



Queensland Health

# Enterprise Architecture Vision 2026



Queensland  
Government

## Queensland Health Enterprise Architecture Vision 2026

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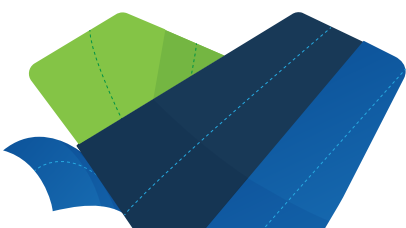
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For more information contact: Office of the Deputy Director-General eHealth Queensland, Department of Health, GPO Box 48, Brisbane QLD 4001

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## A message from the Deputy Director-General, eHealth Queensland

Digital culture is pervasive: consumers of all ages and backgrounds are increasingly relying on digital tools to discover, consume and interact with both virtual and physical products and services. These digital technologies have the potential to transform the delivery of healthcare services, so it is important to look ahead at how Queensland Health can deliver on this potential.

The Queensland Health Enterprise Architecture Vision 2026 outlines how Queensland Health will prepare itself to respond to the opportunities that digital transformation present over the next decade. Enterprise architecture is a key enabler for a digital healthcare service in that it ensures technology investments are optimally aligned to achieving business outcomes whilst also identifying opportunities and risks.

As healthcare models continue to evolve in complexity and sophistication, the demands of a digital health service are greater than ever. Enterprise architecture gives us an

understanding of not only what is possible through digital transformation, but what the factors are that will enable this transformation and ensure the integrity of the health system.

In partnership with the 16 Hospital and Health Services (HHSs) the enterprise architecture vision outlines the foundations of a digital health system that provides integrated services in a timely, safe and secure manner. These foundations will empower both healthcare consumers and providers to optimal healthcare outcomes through digital technologies. These digital technologies will support the delivery of frontline services, maximise the quality of care, revolutionise patient experience and enable new models of care.

I am confident that our vision for Queensland Health's enterprise architecture is achievable and will derive significant value for not only the health system, but the lives of all Queenslanders.



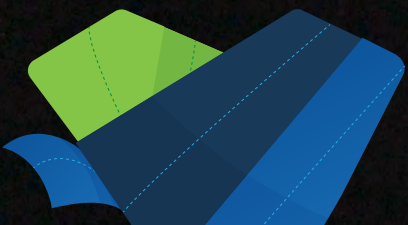
Damian Green  
Deputy Director-General  
eHealth Queensland



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# Introduction

## Our vision

***By 2026, Queensland Health will have an adaptable architecture driven by new models of care and services that rely on data-driven insights and digital adoption.***

The Queensland Health Enterprise Architecture Vision 2026 provides an architectural future state required to underpin Queensland Health’s shifts towards a more accessible, equitable, proactive, efficient, insights-driven and connected health service ecosystem.

The Queensland Health Enterprise Architecture Vision sets out the digital journey towards realising the Advancing Health 2026 and Digital Health Strategic Vision for Queensland 2026. Without this focus, the potential to be bold and do things differently will be constrained. As new models of care and services rely on access to information, and digitally enabled interactions shift care closer to home, the continual design and adaptability of the architecture becomes more critical.

This enterprise architecture vision is intended for executives and decision makers across Queensland Health, its healthcare partners and industry. It provides a framework for use that lasts over time through which digital enablers can reduce demand, improve efficiency and quality of care, and support improvements in healthcare service delivery.

The Queensland Health enterprise architecture must provide connectedness and traceability across services and the patient journey. It must provide reliability and trust for digital adoption in order to enable new models of care and new service experiences for the workforce and the patient.

The enterprise architecture must enable new ways of working to help transform a largely hybrid system of care settings and organisation using a mix of paper and digital capabilities, into an integrated, real-time and responsive health system. To achieve this, research shows that focus across the four dimensions of the Quadruple Aim<sup>3</sup> is needed. Experience-led design is core to informing broader architectural design and adoption.



Figure 1: The Quadruple Aim and some of its indicators

This document focuses on the future of health services delivery and the enterprise architecture required. It articulates an architectural capability that should:

- inform how new models of care and services are enabled by architectural and technology choices
- facilitate data and insights into a longitudinal view for patients and populations that will support more effective ways of delivering care and informed patient-centric behaviours
- support a shift to a wellness mandate to improve the health of all Queenslanders
- deliver a connected services ecosystem focused on the patient/person
- inform the development of digital investment priorities, roadmaps, capabilities, standards and solution designs.

### Underpinning multispeed change

Queensland Health and its HHSs are working to achieve a more sustainable health system and will continue to undergo transformation driven by increasing demand, health spend and disruption. Fundamental shifts will occur in the design and delivery of services leveraging new technologies and data, as well as significant partnerships across the broader health ecosystem. These are needed to respond to:

- changing population demographics
- the rise of the informed consumer, actively participating in their own care management and decision making
- equity of access for those who need it most
- continued improvements to quality of care to reduce unwarranted variation
- unnecessary transfers, preventable presentations and avoidable admissions
- the shift from volumes-based towards values and outcomes-based models
- increasing expectations for a more insights-driven care and service environment derived from a longitudinal view of an individual and population.

The result is a bimodal approach to delivery of healthcare services and its supporting technology. Gartner define bimodal delivery as the practice of managing two separate, coherent modes of delivery, one focused on stability and the other on agility. Mode 1 is traditional and sequential, emphasising safety and accuracy. Mode 2 is exploratory and nonlinear, emphasising agility and speed.<sup>2</sup>

### The Queensland strategic context

Queensland Health is committed to its Advancing health 2026<sup>3</sup> vision, that by 2026 Queenslanders will be among the healthiest people in the world.

Strategically Queensland Health is making several shifts to better support the needs of Queensland. Queensland continues to show significant population growth, with almost 5.7 million residents predicted for 2026, longer lifespan and increased burden of disease. For example, Queensland Health is predicted to grow to 3.7 million hospitalisations (a 62 per cent increase over ten years) by 2026.<sup>4</sup>

In response, Queensland Health is looking to transform health services, optimise the system and grow the capacity of the system.



Queensland Health has already made significant investments in digital health technologies and has a clear Digital Health Strategic Vision for Queensland 2026<sup>5</sup>. The path to a healthier Queensland in 2026 will depend on how investment and adoption of new technologies can contribute to better clinical outcomes, improved models of care and health services, and shifts in care management and service settings. The key to this is an architecture that supports adaptive digital adoption, and more than ever before leverage partnerships across a harmonised health services ecosystem.

## Beyond Queensland

The National Digital Health Strategy, *Safe, seamless and secure: evolving health and care to meet the needs of modern Australia*<sup>6</sup> describes seven strategic priority areas.

1. Health information that is available whenever and wherever it is needed.
2. Health information that can be exchanged securely.
3. High-quality data with a commonly understood meaning that can be used with confidence.
4. Better availability and access to prescriptions and medicines information.
5. Digitally-enabled models of care that improve accessibility, quality, safety and efficiency.
6. A workforce confidently using digital health technologies to deliver health and care.
7. A thriving digital health industry delivering world-class innovation.

The accompanying Framework For Action outlines the plans of organisations across Australia to deliver on these priorities. Queensland Health initiatives include:

- the Interoperability platform strategy<sup>7</sup>
- supply chain reform
- ongoing work in telehealth and secure messaging for referrals
- workforce enablement such as the bring your own device program and Certified Health Informatician Australasia certification initiative<sup>8</sup>.

These will contribute to and leverage investments made by the Australian Digital Health Agency (ADHA) and other jurisdictions to coordinate and expedite outcomes and reduce individual organisation risks.

Internationally, digital health is being leveraged as a disruptor for transformative health system change for improved health services and outcomes. The World Health Organisation have identified eleven digital interventions across areas such as client communication, client health records, supply chain management, health worker training and telehealth<sup>9</sup>.

The National Health Service has established a set of guiding principles, targeting improvements in infrastructure interoperability and open data standards, building consumer-facing digital services to better support the public, and actively looking to scale innovations nationally<sup>10</sup>.

By monitoring and aligning with work interstate, nationally and internationally, Queensland Health can address local needs while leveraging the learnings and investments made in other jurisdictions.







# Digital for health 2026

## The evolving digital healthcare ecosystem

Australia is facing rapidly increasing disruption as technology, access and consumer demand alter the manner which we engage with the healthcare ecosystem. The sector itself is moving away from the traditional focus of in-hospital care towards care closer to home within communities, shifting away from reactive to proactive care at both an individual and population level.

Queensland Health is continuing its readiness to adapt and opportunistically leverage emerging technologies. To take full advantage of new capabilities and partnerships, Queensland Health must position itself culturally and provide clarity to stakeholders regarding capabilities that architecture will enable. As it shifts towards optimisation and transformation of how care and services are delivered, greater focus will be placed on integrating, expanding and scaling its digital health and digital workforce capabilities.

