NHSSCOTLAND DIGITAL ESTATE (DE)

NHScotland

Abstract

Framework, setting out the vision, principles and guidance to help Boards make accurate building information available, maximise operational efficiencies, optimise performance, to lower costs, increase output and maximise facility utilisation.

NHS National Services Scotland

Acronyms

3D	Three Dimensional, something that has width, height and depth
AI	Artificial Intelligence
AIM	Asset Information Model
API	Application Program Interface
AIR	Asset Information Requirements
BASMP	Built Asset Security Management
BASS	Built Asset Security Strategy (BASS)
BMS	Building Management System
BSAIR	Built Asset Security Information Requirements
CAD	Computer-aided design
CapEx	Capital Expenditure
CAFM	Computer Assisted Facilities Management
CDBB	Centre for Digital Built Britain
CDE	Common Data Environment
CMMS	Computerised Maintenance Management System
COSHH	Control of Substances Hazardous to Health
DDA	Disability Discrimination Act
DE	Digital Estate
DT	Digital Twin
EAMS	Estates Asset Management System
EDMS	Electronic Document Management System
EIR	Exchange Information Requirements (also referred to as 'Employers Information Requirements')
EMC	documented Electromagnetic Compatibility
EPR	Electronic Patient Record
GIS	Geographic Information System
IM	Information Management
IoT	Internet of Things
LASER	Light Amplification of Stimulated Emission of Radiation
LEV	Local Exhaust Ventilation
LiDAR	Light Detection and Ranging
MIDP	Master Information Delivery Plan
ML	Machine Learning

OCR Optical Character Recognition

OIR Organisational Information Requirements

LOLER Lifting Operations and Lifting Equipment

PAMS Property and Asset Management Strategy

PAT Portable Appliance Testing

PDF Portable Document Format

PDT Product Data Templates

POE Post occupancy evaluation

PPM Planned Preventative Maintenance

PSCP Principal Supply Chain Partner

ROI Return on Investment

SCADA Supervisory Control and Data Acquisition

SCIM Scottish Capital Investment Manual

UCV Ultra Clean Ventilation

Terms

BIM Level 2 Developing building information in a collaborative 3D environment with data built in but is created by collaborating separate discipline models.

Data information stored but not yet interpreted or analysed [from PAS 1192-2]

Data lake centralised repository that holds vast amounts of raw data in its native format until it is needed.

Data set collection of related sets of information/data and can be manipulated as a unit by a computer.

Digital Twin Digital replica model of a physical asset and its process.

Information reinterpretable representation of data in a formalized manner suitable for communication, interpretation or processing [from BS EN ISO 19650-1]

LIDAR Light Detection and Ranging, surveying method that measures distance to a target by illuminating the target with laser light and measuring the reflected light with a sensor.

Trigger event planned or unplanned event that changes an asset or its status during its lifecycle, which results in information exchange [from BS EN ISO 19650-1]

Key decision point point in time during the life cycle when a decision crucial to the direction or viability of the asset is made (during a project these generally align with project stages) [from BS EN ISO 19650-1]

Contents

Executive summary

The NHSScotland Digital Estate (DE) is a framework supporting the creation of a modern and digitised healthcare estate with a golden thread of information stretching across the entire National Health Service Scotland portfolio of built assets. The DE approach offers a consistent, integrated and repeatable methodology for curating and managing information of physical healthcare assets in a digital environment. The DE is not a list of instructions but a basis for NHSScotland Boards to create their own strategy based upon their specific asset management plans and in the context of their individual technology architecture.

In particular, the DE recognises that a more joined up and appropriate use of data and information is fundamental to supporting effective person-centred care, performance management, population health improvement, research and innovation, as well as value-added effectiveness.

At its core is creating an ecosystem with the ability to search, unify and analyse asset data and information. Having this ability at an enterprise level will support optimisation of NHSScotland Boards asset management strategies and management plans allowing them to use those assets more productively.

The DE builds on and supports the NHSScotland Building Information Modelling (BIM) strategy and guidance putting a lens over the existing estate and how this can be proportionately digitised.

The DE principles can and should be applied to all projects and existing healthcare-built assets to create a smarter NHSScotland built environment.

Note: This document should be read in conjunction with other related NHSScotland Digital guidance, especially Building Information Modelling (BIM), Security and Soft Landings.

Section 1: The NHSScotland Digital Estate (DE)

1.0) Introduction

The NHSScotland Digital Estate (DE) establishes a concept and methodology for NHSScotland Boards to digitise their portfolio of buildings and offer those that manage and use these built assets the best experience both now and, in the future. It has the potential to change the face of health and social care.

This document is a framework which establishes the high-level principles, methods and the target technology architecture needed to create a digital and connected estate.

An important aspect of the framework is the need to be proportionate in the extent of digitisation required especially where, as in most cases, the principles will be applied retrospectively to existing retained estate. It is important therefore to ensure that the approach is value driven and the level of digitisation is aligned with the opportunity and risk appetite. The DE therefore encompasses varying levels of maturity from simple digital documentation to Building Information Modelling (BIM) and on new investments the possibility of dynamic digital twins (DT).

Expectantly the framework will provide practical direction in the long term NHSScotland aspiration of having a modern and digital estate with a golden thread of information stretching across NHSScotland portfolios.

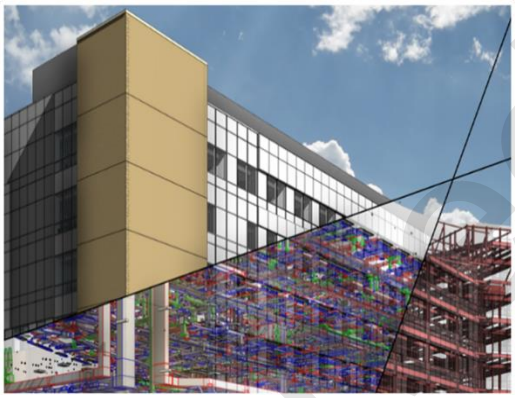


Figure 1 Dynamic Digital Twin

1.1) What is the Digital Estate?

The NHSScotland DE is an information management led approach which facilities the digitisation, integration and curation of appropriate digital models (unifying existing data and records) to enable efficient management of NHSScotland real-estate portfolios.

The NHSScotland DE provides an enterprise level source of searchable reliable information about the Boards built assets supporting joined-up decision making, dynamic insights and ultimately supporting better healthcare outcomes.

Figure 2 The connected estates

The NHSScotland DE approach offers a consistent, integrated and repeatable approach to curating and managing information of physical healthcare assets in a digital environment.

The principles of the Digital Estate

Based on the notion of 'data for the public good', we need strong founding principles to guide the NHSScotland DE and the framework through their development and on into their use.

Therefore, at the heart of the framework are nine values, aligned with our pillars of purpose, assurance and function that we are calling the Digital Estate Principles as shown in figure 3. NHSScotland Boards should embrace these principles in the development of their own DE strategy.

Figure 3 The Digital Estate Principles (based on the Gemini Principles)

1.2) Why is a Digital Estate important to NHSScotland?

Building a Safer Future is the independent review of building regulations and fire safety published in 2018 following the Grenfell Tower fire of 2017. The report principally relates to high-rise residential buildings. It finds that the processes that drive compliance with building safety requirements are weak and complex with poor record keeping and change control. These findings are without doubt representative of all built environment sectors and not just high-rise.

The report strongly recommends a 'golden thread of good quality information' to be created so that building owners receive the information they need and that there is a clear link between the design, construction, occupation and maintenance. The crucial purpose of this golden thread is to safeguard the availability, completeness and correct record of a facility's construction and its regulatory compliance. This may be created through mechanisms including formal, recorded change control, gateway testing, and the managed approach to the delivery of complete and correct facility information.

The creation of a golden thread of information is therefore inherent to NHSScotland Boards who manage portfolios of facilities. The creation of a DE is an opportunity to safeguard that a complete and proportionate digitised record set is in place. Ultimately the NHSScotland DE is an opportunity to enhance and personalise user experiences and generate insights into healthcare service needs.

Additionally, a mature DE model will help maximise operational efficiencies, optimise performance, to lower costs, increase output and maximise facility utilisation.

"The NHSS Digital Estate will help make accurate building information available to those responsible for assessing and demonstrating the safety of NHSS buildings."

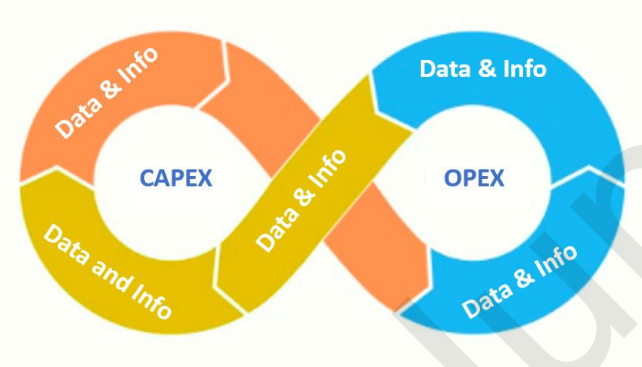


Figure 4 Golden thread of information

1.3) Alignment with other guidance

The NHSScotland DE has been designed to align with and help aid in the implementation of other parallel guidance. This includes:

- CEL35 (2010) which provided a statement of the Scottish Government's policy on property and asset management in NHSScotland entitled 'A Policy for Property and Asset Management in NHSScotland' (https://www.sehd.scot.nhs.uk/mels/CEL2010_35.pdf)
- The NHSScotland Property and Asset Management Strategy (PAMS)
- The Scottish Procurement Policy Note for BIM (SPPN 01/2017) (http:// https://www.gov.scot/publications/implementation-of-building-information-modelling-within-construction-projects-sspn-012017/)

1.4) What are the benefits of a Digital Estate?

The NHSScotland DE strategy has the potential to change the face of asset management and support better health and social care delivery through the following outlined in Table 1.

Table 1 NHSScotland DE strategy outcomes

NHSScotland DE strategy outcomes
Ability to search, unify and analyse asset data and information at an enterprise level supporting optimisation of NHSScotland Boards asset management strategies and optimising/prioritising its asset management plans.
More joined up and appropriate use of data and information, putting in place the infrastructure and supporting improved processes for use of information for wider purposes, to ensure that health and care systems in Scotland are continuously learning. This is fundamental to supporting effective person-centred care, performance management, population health improvement, research and innovation, as well as value-added effectiveness.
Enhanced resilience in asset management and service provision through smarter, faster responses to accidents and disruption. In some cases, using predictive simulation ensuring repairs before the fail process and supporting proactive approach to user service provision.
Data insight, making more informed decisions and providing a better coordinated approach to NHSScotland built asset management strategy.
An accurate repository of all information relating to an NHSScotland built asset through an Asset Information Model (AIM) Common Data Environment (CDE) as a means of receiving and retrieving information in the result of a trigger-related event eliminating the need for re-surveying or manual data collation.
Through feedback loops, better collection of data relating to operational and performance outcomes, especially those that matter most to NHSScotland built asset users providing insight as to how NHSScotland buildings are functioning allowing scenario modelling to drive continuous service improvement and support a net-zero carbon agenda.
Cross Board experience-based learning and feedback from asset and service performance.
Better user experience, communicating real-time data, combined with analytics and predictive simulations to enable better understanding of user behaviours and needs to support effective quality of care.
Creation of an audit trail of documents and decisions made to support statutory compliance and ensuring that NHSScotland built assets as safe and effective for quality of care.

Ultimately through the better information management and analytics the DE will help support our priorities of:

Person Centred, Safe, Effective Quality of Care, Health of the Population and Value and Sustainability.

1.5) The Digital Estate spectrum?

An important aspect of the DE is proportionality where the level of digitisation is in concert with the use cases and the risk profile of the various built assets within a Board's portfolio. Figure 5 illustrates the full spectrum of the NHSScotland DE.

