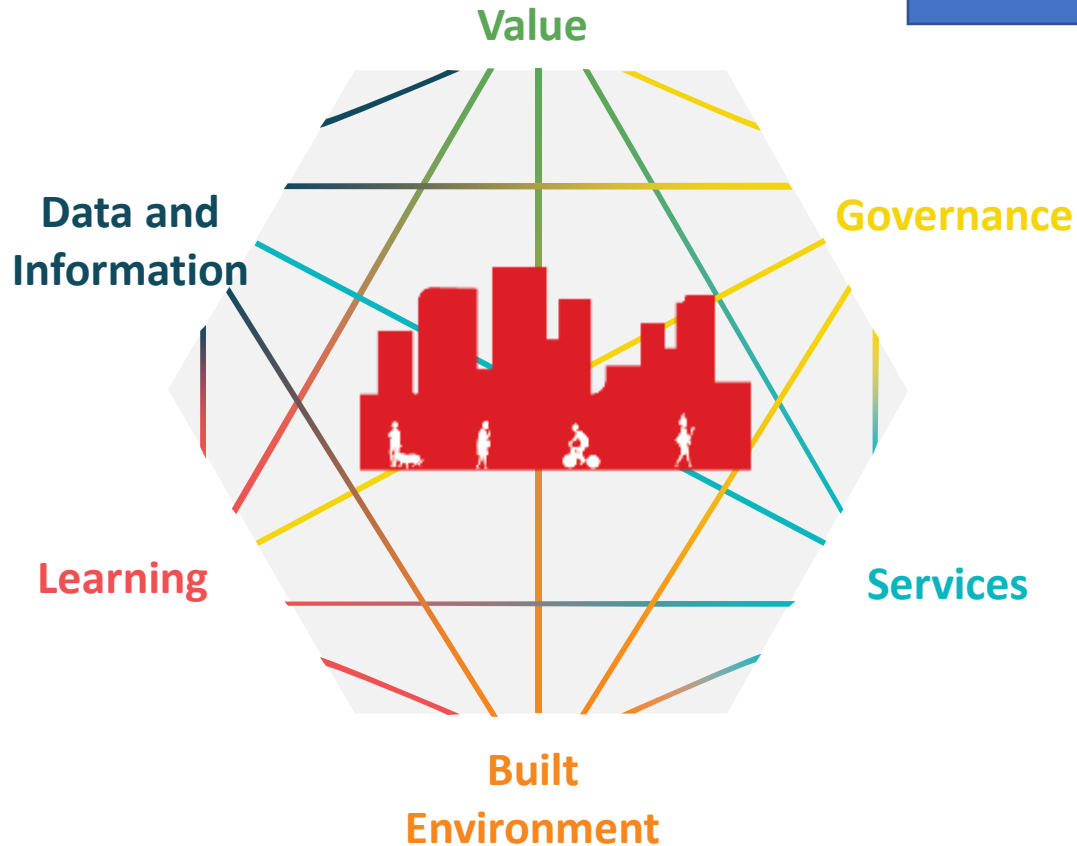
The Research Agenda needs to cover every aspect of digital built Britain – how it's defined, developed, delivered and enhanced

This gives us a way of grouping capabilities that reflects the scope necessary



We find that every aspect relates to every other

... and so there is copious cross-linking highlighted between the capabilities discussed in the framework



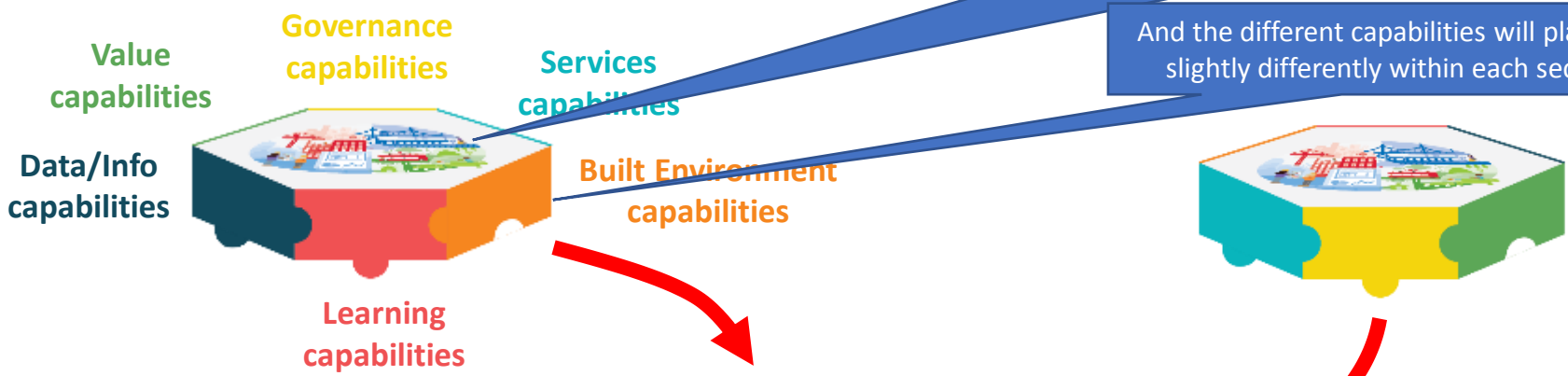
Throughout, we have kept in mind the lifecycle...



