

TECHNOLOGY ROADMAP

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IT Division

2 February 2018

Executive Summary

This roadmap defines the desired future state for the Library technology infrastructure and capability required to achieve, operationalise and sustain Library technology services for internal and external users. The Roadmap has been developed by reviewing the current state, identifying challenges and gaps, and defining solutions to address those challenges and gaps.

The review of the Library's current technology infrastructure and capabilities has identified four key challenges and gaps: meeting customer expectations; the sustainability of digital operations; cybersecurity; and meeting day-to-day business requirements.

In order to respond to these challenges and address those gaps, a set of enabling solutions will need to be provided: innovation, continuous improvement and rapid evolution using available technology and proven development paradigms; a streamlined applications portfolio; flexible and agile architectures; and hybrid computing infrastructure.

A set of next steps, proposed timelines and deliverables for meeting expected Library needs has been developed.

What is a technology roadmap?

A technology roadmap is a plan that matches short-term and long-term organisational goals with specific technology solutions for meeting those goals.

Purpose and Scope

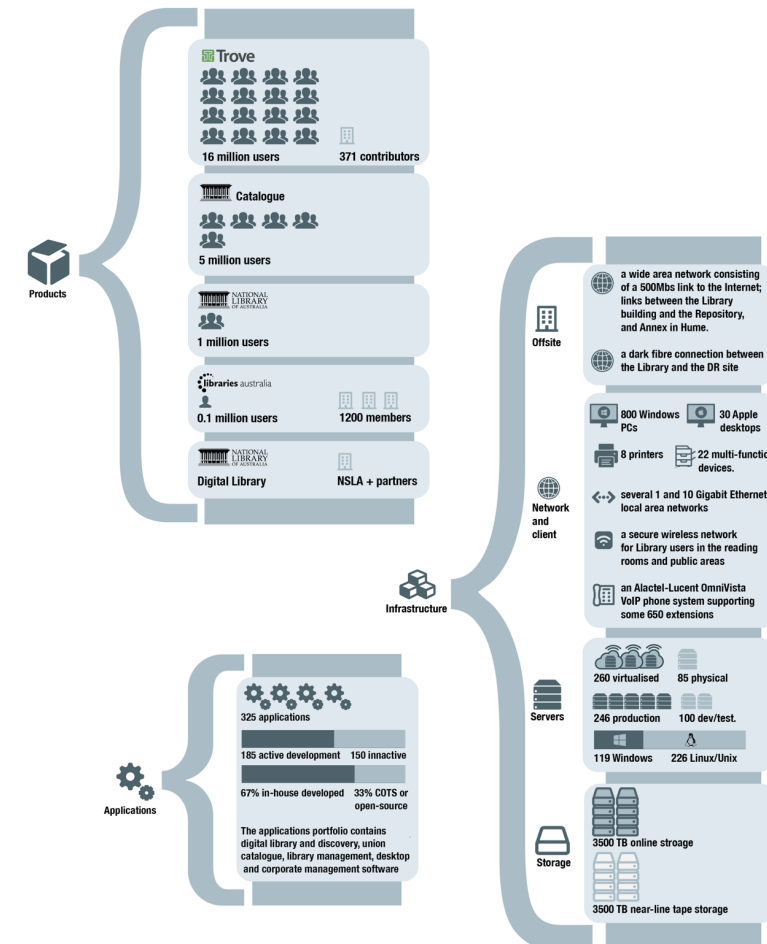
- To review and identify the current state of technology capabilities, covering all services and functions carried out by Information Technology Division (ITD).
- To identify the technological solutions required to achieve Library goals and capabilities, as outlined in the Corporate and IT Strategic Plans, covering operational and strategic needs for the next five years.
- To develop next steps for building and acquiring required expertise, services, and infrastructure – that may/will not be done in the course of project or business as usual (BAU) work – by outlining options and recommending a course of action.

Approach

- Assess business area product plans and consider broader technology and user behaviour trends, including stakeholder consultation and review of business area roadmaps.
- Assess the IT application portfolio, including profiling of applications, functional review and analysis of architecture, programming languages and development frameworks.
- Infrastructure review, including a review of the critical applications list and priorities, network and data centre topology, infrastructure architecture, disaster recovery and business continuity planning (DR/BCP) arrangements, and documentation and procedures.
- Consider response to feedback gathered from the IT Client Satisfaction survey in late 2017.

Information Technology Division overview

The Information Technology Division (ITD) shapes and delivers the technology agenda to support and enable the Library to achieve its operational and strategic priorities. This infographic summarises the Library's technology infrastructure and capability.



Services, assets, and infrastructure

The Library's information technology assets have a current value of \$37m, comprising \$24m of hardware and \$13m of software. The previous graphic provides an overview of ITD services, assets, and infrastructure.

Other technology services provided by ITD

- Product design/development and enhancement, specialising in digital library and discovery
- Corporate/enterprise solutions, including desktop support and public reading room PCs
- Internally provisioned IT infrastructure, including data centre operations

Structure and Staff

- 37 ongoing employees, supplemented by contract staff for program/project work, organised along three branches to align with the "plan, build, and run" lifecycle.
 - **Products Branch**
 - The Products Branch is responsible for working with stakeholders for product planning and management. The branch contains the business analysis, user experience, and quality assurance functions.
 - **Development Branch**
 - The Development Branch is responsible for systems implementation. This includes solutions design, application development, and testing functions.
 - **IT Operations Branch**
 - The IT Operations Branch is responsible for the operation and support of production services. This includes Library IT infrastructure, digital library and discovery services, corporate applications and service desk support.

