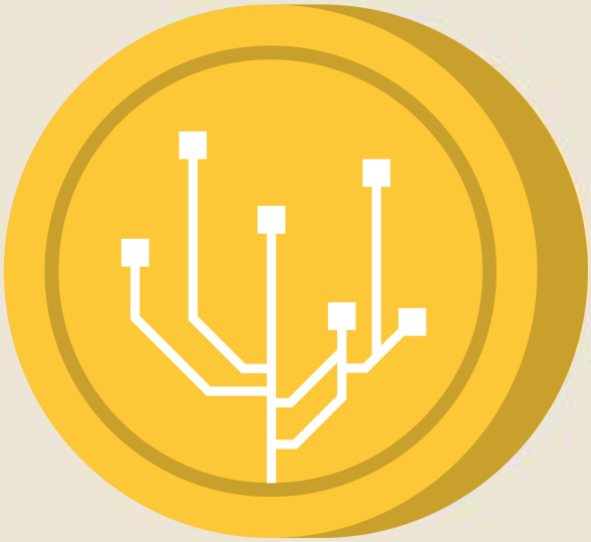
Making Money Smart

Empowering NDIS participants with Blockchain technologies



Citation

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Important disclaimer

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- FinTech Australia
- National Disability Insurance Agency
- National Disability Services
- New Payments Platform Australia
- Reserve Bank of Australia
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Important note

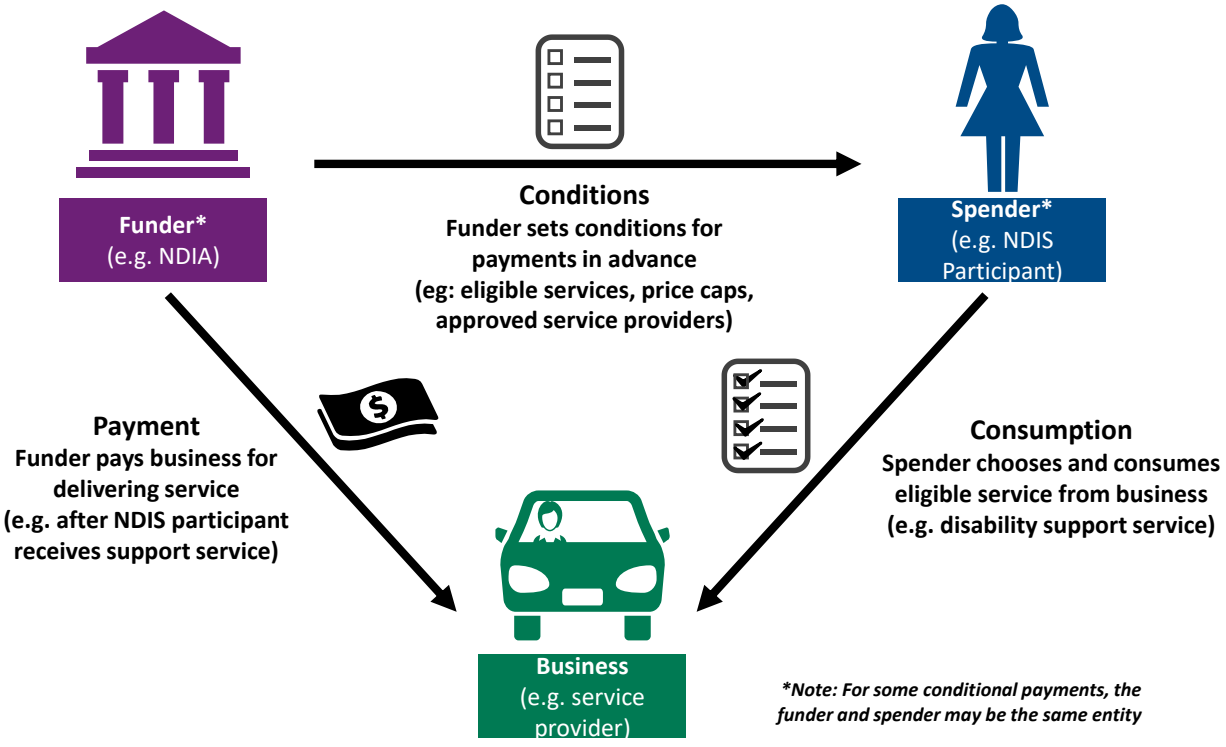
This report does not necessarily reflect the views of the member organisations of the Reference Group. Membership of the Reference Group does not connote endorsement of the project. Reference Group member organisations had no responsibility for the project.

Executive summary

How can 'smart money' better enable conditional payments? This project has sought to answer this question, motivated by the progression of blockchain technologies in recent years.

What are conditional payments? Conditional payment environments are all around us. They occur whenever one party wishes to fund a payment, but only after certain conditions are met. Conditional payment environments can range from public policy programs, to insurance payouts, to corporate and organisation delegations, to the management of trusts and charities, and even to the spending conditions individuals place on themselves, such as savings plans. The National Disability Insurance Scheme (NDIS) is a conditional payment environment; the National Disability Insurance Agency (NDIA) provides funding to people with disability, called participants, to spend on disability support services. Funds are spent in accordance with the rules set for each participant's plan (see Figure 1).

Figure 1: Key parties in conditional payment environments



Most payments in the economy are conditional on something, if only being made in return for some good or service. This report focuses on conditional payment environments where the conditions can be set in advance and where such conditions can be automatically assessed at the moment of purchase.

What is smart money? Smart money, or programmable money, is money that can be programmed to be spent only when certain conditions are met and remember how it has been spent. This project created programmable money by attaching smart contracts to blockchain tokens that can be redeemed for payment in Australian Dollars (rather than through a programmable currency).

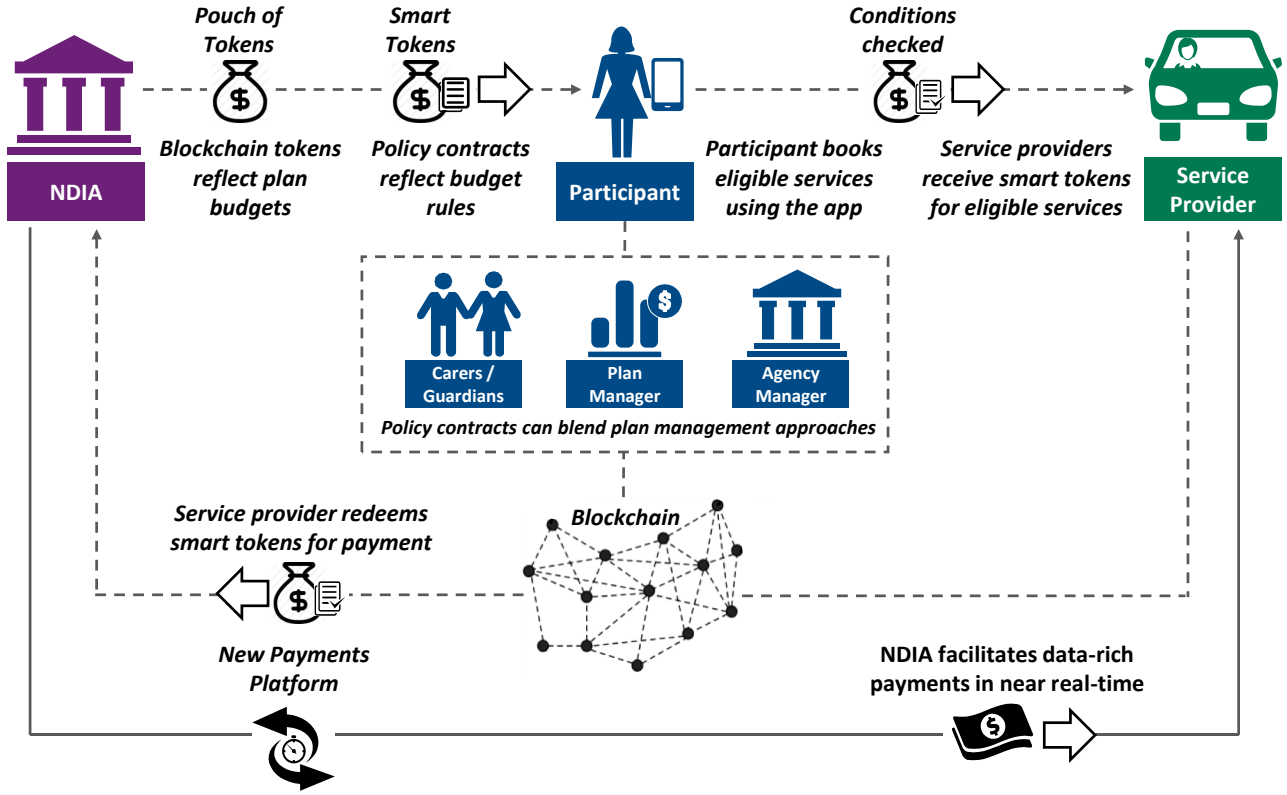
Once programmed, smart money can know who it can be spent by, what it can be spent on, when it can be spent, how much of it can be spent and any other conditions that may be set by the party funding the payment. As smart money is designed not to be misspent, it can reduce friction and enable funders to empower spenders in conditional payment environments. For example, it can reduce the need for funders to assess payments after-the-fact when checking for compliance with spending rules. In addition, as smart money remembers how it has been spent, this can assist with budget management for spenders, and payments reconciliation for businesses.

This project developed a smart money proof of concept and applied it to a use case of the NDIS. The NDIS involves highly personalised payment conditions. Since the NDIS was first envisaged in 2011, and even during its ongoing rollout, payments technology has progressed considerably. This includes research into the application of blockchain technology and smart contracts as well as the introduction of Australia's New Payments Platform.

Each NDIS participant has an individualised plan, which can contain multiple budget categories – each with different spending rules. This high degree of tailoring offers greater choice and control for participants, but also creates new challenges for accessing the right services, managing budgets and making payments. In addition, providers must ensure the services they deliver are eligible for payment. We explored whether smart money can assist with these challenges.

The proof of concept design combines blockchain token technology and Australia's New Payments Platform. The blockchain component was developed as a system using tokens to represent promises to pay in Australian Dollars, smart contracts to create spending conditions based on NDIS plan rules, and registries to represent parts of the payment environment such as lists of eligible service providers for particular services (see Figure 2).

Figure 2: Overview of smart money proof of concept



The proof of concept translates budgets in NDIS plans into blockchain tokens. Each budget line is represented by a separate token for the budgeted amount, with policies dynamically attached to the token to implement the budget conditions. Participants can then use their tokens to book and purchase services through a smart phone app. Participants never see the tokens – only their budget balances – as the tokens operate in the background. The proof of concept was designed to support self-managed, plan-managed and agency-managed participants.

Our technical focus of inquiry was on payment functionality rather than privacy or confidentiality. Nonetheless, to support the confidentiality of information, each budget category in a participant's plan uses a unique private key (a confidential signature for authorising payments), which is automatically and securely accessed from the participant's app. In addition, to support privacy, all demographic and disability assessment information is housed in secure servers off the blockchain.

In our proof of concept, a provider receives blockchain tokens as they deliver eligible services. The service provider could then transfer their tokens to the NDIA to request payment to their bank account through the New Payments Platform. This payment could occur within seconds and include remittance information to enable automatic payment reconciliation for service providers.

The data from bookings and transactions could be viewed in real-time, with appropriate controls to protect confidentiality of data, such as access controls and the de-identification of data. For participants, the real-time data could support the management of budgets. For service providers, it could support business intelligence to deliver improved services. For government agencies, it could support the functions of plan development and oversight, market custodianship, regulation of quality and safeguards, scheme-wide budget planning, and policy review and analysis.

The blockchain system developed for the proof of concept operates on a permissioned Ethereum network, with three processing hubs: one for the NDIA; one for the financial institution enabling payments; and one for an observing regulator. An envisaged full-scale solution would operate on a fast distributed ledger architecture and could incorporate additional processing hubs, with rules determining which hubs process which transactions. For example, service providers might operate hubs only for transactions to which they are a party.

The proof of concept design was informed by engagements with participants, carers, service providers and a project Reference Group. The Reference Group consisted of leaders from disability, government, payments and fintech sectors. Through these engagements, we created user stories for an NDIS participant archetype/persona.

The user stories reflected a broad range of NDIS payment conditions to enable us to critically evaluate the proof of concept. The stories include the potential to blend aspects of plan financial management, including self-management, plan-management and agency-management – as well as potential integrations with systems for service providers, plan managers and eMarkets.

We built the system using an agile approach, with multiple rounds of user testing and iteration involving participants, carers and service providers. The final, formal round of testing involved ten participants and carers trialling the applicability of the participant app for the user stories.

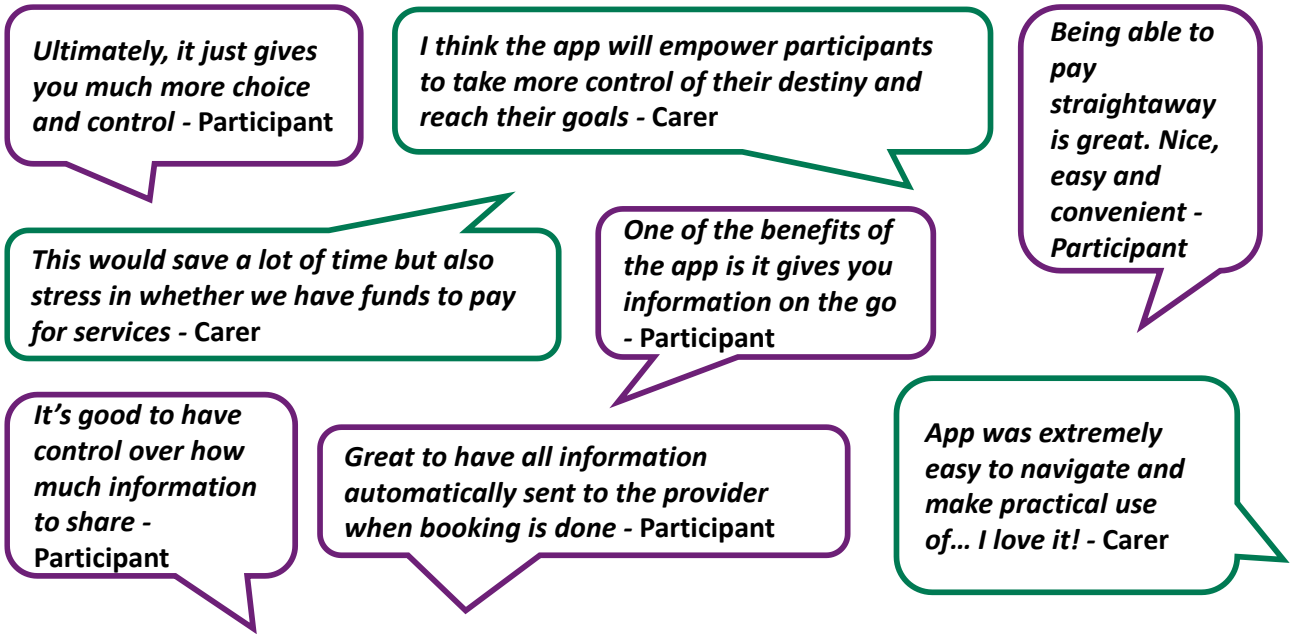
We evaluated the proof of concept using ten design criteria; choice, control, accessibility, simplicity, efficiency, confidentiality, integrity, performance, cost and modifiability. We compared the proof of concept system with the current systems and processes in the NDIS, as well as with two hypothetical alternative future designs: a centralised rules-based database; and a

currency-on-blockchain solution that would add to the project's proof of concept the capability to settle payments directly on the blockchain, rather than through the redemptions of blockchain tokens for bank transfers.

Overall, our results indicate that there is strong potential to better enable conditional payments in Australia. A new concept of smart money is possible using blockchain token technology, and could be integrated with the New Payments Platform (however, this integration was not tested as part of the proof of concept). The benefits could include greater empowerment for spenders, greater payment certainty for businesses, and greater spending integrity for funders.

User testing with participants and carers achieved an 89% net promoter score (NPS) of the prototype app.[1] Figure 3 and Figure 4 summarise some of benefits that could result if the proof of concept was scaled for the NDIS.

Figure 3: User testing quotes from participants and carers



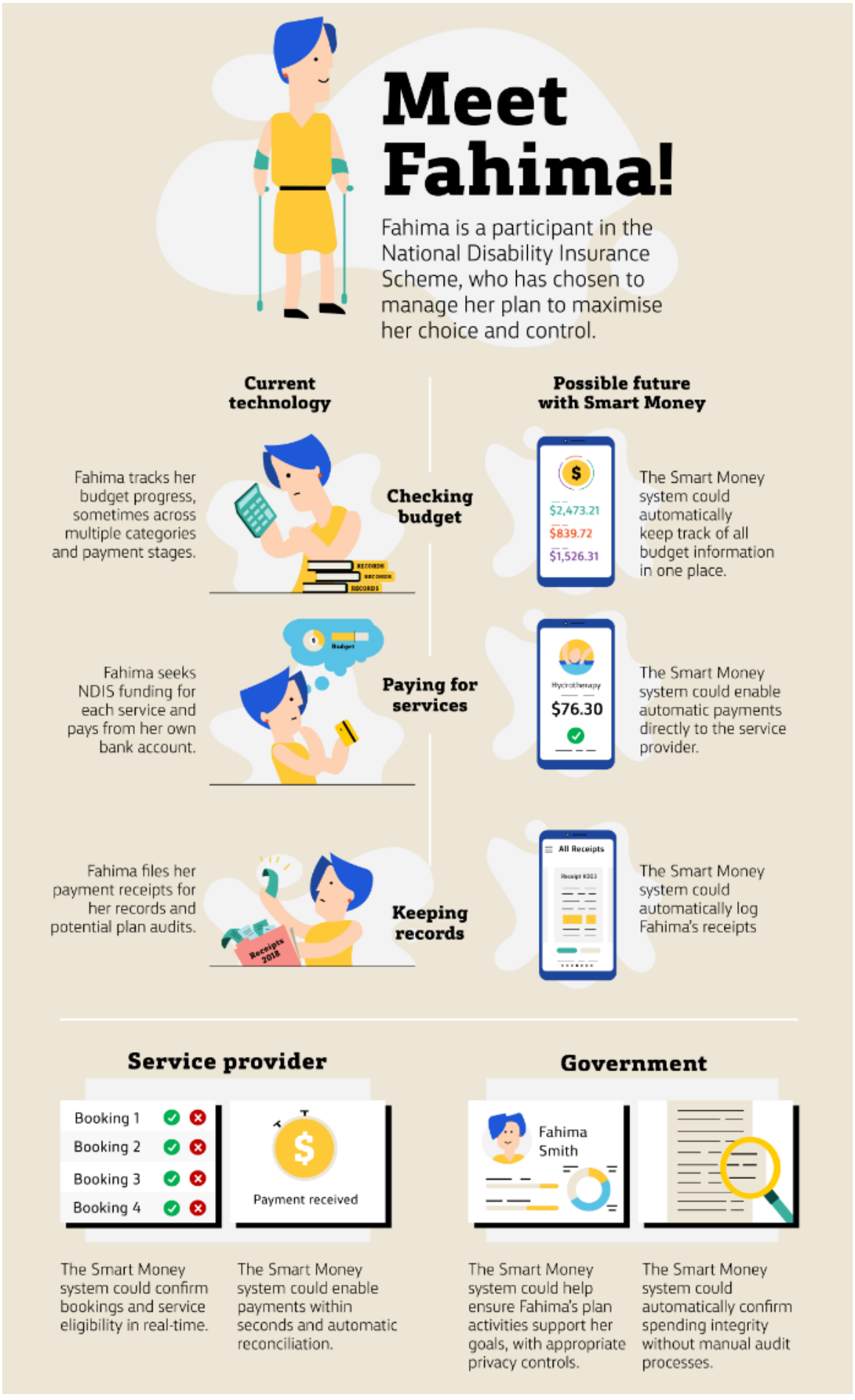
Testing also demonstrated the potential to deliver substantial economic benefits. Participants and carers estimated that the prototype app could save them between 1 hour and 15 hours per week, while service providers estimated potential cost savings of between 0.3% and 0.8% each year. CBA modelling indicates that, even if these estimates were applied conservatively across the NDIS ecosystem, the economic benefits would equate to hundreds of millions of dollars annually, if the proof of concept was leveraged to develop and implement a full-scale solution.[2]

The benefits would be greater if the technology was applied to multiple conditional payment environments to expand the reach and flexibility of smart money and to better share technology infrastructure costs and payment environment data sources across the economy. This may require further research and development, particularly with respect to ensuring sufficient performance and confidentiality.

[1] Measures the willingness of customers to recommend a product to others. Maximum score is positive 100% and minimum score is negative 100%.

[2] See Appendix A.4 for calculation details.

Figure 4: The potential of smart money, explained



The smart money concept offers particular promise in the following use cases:

1. **enhancing public policy programs to achieve better citizen outcomes**, particularly where person-centred funding, cross-jurisdictional funding, outcomes-based funding, or taxes, transfers and rebates are involved
2. **empowering individuals to optimise their spending**, including through smart savings plans, smart diets, smart pocket money, pre-commitment mechanisms to help manage addictions and values-based spending supports, such as ethical product registries
3. **reducing friction and costs for businesses, trustees and not-for-profits**, with respect to insurance payouts, managing corporate delegations and procurement, and providing transparency for funds managed by trusts, charities and membership organisations.

While the technology promises great potential, further work is required to deliver refined solutions. Before any implementation of the smart money proof of concept is commenced for any conditional payment environment, a business case and/or cost benefit analysis would need to be undertaken. Careful consideration would also need to be given to the proposed governance arrangements for the system, including which parties should be processing nodes, who has visibility of the blockchain and who is eligible to set and modify conditions. An agile build and test approach would be most appropriate to manage implementation risks.

If a decision was taken to leverage the proof of concept to develop and implement a full-scale solution for the NDIS specifically, further work would be required to: test a greater variety of use cases; ensure the app is accessible to all NDIS participants; develop integrations with NDIA, service provider, plan manager and participant system interfaces; and enable seamless payments to service providers who do not accept bank transfers.

If the proof of concept was leveraged to develop a solution that functioned across multiple conditional payment environments to unlock platform benefits, further research and development would be required to ensure that the required levels of performance and confidentiality could be achieved across the greater number of processing nodes and users across the platform.

If these areas for future work are progressed successfully, there is great potential for smart money to enable automated conditional payments across the economy, and through this improve the financial wellbeing of people, businesses and communities.

Definitions

Conditional payment environments

A payment environment where one party wishes to fund a payment, but only after certain pre-set conditions have been met. The NDIS is an example of a conditional payment environment.

NDIS

National Disability Insurance Scheme – provides person-centred funding plans for people with disability, known as participants.

NDIA

National Disability Insurance Agency – the agency responsible for implementing the NDIS.

Participants

People eligible to access NDIS supports due to their disability.

Carers/guardians

A person who takes care of an NDIS participant and who may be responsible for managing a plan on behalf of a participant.

Service providers

A person or entity who provides disability support services. They must be registered with the NDIA to deliver services to agency-managed participants.

Agency Management

Agency management is when an NDIA plan manager manages a plan on behalf of an NDIS participant.

Plan Management

When a private plan manager manages a plan on behalf of an NDIS participant.

Self Management

When an NDIS participant manages their own plan.

eMarkets

Emerging online market paces that enable participants to access disability support services

Proof of Concept

A proof of concept is a demonstration or prototype, the purpose of which is to verify that certain concepts or theories have the potential for real-world application. A proof of concept is designed to determine feasibility, but does not represent deliverables.

New Payments Platform (NPP)

NPP is Australia's newest payments system that was launched in February 2018 through an industry collaboration established by the Reserve Bank of Australia with 12 Authorised Deposit-Taking Institutions. The NPP will enable individuals, businesses and government agencies to make simple, near real-time payments with substantially more messaging information.

Net Promoter Score (NPS)

The Net Promoter Score measures the willingness of customers to recommend a company's products or services to others. The NPS is calculated as the percentage of promoters (those who rated their likelihood as an 8 or 9 out of 10 of recommending the product or service to friends or family) less the percentage of detractors (those who rated their likelihood as 6 or below).

Application Programming Interface (API)

An API is a set of routines, protocols, and tools for building software applications that determine and enable separate software components to communicate with one another.

Blockchain

A blockchain is a distributed digital ledger that records transactions between parties, and also a computational platform to execute small programs (called 'smart contracts') as transactions. These transactions are grouped into blocks and each block is cryptographically linked to the previous one, providing the tamper evident property. A blockchain can be replicated across many locations and operated jointly by a collective.

Smart contracts

A smart contract is a program that is recorded on the blockchain ledger and executes as part of transaction validation on the blockchain. In addition to executing the logic encoded in the program, smart contracts can carry digital currency or control access to other digital assets recorded on the blockchain.

Public (or Permissionless) Blockchain

A blockchain operated as a public peer-to-peer system. The system is open to anyone to participate and thus anyone is allowed to download, read and write to the system. Parties are usually identified by pseudonymous public/ private keys, and a form of Nakamoto consensus is typically used to allow a large number (thousands) of processing nodes to operate the blockchain.

Private (or Permissioned) Blockchain

A blockchain operated by a private entity or consortium, with no or limited access by other parties, and typically with a small number (tens or hundreds) of processing nodes operating the blockchain. In this context, compared to public blockchains, technical optimisations may be used to improve the latency and throughput of the blockchain, and different consensus mechanisms may be used to provide stronger guarantees about the completion of transactions.

Token

A digital object that can be transferred between parties and which represents other digital objects or physical objects. In this proof of concept, tokens are digital objects that stand for Australian Dollars for NDIS purchases.

Policy contract

A representation of rules and enforcements of a token, implemented in a smart contract.

Smart token

A token with a policy contract attached, *i.e.* token with rules.

Registries

Authoritative collections of information, often managed by government agencies. A registry holds information about a class of entities.

Currency-on-blockchain solution

In this proof of concept, tokens represent smart money to settle payments directly on the blockchain (rather than through the redemptions of blockchain tokens for bank transfers).

1 Project Scope and Objectives

1.1 Project context

Smart money has broad applications across conditional payment environments

How can we make money "smart", in order to improve conditional payments? A conditional payment occurs when a person or entity wishes for a payment to occur, but only after certain policies or business rules are satisfied. There are many of these kind of environments; see Table 1 below for some examples in Australia.

Table 1: Examples of conditional payment environments

EXAMPLE	PAYMENT CONDITION
Government funding programs	Citizens or service providers only receive payments or subsidies under eligible circumstances
Insurance payouts	Policy holders are only compensated after an eligible event is triggered
Corporate cards/delegations	Employees can only make business-related purchases in line with spending delegations
Trust payments	The trustee must make purchases in line with the purposes of the trust
Charitable donations	Charities can only spend funds in line with donor directions
Scholarships	Scholarship recipients can only spend scholarship funds in line with scholarship rules
Price-dependent transactions	The purchase or sale of a product or security can only occur when the price falls within a pre-set range
Smart savings plans	An individual can only make purchases that align with their savings plan (e.g. monthly budgets for entertainment spending)
Pre-commitment mechanisms	An individual pre-commits to healthy spending behaviours (e.g. self-imposed prohibitions on gambling)

In this project, we have explored the use of blockchain-based smart money for conditional payments. The blockchain platform automatically ensures that pre-set conditions are met before allowing payment to take place (assuming that the conditions are correctly coded and input data is

valid), but also allows policies, business rules, and auxiliary actions to be dynamically added and removed to parcels of money in these environments.

The National Disability Insurance Scheme as an example context

The project required a realistic use case to explore the design and use of smart money. We chose the National Disability Insurance Scheme as an example context for two main reasons.