The journey for patients, families, carers and clinicians can be considered as a complex weave of roles, stakeholders, digital enablers and information flows, as shown in Figure 2. This journey results in the appropriate accumulation and sharing of clinical, social, environmental and administrative data that collectively forms the longitudinal record over time.

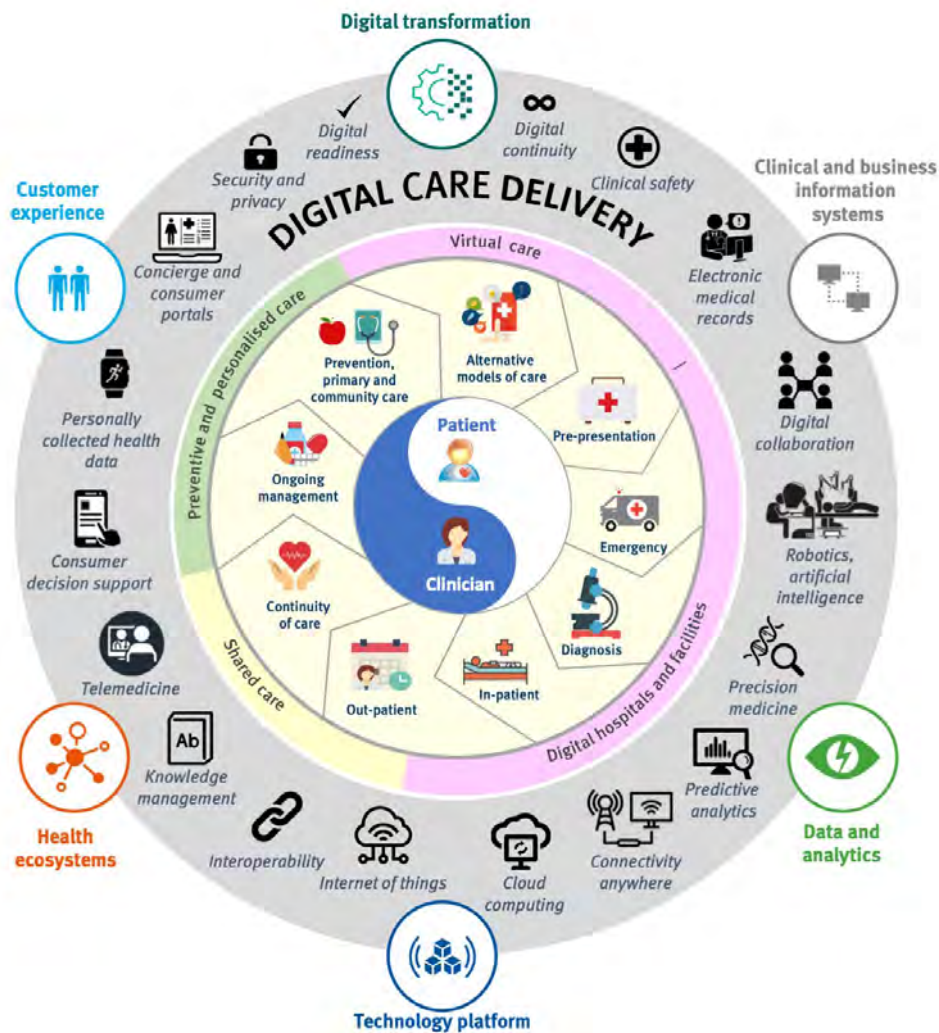


Figure 2: Health is a connected ecosystem of organisations, settings and technologies

The Digital Health Strategic Vision for Queensland 2026 sets the tone for how healthcare will be experienced in 2026.

#### For healthcare consumers and the community:

- increased patient engagement
- safer and faster healthcare services
- improved access to specialist care
- a coordinated and connected health system
- active participation in their own healthcare with more control over their health data
- support via tools and applications to help consumers make choices about their healthcare pathways and healthy lifestyle choices
- greater control over where, when and by whom the required care is provided.

#### For the clinician:

- quality healthcare supported by improved clinical decision making
- increased access to patient health information wherever care is provided.

#### For the health system:

- systematic and high-quality care
- continuous improvement
- rapid translation of research and innovation into system-wide practice.

## Digital trends key to healthcare optimisation and transformation

We live in a world of constant change and evolution in digital technologies. Some of these have already begun to impact the health and wellness sector, while others are likely to do so over the timeframe of this enterprise architecture vision.

#### Near ubiquitous communications and data

By 2026 enhanced and new network and communication technologies will increase universality and responsiveness of applications with faster mobility, lower latency and better connectivity<sup>11</sup>.

This will be supported by the continued trend for 5G, edge computing and cloud. This is creating solutions for storage of big data coming from the internet of things (IoT) and cloud-based compute capabilities, allowing analysis of data close to storage<sup>12</sup>.

These will support IoT, internet of everything and health programs that draw upon complex functions such as virtual reality, gamification, robotics, video coaching and the e-Home.<sup>13</sup>

#### mHealth – mobile healthcare devices

Digitally empowered consumers are increasingly turning to mobile apps to support healthcare<sup>14</sup>. They provide connectivity to personal monitoring devices, drive cognitive change<sup>15</sup> and, when supported by evidence, can be recommended by clinicians as a knowledge/therapeutic tool. Regulation is a topic of some discussion to ensure that health apps have an appropriate evidence base<sup>16</sup>.

**88% of  
Australians  
have a smart phone**



## 97% patients satisfied

According to Harvard Business Review, 97 per cent of patients were satisfied with their telehealth experience and 74 per cent believed it improved their relationship with their healthcare provider

#### Continuity of care – connected anywhere, anytime

Greater focus will be placed on an integrated approach to care delivery across the patient journey that improves experience and reduces costs through less waste and reduced acute demand<sup>17/18</sup>.

New models will improve access, experience, quality, cost and outcomes for the patient and providers. A core part of Queensland Health's approach will be to drive and orchestrate integration across the continuum of care<sup>19</sup> through enabling and supporting infrastructure. Taking a patient-centred approach to change means that technology introduction

should never be approached in isolation and will be driven by new models of care, services redesign and an appetite for innovation.

Models that meet patients where they are, as opposed to in the hospital, will prompt investment in virtual departments to address multiple issues including patient access, affordability of care, clinician shortages and geographic disparities. Portable diagnostic technologies such as x-ray machines and blood testing kits will further enable hospital grade treatment in the home. Virtual department models such as electronic intensive care units (eICUs) will allow hospitals to make optimal use of their existing critical care resources<sup>20</sup>.

Lower costs, better consumer technology and improving patient engagement are driving a renaissance in telehealth<sup>21</sup>. Combined with sensors on or in the body and those in the home, patients can be monitored at home before or after treatment, supporting treatment compliance and key transitions between care settings.

Care settings will be anywhere that patients are. For some patient cohorts, provision of care close to communities and country are significant factors in addressing healthcare needs, treatment compliance and overall outcomes. Information will be shared across Queensland Health sites and key partners, providing the care team with an integrated and interactive ability to manage remote care safely and effectively.

### Digitally aware older Australians

While the ageing population is well recognised, it must not be forgotten that many older Australians have lived through the digital revolution of the last few decades. Combined with a desire to age well and retain their independence within their home, there is an increasing expectation that healthcare can be provided to them and their carers/families enabled by digital technologies.<sup>22</sup>

### The internet of things

Connected sensors that collectively make up the world of IoT have a strong relationship with artificial intelligence (AI). Artificial intelligence can help make sense of the IoT data at high volumes and velocities and IoT is useful for providing real-world, real-time data useful for the training of AI<sup>23</sup>.

Personalised sensors tailored to individual needs and wearables will continue to disrupt healthcare, empowering consumers to participate in the management and monitoring of their health<sup>24</sup>. Though currently dominated by consumer wearables, the addition of more clinical-grade solutions is expected to grow faster than consumer wearables and play a stronger role in treatment interventions<sup>25</sup>.

Wearables support risk monitoring and behavioural change that leads to improved health outcomes<sup>26</sup>. The incorporation of cognitive technologies, smaller and more accurate sensors able to be worn on the skin, injected or ingested, and better interoperability among different platforms is promising, making them the enabler for value-based, preventive healthcare.

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## Organs-on-chips

A combination of advances in DNA sequencing and stem cell research has enabled researchers to grow miniature organs, based on patients' own DNA. Connected to electronic sensors, they can measure response to treatment at a cellular level.

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### Telematics

Availability of environmental health telematics for things such as water and air, pollen, and pathogen studies will enable population risk assessments, capacity planning and alerts for individuals<sup>27</sup>.