Each sector will have its own perspectives, imperatives and priorities – and we will need the capabilities to integrate where and as appropriate

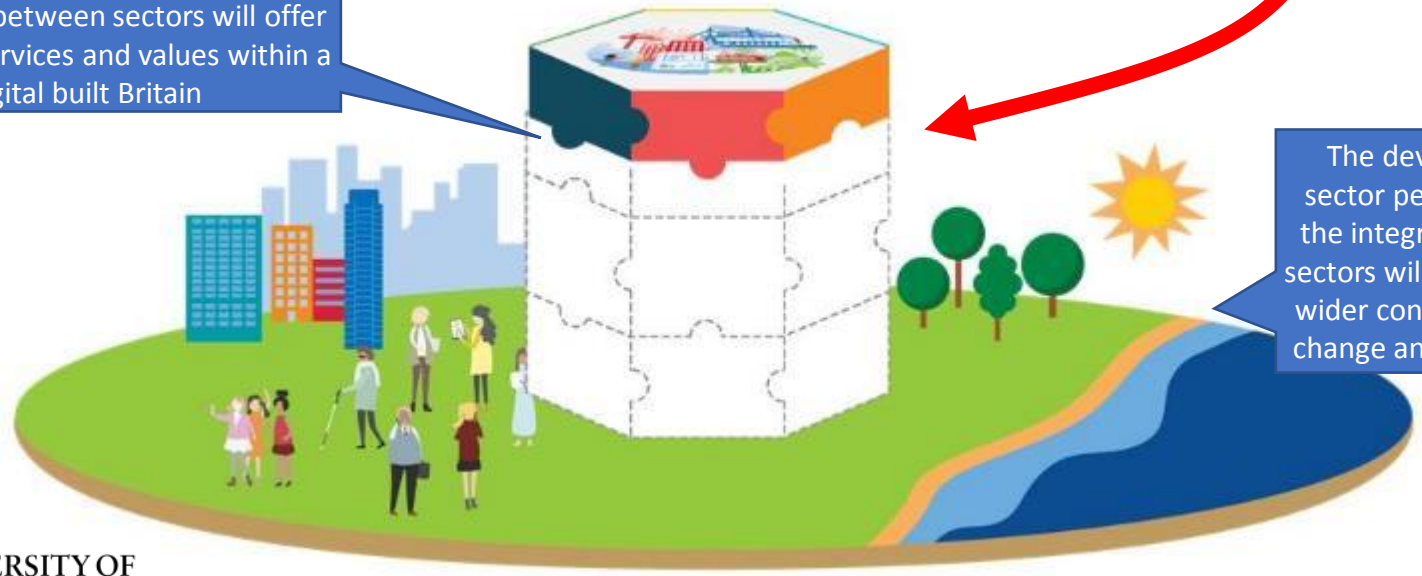
Each sector will have its own dynamics, processes and lifecycles

And the different capabilities will play out slightly differently within each sector