Current State Strengths and Weaknesses

Strengths	Weaknesses
<ul style="list-style-type: none"> • Search and discovery services • Digital library infrastructure • Efficient digital object management workflows • Integrated digital library solutions • Internal applications development, project/program delivery and infrastructure provisioning capability • Cost effectiveness 	<ul style="list-style-type: none"> • 24/7/365 99.95% uptime risk • Complex environment, large range of technology in use • Application portfolio maintenance overhead • Monolithic applications, hard to decouple • Business analytics/intelligence capability • Internal business applications • Scalability and elasticity of infrastructure • Upfront investment and capital requirements

Matching challenges with enabling technology

Gaps and Challenges

The process of developing the Library's technology roadmap involved assessments and review activities covering the business areas, the Library's application portfolio and the Library's technology infrastructure. These activities led to the identification of technology gaps and challenges. The technology roadmap aims to identify those activities ITD should continue, as well as the identification and adoption of mature and emerging enabling technologies, in order to meet the future expected needs of the Library.

Gaps and challenges
<p>Customer and user expectations</p> <p>Apple, Google, Amazon, Facebook, Netflix, and others, have created products and services enjoyed by billions of people, including millions of Australians. To retain and grow our user base, users expect our online and digital services will be delivered in a similar way, and our services need to continue to be relevant, interesting and engaging.</p>
<p>Sustainability of digital operations</p> <p>The Library continues to make significant investments in digital library and discovery systems, and these systems require ongoing maintenance and enhancement. There will also be a need to design, develop and enhance bespoke systems for the foreseeable future. The Library's core digital services are a unique advantage for the Library and are a key point of differentiation for which there are no equivalent commercial or vendor solutions that provide value-for-money. In addition, storage, computational and network requirements are expected to grow beyond BAU rates.</p>
<p>Legacy systems and technical debt</p> <p>While digital library infrastructure and delivery systems have recently been redeveloped and replaced, ITD operates a large application portfolio supporting numerous other online services and day-to-day operations. This portfolio includes systems that do not meet business requirements or that ITD struggles to maintain, including complex monolithic systems such as parts of Libraries Australia, and legacy systems developed using a range of superseded technologies with varying amounts of technical debt that are difficult to maintain and extend, such as parts of Trove discovery.</p>
<p>Cybersecurity</p> <p>The Library will need to protect its data, systems and networks from ever-increasing cybersecurity threats in order to meet and exceed its security obligations to users, partners, and customers. As a provider of national infrastructure, and with digital business aspirations, our systems need to be robust, resilient, and comply with information system policies and requirements.</p>
<p>Business needs</p> <p>Other areas where business needs are not met or at risk:</p> <ul style="list-style-type: none"> • Business continuity and disaster recovery. The Library's secondary IT site has very limited operating capabilities. If the primary onsite data centre is disabled or inoperable, public digital services will be subject to outage. For severe data centre events, acceptable outage period recovery time objectives are unlikely to be met, or, outage periods are likely to be protracted. With the organisation's reliance on IT, and as a provider of national infrastructure and digital business aspirations, this is inadequate and exceeds our risk appetite. • Analytics and reporting. Digital systems will need to support business intelligence, gathered via analytics and other measurements. Current methods are inconsistent, piecemeal, not centralised, and not adequate to demonstrate business value to internal and external stakeholders. • Corporate and enterprise solutions – have taken a back seat to digital library and discovery services but are important for operational efficiency and how the Library runs its operations. The implications and consequence are: systems that do not meet business requirements and do not interoperate with other systems, e.g. customer, partner, and patron data are decentralised resulting in inefficient workflows; the Library does not have systems to manage some workflows, e.g. preservation and exhibitions management tracking systems; and inadequate intranet and poor support for mobile devices for corporate systems.

Enabling Technologies

The roadmap seeks to identify a pathway for mature and evolving technologies to provide the capability to bridge the existing gaps in providing for the Library's business needs.

Enabling Technologies
Innovation, continuous improvement and rapid evolution
<ul style="list-style-type: none">• Use available technology stacks and proven paradigms from market leaders and peers, applying these to Library systems and services.• Take advantage of rapidly improving machine learning and artificial intelligence technology to enhance user engagement, understand user patterns and behaviours, and provide interfaces where users can interact with our systems using natural language.• Take advantage of automation to realise further efficiencies for the Library.• Use lean and agile development processes. Encourage experimentation and innovation by Library staff.• Develop interfaces and tools that enable crowd sourcing transcription, collection description, annotations and content enrichment.
Streamlined application portfolio
<ul style="list-style-type: none">• Consolidate and simplify the application portfolio, with bespoke applications focused on meeting strategic and unique Library requirements. Reduce maintenance overhead by minimising functional duplication and the range of frameworks and programming languages in use.• Use of contemporary corporate systems to manage non-collection related business processes and workflows, such as modern user and rights management systems.
Flexible and agile architecture for interoperability and cloud readiness
<ul style="list-style-type: none">• Ensure the application portfolio and infrastructure is flexible, agile, and can respond to changing business needs and unforeseen requirements. Review and improve architecture, to support a move to cloud solutions and platforms. This can be achieved through modularising monolithic applications, removing dependencies between systems, and using contemporary best-practices for systems architecture.
Hybrid computing/infrastructure
<ul style="list-style-type: none">• Retain the advantages of the current operating model and take advantage of the nascent benefits of cloud and outsourced services by adopting a hybrid computing and infrastructure model. Provision of infrastructure and services internally when most cost effective, there are internal efficiencies, or where a high-level of control is required, and cloud/outsourced when there is a requirement for scalability, elasticity, and to take advantage of shared security and compliance burdens.• Take advantage of on-demand cloud services, especially for disaster recovery and business continuity requirements. The Library previously investigated setup of a redundant data centre, however capital and ongoing operating costs were unaffordable. Viable options meeting cost/benefit considerations now appear to be available.