Reason 1: The potential to improve financial wellbeing

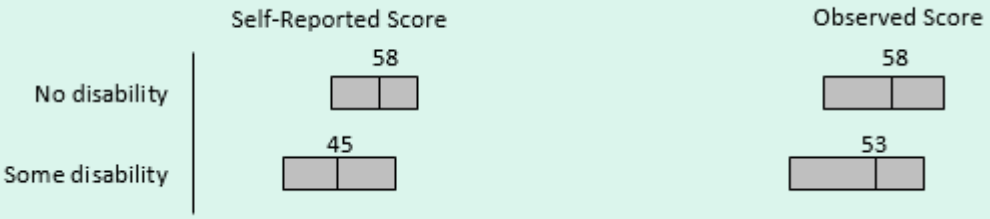
The National Disability Insurance Scheme (NDIS) will be a critical piece of social infrastructure for 460,000 of the most vulnerable members of our community.[3] In addition to living their everyday lives, people with disability must access and fund their required enabling support services. A recent financial wellbeing study identified that people with disability currently experience lower than average subjective and objective measures of wellbeing (see Box 1 below). The NDIS has enormous potential to reduce these shortfalls and provide people with disability with greater choice and control over their lives.[4]

Box 1: Measures of financial wellbeing for people with disability

The University of Melbourne and the Commonwealth Bank recently released a first-of-its-kind report on financial wellbeing in Australia. The CBA-MI Financial Wellbeing Scales combined self-reported financial outcomes with banking data for over 5,500 people, including 611 people with disability.[5]

The study found that, on average, people with disability experience substantially lower levels of financial wellbeing than the general population. Their median scores for both self-reported and observed measures of financial wellbeing were approximately ten points lower than the general population (see Figure 5).

Figure 5: Self-reported and observed measures of financial wellbeing



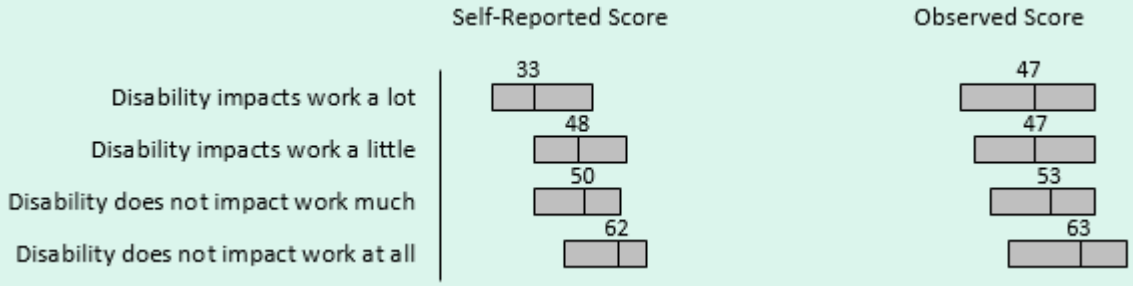
For people whose disability impacts their work, the outcomes are even more pronounced. Their median financial wellbeing scores can be up to 30 points lower than the median scores for people who do not experience an impact of disability on their work (see Figure 6).

[3] NDIS (2016), Media Release: Successful NDIS trial - on time and on budget, statement by David Bowen, inaugural CEO of the National Disability Insurance Agency (NDIA). Available at: https://www.ndis.gov.au/Media-Release/Successful-NDIS-trial-on-time

[4] NDIS (2018), NDIS Overview. Available at: https://www.ndis.gov.au/operational-guideline/overview

[5] Haisken-DeNew J, Ribar D, Salamanca N and Andrea N (2018), Using Survey and Banking Data to Understand Australians' Financial Wellbeing, Melbourne Institute: Applied Economic & Social Research, University of Melbourne.

Figure 6: Self-reported and observed measures for impact of disability on work



As disability can impact work to varying degrees, Australia's investment in the NDIS is important in supporting people with disability to live independent lives, including attaining and maintaining meaningful employment.[6] Any steps that improve the operation of the NDIS may therefore generate a significant improvement in the financial wellbeing of people with disability.

Reason 2: The sophistication of the conditions to program in the smart money

NDIS plans are tailored to the unique combination of goals, objectives and disability support requirements of each participant. To achieve this, NDIS plans contain a range of budget categories with different spending rules that stipulate how funds can be spent, who they can be spent by, who can receive them, and who can set these rules. The highly personalised nature of these rules provides a strong motivation for testing smart contract conditions and the use of technology for conditional payments.

1.2 Project Objectives

Data61 and the Commonwealth Bank undertook this project to:

1. explore the use of blockchain-based smart money for sophisticated conditional payments environments
2. test the potential of smart money to simplify and enhance the NDIS user experience for participants, service providers and the Government
3. identify future areas of work to progress the application of smart money to other conditional payment environments.

In doing so, we focused on four technical objectives:

1. test implementation of a new technology concept for programmable bundles of money, where policies that specify and govern the rules for that money can be dynamically attached or removed
2. explore how smart money can support not only conditional payments but also auxiliary actions, such as self-removal of policies and self-taxing payments, noting that the project did not test the concept of self-taxing payments but that this functionality could be possible under the smart contract framework used in the proof of concept;

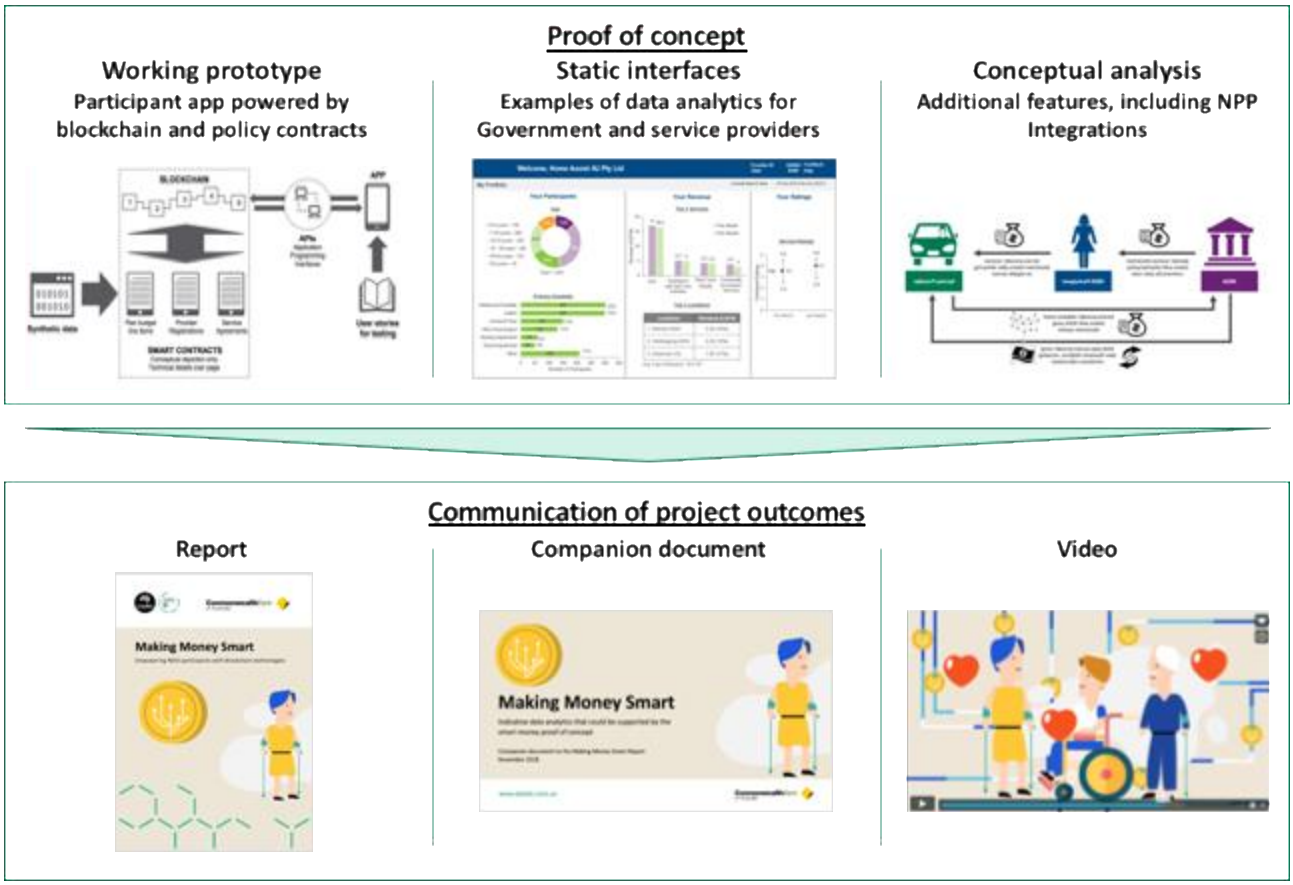
[6] Productivity Commission (2017), National Disability Insurance Scheme (NDIS) Costs, Study Report.

3. determine how blockchain token solutions might potentially be integrated with existing payment mechanisms, such as the New Payments Platform
4. compare the effectiveness of this project's proof of concept – a blockchain token solution that can integrate with the New Payments Platform – with hypothetical alternative designs, including a centralised rules-based database and a currency-on-blockchain solution.

1.3 Project Deliverables

The project has taken a practical approach to testing and evaluating smart money technologies, through a number of deliverables (see Figure 7 below).

Figure 7: Overview of project deliverables



The purpose of each component of the proof of concept is outlined below:

- **The working blockchain prototype for the participant app** was developed to test the extent to which the proof of concept could operationalise NDIS budget rules and provide visibility of information to participants.
- **The static interfaces for government and service provider analytics** were developed to test the extent to which the proof of concept could provide real-time data to solve real-world challenges for government and service providers.
- **The conceptual analysis, including New Payments Platform integration and additional features**, was undertaken to ensure the proof of concept could enable a holistic solution.

This report explores the design of the proof of concept and evaluates its effectiveness against the design criteria outlined in Section 4.2 of this report. The project report, companion document and video can be accessed online at: www.commbank.com.au/makingmoneysmart and data61.csiro.au/smartmoney.

1.4 Project Methodology

This project follows a *design science* approach where we assessed the needs and requirements of stakeholders and state of the art and practice in research literature and industry practice. We designed an approach aimed to fulfil the needs of NDIS participants, service providers and the Government. This approach was designed and developed to achieve a proof-of-concept implementation, which was subsequently tested.

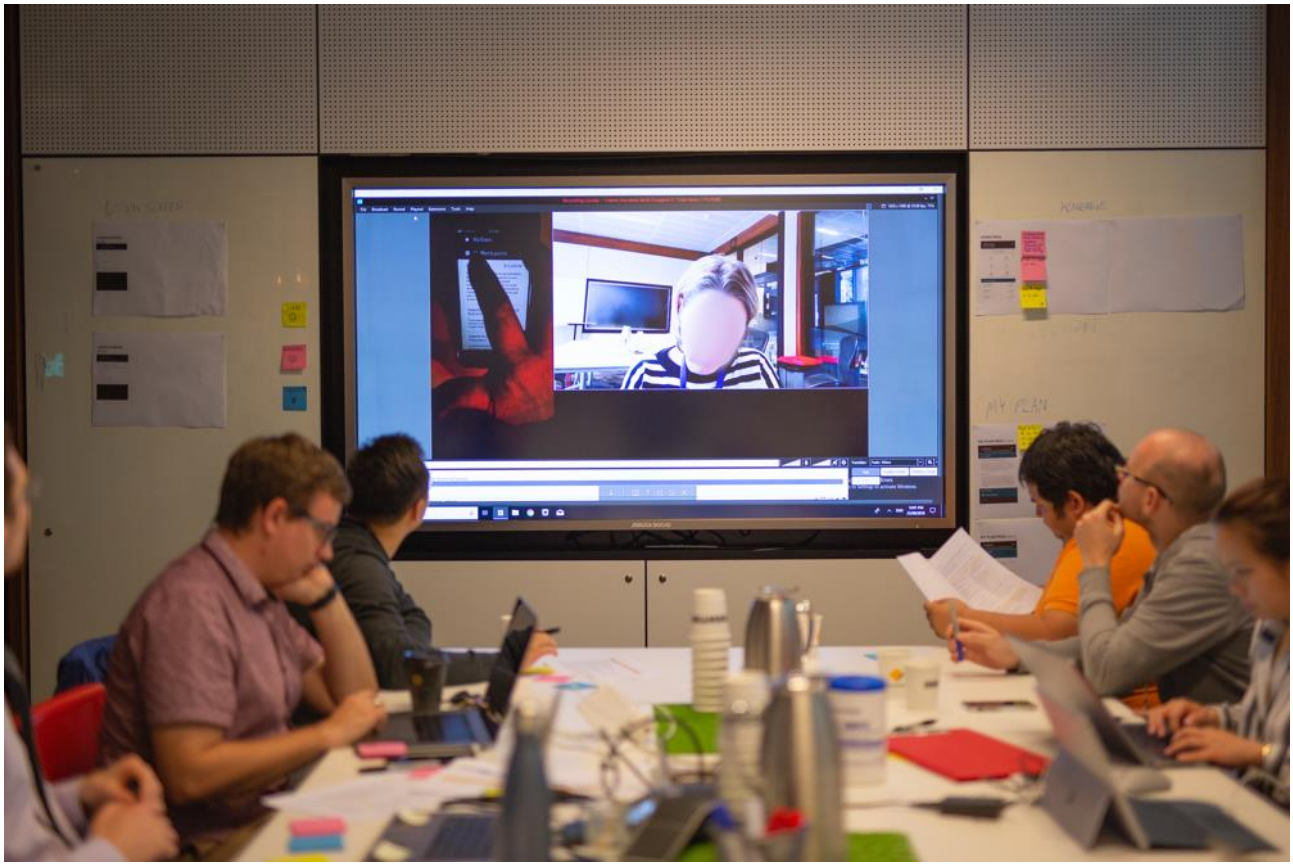
A proof-of-concept implementation focuses on supporting a known number of use cases. This is in contrast to a prototype implementation which supports a larger part of the entire envisaged use cases. However, the implementation is not at the maturity level of software products or services to be used in production and to be exposed to end users. The maturity of new software follows a chain of Research & Development activities which raises the maturity from a proof-of-concept implementation to a prototype and subsequently to a production system. For the previously unexplored concept of programmable or smart money, a proof-of-concept implementation is the appropriate choice.

The evaluation of the proof-of-concept implementation covered two parts: lab-based evaluation and end-user testing. The former was used primarily for aspects that are best tested without the need of any user involvement and are related to the back-end technology. These aspects include functional correctness, speed, etc. End-user testing contributed to some of these aspects, such as end-to-end latency from one user interacting with the system, to another user observing that change. However, the focus of the end-user evaluation was on the human perspective, primarily on determining the fit of the solution for the purpose, identifying parts of the system that either are clear or unclear.

End-user testing was conducted in two phases. In the first phase, volunteers from the Commonwealth Bank Friends of the Lab network, who were NDIS participants, carers or family members, were exposed to the system and their feedback was incorporated into the system. In the second phase, formal testing with NDIS participants, carers and service providers was conducted to assess the system in its final proof-of-concept state. These two phases correspond to two cycles of action research, where an artefact (the system) is tested, changed based on the observations, and then tested again. More cycles would be possible, but the system should mature to a prototype stage before such action is taken.

The proof of concept used synthetic data created for a fictional participant persona. No actual participant or service provider data was used as part of the proof of concept build or testing.

Figure 8: User testing observation room in Commonwealth Bank Innovation Lab



The project sought feedback and advice from the Reference Group on a monthly basis from February 2018 to November 2018. The Reference Group provided input on the design, build, testing and iteration of the proof of concept – and communication of the project outcomes. Nonetheless, this report and other project deliverables should be taken to represent only the views of Data61 and the Commonwealth Bank.

Across the project, we engaged with a broad range of NDIS participants, carers, service providers, disability sector experts, government agencies and industry bodies (see Figure 9).

Figure 9: Making Money Smart project engagement

The evaluation focused on desirability and feasibility of the proof of concept, rather than on the practical or commercial viability of wide-scale deployment. The methodology was chosen in accordance with the unexplored and untested state of the smart money approach. A broader cost-benefit analysis would need to be undertaken before the proof of concept is rolled out across the NDIS. In addition, investment would be needed to scale the proof of concept. An agile process involving additional experiments and pilots may help build an evidence base for a cost-benefit analysis and help manage implementation risks.

1.5 Project assumptions and limitations

1.5.1 Content accessibility

We have taken a number of steps to make this project accessible for people with disability:

1. All Data61 reports, including this report, meet the Web Content Accessibility Guidelines 2.0 AA standards.[7] Going beyond the requirements of those standards, to provide additional accessibility for people with vision impairment for this report, we increased the standard font size, increased contrast ratios, provided alternative text for all figures and ensured information tables do not contain merged cells.

[7] Web Wide Web Consortium Web Accessibility Initiative (2018), Web Content Accessibility Guidelines (WCAG) Overview. Available at: https://www.w3.org/WAI/standards-guidelines/wcag/

2. The working prototype interface leverages the Australian Government Design System[8] which supports designers to meet the Web Content Accessibility Guidelines 2.0 AA design standards.[9] In particular we leveraged the use of standardised, high-contrast colour palettes and incorporated coding to enable smart phone screen readers to order and identify content (for example, headings, buttons, and content in tables).
3. We sought to test the proof of concept with people with a range of disabilities to ensure we applied a holistic perspective. Throughout user testing, we ensured an accessible environment, including building access and necessary supports for test users with accessibility requirements.

While we have taken these efforts to implement and communicate the project in an accessible manner, we acknowledge that we, and society as a whole, are on a journey to improve accessibility for all members of the community. In particular, we acknowledge that due to project scope constraints, the working prototype was not fully accessible for people of all disabilities. If the resulting system was to be scaled and operationalised, additional testing would be required to consider the diversity of NDIS participant needs and that the solution meets their accessibility requirements to the fullest extent possible with available technology.

1.5.2 Security

Security is a broad concept that comprises many different characteristics, including confidentiality, integrity, and availability.

i. Confidentiality is the absence of unauthorised access to read information.
ii. Integrity is the absence of unauthorised creation or modification of information.
iii. Availability is the readiness for correct service for users.

Conditional payments systems have requirements for these three aspects of security, and the NDIS context may bring with it additional complexities, which arise from the management of clinically-related information, and from the role of some carers.

The major focus of this research project was to explore the functionality and applications of smart money, rather than security. Nonetheless, we evaluated the relative strengths and weaknesses of the proof of concept with respect to security in Section 7 of this report, with opportunities for future work outlined in Section 9 of this report.

The proof of concept used synthetic data created for a fictional participant persona. No actual participant or service provider data was used as part of the proof of concept build or testing.

1.5.3 Financial systems

This project has examined the implementation and use of new kinds of payments functionality, and supporting blockchain-based technology architectures. However, we have not sought to

[8] Australian Government (2018), Design System. Available at: https://designsystem.gov.au/

[9] Australian Government (2018). Design Service Standard 9: Make it accessible. Available at: https://www.dta.gov.au/standard/9-make-it-accessible/

address the broader issues of financial systems architecture for blockchain-based payment schemes. There has been increasing interest internationally in the potential costs, benefits, risks, and opportunities of using currencies in blockchains, to settle payments using funds issued and transferred on blockchains. A particular kind of currency on blockchain that has been discussed internationally is Central Bank Digital Currencies (CBDCs), which would require a government-backed currency.[10] This project has not investigated CBDCs.

There are many unresolved issues related to a currency-on-blockchain concept, including their issuance, their interoperation with other forms of money, impact on competition in the commercial banking sector, impacts (positive and negative) on systemic risk, mechanisms for remediation of fraud or error, and mechanisms for implementation of policy. For example, currency-on-blockchain solutions might allow new mechanisms for "admin rights" over money, where issuers might retain underlying authority and control over tokens representing currency that is backed by them, allowing them to respond to court orders over those monies, and to make programmatic updates to policy for those monies. This would give greater regulatory oversight and power to respond to fraud or misuse of money, but could perhaps introduce new risks related to "bugs" in smart contracts and to individuals' cryptographic key management.[11]

While these questions are outside the scope of this project, our exploration of programmable money does partly explore some of the potential benefits of currency-on-blockchain schemes, including the conceptual comparison of our smart money proof of concept with a hypothetical longer-term currency-on-blockchain solution.

[10] Committee on Payments and Market Infrastructures (2018), Central bank digital currencies. Available at: https://www.bis.org/cpmi/publ/d174.pdf

[11] Reserve Bank of New Zealand (2018), The pros and cons of issuing a central bank digital currency. Available at: https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Bulletins/2018/2018jun81-07.pdf

2 Overview of the NDIS and opportunities for enhancement

2.1 Overview of National Disability Insurance Scheme (NDIS)

2.1.1 The NDIS represents a massive increase in investment in people with disability

The National Disability Insurance Scheme (NDIS) is widely regarded as the biggest social reform in Australia since the introduction of Medicare.[12] By July 2020, the NDIS is expected to support 460,000 people with disability through an annual investment of $22 billion.[13] This is an almost two-fold increase in the number of Australians receiving disability support services and a three-fold increase in financial investment.[14]

To meet this increased demand, the disability support workforce is expected to double from 70,000 to 140,000 workers. One in every five new jobs created in Australia during this time will be in the disability sector.[12] The number of registered disability service providers is also increasing rapidly, with a 17% increase between 30 March 2018 and 30 June 2018 alone. The current total of 16,755 providers is expected to continue to grow.[13]

2.1.2 The NDIS aims to deliver greater choice and control to people with disability

The ambition of the NDIS goes broader than increasing the quantity of disability support services available. The NDIS is also transforming how people with disability can access support services, with the aim of providing greater quality, choice and control.[15]

Before the NDIS, disability service providers commonly competed for block-funded contracts to deliver support services to people with disability.[12] This funding model provided people with disability with limited control over which services they accessed, how they accessed them and which service providers they used. Block funding also provided limited incentives for service providers to innovate and improve their efficiency. Arrangements also operated inconsistently across jurisdictions, meaning people with similar disability support needs in different locations received different levels of support. The Productivity Commission found that: "the [then] current disability support system is underfunded, unfair, fragmented, and inefficient, and gives people with a disability little choice and no certainty of access to appropriate supports".[16]

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[12] Productivity Commission (2017), National Disability Insurance Scheme (NDIS) Costs, Study Report.

[13] National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018.

[14] Productivity Commission (2017), The National Disability Insurance Scheme – a review of the costs, PC News- August 2017.

[15] NDIS (2018), NDIS Overview. Available at: https://www.ndis.gov.au/operational-guideline/overview

[16] Productivity Commission (2011), Disability Care and Support, Report no. 54.

The NDIS is designed to address these limitations.[17] It operates on a national scale to ensure all Australians under the age of 65 who have a permanent or significant disability receive reasonable and necessary supports to live their lives and achieve their goals.[18] Participants collaborate with the National Disability Insurance Agency (NDIA) and Local Area Coordinator partners to develop tailored NDIS plans to suit their circumstances. Plans can contain a range of budgets for different service categories, which participants can then use to purchases services. Service providers compete to deliver services on a person-by-person basis. Like other competitive markets, the most successful service providers will be the ones that deliver the services that participants want, in the way they want to receive them and at the best available price. It is through these market mechanisms that the NDIS aims to provide participants with greater choice and control.[19]

2.1.3 Participants have three options for managing their plans

NDIS participants have a broad range of goals, disabilities and preferences. To accommodate these various needs, the NDIS provides a range of options for managing plans. Different plan management approaches provide participants with varying degrees of support and flexibility for accessing services, managing budgets and arranging payments (see Table 2 below).

Table 2: Financial plan management approaches

APPROACH	DEGREE OF CHOICE	TYPICAL PROCESS TO ACCESS SERVICES[20]
1. Self-Managed Participant (or their carer or legal guardian) manages their own plan finances.	Participant can choose eligible services from any service provider at any price point.	Participant requests funds through NDIS portal (myplace), then receives funds in personal bank account, then pays provider to deliver service and keeps payment record in case of audit.
2. Plan Managed Participant pays a private plan manager (using some of their plan budget) to manage their plan finances.	Participant can ask plan manager to procure eligible services from any service provider at any price point.	Plan Manager requests funds through NDIA portal on behalf of participant, then receives funds in account, then pays provider to deliver service to participant and keeps payment record in case of audit.
3. Agency Managed Participant opts for the NDIA to manage their	Participant is restricted to registered service providers, who must	Provider is engaged by NDIA Manager or participant to deliver service, then seeks payment from NDIA after delivering service through the NDIS myplace provider portal.

[17] NDIS (2018), NDIS Overview. Available at: https://www.ndis.gov.au/operational-guideline/overview

[18] National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018.

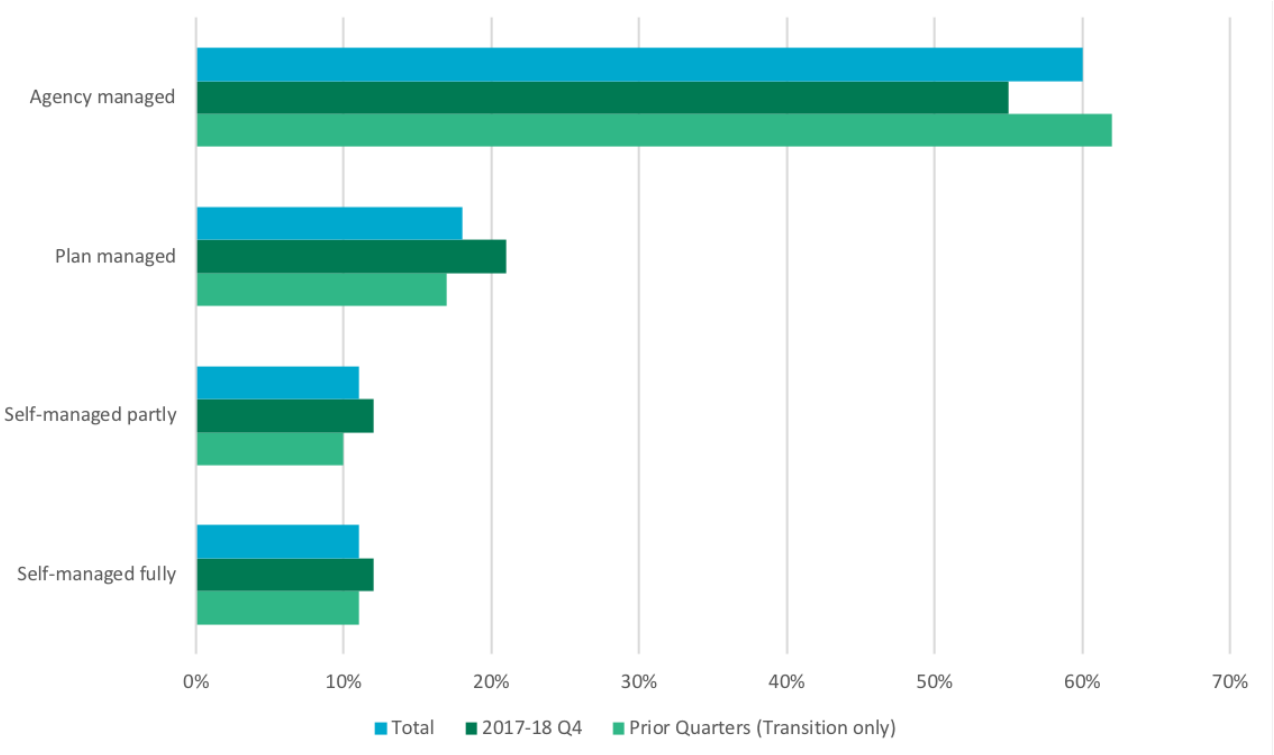
[19] NDIS (2016), NDIS Market Approach, Statement of Opportunity and Intent.

[20] Note: under some circumstances (such as if a support service is required immediately), participants can pay for services first using their own funds and then seek reimbursement from the NDIA afterwards.