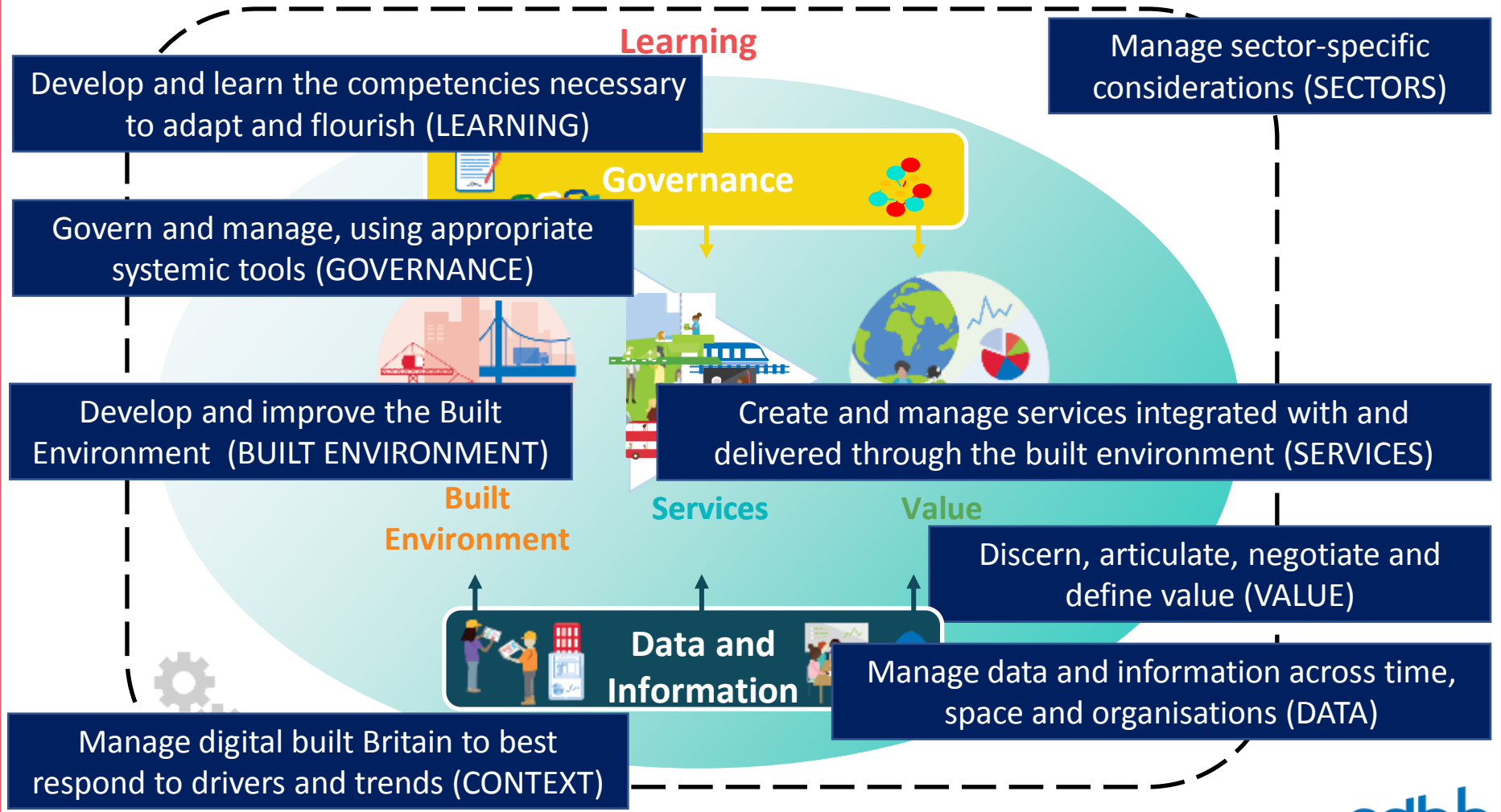


Integration between sectors will offer enhanced services and values within a digital built Britain

The development of sector perspectives and the integration between sectors will unfold within a wider context of external change and development



We have adopted categories to describe the capabilities to span the needs of digital built Britain



Then we have gone on to further unpack the capabilities below these headings

Discern, articulate, negotiate and define value (VALUE)

Create and manage services integrated with and delivered through the built environment (SERVICES)

Develop and improve the Built Environment (BUILT ENVIRONMENT)

Manage data and information across time, space and organisations (DATA)

Govern and manage, using appropriate systemic tools (GOVERNANCE)

Built

Services

Value

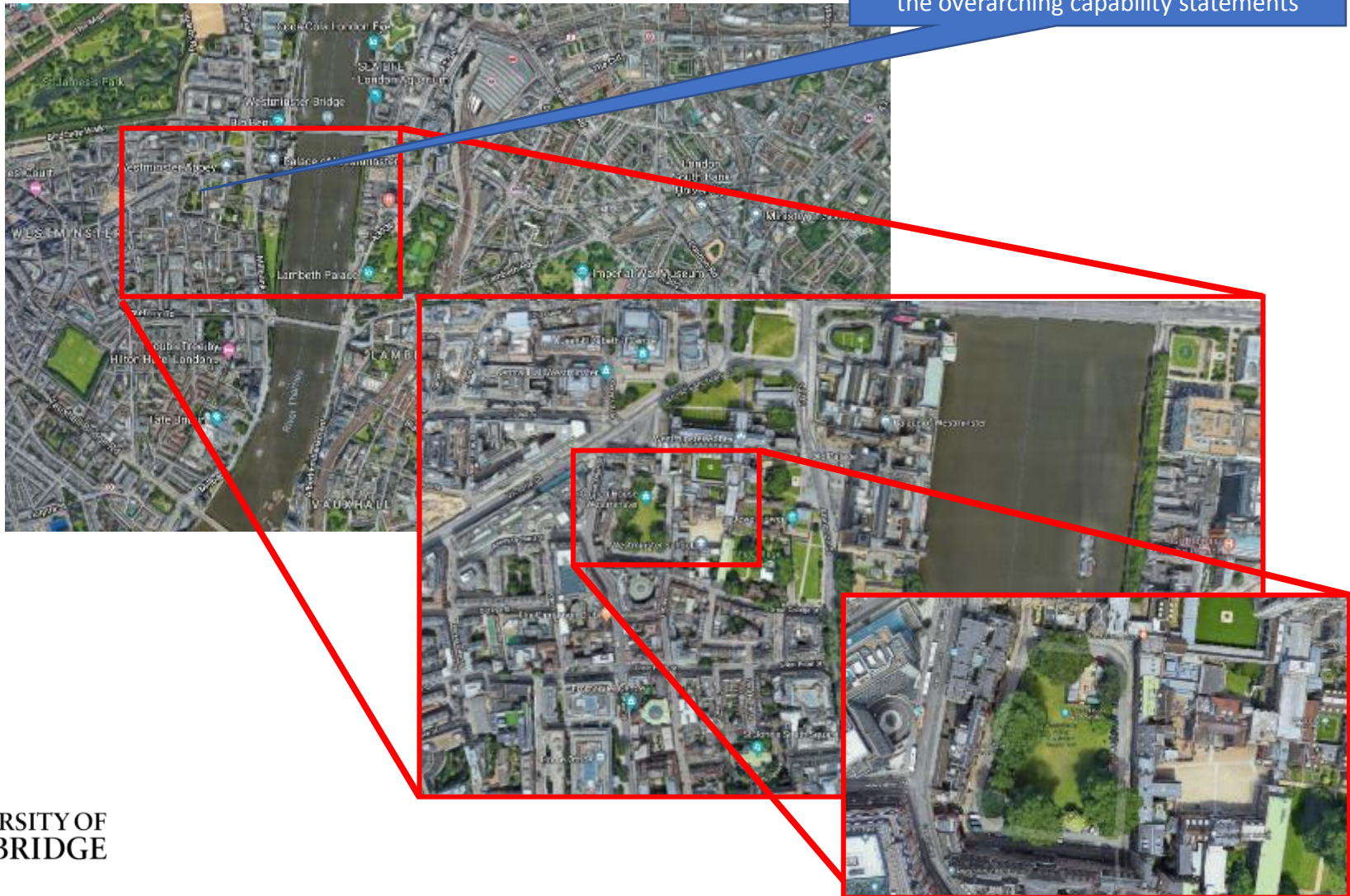
Develop and learn the competencies necessary to adapt and flourish (LEARNING)