Future State

Based on ITD's vision, strategy and technology direction for the Library's core and emerging technology inventory, this roadmap is expected to deliver contemporary, fit-for-purpose and sustainable technology infrastructure.

Future State – expected outcomes from matching challenges with enabling technology
Products, applications and infrastructure
<ul style="list-style-type: none">• Innovative and fit-for-purpose technology services that are reliable, secure, integrated and meet internal and external needs.• Streamlined application portfolio minimising functional duplication and reducing the number of bespoke technology products in operation. Bespoke applications use a common set of modern technology products, reducing the complexity and maintenance costs of internally developed software.• Agile and flexible processes and architecture supporting faster and consistent delivery of technology solutions to meet changing user expectations.• Modern analytics capabilities and business intelligence to support decision making and investment choices.• A high degree of automation using artificial intelligence and machine learning to seek efficiencies, enhance existing capabilities, and explore new opportunities.• Scalable and elastic infrastructure that builds on the successes of ITD initiatives to standardise operating environments and the virtualisation of servers, to allow for greater automation and control of systems. Access the rapid scalability, resilience and flexibility of infrastructure available through cloud services.• High availability and redundancy to reflect the operational and strategic priorities of the Library and 24/7/365 99.95% uptime availability expectations.
Other Considerations
Workforce capability
<p>The ITD will need to ensure that its workforce is positioned to meet the challenges in implementing the transition outlined in the Roadmap. Aligning the workforce to match the operational requirements needed to best deliver the Library's strategic priorities will be critical.</p> <p>The ITD maintains a schedule of its human resources and their capabilities. Gap analysis against projected needs identified in the Roadmap will be undertaken. Strategies for meeting shortfalls or surpluses will be developed over the course of the Roadmap.</p>

Recommended Plan of Action

Priorities, and recommended sequencing

To guide the creation of the technology roadmap, priority systems and activities were assessed. Critical and core systems that support the Library's strategic priorities were assessed with respect to challenges and gaps. Enabling technologies and processes were assessed for their capacity to support the desired future state for each of the prioritised ITD supported components and key Library products and services.

Summary of proposed timelines and deliverables

Short-term (2018)	Medium-term (2019-2020)	Longer-term (2021+)
Products		
<ul style="list-style-type: none"> Improved NLA online presence and digital engagement. 	<ul style="list-style-type: none"> Renewed discovery, delivery and user experience across the breadth of NLA digital services. Increased user curation, crowdsourced content and disintermediated access to the collection. Explore and use machine learning to categorise, describe and organise digital collections and for entity recognition, to improve discoverability. Use natural language processing to enhance access to digital collections. 	<ul style="list-style-type: none"> Continue exploring and applying machine learning and artificial intelligence to enhance automation and improve services. Provide researchers access to capabilities and tools for analysing and data mining our datasets.
Applications		
<ul style="list-style-type: none"> Identify options for agile development and lean project management processes. Commence rationalising applications portfolio and decommissioning low-use applications. Enhance user tracking and analytics to support business intelligence. Replace bespoke and legacy systems with suitable COTS/SaaS products. 	<ul style="list-style-type: none"> Improved agile development and project management methodologies in use. Rationalised applications portfolio, sharing common system components and using common frameworks. Improved architecture in use, supporting scalability, high availability and interoperability requirements. Continue replacing bespoke and legacy systems with suitable COTS/SaaS products. 	<ul style="list-style-type: none"> Streamlined applications portfolio, using a high proportion of SaaS products for non-digital library applications.

Infrastructure		
<ul style="list-style-type: none"> Revised disaster recovery and business continuity arrangements. Operationalise first tranche of improved capabilities. Improved cybersecurity capabilities. Improved scalability of internally provisioned infrastructure, and continue virtualizing server infrastructure. Improved Wi-Fi including implementation of venue analytics for visitor flow and behaviour. 	<ul style="list-style-type: none"> Improved disaster recovery and business continuity arrangements operational, utilising on demand cloud services. Hybrid infrastructure in use, with the capability to access cloud services for temporary or unexpected demand surges and for development and test environments. Investigate and implement telepresence. 	<ul style="list-style-type: none"> A revised and optimised infrastructure provisioning model, based on maturity of market offerings.

Next steps

Implementing the deliverables outlined in the technology roadmap will proceed with these next steps:

- Review/confirm the aims/scope of Modernisation Program funded projects to upgrade critical infrastructure for alignment with the Roadmap, and continue implementation to ensure robust, reliable and durable digital services into the future.
- An increased focus on our internal business systems and a planned, funded approach to contemporising and improving the efficiency and effectiveness in this area.
- Establish programs and projects to address remaining roadmap imperatives, and determine what/how this can be accommodated within ITD resourcing.
- Ensure Library IT asset lifecycle management processes are appropriate, in light of: significant investments in internally developed software and hardware infrastructure; and the advent of outsourced and cloud services, including implications on changes to capital and operating funding profiles and staff skills.
- In keeping with resource constraints and long-term sustainability, ensure investment decisions are focused on strategic long-term priorities and those that have high impact on Library operations.
- Continue to evolve the Library's understanding of the challenges and advantages of cloud adoption. Develop a shared vision with the Library's business units and communicate what is required to achieve operational integration in order to achieve reliable, scalable, and cost-effective infrastructure.