APPROACH	DEGREE OF CHOICE	TYPICAL PROCESS TO ACCESS SERVICES[20]
plan finances or is so required.[21]	comply with price controls.[22]	
Combination Participant chooses a combination of plan management approaches.	Depends on the combination of plan management approaches chosen.	Depends on the combination of plan management approaches chosen

While self-management delivers the greatest degree of choice and control to participants, currently only 11% of participants choose this option (see Figure 10). This relatively low percentage stems from the challenges associated with accessing the right services, managing budgets and making payments. These challenges can be particularly pronounced for people with cognitive disability or for new participants who are still familiarising themselves with NDIS systems and processes.

Figure 10: Distribution of financial plan management approaches[23]



[21] Note: In some cases the NDIA will require a participant to be agency-managed. Factors influencing these determinations can include: the cognitive capacity of the participant, the complexity of the participant's plan and the participant's familiarity with the NDIS.

[22] National Disability Insurance Agency (2018), Pricing and payment. Available at: https://www.ndis.gov.au/providers/pricing-and-payment

[23] National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018. Available at: https://www.ndis.gov.au/medias/documents/coag-report-q4-y5-full/2018-Q4-June-COAG-report-Full.pdf

Trends suggest that the proportion of self-managed and plan-managed participants will increase with time. For example, the proportion of agency managed participants in new plans has recently fallen from 62% to 55%.[24] However, the full potential for participants to self-manage is unlikely to be met if the challenges with the current systems and processes remain (see Section 2.2).

2.1.4 Participant plans have three type of budgets

NDIS plans are tailored to the goals and needs of each participant. This involves setting the plan's budget, which determines the services a participant is eligible to access. There are three budget types, with each containing a range of categories and spending rules (see Table 3).

Table 3: Budget types and categories[25]

BUDGET TYPE	BUDGET CATEGORIES	SPENDING REQUIREMENTS
1. Core A support that enables a participant to undertake their daily activities.	• **Consumables** (e.g. everyday use items such as continence aids) • **Daily Activities** (e.g. assistance with self-care activities) • **Assistance with Social and Community Participation** (e.g. supports to engage in social or recreational activities) • **Transport** (e.g. alternatives to public transport due to disability constraints)	Participant has flexibility to allocate funds across budget categories, unless funds have been set aside for a specific purpose, such as for transport or specialised disability accommodation.
2. Capacity Building A support that enables a participant to build their independence and skills.	• **Choice and Control** (e.g. training and education in plan management or for a plan manager) • **Daily Activity** (e.g. therapy aimed at building capacity to participate • **Employment** (e.g. employment related assessment and counselling) • **Health and Well Being** (e.g. exercise advice to manage disability) • **Home Living** (e.g. support to obtain or retain appropriate accommodation) • **Lifelong Learning** (e.g. assistance moving from school to further education)	Participant has flexibility to allocate funds within budget categories but not across budget categories.

[24] National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018. Available at: https://www.ndis.gov.au/medias/documents/coag-report-q4-y5-full/2018-Q4-June-COAG-report-Full.pdf

[25] NDIS (2016), NDIS Price Guide VIC/NSW/QLD/TAS Valid from: 1 July 2016. Available at: https://www.ndis.gov.au/html/sites/default/files/documents/Provider/201617-vic-nsw-qld-tas-price-guide.pdf

BUDGET TYPE	BUDGET CATEGORIES	SPENDING REQUIREMENTS
	• **Relationships** (e.g. positive behavioural support strategies) • **Social and Community Participation** (e.g. life skills development and training)	
3. Capital Assistive technology, equipment and home/vehicle modifications.	• **Assistive Technology** (e.g. communication aids, wheelchairs or vehicle modifications) • **Home Modifications** (e.g. bathroom rail)	Participant must use funds for supports specifically mentioned in plan (e.g. wheelchair)

2.2 Opportunities for simplification and enhancement

2.2.1 An opportune time for new technologies to enhance the NDIS user experience

In the rollout of the NDIS, the Government has focused on maximising access to participants, and has demonstrated strong progress. The NDIS has reached over 54,000 people with disability who have previously never received publicly funded disability support services.[26] This will grow to almost 200,000 when the rollout is complete in July 2020.[27]

Since the NDIS was first envisaged in 2011, and even during its ongoing rollout, payments technology has progressed considerably. The potential for the application of blockchain technology and smart contracts is much better understood, including through research papers and proof of concepts developed by Data61 and the Commonwealth Bank.[28,29,30,31] In addition, the New Payments Platform (NPP) was publicly launched in February 2018 through an industry collaboration involving the Reserve Bank of Australia and 12 Authorised Deposit-Taking Institutions, including the Commonwealth Bank.[32] The NPP will enable individuals, businesses and government agencies to make simple, near real-time payments with substantially more messaging information than previous payments options.[33]

[26] National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018.

[27] Productivity Commission (2017), National Disability Insurance Scheme (NDIS) Costs, Study Report.

[28] Hanson RT, Reeson A and Staples M (2017), Distributed Ledgers, Scenarios for the Australian economy over the coming decades.

[29] Staples M, Chen S, Falamaki S, Ponomarev A, Rimba P, Tran AB, Weber I, Xu X and Zhu J (2017), Risks and opportunities for systems using blockchain and smart contracts, Data61 (CSIRO).

[30] Commonwealth Bank (2018), The Trade-chain experiment. Available at: https://www.commbank.com.au/corporate/solutions/working-capital/trade-finance/trade-chain-experiment.html

[31] Commonwealth Bank (2018), CBA helps World Bank raise A$110 million with launch of 'Bond-i'. Available at: https://www.commbank.com.au/guidance/newsroom/cba-helps-world-bank-raise-a-110-million-with-launch-of--bond-i--201808.html

[32] In addition to the 13 shareholder participants, around 60 other financial institutions participate in the NPP using the services of aggregators.

[33] Reserve Bank of Australia (2018), New Payments Platform. Available at: https://www.rba.gov.au/payments-and-infrastructure/new-payments-platform/

As the NDIS approaches full rollout, we can now consider how these new technologies could simplify and enhance the operation of the NDIS for participants, service providers (including plan managers and emerging eMarkets) and government agencies.

2.2.2 New technologies might be able to overcome existing challenges

As blockchain, smart contract and New Payment Platform technologies were not available when the NDIS was first envisioned, the NDIS has relied on traditional methods for ensuring service eligibility, booking services, making payments, managing budgets and recording services. These traditional methods have five key challenges.

Challenge 1: Budget information is not always automatically available in real-time

Participants do not always have access to real-time information on how much of their plan budgets they have spent, how much they have allocated to future booked services and how much they have available for new service bookings and purchases. There is no single repository of budget information for self-management and plan-management approaches, and there is a lack of real-time visibility of service eligibility (see Challenge 2 below). Participants and carers have noted challenges with not over or under spending against their plan budgets.[34]

Challenge 2: Service eligibility determinations are not always straightforward

At times, participants and service providers lack the necessary information for ensuring service eligibility before service bookings and payments. This is particularly the case when: plans are under review and budgets are subject to change; when self-managed participants rely on their own judgement; and when participants pay for services upfront out of their own finances and need to seek reimbursement afterwards. This is reflected in the 6 to 9 per cent of delayed or declined payments to service providers due to service eligibility issues.[35]

Challenge 3: Payment interfaces and reconciliation can be complex for service providers

Providers have noted that they experience challenges in accessing the NDIS provider portal and payments functionality.[36] They have noted that payment reconciliation can be a complex and manual process, and can result in lost revenues. These challenges can result in increased queries and manual processes for the NDIA to handle.

Challenge 4: Misspending risks must be identified through manual audit activity

As with any payment environment, there is potential for accidental or deliberate misspending of funds. Misspending risks are managed by requiring participants and plan managers to request approval for funds, either before or after accessing services, and requiring them to retain payment receipts in case of plan audits. While these risks are important to manage, the current systems and processes result in administration costs. Some participants have reported a degree of stress with

[34] Based on qualitative input sourced through confidential engagements by the Commonwealth Bank with participants and carers.

[35] National Disability Insurance Agency (2018), NDIS Weekly Payment Summaries, 2018. Available at: https://www.ndis.gov.au/about-us/information-publications-and-reports.html

[36] Based on qualitative input sourced through confidential by the Commonwealth Bank with disability service providers.

potential plan audits.[37] Compliance activities also involves resourcing by the Government, such as the NDIS Fraud Taskforce, which has 100 dedicated personnel.[38]

Challenge 5: The potential of analytics to improve participant outcomes is not being reached

The Government has relatively strong data sets on the activities of agency-managed participants, but limited and often time-lagged visibility of the activities of self-managed and plan managed participants. This includes visibility of specific services accessed, prices, participant satisfaction and participant progress against plan goals. Greater visibility could support government agencies with plan development and oversight, market custodianship, regulation of quality and safeguards, scheme-wide budget planning, and policy review and analysis. Service providers also have limited visibility of relevant information to help them identify and realise opportunities to deliver higher quality and more accessible services for participants and manage forward revenues. Finally, participants have limited information to find and choose service providers, including service providers in their region, relative prices and service reviews.

[37] Based on qualitative input sourced through confidential engagements by the Commonwealth Bank with participants and carers.

[38] Australian Government (2018), NDIS Fraud Taskforce established to tackle crime, joint media release on 24 July 2018 by The Hon Dan Tehan MP, then Minister for Social Services, the Hon Michael Keenan MP, Minister for Human Services and the Hon Angus Taylor MP, then Minister for Law Enforcement and Cyber Security.

3 Why consider blockchain?

3.1 What are blockchains?

Blockchains (and more broadly, distributed ledger technology) are a digital technology that combine cryptographic, data management, networking, and incentive mechanisms to support the checking, execution, and recording of transactions between parties. It is a distributed digital ledger that records transactions between parties, and also a computational platform to execute small programs (called 'smart contracts') as transactions. These transactions are grouped into blocks and each block is cryptographically linked to the previous one, providing the tamper evident property..

Transactions are confirmed through consensus across multiple parties. Parties proposing a transaction may add it to a pool of transactions intended to be recorded on the ledger. Processing nodes within that blockchain community take some of those transactions, check their integrity, and record them in new blocks on the ledger. The contents of the blockchain ledger are replicated across many geographically-distributed processing nodes. These nodes jointly operate the blockchain system, without the central control of any single party. Nonetheless, an effectively functioning blockchain can ensure that all nodes eventually achieve consensus about the integrity and shared contents of the blockchain ledger.

3.2 What are the potential benefits of blockchains?

Blockchain technology, and in particular private blockchain technology, has a number of strengths that may help address opportunities for improvement for NDIS and other conditional payments. These include: the ability to link the transfer of value with the underlying data connected to that transfer, recording both on the same ledger; the automatic maintenance of an immutable source of truth for value exchanges that can be housed in multiple distributed ledgers contemporaneously; and the ability to integrate enforceable rules as part of conditional exchanges of value. Blockchains could also create network and platform benefits if applied across multiple conditional payment environments.

3.3 How do blockchains work?

Blockchains came to prominence with the digital currency Bitcoin, but are now being implemented in many other platforms, and used for many other purposes.[39] Just like a traditional database, a blockchain can in principle be used to represent transactions or information in any kind of organisation in industry or society. Nonetheless, blockchains are different from traditional databases in important ways, and the full range of technical, organisational, and societal implications are still being explored.

[39] Nakamoto S (2008), Bitcoin: A peer-to-peer electronic cash system. Available at: https://bitcoin.org/bitcoin.pdf

The transactions stored on a blockchain can be more than simple records of the exchange of assets – some blockchain systems also allow computer programs to execute and be stored as part of transactions on the ledger. These are often called 'smart contracts', although the programs are typically not very 'smart', and are sometimes not used to execute or monitor legal contracts. As a result, blockchains can be more than a simple distributed database – they can be general computational platforms for relatively simple computational requirements. This capability significantly expands the power of blockchain systems, and increases their range of use and potential for innovation.

These smart contracts can encapsulate a business process logic and rules, such as those required for conditional payments. Blockchain provides an immutable record of payments which is accessible to nodes jointly operating the platform. This could provide a clear source of truth in conditional payment environments. This could also potentially lead to reduced transaction costs and the detection and prevention of fraud.

3.4 Why did we use a private permissioned blockchain?

There are different configurations of blockchain: public (or permissionless), and private (or permissioned). In a public blockchain there is no restriction on joining the network and performing actions, such as transferring funds by running a processing node. The records on this kind of blockchain are publicly accessible. In a private (or consortium) blockchain, participants must be invited (allowed) to join the network by an authority, and are assigned certain permissions to perform specific actions. The data on this kind of blockchain are only accessible by privileged participants. Some forms of quasi-blockchain platforms do not have a single global ledger, but instead share ledgers only among parties of interest to each transaction. This can better support confidentiality or privacy, but makes it harder to support integrity for ownership of digital assets.

Private and public blockchains have very different trust models: in a public blockchain, participants do not know and trust each other whereas in a private blockchain, participants are authenticated and contractually bound. This leads to different trade-offs in the design of blockchain-based systems, as explored in a recent research study.[40] Public blockchains can be more resilient in hostile environments. However, private blockchains are generally more cost-efficient and higher performing than public blockchains, and have more opportunities for implementing access controls mechanisms for confidentiality.

A private blockchain is a reasonable platform for our proof of concept for the NDIS context. The NDIS operates in a higher trust environment when compared with environments where public ledgers are used, due to the level of regulation present in the NDIS. The Government is responsible for implementing the NDIS and funding payments. NDIS participants are assessed before receiving a plan, and most, if not all, major service providers have already registered their details with the NDIA. This high level of trust can enable the efficiency and performance benefits that can result from private blockchains.

[40] Xu X, Weber I, Staples M, Zhu L, Bosch J, Bass L, Pautasso C and Rimba P (2017), A Taxonomy of Blockchain-Based Systems for Architecture Design. In: IEEE International Conference on Software Architecture.

4 User stories and design criteria for proof of concept

This section outlines the user stories and design criteria that have framed the design and evaluation of the proof of concept.

4.1 User stories for proof of concept

User stories aid the design process by requiring design teams to focus their efforts on meeting high-priority user needs. They assist design teams to operate in an agile fashion and ensure the products and/or experiences they design and build deliver the most value possible, given time and budget constraints.

The challenge for this project was in selecting the right user stories, as no two participants share the same story. Each participant has a unique combination of goals, objectives, life circumstances, type/s of disability, functioning capacity and preferences. Similarly, each service provider has different user requirements.

To address this challenge, the project team consulted closely with NDIS participants, carers, family members, service providers and the Project Reference Group to understand a broad range of user requirements and then to prioritise the requirements for the proof of concept. The user stories we prioritised focused on some of the biggest challenges for participants, service providers and government – as well as the best test cases for the smart money proof of concept.

We developed a participant persona, Fahima Smith, to represent a range of user requirements, including a blend of financial plan management approaches (see Appendix A.6). We created user stories for service providers, including plan managers and eMarkets, and government agencies, including the NDIA, the NDIS Quality and Safeguards Commission and policy departments.

We focused the working prototype on the participant user experience, while ensuring we built realistic static user interfaces and conducted rigorous conceptual analysis for other stories to test the broader proof of concept. The details of the user stories and design approaches we used are outlined in the three tables below.

Table 4: User stories for participant persona, Fahima Smith

USER STORY	WORKING PROTOTYPE	STATIC INTERFACE	CONCEPT ANALYSIS
1. Create user login for participant app & securely login	✓		
2. View participant plan details in app	✓		
3. View and rate progress against plan goals	✓		
4. Check budget balances & review past services access	✓		
5. Book ongoing service from open market	✓		

USER STORY	WORKING PROTOTYPE	STATIC INTERFACE	CONCEPT ANALYSIS
6. Book ongoing service from NDIA provider panel	✓		
7. Confirm requests for complex ongoing bookings		✓	
8. Authorise payment for one-off, in-person purchase	✓		
9. Create and edit plan management nominations		✓	
10. Have nominee pay for a service and review details	✓		
11. View service agreements	✓		
12. Edit service agreements		✓	
13. Rate service providers	✓		
14. View upcoming appointments	✓		

Table 5: User stories for service providers, including Plan Managers and eMarkets

USER STORY	WORKING PROTOTYPE	STATIC INTERFACE	CONCEPT ANALYSIS
15. Register services to receive bookings and payments			✓
16. Confirm eligibility at the time of booking/payment	✓		
17. Receive blockchain tokens for services	✓		
18. Cash in tokens for New Payments Platform payment			✓
19. Send payment requests for one-off purchases	✓		
20. Send booking requests for ongoing services			✓
21. Access data analytics to improve performance		✓	
22. Perform Plan Management functions			✓
23. Integrate eMarket systems for bookings & payments			✓

Table 6: User stories for government agencies

USER STORY	WORKING PROTOTYPE	STATIC INTERFACE	CONCEPT ANALYSIS
24. Convert participant plans into smart tokens	✓		
25. Ensure participant bookings & payments are eligible	✓		
26. Pay service providers when they cash in tokens			✓
27. Reflects updates to participant plans in blockchain			✓
28. Perform Agency Management functions			✓
29. Access data analytics to support: • plan development and oversight • market custodianship • regulation of quality and safeguards		✓	

USER STORY	WORKING PROTOTYPE	STATIC INTERFACE	CONCEPT ANALYSIS
• macro budget planning for the NDIS • policy analysis and development			

4.2 Design criteria for proof of concept

We developed a broad range of design criteria to design, build and test the proof of concept. The criteria emphasise choice and control, the two key aims of the NDIS[41], and include a range of usability requirements and system considerations (see Table 7 below).

Table 7: Design criteria for proof of concept

CRITERIA	THE PROOF OF CONCEPT:
1. Choice	Maximises the potential of participants to make informed decisions about the services they access
2. Control	Maximises the potential of participants to take control of their plans and delegate control as they choose
3. Accessibility	Is accessible to all participants regardless of their disability and all service providers, including plan managers and eMarkets
4. Simplicity	Makes payments simple for participants, carers, plan managers, service providers and government
5. Efficiency	Reduces administration time and costs for participants, plan managers, service providers and government
6. Confidentiality	Ensures the confidentiality of personal and commercially sensitive information
7. Integrity	Ensures funds are spent as intended and enables government to identify any potential instances of misspending
8. Performance	Achieves low latency, sufficient throughput and real-time payments
9. Cost	Can be implemented and maintained at low cost
10. Modifiability	Can accommodate changes in policy settings and be applied across a range of conditional payment environments

[41] NDIS (2018), NDIS Overview. Available at: https://www.ndis.gov.au/operational-guideline/overview

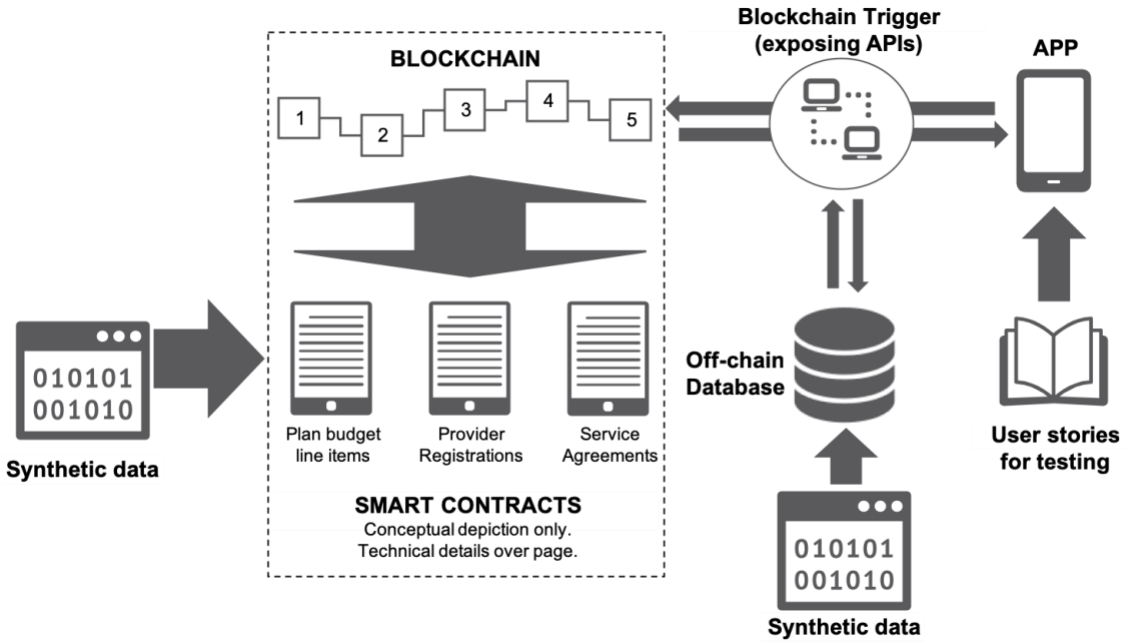
5 Design of proof of concept

5.1 Overview of proof of concept design

As shown in Figure 11 there are several components for the working prototype:

- **Participant application** – a mobile app that enables participants to: review their NDIS plan, budget balances, service agreements, previous payments and nominees; and make bookings and payments in a range of contexts.
- **Blockchain trigger** – a component that intermediates the communication between the mobile app and the blockchain smart contracts. This component also interacts with data stored off-chain, e.g. in a traditional database. The kind of data to be stored off-chain are explained in Section 5.3.3. This component exposes an Application Programming Interface (API) for communication with the participant mobile app.
- **Blockchain and smart contracts** – these create the conditions for payments and record payments, and are discussed in detail in Section 5.3.

Figure 11: Components of Proof of Concept



5.2 User interface design

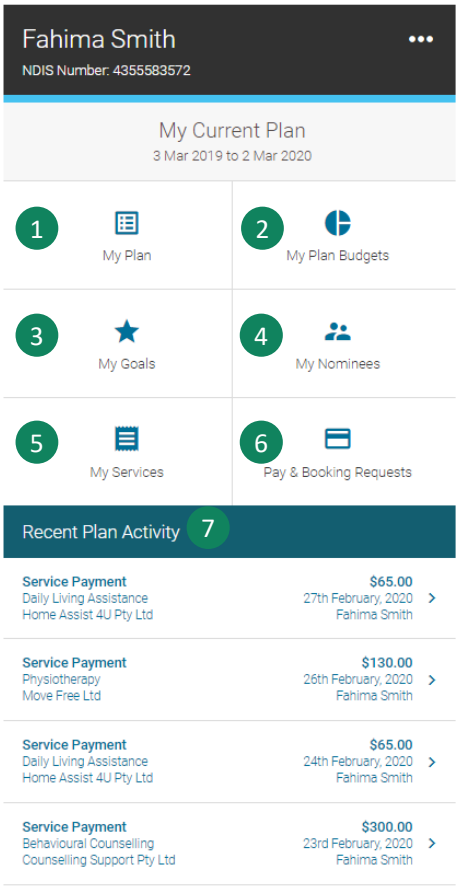
The user interface is an app that runs on a participant's smart phone. We designed the user interface to support the user stories (see Section 4.1). The design of the user interface is inspired

by the designs of the existing NDIS myplace participant portal and CommBank app, and leverages the Australian Government Design System.[42,43,44]

The user interface centres on seven key functions, which are available from the home screen:

1. **View participant plan**, based on current information fields in participant plans currently provided to participants.[45]
2. **View plan budgets**, including starting budget, amount spent, amount committed to future booked services, amount available for new bookings and purchases and most recent services accessed from each budget.
3. **View plan goals** and self-assess progress against plan goals.
4. **Manage nominees**, including view, create and edit spending delegations (e.g. carer, family member, private plan manager, etc).
5. **Manage services**, including book new services (including viewing budget implications before confirming bookings) and view service details, including agreements, upcoming appointments and previous services accessed.
6. **View and action requests** for payment (for in-person purchases) and bookings (for bookings arranged outside interface).
7. **View most recent plan activity** to ensure payments are accurate and authorised.

Figure 12: App home page



The user interface also enables users to register the app and login to the app. The user interface focuses on plan financial management functions and so does not include some of the functions available in the myplace portal, such as My Messages, Events and myGov Inbox. We designed the proof of concept so that, if it was scaled, the plan financial management functions could be integrated within the myplace portal and other existing plan management systems.

[42] National Disability Insurance Scheme (2018), NDIS myplace participant portal, Step-by-step guide. Available at: https://www.ndis.gov.au/medias/documents/myplace-participant-steps-pdf/Participant-Portal-Step-by-Step-Guide.pdf

[43]Commonwealth Bank of Australia (2018), The CommBank app. Available at: https://www.commbank.com.au/digital-banking/commbank-app.html

[44] Australian Government (2018), Design System. Available at: https://designsystem.gov.au/

[45] For example NDIS plans, see: Summer Foundation (2018), Sample NDIS Plans. Available at: https://www.summerfoundation.org.au/resources/sample-ndis-plans/

5.3 Design of blockchain tokens and policy contracts

5.3.1 Blockchain architecture

Figure 13 Overview of Making Money Smart Blockchain Architecture

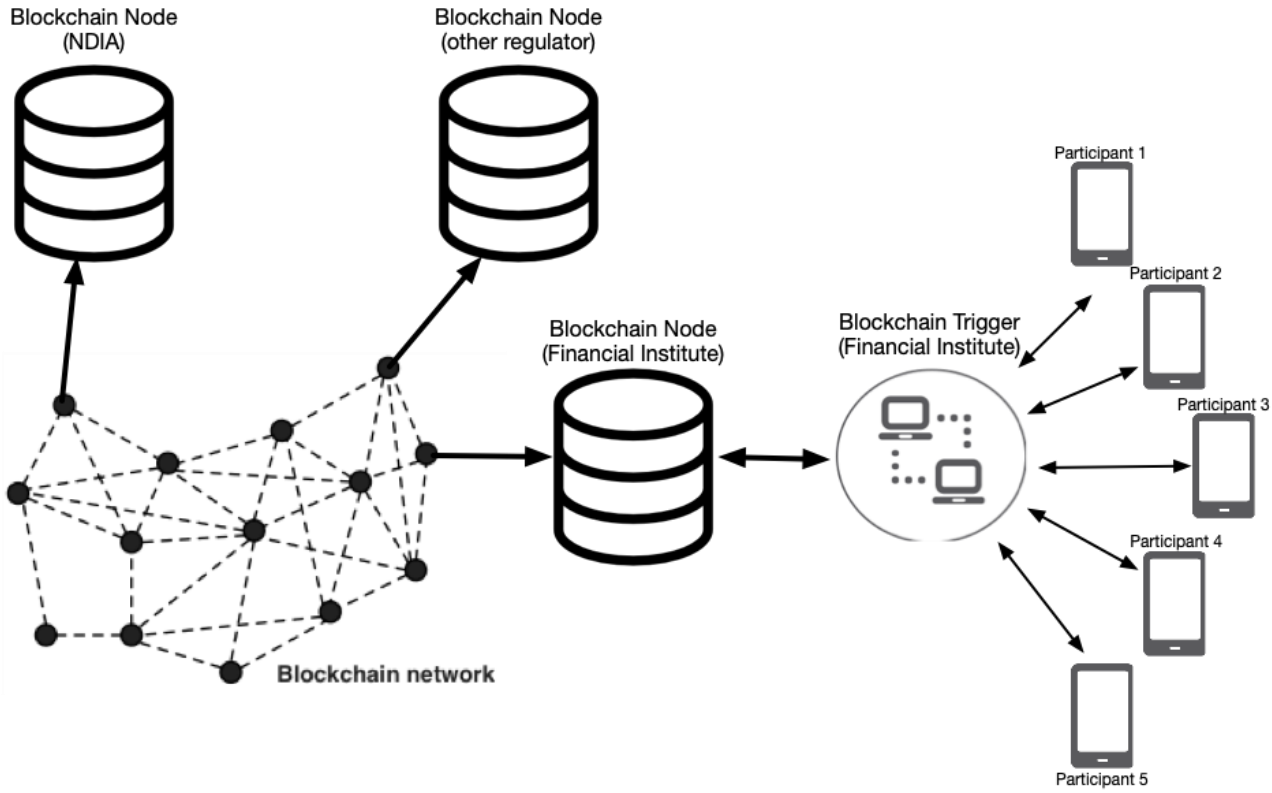


Figure 13 shows the overall blockchain architecture. It uses a private blockchain with three nodes, although for the prototype implementation all nodes operate on a single cloud infrastructure. A blockchain trigger (a component which interacts with the blockchain) exposes REST[46] Application Programming Interfaces (APIs) for interaction with the mobile application that the NDIS user will use as the main device to interact with Making Money Smart. Representational State Transfer (REST) is an architectural style for distributed hypermedia systems and is used by modern web services, such as Google, Facebook, Netflix. The blockchain trigger is hosted by an app service provider. For this proof of concept project, the three nodes represent the NDIA, a financial institution, and a regulator observing transactions. The financial institution here acts as app servicer provider and also payments provider, but these roles could be separated. If additional financial institutions or funding agencies were added, significant architectural changes would be required to more adequately target confidentiality or privacy requirements, but that is not the focus of this research project.