Manage digital built Britain to best respond to drivers and trends (CONTEXT)

Manage sector-specific considerations (SECTORS)

This is structured as a massive hierarchy of capabilities ... most capabilities and enabling technologies are in there at some level

... even if they're not immediately visible in the overarching capability statements

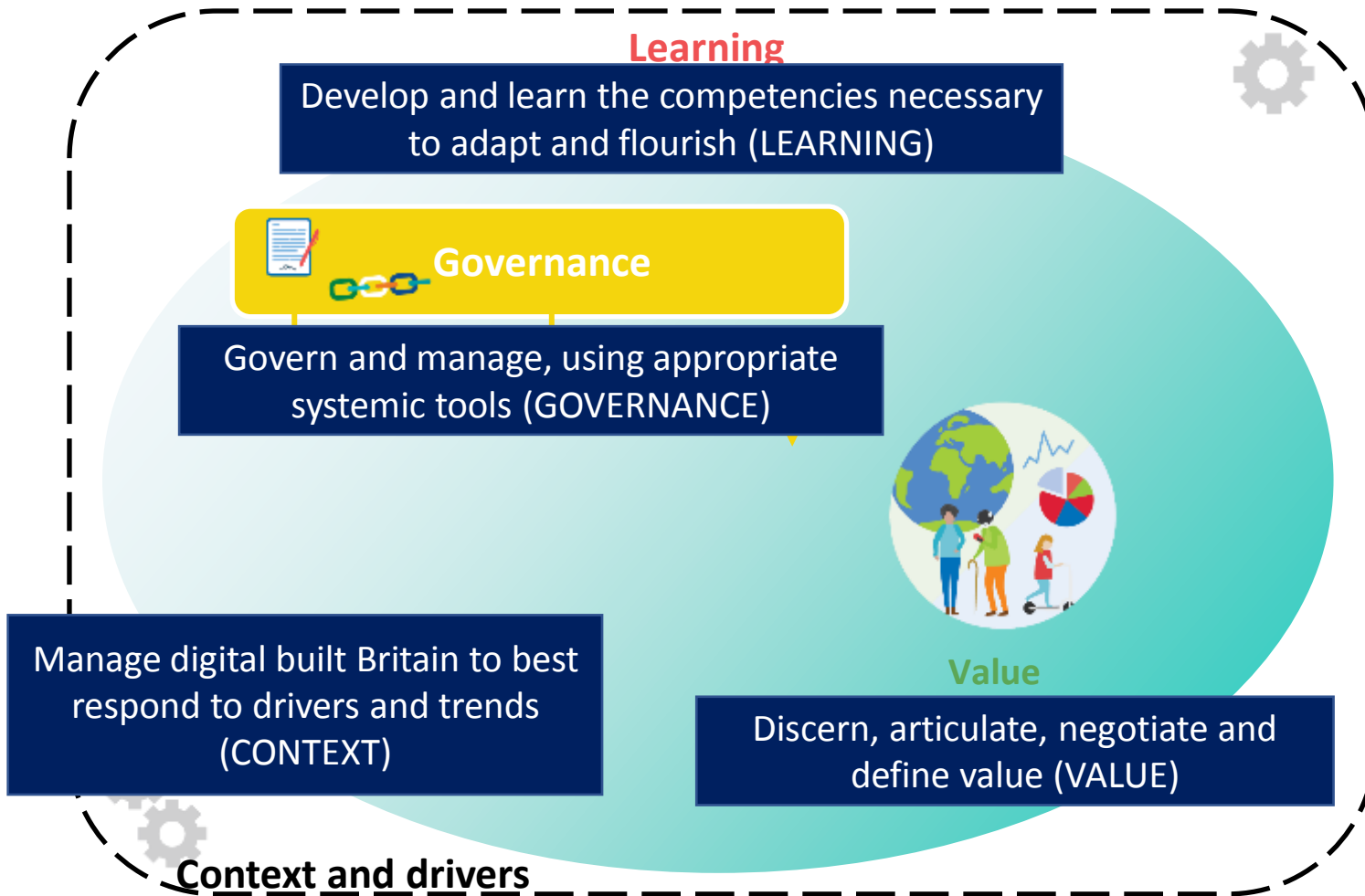


We are also developing the Research Landscape to identify centres of competence

These tags will provide a link between the Landscape and the portfolio of capabilities

Centre of Expertise	Host Institution	Centre Type	Summary Description	Tag 1	Tag 2	Tag 3	Tag 4
ACHILLES (Assessment, Costing and enHancement of long lIfe, Long Linear assETs)	University of Newcastle	Multi-Institution Research Project	EPSRC-funded grant to 7 institutions to carry out research into the deterioration of long-linear infrastructure assets	Supporting the Natural Environment through dbB	Model and Manage Interactions	Communicating Data Insights	Ensuring Future Resilience
Administrative Data Research Partnership	Office for National Statistics	Nationally Relevant Body	Forthcoming ONS-ESRC partnership to make de-identified administrative data available to researchers				
Advanced Manufacturing Research Centre	University of Sheffield	Multi-Institution Research	Network of research centres, with specialisms including integrated manufacturing, design	Data and Digital Tools	Developing Data-Dependent Technologies	Modelling, Simulation and Digital Twins	
Advanced VR Research Centre	Loughborough University	Research Centre/Group	Uses advanced modelling, simulation, digital twin and interactive visualisation techniques to investigate industrial challenges	Developing Data-Dependent Technologies	Modelling, Simulation and Digital Twins	Data Acquisition and Management	Specifying Data Needs
Alan Turing Institute	British Library	Nationally Relevant Body	National Institute for data science and artificial intelligence	Data Acquisition and Management	Modelling, Simulation and Digital Twins	Model and Manage Interactions	Communicating Data Insights
Asset Management - Institute for Manufacturing	University of Cambridge	Research Centre/Group	Research group working on approaches to maximise the value realised from complex engineering systems and assets	Complex and Integrated Systems	Model and Manage Interactions	Making dbB Investible	Data and Digital Tools
Bartlett Faculty of the Built Environment	University College London	University Department	Multidisciplinary faculty, with expertise in architecture, construction, planning and project management				
BEAM Research Centre	Glasgow Caledonian University	Research Centre/Group	Centre focused on built environment asset management with a focus on sustainability in social, environmental and economic terms	Ensuring Future Resilience	Professional Competencies	Making dbB Investible	Data and Digital Tools
Bennett Institute for Public Policy	University of Cambridge	Knowledge Exchange Centre	Seeks to build connections between technology and science innovations and political and economic decision making				