Telematics will improve transparency and visibility of supply chain factors within the US pharmaceutical industry, especially in response to the *Food and Drug Administration's Drug Supply Chain Security Act*<sup>28</sup>. On receipt, clinical facilities will increasingly be adopting wireless thermometers to monitor cold chain without the need for workforce<sup>29</sup>.

**\$200b(us)**  
likely savings in the  
next 25 years using  
wearables and remote

**50% of patients**  
with chronic conditions  
don't take their medication,  
ingestibles will change this.

### Smart assistive technologies

Consumers living with impaired mobility or disabilities will be digitally empowered to remain independent within the comfort of their home, allowing them to self-manage and receive treatments or transition home sooner. Smart assistive technologies such as digital voice assistants and devices for specific disabilities (e.g. spoons for those with hand tremors), domestic robots that can perform simple functions like retrieving objects, helping people walk, providing reminders for medications or interacting with lonely seniors will develop rapidly over the next two to five years<sup>30</sup>. Advancements driven by dynamic longitudinal datasets collected from the devices will see acceleration in smart technologies available.

### Interoperability

Key to enabling a patient-centred care ecosystem is establishing a simple and secure longitudinal view of the patient that supports clinical practice and the management, delivery and evaluation of health services, and enables innovation to scale. This requires the standards for the exchange, integration, sharing and retrieval of electronic health information.

Data within systems at the point of care and across other third parties will be available for shared use across providers and partners within the health ecosystem. With this comes the recognition that a patient's record exists across the ecosystem of federated and integrated systems, not just in any one system of record, and recognises the complete determinants of a person's health and wellness<sup>31</sup>. Notably, there will be an active shift towards person-centred and citizen-centred views<sup>32</sup>. This will support collection, curation and linkage of individual and population level insights, to improve decision making, response and delivery.

As traditional care settings are replaced with home-based care, community integration will become critical. Care settings will seamlessly access a longitudinal information view from an individual to population level, to ultimately support better health outcomes efficiently.

There is a global shift towards application programming interfaces (APIs) such as Fast Healthcare Interoperability Resources (FHIR), the next generation interoperability standard created by Health Level Seven (HL7) to leverage the latest in web standards<sup>33</sup>. HL7 FHIR will become the de facto standard for most healthcare interoperability<sup>34</sup>.

### Democratisation of data

As digitisation increases across the healthcare sector, sources of health data are increasing but are not always available to be utilised to improve outcomes. Use of open standards

and agreement on national and statewide data standards, definitions and terminologies will support pervasive integration. This will be the catalyst for measurable health gains through effective collaboration.<sup>35</sup>

### Connected care communities

Global connectedness is bringing people together focused on shared interests and challenges in their health. These will be dominated by the empowered consumer sharing information and support, and be an avenue for Queensland Health to engage, connect and disseminate health information and support to target 'at risk' groups. These platforms serve as 'data donor' communities for research<sup>36</sup>.

### Artificial intelligence and machine learning

Information will be enabled through platforms and apps, leveraging AI and automation workflows. It will use various inputs such as graphical, text and voice in multiple devices. Artificial intelligence and machine learning will be integrated to deliver clinical decision support. Deep learning is one approach inspired by the structure of the brain and its interconnecting neurons (i.e. neural networks) which is accelerating in its maturity. It has been effectively applied in areas such as image and speech recognition, bioinformatics and drug design<sup>37</sup>.

As Queensland Health integrates within the broader digital health ecosystem, primary and community level information and capabilities will produce AI-led intervention support that reduces patient risk in various care settings, and as they transition between providers.

### Precision medicine and genomics

Genomic medicine is transforming healthcare. Advances in technology have dramatically reduced the cost and effort to sequence a whole genome and the accessibility of the data. This genomic data needs to be stored and then analysed multiple times, for both clinical care and research purposes<sup>38</sup>.

Genomic sequencing will reduce in cost and in practice, leveraging individual variability in genes, environment and lifestyle for diagnosis and treatment of disease<sup>39</sup>. The market for precision medicine will become mainstream by 2026 with pharmaceutical companies making the biggest investments. The market covers therapeutic intervention, molecular diagnostics, imaging and informatics<sup>40</sup>.

**30,000 samples**  
Genome Canada is aiming to build  
a national rare disease cohort from  
patients and their families

*'Genomics has completely changed the practice of cancer medicine, enabling personalised medicine for a large fraction of cancer patients. It promises to disrupt in a positive manner virtually all areas of medical practice. We look forward to making medicine safer by incorporating pharmacogenomics into the electronic prescription system to help catch potential adverse drug reactions before they happen.'*

- Matt Brown, Director, Australian Translational Genomics Centre

### Augmented and virtual reality

Surgeons use various techniques to visualise the area on which they are to operate, but augmented reality, which can project 3D representations of the patient's anatomy into the surgeon's field of view, is likely to improve accuracy and outcomes for patients<sup>41</sup>.

Meanwhile virtual reality (VR) is finding increasing traction as a training tool for surgeons, avoiding the risks associated with surgeons obtaining their initial experience with actual patients and the need for cadavers<sup>42</sup>.

VR is also gaining acceptance as a treatment approach for patients with mental health issues or for cognitive training in the elderly<sup>43</sup> and as a diversional therapy for other patients<sup>44</sup>.

### 3D printing

Rapid improvements in 3D printing technology are resulting in uptake within the healthcare sector<sup>45</sup>. Queensland Health has already successfully used 3D printing technology at the Queensland Children's Hospital to support cardiac surgeons to plan complex paediatric open-heart surgery<sup>46</sup>. Technologies are continuing to support research into bioprinting including printing organs using a patient's own stem cells.

### Autonomous vehicles and drones

Missed clinical appointments due to transportation problems, and access to services due to remoteness transport challenges, create wastage and cost in an already supply-constrained health system<sup>47</sup>. The existing trend towards non-emergency transport by ride-sharing companies will itself be disrupted with the eventual introduction of driverless vehicles<sup>48</sup>.

Autonomous robots will increasingly be used in clinical and aged care facilities to relieve staff of mundane transport tasks such as moving clean and dirty linen around the facility and food services production. This also has workplace health and safety benefits<sup>49</sup>.

Drones will have regulated airways and have various remote and metro healthcare applications such as delivery of medications and supplies, reducing delivery time considerably.

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## Delivery drones

Drones are being trialled for blood supplies in Rwanda. UNICEF has trialled drone delivery of laboratory samples as part of their humanitarian efforts in Malawi.

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### Patient-generated health data

It is well recognised that lifestyle, behaviours and the environment have a far greater influence on patient outcomes than the efforts of healthcare providers<sup>50</sup>. This will see an increased use of population health analytics for targeted lifestyle campaigns with greater accountability placed on individuals around personal lifestyle and behaviour choices.

### Cybersecurity and privacy

Cybersecurity and privacy are now boardroom conversations rather than technical ones<sup>51</sup>. Globally, healthcare systems will be burdened with greater regulations due to the rising risk of fraud, ransomware and security concerns around patient data.

The cost of regulatory compliance is high, but that of non-compliance is higher. Data breaches by the healthcare sector

are at the time of writing the largest of any individual sector<sup>52</sup>, and the impact of cybersecurity breaches can be significant for both patient and the healthcare organisation.

The move in Australia to explore a Trusted Digital Identity Framework by the Digital Transformation Agency is just one response to this need and will incorporate elements already being used in the healthcare sector such as the myGovID<sup>53</sup>.

Consumers are more aware than ever of the need for privacy and security around their health data. Events around Facebook and Cambridge Analytica in 2018 brought worldwide public attention to the management of their data and will continue to be a growing area of interest by consumers<sup>54</sup>.



# 2026 Architecture vision

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***By 2026, Queensland Health will have an adaptable architecture driven by new models of care and services that rely on data-driven insights and digital adoption.***

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To achieve the enterprise architecture vision, the healthcare system needs Queensland Health to adapt its business processes, core technology, architectural environment, and workforce so that it can leverage more 'at the edge' patient-centred and efficient solutions. An adaptive architecture will:

- facilitate the use of data and information to drive insights from the point of care to population levels
- support connected health and care, in any location, in an equitable manner
- be co-designed with patients and clinicians
- challenge and enable new models of care and service delivery
- be able to respond to healthcare innovation and its technology needs
- support the bimodal nature of healthcare delivery in Queensland.

To put Queensland at the leading edge of healthcare and clinical research, the architecture will be designed to harness

the volume and velocity of health data being collected through our investment in the integrated electronic Medical Record (ieMR) and other clinical information systems and devices.

A platform-oriented approach for delivering transformational healthcare services is key to providing an adaptive architecture. Figure 3 details this platform approach and is adapted from the Digital Care Delivery Platform as published by Gartner<sup>55</sup>.