5.3.2 Attaching policy contracts to tokens

Each token represents an amount of funds that the Government promises to pay for NDIS purchases, denominated in Australian dollars. All existing tokens are grouped into pouches, each

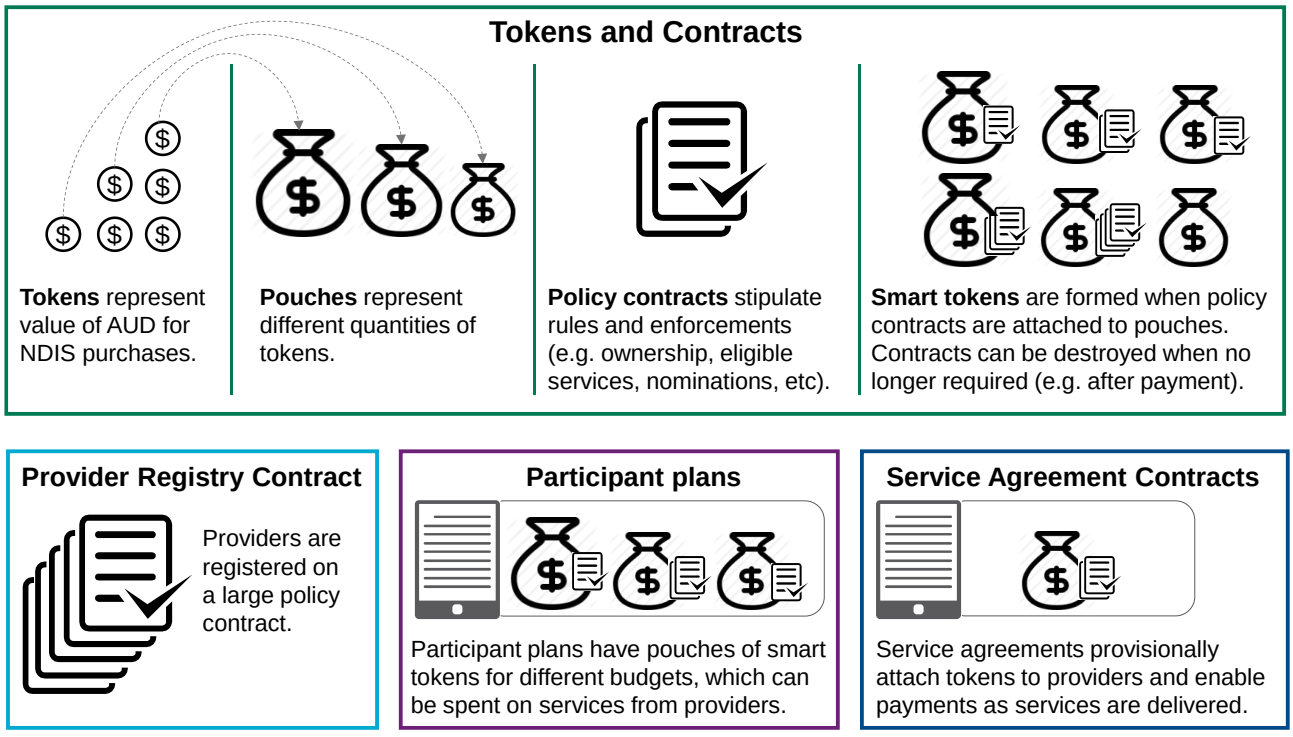
[46] Fielding R (2000), Architectural Styles and the Design of Network-based Software Architectures.

of which can hold different quantities of tokens and has one or more policy contracts attached to it. A policy contract stipulates the rules for usage of the tokens and their usage enforcements. Smart tokens are formed when a policy contract is attached to a pouch of tokens. The usage of a token within a pouch must satisfy all the rules of the attached policy contracts.

Figure 14 shows the overall design of the smart contracts for the smart money proof of concept. An NDIS plan for a participant is represented as a collection of smart tokens, i.e. multiple pouches with different policy contracts attached to them. The registered NDIS providers are added to the provider registry contract. This contract is a data registry that records providers and their respective attributes, including the services that they provide. Finally, we have a Smart Money Contract, which encapsulates the process logic of the smart money proof of concept.

A policy contract can be dynamically attached to or removed from a pouch of tokens as the policy contract interface is designed to be generic. This allows for conditions to adapt to changes in the policies governing the tokens. For bookings and payments, a stricter enforcement approach is applied, whereby the proof of concept requires that all the rules are satisfied beforehand.

Figure 14: Smart contract design for proof of concept



There are three different activities that we support: transfer token (i.e. make a payment), make service agreement (i.e. make on booking for ongoing services) and nominate a nominee to spend on participant's behalf. To illustrate the functionality of each contracts and their interactions, a sample scenario will be used. An NDIS participant, Alice, would like to pay service provider, Bob, 100 tokens to repair her power scooter. The Smart Money Contract will first check whether there is sufficient balance in that pouch and then perform the following checks for each policy contracts that are attached to that pouch:

1) Confirm that Bob is a registered NDIS provider.

   The smart money contract will trigger a function that is provided by the provider registry contract to confirm that Bob is a registered provider.

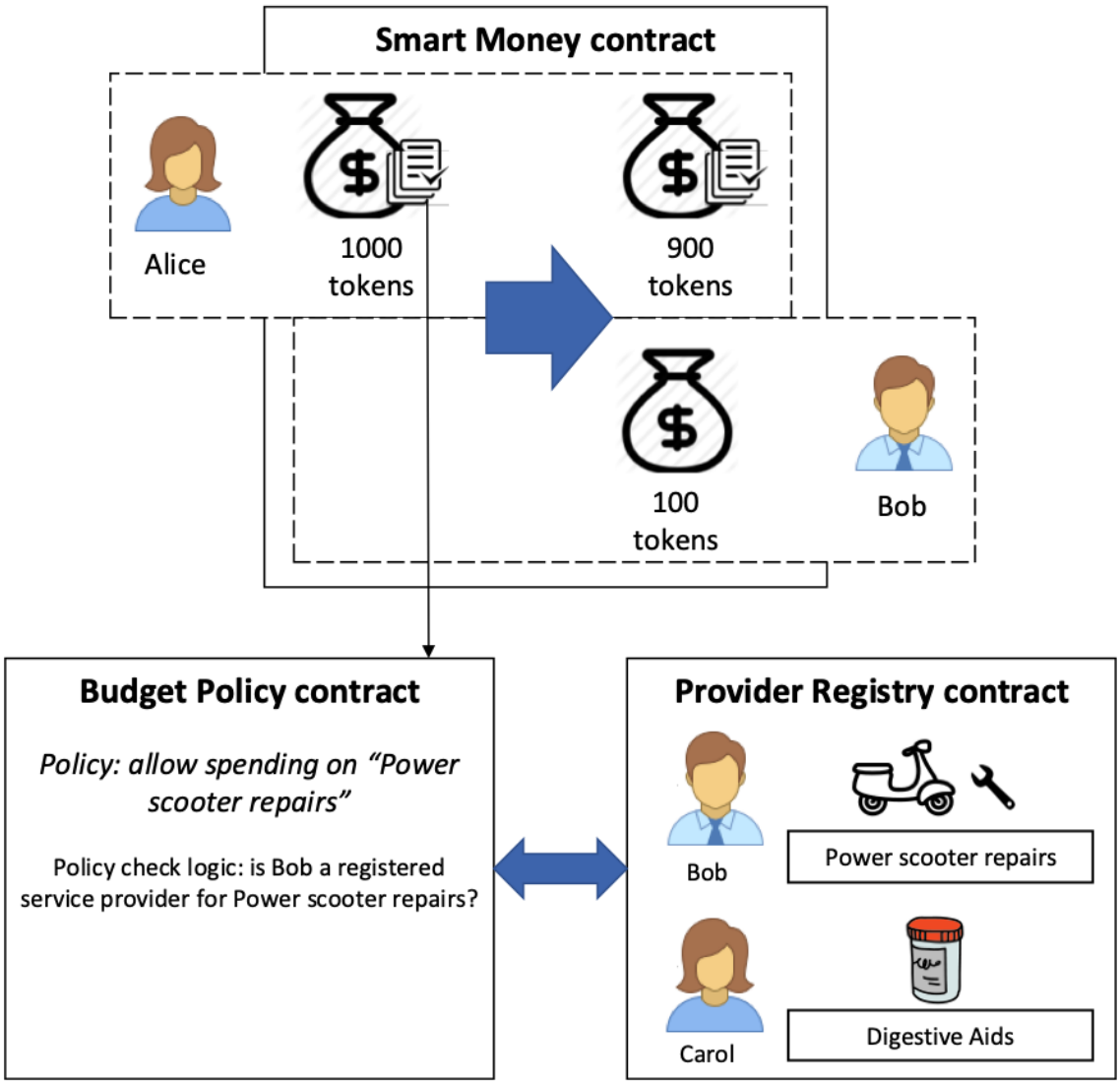
2) Confirm that Bob is registered to provide that service.

   The smart money contract will trigger a function that is provided by the provider registry contract to confirm that Bob is registered to provide that service.

3) Confirm that all the rules in the policy contract are satisfied.

   The smart money contract will trigger a function that is provided by each of the policy contracts, which will confirm that Alice is eligible to access that service.

Figure 15 Interactions between contracts



If all the checks are confirmed and Alice is allowed to make the payment, a new pouch containing 100 token will be created for Bob with no policy contract attached to it.

A service agreement for ongoing services is implemented by creating a new pouch with the total agreed payment (say 300 tokens) and an additional new policy contract attached, which states that the tokens can only be spent on a particular provider. This will reduce the original pouch of token by 300 tokens and the new pouch will have 300 tokens.

Alice can also nominate her mother, Carol, to spend her smart tokens on her behalf. In the current working prototype, nominations are recorded and monitored by the Smart Money Contract on a

per-account basis. This allows Carol to spend all of Alice's smart tokens. An alternative design that we have explored is to allow Alice to nominate Carol to spend only specific smart tokens of hers.

5.3.3 Off-chain data

Data stored on the blockchain are accessible to all processing nodes and are stored in perpetuity. As a result, it is preferable to store sensitive data, such as personal information, outside of the blockchain on secure servers. Our proof-of-concept stores the following data off-chain:

- the participant's personal information relating to their NDIS plan, including information about the people who support them, their daily life and their goals
- the mapping from the NDIS participant's name to his/her Ethereum address. Their details, such as NDIS participant number is also kept off-chain
- the booking details for a service agreement, such as date, time and length. The agreement between an NDIS participant and an NDIS provider is stored on the blockchain, as a service agreement policy contract
- ad-hoc payment requests and actions taken. These are one-off payment requests that are not related to a particular service agreement or budget policy contract. We also record whether request has been accepted or declined.

5.4 Potential for integration with the New Payments Platform

While payment could occur through a number of means, including conventional bank account transfers, the project focused on potential integration with New Payments Platform (NPP) payments, due to the benefits the NPP can provide, including enabling individuals, businesses and government agencies to make simple, near real-time payments, 24 hours a day, seven days a week, and with substantially more messaging information than existing payment arrangements.[47]

The NPP integrations for the proof of concept were not built as part of the working prototype; rather they were considered through conceptual analysis using an Application Programming Interface (API) Sandbox toolkit. This analysis confirmed that the blockchain system could collect the data necessary to enable NPP payments and for relevant integrations with the NPP to be built.

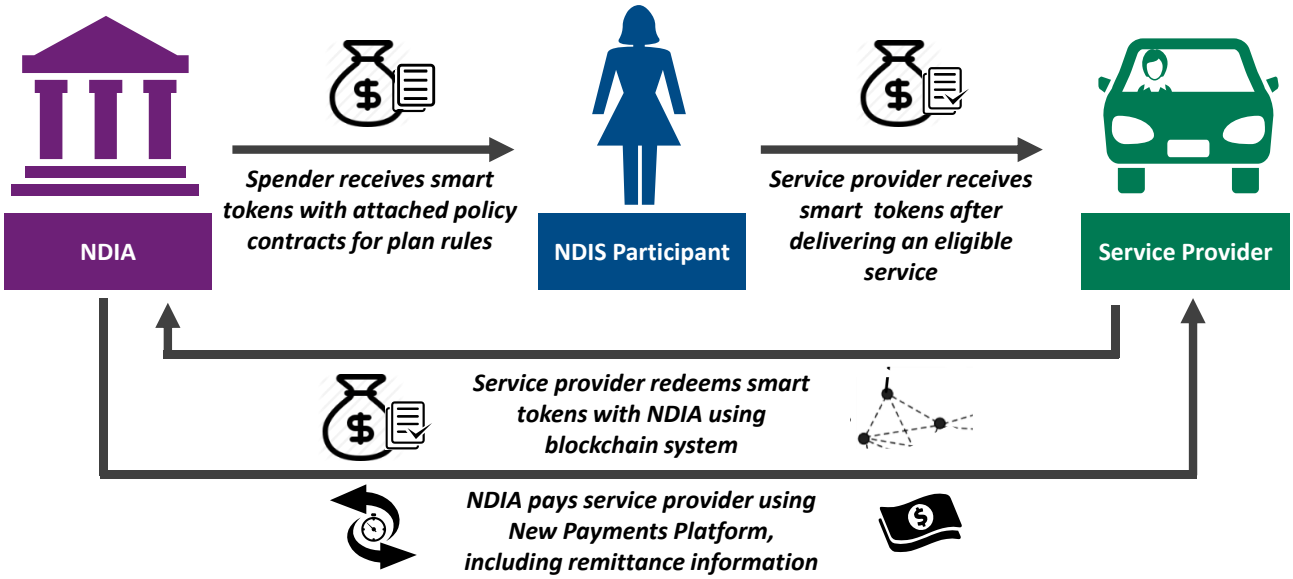
The steps to enable payments are as follows and visualised in Figure 16 further below:

1. **The service provider receives blockchain tokens in real-time in exchange for delivering an eligible service.** The blockchain system records details from the value exchange, including the service delivered, price of service, participant served, time of service and who authorised the booking/payment.
2. **The service provider transfers their tokens to the NDIA to request payment.** The service provider could choose to automate this process for each service it delivers or in batches at the end of set time periods, such as each hour or each day.

[47] Reserve Bank of Australia (2018), New Payments Platform. Available at: https://www.rba.gov.au/payments-and-infrastructure/new-payments-platform/

3. **The NDIA receives the blockchain tokens and automatically confirms the details** of the payment request using the data contained within the blockchain tokens.
4. **The NDIA could then automatically pay the service provider within seconds with remittance information included** using the NPP overlay service known as Osko by BPAY.[48,49] The payment could be made to the service provider's bank account using the provider's pre-registered BSB and Account Number or PayID (such as a mobile phone number, email address, business name or Australian Business Number). In the short term, the remittance notice could be contained within a 35 character transaction reference field to record the invoice number and a 280 character free-text field to record the transaction details. Later iterations of the Osko service would enable the remittance notice to be upgraded to a machine readable PDF, which could be accessed via a hyperlink to a certified document host.
5. **The service provider could automatically reconcile the payment** using an Application Programming Interface (API) to integrate the remittance information from the NPP payment with their IT systems. Both versions of remittance information could be integrated with IT systems, though the linked PDF version could be more accessible for people to manually review details where required.

Figure 16: Exchange of tokens for New Payments Platform payments



5.5 Data analytics capabilities

The smart money proof of concept could improve the collection and use of NDIS data. The data benefits would include:

1. **Comprehensive coverage** of plan activities, regardless of plan management approach

[48] New Payments Platform Australia (2018), How it works. Available at: https://www.nppa.com.au/the-platform/how-it-works/

[49] BPAY (2018), Osko by BPAY: A new way for Australians to pay. Available at: https://www.bpay.com.au/Member-Financial-Institutions/Osko-by-BPAY.aspx

2. **Confidentiality controls** to limit access to personal and commercially sensitive information
3. **Real-time** collection and access to data
4. **Accurate data** through an immutable source of truth
5. **Additional data fields**, including budget amounts committed to future booked services, self-assessments against plan goals and participant satisfaction ratings of service providers.

The data could assist government agencies and policy departments with the following functions:

- Participant plan development and management/oversight
- Market custodianship
- Regulation of quality and safeguards
- Budget planning for the NDIS
- Policy analysis, development, review and improvement
- Government and service providers, including access controls for different users.

The data could assist service providers to understand:

- participant demographics, goals and disabilities
- participant satisfaction ratings and self-assessed progress against goals
- past, booked and forecast revenue
- market position, including in relation to service prices and share of participant plans
- unmet customer needs by geography, service and support requirements.

A companion document to this report, titled *Making Money Smart: Indicative data analytics that could be supported by the smart money proof of concept*, provides examples of data analytics to achieve the above benefits using the data that could be captured by the proof of concept.[50]

5.6 Additional features for consideration

The following features were considered but not built during the project. We expect that future iterations of the smart money proof of concept could support these additional features.

Enabling participants to combine their private funds with NDIS funds for payments

The technology could allow participants to use their private funds for disability support payments. This may be useful when: a transaction involves some items that are eligible and others that are ineligible under the participant's plan rules; the participant's plan has insufficient funds for the transaction; or if a participant wishes to boost their level of disability supports across their plan timeframe. To enable this, the blockchain system could enable participants to convert their private bank funds into tokens (either in advance or during the time of purchase). Policies attached to the

[50] Royal D, Lim N, Staples M, Rimba P and Gilder S (2018), Making Money Smart: Indicative data analytics that could be supported by the smart money proof of concept, Companion document to the Making Money Smart report, Data61 (CSIRO).

tokens could designate that they are sourced from the participant's private funds and deliver greater flexibility than other tokens in the participant's plan.

Decision-making aides to support self-management

Some participants are currently not allowed to self-manage their plans due to decision-making disabilities. In these cases, the conditions in the blockchain tokens could be adjusted to support aspects of self-management and enable greater choice and control. For example, conditions could be set to: provide greater specificity on the services a participant can choose from; safeguards on how quickly tokens could be used to ensure supports are accessible across the plan timeframe; and third party approvals for larger purchases, to enable confirmation that the participant understands the implications of the booking or transaction. Such conditions could be relaxed as a participant becomes more familiar with managing their NDIS plans. As per our design criteria, any implementation of additional conditions should be focused on maximising the degree of choice and control available to participants.

Graduated registration processes for service providers

Feedback from specialist disability service providers suggests that they would highly value the benefits that the smart money proof of concept could deliver, and would therefore be willing to proactively register their service details in the blockchain system. However, general providers of services, such as home cleaning business, may have lower incentives to pre-register, as only a small proportion of their income may derive from the NDIS.

To overcome this issue, it may be possible to establish a graduated registration process, whereby for small transactions, service providers and/or participants could register the service in the moment, by manually entering the details and providing the service provider's bank account information. As service providers generate more revenue from the NDIS, or experience repeat custom from NDIS participants, they could then be required to more formally register their services.

Automation of the Goods and Services Tax (GST)

GST automation can potentially be supported by defining a policy contract to represent the GST regulation. In our proof of concept, we define a common set of interfaces for the policy contracts which can be attached to the tokens. This allows for flexibility in implementing the specific policy contract logic for different types of policies to the developer, as long as it follows the pre-defined contract interface. Thus, a simple example of GST automation could be implemented as a new type of policy contract that would be attached to all tokens owned by participants. Whenever a token transfer was made, this policy logic could calculate the GST applicable from the transaction value (which includes GST) as well as the type of service or product being purchased. It could then automatically deduct part of the tokens and transfer those to a pre-defined account belonging to the taxation agency. Finally, the remaining tokens could be transferred to the intended recipient after the GST policy contract logic was executed.

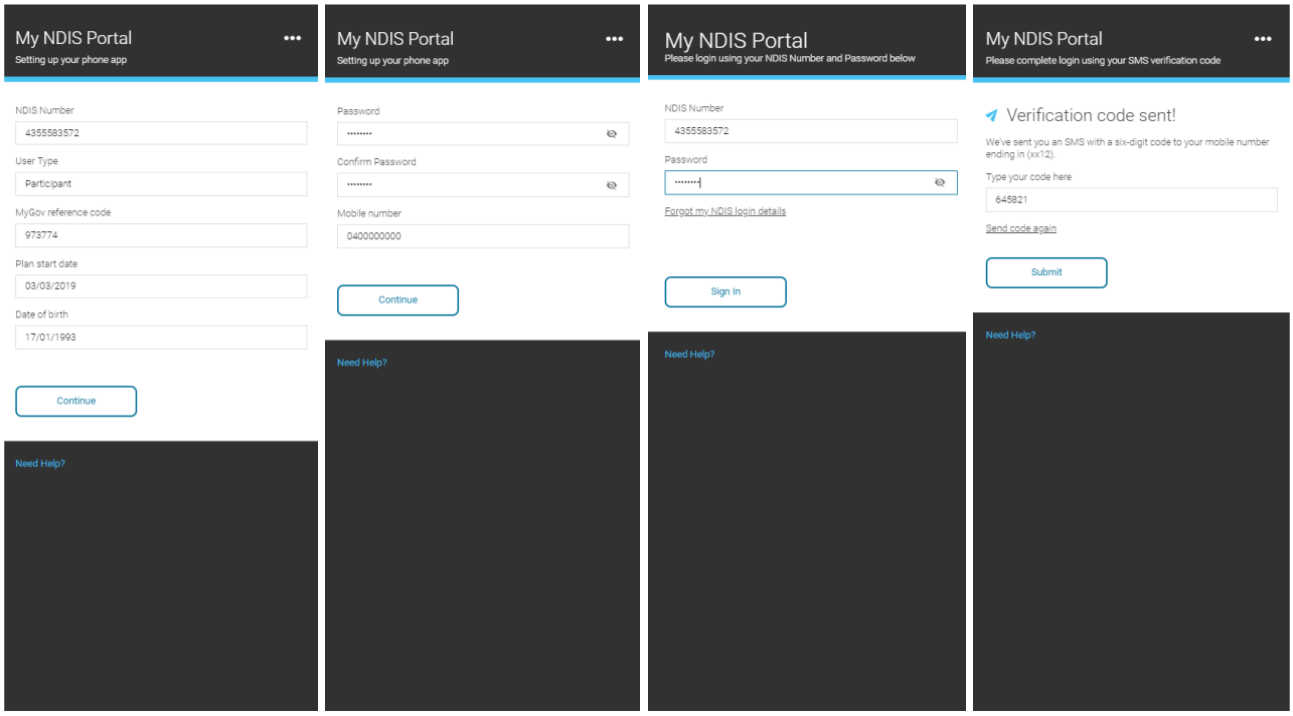
6 Operation of proof of concept

This section describes how the proof of concept enables the user stories outlined in Section 4.1 of this report, which centre on the needs of participant persona, Fahima Smith.

6.1 Create user login for participant app and securely login

The project has considered how Fahima could create her user login and then securely log in using the participant app (User Story 1). The example process is indicative and would be subject to government and stakeholder views (see Figure 17).

Figure 17: Pages for creating user login and securely login

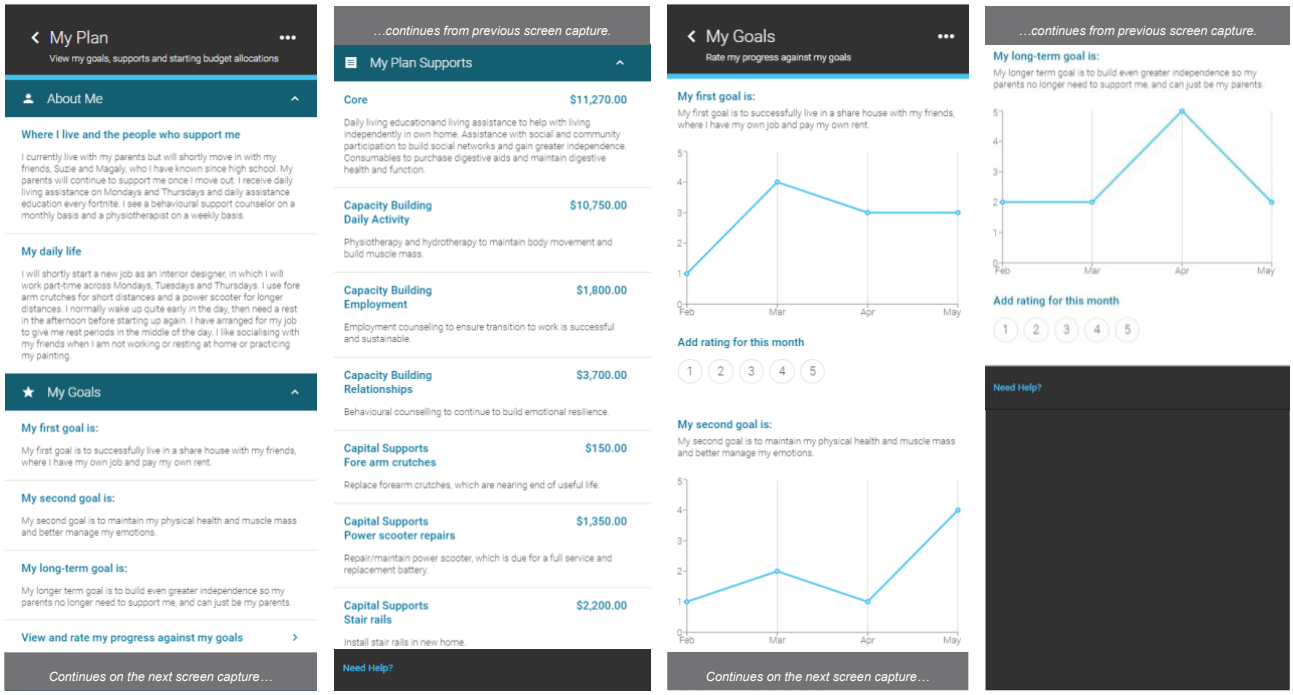


The example process for creating the user login requires Fahima's NDIS number, user type (e.g. participant), MyGov reference code, plan start date and Fahima's date of birth. The example login process requires Fahima's NDIS number (which the app is set up to remember for Fahima), a password that Fahima creates and secondary verification through six-digit code sent by SMS to Fahima's smart phone. The login process would grant Fahima access to the app, which automatically stores the blockchain private key for each of Fahima's plan budgets.

6.2 View plan and rate progress against goals

After logging in, Fahima can view her plan details by selecting "My Plan" from the home page (User Story 2). She can view all the information that is currently provided in participant plans, including information about her, her goals and the budgets for her plan supports (see Figure 18).