In the first working session we explored in more detail the capabilities around the periphery of the core three



We worked in five groups, using this template to guide the thinking, with a plenary session to summarise views

Table:	Sub-topics that need adding or deserve extra emphasis	Primary dependencies / cross-links	Other developments / revisions
Discern, articulate and negotiate <u>value</u>			
<u>Govern</u> and Manage, using appropriate <u>systemic tools</u>			
<u>Develop</u> and learn the <u>competencies</u> necessary			
Manage dbB to best respond to <u>drivers and trends</u>			

We captured many insights on post-it notes

... and the following pages reflect the highlights

... while finer details will be included in the final document

In order to discern, articulate, negotiate and define value, we will need to:

Envisage, explain and characterise digital built Britain (at all spatial and temporal scales), its benefits for and impact on the people, economy and environment

- Explore and debate the role of digital built Britain in the society of the UK and its evolution
- Engage with a wide and inclusive community of stakeholders and researchers
- Define coherent and consensus views on priorities of and linkages between outcomes outputs, activities within digital built Britain
- Choose and use appropriate models (social, economic, engineering) for exploration, explanation, communication, and prediction of the implications of digitalisation in the built environment
- Define and use measures of performance (KPIs) that enable the management of outcomes

Beware any temptation to use sectoral boundaries – all the considerations here will cross sectoral bounds, in many dimensions (via business models, complex systems, networks of uncertainty etc.)

Recognising ‘opportunity’ and ‘risk’ in an uncertain world – this as a significant extension of the thinking

Recognise the pervasive value of security throughout

This capability sets the context for the next two

Emphasise the importance of intangibles and, especially, the complex web of causative factors on outcomes

Recognise the subjectivity of intangibles and beware any approaches to hide this behind (possibly spurious) quantification

Add extra emphasis to creating a deep understanding about the role of the built environment and its management in contributing to the social outcomes sought by the UK. Translate such understanding into capability

Acknowledging changing context – including power relations

Pay particular attention to interfaces – where data and information matter most and where value is created, realised or destroyed

Reference work and literature in Large Technical Systems

Note also the implications of Systems of Systems models

Make explicit the underlying Theories of Change

Beware the risks of quantifying intangibles in ways that oversimplify the difficult trade-offs to be made and the potential for misleading measures of outcomes and subsequent error

Explore potential links to Sustainable Development Goals and other frameworks

In order to discern, articulate, negotiate and define value, we will need to:

Assimilate wants and needs from diffuse and varied user groups and translate into procured services and assets for the public good

- Discern, articulate and negotiate prioritised through-life value and expenditure on behalf of users and non-users
- Discern, articulate and negotiate value across interacting public and private institutions
- Translate needs and wants into meaningful specifications
- Establish the potential benefits and disadvantages of centralised monitoring, data collection and management of UK national assets and specify accordingly
- Balance demand management and other forms of social influence with the ethics of power and culturally or contextually differing values and agendas
- Pre-empt and adapt to market demand as users become more digitally competent and their expectations change
- Define and use measures of performance (KPIs) for management of services and assets for the people and economy of the UK

Acknowledge and refer to the ongoing debate about 'public value' and its creation

Recognising 'users' of all kinds – using the services in assets in unexpected ways ('Skateboarders are users too')

... and future generations

.. and as they work in conjunction with people and communities (see 'asset based services')

In order to discern, articulate, negotiate and define value, we will need to:

Internalise corporate value and find approaches and business models to make digital built Britain investible

- Model whole-life value and totex
- Extract value and allocate reward to providers for value creation / cost reduction which is offset in time and space
- Identify and analyse the impact and cost/benefit of digital tools and technologies
- Identify and overcome current and future barriers to uptake
- Model the ways in which sector capabilities enabled by digitalisation will support international competitiveness

Explore implications of

- The value of 'data as an asset',
- How servitisation as a philosophy will change the flavour of the value of data
- The shift from 'value to the asset owner' to 'value to the service provider' to 'value to the user' (hence illuminating the differences between value creation and value capture)

Identify other sources of value (e.g. social and intangible) down the supply chain

Note the value to be created by asset management in the broadest sense rather than merely managing assets post hoc

Note carefully the counterfactual – the cost of inaction

Exploring data and information as an asset

Beware risks of an over-emphasis on sector boundaries

Note how changing sector boundaries, changing business models and changing technologies (e.g. OSM) could change the underlying competitive dynamics of sectors, supply chains and companies

In order to govern and manage, using appropriate systemic tools, we must be able to