Adoption of this architectural approach will allow a rapid shift that focuses on:

- wellness rather than illness
- a linked continuum of care
- personalised and targeted care plans
- broader population health interventions
- data-driven healthcare policy.

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Five interconnected platforms combined form the conceptual definition of a digital healthcare platform for Queensland Health:

1. Customer experience platform focused on patients and consumers' experience throughout their healthcare journey.
2. Health ecosystem platform covering partners and alliances, as well as interoperability across the health ecosystem to provide patient-centred care delivery.
3. Healthcare technology platform providing virtual care, remote monitoring, telehealth, mobility and internet of healthcare things (IoHT) systems and devices.
4. Clinical and business information systems platform providing legacy and new core systems including electronic health record and digital hospital systems.
5. Data and analytics platform which is the intersection for data in the peripheral platforms to provide aggregated data and analytics, which lead to evidence-based care outcomes, and providing insights to external decision support systems.

The healthcare, business focused platforms will require adaptive digital architecture foundations that underpin the capabilities needing to be delivered. These foundations are comprised of the enabling technical architecture (e.g. IT infrastructure technology and software services) and a level of information architecture such as core standards to address interoperability needs.

The five platforms and foundations are described in detail in the next section.



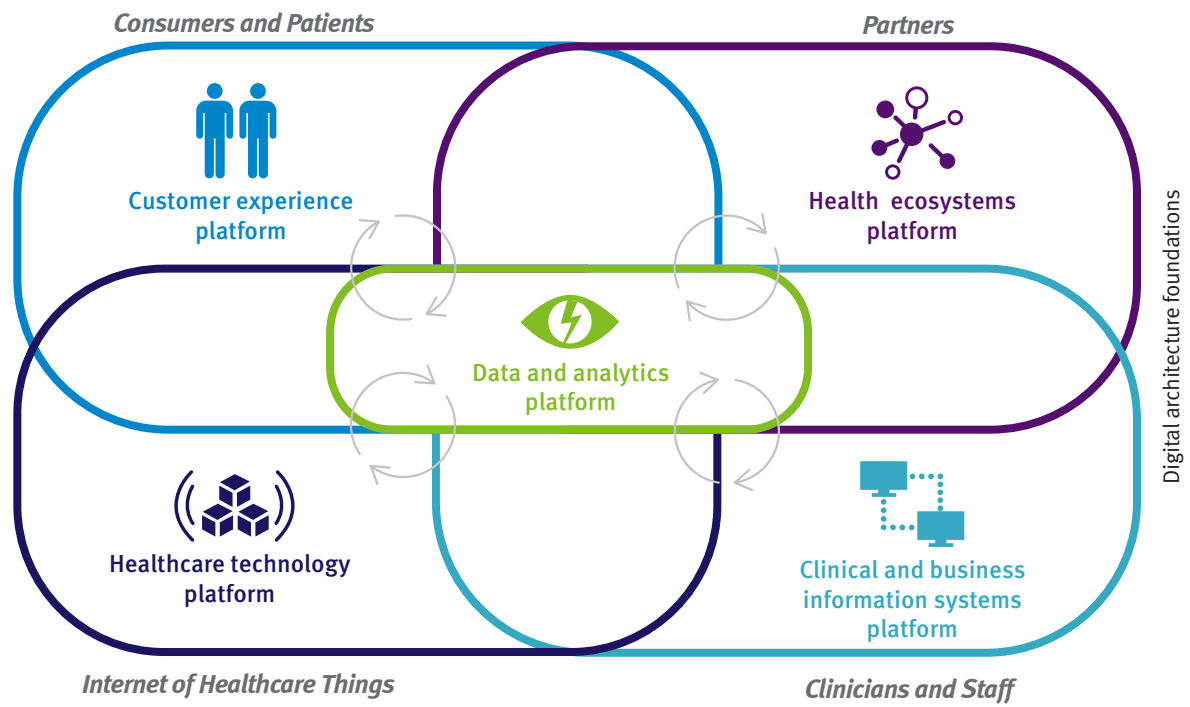


Figure 3: The healthcare platforms supported by foundations



## Customer experience platform



### Virtual engagement

Consumers are growing increasingly comfortable with the use of technology to deliver services to them. Consumer videoconferencing has already revitalised the delivery of personal telehealth services.

By 2026, we will see an architecture that provides healthcare services to consumers in locations of their choosing, where this is clinically appropriate. This will reduce costs for patient transfer, increase utilisation of clinical resources and deliver a consumer experience better matched to changing community expectations.

### Decision support

AI techniques and technology will augment the specialist skills of our clinical workforce. This will enable them to focus on appropriate treatment approaches rather than analysis and diagnosis of standardised healthcare issues.

Delivery of AI-based advisory services to clinicians will become a standard part of their clinical workflow. These services would support efficiency gains and improve workforce satisfaction amongst staff.

### Patient decision aids

Consumers are increasingly seeking health advice and treatment information through digital channels. Queensland Health will be able to meet this need through better use of AI technologies (e.g. cognitive assistants).

Investment to leverage AI to add value to existing and new consumer channels will support an improved consumer experience and reduce unnecessary clinical consults. Concierge services will assist patients navigate the health system and clarify their healthcare journey.

### In-home care and monitoring

Australians are high adopters of smart phones and tablet devices, and are constantly connected to people and information via the internet. By leveraging proven and evolving mobile technologies, by 2026 Queensland Health will be able to provide alternative treatment pathways for consumers that can bypass or avoid hospital-based treatments. While this will improve quality of life and reduce costs for both patients and health services, it will require enhancements in identity management and patient data security.

## Healthcare technology platform



For healthcare, an increasing number of health-related devices such as IoT devices will talk to users and each other and disrupt traditional workflows. A surge in use of wearable technologies by consumers is already challenging healthcare practitioners to tap into a vast quantity of biological and consumer-generated data.

The architecture of 2026 will support digital hospitals of the future that are sensor-rich and include:

- clinical measurements (e.g. vital sign monitoring)
- self-monitoring
- self-calibrating medical equipment
- real-time location-based services for patients, staff and equipment.

In the consumer space, smart devices including health-focused devices will dominate our lives by 2026. The architecture will support leveraging the data from these consumer owned devices, together with the data acquired from specialist devices.

In healthcare, access to contextual information for clinical and business decision-making is critical. Our IT communications networks will support access to data, voice and video services from both fixed and mobile devices.

By 2026, the architecture will manage priority and quality of service as a vital component of a contemporary communications network, support the capture of data from clinical and consumer-generated devices, and leverage the growth of edge-computing in these devices to provide data-driven insights as close to the point of care as possible.

## Health ecosystems platform



Understanding the complete health ecosystem and the service boundaries between components is critical to delivering digital services in 2026.

By 2026, Queensland Health will have established an ongoing process to identify, understand and build these factors into the architecture.

### Clinical terminology services

Clinical terminology services refer to the provision of tools and functions that support the codification of diagnostic and treatment data. This is based on internationally accepted standards and allows for data to be consistently consumed, shared and compared.

Standard terminologies in healthcare within Australia include:

- SNOMED CT-AU: Australian extension to SNOMED CT including the Australian Medicines Terminology
- ICD-10-AM: International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification
- LOINC: Logical Observation Identifiers Names and Codes.

To support the integration and use of clinical terminologies in clinical practice, research and planning requires several services and capabilities to be created—allowing for terminology discovery, mapping and recording.

By 2026, Queensland Health will have established clinical terminology support for all major clinical systems as a base requirement for common metadata to support data analytic capabilities.

### National digital health infrastructure

The Commonwealth's My Health Record system is Australia's national shared electronic health record system. In addition to providing a rich source of clinical data, national digital health infrastructure also provides services such as:

- national identifier services for patients, providers and provider organisations
- services for secure information exchange
- standards in clinical terminologies.

By 2026, Australian consumers and healthcare providers will be increasingly reliant upon My Health Record and the information it contains as an integral part of healthcare delivery, especially for consumers with complex and chronic needs or those who are highly mobile.

This reliance will occur in one of two ways:

- clinical systems used at the point of care will seamlessly push and pull data from the My Health Record
- clinicians will be able to communicate securely with other clinicians via My Health Record.

Irrespective of the method of access, Queensland Health has an obligation to be a consumer of national digital health data and services, and a My Health Record data publisher.

The Queensland Health architecture will manage and maintain a suite of services that facilitate My Health Record and other national interoperability programs.

### Research

By 2026, Queensland Health will support a productive exchange of information with the research community through the appropriate provision of data via digital channels that allow research to provide insights and help inform and improve patient outcomes.

This will leverage improvements in connectivity and identity management, as well as the use of appropriate and more responsive storage technologies. A robust consent model will be established in consultation with the research community, consumers and privacy advocates.