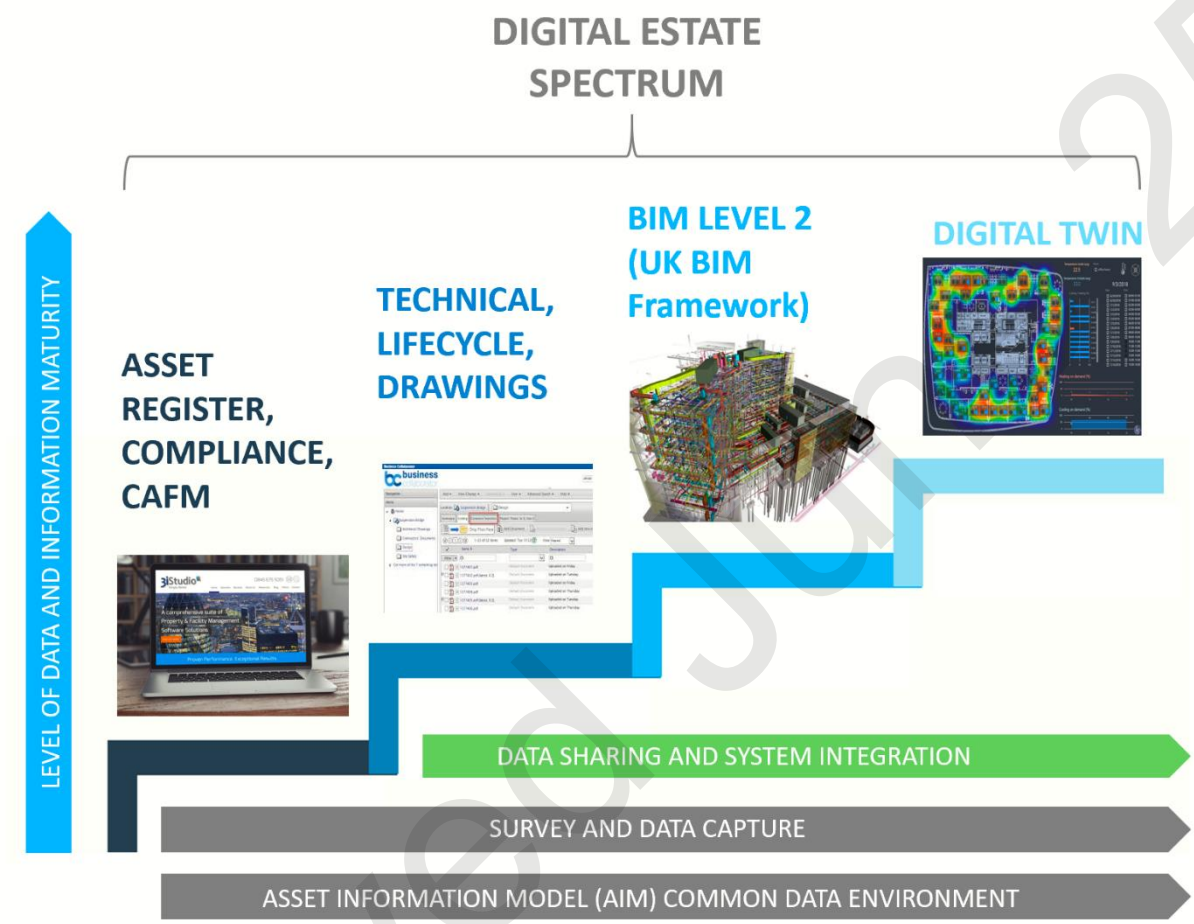


Figure 5 NHSScotland DE spectrum

This DE definition framework is a four-stage category structure that enables a range of digital approaches to be conceptualised to help better understand levels of maturity. The framework spans a variety of digital approaches underpinned by the concepts of:

- The Asset Information Model (AIM) Common Data Environment (CDE) technologies and processes;
- Survey and data capture methodologies; and
- Data sharing and system integration.

The four stages of the NHSScotland DE spectrum defined overleaf are intended to help Boards determine at a headline level the appropriate extent of data and information required to support a buildings asset management objectives and plan.

Category 1: Asset Register, statutory compliance information and CAFM Data

Asset register, statutory compliance information, Computer Assisted Facilities Management (CAFM) is the baseline data and information set for NHSScotland Boards.

This level of DE maturity provides centralised core estate data and information relating to the Board's land and property portfolio, compliance against statutory requirements plus related planned preventative maintenance (PPM) activities.

The data also relates to the condition and performance of these existing property assets; the costs of rectifying backlog maintenance; and the risks associated with the condition, compliance and suitability of the property assets to enable prioritisation of the main issues.

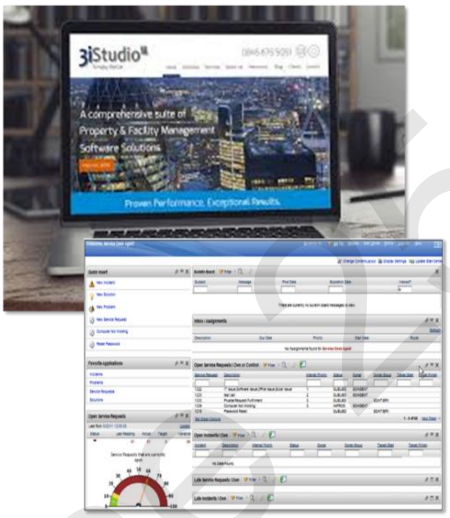


Figure 6 Estates Asset Management System (EAMS) with CAFM module

NHSScotland already uses an electronic Estates Asset Management System (EAMS) (figure 6) which is the foundation of the DE technology stack. Additionally, all Boards have a Computer Assisted Facilities Management (CAFM) system which can potentially be connected to the EAMS platform.

It is important that all statutory information relating to the built asset is current, digital and with sufficient metadata to support easy retrieval when required, for example in relation to a trigger event.

Category 2: Technical, Lifecycle and Drawings

At this level of maturity, data and digital information about the built asset can be used to inform decisions or answer questions related to technical performance such as building systems or products, its maintainability, lifecycle planning or spatial measurement. Typical information at this stage may include CAD files, Product Data Templates (PDT), electronic Operation and Maintenance documents (in a PDF format). (figure 7)

Information should be indexed and searchable using consistent naming conventions and stored in an appropriate Common Data Environment (CDE). Ideally where practical information such as CAD files should be bi-directionally linked to the asset register database EAMs.

Processes and roles should be established to make sure data and information is secure and is accurate and up to date.

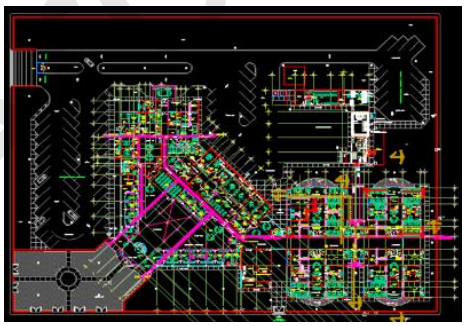


Figure 7 CAD files, Product Data Templates (PDT) and electronic Operation and Maintenance documents

Category 3: BIM Level 2

Building Information Modelling (BIM) Level 2 (also known as the UK BIM Framework) maturity encompasses the generation and management of structured information models comprising all named datasets used throughout the lifecycle of a built asset.

Information models will include a series of domain and collaborative federated models. The models, consisting of both object-oriented 3D geometrical and non-graphical data, are prepared by different parties during the project life-cycle within the context of a common data environment (figure 8). Using agreed information exchanges, project participants will have the means necessary to provide defined and validated outputs via digital transactions in a structured and reusable format.

Appropriate and proportionate measures will be applied to manage the security risks that affect a built asset, asset data and information.

Soft landings processes will be used to align interests between those who design and construct an NHSScotland asset and those who subsequently use it.

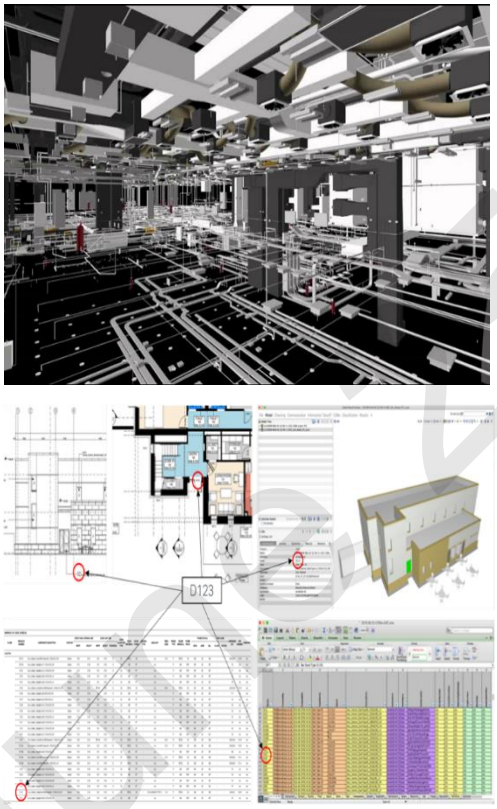


Figure 8 Information model

In most cases NHSScotland Boards will be specifying BIM Level 2 requirements for future new capital works as opposed to retrospectively modelling. However, when reviewing their portfolio there will be instances when there is benefit for creating a light retrospective model as a means of interface for other NHSScotland asset management systems.

Category 4: Digital Twin (DT)

Digital twinning for NHSScotland is the linking of physical assets (buildings and potentially end users) to a digital representation using data from sensors and analysing condition, efficiency and real-time status etc. This connectivity coupled with data analytics will not only reform levels of operational effectiveness of facilities, but extra insights from the Digital Twin (DT) will help to reshape and improve services, support person-centred care and improve outcomes. It is worth noting however that achieving a full DT for much of the retained estate is challenging and therefore it is important that expectations are managed from the outset. The DT should be both appropriate and proportionate to what the Board is trying to achieve.

Figure 9 conceptualizes the NHSScotland thinking behind the DT construct and highlights the frictionless data thread and inter-play between the physical facility and the digital model. Central to this model is having a good virtual foundation to connect with, and that is only possible through the use of BIM with its associated lifecycle data. Once in place it can integrate with sensing and analytics layers where advancements in internet of things (IoT), operational technologies and artificial intelligence (AI) are truly advancing the cyber physical value proposition enabling new levels of operational productivity.

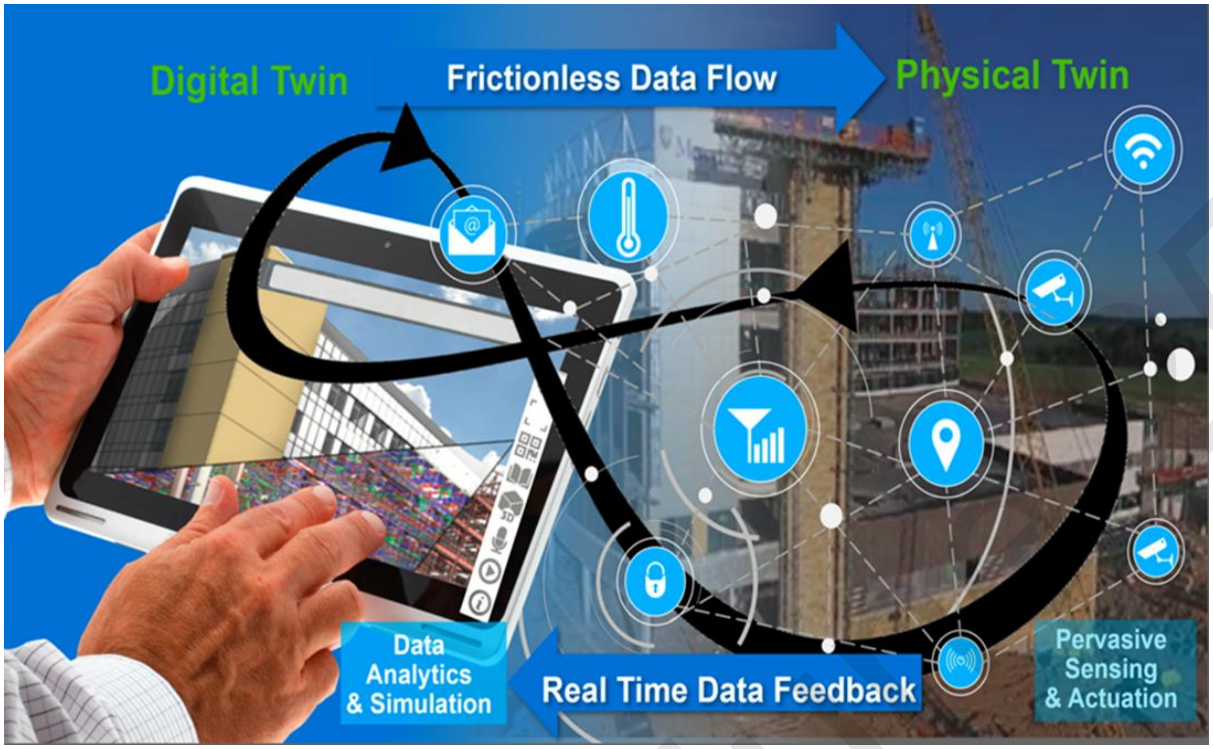


Figure 9 Concept of NHSScotland thinking behind the Digital Twin construct

Despite the term "digital twin" becoming progressively common in our construction lexicon, often as an abstract concept, there is no one agreed definition of what it is. Therefore, in order to describe the digital twin concept, it is first worth exploring what are considered its main characteristics:

- A trustworthy and accurate digital representation of something physical (such as a system or built asset such as a hospital building or portfolio of healthcare assets) (figure 10);
- Feedback loops from sensors and connected equipment enabling near real time data transportation and connectivity between the virtual replicate and the physical environments;
- A secure, single source of truth enabled by a common data environment such as a federated data lake; and
- Analytics, including potential machine learning and algorithm simulation providing insight, generating many possible forward solutions and supporting improved decision making.

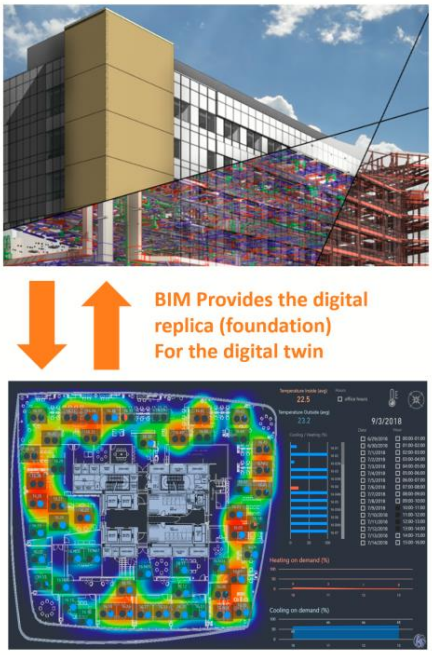


Figure 10 Digital Twin

The DT may also have different levels of maturity depending upon the complexity and the data use cases of the built assets it is associated with as figure 11.