Design and manage the regulation of digital built Britain

- Assess the implications of policy changes (both immediate and adjacent) on dbB, its governance and management
- Analyse and design the interaction between regulation, standards and data / information management
- Predict and manage the interactions / dynamics between governance and stakeholders
- Develop the planning regime and mechanisms in the light of digitalisation
- Design legislation and regulation, advice and guidance and the supporting processes to support / enable automated compliance checking

Acknowledge the trade-offs and the embedded questions inherent in centrally regulated versus 'free-market' philosophies of governance

Recognising that this domain will be characterised by needing to govern the management of large amounts of (potentially sensitive) data for decades

How to evaluate the options and to decide between centralised or decentralised, government or self-regulation and the candidate vehicles for its achievement

Including the role of non-state actors

Recognise current work in the approaches and issues in regulation and governance of infrastructure based services

Recognising the change-management task

... and guidance materials

... in the face of new and rapidly developing technologies

In order to govern and manage, using appropriate systemic tools, we must be able to

Create, standardise and roll-out new contractual structures which will support the realisation of digital built Britain

- Create new forms of contracting to underpin value creation and appropriation in the digital built environment
- Standardise and adopt new contractual forms
- Create and manage risk management tools

Create and manage standards to underpin the development and operation of dbB

- Define and develop standards for use through-life across increasingly integrated services and assets
- Use standards to better support the through-life use of information and its exchange between stakeholders
- Develop and apply standards for the use of predictive modelling and the use of data and information

Add the capability to define, with the right mix of flexibility and robustness, the characterisation of data and information, and the associated responsibilities and liabilities in ways that will underpin effective contracts

A suggested revision to 'value management tools' – need also to retain references to risk and uncertainty and the capacity to manage so far as possible

... making appropriate use of current standards, disseminating and engaging with current work that is already available

In order to govern and manage, using appropriate systemic tools, we must be able to

Engage with complex and integrated systems and projects, using data, information and digital tools to make and communicate good decisions

- Understand, predict and manage for the integration and interaction of infrastructure built assets and services
- Assess the interconnected implications of decisions and their processes associated with complex and interacting projects
- Scope and design modelling and analysis support for major decisions
- Discern, measure and communicate outcomes in major digital built Britain projects

Ensure cross-referencing of the tight coupling between these capabilities and those associated with 'Value'

Referencing past and continuing work of NIC, ATI, ITRC, CIRIA and many others

Note also

- The implications of Systems of Systems
- The modelling of social systems alongside technical systems

Extend modelling to include the dynamics of interacting supply chains and business models, especially across sector 'boundaries'

Exploring data and information as sources of coupling and interaction and routes to resilience or vulnerability

Evaluate *a priori* the value of appropriately scoped modelling and analysis in support of decisions

In order to develop and learn the competencies necessary to adapt and flourish, we must be able to

Recognising this as a process

... conscious always of those who might be left behind

Capturing the need, across many constituencies, for a competence in trade-off and compromise

Add note that nowhere is this a call to substitute user competence as an alternative for good design to maximise accessibility and ease of use

Value the benefits of enhancing learning and development

- Characterise and value the impact and benefit of investing in digital competencies
- Characterise and maximise the targeting, design and dissemination of research and demonstrators
- Optimally target teaching and learning to benefit people, organisations and sectors

Map out the ecosystem of participants in the domain to identify leverage points in adaptation and development

- Map and model the interplay of digitalisation, data and tools with competency of individual and organisations
- Map out the wider ecosystem to identify non-participants and under represented populations in order to address the digital divide

... recognising that this will change over time, especially as value networks change and as 'sector boundaries' change

... explore the alignment of competencies with information transactions across the rest of the framework

Clarify supply and demand and mis-matches of skills and competences

In order to develop and learn the competencies necessary to adapt and flourish, we must be able to

Develop personal digital competencies

- Predict and define data-literacy needs and access routes for different groups of people in digital built Britain
- Teach and foster life-long data literacy
- Instil security-mindedness in individuals

Recognising the desirability of widespread capability in systems thinking, or at least an awareness of systems implications

Add note that nowhere is this a call to substitute user competence as an alternative for good design to maximise accessibility and ease of use

... including the competence to ask good questions about the purposes and provenance of data and information

Develop professional and practitioner competencies

- Define, develop and maintain agreed frameworks to underpin co-ordinated management of digital skills development
- Embed an understanding of the needs and imperatives for digital literacy and competence
- Achieve appropriate digital competence for people working throughout the supply chains
- Enable the teaching and certification communities to embed and assure competencies ahead of time

... including the ability to ask the right question, to articulate and specify the data needed and to ensure the competence to use the information in ways that reflect its source and quality

In order to develop and learn the competencies necessary to adapt and flourish, we must be able to

Develop organisational and institutional competencies

- Incorporate the benefits of digitalisation in organisational processes, structures and cultures
- Build institutional capabilities in the teaching, adoption, embedding and assurance of digital competencies
- Build client and owner competence in the use of data, information and digital tools to enhance the procurement and through-life management of new and legacy assets
- Built capabilities to use data, information and digital tools to enable better alliances, JVs, partnerships and supply chains
- Embed security-mindedness in culture, practice and processes

Ensure that functions within organisations understand the system-wide sources of value and cost in order to avoid merely local functional optimisation in an ever-more integrated world

Build and apply competence (as a client or owner) to specify and use data to better manage assets for through-life value (link to 'Built environment' section)

Develop sector competencies

- Promulgate and incentivise good practice in adopting digitalisation via sector institutions and leadership bodies
- Work within and across sectors to promote movement between sectors and to share lessons and apply these in future industry processes, governance and practice
- Develop and support supply chain competence in the adoption and application of appropriate digital tools and technologies