Appendix A: Current state strengths and weaknesses

Advantages		
Products	Applications	Infrastructure
<p>Search</p> <p>The Library's products and services offer discovery and delivery of millions of digital items. ITD has developed significant search expertise to support the Library's discovery services.</p> <p>Following</p> <p>The products have a large and loyal user base who have been engaged and contributed back to the Library.</p> <p>Design capability</p> <p>The long-term investment and development of User Experience (UX) expertise is a significant strength for the Library. Recent development of delivery systems for DLIR program benefited from this expertise.</p>	<p>Digital Library Infrastructure</p> <p>The Digital Library Infrastructure is exceeding its design goals and providing operational efficiencies to the Library.</p> <p>Internal development capability</p> <p>The in-house development approach has proven cost-effective. The DLIR program was able to effectively scale-up to meet project needs. Development processes have matured and are repeatable and effective.</p> <p>Optimised workflows</p> <p>In-house developed systems are generally more aligned to business needs that equivalent COTS or open-source products.</p> <p>Integrated solutions</p> <p>The efficiencies that can be leveraged when infrastructure, applications and release processes are tightly integrated.</p>	<p>Virtualisation</p> <p>The move to virtualisation has been a cost-effective measure with increased performance, stability and reduced resource consumption.</p> <p>Standardisation</p> <p>The standardisation of operating system environment has improved consistency, maintainability, and efficiencies in provisioning of new servers.</p> <p>Physical servers only where needed</p> <p>Small proportion of physical servers, at 33%, for high performance computing requirements. These will be considered for virtualisation when value-for-money technology is available.</p> <p>Desktop virtualisation</p> <p>Desktop virtualisation expands collection access and reach, by enabling secure access to restricted legal deposit material in Library reading rooms. This solution will also be used for provide access to NSLA libraries through NeD.</p> <p>Infrastructure operations capability</p> <p>Operation and continued enhancement of a complex technology ecosystem using internal capabilities.</p>

Limitations		
Products	Applications	Infrastructure
<p>Functional Limitations</p> <p>The sustainability of the Library's products and services is challenged by the legacy nature of many of the underlying system components. Seemingly straightforward requests are often more complex to fulfil as a result. There is a high level of manual intervention to support regular business as usual activity from product owners. For example, deep linking requests in Libraries Australia are not self-service by the business area but require manual IT intervention.</p> <p>Analytics and reporting</p> <p>Some product owners find it difficult to communicate value because systems do not provide the breadth and quality of reporting data, or data provision is inconsistent and distributed.</p> <p>Many systems support user profiles but business intelligence around users is limited by the constraints of the user management functions of the Library's systems. For example, tracking and measuring users as they move across the Library's products and services is limited.</p> <p>Efficiencies and innovation</p> <p>Legacy systems, such as some Libraries Australia components, provide unproductive manual workflows for Library staff. These workflows and interfaces do not allow for the efficiencies that are needed to maintain service levels with decreasing staff levels.</p>	<p>Architectural shortcomings</p> <p>Most applications have strong interdependencies that are difficult to decouple. These dependencies add complexity to developing, deploying and maintaining applications (see Appendix D).</p> <p>Complex dependencies between products, applications and infrastructure.</p> <p>Range of technology in use</p> <p>The number and type of programming languages and application frameworks in use across the application portfolio. This impacts the ability to maintain applications as the staff skills profile cannot sustainably support this diversity.</p> <p>Scalability</p> <p>Scalability of applications, both horizontally and vertically, due to the past application design decisions. This affects availability and performance of applications and results in downtime during upgrades. Public facing applications will struggle to cope with increased user demand.</p> <p>Deployment processes</p> <p>Deployment processes and procedures, particularly release management, can result in time consuming overhead and inconsistent results. This impacts ongoing reliability and resilience of systems to meet 24/7 demand.</p> <p>External dependencies and legacy systems</p> <p>Maintenance of COTS products is dependent on vendor support. This is a significant consideration as ITD has heavily</p>	<p>24/7/365 risk</p> <p>Disaster Recovery and Business Continuity Planning (DR/BCP) is not current and is insufficient for the Library's business and strategic priorities.</p> <p>The Library does not have high availability internet. There is only a single internet gateway.</p> <p>Scalability and Elasticity</p> <p>ITD infrastructure has scaled well in response to business needs but lacks the elastic scalability that is provided by commercial infrastructure as a service providers (IaaS).</p> <p>Resourcing</p> <p>ITD maintains significant Microsoft Windows infrastructure but does not have the capacity for a dedicated Windows support function. This support has typically been distributed across existing staff and lacks the efficiencies that dedicated support provides.</p> <p>Increasing cybersecurity threats and compliance requirements, requiring more frequent system patching and upgrades, more robust controls, and more detailed logging and access management, place further strain on resourcing.</p> <p>Lifecycle management</p> <p>Software and hardware asset renewals can be difficult to plan for and manage effectively, for requirements that are uncertain or change.</p>

Inflexible systems are unable to support opportunities for new modes of access, changing delivery expectations, or new types of acquisition (e.g. the open public access catalogue).
Lack of flexibility for some systems means lost opportunities to innovate with re-use and repurposing of data.
Interoperability between systems can be inconsistent and prevent efficiencies and robust data flows (e.g. some systems in the catalogue and union catalogue suite).

integrated some COTS products into Digital Library workflows.
Ongoing overheads supporting legacy software beyond refresh cycles or useful lives, particularly internal business applications.
The current user authentication system for public products and services is deficient in supporting current and future needs.