The architecture will support collaborative or partnership arrangements (e.g. Queensland Genomics Health Alliance, the Herston Biofabrication Institute and the Translational Research Institute), necessitating a managed flow of data and compute capabilities across partner networks. Federated repositories that identify and provide decision support to phenotypes and genotypes will become critical to clinical workflows.

## Clinical and business information systems platform



The systems that support our clinical workflows, business operations and support functions are pivotal to our ability to deliver the correct services in the right location.

With rapidly advancing and changing digital and architectural landscapes, Queensland Health will take a bimodal approach to visioning and planning that can accommodate today's needs and meet tomorrow's challenges, by leveraging emerging opportunities to respond to those future needs.

The architecture will keep evolving to better support the federated model within Queensland Health, with some systems deployed on an enterprise basis, whilst some best-of-breed systems will be selected to address specific local needs, noting that such cases may increase the complexity of interoperability demands.

### Clinical systems

By 2026, we will have deployed and optimised a range of clinical systems to support clinical needs across the state,

mindful of the specific needs of different locations and specialties. These platforms will support the transformation of the way healthcare services are delivered within our community.

### Business systems

While the provision of healthcare services to Queenslanders is our primary objective, we can only continue to do this if we have the financial and workforce capabilities to do so. Queensland Health requires the architectural foundations to support contemporary business, finance and logistics solutions that support the needs of Queensland Health and the HHSs.

Exchange of relevant data with clinical systems (e.g. supply chain) will be standardised and critical business metrics will be established for the data and analytics platform to provide insights for improved operational efficiencies.

## Data and analytics platform



The data and analytics platform is strategically positioned at the intersection of the other platforms. Not only will it provide an information hub for analysis and intelligence purposes, but it will also enable intelligence and insights to flow outwards, thereby providing a feedback loop to the whole ecosystem. For example, edge-located decision support technology will be potentially fine-tuned and controlled with information only derived by a centralised source. It will also serve as the catalyst for data cleansing and increased data capture across the healthcare landscape.

### Health intelligence and insight

By 2026, all Queensland Health patients, personnel and partners will have access to secure, trusted and timely clinical and business insights to support their operational and strategic decisions<sup>56</sup>. This will:

- deliver data and clinical intelligence in a timely and cost-effective manner
- accelerate the realisation of digital healthcare delivery
- improve our organisational performance
- build a capable and empowered workforce and partnerships
- provide reliable, flexible, secure and high-performance platforms
- enhance trust in our information and our organisation.

Technology and workforce enhancements will bring together clinical and business data that can be interpreted to provide

local relevance within a framework providing consistent alignment and governance.

### Genomics and precision medicine

Queensland Health will develop capability in parallel with progress in other areas and collaborate with other groups working in the genomics field. This will require:

- delivery of foundations such as frameworks, standards and architectures in collaboration with the Queensland Genomics Health Alliance (QGHA) and other groups
- ensuring that clinical systems have the necessary technical support for genomics data and clinical decision applications
- integration between clinical systems to support application of genomic data to improve healthcare delivery.

By 2026, Queensland Health will have established the core capabilities to begin leveraging genomic data at scale and across service areas.

### Machine learning and artificial intelligence

By 2026, AI will perform a significant role in routine diagnosis within Queensland Health. Providing support for clinicians in triaging clinical images and other diagnostic processes, the technology will be integral to supporting improved experiences for both clinical staff and consumers.

Queensland Health's architecture will support the multiple computational models required by AI, in partnership with researchers and vendors providing established products.

## Digital foundation principles

The digital health architecture for 2026 is underpinned by ten key design principles:

- Clinically safe: All solutions must deliver clinically safe and highly reliable systems.
- Business enabled: Solutions must be customer focused, with technology an enabler, not the driver.
- Data culture: We need to acquire, analyse and use data as part of our normal practices.
- Secure and available: Our solutions must build in privacy and security but allow those who need to access data to be able to do so.
- Scalable and extendable: We need to design solutions with scaling in mind at the start.
- Standardisation and reuse: Proven technologies, patterns and practices will support better outcomes.
- Simplicity: Designs need to reduce complexity and the ongoing costs that result.
- Workforce skills: We need to understand the workforce impacts on our designs.
- Future proof: We need to understand we are building for an evolving future.
- Mobile: Solutions need to enable and enhance mobile healthcare scenarios and work as seamlessly as possible in locations with limited connectivity.



## Digital architecture foundations

The digital healthcare platforms are supported by foundational architectural capabilities which are realised across aspects of the Queensland Government Enterprise Architecture (QGEA) Framework<sup>52</sup>, as shown in Figure 4. The foundational elements and the eHealth Queensland architecture are consistent with the QGEA framework.

Each capability potentially requires its own specialised architectures and initiatives to realise the desired objectives, and solutions will need deep consideration to the associated legacy, regulatory and cultural context.

### Secure, private and resilient

Queensland Health will continue to strengthen security and privacy as a fundamental architectural component that enables access to data by those that need it. All systems and services need to be designed from their foundations to be secure, rather than applying security as an add-on, and have all the relevant controls to ensure an appropriate degree of protection is in place.

To meet some of the objectives, especially those related to research, we will develop consent and ethics models that can inform the requirements for security and privacy.

The move to a digital platform for hospitals and service delivery in other settings increases the need for robust architectural foundations. By 2026, Queensland Health will have developed network topologies and approaches that are resilient in the face of failure and will have embedded this approach in all system design. Regular resilience audits will be a standard part of our approach to service improvement.

### Connected

Access to contextual information for clinical and business decision-making is critical in healthcare. A reliable communications network is needed to deliver information to the various devices used in that delivery.

Given the size and population distribution of Queensland, connectivity challenges have always existed. However, bandwidth and reliability has been trending upwards to enable greater connectivity to reliable digital services.

To continue this trend, by 2026 we will enable and improve connectivity across wired and wireless services by enabling and supporting latest technology within our network boundaries (e.g. with SDN, SD-WAN) and by leveraging

desirable commercial offerings when available (e.g. 5G). External connectivity to internal resources must be supported in a secure and resilient manner.

### Scalable and responsive

Infrastructure services are undergoing a significant transformation due to disruptions caused by advances in cloud computing. A principle driver of cloud computing is both the commoditisation of enterprise computing and consumer demand.

On-premise infrastructure will remain an important part of the Queensland Health IT landscape for the near future, however by 2026 there will be increased adoption of cloud-based services, in line with the Queensland Government Cloud Computing Strategy.

Considerable planning and execution effort will be required to gain maximum value from a transition to cloud infrastructure. Legacy information systems will be strategically replaced or upgraded with newer cloud-native solutions. Rather than bulk workload movements, such as lift-and-shift, new solutions will be delivered leveraging cloud first and cloud native principles.

At a data centre level, opportunities are available to increase the agility and effectiveness of existing data centre services—network, server, data storage (including backups) and desktop services. Virtualisation and containerisation techniques will be implemented/extended, new software-defined infrastructure components will be utilised where appropriate, and new storage technology utilised.

### Interoperable

Continued support for interoperability is required to balance the needs between best-of-breed and enterprise-wide systems. By 2026, Queensland Health will uplift this capability through the development and adoption of best-practice integration services and application programming interfaces (APIs).

Common information models are also important to achieving interoperability, especially when considering the need for interaction between state, national and international information flows. Great strides are being made with the focus on electronic health records, however additional work is required to cover the full longitudinal context of healthcare. Identifying, participating in standardisation groups and developing/co-developing these models will need to continue, and be accelerated as required.