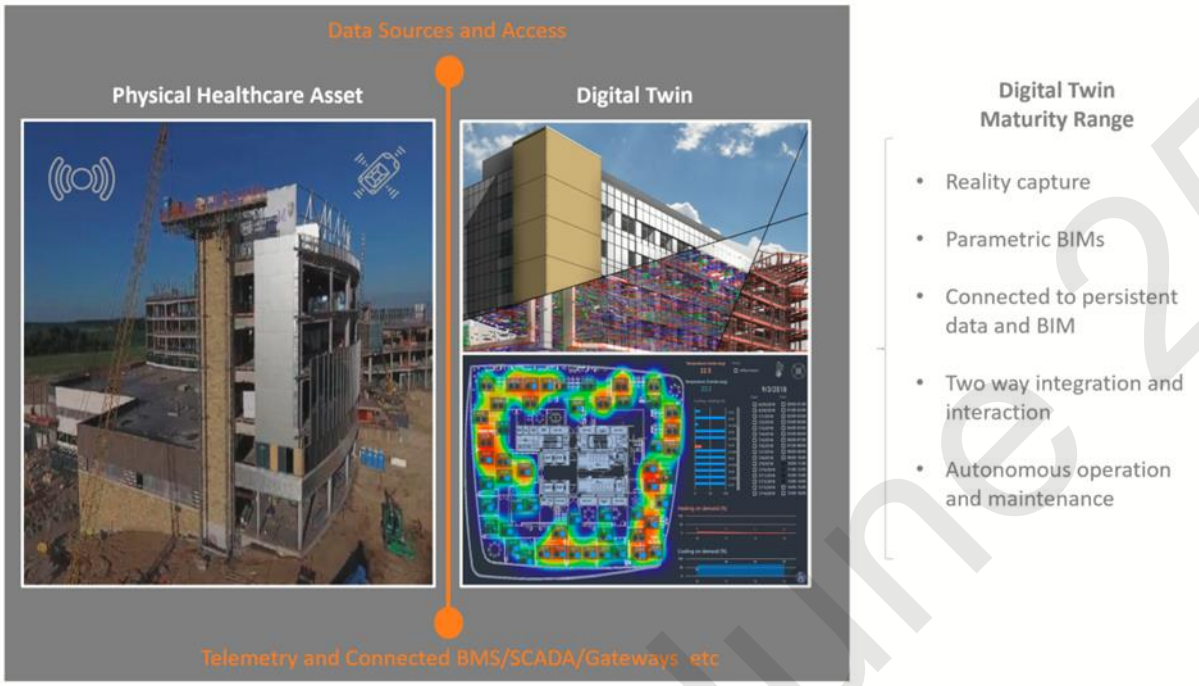


Figure 11 Digital Twin Maturity

The Centre for Digital Built Britain (CDBB) in the UK noted that "what distinguishes the digital twin from any other digital models is its connection to the physical twin." This non-static representation is an important characteristic. In simple terms the digital twin enables the health of a built asset to be better understood allowing NHSScotland Boards to take smarter logical action based on that health picture.

The Value Proposition of the digital twin for NHSScotland Boards

The journey to creating and curating a DT takes investment and commitment, especially for those that are mirroring at a portfolio level. If live built data is the new oil, you must invest in mining for it, but once you have access there's great value within it. There are many benefits to the DT model and the more the breadth and maturity of the connectivity and analytics the better the outcomes both qualitative and quantitative including the examples summarised below:

Better user experience

Communicating real-time data, combined with analytics and predictive simulations will enable better understanding of health facility user behaviours and needs. Harnessing and understanding of this data will support decision making to help tailor and optimise experiences and outcomes for the users of that built healthcare asset. This will be especially true of tracking user movements within a space giving valuable insight leading to better:

- Tailored healthcare pathways and experience;
- Better way finding;
- Improving the spaces in which patients are treated / occupy / access, visitors use, and staff work in;
- Personalised building services environment for patients and staff;

- Real-time traffic, mobility and parking monitoring, simulation and management;
- Safety and security;
- Equipment management;
- Equipment tracking; and
- A portal for asset users to access and process information such as latest status notifications.

Improved resilience and asset life cycle decisions

Digitally connected built asset systems as they continue to mature will enhance resilience in asset management and service provision through smarter, faster responses to trigger events, accidents and disruption in some cases using predictive simulation to allow a repair before fail process.

With many planned preventive maintenance activities carried out too frequently, or spent on assets with negligible effect on uptime leveraging data across the whole lifecycle will not only facilitate real-time pulse checks on the asset health, but support better operational responsiveness with optimised maintenance strategies and maximised asset availability, moving more towards a condition based maintenance regime.

Certainty of outcome

Turning data into better outcomes is a key primary objective of the DT construct creating an ability to simulate and test operational performance in a virtual environment. This is especially important to healthcare clients where state-of-the-art analytics married with health informatics and data science will help optimise complex space decisions and service provision predicting the impact of decisions before they are even made. Additionally, real world data will help inform certainty of cost and time outcomes, shifting to cost and time calculation as opposed to estimation. Where a client has distributed built assets in the case of NHSScotland Boards, the digital twin will, if upscaled, potentially facilitate portfolio wide operational cost measurement and balancing leading to improved outcomes at a macroeconomic level.

Whole life cost optimisation

Many mature clients and procurers are already targeting savings across the whole-life of an asset or estate and increasingly are seeing the digital-twin as being a valuable enabler. The DT concept can when mature, facilitate cross asset benchmarking, asset management scenario simulations, combined with real-time outcome cost data.

One of the biggest opportunities is from the feedback loops. This enables robust forward investment planning for example; demand data for a healthcare estate (including open data sources such as population prediction, local planning applications for housing) may forecast a growth in patient numbers over the coming years. This can be queried consuming asset registry, real-time space utilisation and condition index data and simulated to determine the optimum investment scenario such as a new build, refurbishment programme or a building consolidation strategy. Traditionally these feedbacks loops have been months or years. Now with a continuous data acquisition cycle and daisy chained queries, strategic decision making can happen in near real time.

Essentially digital twinning can help NHSScotland Boards do more with what they already have and drive substantial improvements in their asset management strategy and make smarter, evidence-based investment planning and optimising the whole life cost of managing their portfolios and assets.

Sustainable future

One of industry's biggest challenges is helping create a sustainable future for our built environment with a particular focus on optimisation of operational carbon performance. Data capture, unification, and analysis from transport and logistics, social infrastructure, waste management, utilities and energy management, to name a few, can when applied to a macro-level digital twin (say city-level) to give holistic insight and allowed joined up scenario planning. The smart building agenda is already well underway with the likes of the Edge Building in Amsterdam having proven how highly connected assets can shape better user efficiency and hence better resource efficiency. This demand for responsive smart built assets will grow, space or network availability will become maximised through a data driven approach and ultimately optimising the amount of assets needed which will maximise the carbon reduction.

Whilst a DT can be created at any stage in the NHSScotland asset lifecycle, the most effective is when it is proposed at the early stages of a new capital investment when it can be built into the business case. Consideration needs to be given to costs associated with:

- Smart building controls and edge devices, gateways and telemetry for dynamic data capture;
- Operational data storage in an AIM CDE or data lake; and
- Analytical software or cost per analytical transaction in the cloud.

It is important that a return on investment (ROI) study be taken for any proposed DT and benefits considered not just in terms of operational savings, but importantly the societal benefits to NHSScotland.

Whilst digital twinning can be undertaken in terms of retro fitting, it is recommended that this is in relation to specific targets or goals such as carbon reduction where a DT can be created of specific systems to capture and analyse in-use carbon performance.

Section 2: NHSScotland Digital Estate (DE) - Getting started at an organisational level

As with all change programmes the most important initial aspects relate to people, with a need for clear leadership and engagement with stakeholders. It is therefore critical that a Digital Estate champion or lead is appointed to ensure a smooth start to any DE programme, (see below). It is important that this becomes a key role of someone's job, otherwise there is a real threat that momentum can stall. Initial stakeholder discovery sessions should be undertaken to identify role specific DE needs, current issues around data, information searchability and queries, and also to identify opportunities for improvements through an integrated portfolio level ecosystem.

2.1) The Digital Estate (DE) Champion

NHSScotland Board leaders that have cross functional responsibility for built assets should consider appointing a Digital Estate Champion to guide the Board's implementation of and work with the internal estates / asset management / property teams on the implementation of DE. This DE Champion role will consider the organisation's needs, circumstances, alongside appropriate NHSScotland and Scottish government policies, regulations, objectives, and acts.

The DE Champion should have good understanding of the Board's asset management strategy and plan and understand the operational aspects of building management. They should, in addition, have good knowledge of information management, BIM and asset management technologies.

DE Champion

Typically, the DE Champion's role will include:

- Ensuring that the Board's DE implementation remains in step with their programme and other organisational strategic objectives and initiatives;
- Ensuring that information management standards and processes are applied;
- Co-ordination of DE pilot projects;
- Managing the DE technology architecture establishment;
- Capturing lessons learned and sharing these across the Board; and
- Ensuring that the AIM is being effectively curated.

2.2) The NHSScotland Digital Estate Citizen

The success of the NHSScotland digital estate is not just about technology and process but most importantly the people who will create, consume and curate the information within the ecosystem. This DE framework therefore suggests the concept of the digital citizen and four key tenants (as per figure 12) to help create behaviours which will impact the quality, content and collaboration of the solutions that NHSScotland provide. It is important that the Digital Estate Citizen concept is implemented as part of a wider culture change within NHSScotland.

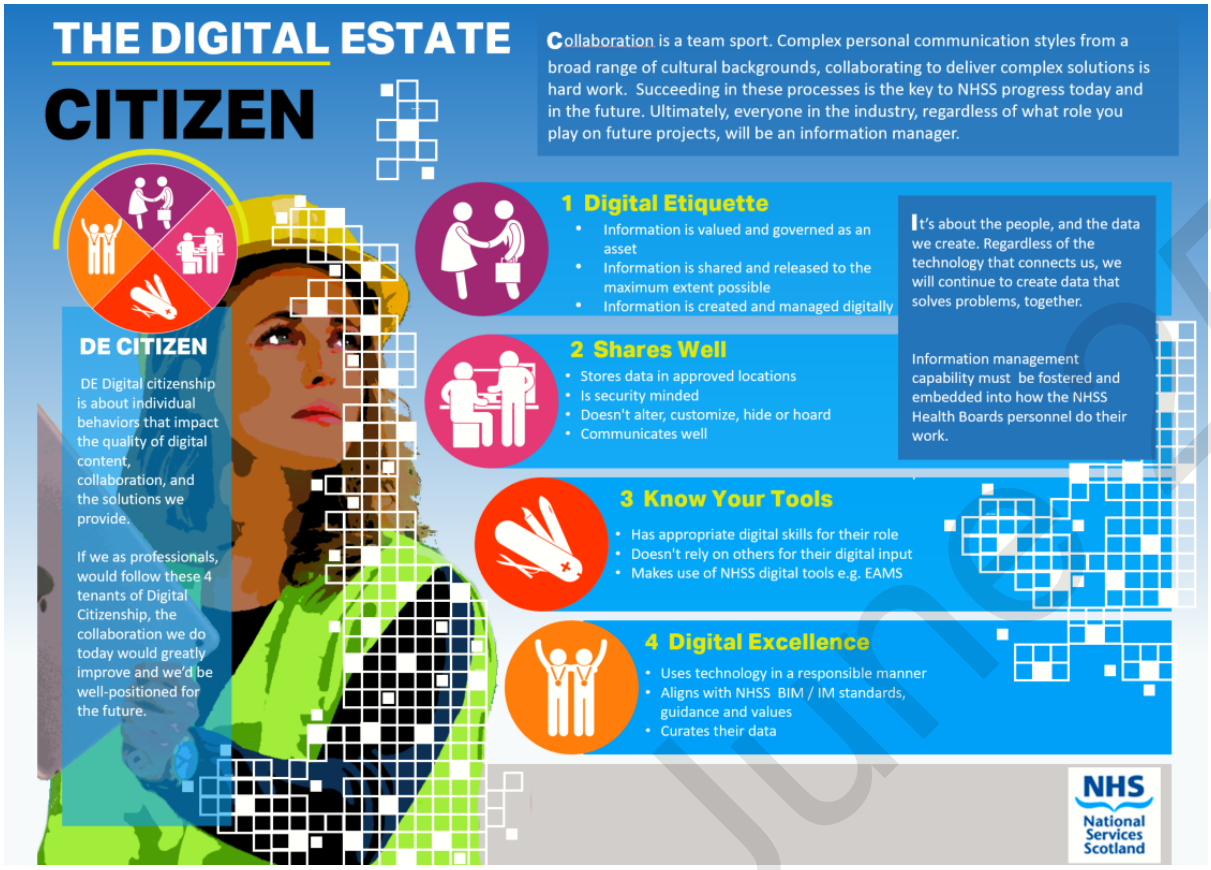


Figure 12 The Digital Estate Citizen

2.3) Understand your Board's current digital baseline

One of the priority activities for the DE Champion is to baseline the Board's current maturity with regards to built asset digitisation. An audit should be undertaken to determine organisational maturity and the digital footprint on a facility by facility basis. The information value-chain pyramid from Project 13 (developed by Institution of Civil Engineers (ICE)) Digital Transformation Workstream: Infrastructure industry benchmarking report is a useful reference point. (figure 13)

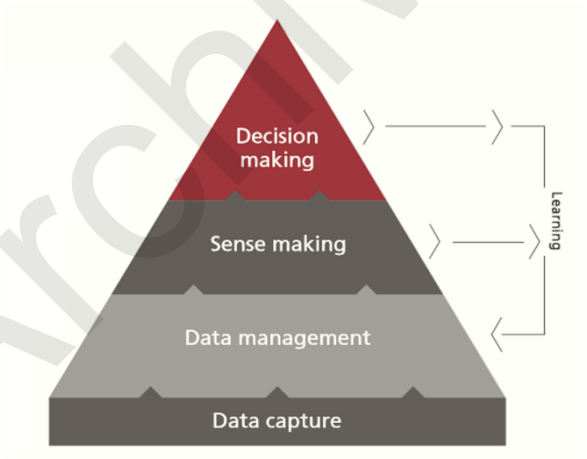


Figure 13 The Information Value-chain (Project 13)

Project 13 suggest the following best practice and trailing edge scenarios as a means of assessing a digital asset management approach.