Figure 18: Pages for viewing plan and rating progress against goals

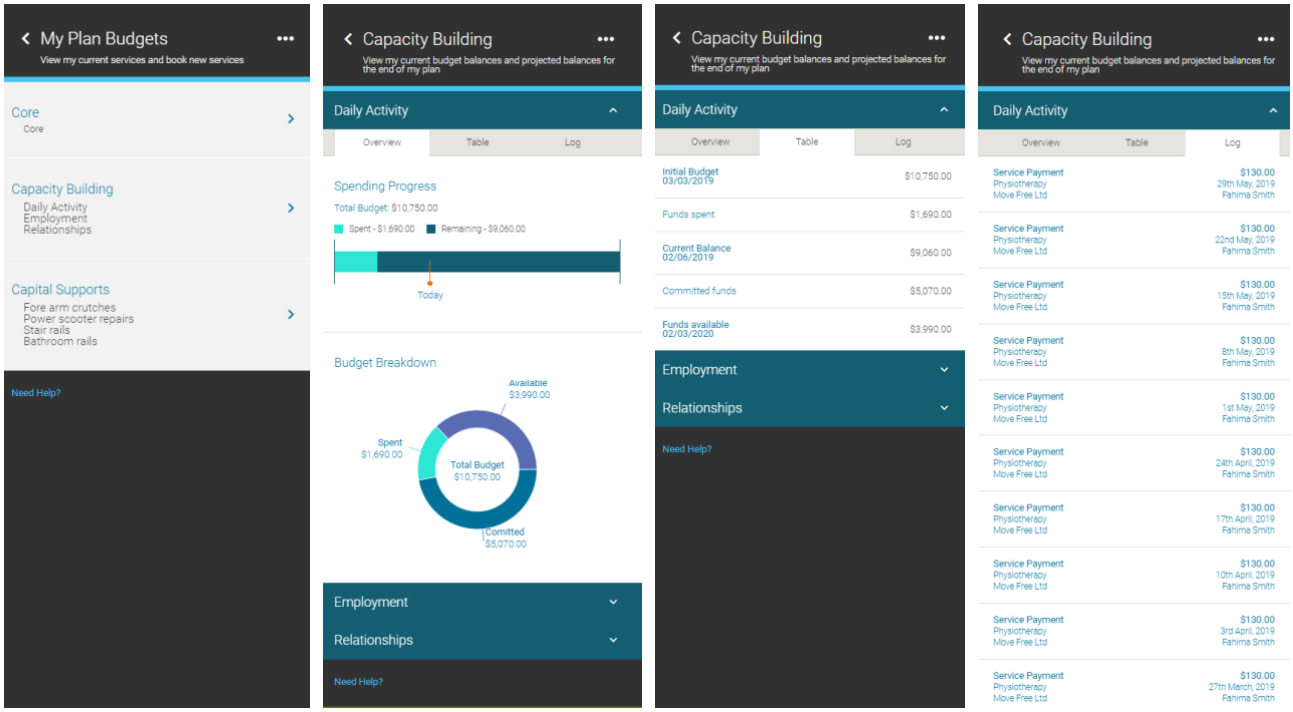


Fahima can also select to view her progress against her goals, and create new self-assessed ratings, which can be tracked over time (User Story 3). The ratings are enabled by the working prototype but do not require blockchain to operate.

6.3 Check budget balances and review past services accessed

To check budget balances and past services accessed (User Story 4), Fahima can select “My Plan Budgets” from the homepage of the prototype app and then see a summary of her budgets and budget categories (see Figure 19).

Figure 19: Pages for checking budget balances and past services accessed



Fahima can select her budgets and budget categories to see additional information, including: charts on her spending progress and funds available for new services; a summary table with the same information; and a service log for each service she has accessed from each budget category.

This information is sourced from the blockchain through APIs in real-time. The blockchain captures Fahima's plan budgets when her plan is first created, through tokens with policy contracts stipulating how she can spend the funds in each budget (User Story 24). The blockchain then records each service booking by attaching policy contracts to the relevant tokens to prevent those tokens from being used on other services. The blockchain records payments by transferring ownership of tokens from Fahima's private key to the relevant service provider's private key. By recording these outcomes, the proof of concept is able to source the relevant information to calculate Fahima's budget balances and record Fahima's past services accessed.

6.4 Make simple ongoing bookings

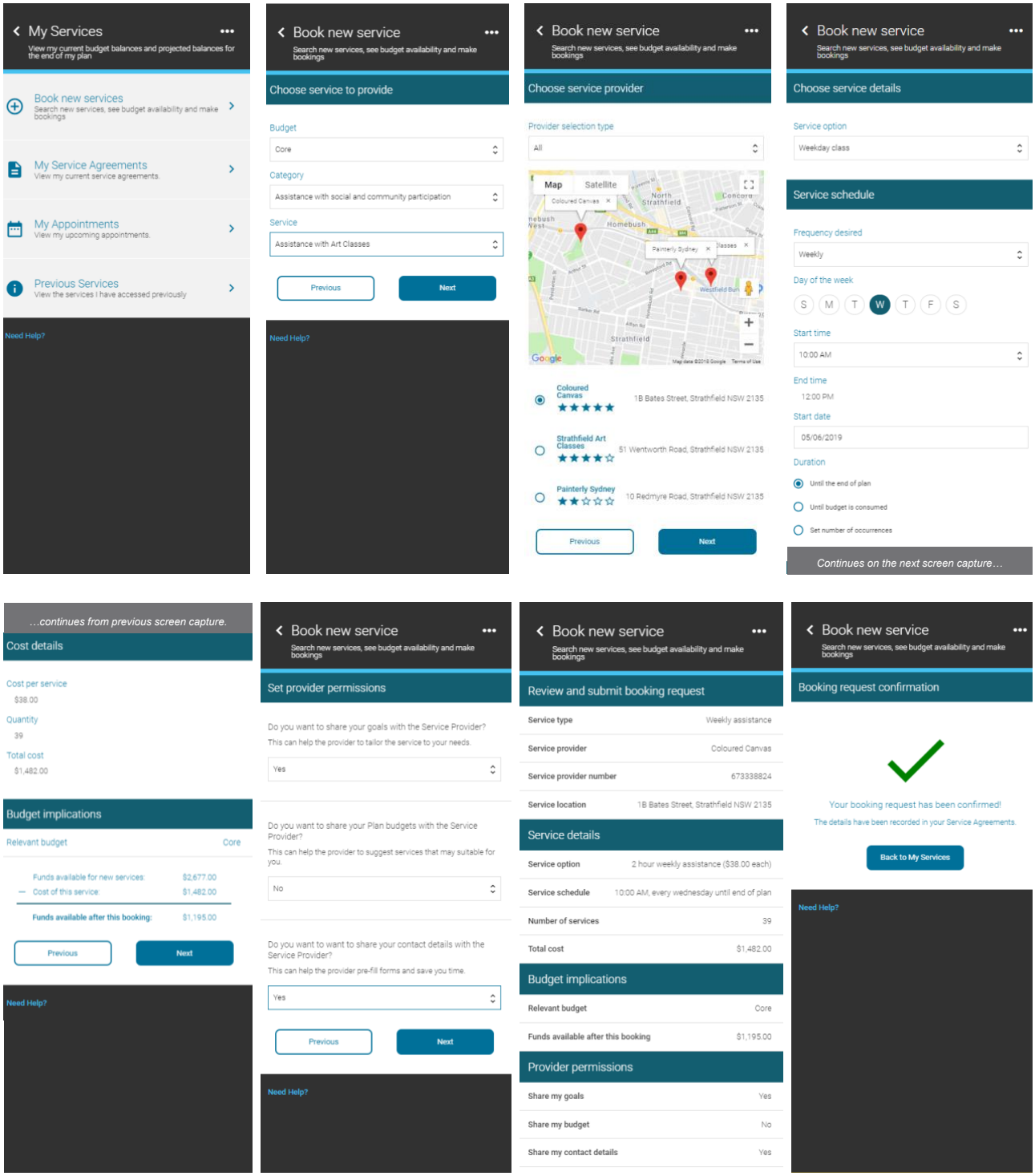
Making simple ongoing bookings relates to User Story 5 (booking ongoing service from open market) and User Story 6 (booking ongoing service from the NDIA provider panel, including the price caps that are currently only available to agency-managed participants).

To book an ongoing service, Fahima can select "My Services" from the homepage of the app, then "Book New Services" (see Figure 20). From this page, Fahima can select the budget type (e.g. Core), category (e.g. Assistance with Community Participation) and service she wishes to access (e.g. Assistance with Art Classes). The blockchain could prevent Fahima from searching services for which she is not eligible.

Fahima can then see a map of services in her area, which is sourced from data in the blockchain that the relevant service providers have pre-registered. Fahima can filter the search by all providers (relevant for User Story 5), providers on the NDIA Central Panel including price caps (relevant for User Story 6) or providers she has previously accessed. Fahima can also see star ratings for service providers recorded by other participants, which are stored in the back-end of the working prototype but do not require blockchain to function.

After selecting a provider, Fahima can choose what type of service she wants (e.g. weekday classes), how frequently she wants to access it (e.g. once weekly) and what day and time in each period she accesses it (e.g. every Wednesday at 10:00 am until the end of the plan). The app then sources service price information from the blockchain to calculate the price of the service booking and sources information from Fahima's budget to show how much funds are available for the booking and how much would remain available after the booking.

Figure 20: Pages for booking new ongoing service



Next, Fahima can choose how much data to share with the service provider (e.g. share her plan goals and contact information for pre-filling forms but not share her budget information) before confirming the service details. The app then refers to the blockchain to ensure the booking aligns with Fahima's plan details and budget availabilities (User Story 16 and User Story 25), before providing Fahima with a booking confirmation message. Once the booking is confirmed, the dynamic policy contracts attached to the relevant smart tokens are updated so that the tokens cannot be used for other services (User Story 27).

6.5 Confirm booking requests for more complex ongoing bookings

Not all service bookings are as straight forward as those outlined in User Story 5 and User Story 6. Service providers often tailor their services to participant needs and must ensure they have appropriate staff available at the right times. This can require telephone discussions, face-to-face consultations and online interactions via service provider websites, email and eMarkets.

The proof of concept could enable these more complex service bookings by enabling service providers (User Story 20) and eMarkets (User Story 23) to send booking requests to participant apps (User Story 7), once the details for the service booking are confirmed. The booking requests would operate in a similar way to payment requests (see Section 6.7 below), only the confirmation would set aside the tokens for the booked services rather than transfer the tokens immediately to the service provider as payment.

6.6 Pay for ongoing services as they are provided

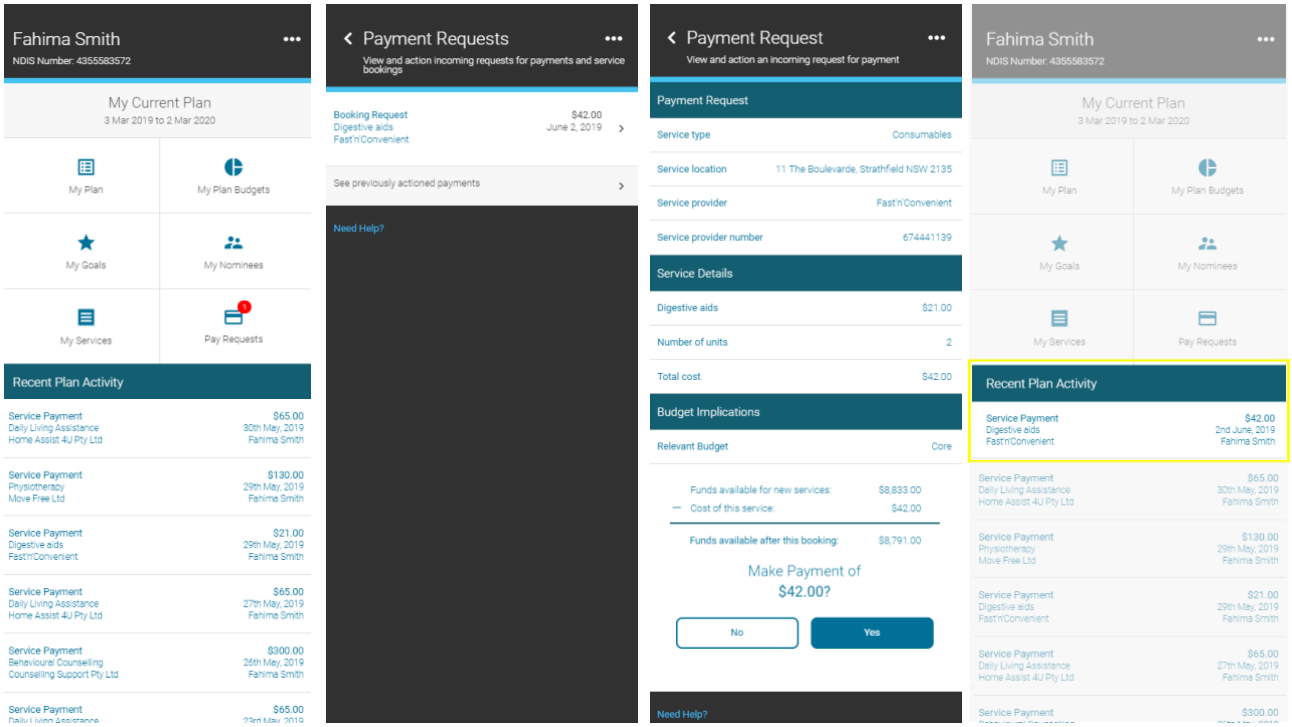
Once a service agreement is created, the relevant blockchain tokens in the participants' plan are set aside to pay for those services as the services are accessed. As each service is accessed, the tokens are transferred from the participant's private key to the service provider's private key on the blockchain. The working prototype automatically activates the transfer of tokens at the time each service is due to be provided; though the blockchain design could be set up to make the token transfer contingent on the participant and/or service provider confirming that the service has been delivered if this was preferred. Once the service provider receives the tokens, they could cash them in for payment on the NPP (User Story 18 and User Story 26) as outlined in Section 5.4.

6.7 Authorise payment requests for one-off, in-person payments

NDIS participants sometimes make one-off purchases for items like consumables, transport and capital supports. These payments are generally calculated by the service provider's point of sale system, rather than the online interactions assumed above. To enable in-person payments, the proof of concept has been designed so that the service provider could send a pay request to the participant after their point of sale system has calculated the service cost. The participant could then authorise the payment from their app (see Figure 21).

For User Story 8, the prototype assumes that Fahima has already provided her NDIS number to the store (either verbally or by scanning a QR code). The store then sends a pay request to Fahima's app using integrations that could be created in their point of sale system. Fahima then receives a notification in her home page, and is able to select "Pay Request" to view all pay requests and select the current pending payment request. She can review the details of the pay request, including the service provider details, line items of the invoice and budget implications for her plan. These data are sourced from the blockchain system.

Figure 21: Pages for authorising a payment request



Once Fahima confirms the payment, her tokens are transferred from her private key to the service provider's private key on the blockchain. Fahima receives a notification message to confirm the token transfer and she can view the payment details under "Recent Plan Activity" on the home page. Once the service provider receives the tokens, they could cash them in for payment on the NPP (User Story 18 and User Story 26) as outlined in Section 5.4.

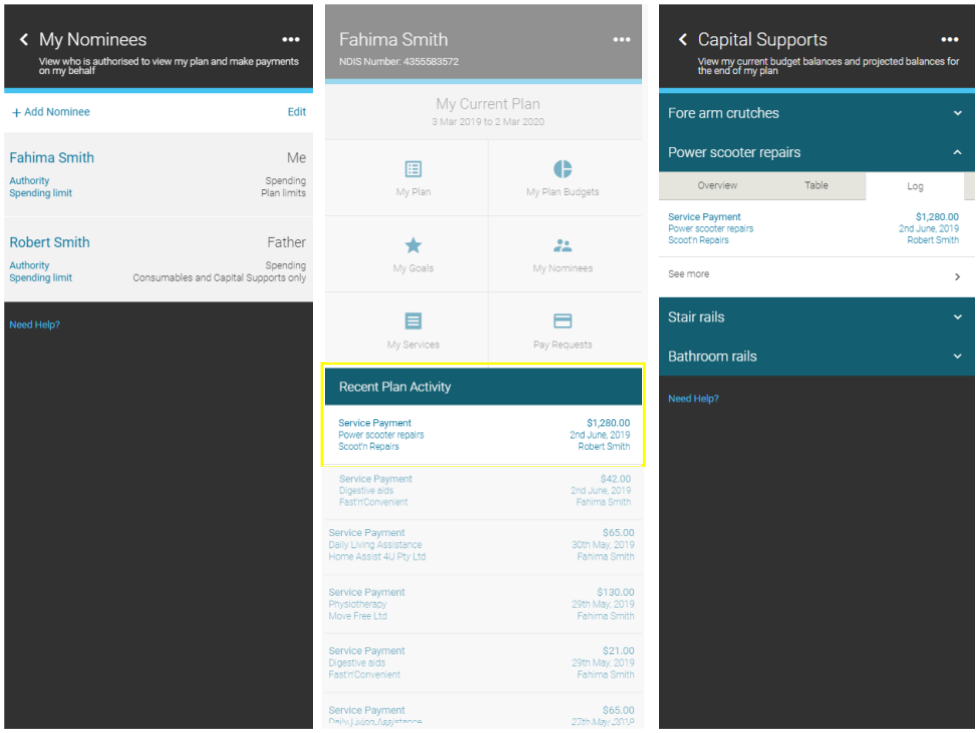
6.8 Have nominees pay for services

Depending on financial plan management approach and preferences, participants may require Agency Managers, Private Plan Managers, carers and/or family members to make payments on their behalf (User Story 9). The blockchain architecture has been designed to enable such nominations.

In User Story 10, Fahima's father, Robert, has taken Fahima's power scooter to the repair shop and wishes to authorise payment for the repairs (see Figure 22). Fahima first helps Robert to confirm that he is eligible to authorise the payment by selecting "My Nominees" from the home page and reviewing the details of her nominees. Her "My Nominees" page shows that Robert is eligible to make payments for Capital Supports. The information for this is sourced from the blockchain, and in particular policy contracts attached to Fahima's capital support tokens that stipulate that Robert is an authorised nominee. Fahima advises Robert that he is authorised to make the payment, which he does.[51]

[51] This is assumed to take place through a nominee app, which was not built as part of the proof of concept. During the user testing, the user tester facilitator activated the payments as though they were Robert using a hidden function in the participant app interface.

Figure 22: Pages for reviewing nominees and their plan activities



The blockchain records Robert's authorisation. Fahima can view the payment in her "Recent Plan Activity" or by selecting the capital supports services log from the "My Budgets" page.

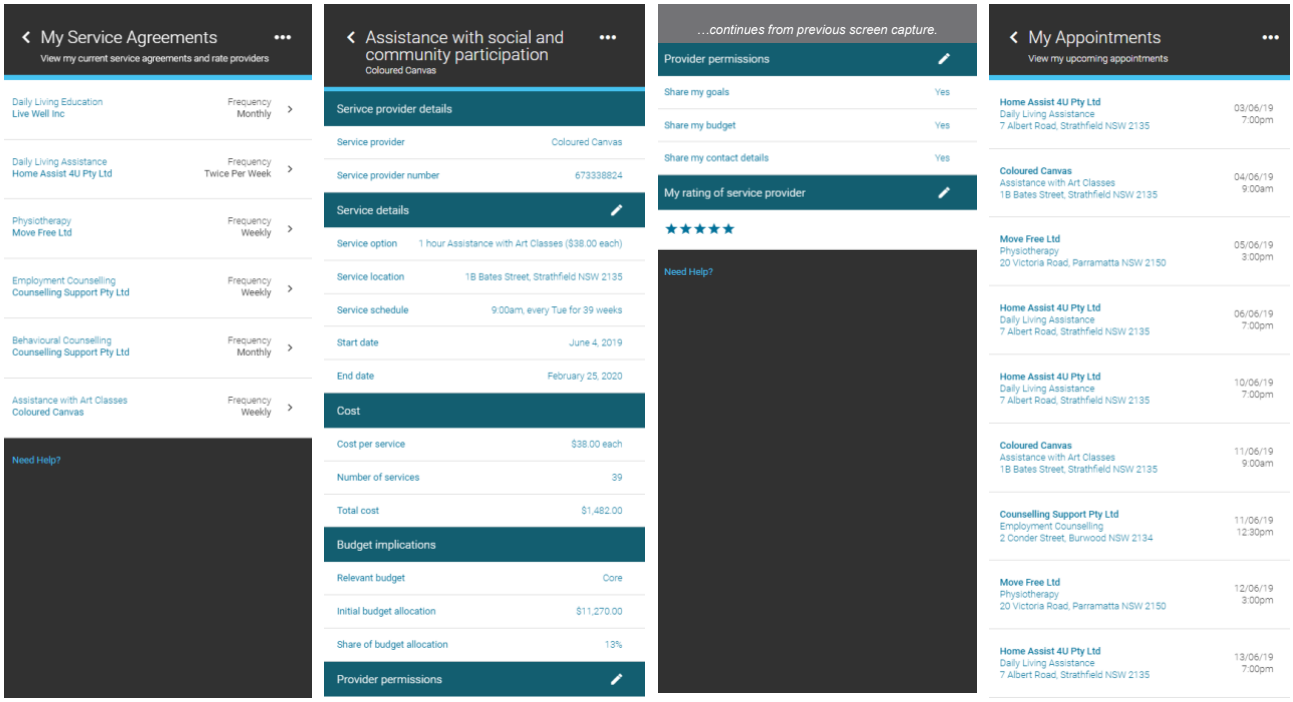
6.9 View service agreements and rate service providers

After Fahima makes bookings, she can view the service agreements (User Story 11) by selecting "My Services" from the home page, then "My Service Agreements", then the relevant service agreement (see Figure 23). The data in the service agreement is sourced from the blockchain and includes the service provider information, service details, service cost (including the proportion of Fahima's budget used on that service booking), privacy settings and service provider rating.

Fahima could seek to change the booking details (User Story 12), though this function was not built into the working prototype, and can rate the quality of the service provider (User Story 13), which is built in the working prototype but does not require blockchain technology.

Fahima can view her upcoming appointments by selecting "My Appointments" from the "My Services" page. The appointment information includes the service provider name, service details, service location, date and time.

Figure 23: Pages for reviewing and editing service agreement and provider rating



6.10 Access data analytics to improve service quality and safety

The proof of concept could support enhanced data analytics for support service providers (User Story 21), plan managers (User Story 22) and government agencies (User Story 29). These parties could leverage the insights to identify opportunities to improve their performance and enhance service quality and safety for participants.

A companion document to this report, titled *Making Money Smart: Indicative data analytics that could be supported by the smart money proof of concept*, provides detailed examples of these analytics.[52] See examples of analytics in Figure 24.

Figure 24: Examples of data analytics from companion document

[52] Royal D, Lim N, Staples M, Rimba P and Gilder S (2018), Making Money Smart: Indicative data analytics that could be supported by the smart money proof of concept, Companion document to the Making Money Smart report, Data61 (CSIRO).

7 Evaluation of proof of concept

7.1 Overall evaluation

7.1.1 Evaluation approach

This section evaluates the proof of concept against the design criteria outlined in Section 4.2 of this report, including a comparison of the proof of concept against the current state and hypothetical alternative future states.

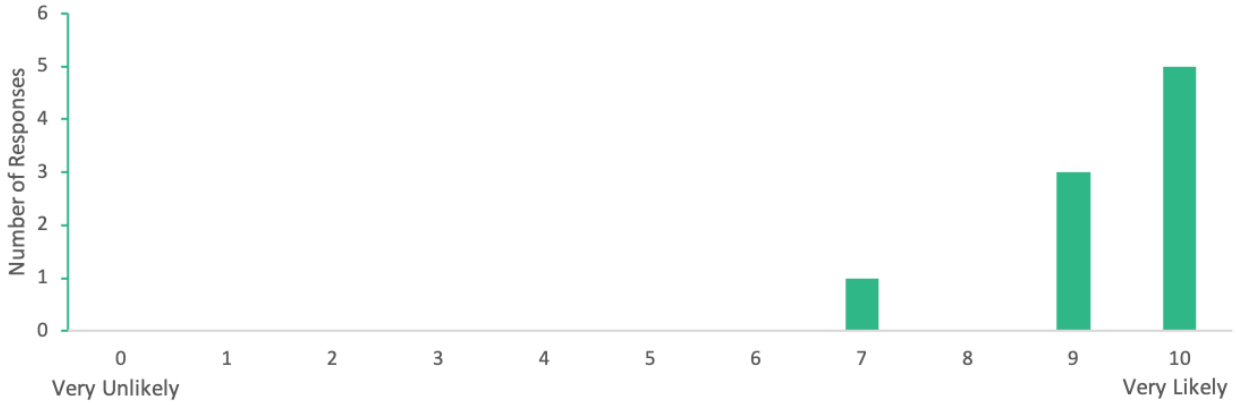
The evaluation is primarily qualitative and is informed by input from:

1. **NDIS participants and carers** – Formal and iterative user testing of the working prototype with self-managing NDIS participants and carers, who were selected to represent a range of self-managing use cases, which the project's user stories focus on.
2. **Service providers and disability sector experts** – Demonstrations of the working prototype and discussion of the broader proof of concept.
3. **Reference Group and project team** – Ongoing discussions and considerations throughout the project.

7.1.2 General evaluation

The proof of concept was designed with participants and carers in mind. In that respect, the formal user testing results of the prototype app were very pleasing, with a net promoter score (NPS) of 89% based on nine completed surveys by participants and carers (see Figure 25).[53]

Figure 25: Net promoter score results from formal user testing



While these results are encouraging, the sample size for the user testing was limited and the user testing focused on participants and carers who were self-managing NDIS plans. A broader range of

[53] The NPS is calculated as the percentage of promoters (those who rated their likelihood as an 8 or 9 out of 10 of recommending the app to friends or family) less the percentage of detractors (those who rated their likelihood as 6 or below out of 10).

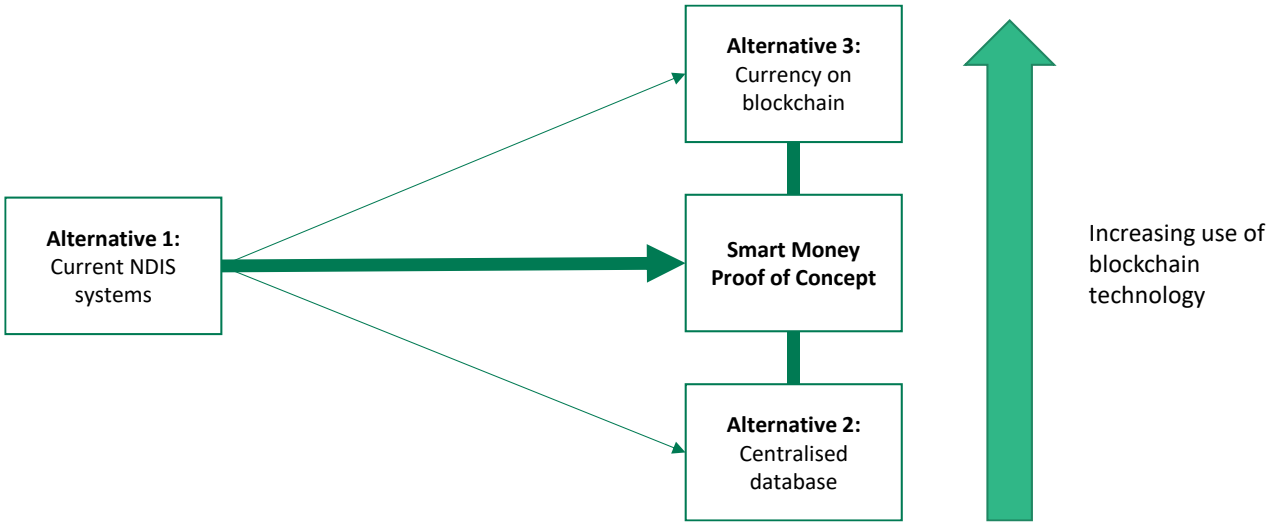
testing would be required to fully evaluate the working prototype. The user testing results across each of the project's design criteria are in Sections 7.1 to 7.10 below. The quotes provided are sourced from the final, formal user testing sessions with participants and carers.