Develop the ability to learn from other sectors (e.g. from NPfIT in NHS, the long-life assets in defence, e.g. the B52, Oil & Gas, long-life assets of equivalent complexity and integration)

In order to manage digital built Britain to best respond to external drivers and trends we must be able to

Characterise the likely impact of future trends and events; evaluate and develop the action capabilities to respond

- Model likely impact of future trends and events and identify response options and those responsible for action, integrating between bodies where necessary
- Design indicator sets related to the need for decisions and/or action
- Map out decision sets and assess their likely impact, benefits and costs
- Design timely and structured decision processes to respond to indicators

Design and rehearse proactive response by the appropriate bodies to identified hazards

- Design and rehearse responses to slow drivers through forecasting the impact of gradually acting trends
- Design and rehearse emergency response to fast-moving drivers

Monitor and model the range of drivers and trends likely to impact the built environment

- Monitor and model i) environmental changes and pressures, ii) demographics, iii) economic cycles, iv) political circumstances, v) cultural norms and expectations, vi) new technologies, etc.

... especially the 'horizon scanning' necessary for new technologies and the capability to characterise and manage new technologies

We will now explore in more detail the capabilities around the core three



Built Environment

Develop and improve the Built Environment (BUILT ENVIRONMENT)

Create and manage services integrated with and delivered through the built environment (SERVICES)



Services



Data and Information

Manage data and information across time, space and organisations (DATA)

We worked in five groups, using this template to guide the thinking, with a plenary session to summarise views

Table:	Sub-topics that need adding or deserve extra emphasis	Primary dependencies / cross-links	Other developments / revisions
Create and manage <u>services</u> integrated with and delivered through the built environment			
Optimise the <u>built environment</u>			
Acquire, share and manage <u>data</u> across time, space and organisations			

In order to adapt and manage services integrated with and delivered through the built environment, we must be able to

Explore implications of 'servitisation'

Discern and define value and its negotiation in the context of asset-based services

- Discern and define the links between outcomes / value and outputs / KPIs for services delivered in and through built assets
- Define service and asset security 'performance'
- Define risk, authority and liability relationships between asset entities and service entities
- Forecast market dynamics and user behaviours in the face of digitalisation and integration

As an extension of "infrastructure-based" services

Emphasise further the links between services and outcomes, especially the intangible – see 'Value' section

Define an architecture of 'causality' between assets / infrastructure and the dependent and provided services which can underpin specification, creation and management of service

- Identify the coupling between activity and value (through asset lifecycle) for the interaction of i) services and assets and ii) services and networks
- Develop and use models (e.g. digital twins) to design and manage effective couplings of services and their supporting assets
- Understand and predict the interdependency and behaviours between different services at a discrete levels of abstraction and spatial extents (e.g. national, city, town, or neighbourhood)

Emphatic support for the need to understand service / asset / data interaction across the lifecycles of each

Noting the significant implications of the different lifecycles of services and of assets

In order to adapt and manage services integrated with and delivered through the built environment, we must be able to

Explore the use of language here to best communicate the services and their relationship with assets

Create the commercial relationships and business models to develop, deliver and exploit asset-dependent services

- Create business models that reflect the value of trade-offs in the timing of investment and in the design and operation of each of services and the built environment
- Create business models and commercial relationships that distribute or mitigate risk
- Create the data and information sharing mechanisms for the development and delivery of services integrated with and delivered through the built environment

Recognising the potential impact of business models and their specificity to the context and capabilities of the organisations in the value chain, this may entail research to explore options, prediction and evaluation and also maybe experiments or trials. Note the link across to the requisite contractual structures.

In order to adapt and manage services integrated with and delivered through the built environment, we must be able to

Specify and manage services integrated with and delivered through the built environment to deliver value for users and investors

- Specify services that exploit the capabilities offered by digitalisation of the built environment
- Design and create services that exploit the capabilities offered by digitalisation of the built environment and benefit from increasing integration
- Create meaningful measurements of services and of key attributes of their underpinning built assets, through-life
- Manage the delivery of services in the context of the digitalised built environment
- Define, monitor and manage asset condition through-life to enable and enhance services

Note the need to develop capabilities around shared languages and shared mental models among and between people working

- With services and assets
- Across organisations
- Across sectors

Note that this is mirrored across the interfaces between assets and services

In order to develop and improve the Built Environment across its lifecycle, embracing digitalisation we must be able to

We have replaced the word “optimise” with “develop and improve”, as appropriate, throughout the document. In such a complex environment true optimisation is unlikely and, if focused on an incomplete set of considerations (e.g. with respect to objective functions, non-linearities, fitness landscape) would actually be unhelpful. The word has connotations of optimisation with respect to cost or efficiency and may therefore fail to reflect a very real concern about resilience.