- **Best practice:** An asset management system controls access for the whole enterprise to all data sources. Teams are starting to derive value from predictive analytics and machine learning.
- **Trailing edge:** Data silos exist – multiple asset registers, with duplication and inconsistencies. Asset management processes are immature. Decisions are not data-driven but are mostly based on prescribed procedures and individuals' experience.

Table 2 Maturity Assessment Criteria

Ref	Theme	Maturity assessment criteria
1.0	**Data capture:**	
1.1	Organisational level	Does my Board have operating procedures in place to capture new data and information from a trigger event such as refurbishment or maintenance task? Can my DE ecosystem efficiently pull in data from all required systems e.g. sensors, SCADA etc.
1.2	Facility level	What extent has digital data and information been captured for this facility? Does it meet my functional requirements? Is it to an appropriate level of information need? Is it to a suitable quality?
2.0	**Data management:**	
2.1	Organisational level	Does my Board have operating procedures in place to manage data and information both on capital projects and across the operational lifecycle? Is the information fit for its intended purpose and can it be shared and reused?
2.2	Facility level	Is the facility's data and information being adequately curated with consistent naming conventions and classification applied?
3.0	**Sense making:**	
3.1	Organisational level	Does my Board have a DE ecosystem which will allow for data to be modelled and analysed to make sense of it?
3.2	Facility level	Is the facility data providing enough insight for efficient operation, performance and user experience?
4.0	**Decision Making:**	
4.1	Organisational level	Does my Board have the digital tools and level of DE ecosystem integration which will support organisational asset management and forward planning?
4.2	Facility level	Can data driven decision making be undertaken in the event of a trigger event at the facility? Can information and data be searched and retrieved digitally and automatically?
5.0	**People:**	
5.1	Organisation level	Are leadership bought into the DE value proposition with suitable knowledge to use the data and information to improve organisational decision making and insight?
5.2	Facility level	Is there sufficient capability and capacity from staff at a local level to support the digital and information management workflows required in the DE strategy implementation?

Based upon the foregoing assessment, a DE Champion should be able to assess and prioritise upskilling needs both at organisational and facility level. It is important that the Board start with getting the basics right first and getting everyone to a consistent information management baseline.

2.4) Develop your Digital Estate (DE) persona pathways

A key objective of the DE is to enable better end user experience from estates and facilities teams to end-users. By understanding user stories and how key personas will use data, information and digital technologies, we can better establish the functional model required from the Board's DE.

Consider what key decisions each persona needs to make, as they navigate a typical life-cycle pathway, what data and information they need to support their experience. It is also important to understand how different personas interact and what collective decisions they may make as this might be answered by unified data sets.

Also consider how they would like to interact with their data, is it through a mobile app, web browser or a dashboard report etc?

It may also be useful to determine and categorise what can be done in the near future and what can be done in future trajectories.

It is important to understand that stakeholders at opposite ends of the organisation may be discounted. Communication lines, objectives and outcomes are likely to be different and information can become decentralised. This means that it is hard to access and is not used for wider strategic planning and decision making. While for example technical information and operational asset data will assist estates and maintenance teams, this data is likely to have no direct value to the NHSScotland boardroom stakeholders. However, when this data is aggregated up together with other asset and system data, it can give valuable insights and matrix to help in comparative analysis and evaluation against KPI's and strategic business objectives. This could include insights such as:

- Asset level performance vs. estate level environmental targets; and
- Real time energy use vs. yearly operational expenditure budgets.

End users

Ultimately patient care is the reason for the NHS to exist, and a great deal of focus should be given to the end users that use the NHS estate. This group of people will be wide ranging, from visitors, patients and staff to clinicians.

Consider typical questions a first-time visitor to the hospital needs in order to find their way to a particular clinic.

- Where is the best place to park? *Upon entering the hospital estate, visitors can conveniently see which carparks have available spaces in real time using digital display boards.*
- Where is Clinic 3? *Using a way finding app, they can successfully negotiate the hospital to arrive at their appointed time.*

Senior leadership team & senior stakeholders

This group of people will often be influential and play a significant role in the success of NHSScotland projects. They will be interested in high level strategic information rather than the detail. This may include information and data to support a business case and financial planning, such as high-level

schedules and running costs. They are likely to use mediums such as dashboard reporting upon which to make informed decisions.

Consider the typical questions that senior leaders may ask in the early development of a new asset and the information needed e.g:

- Does the proposal impact on current delivery services or activities? *Information required includes an Impact analysis on any current delivery services or activities affected by the proposal for example functionality, transportation, building operations.*
- What is the proposed Procurement route? *Information required includes Procurement Strategy advice and Report indicating proposed procurement route and outline programme prepared for the preferred solution.*

Project managers & project delivery team

This group will be interested in Capital Expenditure (CapEx) and information during the design and construction phases. If you are managing or delivering works on an existing asset, e.g. repair, maintain and or improve, it is vital that you create a data set that will update the relevant asset information model including key systems such as EAMS and Board CAFM system.

It is recommended that an employer's information requirement be prepared for any such work. This should be proportionate to the complexity and scale of the project and maybe a simple matrix of delivery milestones, principles information requirements and format.

Property services estates and facilities management

Property services, estates and facilities management will be primarily interested in assets and systems. They require access to technical information such as Product data sheets as well as data and information related to testing, inspection and commissioning activities. While design data is still important, their focus will be on what was 'actually' installed and needs to be maintained. Estates and facilities teams are likely to record and capture data in order to check performance and record compliance against any statutory obligations or manufacturer's warranty requirements. This data capture may be undertaken using handheld or 'field' devices that pull and push information for the central information models.

For example, building performance apps can give access to real time job logs. Maintenance personnel can report building maintenance issues on the spot by taking a geotagged photograph and providing a short description. This can then by prioritised in the app based upon pre-set criteria and actioned by other team members. The person that reported the issue will be automatically updated and notified. (figure 14)

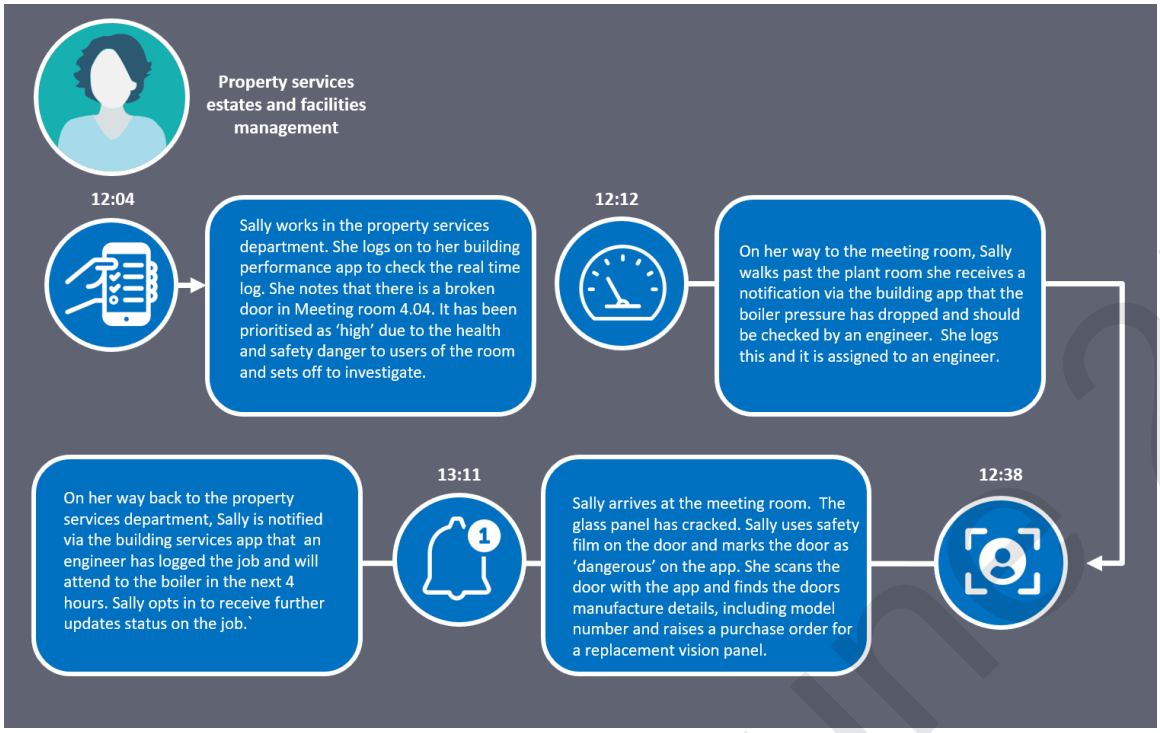


Figure 14 Property service estate and facilities management persona example

2.5) Create a Digital Estate (DE) strategy

Having undertaken research into the current "as-is" position of the Board's DE and defined the user pathways, it is now practical to build up an initial DE strategy unique to your Board. Figure 15 highlights the typical areas of consideration.

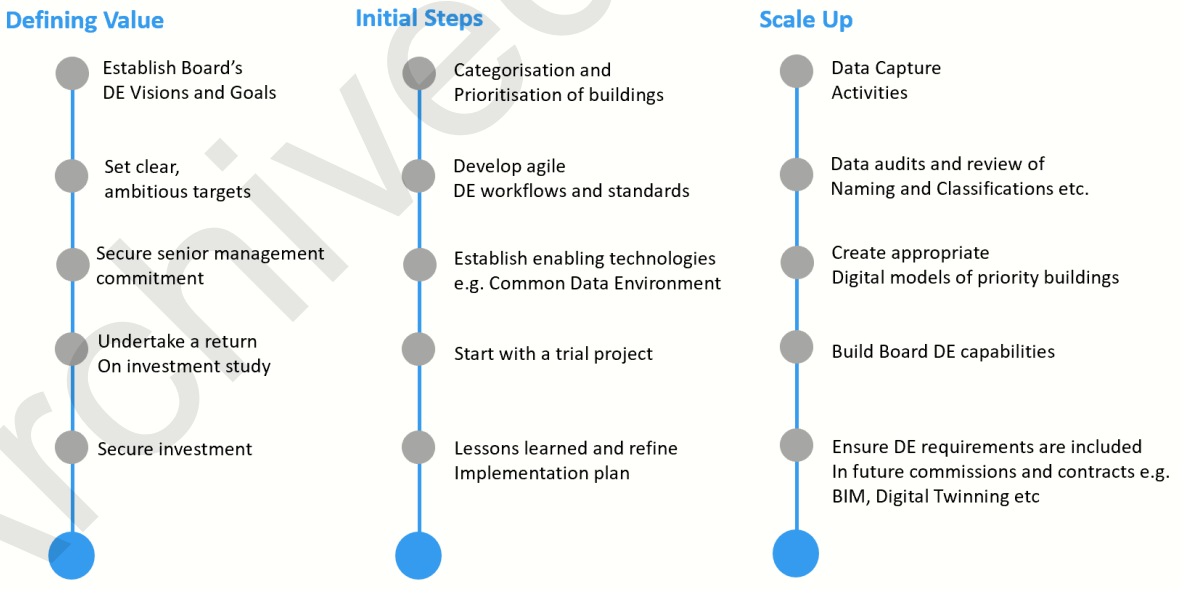
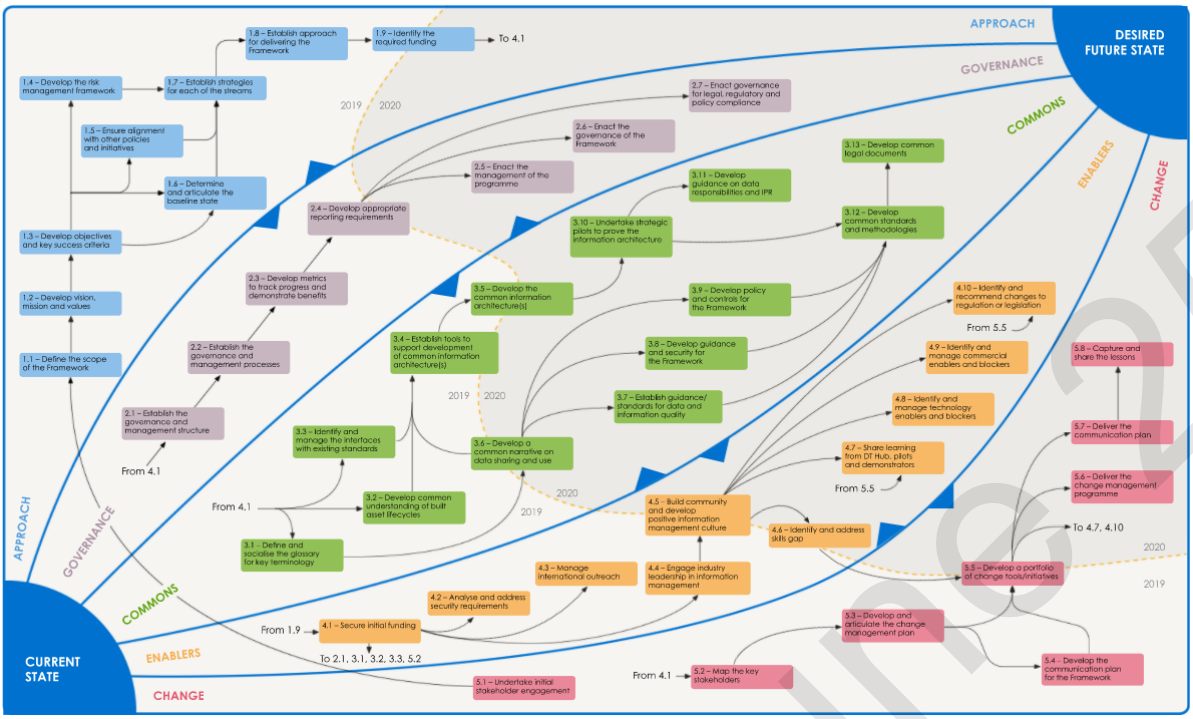