7.1.3 Comparative evaluation

The proof of concept can also be evaluated relative to hypothetical alternative solutions, including:

1. **The current state of NDIS systems and processes** – to evaluate the extent to which the proof of concept could enhance the current state.
2. **A centralised database with New Payment Platform (NPP) integrations**, as a near-term alternative future state – to evaluate the extent to which blockchain could add value.
3. **A currency-on-blockchain solution** that leverages the proof of concept design but that would also settle payments on the blockchain, as a long-term alternative future state – to evaluate the merits of settling payments on-chain.

Figure 26: Possible alternative solutions considered



Detailed comparisons of the proof of concept against these alternative states are provided at Appendices A.1, A.2 and A.3 of this report. At a high level, we concluded that:

1. **The proof of concept has the potential to enhance outcomes across almost all criteria relative to the current state**. Some of the improvements would stem from the use of blockchain, while others would stem from general improvements in systems and processes. The main area where the proof of concept is not unambiguously superior is the confidentiality criterion, where the proof of concept has both relative strengths and weaknesses – the relative weaknesses represent opportunities for future research and experimentation (see Section 9).
2. **The proof of concept could achieve a similar user experience to a centralised database, while offering the potential of platform advantages** if the smart money technology was applied across multiple payment environments, though further work may be required to deliver sufficient performance across multiple payment environments.

3. **In the long term, the smart money proof of concept could be augmented by a currency-on-blockchain solution, though whether this solution would be desirable from a broader policy perspective is still uncertain**.[54,55] Considerable further research and testing would be required to address a range of implementation considerations and risks associated with a currency-on-blockchain solution. This includes, but is not limited to, the impact that this might have on the financial system. So, any implementation pathway would likely be gradual and could be aided by commencing with a blockchain token solution, such as the smart money proof of concept.

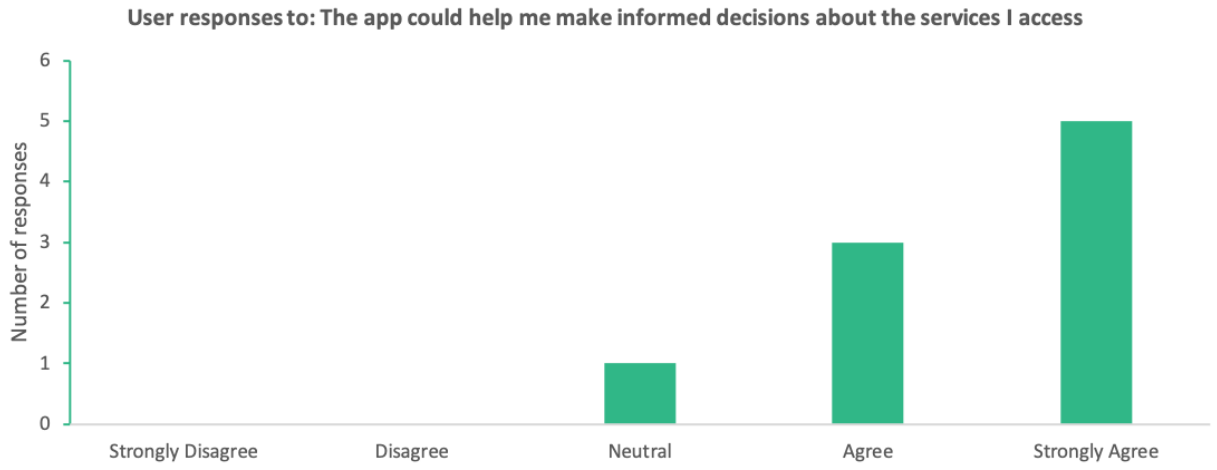
7.1 Choice

Our assessment is that the proof of concept could enhance the level of choice available to NDIS participants, no matter which method of plan management they use – though one of the proof of concept's biggest benefits is that it could enable more participants to self-manage their plans, which is the plan management approach that offers the highest degree of choice.

> *"We currently have to go to a support coordinator to understand our plan. I can't borrow the app now, can I?"* – Carer

The proof of concept would also make it easier for participants to make informed decisions using real-time, comprehensive and granular budget and payment information. It could also make it easier for participants to search, compare, choose and book services (including through direct interfaces and the potential to integrate bookings with eMarkets). This assessment is supported by the user testing results (see Figure 27 below).

Figure 27: Choice criterion - user testing results



[54] Reserve Bank of Australia (2017), An eAUD, speech by Philip Lowe (Governor) in an address to the 2017 Australian Payment Summit, Sydney - 13 December 2017. Available at: https://www.rba.gov.au/speeches/2017/sp-gov-2017-12-13.html

[55] Reserve Bank of Australia (2018), Cryptocurrencies and Distributed Ledger Technology, speech by Tony Richards (Head of Payments Policy Department) at the Australian Business Economists Briefing, Sydney – 26 June 2018. Available at: https://www.rba.gov.au/speeches/2018/sp-so-2018-06-26.html

While these results for the proof of concept are encouraging, they could also be achieved by a centralised database solution or currency-on-blockchain solution, as the back-ends of the solutions would not impact the front-end user experience.

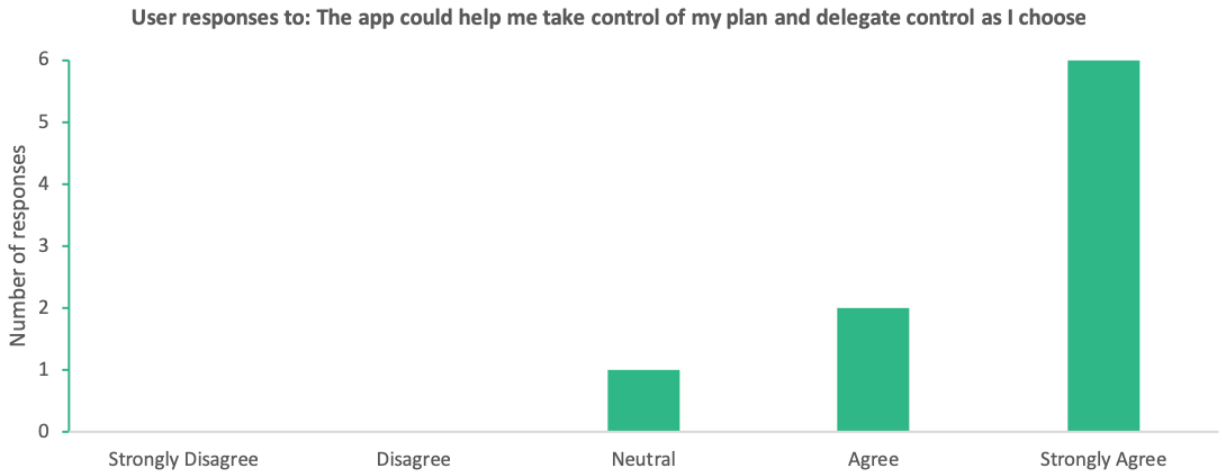
7.2 Control

Our assessment is that the proof of concept could enhance the level of control for participants. It could increase the transparency available to participants so that they could ensure their plan activities match their preferences.

> "*It's easy to check past payments & details of services. It's good to have control over how much information to share*" – Participant

It could also provide control for participants to set and blend their plan management approaches (e.g. accessing the NDIA central panel of providers while self-managing) and set nominees to help manage their plan. For participants with decision-making disabilities, the technology could also be leveraged to provide decision-making aides, which may enable a greater proportion of participants to self-manage their plans and exercise more control over their plan supports. The provider rating function could increase consumer power for participants and help them access quality and safe services. This assessment is supported by the user testing results (see Figure 28 below).

Figure 28: Control criterion - user testing results



While these results for the proof of concept are encouraging, they could also be achieved by a centralised database solution or currency-on-blockchain solution, as the back-ends of the solutions would not impact the front-end user experience.

7.3 Accessibility

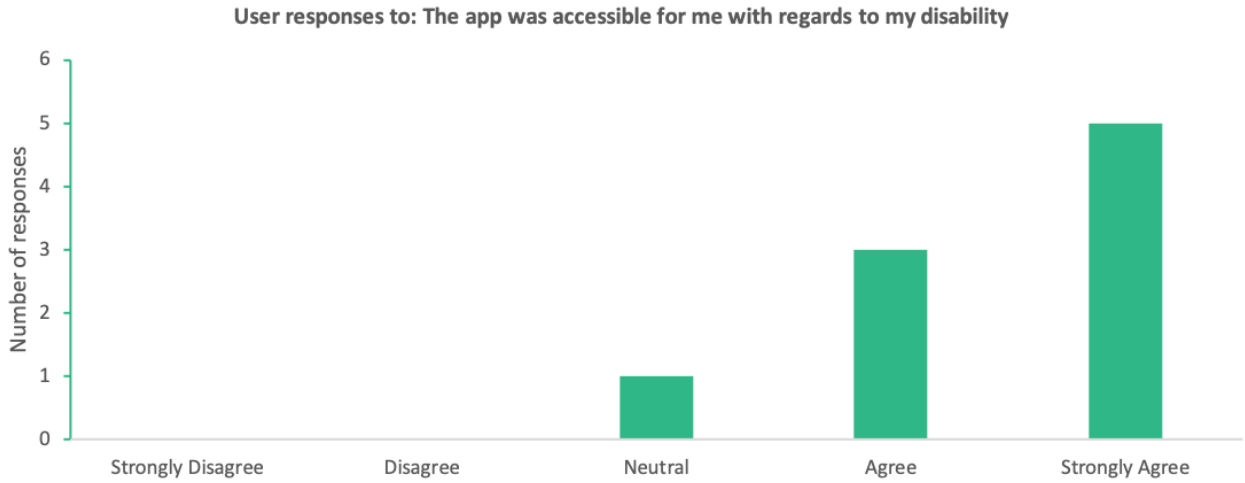
Our assessment is that the proof of concept could enhance the level of accessibility for participants and ensure accessibility for service providers, including plan managers and eMarkets. However, further work would be required to achieve a sufficiently high level of user accessibility for a full-scale rollout.

The use of a smart phone app as the primary user interface could enable participants to leverage accessibility technology available on smart phones, including screen readers, image magnifiers, automated actions, assistive touch, voice commands and external hardware integrations for user control interfaces. While user testers indicated that the smart phone app was more accessible than the current myplace portal (see Figure 29), further refinement would be required to deliver a high level of accessibility. This would include ensuring all text is sufficiently large and that the text is appropriately formatted to enable a screen reader to read all pages effectively. Further design and testing with people with a broader range of disabilities could help deliver these refinements.

The use of a smart phone app could deliver access to budget information and payment functionality on the go, which was highlighted as a key benefit from a range of user testers. In addition, removing the need for self-managing participant to pay from their own bank account could help participants to avoid cashflow or timing issues that may delay their access to urgent services. The greater simplicity of the user experience was also seen as an enabler of participants accessing the services they require, particularly for people suffering from anxiety.

"*Not only saves time, but reduces stress in booking services. For people with mental illness, the stress involved in booking services may be a barrier in accessing services*" – Carer

Figure 29: Accessibility criterion - user testing results



Secure API access for service providers, plan managers and eMarkets would ensure these parties could maintain, and in some cases enhance, their access to the NDIS ecosystem. This could increase the range of services accessible to participants and competition in market place.

While these results for the proof of concept are encouraging, they could also be achieved by a centralised database solution or currency-on-blockchain solution, as the back-ends of the solutions would not impact the front-end user experience.

7.4 Simplicity

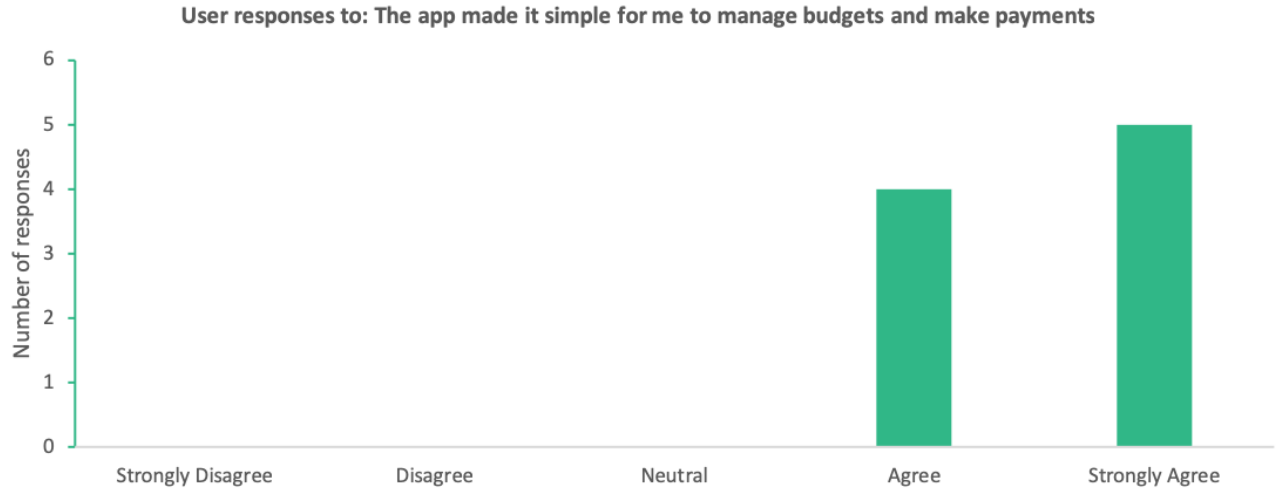
Our assessment is that the proof of concept could make budget management and payments simpler for participants, carers, plan managers, service providers and the Government.

The app could simplify the booking and payment experience for participants, carers and plan managers through the search, compare, pay, budgeting and receipting functions. It would also make it easier for participants to set and modify plan management delegations for nominees and for nominees to understand and exercise their delegations. This assessment is supported by the user testing results in Figure 30 below.

> *"Being able to pay straightaway is great. Nice, easy and convenient."* –Participant

The proof of concept could make it simpler for service providers to book services and receive payments, including through the potential of: a graduated registration process; the ability to sell services in app and eMarkets; the ability to send booking requests; automatic eligibility checks; real-time booking/payment authorisation; payment within seconds after delivering service; attached remittance information for automatic reconciliation; and real-time data analytics to improve performance.

Figure 30: Simplicity criterion - user testing results



The proof of concept could make it simpler to administer the NDIS, including through the potential of: removing manual reviews of payment/funding requests by participants, plan managers and service providers; removing the need for manual audits of spending activities; automated reconciliation of payments to service providers; and real-time data analytics to improve policies and processes. The Government would also likely benefit from reduced queries from participants and service providers due to the greater functionality on offer and greater transparency of information.

While user testers recorded favourable responses to the simplicity of the working prototype, the prototype delivered a simplified view of the booking process, including assuming services were available when the participant chose and that all services providers were integrated with the proof of concept. Integration work would be required to make the second assumption a reality, which could slow down access to some of the simplicity benefits described above. The simplicity benefits outlined above could also be achieved by a centralised database solution. A currency-on-blockchain solution could also deliver similar simplicity benefits, depending on the balance between removing NPP integrations for payments and reducing requirements for payments

reconciliation processes, against the potential complexity of a greater number of conditions to manage within the currency-on-blockchain solution.

7.5 Efficiency

Our assessment is that the proof of concept could reduce administration time and costs for participants, carers, plan managers, service providers and the Government. The time and cost savings would stem from the simplicity benefits outlined in Section 7.4 above.

> "*Great to have all information automatically sent to provider when booking is done. No need to key it in manually*" – Participant

After testing the proof of concept with participants, carers and service providers, we asked them to estimate the time and costs savings that could result. Participants and carers estimated that the proof of concept could save them between 1 hour and 15 hours per week, with an average result of 3 hours. Service providers estimated that the proof of concept could save them approximately 0.3% to 0.8% of costs as a percentage of revenue. We modelled these benefits across the scale of the NDIS full-implementation scope due in July 2020, using sensitivity analyses for low-range and mid-range scenarios using conservative inputs (see Appendix A.4). We conclude that the economic benefits would be the order of hundreds of millions of dollars annually, if the proof of concept was leveraged to develop and implement a full-scale solution across Australia. Further testing and analysis would be required to provide a robust, specific estimate.

The sensitivity analysis at Appendix A.4 does not include potential time and cost savings that could result for participants and carers who are plan-managed or agency-managed. It also does not include potential efficiencies that could result for government from streamlined payment processes, the removal of manual auditing processes or a potential reduction in budget and payment related queries from participants, carers and service providers. The model does not include potential cost savings or revenue benefits for service providers from ensuring they only provide eligible services.

The model is static; it assumes that the full benefits of the proof of concept would be immediately available. If the proof of concept was implemented gradually, then the efficiencies would not all be available immediately. The model estimates economic, rather than financial, benefits. Some of the efficiencies do not represent financial costs to the NDIS, such as the time of participants and carers. In addition, some of the cost efficiencies may not be recoverable or should not be recovered if they are deemed to represent the removal of existing inefficiencies in the NDIS.

While these results for the proof of concept are positive, they could also likely be achieved by a centralised database solution or currency-on-blockchain solution.

7.6 Confidentiality

Following the principles of choice and control, the proof of concept would provide participants with choice and control over the extent to which their data is shared with service providers (or any other parties that do not require access to the data for the administration of the NDIS). Therefore,

the analysis below focuses on risks to the confidentiality of data stemming from possible attacks or systems failures across the various solution alternatives.

Our assessment is that the proof of concept could reduce the consequence of possible breaches by de-identifying data, while potentially increasing the likelihood of breaches through an increased surface area for attacks, particularly if the proof of concept was applied across multiple conditional payment environments. There are opportunities for further work to address these potential increases in the likelihood of risks while maintaining the benefits of reduced consequences.

The proof of concept could reduce the consequence of possible breaches by holding the majority of participant data off-chain (and therefore not all in one place), making the blockchain accessible only through a web-based interface (the blockchain trigger), and anonymising the data held on-chain through private keys, including different private keys for different budgets in participants' plans. This would mean that if a breach occurred, it would be difficult, though not impossible, for the attacker to re-identify participants' data.

The proof of concept may lead to an increased likelihood of data breaches, as each processing node would have visibility of all the data on the blockchain. With multiple nodes having access to the blockchain, the surface area for attacks, either external or internal to each node's organisation, would be greater. This would be unlikely to have a major impact on the NDIS proof of concept, as the number of nodes are few and the ability to implement minimum standards would be strong. However, if the proof of concept was applied across multiple conditional payment environments with multiple nodes of varying trustworthiness, the risks would be greater. Another factor to consider if the proof of concept was applied to multiple conditional payment environments is how to ensure that each node only sees information that is relevant to them.

Opportunities for future work to reduce the likelihood or breaches include: the use of multiple distributed ledgers or dedicated channels to restrict visibility for some nodes; the use of secure private computation technologies to encrypt data held on-chain; and the exploration of zero-knowledge proof technologies, which prevent processing nodes from seeing the data of the transactions they process.

The proof of concept would experience similar relative strengths and weaknesses when compared with a centralised database solution. On the other hand, a currency-on-blockchain solution would involve the highest level of risk, as the attack surface area would be even higher and the value of breaching a currency, in addition to the data, would be much higher.

7.7 Integrity

Our assessment is that the proof of concept would enhance the level of integrity in the NDIS. The data stored on the blockchain is immutable and all the transactions are validated by all processing nodes in the blockchain network. Therefore, any unauthorised modification of information will be detected easily. The logic of the Smart Money Contract is immutable once deployed on the blockchain and thus preserves the integrity of the system.

The current working prototype also ensures integrity of payments – ensuring that participants can only access eligible services and only if enough funds are available. This is enforced by the token

concept and the policy contracts that are attached to the tokens. The Smart Money Contract also assists in preventing users from misspending if the user interface validation fails. This prevention mechanisms was successfully tested during user testing when user testers attempted to book services where: insufficient funds were available; the sessions being booked were outside the plan timeframes; double bookings were attempted from multiple interfaces at the same time.

While the blockchain system would ensure that only transactions that meet the conditions in policy contracts could occur, it would not prevent human error in creating policy contracts. This, combined with the increased speed at which payments would be made, could make it more difficult for human intervention to stop a payment, where the policy contract was found to be incorrectly attached. Rules could be embedded into the proof of concept to address this, such as manual approvals by the NDIA and/or the financial institution making the NPP payment, for very large and other types of higher-risk payments.

The proof of concept would likely also compare favourably to a centralised database solution for the same reasons outlined above, though the benefits would be marginal as the integrity risks to a well-established centralised database solution would be low. The proof of concept compares similarly to a currency-on-blockchain solution.

7.8 Performance

Our assessment is that the proof of concept would improve the latency and throughput of process coordination between parties in the ecosystem for service interactions and reconciliation, through automation of processes that are currently manual. Additionally, the overall speed of payments would improve, through integration with the NPP. However, further work would be required to guarantee real-time blockchain token processing, particularly if the proof of concept was applied across multiple conditional payment environments, and therefore required greater throughput.

By July 2020, the NDIS could involve 1.3 million payments per week, or 2.17 payments per second.[56] The New Payments Platform already has the capacity to meet this requirement.[57] We estimated that the required throughput for the blockchain component of the proof of concept would be approximately 3.26 transactions per second.[58] Peak transaction throughput demands would be significantly higher; how much higher is unknown, but early indications are that peaks can be around twice the average load[59]. We expect throughput requirements could be met by the private Ethereum network trialled in the working prototype, which operates on a *proof of authority* basis, which is an efficient way to process transactions in payment environments where the processing nodes are trusted and the payers and receivers are known to each other.

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[56] Current weekly transactions for approximately 140,000 participants are 400,000 transactions per week. When scaled for 460,000 participants, this number reaches 1.3 million transactions per week. Source: National Disability Insurance Agency (2018), NDIS Weekly Payment Summaries, 2018. Available at: https://www.ndis.gov.au/about-us/information-publications-and-reports.html

[57] Based on the New Payment Platform implementation experience of the Commonwealth Bank.

[58] Each payment could involve multiple blockchain transactions (e.g. to initially set aside a group of tokens for an ongoing booked service, the transfer of tokens to service providers and the redeeming of tokens with the NDIA). We estimate that, on average, each payment would involve approximately 1.5 transactions on the blockchain network, resulting in a requirement of 3.26 transactions per second.

[59] Based on a recent bulletin by Rush and Louw (2018), The New Payments Platform and Fast Settlement Service. Available at https://www.rba.gov.au/publications/bulletin/2018/sep/the-new-payments-platform-and-fast-settlement-service.html

However, if the solution was applied to additional conditional payments a different approach may be required to deliver sufficient trust across a wide range of processing nodes and between payers and receivers who may not know each other. In current public blockchains, *proof of work* processing can increase trust by requiring nodes to compete to verify transactions by solving complex puzzles in an energy-intensive activity known as mining. However, this is a relatively slow way to process transactions, which results in a relatively low transaction throughput.[60] There are two key opportunities to enable faster payments than with current public blockchain systems:

- **Alternative blockchain networks or improvements to existing networks** could deliver higher throughput. Outside the core architecture of blockchain systems, other factors to consider include the number of nodes, the processing power of nodes and possible sharding of blockchains. Studies by Data61, R3 and the Depository Trust & Clearing Corporation have measured various networks achieving from between tens of transactions per second to thousands of transactions per second. However, at the higher level these systems did not allow the complexity of smart contracts used in our proof of concept.[61,62,63]
- **Pre-authorising transactions using the data already on the blockchain** using a payment authorisation scheme somewhat similar to existing card schemes, which would thus be expected to process payments at rates closer to the card schemes at more than 1,000 transactions per second.[64] A pre-authorisation approach would confirm (using a query on a local copy of the blockchain) whether the participant had sufficient tokens for payment based on data available on the blockchain data at the time of authorisation request. The transfer of the tokens would then occur after the authorisation is confirmed. In most cases, the blockchain transaction would occur within seconds or milliseconds of the authorisation, though in peak periods these timeframes could lengthen. The longer the timeframe for transaction processing and propagation within the blockchain network, the greater the risk that a participant could purchase two items using the same set of available tokens, or without sufficient tokens. In the context of the NDIS, compared to a generic payments environment, this risk would be minimal due to the types of purchases participants can make and because their identity is known by the NDIA and service provider (which would all but remove incentives for systematic fraud). The risk of double spending could be greater if the proof of concept was applied to lower trust environments where funders, spenders and businesses do not all know one another. However, this risk could be low and manageable depending on the strength of identity management and depending on individuals' payment size and volume.

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[60] Rimba P, Tran AB, Weber I, Staples M, Ponomarev A, Xu X (2018) Quantifying the Cost of Distrust: Comparing Blockchain and Cloud Services for Business Process Execution. In: Information System Frontiers.

[61] CSIRO (2018), Next generation blockchain boosts speed and energy efficiency on global scale, Viewed 22 October 2018, Viewed 21 October 2018, <https://www.csiro.au/en/News/News-releases/2018/Next-generation-blockchain-boosts-speed-and-energy-efficiency-on-global-scale>

[62] R3 (2018), Corda performance: to infinity…and beyond. Available at: https://www.r3.com/wp-content/uploads/2018/04/Corda-Performance-ENG.pdf

[63] Depository Trust & Clearing Corporation (2018), DTCC announces study results demonstrating that DLT can support trading volumes in the US Equity Markets. Available at: http://www.dtcc.com/news/2018/october/16/dtcc-unveils-groundbreaking-study-on-dlt

[64] Mastercard 2012, Mastercard sees Black Friday performance up 26 percent. Available at: https://newsroom.mastercard.com/2012/11/26/mastercard-sees-black-friday-performance-up-26-percent/

A centralised database would likely be faster than the proof of concept, while a currency-on-blockchain solution would likely be slower, as a public blockchain would likely be required. In a public blockchain, proof of authority would be less suitable as a basis for the consensus mechanism because of the greater range and number of node operators. Proof of work is not necessarily required for public blockchains, but performance would nonetheless inherently be more limited.

7.9 Cost

Our evaluation has not involved a comprehensive quantitative costing of envisaged full scale proof of concept, including the cost of the blockchain network, blockchain trigger and running multiple processing nodes.[65]

Our qualitative assessment is that the proof of concept could potentially lower ongoing and maintenance costs, while involving upfront investment costs to establish the system. Compared with a centralised database solution, the proof of concept would likely be more expensive if only implemented for the NDIS but potentially less expensive if applied across multiple payment environments, and the core costs of the solution and the data collected from each payment environment could be shared, leveraging the platform benefits of the proof of concept stemming from its modifiability (see below). The proof of concept would likely be less expensive than a currency-on-blockchain solution to establish, but potentially more expensive over the longer term as a currency-on-blockchain solution may have even wider application across the economy.

7.10 Modifiability

Our assessment is that the proof of concept would deliver greater modifiability benefits, due to the modifiability of the policy contract conditions. The proof of concept supports dynamically adding or removing policy contracts from pouches of tokens. As only the interfaces of policy contracts are exposed, there is flexibility for defining each policy condition. Therefore, new policy contracts could be designed for new rules created within the context of the NDIS or for alternative conditional payment environments.

The flexibility of policy contracts would also lead to the proof of concept delivering an advantage over a centralised database, particularly when applied across multiple payment environments, which generates the potential for platform effects. One downside to the proof of concept is that, if a change to the underlying architecture of the blockchain is required, it could be more problematic due to the immutable nature of the blockchain and multiple nodes that would need to adapt.

The proof of concept may also have advantages over a currency-on-blockchain solution, as the latter would likely involve a far greater array of nodes and payment environments, which could make changes to the underlying architecture, or even the creation of new policy contracts, more complex.

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[65] We have not sought to cost the proof of concept, which we envisage operating on a non-Ethereum blockchain network, which would have a different cost structure to the working prototype. However for completeness, the working prototype uses a private Ethereum network hosted on Google Cloud. We ran 4x n1-standard-1 nodes in our Google managed Kubernetes cluster, each with 100gb SSD billed at US$0.674/hour per node. Each of the nodes had 1 vCPU and 3.75 GB RAM.