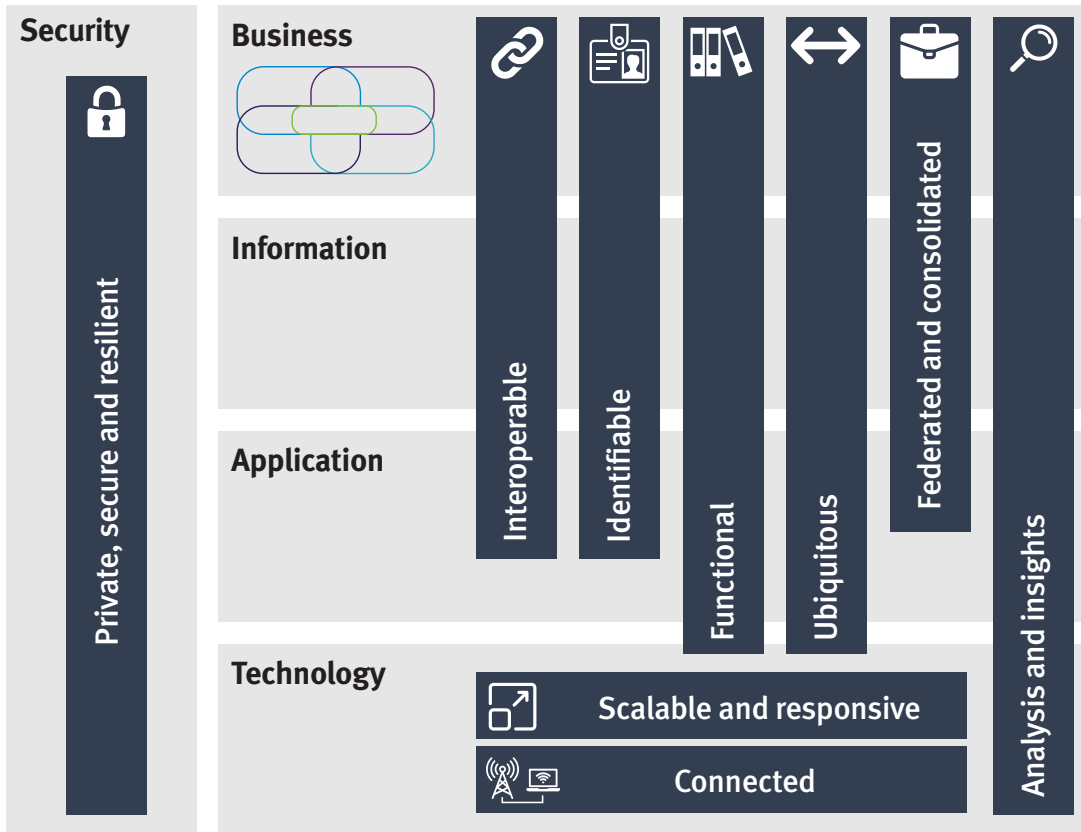


Figure 4: Aligning foundational capabilities to the QGEA Framework

## Identifiable



Queensland Health's ability to effectively identify and differentiate between patients and providers is a key enabler for delivering safe and effective services. In healthcare, mis-identifying a patient or creating duplicate records for a patient can put the patient at risk of potential harm.

As many systems require patient and clinician information, reliable identification systems are mandatory. This is required to manage a patient's identity across multiple systems and reduce the duplication of patient records.

Similarly, a single clinician identity, supported by multiple clinical roles, is essential for a successful integrated healthcare system. Correctly recording who has ordered and delivered clinical services, to enabling decision support and workflow capabilities is vital.

By 2026, Queensland Health will have established identity management across patient and provider cohorts, working with other government and industry partners to deliver a federated approach. This will include identity management for partner organisations within the healthcare ecosystem.

## Functional



By 2026, we will provide contemporary user experiences, together with the appropriate information and services, for clinicians, consumers and external partners.

Empowered and technology-savvy users are also driving end-user device innovation, and we will co-design with stakeholders on new service delivery channels.

This presents several challenges for enterprise computing in terms of provisioning applications and services, and the security of information delivered and stored on devices.

## Ubiquitous



By 2026 we will provide information and system access as close to the point of care as possible. This access will play a vital role in helping healthcare organisations deliver care, support clinicians and optimise patient outcomes.

Mobility will be optimised throughout the health system, to provide the right information and services, at the right time regardless of location and connectivity status. By 2026, all systems will support mobile access in both connected and disconnected modes as appropriate.

## Federated and consolidated



Consolidation of federated information to provide data that is clean, validated and usable will be in place by 2026. Data sets from federated sources will be merged and cross-referenced to maximise opportunities available from advanced data mining and analytical processing (AI/machine learning).

Developing and evolving the appropriate architectures for the required data acquisition, assurance, conformance, discovery and analytics capabilities will be an ongoing focus.

## Analysis and insights



All aspects of the digital health architecture need to focus on the delivery of data in ways that support its future analysis, regardless of the approach used.

By 2026, the architecture will support analytic capabilities in a federated manner, allowing analysis as close to the point of care as is practical, whilst leveraging the learnings for use across the enterprise. The multiple layers of the analytical foundations are described below.

### — Descriptive

Users will have access to clinical and business data and basic operational analytics that allow the healthcare system to be monitored and improved.

### — Diagnostic

Allows users to understand what happened and why, before moving to the predictive stage.

### — Predictive

Predictive algorithms and models will allow large quantities of data to be analysed to promote better lifestyle choices, better diagnosis and treatment, and improve the overall responsiveness of the healthcare system.

### — Prescriptive

In certain cases, AI will allow complex data to be analysed and decision support systems to be streamlined or automated.



# Policy, standards and governance

## Governance

Underpinning the delivery of this enterprise architecture vision is the need for effective governance. Ross and Weill<sup>58</sup> describe IT governance as 'the decision rights and accountability framework for encouraging desirable behaviours in the use of IT'.

Effective governance of digital investments is critical to delivering value and ensuring sustainability of those investments. It also needs to address how project investments are accessed in the following areas:

- align with strategic business goals and objectives
- reduce risk to the organisation and are appropriately risk managed
- optimise use of resources
- performance measurement is transparently and accurately assessed
- delivery of value and expected benefits.

In a federated model, such as in Queensland Health, there are several key characteristics that must be considered:

- networked not hierarchical – connections are based on shared purpose, values and language
- decentralised not centralised – agreed, rules-based operating norms are used
- adaptive not rigid – a much greater reliance on constant communication and collaboration to ensure collective responses
- syndicated not separated – decision-making and arbitration mechanisms are still required but rely on transparency.

eHealth Queensland will continue to work with all stakeholders to enhance the governance of digital investments to ensure engagement and empowerment of those stakeholders.

## Policy frameworks

In addition to the need for an IT governance framework, we also need a clinically driven policy framework that considers the federated model of HHS-led healthcare delivery.

The required policy framework needs to focus on the establishment of best-practice guidelines, based on national and international standards (for example ISO 38500), to assist HHSs in the development of IT related policies appropriate to their service.

This policy framework is constructed of building blocks that can be referenced by HHSs and where necessary annotated and enhanced as required to meet local requirements. Such an approach will ensure that there is consistent IT policy in place across Queensland's healthcare system.

Where necessary, the system manager may need to mandate policy to ensure compliance with other state government policies, legislation and regulatory requirements.

## Standards

The healthcare sector has a multitude of standards, which ironically pose an ongoing challenge to interoperability. The standards landscape is everchanging, with emerging standards constantly appearing.

Queensland Health will monitor these emergent standards, and in collaboration with the clinicians and software vendors, work towards a consistent plan for standards adoption. The architecture will support the presence of multiple standards (or generations of standards), whilst still progressing the adoption of contemporary standards over time.

# Transition fundamentals

The Queensland Health Enterprise Architecture Vision and related investments must be underpinned by the eight Queensland Health principles of digital health disruption:

- co-designed healthcare
- empowered workforce
- innovation focused
- collaboration
- empowered health consumers
- research into action
- effective governance
- sustainability.

## Federation considerations

Queensland Health operates a federated model of healthcare delivery with 16 separate HHSs established under statute, each with varying levels of capability and capacity.

Within this legislative framework, as the system manager the Department of Health is responsible for the overall management of the public sector health system.

A key objective of the *Hospital and Health Boards Act 2011* is to strengthen local decision-making and accountability. Therefore, a key to the success of this vision document is that the architectural elements described herein are co-designed with the HHSs.

In the interests of efficiency, consistent standards and system interoperability, certain architectural elements will be best established and maintained by the system manager. Decisions regarding responsibility for architectural elements will be made by agreement reached through consultation with stakeholders.

## Constraints for rural and remote

It is often easy to assume that all care settings are equal, with fast and reliable internet access, ubiquitous access to transport and services infrastructure, and a large local workforce well trained in modern, resilient technology solutions.

Unfortunately, like other parts of remote Australia, provision of health services in remote and rural settings is an ongoing challenge. Any response to delivery of healthcare through improvements in digital health must acknowledge the constraints that exist for remote and rural communities.

The digital health architecture needs to recognise and respond to these constraints to ensure it does not inadvertently limit access to systems outside major population centres.

Queensland Health will ensure equity in digital delivery, ensuring that no-one is left behind.

## Legacy shifts

Queensland Health has a long history of adopting technologies to support the delivery of healthcare. This has delivered a stable and robust healthcare service.

This is not without its issues. The critical nature of most healthcare systems means that they are not changed regularly or easily. The architecture will recognise and respond to the existing legacy systems, and plan for transformation in incremental stages that is manageable by system users.

## Organisational context

All future healthcare models and services will involve digital technologies and will therefore be dependent on architecture to ensure its success. However, different levels of capability and capacity exist and it's critical that the relevant architecture and eHealth Queensland operate with this front of mind.