Figure 15 Defined user pathways



2.6) Create a Digital Estate (DE) roadmap and implementation plan

Figure A specimen implementation plan. (This Roadmap was developed by the Roadmap Working Group that was established as part of the ongoing work of the Digital Framework Task Group.)

To help communicate the Board's strategy, a DE transformational roadmap should be created determining the key activities and milestones when moving from the current to the desired state. It is a good idea to break the roadmap into key streams.

Typical stream for the DE may include:

Approach: overall approach to realising the benefits of a DE.

Enablers: DE structure, processes and technologies.

Governance: how the DE will be managed.

Change: what steps are required to ensure adoption of DE across the Board.

Data capture: how data from existing buildings will be captured over time.

To support the DE road map, an explicit implementation plan should be prepared illustrating the primary tasks, their owners plus any deliverables.

2.7) Information Management Processes and Standards

NHSScotland Boards should follow and embed Scottish Government, NHSScotland guidelines and industry standards when creating new project information models or altering existing which will feed into the portfolio level AIM CDE. These key information management tasks as an appointing party include in summary:

Phase	Activities
Information management process - assessment and need	Appoint individuals to undertake the information management functions:
	Establish the project's information requirements
	Establish the project's information delivery milestones
	Establish the project's information standard
	Establish the project's information production methods and procedures
	Establish the project's reference information and shared resources
	Establish the project's common data environment
	Establish the project's information protocol
Information management process - invitation to tender	Establish the appointing party's exchange information requirements
	Assemble reference information and shared resources
	Establish tender response requirements and evaluation criteria
	Compile invitation to tender information
Information management process - appointment	Complete lead appointed party's appointment documents
Information management process - information model delivery	Review and accept the information model
Information management process - project close-out	Archive the Project Information Model
	Capture lessons learnt for future projects

In parallel with the creation of the digital data and information intake from new project investments it is important that NHSScotland Boards review their existing estate and ensure that this is being properly curated.

2.8) The Digital Estate (DE) – Technology Architecture

The term 'Technology Architecture' is used to describe the infrastructure required by NHSScotland to support their applications, operations, and reporting requirements. It includes elements such as hardware (e.g. servers, monitors, printers, keyboards) and Software (e.g. the software applications). Outdated asset management technology architecture with siloed systems often have poor levels of interoperability. In most cases they are no longer efficient, nor sufficient, for meeting modern NHSScotland business objectives and other related policy requirements.

The aim of NHSScotland Boards should be to develop an open, interoperable, scalable digital architecture for their estate, one that enables new capabilities and functions both for asset management activities and improved end user experience in an effective and data-informed way.

The architecture should facilitate the creation of a federated portfolio model known as an asset information model (AIM) consisting of several discrete parts. The extent and nature of these parts shall be related to the purpose scale and complexity of the Board's assets.

When developing the AIM architecture, it should ideally contain the following parts:

Parts	Description
a)	Information concerning the original project brief, specification, design intent and analysis relating to the original installation of the asset and any subsequent changes.
b)	CAD and / or 3D object-based model(s) of the environment and location of the asset.
c)	Information, or links to information, concerning any data obtained from the maintenance, survey or other work carried out on the asset during its lifetime.
d)	Information, or links to information, concerning any data obtained from monitoring the operation and condition of the asset, for example through a SCADA or building controls.

Within the AIM, data and information should be stored in a data store and a file store respectively.

It is essential that the architecture will support the high-level asset and estate management activities for example:

- making life cycle cost comparisons of alternative capital investments;
- identifying expiry of warranty periods;
- availability of data and information to support planning and decision making;
- determining the cost of specific activities (activity-based costing), e.g. the total cost of maintaining a specific asset(s)/asset system;
- obtaining/calculating asset replacement values;
- undertaking financial analysis of planned income and expenditure;
- undertaking the on-going identification, assessment and control of asset related risks.
- A Board should develop a series of user activities as a reference for the digital estate architecture.

Section 2.8.1 outlines the suggested characteristics NHSScotland Boards should consider when developing a high-performance technology blueprint.

2.8.1) Value Driven

The technology blueprint should be aligned with the Board's "Digital Estate Principles" especially the need to ensure that it has:

- **Purpose:** must have clear benefits
- **Assurance:** must be trustworthy
- **Function:** must function effectively

The journey across the DE spectrum will take time and commitment and the value unlocked by the technology ecosystem will grow the more the technology stack connects and moves from a static information landscape to a two-way integration and interaction with the Boards physical built assets.

Boards should develop a staged benefits realisation plan and reverse engineer this into their technology stack design. It is important to note that value will come from connecting and complementing existing technology solutions rather than retiring what is already in place.

2.8.2) User-centric Design

When designing high-performance DE architecture and systems, consider the ease of use and intuitiveness of its design. An architecture which enables a clean and simple interface will enable the

various personas to concentrate on their tasks at hand, rather than trying to navigate their way through multiple software solutions and duplication of data that makes tasks more difficult to manage and complete.

It is important that persona pathways are fully explored and mapped to inform the architecture design both in the short and long-term.

2.8.3) Data Organisation

Boards should assess their current asset management architecture and ask key questions; does it make it easy to input, view, and find your data both at facility and portfolio level? If not, consider a redesign as part of the DE architecture where the common data environment (CDE) sits at the heart of your solution. Quick, easy access to well-organised, classified data, such as a particular asset's maintenance and inspection history, will help your Estates teams to make well-informed decisions when performing their work in the office or on site. Modern and connected asset management architecture is reliant upon high quality data and information that is secure and consistent especially in terms of naming conventions and meta-data.

2.8.4) Scalability

The Board's DE architecture should be able to scale up over time, therefore system integration and data sharing are important. Moving from a static CDE to the connected and persistent data of digital twinning will be one of the biggest technology step changes. Proportionality is important and the need for the architecture to work both in the context of facilities with BIM and those with digital twins are important as a portfolio will have a blended information environment.

2.8.5) Establish Connections to Other Enterprise Systems

It takes more than one technology system to keep a NHSScotland estate running efficiently. High-performance DE technology is the place where those enterprise systems connect. The right DE architecture integrates easily with everything from your asset register to your CAFM platform and will share data with them, ideally in real time.

The integrated processes and ecosystem promoted through the NHSScotland DE approach can help improve NHSScotland Boards asset management implementation and optimise the whole life cost of managing portfolios and their associated built assets. An integrated ecosystem will help make better sense of asset data by linking up current systems and leveraging the possibilities of chained querying and unified analytics.

In most cases NHSScotland Boards will have over the years created autonomous data stores for their asset and facilities management which often leads to duplication or limited ability to exploit that data in a unified query.

The nature and extent of existing systems that a NHSScotland Board may wish link to may vary, but could include:

- asset registry systems;
- CMMS / CAFM systems;
- document management systems;
- work/programme planning and scheduling systems;
- materials management and spares inventory systems;
- purchasing systems;
- accounting and financial planning systems;

- asset utilisation systems;
- engineering design and modelling systems;
- performance reporting systems;
- condition monitoring systems;
- geographical information systems (GIS) and spatial analysis toolkits;
- asset possession/shutdown/outage planning systems;
- SCADA and BMS.

There are many use cases for a NHSScotland Board creating an integrated ecosystem including:

- Immediate access to information following a trigger event such as a system failure;
- optimising the asset management strategy and optimising/prioritising its asset management plan(s);
- assessing the financial benefits of planned improvement activities;
- modelling the asset to support operational decision making;
- determining the operational and financial impact of asset unavailability or failure;
- making life cycle cost comparisons of alternative capital investments;
- identifying expiry of warranty periods.

Figure 17 illustrates an example of an integrated ecosystem which highlight the interface between the asset information model and other enterprise systems that an organisation may have.

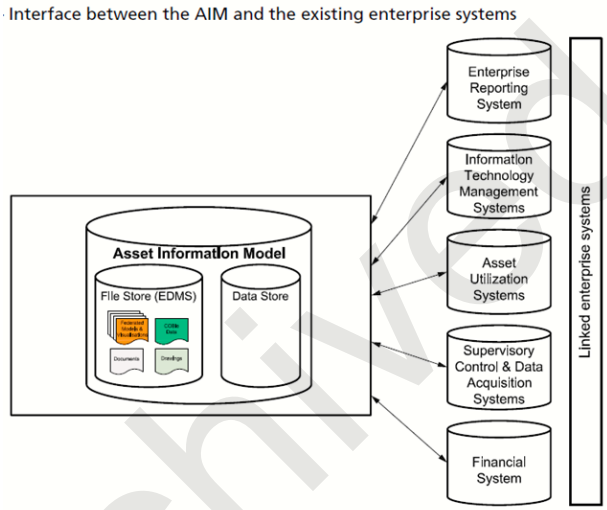


Figure 16 Integrated ecosystem

As part of the NHSScotland DE road map NHSScotland Boards should develop an integrated information strategy to facilitate sharing of data between their various systems.

Developing use cases for the ecosystem, persona level queries and mapping these to data sources is a good starting point.

2.8.6) Specimen Architecture

The envisaged architecture of the NHSScotland DE ecosystem provides a scalable, configurable common data platform, essentially a motherboard which technology modules can be plugged in to

meet the individual needs of NHSScotland Boards. The core technology can be as basic as a project common data environment or extending to a full dynamic digital estate with federated digital twins.

Key functional principles include the ability to: manage, search and assess data, activities or issues from the large to the small-scale projects or portfolios. A very mature architecture may also support the making of decisions for future operations based on real time results, optimise a process, or an asset that houses a process.

Figure 18 illustrates the high-level principle architecture of the NHSScotland DE information management landscape based on six layers.

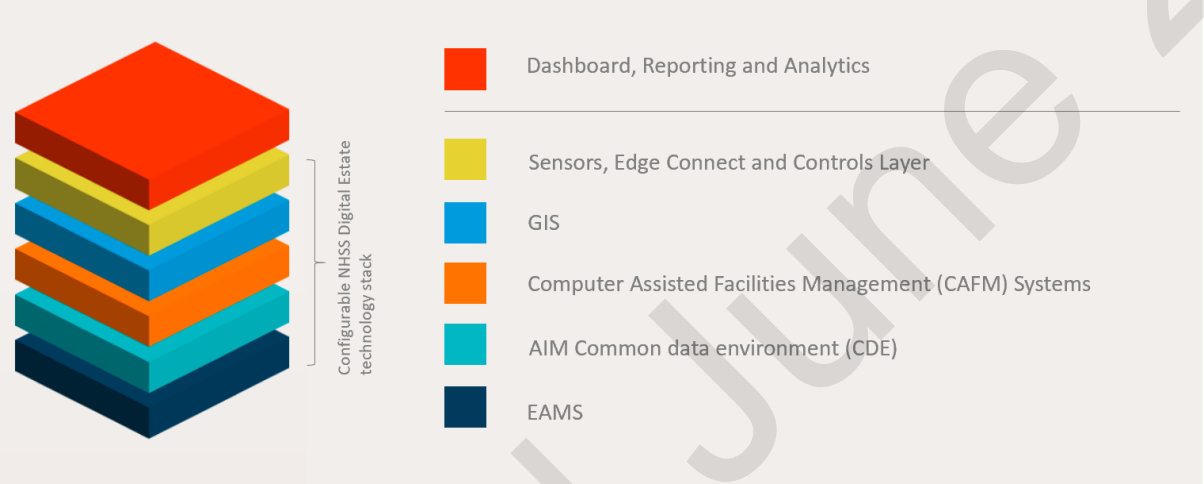


Figure 17 NHSScotland DE Information landscape

The foundation layer is the EAMS (3i Studio) system which provides an asset register and property database, document management system (aimed at storage of statutory documents, photographs and CAD files) and storage of condition survey and lifecycle data. EAMS also incorporates Easylink functionality to ensure bidirectional connection between the asset register and CAD files. Ensuring that EAMS is used to its full potential is essential to establish a strong foundation to build upon.