8 Possible applications of smart money in other conditional payment environments

8.1 Rationale for considering alternative applications of smart money

This research project has explored the implementation and use of a new concept for smart money for conditional payments. We have used a specific context of the NDIS to help motivate, illustrate, and evaluate the concept and a prototype. There are other possible use cases across the economy for conditional payments. We discuss these below, noting that each case would require further consideration before implementation. Some of the potential capabilities of smart money have not been fully explored in this project, for example for self-taxing payments, automated variable escrow payments, and user-defined flexible policies for money. These capabilities may expand the functionality available for conditional payments beyond conventional payments technologies.

8.2 Enhancing public policy programs to achieve better citizen outcomes

The smart money proof of concept has the potential to support a range of public policy programs, including programs involving person-centred funding, outcomes-based funding and taxes, transfers and rebates (noting these categories are not mutually exclusive).

Person-centred funding

The NDIS is just one example of a person-centred, or consumer-directed, funding program in Australia. Many health, human service and social service programs involve aspects of person-centred funding, and Federal, State and Local Government across Australia are continuing to explore ways to make service delivery more citizen centric. A recent example outside the NDIS is the introduction of the Consumer Directed Care reforms for aged care.[66]

The smart money proof of concept has the potential to deliver similar benefits as those described in this report for the NDIS, including greater simplicity, transparency and efficiency of payments. The benefits of the technology could also make it easier for governments to introduce new person-centred funding programs that previously were not available, empowering more citizens to exercise choice and control over the services they access.

Cross-jurisdictional funding

Another potential benefit could arise from applying the technology to similar schemes across jurisdictions. For example, States and Territories across Australia operate schemes to subsidise patient travel for health procedures not available in a patient's local areas of residence.[67] The

[66] Australian Government Department of Health (2018), Recent Aged Care Reforms. Available at: https://agedcare.health.gov.au/reform/recent-aged-care-reforms

[67] National Rural Health Alliance Ltd (2018), A Guide to Patient Assisted Travel Schemes, Available at: https://ruralhealth.org.au/sites/default/files/publications/nrha-guide-pats_0.pdf

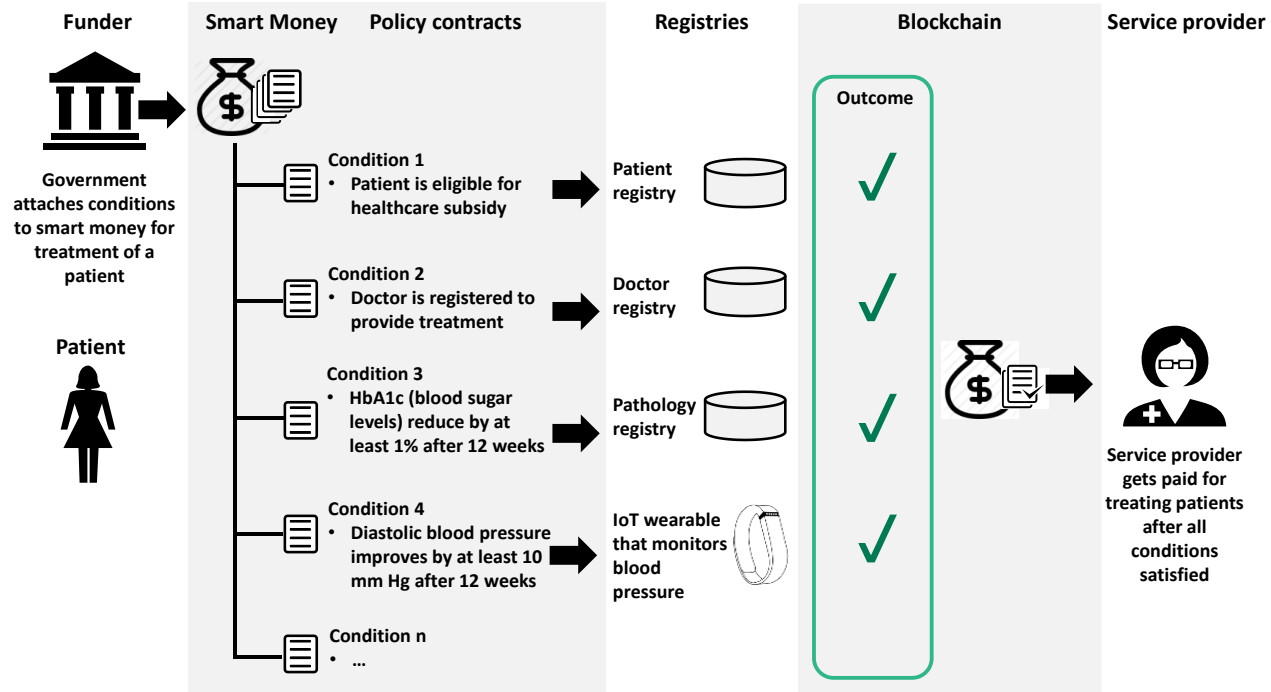
travel support needs of each patient are often highly personalised. By transitioning such a program to a blockchain system, a State could gain greater visibility of the application of their scheme rules throughout their State, but also with other States' schemes. The insights gained could identify opportunities to improve the consistency of support across geographies and ensure value for taxpayer money.

Outcomes-based funding

There is a growing trend across Australia towards outcomes-based funding, such as social impact investment through social impact bonds. Such programs aim to deliver financial and social returns for investors and increase the capital available for social outcomes.[68] The programs pay investors for the outcomes their services deliver, rather than for the amount they invest (inputs) or number of services they deliver (outputs). The smart money proof of concept could support such schemes by making payments to investors dependent on the social outcomes achieved. Such applications would deliver greatest benefits when multiple measurements of social impact are involved.

One potential application in the medium to longer term could be for value-based healthcare, which is still an emerging area of public policy. Value-based health care seeks to maximise the health benefits delivered to patients as a proportion of the cost of providing healthcare. Smart money could be applied in these contexts by making payments (either partial or total) to healthcare professionals dependent on the patients' health outcome (rather than for time and cost of the healthcare professional incurs in delivering their service). This could combine smart money technology and the Internet of Things (IoT) (see Figure 31 for an indicative example).

Figure 31: Indicative example of enabling value-based healthcare



[68] Parliament of Australia (2013), Part III: Emerging investment vehicles and innovation. Available at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Completed_inquiries/2010-13/capitalmarket2011/report/c06

The outcomes could be measured by traditional medical tests, such as blood tests completed in laboratories, but also through data automatically captured by IoT devices, such as wearable sensors that measure electrocardiogram (ECG) readings and blood pressure.

Healthcare is just one example of where outcomes-based funding may be able to deliver benefits for citizens. There could be similar applications across education, social services and human services. However, one key consideration will be to ensure that what the smart money system is set up to measure, is what matters – to prevent the system from creating perverse incentives that lead to poor public policy outcomes.

Taxes, transfers and rebates

Smart money has potential to assist with automating the payment of taxes and rebates, particularly those that are applied to individual transactions, such as energy rebates, sales taxes, tariffs and levies. Smart money could also help automate the payments of conditional benefits and rebates for citizens, and ensure that the benefits reach all eligible citizens with low administration costs. The Government could also leverage smart money to target how benefits are used, such as requiring economic stimulus payments to be spent by citizens in particular sectors of the economy and within particular timeframes, to maximise their boost to the economy. The Government could also target other benefits, such as welfare, towards activities that are considered beneficial to recipients' wellbeing and capability development.

8.3 Empowering individuals to optimise their spending

Smart money has potential to improve payments where the funder and spender of a conditional payment are the same person. There are numerous examples across behavioural economics and traditional economics where individuals do not optimise their spending due to cognitive biases (e.g. optimism or lack of self-control) and market failures (e.g. information asymmetries). The spending conditions available through the smart money proof of concept could help individuals pre-commit and then stick to spending behaviours while automating the incorporation of greater information in their purchasing decisions.

Figure 32 below highlights the range of interventions individuals could establish to support their spending decisions. At the lowest level of intervention, individuals could gain greater visibility of their purchasing behaviour and see how they track against their spending goals. The next level could involve 'in-context' reminders during purchases that do not align with their spending goals, and the option to accept or reject those purchases. Individuals could set harder limits to enforce their spending goals, or in the case of services and products they find particularly harmful to their wellbeing, prohibit those purchases.

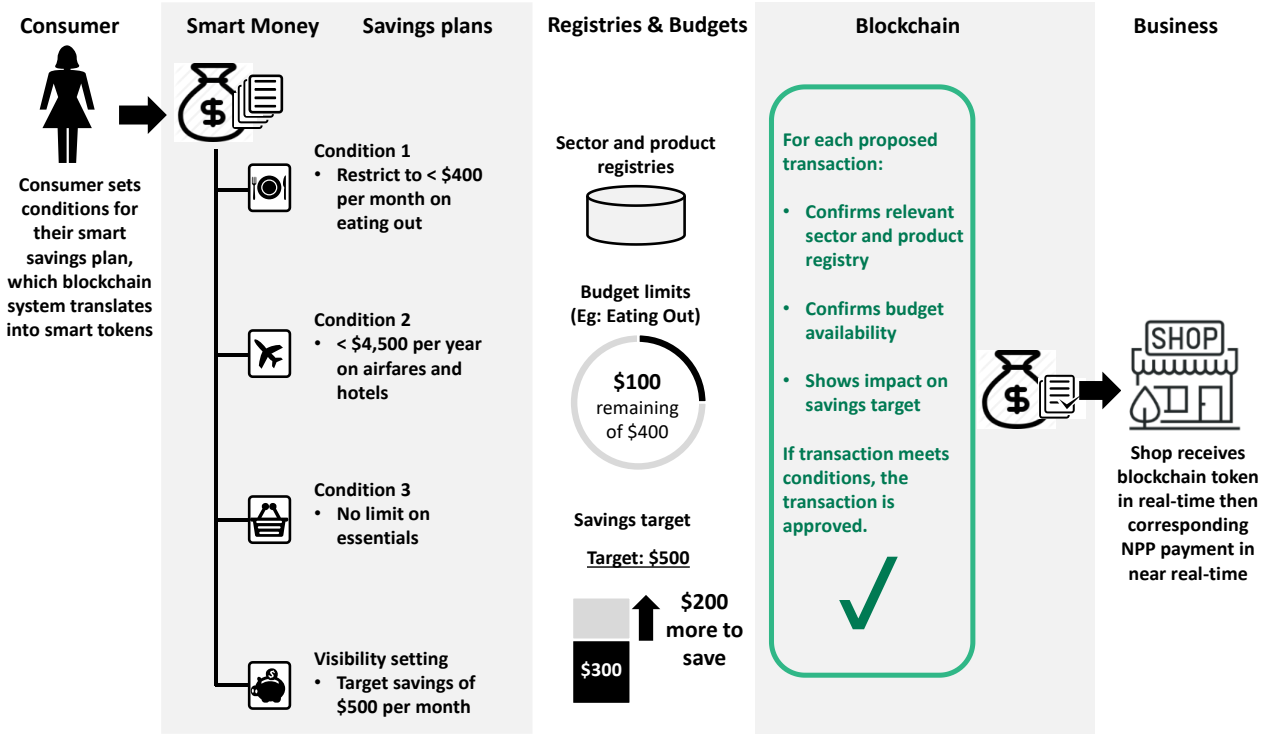
Figure 32: Spectrum of possible interventions to support spending decisions

The examples below illustrate how these interventions could support specific spending goals.

Smart savings plans to help individuals get in control of their spending

Individuals could set spending conditions to help them budget for the future. This could include ensuring flexibility of funding for essentials, such as health, education and food expenses, while limiting monthly spending on entertainment and travel. It could also include an overall spending target that is not enforced but which provides visibility of the individuals' spending progress. The blockchain could record spending transactions as they occur and then intervene when individuals reach their spending limits (see Figure 33).

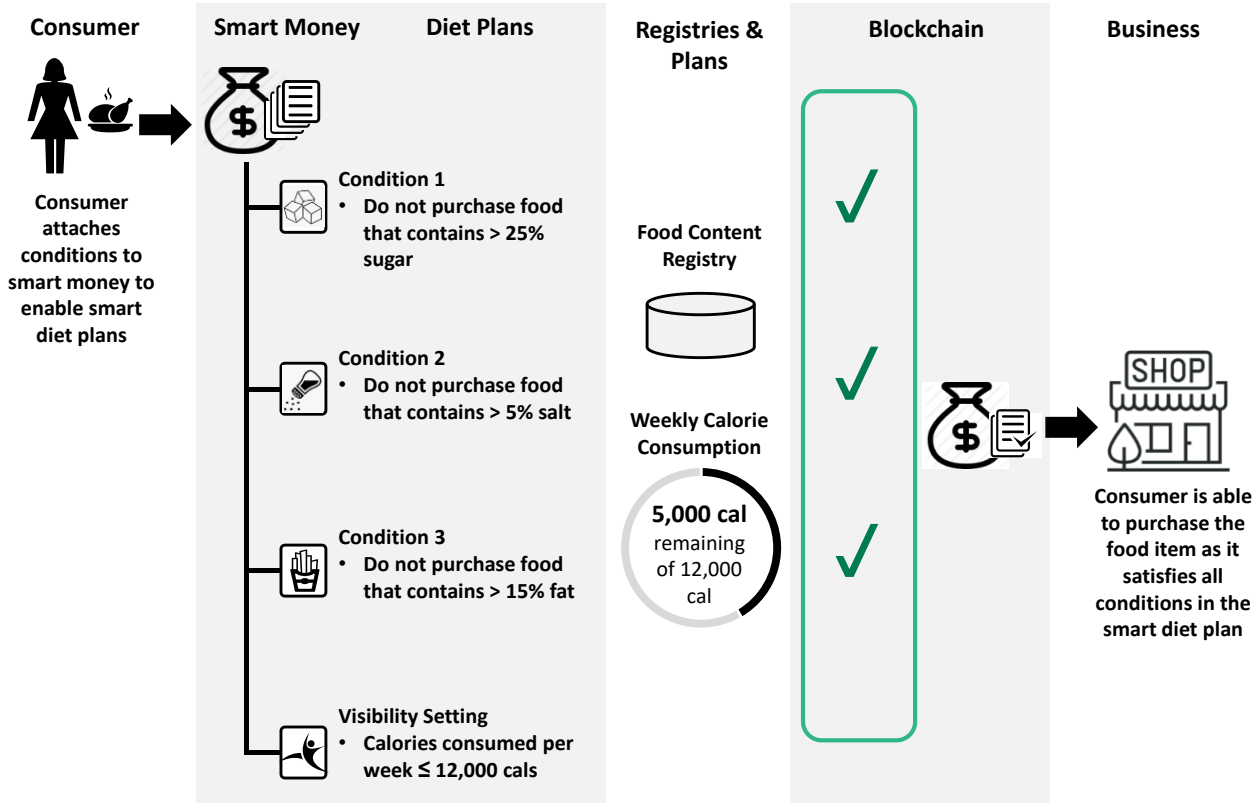
Figure 33: Indicative example of enabling smart savings



Smart diets to help people achieve their health goals

The smart money proof of concept could also enable third parties to create registries that individuals could use for setting spending conditions. For example, an organisation that promotes healthy eating could record the calorie, sugar, salt and fat intake of different food items. Individuals could then set themselves conditions to achieve their health goals. For example, they may choose to set themselves calorie targets for each week as well as restricting themselves from purchasing food items that exceed specific sugar, salt and far limits (see Figure 34).

Figure 34: Indicative example of enabling smart diets



Pre-commitment mechanisms to help people manage their addictions

Similarly, people with addictions could limit their exposure to addictive substances and behaviours. For example, if someone had an addiction to gambling, alcohol or cigarettes and had a desire to quit, they could self-impose restrictions on their spending on these activities. While such approaches may not be a comprehensive or infallible way to overcoming addiction, they could help restrict access and thereby reduce some of the impacts.

Other potential use cases for individuals and households

Similar to smart diets, organisations could set up separate registries for different types of values that individuals may wish express in their spending decisions. For example, people may wish to set targets and reminders for products that are Australian made, ethically sourced or organic and some people may wish to set prohibitions on products that do not meet religious requirements or contain animal products.

Individuals may also wish to set conditions relating to price. The smart money system could enable them to set up a purchase for an item from multiple websites, but only after the price falls below a certain level. This may create greater consumer power for accessing the best deals, such as for online shopping or travel purchases.

Parents may wish to ensure that their children spend their pocket money on specific items and not others, or they may wish to incentivise saving by creating bonuses when children do not spend all their pocket money in one week. Such incentives could be enabled by the smart money system.

8.4 Increasing trust and reducing costs for businesses and not-for-profits

Facilitating insurance payouts

Insurance companies could set conditions for payouts occurring. The conditions could include the eligibility of the policy holder (e.g. car insurance policy holder), the eligibility of the insured event (e.g. whether the car accident meets the conditions of the policy), the eligibility of the business rectifying the event (e.g. whether the smash repairer is an approved repairer) and whether the excess has been paid. Insurers could establish different processes for different conditions. Straightforward conditions could be processed automatically, while more complex rules (e.g. for determining what caused the accident) could require human judgement and manual confirmation.

Smart money could also enable industry-wide benefits. If multiple insurers used the same system, they could set information access rules that enabled them to gain real-time insights on industry payout averages for different types of events, ensure they are delivering their services at competitive prices, and ensure they do not collectively payout multiple claims for the same insured event with multiple policies. The governance of such an arrangement would need to be considered carefully from a competition and consumer perspective.

Simplifying spending delegations and procurement processes

Organisations often rely on a range of mechanisms for managing budgets and delegating spending control, including: procurement budgets and systems; HR and payroll systems; and corporate cards, including virtual cards and other similar solutions. The smart money proof of concept could enable an organisation to incorporate these different rules in one spending system, creating real-time and comprehensive visibility of spending, which could assist with budget management, fraud control and ensuring consistency across business units.

The benefits could also enable greater degrees of delegations and more empowerment for staff to achieve the organisation's mission. For example, corporate cards currently enable spending limits and some broad spending category restrictions, such as restrictions on purchases from merchants that offer gambling services. However, they do not enable conditions on specific items being purchased or in-context conditions, such as enabling purchases for particular times and dates when a staff member is travelling, or for specific items that staff need to purchase (e.g. an employee at a café purchasing emergency milk supplies from a supermarket on a busy day). The smart money system could enable such conditions, and thereby provide more flexibility, efficiency and control, which could enable more businesses to empower their employees to purchase items that support their business objectives.

Increasing trust and transparency for not-for-profit activities

Trusts, charities, bodies corporate, membership bodies and scholarships are all responsible for managing funds for a particular purpose. To remain viable, they need to demonstrate to their funders (donors, members, etc) that the funds are being spent appropriately. This often requires manual, after-the-fact reporting processes and involves risks of misspending and fraud. The smart money system could help address these issues and increase trust between the bodies and their funders. This greater trust and transparency could enable these bodies to attract greater more funding and better deliver on their purposes.

9 Summary of areas for future work

The project has identified a number of considerations for future work. These relate to confidentiality, systems integrations, legal and compliance, additional features for the NDIS use case, alternative use cases to consider and the implementation of the technology for any use case.

9.1 Confidentiality and performance considerations

The normal concerns in payments environments for commercial confidentiality and personal privacy are magnified in the NDIS context, which supports payments that can be related to personal medical concerns, and where carers are often involved in facilitating both payments and personal care. Financial institutions have obligations to manage payments made through their systems, and funders have obligations to manage the proper use of funds in their schemes.

In this project, we have not investigated the security policy requirements and implementation mechanisms for blockchain-based conditional payments. Nevertheless, some mechanisms have been used in this project to support confidentiality, such as keeping personal data off-chain, using public/private key-pairs for individual budget items (rather than for individual participants), using web interfaces to provide controlled access to blockchain data, and operating the blockchain on a secure private network. These mechanisms, combine with minimum security protocols for the permissioned nodes (hypothesised to be the NDIA, a regulator and financial institutions) in the proof of concept, could achieve sufficient confidentiality outcomes in the context of the NDIS case study.

However, if the proof of concept was applied across multiple conditional payment environments, further work could be required, as the ability to rely on minimum security protocols across multiple nodes would become more complex and it may not be appropriate for each node to see all information. In these cases, other technologies may be relevant to future implementations of smart money with higher confidentiality, such as the use of multiple distributed ledgers, the use of secure private computation technologies, and exploration of zero-knowledge proof technologies.

In addition, further work could be required to deliver sufficient performance of the proof of concept if it was applied to multiple conditional payment environments. To achieve required levels of latency and throughput, further research and development work could be targeted towards exploring alternative blockchain networks and pre-authorising payments using pre-existing data on the blockchain at the time of payment authorisation.

9.2 System integration considerations

This project has examined the implementation and use of new kinds of payments functionality, and supporting blockchain-based technology architectures. Our exploration of programmable money does partly explore some of the potential conceptual benefits of currency-on-blockchain schemes. A step forward towards achieving this would be building and testing the NPP integrations conceived in this project (see Section 5.4).

We would like to explore the possibility of integrating with existing business systems for capturing item level information of products and services. This opens up further opportunities by enabling data analytics and machine learning to further optimize the experience of the end users (in the scope of this project's case study, NDIS participants).

We would like to explore secure, user-friendly methods for participants and service providers to retrieves lost private keys, in the event of a lost smart phone or system outage. This would require further design and testing.

9.3 Considerations of alternative conditional payment environments

The proof of concept can be used to integrate with funder systems and support adaptation with different rules and regulations. As discussed in Section 5.3, policy contracts can be defined and implemented to represent rules and enforcements of a token. We would like to further evaluate the generalisability of our proof of concept with a case study from a different domain.

This report identifies three broader areas for future applications:

1. enhancing public policy programs to achieve better citizen outcomes, particularly where person-centred funding, cross-jurisdictional funding, outcomes-based funding, or taxes, transfers and rebates are involved
2. empowering individuals to optimise their spending, including through smart savings plans, smart diets, smart pocket money, pre-commitment mechanisms to help manage addictions and values-based spending supports, such as ethical product registries
3. reducing costs and friction for businesses, trustees and not-for-profits, with respect to insurance payouts, managing corporate delegations and procurement, and providing transparency for funds managed by trusts, charities and membership organisations.

9.4 Legal and compliance considerations

Any implementation of the smart money proof of concept would need to comply with all relevant legislation and regulation in the relevant operating environments. Key aspects of Australia's legal and compliance regime that would need to be considered relate to, but are not limited to, Anti Money Laundering, Counter-Terrorism Financing, Sanctions, data storage and privacy laws and regulations. While the use of blockchain may require a new approach for complying with some of these laws and regulations, it also offers the potential for improved compliance outcomes in some respects due to the immutability and real-time visibility of data held on the blockchain.

9.5 Implementation considerations

Before any implementation of the smart money proof of concept is commenced for any conditional payment environment, a business case and/or cost benefit analysis would need to be undertaken. Careful consideration would also need to be given to the proposed governance arrangements for the system, including which parties should be processing nodes, who has visibility of the blockchain and who is eligible to set and modify conditions.

If a decision was taken to implement the technology in a conditional payment environment, an agile implementation approach would be most appropriate to de-risk the implementation. For example, it may be appropriate to commence with the blockchain system mirroring existing systems, to ensure that the blockchain system and policy contracts established have the capability to manage all the permutations of spending conditions in the payment environment. After this, targeted pilots with relatively low numbers of spenders and businesses could be undertaken to test the usability of the technology. After each successful stage, the pilots could be expanded to include more users and expanded capabilities. Over time, the system could expand to full rollout. Clear success criteria should be established ahead of each expansion in scope and capability to reinforce a 'test and learn' approach and guide decisions on whether, and what pace, future iterations should occur.

9.6 The potential is exciting

If these areas for future work are progressed successfully, there is great potential for smart money to enable automated conditional payments across the economy, and through this improve the financial wellbeing of people, businesses and communities.

References

Australian Government (2018), Design System. Available at: https://designsystem.gov.au/

Australian Government (2018), Design Service Standard 9: Make it accessible. Available at: https://www.dta.gov.au/standard/9-make-it-accessible/

Australian Government (2018), NDIS Fraud Taskforce established to tackle crime, joint media release on 24 July 2018 by The Hon Dan Tehan MP, then Minister for Social Services, the Hon Michael Keenan MP, Minister for Human Services and the Hon Angus Taylor MP, then Minister for Law Enforcement and Cyber Security.

Australian Government Department of Health (2018), Recent Aged Care Reforms. Available at: https://agedcare.health.gov.au/reform/recent-aged-care-reforms

BPAY (2018), Osko by BPAY: A new way for Australians to pay. Available at: https://www.bpay.com.au/Member-Financial-Institutions/Osko-by-BPAY.aspx

Committee on Payments and Market Infrastructures (2018), Central bank digital currencies. Available at: https://www.bis.org/cpmi/publ/d174.pdf

Commonwealth Bank (2018), CBA helps World Bank raise A$110 million with launch of 'Bond-I'. Available at: https://www.commbank.com.au/guidance/newsroom/cba-helps-world-bank-raise-a-110-million-with-launch-of--bond-i--201808.html

Commonwealth Bank (2018), The Trade-chain experiment. Available at: https://www.commbank.com.au/corporate/solutions/working-capital/trade-finance/trade-chain-experiment.html

Commonwealth Bank of Australia (2018), The CommBank app. Available at: https://www.commbank.com.au/digital-banking/commbank-app.html

Depository Trust & Clearing Corporation (2018), DTCC announces study results demonstrating that DLT can support trading volumes in the US Equity Markets. Available at: http://www.dtcc.com/news/2018/october/16/dtcc-unveils-groundbreaking-study-on-dlt

Fielding R (2000), Architectural Styles and the Design of Network-based Software Architectures.

Haisken-DeNew J, Ribar D, Salamanca N and Andrea N (2018), Using Survey and Banking Data to Understand Australians' Financial Wellbeing, Melbourne Institute: Applied Economic & Social Research, University of Melbourne.

Hanson RT, Reeson A and Staples M (2017), Distributed Ledgers, Scenarios for the Australian economy over the coming decades.

Mastercard 2012, Mastercard sees Black Friday performance up 26 percent. Available at: https://newsroom.mastercard.com/2012/11/26/mastercard-sees-black-friday-performance-up-26-percent/

Nakamoto S (2008), Bitcoin: A peer-to-peer electronic cash system. Available at: https://bitcoin.org/bitcoin.pdf

National Disability Insurance Agency (2018), COAG Disability Reform Council Quarterly Report, 30 June 2018. Available at: https://www.ndis.gov.au/medias/documents/coag-report-q4-y5-full/2018-Q4-June-COAG-report-Full.pdf

National Disability Insurance Agency (2018), NDIS Weekly Payment Summaries, 2018. Available at: https://www.ndis.gov.au/about-us/information-publications-and-reports.html

National Disability Insurance Agency (2018), Pricing and payment. Available at: https://www.ndis.gov.au/providers/pricing-and-payment

National Disability Insurance Scheme (2018), NDIS myplace participant portal, Step-by-step guide. Available at: https://www.ndis.gov.au/medias/documents/myplace-participant-steps-pdf/Participant-Portal-Step-by-Step-Guide.pdf

National Rural Health Alliance Ltd (2018), A Guide to Patient Assisted Travel Schemes, Available at: https://ruralhealth.org.au/sites/default/files/publications/nrha-guide-pats_0.pdf

National Disability Insurance Scheme (2016), NDIS Market Approach, Statement of Opportunity and Intent.