Challenges		
Products	Applications	Infrastructure
<p>Meeting customer and user expectations</p> <p>Meeting changing user demands and modes of access. Providing levels of engagement through existing products and services that will meet user and business expectations. Competition in the marketplace from vendors attracting Library customers to newer and more responsive products and services.</p> <p>Meeting internal business needs</p> <p>Supporting meaningful business intelligence through analytics and metrics to measure business value for the Library. Providing products and services that match the changing staff profile and skills required to manage data at scale. Providing products and services that scale flexibly with increased usage.</p>	<p>Sustainability</p> <p>While the Library's in-house development capacity has been cost-effective, it is a capital-intensive activity. This adds complexities such as depreciation, managing asset replacement cycles, and maintaining the skills needed to support and enhance these codebases. The sustainability of a large application portfolio is low. Supporting a large number of legacy applications reduces ITD capacity to provide higher levels of support for key applications.</p> <p>Agility and flexibility</p> <p>The restrictions and complexities when infrastructure, applications and release processes are tightly integrated. This limits the sustainability and options available when considering flexibility and integration. Development processes are not agile enough. More recent development approaches have incorporated some agile techniques but the full advantages of agile methodologies for delivering business benefits to the Library are not being harnessed.</p> <p>Scalability</p> <p>Applications are not fully horizontally and vertically scalable. More recent developments have incorporated these considerations but the majority of the application portfolio is not easily scalable.</p>	<p>Sustainability</p> <p>Whilst the Library's infrastructure service has been cost-effective, the in-house provision of infrastructure is a capital-intensive activity. The hardware and software asset replacement cycle requires upfront investment, management of capital and depreciation budgets, and therefore incurs management and administrative overhead. Increasing future supplier costs, from new licencing and pricing models.</p> <p>Enterprise uptime requirements</p> <p>Customer and user expectations are being shaped by the service levels offered by commercial providers. As the Library develops national infrastructure services, it will need to provide commercial grade service levels. This includes high-availability infrastructure, robust DR/BCP support, and compliance with the increasingly stringent Australian Government Cybersecurity requirements.</p> <p>Cybersecurity threats</p> <p>Ever-increasing cybersecurity threats, and the need to meet and exceed security obligations of a growing user, partner and customer base.</p>

Appendix B: Detailed Timelines and deliverables

	Stream	Intention	Application	Year 1	Year 2	Year 3-5
Applications	Digital Library	Improve	DL Collections	Bulk digitisation enhancements. Review integration architecture.	Upgrade all SOLR databases to a common version. Update Digital Library to support high availability.	
		Improve	Bulk Collecting Channels	Fully integrate bulk collecting with E-Deposit. Enhance the bulk collecting with new contributors.		
		Improve	DL Web		Upgrade all SOLR databases to a common version.	
		Sustain	Preservica		Review the cost/benefits of using Preservica. Improve the integration of Preservica with the rest of Digital Library.	
		Sustain	Archives Space			
		Sustain	DL Newspapers	Migrate objects from DOSS to DOSS2.	Fully migrate DL Newspapers to use the preferred frameworks. Investigate potential workflow improvements enabled by new advances in AI.	
	Discovery and Delivery Services	Improve	Trove Discovery	Enhance metrics and analytics for Trove and related systems. Improve Trove relevance ranking. Improve Trove UI enhancements.	Upgrade all SOLR databases to a common version. Continue to enhance Trove based on recommendations of the Trove Atlas review.	Fully migrate Trove to use the preferred frameworks. Support natural language queries.
		Improve	Trove Delivery	Review integration architecture.	Update Trove Delivery to support high availability.	
		Sustain	Catalogue	Review and confirm business priorities.		
		Replace	UMS	This is bespoke software which implements a common business function. Replace with a COTS product.		

	Libraries Australia	Sustain	LA Search		Upgrade all SOLR databases to a common version.	
		Sustain	LA Admin / Record Export / Products			
		Sustain	Record Import			
		Sustain	Web Cataloguing			
		Sustain	Cataloguing Client			
		Sustain	Document Delivery			
	Library Operations	Sustain	Get a Library Card		Fully migrate to use the preferred frameworks or replace with a COTS product.	
		Sustain	What's On		Replace with a COTS product.	
		Sustain	CopiesDirect		Fully migrate CD to use the preferred frameworks.	
		Sustain	EResources		Replace with a COTS product.	
		Sustain	Staff Time		Replace with a COTS product.	
		Sustain	RefTracker		Move to Cloud hosted version.	
			Replace	Exhibitions Management Systems	Review and confirm solution options.	
	ILMS	Sustain	Voyager	Review and confirm business priorities.		