The second layer is the asset information model (AIM) common data environment (CDE), a file and data store for a federated model of a Board's estate consisting of several discrete parts. The extent and nature of these parts shall be related to the complexity, purpose and scale of the assets.

The AIM CDE should incorporate an aggregated data tier that combines a selection of building and operational data and allows this information to be linked with selected data from the Board's other enterprise systems. This aggregation is performed within a secure environment within the AIM CDE. The AIM CDE and EAMS should be linked ideally through webservices or Application Programme Interfaces (APIs) to facilitate data sharing.

The investment in an AIM CDE is a priority area in the development of the DE architecture and holds both the detailed and strategic information necessary to summarise the performance of the estate and facilitate strategic decision-making.

The third layer is the computer assisted facilities management (CAFM) system and associated data. Most Boards will likely already have CAFM technology and consideration should be given to again linking this to the AIM CDE (connected to EAMS) to push and pull data between the various systems.

For more advanced architecture a Geographic Information System (GIS) system should be introduced or where already in place linked to the AIM CDE. GIS tools allow users to create interactive queries (user-created searches), analyse spatial information, edit data in maps and when linked to the AIM CDE incorporate BIMs.

Once the foregoing systems and data layers are in place, a sensor, edge connect and controls layer can be introduced to collect and analyse operational and performance data.

The top layer relates to dashboard, reporting and analytics which is key to making data related decisions to all the Boards data and information especially that which has been aggregated. Most CDEs incorporate some degree of built-in dashboarding and reporting functionality which may initially meet a Boards needs. However, as the DE model matures and incorporates digital twinning, it is likely that further analytic applications may need to be considered. A good analytics system will allow users to find and analyse almost any piece of their spatial or non-spatial information by keying in just a few words. Boards should develop a schedule of queries and articulate them as a series of plain language questions.

2.8.7) Digital Estate Architecture – Concept Diagram

The suggested digital estate architecture is presented in the conceptual diagram overleaf. The diagram has been designed to show how over time how a connected ecosystem may grow and develop.

Your existing technology stack probably already comprises several of the components in the target architecture such as EAMs and a CAFM system. You may also in your more modern health facilities have intelligent building control systems and sensors which are already capturing huge amounts of real time data.

Importance should be placed on developing integration capabilities that will enable data from these to flow securely and will support the use of analytical tools to aid decision-making. Figure 19 (overleaf) highlights the key next steps.

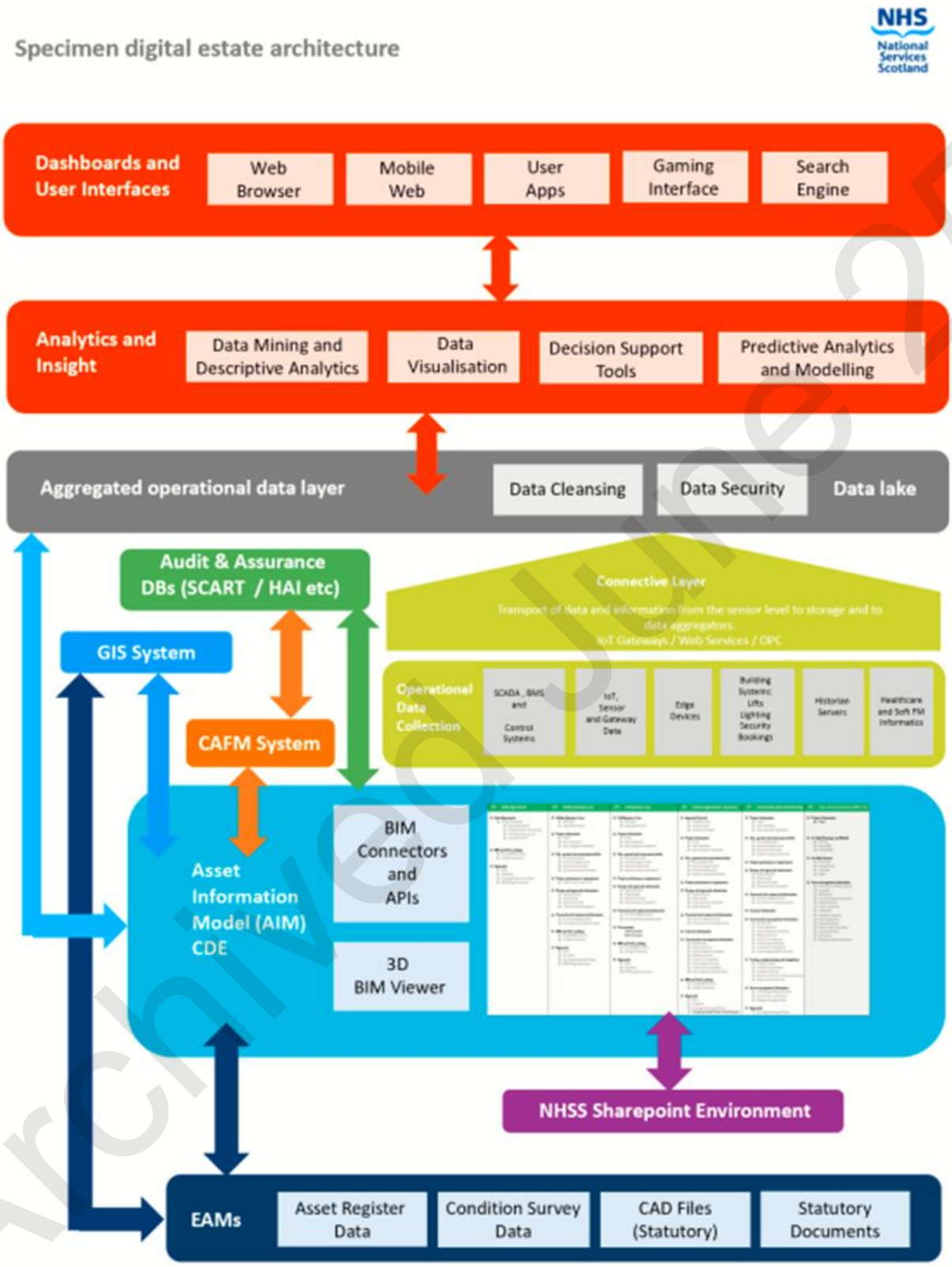


Figure 18 Specimen digital estate architecture

2.8.8) Curation of the Digital Estate (DE)

It is essential that NHSScotland Boards consider both the information management processes, and roles for maintaining the digital estate and its data and information.

The Board should create the role of Information Manager who should have the responsibility for accepting information into and managing the AIM CDE during the operational stages.

Whilst the role may be shared by several Information Managers, there should only be one point of responsibility for this role for the whole of the Board.

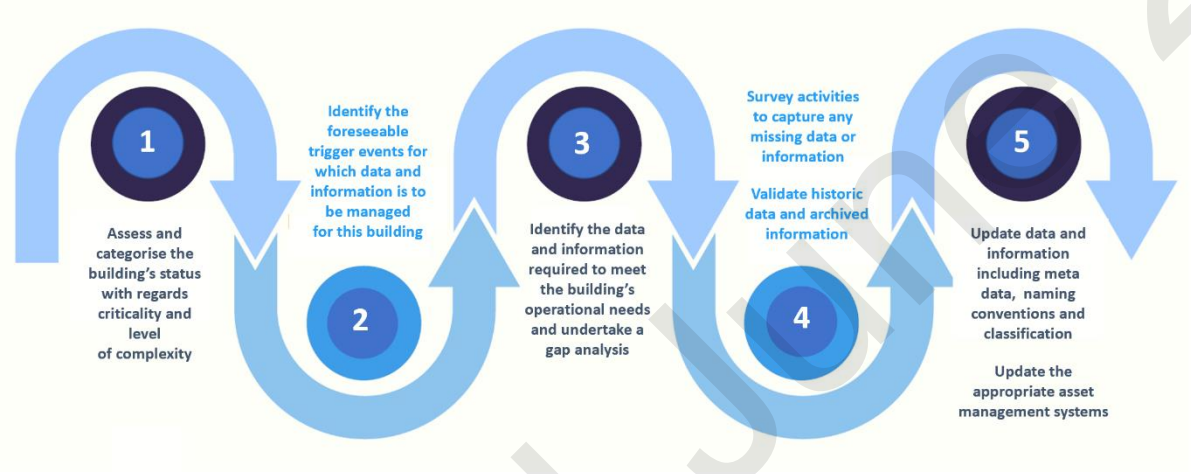
The Board should establish processes and procedures to cover the following aspects of maintaining their digital estate and its' AIM:

	Description
a)	Allocation of roles, responsibilities and authorities for the origination, generation, capture, maintenance, retention, transmission, access to, assurance and archiving of information and data.
b)	Definition of the content, meaning, formats and medium for the representation, retention, transmission and retrieval for all information and data.
c)	Requirements for information and data maintenance, including version control, integrity checks, validation and other assurance activities.
d)	Measuring, monitoring, reporting and continually improving the quality of information and data to support Board needs.
e)	Requirements for the generation, capture or importing of the identified items of information and data.
f)	Requirements for the storage of information and data according to integrity, security and confidentiality requirements.
g)	Requirements for disaster recovery, including the recovery point and the recovery time;
h)	Retrieval, distribution and availability of information and data to designated parties as required by agreed schedules or defined circumstances.
i)	Requirements for the archival of designated information and data, for example for the purpose of retaining audit records and knowledge preservation.
j)	Requirements for the disposal of obsolete, unreliable or unwanted information and data in accordance with the organisation's requirements and security and privacy requirements.

Section 3: NHSScotland Digital Estate (DE) – Getting started at building level

Having created an organisational DE framework at a NHSScotland Board level it is now practical at this stage to begin to create a DE at a building by building level. Figure 20 suggests a route-map that a Board should follow.

Figure 19 Suggested route map



3.1) Assess building's status

The NHSScotland DE strategy is based upon having an appropriate and proportional digital representation of an estate. This will vary from building to building and will be based upon its usage and risk profile.

One of the first activities that a Board should consider is the assessing and categorising their buildings, usually on a site by site basis to prioritise which buildings need digitised first.

The framework below, and in table 3, can help you prioritise the order in which you consider digitisation of the buildings within your portfolio.

Firstly, determine for each building type the level of complexity and give it an associated score e.g.

Level of complexity	Exemplar Definition	Score
Simple	Technically a simple building with straightforward building services and equipment.	1
Moderate	Technically a normal building with a generally straightforward building services and equipment but has some spaces which have more complexity e.g. a plantroom.	2
Complex	Technically a complex building with multifaceted building services and intricate equipment.	3
Highly complex	Technically a highly complex building with specialist building services and highly specialist equipment and plant.	4

Secondly, determine for each building type the level of business continuity and give it an associated score e.g.

Level of business continuity	Exemplar Definition	Score
Non-essential	Low to moderate consequences of failure / downstream impact	1
Essential	High level of demand with high consequence of failure / downstream impact.	2
Critical	Critical consequence of failure / downstream impact.	3

Thirdly multiply the two scores together to calculate the total score. You may wish to put in a further weighting for buildings which are not currently occupied or leased (e.g. those that are vacant or surplus) and multiply the total score by 0.5.

Table 3 Assess building's status framework

	Building type	Level of complexity	Level of business continuity	Score
	Acute Hospital			
	Children's Hospital			
	Maternity Hospital			
	Specialist Hospital			
	Mental Health Hospital			
	Community Hospital			
	Older People Hospital			
	Multi Service Hospital			
	Health Centre			
	Clinics (including Day Hospitals and Resource Centres)			
	Offices			
	Support Facilities			
	Staff Residential Accommodation			
	Patient Residential Accommodation			
	GP Practice			
	Dental Practice			
	Pharmacy			
	Optician			
	Care Home			
	Non-NHS functions			
	Non-Operational			
	Landlord scenarios			

NOTE: It is important to note that these tables are for guidance only and NHSScotland Boards should tailor these to meet the unique nature of their portfolio.

3.2) Identify foreseeable trigger events

It is important to understand and identify what data and information is needed to support foreseeable trigger events during a building's operational lifecycle.

A trigger is a planned or unplanned event that changes an asset, or its status, and a trigger event is a response to a trigger and the reflection of the altered state of the asset in the AIM. Typical trigger events may include:

- maintenance work on an asset, whether planned or reactive;
- inspection of an asset; and
- minor works on an asset, such as repairs, component replacements or minor upgrades.