National Disability Insurance Scheme (2016), Media Release: Successful NDIS trial - on time and on budget, statement by David Bowen, inaugural CEO of the National Disability Insurance Agency (NDIA). Available at: https://www.ndis.gov.au/Media-Release/Successful-NDIS-trial-on-time

National Disability Insurance Scheme (2018), NDIS Overview. Available at: https://www.ndis.gov.au/operational-guideline/overview

National Disability Insurance Scheme (2016), NDIS Price Guide VIC/NSW/QLD/TAS Valid from: 1 July 2016. Available at: https://www.ndis.gov.au/html/sites/default/files/documents/Provider/201617-vic-nsw-qld-tas-price-guide.pdf

New Payments Platform Australia (2018), How it works. Available at: https://www.nppa.com.au/the-platform/how-it-works/

National Institute of Standards and Technology (2018), NISTIR 8202: Blockchain Technology Overview. Available at: https://nvlpubs.nist.gov/nistpubs/ir/2018/NIST.IR.8202.pdf

Parliament of Australia (2013), Part III: Emerging investment vehicles and innovation. Available at: https://www.aph.gov.au/Parliamentary_Business/Committees/Senate/Economics/Completed_inquiries/2010-13/capitalmarket2011/report/c06

Productivity Commission (2011), Disability Care and Support, Report no. 54.

Productivity Commission (2017), National Disability Insurance Scheme (NDIS) Costs, Study Report.

Productivity Commission (2017), The National Disability Insurance Scheme – a review of the costs, PC News- August 2017.

R3 (2018), Corda performance: to infinity…and beyond. Available at: https://www.r3.com/wp-content/uploads/2018/04/Corda-Performance-ENG.pdf

Reserve Bank of Australia (2017), An eAUD? Speech by Philip Lowe (Governor) in an address to the 2017 Australian Payment Summit, Sydney - 13 December 2017. Available at: https://www.rba.gov.au/speeches/2017/sp-gov-2017-12-13.html

Reserve Bank of Australia (2018), Cryptocurrencies and Distributed Ledger Technology, speech by Tony Richards (Head of Payments Policy Department) at the Australian Business Economists Briefing, Sydney – 26 June 2018. Available at: https://www.rba.gov.au/speeches/2018/sp-so-2018-06-26.html

Reserve Bank of Australia (2018), New Payments Platform. Available at: https://www.rba.gov.au/payments-and-infrastructure/new-payments-platform/

Reserve Bank of New Zealand (2018), The pros and cons of issuing a central bank digital currency. Available at: https://www.rbnz.govt.nz/-/media/ReserveBank/Files/Publications/Bulletins/2018/2018jun81-07.pdf

Rimba P, Tran AB, Weber I, Staples M, Ponomarev A and Xu X (2018), Quantifying the Cost of Distrust: Comparing Blockchain and Cloud Services for Business Process Execution. In: Information System Frontiers.

Royal D, Lim N, Staples M, Rimba P and Gilder S (2018), Making Money Smart: Indicative data analytics that could be supported by the smart money proof of concept, Companion document to the Making Money Smart report, Data61 (CSIRO).

Staples M, Chen S, Falamaki S, Ponomarev A, Rimba P, Tran AB, Weber I, Xu X and Zhu J (2017), Risks and opportunities for systems using blockchain and smart contracts, Data61 (CSIRO).

Summer Foundation (2018), Sample NDIS Plans. Available at: https://www.summerfoundation.org.au/resources/sample-ndis-plans/

Web Wide Web Consortium Web Accessibility Initiative (2018), Web Content Accessibility Guidelines (WCAG) Overview. Available at: https://www.w3.org/WAI/standards-guidelines/wcag/

Xu X, Weber I, Staples M, Zhu L, Bosch J, Bass L, Pautasso C and Rimba P (2017), A Taxonomy of Blockchain-Based Systems for Architecture Design. In: IEEE International Conference on Software Architecture.

Web Wide Web Consortium Web Accessibility Initiative (2018), Web Content Accessibility Guidelines (WCAG) Overview. Available at: https://www.w3.org/WAI/standards-guidelines/wcag/

A.1 Comparison of proof of concept with current state

This appendix compares the proof of concept with the current state of NDIS systems and processes, using the project's design criteria. The comparison seeks to evaluate the extent to which the proof of concept could enhance the current state.

The table outlines where the proof of concept is superior, equal or inferior to the current state through the use of plus, equals and minus signs respectively.

Table 8: Comparison of proof of concept with current state using design criteria

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENT STATE
1. Choice Maximises the potential of participants to make informed decisions about the services they access	+ Easier to self-manage their plan, which is the management approach that provides the most choice for participants. + Easier to make informed decisions using real-time, comprehensive and granular budget and payment information. + Easier to search, compare, choose and book services (including through direct interface and potential to integrate bookings with eMarkets).
2. Control Maximises the potential of participants to take control of their plans and delegate control as they choose	+ Easier to self-manage their plan, which is the management approach that provides the most control for participants. + Greater transparency of information to enable participants to ensure their plan activities match their preferences, regardless of management approach. + Ability for participants to control and blend their plan management approaches, including establishing and editing nominee rights. + Ability to provide greater access to aspects of self-management, through assisted self-management options, to participants that do not have the capacity for full self-management. + Ability for participants to review service providers and thereby increase their individual and collective consumer power.
3. Accessibility Is accessible to all participants regardless of their disability and all service providers, including plan managers and eMarkets	+ Greater access for people with vision impairment and people who prefer accessibility options available through smart phone (though prototype app would require further accessibility options before a full rollout could be considered). + Greater access through omni-channel experience (mobile app, web interface, eMarkets, provider websites, phone calls and face-to-face). + Potential for API access for service providers on NDIA panel, unregistered service providers, plan managers and eMarkets. + No bank account required for self-management or for plan managers.

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENT STATE
4. Simplicity Makes payments simple for participants, carers, plan managers, service providers and government	+ Simpler booking and payment experience for participants, including search, compare, pay, budgeting and receipting. + Simpler experience for carers and plan managers to understand and exercise their nominee rights. + Simpler for service providers to book services and receive payments, including the potential for: a graduated registration process; search-ability of services in app and eMarkets; ability to send booking requests (from website or after phone call or face-to-face conversation); automatic eligibility checks; real-time booking/payment authorisation; payment within seconds after delivering service; attached remittance information for automatic reconciliation; real-time data analytics to improve performance. + Simpler for government to administer the NDIS, including the potential for: removal manual reviews of payment/funding requests by participants, plan managers and service providers; removing the need for manual audits of spending activities; automated reconciliation of payments to service providers; and real-time data analytics to improve policies and processes.
5. Efficiency Reduces administration time and costs for participants, plan managers, service providers and government	+ Reduced time for participants to self-manage plans and engage with Agency and Plan Managers. + Reduced inefficiencies to service providers of handling bookings and payments and managing participant plans. + Reduced costs to government of making payments, handling enquiries and managing participant plans. + Conservative estimate of annual economic value of efficiencies is approximately $370 million (see Appendix A.4).
6. Confidentiality Ensures the confidentiality of personal and commercially sensitive information	+ Holding the majority of participant data off-chain would support confidentiality. + Using different private keys for each budget category in participant plans would reduce the extent of data leakage if a breach occurred and the potential for re-identification. = Security of data on blockchain, policy contracts and registries would be unlikely to be more or less secure than existing storage and access arrangements. – Systemising the collection and use of data would mean more data would be collected and used, and therefore more data would be at risk if a breach occurred. – Due to multiple nodes used in blockchain, proof of concept would have a greater surface area for cyber-attacks (which is similar to considerations around cloud computing when it was first implemented) and would require additional measures to ensure a baseline level of security across nodes. – The risk of unintended consequences would warrant a conservative implementation approach to prevent risks of: re-identifying data, particularly if algorithms used to protect confidentiality of data fail (e.g. access controls for small groups of participants or service providers); providing node access to the wrong parties (particularly if the proof of concept was applied to multiple conditional payment environments). While a conservative implementation approach could help manage these risks, it would also inevitably slow down access to other benefits outlined in this table.

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENT STATE	
7. Integrity Ensures funds are spent as intended and enables government to identify any potential instances of misspending	+	Transactions could only occur if the participant is eligible to access the service and the service provider is eligible to deliver the service.
	+	Data would be held on an immutable source of truth, ensuring data could not be easily manipulated for malicious purposes. Authorised updates to on-chain data (e.g. service price) would leave a clear audit trail as the blockchain is an append-only data structure.
	+	Data would be identifiable to all verified nodes at all times, ensuring greater transparency of information and reduced potential for people to commit fraud undetected, which in itself would act as a preventative factor.
	=	As per the current state, if a participant or service provider incorrectly records the nature of a transaction, errors could still occur (though these could be more quickly identified by the proof of concept).
	−	Payments could be set up to occur automatically and within seconds of authorisation, meaning that if an error occurred there would be no time for human intervention to prevent the incorrect payment.
8. Performance Achieves low latency, sufficient throughput and real-time payments	+	Lower latency than myplace portal for participants and service providers.
	+	Higher throughput due to automation of eligibility confirmation and payments processing.
	+	Potentially faster payments (within seconds after service is completed versus hours or days for existing payments).
9. Cost Can be implemented and maintained at low cost	+	Lower ongoing and maintenance costs, as existing payment system was not tailored to the requirements of the NDIS.
	+	Costs could be shared across multiple conditional payment environments, creating economies of scale.
	−	Implementation costs would need to be substantial, including the need to ensure the upfront design is robust and adaptable for multiple conditional payment environments.
10. Modifiability Can accommodate changes in policy settings and be applied across a range of conditional payment environments	+	The current system was not designed to be modifiable for other conditional payment environments.
	+	The proof of concept would likely be more adept at systemically incorporating any potential changes to NDIS plans or policies.

A.2 Comparison of proof of concept with centralised database

This appendix compares the proof of concept with a hypothetical centralised database solution, using the project's design criteria. The comparison seeks to evaluate the extent to which blockchain could add value.

In essence, the centralised database solution would operate identically to the proof of concept, only with a rules-based engine running the conditions rather than blockchain tokens with attached policy contracts. The assumptions behind the centralised database solution are:

- the solution could be implemented in the same timeframe as the proof of concept
- the database would be held within the NDIA and have a rules-based engine to manage NDIS plan rules
- data could be accessed through NDIA, participant, service provider and plan manager systems using application programming interfaces (APIs)
- payments would be integrated with the NPP in the same way as the proof of concept.

The table outlines where we the proof of concept is superior, equal or inferior to a centralised database through the use of plus, equals and minus signs respectively.

Table 9: Comparison of proof of concept with hypothetical centralised database

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CENTRALISED DATABASE SOLUTION	
1. Choice Maximises the potential of participants to make informed decisions about the services they access	=	A centralised database solution could deliver the same benefits as the proof of concept in relation to this criterion.
2. Control Maximises the potential of participants to take control of their plans and delegate control as they choose	=	A centralised database solution could deliver the same benefits as the proof of concept in relation to this criterion.
3. Accessibility Is accessible to all participants regardless of their disability and all service providers, including plan managers and eMarkets	=	A centralised database solution could deliver the same benefits as the proof of concept in relation to this criterion.
4. Simplicity Makes payments simple for participants, carers, plan managers, service providers and government	=	A centralised database solution could deliver the same benefits as the proof of concept in relation to this criterion.
5. Efficiency Reduces administration time and costs for participants, plan managers, service providers and government	=	A centralised database solution could deliver the same benefits as the proof of concept in relation to this criterion.

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CENTRALISED DATABASE SOLUTION	
6. Confidentiality Ensures the confidentiality of personal and commercially sensitive information	+	Holding the majority of participant data off-chain (and assuming sufficient controls over access to this information) for each budget category in a participant plan would make data less identifiable, if a breach of the blockchain occurred, while a centralised database would be more likely to directly integrate the data in one location.
	+	Using different private keys for each budget category in participant plans would reduce the extent of data leakage if a breach occurred and the potential for re-identification.
	–	Due to multiple nodes used in blockchain, the proof of concept would have a greater surface area for cyber-attacks (similar to considerations around cloud computing when it was first implemented) and would require additional measures to ensure a baseline level of security across nodes.
	–	The risk of unintended consequences would warrant a more conservative implementation approach than with the introduction of a centralised database solution, though both solutions would carry implementation risks.
7. Integrity Ensures funds are spent as intended and enables government to identify any potential instances of misspending	+	Data would be held on an immutable source of truth with high levels of transparency, making it very difficult to adjust or manipulate data and thus reducing risks of internal fraud.
	+	Data would be identifiable to all verified nodes at all times, ensuring greater transparency of information and reduced ability of people committing fraud to go undetected.
	–	Any erroneous or fraudulent payments that were made would be easier to reverse with a centralised database.
	=	Both solutions would share benefits of reducing the incidence of ineligible transactions while raising risks related to faster payments (e.g. where human intervention could not prevent errors before payment is made).
8. Performance Achieves low latency, sufficient throughput and real-time payments	=	Both solutions could achieve similar latency and throughput for an NDIS use case.
	=	Both solutions would achieve similar speed of payment no matter the use case, as both would make payments on the NPP.
	–	If the solutions were applied across multiple conditional payment environments, and volumes became larger, the blockchain proof of concept may have higher latency and lower throughput based on existing blockchain technology, though as blockchain technology continues to progress this performance gap is likely to tighten.
9. Cost Can be implemented and maintained at low cost	+	The modifiable nature of the blockchain component of proof of concept could enable network costs to be shared across multiple conditional payment environments.
	–	The proof of concept would involve upfront costs to ensure the design is robust and adaptable for multiple conditional payment environments, and to ensure implementation risks are managed appropriately.
10. Modifiability Can accommodate changes in policy settings and be applied across a range of conditional payment environments	+	Dynamic policy contracts would likely be easier to modify than rules in a centralised database, particularly across multiple conditional payment environments.
	+	The platform nature of a blockchain solution would enable users to create new policies as new needs arise and new conditional payments are incorporated.
	–	An immutable ledger and multiple nodes can make it more difficult to update the system, if changes to the underlying architecture are required.

A.3 Comparison of proof of concept with currency-on-blockchain solution

This appendix compares the proof of concept with a hypothetical blockchain solution that additionally incorporates currency on chain, using the project's design criteria. The comparison seeks to evaluate the merits of settling payments on-chain.

High-level assumptions behind the currency-on-blockchain solution are that the currency would:

- not be available in the short to mid term and would require the development of an appropriate governance framework
- enable conditional spending in the same way as this project's proof of concept
- be accessible to NDIS users through participant, service providers, and plan manager system interfaces
- be widely used by individuals and businesses across multiple payment environments, without the need for a bank account, as all settlement would occur on-chain.

Further consideration would need to be given to a number of factors, such as fungibility and liquidity, and the relationship and interactions with the existing Australian currency and the financial system more broadly.

The table outlines where we the proof of concept is superior, equal or inferior to a currency-on-blockchain solution through the use of plus, equals and minus signs respectively.

Table 10: Comparison of proof of concept with hypothetical currency-on-blockchain solution

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENCY-ON-BLOCKCHAIN SOLUTION	
1. Choice Maximises the potential of participants to make informed decisions about the services they access	=	A currency-on-blockchain solution could deliver the same benefits as the proof of concept in relation to this criterion.
2. Control Maximises the potential of participants to take control of their plans and delegate control as they choose	=	A currency-on-blockchain solution could deliver the same benefits as the proof of concept in relation to this criterion.
3. Accessibility Is accessible to all participants regardless of their disability and all service providers, including plan managers and eMarkets	=	A currency-on-blockchain solution could deliver the same benefits as the proof of concept in relation to this criterion.

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENCY-ON-BLOCKCHAIN SOLUTION	
4. Simplicity Makes payments simple for participants, carers, plan managers, service providers and government	=	A currency-on-blockchain solution could deliver the same benefits as the proof of concept in relation to this criterion.
	–	On-chain settlement would increase simplicity for payments, as separate payments on the New Payments Platform would not be required.
	+	The currency on blockchain system may create more complexity for users if they need to manage liquidity across the currency on blockchain and traditional store of funds (such as bank accounts).
	+	Additional policies for the currency-on-blockchain solution may create more complexity for users.
5. Efficiency Reduces administration time and costs for participants, plan managers, service providers and government	=	A currency-on-blockchain solution could deliver the same benefits as the proof of concept in relation to this criterion.
	–	A currency-on-blockchain solution would involve a single, rather than dual, system for transactions.
6. Confidentiality Ensures the confidentiality of personal and commercially sensitive information	+	The risk of unintended consequences would be highest for a currency-on-blockchain solution, necessitating an even more conservative implementation approach than the blockchain proof of concept.
	+	A currency-on-blockchain solution would likely have a higher level of use and a larger number of nodes than the proof of concept and therefore would involve higher risks to confidentiality of information.
	+	The wider applicability of a currency-on-blockchain solution would create higher incentives for people to try to breach the system and greater potential for re-identification of parties if the system is breached.
	=	Both solutions could hold data off-chain and use different private keys for each budget category to reduce the extent of data leakage if a breach occurred and reduce the risk of re-identification.
	=	Both solutions could have similar levels of security for data storage and access.
7. Integrity Ensures funds are spent as intended and enables government to identify any potential instances of misspending	=	Both solutions would reduce the incidence of ineligible transactions while raising risks related to faster payments (e.g. where human intervention could not prevent errors before payment is made).
	+	Erroneous or fraudulent payments using a currency-on-blockchain solution could be more difficult to reverse, and would require new governance arrangements.
8. Performance Achieves low latency, sufficient throughput and real-time payments	+	For blockchain transactions, the proof of concept would likely be faster as it would contain fewer processing nodes and involve a faster method for proving the validity of transactions.
	–	On-chain settlement would result in faster payment for service providers, as service providers would not need to cash tokens for payment on the New Payments Platform (although this is likely to be an immaterial difference give the scope for automation with, and speed of, NPP payments).

DESIGN CRITERIA	PROOF OF CONCEPT VERSUS CURRENCY-ON-BLOCKCHAIN SOLUTION
9. Cost Can be implemented and maintained at low cost	+ A currency-on-blockchain solution would likely require significantly greater upfront costs to ensure design is robust and adaptable for multiple conditional payment environments, as a currency-on-blockchain solution would likely be expected to operate across a larger number of conditional payment environments and so could be harder to update overtime. – The costs of a currency-on-blockchain solution could be shared across a larger number of conditional payment environments. – A currency-on-blockchain solution would not require development or maintenance costs for integrations with the NPP. + System integration costs could be higher for currency-on-blockchain solution, particularly during a transition to the new technology.
10. Modifiability Can accommodate changes in policy settings and be applied across a range of conditional payment environments	+ A currency-on-blockchain solution would have more nodes and greater security requirements, making it more difficult to create new policies and incorporate new payment environments. + The wider application of a currency-on-blockchain solution would result in more stakeholders and therefore make it more difficult to modify the system for new use cases.

A.4 Estimated economic value of efficiencies that proof of concept could deliver

Our model provides a sensitivity analysis based on results from user testing, namely:

- estimates of 1 hour to 15 hours per week in time saving for self-managing participants and carers, with an average of 3 hours
- estimates of 0.3% to 0.8% of cost savings as a percentage of revenue for medium-sized service providers.

Given the small sample size of our testing, the model applies conservative inputs using the above estimates:

1. The low-range analysis applies very conservative inputs
2. The mid-range analysis applies conservative inputs.

In addition, both analyses do not include:

- potential time and cost savings that could result for participants and carers who are plan-managed or agency-managed
- potential efficiencies that could result for government from streamlined payment processes, the removal of manual auditing processes or a potential reduction in budget and payment related queries from participants, carers and service providers
- potential cost savings or revenue benefits for service providers from ensuring they only provide eligible services.

The model is static; it assumes that the full benefits of the proof of concept would be immediately available. If the proof of concept was implemented gradually, then the efficiencies would not all be available immediately. The model estimates economic, rather than financial, benefits. Some of the efficiencies do not represent financial costs to the NDIS, such as the time of participants and carers. In addition, some of the cost efficiencies may not be recoverable or should not be recovered if they are deemed to represent the removal of existing inefficiencies in the NDIS.

The sensitivity analysis indicates that relatively conservative estimates place the potential economic benefits across the NDIS ecosystem from a full-scale implementation of a solution based on the proof of concept to be between roughly $160 million and $420 million per year. Further testing and analysis would be required to provide a more precise and robust estimate.

Table 11: Economic modelling for low-range sensitivity analysis

PLAN MANAGEMENT TYPE	SELF	PLAN	AGENCY	ALL	NOTES AND ASSUMPTIONS
Total NDIS participants by July 2020				460,000	From: National Disability Insurance Agency (2018) COAG Disability Reform Council Quarterly Report, 30 June 2018, Geelong
Estimated participant numbers	115,000	115,000	230,000	460,000	Assumes: 25% self-managed, 25% plan-managed &50% agency-managed
Plan Administration					
Estimated hours saved per user per week					
-Participants and Carers	0.50				Estimate: based on half the minimum time saving per week (1 hour) according to self-managing participants and carers that participated in user testing
-Private Plan Managers		0.25			Estimate: assumes time saving for private plan managers would be lower than for participants and carers
-Agency Plan Managers			0.10		Estimate: assumes time saving for agency plan managers would be lower than for participants, carers and private plan managers
Estimated economic value of user time (all users) $20.58					From: Level 1 - Pay Point 1, in: Pay Guide: Social, Community, Home Care and Disability Services Industry Award 2010
Estimated value of plan management efficiencies (AUD Million)					
-Participants and Carers	$62			$62	Calculation: Number of participants x hours per week x 52 x time value
-Private Plan Managers		$31		$31	Calculation: Number of participants x hours per week x 52 x time value
-Agency Plan Managers			$25	$25	Calculation: Number of participants x hours per week x 52 x time value
Total estimated plan mgmt efficiencies	**$62**	**$31**	**$25**	**$117**	
Payment processing and reconciliation (AUD Million)					
Total NDIS expenditure by July 2020 $22,000					From: National Disability Insurance Agency (2018) COAG Disability Reform Council Quarterly Report, 30 June 2018, Geelong
Estimated expenditure by plan management type	$5,500	$5,500	$11,000	$22,000	Assumes: 25% =self-managed, 25%= plan managed and 50% = agency-managed
Estimated service provider savings as % of revenue	0.20%	0.20%	0.20%		Estimate: based on less than the minimum rough efficiency estimates (0.3% cost savings as percentage of revenue) from select service providers, applied across NDIS ecosystem
Total estimated payment processing efficiencies	**$11**	**$11**	**$22**	**$44**	Calculation: NDIS expenditure x % savings estimated
TOTAL ECONOMIC VALUE OF ESTIMATED EFFICIENCIES	**$73**	**$42**	**$47**	**$161**	Calculation: Estimated plan management efficiencies + Estimated payment processing efficiencies

Table 12: Economic modelling for mid-range sensitivity analysis

PLAN MANAGEMENT TYPE	SELF	PLAN	AGENCY	ALL	NOTES AND ASSUMPTIONS
Total NDIS participants by July 2020				460,000	From: National Disability Insurance Agency (2018) COAG Disability Reform Council Quarterly Report, 30 June 2018, Geelong
Estimated participant numbers	115,000	115,000	230,000	460,000	Assumes: 25% self-managed, 25% plan-managed &50% agency-managed
Plan Administration					
Estimated hours saved per user per week					
-Participants and Carers	1.50				Estimate: based on half the average time saving per week (3 hours) according to self-managing participants and carers that participated in user testing
-Private Plan Managers		0.50			Estimate: assumes time saving for private plan managers would be lower than for participants and carers
-Agency Plan Managers			0.25		Estimate: assumes time saving for agency plan managers would be lower than for participants, carers and private plan managers
Estimated economic value of user time (all users) $20.58					From: Level 1 - Pay Point 1, in: Pay Guide: Social, Community, Home Care and Disability Services Industry Award 2010
Estimated value of plan management efficiencies (AUD Million)					
-Participants and Carers	$185			$185	Calculation: Number of participants x hours per week x 52 x time value
-Private Plan Managers		$62		$62	Calculation: Number of participants x hours per week x 52 x time value
-Agency Plan Managers			$62	$62	Calculation: Number of participants x hours per week x 52 x time value
Total estimated plan mgmt efficiencies	**$185**	**$62**	**$62**	**$308**	
Payment processing and reconciliation (AUD Million)					
Total NDIS expenditure by July 2020 $22,000					From: National Disability Insurance Agency (2018) COAG Disability Reform Council Quarterly Report, 30 June 2018, Geelong
Estimated expenditure by plan management type	$5,500	$5,500	$11,000	$22,000	Assumes: 25% =self-managed, 25%= plan managed and 50% = agency-managed
Estimated service provider savings as % of revenue	0.50%	0.50%	0.50%		Estimate: based on mid-range of rough efficiency estimates (0.3%-0.8% cost savings as percentage of revenue) from select service providers, applied across NDIS ecosystem
Total estimated payment processing efficiencies	**$28**	**$28**	**$55**	**$110**	Calculation: NDIS expenditure x % savings estimated
TOTAL ECONOMIC VALUE OF ESTIMATED EFFICIENCIES	**$212**	**$89**	**$117**	**$418**	Calculation: Estimated plan management efficiencies + Estimated payment processing efficiencies

A.5 Project Reference Group Membership

Members

The Reference Group included the following organisations, in alphabetical order:

- Ability First Australia
- Australian Digital Commerce Association
- Department of Human Services
- Department of Social Services
- Digital Transformation Agency
- Disability Advocacy Network Australia
- FinTech Australia
- National Disability Insurance Agency
- National Disability Services
- New Payments Platform Australia
- Reserve Bank of Australia
- The Treasury

Important note

This report does not necessarily reflect the views of the member organisations of the Reference Group. Membership of the Reference Group does not connote endorsement of the project. Reference Group member organisations had no responsibility for the project.

A.6 Participant persona for user testing

Name: Fahima Smith

Age: 26 years old

Disabilities:

- Cerebral Palsy (Gross Motor Function Classification System Level 3). Requires walking aids for general movements and car transport for anything over 300 metres.
- Autism (Level 1 based on the Diagnostic and Statistical Manual of Mental Disorders).

About Fahima

Fahima loves engaging with the community and socialising. She has a good group of friends that date back to high school and receives fantastic support from her parents. She has a passion for visual arts and has always wanted to be an interior designer. She is extremely intelligent and has a unique ability to combine bold colours in surprising and visually pleasing ways.

Fahima's current NDIS plan

Fahima has accessed support through the NDIS for several years. Her latest plan review was three months ago.

At the time of the review, Fahima was living with her parents. With the support of the NDIS and her parents, she had recently completed a Certificate IV in Interior Decoration and managed to line up a part-time graduate role at a local interior design company. Ecstatic with her accomplishment, Fahima was keen to gain even greater independence by living with her friends in a share house, with some ongoing support from her parents. Her friends, Suzie and Magaly, are both very responsible and wished to make Fahima's transition a success.

In discussions with NDIS Planner, Fahima noted that:

1. she no longer required support to transition through her studies but was keen to access counselling support to ensure she could make her new job a success
2. she would require minor home modifications in her new share house
3. she would need to maintain physiotherapy support and relationship counselling support
4. she was keen to access hydrotherapy, as her physiotherapist and GP recommended it to maintain her muscle mass
5. she was keen to maintain her visual arts classes to maintain engagement with the community
6. her walking aids (forearm crutches for short walks and power scooter for longer trips) would need repairs/replacement during the next year.

Fahima's goals

Fahima's first goal is to successfully live in a share house with her friends, where she has her own job and pays her own rent.

Fahima's second goal is to maintain her physical health and muscle mass and better manage her emotions.

Fahima's longer term goal is to build even greater independence so her parents no longer need to support her and can just be her parents.

Fahima's plan supports

In consultation with Fahima, the NDIA prepared the following budgets for Fahima's plan.

Budget	Category	Services	Total
Core	Daily activities	• Daily Living education • Assistance with self-care	$24,500
	Assistance with social and community participation	• Assistance with art classes	
	Consumables	• Continence aids	
Capacity Building	Daily activity	• Physiotherapy • Hydrotherapy	$17,750
	Employment	• Employment counselling	$7,500
	Relationships	• Behavioural counselling	$3,750
Capital supports	Assistive technology 1	• Replacement of fore arm crutches	$350
	Assistive technology 2	• Maintenance of power scooter	$1,350
	Home support 1	• Stair rails	$2,200
	Home support 2	• Bathroom rails	$2,800
		Total supports	**$60,200**

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