Infrastructure	Client			Review Desktop Anti-Virus and spam filter solutions. Improve staff productivity with improvements to meeting room technologies and access to mobile devices.		
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Server	Move selected application infrastructure to a virtualised environment and investigate the possibilities of private cloud for hosting.	Continue to move selected application infrastructure to a virtualised environment and investigate the possibilities of private cloud for hosting. Review virtual infrastructure requirements and Investigate options to move virtual machines to off site hosting.	Continue to move selected application infrastructure to a virtualised environment and investigate the possibilities of private cloud for hosting.
Storage	Leverage Software Defined Storage capabilities of the new Unity array.		Review Storage requirements and offerings for the Unity and Isilon hardware.
Network and Voice	Implement building-wide Wi-Fi. Review and select ISP to provide high availability internet and other beneficial offerings. Review telephony requirements. Decommission Radio links in favour of fixed line NBN to other sites. Review Firewall requirements.		
IT Services	Move corporate COTS applications to suitable cloud offerings.	Move to cloud hosted Office 365, including email. Investigate viability of Microsoft Sharepoint for corporate communication. Continue to move corporate COTS applications such as Finance1 and Aurion to suitable cloud or shared service offerings.	Continue to move corporate COTS applications to suitable cloud offerings.



Process and Approach	<p>Cloud ready: Update applications to support load balancing/clustering/high availability.</p> <p>Improve support for browser testing.</p> <ul style="list-style-type: none"> Review tooling available for automated testing. Investigate cloud hosted options for testing. <p>Decommission unused utilities.</p> <p>Update applications to externalise and secure passwords using a password vault</p>	<p>Continue to update applications to support load balancing/clustering/high availability.</p> <p>Decommission unused utilities.</p> <p>Provide high availability for the following:</p> <ul style="list-style-type: none"> Relational databases - MySQL Digital Object Storage System (DOSS) <p>Investigate using prebuilt environments to make development easier. Options include:</p> <ul style="list-style-type: none"> Virtual machine images - possibly using Vagrant Docker containers - possibly using Anisible Cloud platform as a service 	<p>Continue to update applications to support load balancing/clustering/high availability.</p> <p>Decommission unused utilities.</p> <p>Consider moving our preferred development language to Kotlin in order to allow frictionless development of Web and Mobile applications.</p>
Innovation	<p>User engagement, crowdsourcing and disintermediation</p> <p>Optimise the mobile web experience integration with social media services and the use of video to improve our audience reach. Continue to explore native mobile apps to bring rich experiences to our audience.</p>	<p>Explore options for increased user curation, crowdsourcing and disintermediation, such as the use of transcription tools and geocoding.</p> <p>Investigate the feasibility of apps on emerging platforms such as Apple TV, Google Chromecast and other relevant ubiquitous computing platforms.</p>	
	<p>Big Data analytics and Open Data</p>	<p>Subject to funding from the research sector, provide researchers access to capabilities and tools for analysing and data mining our datasets to generate new knowledge.</p> <p>Provide open access to the Library's datasets, subject to resourcing and legal constraints.</p>	

Machine Learning and Natural Language Processing	When redeveloping applications for the cloud, explore access to higher level capabilities that may be available including: <ul style="list-style-type: none"> The potential of machine learning to enhance discovery for our large digital collections The potential of natural language processing, allowing users to speak and listen to our systems, to enhance access to our content, particularly for disabled and visually impaired users. 	Machine learning and natural language processing based activities continued.	
Automation			Exploring solutions to improve efficiencies and explore new approaches to eliminate all unnecessary processes, and to automate all repetitive collection management workflows. Explore the use of digital assistants.

Appendix C: Core services and critical applications

This section describes the significant software developed and/or maintained by ITD.