Evaluate, manage and protect the natural environment as an essential resource for and partner with the built environment

Ensure the ‘lifecycle’ gives adequate / greater attention to the strategic planning phases that occur before DBOI

- Enhance system modelling perspectives to broaden consideration of natural environment issues
- Translate the desired outcomes from - and impacts on - 'ecosystem services' into specifications for services and built assets
- Design and use metrics for managing the interactions between the built and natural environments

Note the need to develop capabilities around shared languages and shared mental models among and between people working

Model and manage interactions in coupled infrastructure and associated services

- With services and assets
- Across organisations
- Across sectors

Note that this is mirrored across the interfaces between services and assets

- Model and predict interactions in tightly coupled infrastructure systems, especially interactions through digital interconnections or modelled/predicted by new digital tools
- Manage interactions between services, assets and organisations

Explore also loose couplings and Systems of Systems

In order to develop and improve the Built Environment across its lifecycle embracing digitalisation we must be able to

Use data, information and models to better manage assets for value through-life

- Understand and achieve the value from modelling tools (e.g. digital twins)
- Use shared data/information and digital data/information to inform asset management processes
- Develop and improve integrated assets or portfolios / fleets of assets through-life
- Manage and develop assets, especially legacy assets, exploiting data, information and digital tools
- Strategically collect, share and use data and information based on available modelling tools

Develop and use new technologies which have a critical dependency upon / which are greatly enhanced by digital tools and enabling data

- (Work in progress to include the **capabilities** as appropriate from candidate technologies, e.g. PLM, AR/VR, OSM)

NB the need to re-frame this in terms of identifying sources and mechanisms of value creation and therefore the implications of asset management, in contrast to merely 'managing assets'. Essential to add explanatory material to describe the capability accurately

Articulate and explore the differences between 'snapshot' data from a single point in time and 'longitudinal' data sets. Note also issues of provenance.

Add new sub-capability "Choose appropriate strategies for development and improvement, exploring whether and how optimisation might be undertaken", recognising that this entails having the intangibles well articulated within the trade-offs, and that the nature of the trade-offs and of the decision space are well understood.

Manage IP / confidentiality
Manage traceability to maintain design intent.

Include Machine Learning and Artificial Intelligence

In order to manage data and information across time, space and organisations, we must be able to

We have replaced the word “data” with “data and information” to reflect the nuances of both and avoid the risk of too narrow a perspective

Specify needs for data and information and for its discovery, use and management; govern the use of data and information to maximise its value and minimise its downsides

Note specifically the interfaces in processes between organisations and entities at all scales

Encompassing data lifecycles

- Plan the use of data and information based on how it will be used to create value
- Characterise and define the attributes of a stream or set of data and information for particular applications, subject to an agreed framework
- Measure and manage the attributes of a stream or set of data and information for particular applications, subject to an agreed framework
- Make data and information discoverable and accessible
- Express data and information uncertainty and communicate its implications to users

Identifying and compensating for sources and effects of bias in data definition, collection and use

With security as an ever-present consideration

Consider the resilience implications of flaws and imperfections in data and information, flaws that may arise at any point in the data lifecycle

Ensure consideration of synthetic data, especially with respect to its provenance and metadata

In order to manage data and information across time, space and organisations, we must be able to

Create the operating and organisational governance frameworks for data, information and models

- Craft data and information management frameworks which mesh with industry sector processes and frameworks
- Specify needs for integrated legislation, regulation and standards to enable and underpin organisations' actions and collaboration across sectors
- Create frameworks that support ethical data and information management within and between organisations

Managing the changing 'purpose' of data (especially where permissions relate to a different purpose)

Create the technical frameworks and tools that will facilitate sharing

- Develop data and information structures, architectures and schema that enable the delivery of smart services and infrastructures at multiple scales

Explore the implications of upper ontologies as a mechanism for translation, not only between data schema and between vocabularies, but also as a translation route between different world models

Note to focus on interfaces and 'touch points' both to prioritise attention and to highlight the most critical 'translation' tasks and ontology overlaps

In order to manage data and information across time, space and organisations, we must be able to

Acquire and manage data and information

- Acquire and augment integrated data and information about new and legacy asset attributes (including and beyond geometry)
- Ensure strategic day-to-day management of data and information attributes to ensure its value remains consistent with expectations
- Manage data and information reliably and ethically across supply chains
- Preserve appropriate levels of security over time to manage liability, risk and IP when sharing data and information
- Enable permissioned access to data and information in formats that are tailored to users' needs and competence

Encompassing the data lifecycle

Recognising and explicitly sharing the context necessary to interpret the information appropriately, especially the provenance of the data and whether it is, for example, a 'snapshot' or but one item from a longitudinal data set.

In order to manage data and information across time, space and organisations, we must be able to

Use data and information to generate insights

- Build models that are robust, capable of federation/integration, capable of combining data and information from multiple sources and actors, from assets of all ages
- Integrate models and live data and information (e.g. Digital Twin)
- Integrate models and asset management tools
- Build tools to query information repositories that are based on formal structures

Explore the potential of semantic enrichment, the tools to achieve this and the enhancement of value in better use of data coupled with nuanced information

Noting that design-time models embody data that needs to be maintained and shared, importantly, for example, records of intention and causality

Highlighting, as appropriate, current work in modelling and sharing of data and information

... at multiple scales – and underground

Communicate and act on data and information

- Communicate data and information in ways that maximise insight and incentive to action
- Make and communicate decisions acknowledging data and information provenance and limitations
- Feed insights back along the value chain of the built environment to augment and improve future practice

We mentioned earlier that everything is linked to everything – but which linkages are more important and / or which linkages are absent today

Detail matters here – please work at a detailed level to tease out the capabilities needed to link between

- Sectors
- Parts of supply chain
- Elements of the life-cycle
- Capabilities themselves

The purpose here is not to combine capabilities in ways that might generate fragility, but, on the contrary, to identify critical capabilities that may be hidden in adjacent sections while having a considerable bearing on the UK's ability to deliver other capabilities.

Noted that the definitions of sectoral boundaries may lead to excessive focus on 'silos'. Also that sectoral perspectives may offer novel insights

Points from this session have been captured among the previous pages

We will use the insights from this workshop to further develop the description and detailing of capabilities within the framework

With many thanks to all involved

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Comments or questions very welcome
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