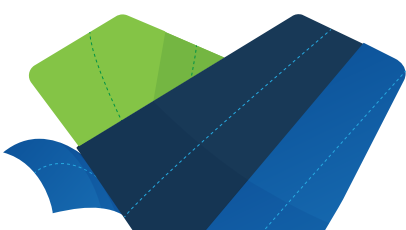
Optimising and transforming healthcare delivery in Queensland requires an adaptive architecture. Such an architecture must be co-designed with and communicated to stakeholders inside and outside Queensland Health in a clear and concise way, to leverage the value both to the system and to individual stakeholders.

## Workforce development

The National Digital Health Strategy outlines seven strategic priorities for digital health in Australia. Priority six is 'A workforce confidently using digital health technologies to deliver health and care'.

In adopting a strong digital health agenda, Queensland Health will continue to invest in training and support for our workforce. The architecture will support and encourage workforce participation, regardless of location. This is particularly true of rural and remote locations, which needs a practical application of the architecture to support both the attraction and retention of skilled staff.

Individuals need to be trained in analysis of large datasets acquired from patient health records such that greater understanding of the relationship between treatment and patient outcomes can be inferred<sup>59</sup>. Continued investment in health informatics and in-demand ICT skilled staff will be required to support delivery of this enterprise architecture vision.



### Financial sustainability

Queensland Health, like most health service providers, operates within a constrained budget. Since the COVID-19 pandemic first impacted Queensland, the Queensland Government has taken a responsible and staged approach to economic recovery. Accordingly, the architecture must recognise this, and prioritise solutions consistently with the principles outlined in the eHealth Investment Strategy<sup>60</sup>. These principles include:

- alignment to strategic intent (e.g. improve access to healthcare)
- delivery of greatest benefit (value) to the healthcare system
- contribution to risk mitigation/reduction to the patient and the broader healthcare system
- balance between remediation versus transformation
- arising urgent and nondiscretionary (unavoidable)
- capacity (internal and external) to deliver the investment
- sustainability
- organisational readiness.

For the architectural environment to be truly adaptive and sustainable, Queensland Health will need to work with the Queensland government to establish alternative funding models and agreements.

### Partnerships for success

Queensland Health is a statewide health ecosystem that works collaboratively with a range of agencies and providers (public and private). It is also a federated health delivery business comprising Queensland Health and its HHSs. This means the health system needs an architecture delivery framework that considers and engages:

- HHSs in both metropolitan and rural/remote areas
- Queensland Health units such as the Queensland Ambulance Service
- federally funded organisations such as the Australian Digital Health Agency, the Australian Institute for Health and Welfare, Health Direct Australia and primary health networks

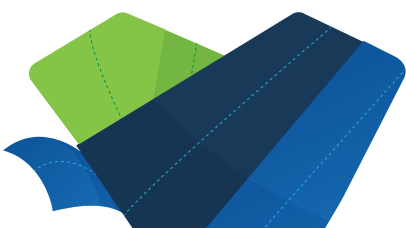
- private health providers including private hospitals and residential aged care facilities
- community, health, social, transport and other patient/consumer services providers
- policy makers to ensure alignment between architecture and legislation
- workforce teams and industrial relations organisations to understand impacts on our workforce
- procurement teams and/or supplier to ensure supply against agreed minimum architecture requirements and value for Queensland Health (requires new ways of contracting to support capacity and resilience in a digitally dependant environment)
- universities and other research groups.

### Information management foundations

Data and information are fundamental enablers of new models of care and service delivery. The Queensland Health Information Management Strategy<sup>61</sup> sets the agenda for information management across all business areas of Queensland Health for all data (including clinical and non-clinical) and emphasises government information as a core strategic asset. This strategy will act as a foundation to support delivery of this enterprise architecture vision, and in turn be enabled by it.