By understanding the key triggers and trigger events that a building may encounter then it becomes easier to determine what data and information is required.

3.3) Identification of data and information requirements

Based upon the findings of 3.1 and 3.2 the NHSScotland Board can now begin to establish the asset information requirements (AIR) that the building being assessed will require that respond only to clear purpose and need. You should determine what data and information your building needs in order to:

- Support and answer the trigger events in 3.2;
- Ensure that your asset management systems are fully populated;
- Meet your statutory requirements;
- Support your asset and facilities management objectives; and
- Support r NHSScotland Board's organisational objectives.

These AIR can be assembled into a matrix and cross referenced against existing historical data and information and any gaps determined. This gap analysis will give a clear plan of required data and information that is needed for that particular building.

It is likely that the AIR will be similar for buildings of a comparable type, for instance an acute hospital or a children's hospital. Typical AIR for NHSScotland Boards to consider are contained within Appendix 1. These sample AIRs have been structured into eleven maturity levels as illustrated in table 4.

Table 4 Maturity levels

Maturity Level	AIR Set
1A	Asset register data level one – general information at NHSScotland Board level
1B	Asset register data level two – general information at site level
1C	Asset register data level three – general information at block level
1D	Asset register data level four – general information at floor level
1E	Asset register data level five – general information at room level
2	Statutory compliance information
3	CAD and layout drawings and information
4	Survey and GIS information
5	Technical data and information
6	Lifecycle data and information
7	Building Information Models
8	Telemetry and IoT
9	NHSScotland Board enterprise systems

Maturity Level	AIR Set
10	External open data

3.4) Data capture

Based upon the AIR gap analysis undertaken in 3.3 an NHSScotland Board should then develop a data and information capture plan to establish how the variances can be closed.

In addition, it is important that Boards validate historic data and archived information such as CAD files and ask key questions such as:

- How current is my data and information sets?
- What is the history and provenance of the existing data?
- Do I have the right level and type of data and information to make decisions?
- Is it on a common data platform and does it correlate with different reference systems?

Some of the activities which are non-priority may be captured during routine survey works however other priority sets may need more immediate attention. The data and information capture can generally be broken down into the following categories:

- Information gaps - missing or incomplete documents, drawings, reports, certificates or surveys;
- Data gaps - data missing or incomplete within the asset management systems.

Information can furthermore be broken down into non-graphical and graphical information. In addition to gaps in non-graphical information there may also be paper documents and other analogue formats that need digitising.

Below are examples of the various methodologies that a Board should consider as a means of data and information capture. It is important to employ techniques which are appropriate to the Board's requirements and budget.

3.4.1) Document scanning

To capture and classify physical historical documentation into an electronic system, an Optical Character Recognition (OCR) software can be used. This technology is ideal for capturing high volumes of paper-based documentation and then converting it into business ready data allowing it to be easily retrievable at a DE users fingertips. By addressing the client's exact needs of classification requirements, the software can be preconfigured to scan then classify the documents based on factors such as keywords, layout and templates. The OCR data capture will also classify the documents into different folders based on the document type, which are established in the preconfigured requirements set up. This method is hugely cost efficient due to the level of accuracy it can guarantee on capturing the data and eliminates the risk of any human error. An additional benefit of not having to store physical paper files ultimately means saving on a Board's storage space and moves the client to a more innovative digital environment.

3.4.2) Geometrical – data capture

A variety of data capture methods are available however, it is important to choose the one that is most suitable for a project or existing building in terms of cost efficiency and accuracy. The following methods discuss the type of surveys and the output of data capture that they produce as well as the suitability for retrospective surveys.

Traditional measured survey

This method gives an accurate and high precision survey of the layout and measurements of the building or space within it. This data capture option requires a survey team to be employed to provide an accurate analysis and data output. A total station or similar (figure 21) is used to measure both vertical and horizontal angles as well as the slope distance from the station to a point on the building being measured. This data is collected, and a triangulation is generated for several significant points on the building such as vertices for the doors, windows, inner frames of rooms etc. The points are collected accurately in an overall coordinate system and with the addition of using a direct survey; these points can then be connected to link the different areas of the building together. This method is however more expensive than modern methods due to the costs of the surveying equipment, processing time post survey and ultimately a slower procedure to capturing the data on site. Also, the inbuilt GPS receiver that receives the coordinates can encounter location accuracy errors due to interference with satellites.

Figure 20 Image of a total station - Source: Leica

Traditional surveys are best employed when the spaces being measured are of simple geometry, low volume or related to simple topography capture.

360 Photogrammetry

With the use of 360° cameras an accurate and data smart survey can be captured in an extremely time and cost-efficient manner (as per figure 22). This method is commonly used through the construction process of a building and allows project teams to regularly review the construction progress and identify any issues. Additionally, this method can be utilised retrospectively to photo document as-built conditions or capture a 3D virtual walkthrough of existing operational buildings.

Photogrammetry consumes imagery from many cameras and sensor types and may utilise a wide variety of cameras, from smartphones, handheld 360 cameras to highly specialised airborne or terrestrial multidirectional acquisition systems. 360 photogrammetry can take advantage of any available image format and metadata to create 3D models.

Depending on the camera used, the images are captured using various position points around the building and the data is captured quickly, also obtaining a decent-resolution point cloud scan of the area or a simple mesh of digital images. An overlap of the images is needed to eliminate any error in the data capture. Once the survey is complete the images and /or point cloud are extracted from the camera and then processed and compiled together into a visualisation software producing a 3D model. Due to the digital images or point cloud information having fair resolution, relatively accurate measurements can be taken as the user moves around the virtual room. This data capture is comparatively cheaper and more time efficient than that of traditional and laser scanning surveys. The accuracy from the photogrammetry is less than that of laser scanning data capture so is more appropriate for use when accuracy isn't of the upmost importance. In-house photogrammetry can be taken to capture the building layout and collaborate the data in a slightly less accurate capture. This method provides a useful 360° visualisation of the building layout and condition and allows a helpful walkthrough between the rooms for the client to conduct reviews and building construction consultations. This can be advantageous if regular captures are required to monitor maintenance / adaption works and accuracy isn't of the essence.

Figure 21 Image of 360 cameras. Source: Matterport

Laser scanning

The client value proposition for 3D laser scanning or (LiDAR) is not simply bringing efficiencies to existing surveying methods. 3D scanning provides owners with a powerful toolkit to accomplish previously unattainable measurement goals and creates a solid foundation for improved asset information management.

Scanning systems primarily capture the physical position of a target object, represented as a series of points (forming a "point cloud") typically in Cartesian coordinates (XYZ). This is accomplished by comparing the emitted and returned light pulse and determining the value of the target object in relation to the position of the scanning instrument. The scanner calculates the position by measuring the angle of the scanner assembly (scanner head and reflector) and the time of light travel (measured directly as in time-of-flight scanners, or indirectly, as in phase- and light- based scanners). A scanner and typical point cloud are illustrated in figure 23.

Figure 22 Typical scanner and point cloud. Source: Faro

This modern method of data capture has surpassed traditional survey methods and provides a highly accurate, innovative survey in a relatively time efficient manner. The accuracy comes from the survey scan producing more points for the point cloud data than any other survey and as a result the LiDAR is more precise. This data capture requires a specialised survey team to set up the laser scanner equipment so they can professionally and correctly collect the data for position and distance measured. This method is comprehensive and provides 3D data from just one scan location, however in comparison to 360° photogrammetry it is more time consuming. It can also be more expensive due to equipment costs and processing time, yet the accuracy and volume of data collected and the ultimate deliverable output for the client from this data makes it a worthwhile investment. The advantage of the investment is to reduce the need for site visits and inspections due to the volume of information captured and producing a comprehensive 3D true to life model for all project team to view and analyse. This method is a more innovative solution than that of the traditional total station procedure, which has the tendency to only give a 2D output and is a more time-consuming survey process.

3D scanning has much more to offer than simply improving existing surveying workflows. In fact, 3D scanning creates a foundation for a BIM approach by capturing existing conditions in a highly accurate, 3-dimensional format that can be used as a basis for assessment or future capital work design. BIM is not just about design and construction, but rather the entire lifecycle (figure 24). BIM does this by accomplishing the following:

- Improving assessments of existing conditions (existing data sets like record blueprints and drawings poorly represent conditions and can present liability issues to contractors)

- Validating construction quality during post occupancy and improving asset management strategies for clients owning large asset portfolios.

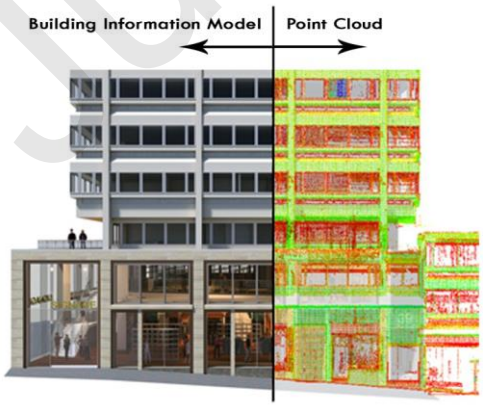


Figure 23 Point cloud to BIM

Document scanning

Whilst laser scanning supports BIM, Boards should recognise that there is a cost of converting a point cloud survey into a model. This includes high volume data capture services with OCR including indexing and classification.

In addition, it is important that Boards validate historic data and archived information such as CAD files and ask key questions such as:

- How current is my data and information sets?
- What is the history and provenance of the existing data?
- Do I have the right level and type of data and information to make decisions?
- Is it on a common data platform and does it correlate with different reference systems?

Laser scanning is best employed when there is a large volume of topological points to be captured or the objects to be captured have complex geometry. A laser survey of a few hundred topological points/features can be captured in a few hours or scan the same area in the same amount of time and obtain so much more information than traditional surveying. In addition, the extent of data capture

and complexity laser scanning becomes more beneficial when there are challenges with access such as heights or safety requirements preventing.

3.5) Update data, information and asset management systems

Having reviewed the historic data and information it is likely that some areas will need updated or refreshed.

The data and information should be updated so it is compliant with NHSScotland and NHS Boards metadata standards, naming conventions and classification systems.

Metadata standards – meta data is the backbone of digital curation. Without it a digital resource will be unretrievable, unidentifiable or un useable. Meta data should be descriptive of contextual information which refers to or is associated to another object or resource. An appropriate meta data stand should support several defined functions, such as technical meta data which describes technical processes used to produce digital objects or use meta data which can be used to manage user access or tracking. It is recommended that NHS Boards use an appropriate meta data standard that addresses their particular needs and complexities for example ISO or BSI.

Naming conventions - You should use an agreed naming convention and create and maintain project codes. This is becoming more vital as more and more information is shared digitally, requiring the need for structured, consistent and understandable naming conventions. BS EN ISO 19650-2 together with the UK National Annex BS 1192 sets out how construction project documents are to be named. The set of project documents and each document within it are viewed as a hierarchy of named containers. The standard recommends how to structure names to convey information about the containers required for effective information management.

Classification systems - Adopting a common language is essential when coordinating construction project information across a project or NHSScotland estate. Classification provides a common language or 'reference dictionary' that is used to accurately describe things. NHS Boards should classify the data and information being put into the Asset Information Model (AIM) using a classification system in accordance with BS ISO 12006-2.

Data classification systems are essential for co-ordinated construction project information, as they allow information to be recognised, differentiated and understood. They enable data to be indexed and structured, so everyone can find the information they are looking for. One such classification system is Uniclass 2015, described as a unified classification system for the construction industry. It is unified in the sense that it covers all construction sectors including buildings, landscape and infrastructure.

Uniclass 2015 works by way of a hierarchical suite of tables allowing information about a project to be defined from the broadest view of it to the most detailed, from a hospital complex, to a Ward, to a hospital bed screen. There are tables within the classification that cover different classes of information and deal with different scales of information.

Section 4: Getting started on your DE journey

Having created an organisational DE framework at a NHSScotland Board level it is now practical at this stage to begin to create a DE at a building by building level. Figure 20 suggests a route-map that a Board should follow.

4.1) Next steps

Having read the DE framework, it is important to now plan how you will adapt your current ways of working and move towards this best practice.

For each NHSScotland Board their DE journey will vary in scale, timeframe and resourcing however the following next steps are suggested for each Board:

Steps	Key DE Activity
1.	Make sure that your Board is actively involved in the NHSScotland Digital Estate Group facilitated by Health Facilities Scotland (HFS).
2.	Assign the role of DE Champion to ensure that you have someone responsible for the development and co-ordination of your Board's DE strategy and its implementation.
3.	Develop your DE vision, goals and associated targets aligned with your Boards' organisational and asset management strategy and objectives.
4.	Create your DE strategy and implementation plan.
5.	Secure senior management commitment and investment.
6.	Execute your DE implementation plan working towards embedding in best practice and feedback loops.

4.2) Conclusion

This NHSScotland DE framework has set out a vital vision, principles and guidance for your Board and when applied will help make accurate building information available, maximise operational efficiencies, optimise performance, to lower costs, increase output and maximise facility utilisation.

It should be noted that implementing a DE plan will take time and should be built around continuous improvement. It is important that NHSScotland Boards are proportionate in levels of digitisation applied and prioritise which buildings will have the greatest benefit from applying the DE approach to.