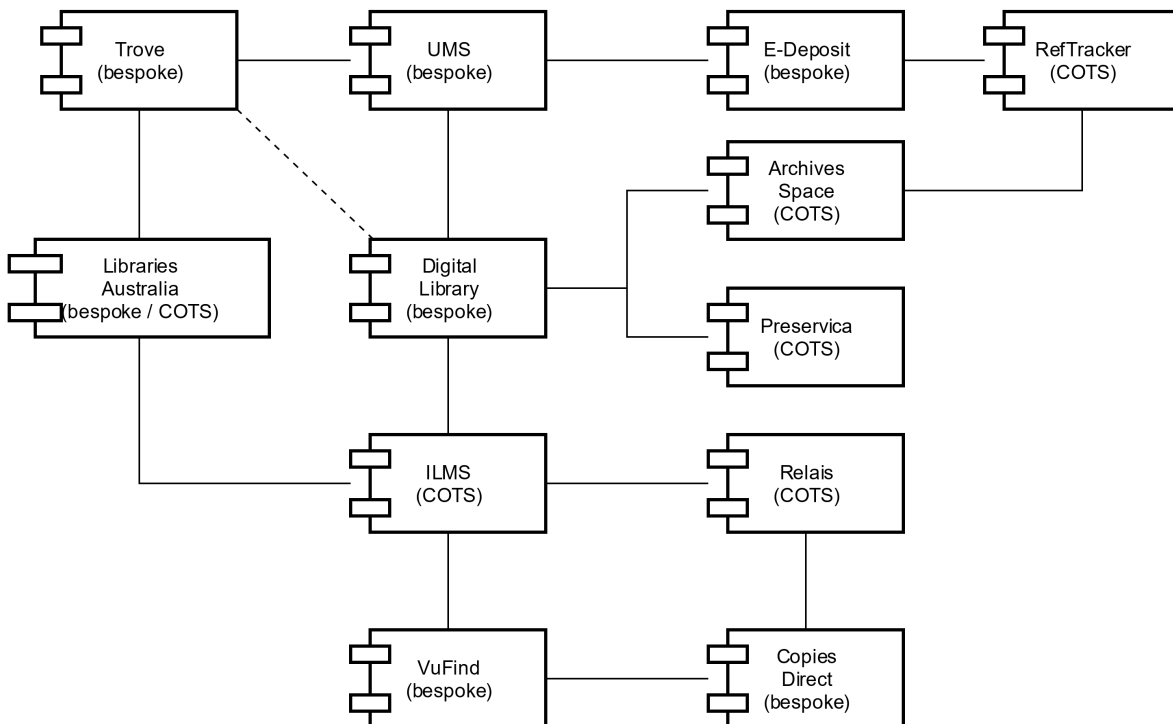
Core Services	Software	Source	Primary technologies	Maintenance Capability ¹	Enhancement Capability ²	Support priority	Action
Digital Library	DL Collection (DLC)	bespoke	Java 8, Spring, MySQL, HTML 5	high	high	high	improve
	Preservica	COTS		support contract	support contract	high	sustain
	ArchivesSpace	COTS		open source	open source	high	sustain
	DL Newspapers (DLN)	bespoke	Java 7, NLA Service Framework, MySQL, Lucene, HTML 4	medium	medium	high	sustain
	Bulk collecting channels	bespoke	Java 7, Spring, Camel	high	high	high	improve
	DL Web	bespoke		high	high	high	improve
Discovery and Delivery Services	Trove	bespoke	Java 7, Restlet, Spring, MySQL, SOLR, HTML 4	medium	medium	high	improve
	Trove Delivery	bespoke	Java 8, Spring, MySQL	high	high	high	improve
	Catalogue (VuFind)	COTS/bespoke	PHP, Perl, SOLR, HTML 4	medium	low	medium	sustain
Libraries Australia	LA Search	bespoke	Java 7, Restlet, MySQL, SOLR, HTML 5	high	high	high	sustain
	LA Admin / Record Export / Products	bespoke	Java 7, NLA Framework, MySQL, SOLR, HTML 4	low	low	high	sustain
	Record Import	bespoke	Java 7, NLA Framework, HTML 4, CBS utilities	medium	low	medium	sustain
	Web Cataloguing	COTS/customised		support contract	support contract	medium	sustain
	Cataloguing Client	COTS/customised		support contract	support contract	medium	sustain
	Document Delivery	COTS		support contract	support contract	medium	sustain
	Get a Library Card	bespoke	Ruby 1.5.5, Rails	medium	low	medium	sustain

¹ Maintenance capability: An estimate of our ability to maintain the application at its current level of functionality.

² Enhancement capability: An estimate of our ability to enhance the application with new functionality.

Library Operations	What's On	bespoke	Ruby 1.5.5, Rails	medium	medium	low	replace
	Exhibitions Management Systems	bespoke	Filemaker Pro	low	low	medium	replace
	CopiesDirect	bespoke	Ruby 1.5.5, Rails	medium	low	medium	sustain
	EResources	bespoke	PHP5	low	low	medium	sustain
	Staff Time	bespoke	Java 7, NLA Framework, MySQL, HTML 4	low	low	low	sustain
LMS	ILMS	COTS		support contract	support contract	high	sustain

Appendix D: Library system dependencies



Appendix E: Application technologies

Frameworks

This section describes the application frameworks used by the bespoke software developed by the Library.

Framework	Used by	Comment	Actions
NLA Framework	ALG, ILRS, Libraries Australia Administration, Record Export Service, Products, Record Import Service, Staff time		Migrate to preferred framework where possible
NLA Services Framework	NCM, UMS		Migrate to preferred framework where possible
Web Objects Framework	PANDAS	Commercial framework published by Apple. Support discontinued in 2009 at which point it migrated to be an open source framework.	Sustain
Ruby on Rails and Sinatra Framework	Get a Library Card, What's On, Copies Direct, Sprightly		Migrate to preferred framework where possible. Look for suitable COTS products.
Restlet Framework	Libraries Australia Search, Trove UI applications		Migrate to preferred framework where possible
Spring Framework	Digital Library applications		Preferred framework

Languages

This section describes the programming languages used by the bespoke software developed by the Library.

Language	Versions	Comment	Actions
Java	5, 6, 7, 8	Used by most of the internally developed applications and services	Preferred language.
Ruby	1.5.5	Used by internally developed applications and services	Discontinue use for bespoke development.
PHP	5	Predominately used by VuFind and E-Resources	Sustain. Discontinue use for bespoke development.

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Perl	5.16	Predominately used by VuFind and various utilities	Sustain current applications. Discontinue use for bespoke development.
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Databases

This section describes the database management systems used by the software in the Library.

Database Server	Versions	Comment	Actions
MySQL	5.6	Used by most of the new applications such as Digital Library.	Preferred platform.
Oracle	11.1	Used by some older applications such as ALG, ILRS	Migrate.
SOLR	6.6.1, 5.1.0, 4.7.2, 3.x	Used by discovery applications. Version used is dependent on when the application was developed	Preferred platform. Migrate to common version.
Lucene	2.9.3	Used by NCM	Migrate to SOLR.
FileMaker Pro	TBC	Used by Exhibitions Management System	Migrate.
Microsoft Access	TBC	Used by some older systems such as Complaints, RNSM	Sustain.

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Appendix F: ITD in detail

Products

The ITD supports the applications and systems that comprise the Library's products and services. These products and services have significant usage, with the unique users for 2017 as follows:

- Trove: 16,384,381
- Catalogue: 4,785,563
- Libraries Australia Search: 152,509

The Library's primary products and services have been mapped to ITD core service streams to ensure service levels meet business expectations and needs. The core service streams are:

- Discovery Systems (including Trove and VuFind)
- Libraries Australia
- Digital Library
- Library Operations
- ILMS
- IT Services

Each core service stream and its component systems are managed to ensure clarity and consistency around change management, security and governance, service capacity, reporting, and other considerations.