# References

1. Sikka R, Morath JM, Leape L The Quadruple Aim: care, health, cost and meaning in work BMJ Quality & Safety 2015;24:608-610. <http://dx.doi.org/10.1136/bmjqs-2015-004160>
2. Gartner IT Glossary. (2017, February 21). Retrieved June 13, 2019, from Gartner IT Glossary website: <https://www.gartner.com/it-glossary/bimodal/>
3. Queensland Health, "A vision and 10-year strategy for health in Queensland," [Online]. Available: <https://www.health.qld.gov.au/system-governance/strategic-direction/plans/vision-strategy>. [Accessed 9 May 2019].
4. Queensland Chief Health Officer, "Data from the 2018 Chief Health Officer report," 2018.
5. Queensland Health, "A vision and 10-year strategy for health in Queensland," [Online]. Available: <https://www.health.qld.gov.au/system-governance/strategic-direction/plans/vision-strategy>. [Accessed 9 May 2019].
6. Australian Digital Health Agency, "Australia's National Digital Health Strategy," [Online]. Available: <https://conversation.digitalhealth.gov.au/australias-national-digital-health-strategy>. [Accessed 9 May 2019].
7. Queensland Health, "Queensland Health Interoperability Platform Strategy," 2016. [https://qheps.health.qld.gov.au/data/assets/pdf\\_file/0027/474273/qh-interoperability-platform-strategy.pdf](https://qheps.health.qld.gov.au/data/assets/pdf_file/0027/474273/qh-interoperability-platform-strategy.pdf)
8. Australian Digital Health Agency, "Framework For Action," [Online]. Available: <https://conversation.digitalhealth.gov.au/framework-for-action>. [Accessed 9 May 2019].
9. World Health Organisation, "WHO guideline: recommendations on digital interventions for health system strengthening," World Health Organisation, Geneva, 2019.
10. J. Bland, H. Khan, J. Koder, T. Symons and S. Westlake, "The NHS in 2030: A Vision of a people-powered, knowledge-powered health system," NESTA, 2015.
11. Connectivity of tomorrow. (2019). Retrieved May 31, 2019, from Deloitte Insights website: <https://www2.deloitte.com/insights/us/en/focus/tech-trends/2019/future-of-connectivity-advanced-networking.html>
12. Ashok, A. (2018, July 5). Four Trends In Cloud Computing CIOs Should Prepare For In 2019. Forbes. Retrieved from <https://www.forbes.com/sites/forbestechcouncil/2018/07/05/four-trends-in-cloud-computing-cios-should-prepare-for-in-2019/#42a654984dc2>
13. West, D. (2016). How 5G technology enables the health internet of things. Retrieved from <http://www.insidepolitics.org/brookingsreports/HealthIoT.pdf>
14. CSIRO Future of Health Report. (2019). Retrieved May 31, 2019, from Csiro.au website: <https://www.csiro.au/en/Do-business/Futures/Reports/Future-of-Health>
15. Udor-Sfetea C, Rabea R, Najim M, Amin N, Chadha M, Jain M, Karia K, Kothari V, Patel T, Suseeharan M, Ahmed M, Sherwani Y, Siddiqui S, Lin Y, Eisingerich AB, Evaluation of Two Mobile Health Apps in the Context of Smoking Cessation: Qualitative Study of Cognitive Behavioral Therapy (CBT) Versus Non-CBT-Based Digital Solutions, JMIR Mhealth Uhealth 2018;6(4):e98, DOI: 10.2196/mhealth.9405
16. McKay, F. H., Cheng, C., Wright, A., Shill, J., Stephens, H., & Uccellini, M. (2018). Evaluating mobile phone applications for health behaviour change: A systematic review. Journal of Telemedicine and Telecare, 24(1), 22–30. <https://doi.org/10.1177/1357633X16673538>
17. Cathy Schoen, Robin Osborn, Sabrina K.H., How, Michelle M. Doty, and Jordon Peugh. 'Chronic Condition: Experiences of Patients with Complex Health Care Needs, In Eight Countries'. 2008. Health Affairs, 01/2009, Volume 28, Issue 1
18. Don Berwick. 'Improvement, Trust and the Healthcare workforce'. 2002. Journal of Quality and Safety in Healthcare, Volume 12. (first presented at 2nd Asia Pacific Forum for Quality Improvement in Healthcare – Singapore 2002)
19. Queensland Clinical Senate, "Queensland Digital Clinical Charter," 2019.
20. Udeh, C., Udeh, B., Rahman, N., Canfield, C., Campbell, J., & Hata, J. S. (2018). Telemedicine/Virtual ICU: Where Are We and Where Are We Going?. Methodist DeBakey cardiovascular journal, 14(2), 126–133. doi:10.14797/mdcj-14-2-126
21. DIGITAL HEALTH: CREATING A NEW GROWTH INDUSTRY FOR AUSTRALIA Strengths, Opportunities, Constraints and Barriers to the Commercialisation of Evidence Based Digital Health Technologies in Australia. (n.d.). Retrieved from <http://andhealth.com.au/wp-content/uploads/2018/12/Digital-Health-Creating-a-New-Growth-Industry-in-Australia.pdf>
22. Egan, N. (2017, March 24). Opportunities for providers as seniors adopt digital healthcare - Australian Ageing Agenda. Retrieved May 30, 2019, from Australian Ageing Agenda website: <https://www.australianageingagenda.com.au/2017/03/24/opportunities-providers-seniors-adopt-digital-healthcare/>
23. Queensland Health, "Queensland Health Clinical Intelligence and Business Intelligence Strategy," July 2018.
24. Disruptive Asia, "Consumer wearables to disrupt medical device market," [Online]. Available: <https://disruptive.asia/consumer-wearables-disrupt-medical-device-market/>. [Accessed 23 May 2019].
25. S. G. Anderson, "Wearables Move Beyond the Consumer...and Into the Clinic?," SPIE - The International Society for Optics and Photonics, [Online]. Available: <https://spie.org/news/spie-professional-magazine/2019-january/wearables-move-beyond-the-consumer?SSO=1>. [Accessed 23 May 2019].
26. M. Swan, "The Quantified Self: Fundamental Disruption in Big Data Science and Biological Discovery," Mary Ann Liebert, Inc., [Online]. Available: <https://www.liebertpub.com/doi/full/10.1089/big.2012.0002>. [Accessed 23 May 2019]
27. Environmental Monitoring for Smart Cities - IEEE Journals & Magazine. (2017). Retrieved May 31, 2019, from IEEE.org website: <https://ieeexplore.ieee.org/abstract/document/7967658/citations#citations>
28. Sorenson, D. (2017). Transparency for Pharmaceutical Supply Chain Solved by Telematics. Retrieved May 29, 2019, from Totaltraxinc.com website: <http://info.totaltraxinc.com/blog/transparency-for-pharmaceutical-supply-chain-solved-by-telematics>
29. HLP Controls Pty Ltd, "Automatic temperature monitoring in hospitals," Hospital & Healthcare, [Online]. Available: <https://www.hospitalhealth.com.au/content/clinical-services/article/automatic-temperature-monitoring-in-hospitals-1437544616#axzz50ixmsAw4>. [Accessed 23 May 2019]
30. E. Topol, "Preparing the healthcare workforce to deliver the digital future," National Health Service, 2019.
31. The Longitudinal Patient Record Dramatically Affects Population Health: 2 Ways Its Impact is Being Realized. (2016). Retrieved May 29, 2019, from Orion Health website: <https://orionhealth.com/us/knowledge-hub/blogs/the-longitudinal-patient-record-dramatically-affects-population-health-2-ways-its-impact-is-being-realized/>
32. Continuity and coordination of care A practice brief to support implementation of the WHO Framework on integrated people-centred health services. (n.d.). Retrieved from <https://apps.who.int/iris/bitstream/handle/10665/274628/9789241514033-eng.pdf>
33. HL7, "FHIR v4.0.0," Health Level Seven, [Online]. Available: <https://www.hl7.org/fhir/>. [Accessed 28 May 2019].
34. S. Posnack and W. Barker, "Heat Wave: The U.S. is Poised to Catch FHIR in 2019," HealthIT.gov, [Online]. Available: <https://www.healthit.gov/buzz-blog/interoperability/heat-wave-the-u-s-is-poised-to-catch-fhir-in-2019>. [Accessed 28 May 2019].
35. Unlocking the power of data to improve health outcomes: five trends to watch. EY, 2019.
36. <https://www.kingsfund.org.uk/publications/eight-technologies-will-change-health-and-care>
37. Queensland Health, "Queensland Health Clinical Intelligence and Business Intelligence Strategy," July 2018.
38. eHealth Queensland, "eHealth Queensland Digital Genomics Discussion Paper," Queensland Health, Brisbane, 2018.
39. Aronson, N. (2015). Making personalized medicine more affordable. Annals of the New York Academy of Sciences, 1346(1), 81–89. <https://doi.org/10.1111/nvas.12614>
40. Das, R. (2017, March 8). Drug Industry Bets Big On Precision Medicine: Five Trends Shaping Care Delivery. Forbes. Retrieved from <https://www.forbes.com/sites/reenitadas/2017/03/08/drug-development-industry-bets-big-on-precision-medicine-5-top-trends-shaping-future-care-delivery/#36997ef55d3a>
41. Pratt, P., Ives, M., Lawton, G. et al. Eur Radiol Exp (2018) 2: 2. <https://doi.org/10.1186/s41747-017-0033-2>
42. Gallagher AG. Proficiency-based progression simulation training for more than an interesting educational experience. J Musculoslet Surg Res [serial online] 2018 [cited 2019 May 29];2:139-41. Available from: <http://www.journalmsr.com/text.asp?2018/2/4/139/244728>
43. Mathias, L., Rahman, A., Skurla, M., & Vahia, I. (2019). THE APPLICATION OF VIRTUAL REALITY IN GERIATRIC MENTAL HEALTH: THE STATE OF THE EVIDENCE. The American Journal of Geriatric Psychiatry, 27(3), S133–S134. <https://doi.org/10.1016/j.jagp.2019.01.085>
44. Bologna, R. (2018). Rethinking Child Mental Health Play Therapy Counsellors' Relational Practices with Parents. Retrieved from [https://researchoutput.csu.edu.au/ws/portalfiles/portal/25225358/Rosa\\_Bologna\\_PhD\\_Thesis\\_2018.pdf](https://researchoutput.csu.edu.au/ws/portalfiles/portal/25225358/Rosa_Bologna_PhD_Thesis_2018.pdf)
45. Chae, M. P., Rozen, W. M., McMenamin, P. G., Findlay, M. W., Spychal, R. T., & Hunter-Smith, D. J. (2015). Emerging Applications of Bedside 3D Printing in Plastic Surgery. Frontiers in Surgery, 2, 25. <https://doi.org/10.3389/fsurg.2015.00025>



46. Children's Health Queensland. (2017, May 19). 3D model helps surgeons fix Caleb's heart | Children's Health Queensland. Retrieved May 29, 2019, from Children's Health Queensland website: <https://www.childrens.health.qld.gov.au/latest-news-3d-model-helps-calebs-heart-surgery/>
47. D. Etherington, "Lyft commits to cutting the problem of health care transportation in half by 2020," 5 March 2018. [Online]. Available: <https://techcrunch.com/2018/03/05/lyft-commits-to-cutting-the-problem-of-health-care-transportation-in-half-by-2020/>. [Accessed 13 May 2019].
48. Kwan, C. (2019, May 20). Australian aged care provider trials driverless vehicle. Retrieved May 29, 2019, from ZDNet website: <https://www.zdnet.com/article/australian-aged-care-provider-trials-driverless-vehicle/>
49. Laurence, E. (2017, April 7). Aged care provider trials use of robot to free up staff. ABC News. Retrieved from <https://www.abc.net.au/news/2017-04-07/nursing-home-robot-trial-wollongong/8426442>
50. Nash DB, "Population Health: Why It Matters," Essentials in Population Health, Children's Hospital Association, Thomas Jefferson University, October 2016, <https://www.childrenshospitals.org/PopulationHealthWhyItMatters.pdf>
51. 12 important cybersecurity questions for your Board. (2017). Retrieved May 30, 2019, from Companydirectors.com.au website: <https://aicd.companydirectors.com.au/membership/the-boardroom-report/volume-15-issue-10/12-important-cyber-security-questions-for-your-board>
52. Health sector tops latest OAIC breach report, yet again. (2019, May 8). Retrieved June 14, 2019, from Healthcare IT Australia website: <https://www.healthcareit.com.au/article/health-sector-tops-latest-oaic-breach-report-yet-again>
53. Digital Transformation Agency. (2019, February 27). Digital identity. Retrieved June 13, 2019, from Digital Transformation Agency website: <https://www.dta.gov.au/our-projects/digital-identity>
54. Facebook and Cambridge Analytica | Office of the Australian Information Commissioner - OAIC. (2018). Retrieved May 30, 2019, from Oaic.gov.au website: <https://www.oaic.gov.au/media-and-speeches/statements/facebook-and-cambridge-analytica>
55. Gartner, "The Realtime Health System Architecture for Health Delivery Organisations," 2018.
56. Queensland Health, "Queensland Health Clinical Intelligence and Business Intelligence Strategy," July 2018.
57. Queensland Government Chief Information Office (2019), "About the QGEA", <https://www.qgcio.qld.gov.au/information-on/qgea/about-the-qgea>
58. Ross JW, Weill P (2004) IT Governance on one page. SSRN Working Paper Series – Centre for Information Systems Research, MIT, WP No.349 and Sloan WP No. 4516-04
59. E. Topol, "Preparing the healthcare workforce to deliver the digital future," National Health Service, 2019.
60. Queensland Health, "eHealth Investment Strategy," 2015.
61. Queensland Health, "Queensland Health Information Management Strategy," 2018.



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