Making changes in the way that you capture, manage and integrate data and information about your estate will support joined up decision making, provide dynamic insights and ultimately support better healthcare outcomes.

HFS Contact

Digital Estate and Asset Management Team

Email - nss.DEandAMTeam@nhs.scot

Appendices

Appendix 1 – Exemplar data and information sets

1.1.1 General information at Board level **(level 1 A – asset register)**

The following data and information sets are an exemplar requirement for each NHSScotland Board at a headline level to identify:

General information at Board Level		
Level	**Information required**	**Example**
Level 1 A	Population data	
	Geographical coverage	
	Which Local Authority the Board covers	

1.1.2 General information at site level **(level 1 B – asset register)**

The following data and information sets are an exemplar for each NHSScotland Board at site level to identify all land and sites:

General information at site level		
Level	**Information required**	**Example**
Level 1 B	Site Reference Number (SRN) based on existing national code;	
	Name of NHS Board	
	Site name	
	Site address	
	Town	
	Postcode	
	Contact name	
	Contact number	
	Contact email	
	Site status; and Requirement of site (essential/non-essential	
	Quantitative data for sites	
	Land / Site area	
	Valuation of sites (recorded against site)	

1.1.3 General information at block (building) level **(level 1 C – asset register)**

The following data and information sets are an exemplar for each NHSScotland Board at site level to identify all blocks and buildings:

General information at block (building) level		
Level	**Information required**	**Example**
Level 1 C	Site name and address	
	Block name and address	
	Block number	
	Block use	
	Type of block (code)	
	Gross internal area	
	Gross external area	
	Number of floors	
	Heated volume	
	Number of car parking spaces: staff, visitor, disabled	
	Tenure of blocks	
	Status of blocks	
	Requirements of blocks (essential/non-essential)	
	Historic listing; and	
	Build year of Block	
	Six facet ranking:	
	facet 1: physical condition building & engineering (of each element and sub-element)	
	facet 2: statutory compliance	
	facet 3: environmental management	
	facet 4: space utilisation	
	facet 5: functional suitability, and	
	facet 6: quality.	
	Access to existing reports	
	Condition and lifecycle survey	
	Representative photographs in a digital format	
	Contact names and numbers of key estates personnel to arrange access (at site and block levels)	

1.1.4 General information at floor level **(level 1 D – asset register)**

The following data and information sets are an exemplar for each NHSScotland Board at a floor by floor level:

General information at Floor level		
	Information required	**Example**
Level 1 D	Site Code	
	Block number	
	Floor level	
	Floor code	
	Floor description	
	Gross internal area	

1.1.5 General information at room level (**level 1 E – asset register)**

The following data and information sets are an exemplar for each NHSScotland Board at a room by room level:

General information at Room level		
	Information required	**Example**
Level 1 E	Site Code	
	Block number	
	Floor level	
	Room number	
	Zone name	
	Room description	
	Room area	
	Space utilisation	
	Functional suitability	
	Quality	

1.1.6 Statutory Compliance data and information **(Level 2)**

The following data and information sets are an exemplar requirement for each NHSScotland Board to support the demonstration of statutory compliance:

Statutory Compliance data and information	
	SCART assessments
	Risk assessments: floor surfaces and stairwells
	Training plans for statutory and mandatory themes
	Pressure Systems 2014:
	evidence of appointed person / acceptance
	written scheme of examination
	list of component parts
	inspection reports
	safe operating procedures
	maintenance records
	instructions for control of contractors
	certification records
	operation and maintenance guidance
	manufacturer records
	Infection Control:
	audit reports
	Washer Disinfectors:
	test and maintenance records
	Lifting Operations & Lifting Equipment (LOLER) Regulations 1998 (Incorp. SHTM 2024 (Lifts)):
	lift inspection certificates
	operational plan
	Electrical - Electrical services supply and distribution 2014:
	Inspection and maintenance records
	logbooks
	documented Electromagnetic Compatibility (EMC) audits
	risk assessments
	planned preventive maintenance strategy including standard operating procedures, method statements, permits to work
	Contingency Planning (Civil Contingencies Act 2004) contingency plans for failure of:
	electrical supply
	medical gases
	water supply
	heating systems
	steam supply
	patient call systems
	Window security: risk assessment

	Decontamination of equipment: permit system
	Control of Substances Hazardous to Health (COSHH) Regulations 2002:
	records of annual performance check for Local Exhaust Ventilation (LEV)
	maintenance register of LEVs
	risk assessment register for all hazardous substances (including product data sheets)
	Working at Height Regulations 2005
	register of all access equipment
	record of inspections
	Electrical - Electrical safety guidance for low voltage systems 2014
	maintenance records and logbooks
	permit to work books
	operational procedures manuals
	operational and maintenance manuals
	Electrical - Electrical safety guidance for high voltage systems 2014
	Maintenance records and logbooks
	Permit to work books
	Operational procedures manuals
	Operational and maintenance manuals
	Electrical - Bedhead services 2014
	Maintenance records and logbooks
	Permit to work books
	Operational procedures manuals
	Operational and maintenance manuals
	Medical Gases 2014
	MGPS “as fitted drawings”
	Permit to work books
	Maintenance reports
	MGPS Training Records
	Record of liquid oxygen supplies
	Operations & Maintenance Manual with all plant and system components technically detailed with fault conditions identified
	Written Scheme of Examination in line with the Pressure Systems Safety Regulations 2000
	Compliance surveys
	Design Review, Installation, Validation & Verification Documentation
	Asbestos 2014
	Asbestos Management Plan
	Asbestos Register
	Gas Safety (Inst & Use) Regulations 1998
	Register of gas burning appliances
	Risk assessments
	Maintenance records Gas Safety (Inst & Use) Regulations 1998
	Safety inspections and certificates
	Dangerous Substances and Explosive Atmospheres Regulations 2002

	survey of locations of dangerous substances
	risk assessments
	Firecode - General (incorporating SHTM80-86 bar 82)
	approved contractors register
	quality checks
	Firecode - General (incorporating SHTM80-86 bar 82)
	fire risk assessment
	fire engineering report
	portable fire extinguisher test certificates
	hot work permits
	Workplace (Health, Safety and Welfare) Regulations 1992
	maintenance records for relevant equipment
	site risk assessments
	Heating and Ventilation 2014
	records and log books
	inspection records for ventilation systems serving critical areas
	records regarding system plant performance
	training records
	permits to work
	records validating performance of Ultra Clean Ventilation (UCV) theatres
	Firecode, Alarm and Detection Systems (incorporating SHTM 82)
	test records
	Noise at Work Regulations (Incorporating SHTM 2045) Acoustics
	noise assessments
	acoustic report
	Water 2014
	records and log books
	water quality test certificates
	water and surface temperature test certificates
	legionella risk assessments
	action plan linked to risk assessment
	written Scheme (Operational Procedures) in use for Control of Legionella in each Domestic Water System
	'As-Fitted' drawings of all the Domestic Water Systems
	water safety plan
	Lifting Operations and Lifting Equipment (LOLER) Regulations 1998 - (Lifting Equipment)
	test certificates for lifting equipment held on record
	Management of Health & Safety at Work Regulations 1999 (Incorporating SHTM 2050)
	estates Dept Health & Safety manual which details safe working practices
	estates risk register
	Energy Performance Certificate
	Fire (General)
	fire risk assessment and management plan

	fire action plan
	fire and emergency file
	Disability Discrimination Act (DDA)
	checklist of DDA compliance
	Electrical (General)
	electrical portable appliance (PAT) test records
	certificates of testing for all fixed wiring and distribution boards
	certificates of testing for emergency lighting
	lighting protection risk assessment
	standby generation test certificates
	UPS test certificates
	system commission data and logs
	report evidencing that all electrical installations within radiography, diagnostic and imaging facilities comply with the recommendations contained within the medicines and healthcare products regulatory agency (MHRA) document entitled “medical electrical installation guidance notes (MEIGaN)
	Statutory Applications and Consents
	planning approvals
	building warrants
	road consents

1.1.7 Survey and GIS data and information **(Level 3)**

The following data and information sets are an exemplar requirement for survey and GIS data:

Survey and GIS data and information
Boundary identification survey
Site topographic (feature and level) survey
Floor level datums
Measured survey of as built (which might include a LiDAR)
Utilities survey data and drawings
GIS data
Survey control network information
Post occupancy evaluation (POE) surveys
Condition survey data as per: Estates Asset Management: Property Appraisal Manual

1.1.8 CAD and Layout drawing information **(Level 4)**

The suggested minimum information set is:

Site Level drawings:

CAD and Layout drawing information	
	SCART assessments
	Block distribution on the site
	Block numbers (to be agreed with NHS Board)
	Site boundary – polyline to provide GEA (m^2) of site
	On the larger more complex sites, it will be beneficial for the NHS Boards to show the boundaries of individual blocks, particularly where there more than one within a physical building.
	Block Level drawings: Building plans, zones and elevations at block level. The CAD drawings should have industry standard layering and consist of:
	Walls (external and internal)
	Doors
	Windows
	Sanitary fittings
	Fixed furniture
	m^2 per room – with polyline
	overall GIFA m^2 of block – with polyline
	"as fitted" drawings of:
	Medical gases
	Domestic Water Systems
	Other optional suggested information set is:
	Optional Block Level Drawing:
	Building sections
	Details of through wall construction
	Optional "as fitted" information set:
	Electrical services
	Building management systems and controls
	Security systems
	Mechanical systems
	Plumbing and drainage systems
	Lifts and elevators
	Catering systems
	Furniture, fittings and equipment
	Patient bedheads
	Foundations and retaining walls
	Structural Frame
	Room Level drawings:
	Room elevation c-sheets and linked room data sheets

1.1.9 Technical data and information **(Level 5)**

The suggested minimum data and information set is:

Technical data and information
Unique asset identification numbers
Descriptions of assets and the asset systems they serve
Engineering data and design parameters
Functions of assets, including any interdependencies to the activities that require them
Vendor data (details of the organisation that supplied the asset) including asset lead time
Asset manufacturer and model reference
Asset specification
Locations of the assets, possibly using spatial referencing or geographical information systems;
Commissioning data and test certificates
Access planning
Spatial data relating to assets, for example pavement areas, room sizes
Warranties and guarantee periods
Operation and maintenance information
Recycling and disposal information

1.1.10 Lifecycle data and information **(Level 6)**

The suggested minimum data and information set is:

Lifecycle data and information
Purchase cost data (including land, finance and fees)
Construction cost data
Rent and rates data
Operation and occupancy data
Energy and utility cost data
Maintenance costs (Hard FM) data
Lifecycle replacement cost data
Projected disposal cost data
Income data
Academic lifecycle models
Lifecycle period data for elements and sub elements
Replacement costs data for elements and sub elements
Asset, element financial impact of unavailability data
Key performance indicator data
Planned maintenance task cost data
Total cost to occupy data

1.1.11 Building Information Modelling **(Level 7)**

The suggested minimum data and information set is:

Building Information Modelling	
BIM Level 1	
	Organisational Information Requirements (OIRs)
	Asset Information Requirements (AIRs)
	Record of project BIM Level 1 Exchange Information Requirements (EIRs)
	Built Asset Security Strategy (BASS)
	Built Asset Security Management (BASMP)
	Built Asset Security Information Requirements (BSAIR)
	As-Built CAD files in a native file format
	As-Built non-graphical data in an agreed file format e.g. Excel
BIM Level 2	
	Organisational Information Requirements (OIRs)
	Asset Information Requirements (AIRs)
	Record of project Exchange Information Requirements (EIRs)
	Built Asset Security Strategy (BASS)
	Built Asset Security Management (BASMP)
	Built Asset Security Information Requirements (BSAIR)

	As-Built domain models in a native file format
	As-Built federated models
	As-Built 2D PDFs cut from models
	As-Built non-graphical data in an agreed file format e.g. COBie
	Records: BIM Protocols, BEPs, MIDPs, BIM assessments, Soft Landings plan

1.1.12 IoT and Telemetry Data **(Level 8)**

Potential data sets may include:

IoT and Telemetry Data
Occupancy level data – building and room level (motion, velocity and displacement)
Building visitor data – overall and per hour of day
Smartcard swipes – building and department level
Average energy use data
Average energy consumption data
Temperature data
Humidity and moisture data
System flow data
Leak data
Chemical and gas data
Acoustic, sound and vibration data
Current car park availability data
Building control and management system data
Lift and escalator management data
SCADA data
Incident services data
CCTV feed
Security data
Access control data
Position, presence and proximity data
Public information data

1.1.13 NHSScotland Board enterprises systems **(Level 9)**

Integration with other enterprise systems may include the undernoted databases:

NHS Board enterprises systems
Asset Information Model (AIM) CDE
Asset register database (EAMS)
Computer assisted facilities management (CAFM) database
Admin and room booking databases
Financial and ERP databases
Historian and OPC servers
Help desk databases
Inventory databases
GIS database
Field device database

1.1.14 External Open Data **(Level 10)**

Integration with external databases may include:

NHS Board enterprises systems
Meteorological
Communications
Demographics
Transport / Including Ticketing
Power
Water
Scottish Government open data
UK Government open data
Scottish remote sensing portal
Ordnance survey data

NHS
National
Services
Scotland