Support for core service streams are staffed from across the ITD, with the following allocations based on estimated requirements:

- Business Analysts – 2FTE
- Developers – 5FTE
- IT Operations staff – 2 FTE

Resource requirements by service have been allocated as follows:

- Discovery Systems – 40%
- Libraries Australia – 10%
- Digital Library – 40%
- Library Operations and ILMS – 10%

Desired future state

- Products and services that compete with commercial levels of availability, security and responsiveness.
- Products and services that deliver staffing efficiencies through smarter and more adaptable workflows and contemporary interfaces.
- Products and services that meet expectations for personalisation and customisation.

- Products and services that are responsive to changes in business needs.

Applications

The Library undertakes the in-house development of a range of systems to support the acquisition, management and delivery of its collections, and to support a range of national discovery and collaboration services. The Library generally uses commercial off-the-shelf software for corporate functions and wherever appropriate for library systems.

ITD maintains a portfolio of 325 applications across the five core service streams. Of these, 185 are under active development. Of these, 67% have been developed in-house. The remainder are commercial or open-source products.

Of the large number of applications identified, a technical architecture review determined that there are 21 pieces of significant application software (see Appendix B).

The majority of the in-house developed applications follow a 3-tier approach:

- Web interface: HTML and client-side JavaScript
- Monolithic application: contains all business and view logic in a single executable
- Database: generally relational, providing full-text search

Infrastructure

ITD maintains the Library's ICT infrastructure and support its online services and on-site IT activities through seven key objectives: client, server, storage, network and voice, computer room, specialist equipment and systems:

1. Client

The Library's client infrastructure includes desktop PCs and software, printers and multi-function devices (MFDs), low-end scanning equipment, label printers, etc. The Library maintains over 800 desktop PCs. These desktop PCs and software environment were replaced in 2017 with a mix of HP all-in-ones and Dell hardware. This provided a new Library Standard Operating Environment (SOE) in adherence to Commonwealth Operating Environment (COE) requirements set out by the Whole of Government Common Operating Environment Policy. This platform is Windows 10 with Office 2016 installed.

ITD maintains approximately 30 Apple desktops, 78 printers and 22 MFDs devices.

ITD provides client support via a helpdesk and service desk ticketing system.

2. Server

The Library operates a pool of Linux, UNIX (Solaris) and Windows midrange servers to support all IT services delivered to staff and the public. The majority of these servers are running Fedora based Linux systems; external servers using Red Hat Enterprise Linux; and others running CentOS Linux.

There are approximately 350 servers maintained by the ITD consisting of approximately 260 virtualised machines (VMs), and 85 physical machines.

3. Storage

The Library maintains a large sophisticated multi-tier storage system to support its digital collection needs, as well as conventional online storage and backup systems to support its staff and corporate activities. The storage system tiers consist of:

- Tier 1 Storage is Solid State Drive technology that supports ultra-high-speed access to indexes. These machines are specially built to support SOLR indexing used in Trove.
- Tier 2 Storage is a Block level storage SAN (VNX/VPLEX) which is predominantly for database, back-office file systems and virtualisation storage that provides high speed access and as such is more expensive.
- Tier 3 storage is Node level storage (Isilon) and is used for collection material such as newspaper images, both master and derivative and is far more cost effective than the block level storage.
- Tier 4 is traditional tape storage using LTO6 technology. This is used for primarily for offsite storage, archive and for data recovery should a disaster occur.

The overall storage infrastructure consists of 3500TB of online storage and 3500 of near-line tape storage.

4. Network and voice

The Library operates a high-performance local area network, both wired and wireless, to deliver services to staff and users of the library. This encompasses firewalls, content management systems and other network infrastructure. The network consisting of a 500Mbps link to the Internet; and links between the main Library building and the Repository and Annex in Hume. There are a number of 1 and 10 Gbs Ethernet local area networks, as well as a secure wireless network for Library users in the reading rooms and public areas.

The Library maintains a single dark fibre connection between the Library's Parkes building and the DR site in Dickson.

The Library's voice infrastructure consists of an Alactel-Lucent OmniVista VoIP phone system supporting some 650 extensions.

5. Computer room

The Library operates a medium sized computer room in its main building that houses the majority of its server, storage and network infrastructure. The Library also maintains a small set of infrastructure at TransACT House in Dickson, comprising the limited Disaster Recovery (DR) contingency.

6. Specialist

Specific areas within the Library operate a range of specialist equipment associated with collection acquisition, management and delivery. The procurement and replacement of this infrastructure is managed by the relevant business area with advisory support from IT. Examples of equipment in this category include high end scanning equipment, high-end photographic printers, and prepublication printing equipment.

7. Systems and services

ITD infrastructure supports a range of commercial off-the-shelf, open source and in-house developed software to support the Library corporate and business system needs. The Library generally uses commercial off-the-shelf software for corporate functions and wherever appropriate for library systems. Corporate applications include Finance One, HP Record Manager, Citrix, and Active Directory. Business area applications include Relais, RefTracker and DocWorks.

ITD Infrastructure supports many in-house developed systems to support the Library's application environment. These systems level applications and services include software monitoring systems, application deployment tools, digital object storage systems, and logging systems.

