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New Zealand's Innovation Agency

Digital Assets and Decentralised Finance

The opportunities and the
challenges for New Zealand

White Paper | March 2023

"I think that blockchain is nothing less than the second generation of the Internet. It will change every institution, in some ways more so than the first generation did."¹

Rik Kirkland, Director of Publishing at McKinsey & Company

"Crypto-assets are potentially changing the international monetary and financial system in profound ways."

International Monetary Fund Blog

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¹<https://www.mckinsey.com/industries/technology-media-and-telecommunications/our-insights/getting-serious-about-blockchain>



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Foreword

Technological disruption is often at the heart of major changes in economic activity, consumer behaviour or cultural values. Ever since the very first disruptive technologies, like the ability to make fire, humans have had to evaluate the pros and cons of our discoveries. Despite this, some of the technologies we've adopted have subsequently needed to be rolled back or severely controlled to avoid significant consequences for society and life on our planet.

Disruptive technologies pose an interesting challenge to public sector administration and governments around the world, as politicians and lawmakers have to find the right balance between reaping the benefits and limiting potential harm to society.

At this point in the 21st century, we are getting to grips with a host of disruptive technologies, both small and large-scale. Arguably, one of the most impactful disruptions is around digital assets, particularly blockchain/distributed ledger technologies (DLT). In fact, we can see 2022 as a watershed moment for these technologies. After about 12-13 years of exploration by neophiles, they are on the cusp of achieving widespread and mainstream adoption.

This discussion paper outlines the current level of technology adoption, existing and potential use cases, and previous attempts to regulate and tax DLT. It follows our first report on blockchain technologies, published in 2017¹. In the last five years, both technological advances and adoption rates have grown exponentially, and we believe it is time to ask how Aotearoa New Zealand should deal with this disruption.

The material reviewed for this paper, our interactions with leading entrepreneurs and companies, and underlying evidence-based trends suggest it is time for a considered intervention by the New Zealand Government. We believe that the mass adoption of DLT is more likely than its demise. This presents an opportunity for our government to ensure

New Zealand captures the wide-ranging benefits while mitigating or limiting the risks to consumers and society.

Faced with significant technological paradigm shifts, government intervention can help the private sector by creating certainty in its operating environment, particularly around legislation, regulation and taxation. For innovation to thrive, private sector firms need to know how their commercial activities will be taxed. They need clarity about the legislation and regulations they must adhere to while exploring new product and service offerings. Only our government can provide this certainty, and our choices will most likely affect the extent to which New Zealand can capture above our fair share of economic or societal benefits.

In 2011, our namesake Sir Paul Callaghan gave a pivotal presentation in which he highlighted seven myths of life in New Zealand, beautifully characterised by his famous quote, "We are poor because we choose to be poor". Basing his thinking on socio-economic indicators, Sir Paul asserted that our choices of industries, technologies and approaches largely determine our wellbeing as a nation. Last year's Productivity Commission Report on frontier firms highlighted the fact that we have made little progress on the same key socio-economic indicators. In some cases, such as productivity measures, we have regressed over the last 30 years. We can attribute most of our growth in GDP to working harder/longer hours – not to capturing more value from our work.

We believe DLT represents one of the most significant opportunities for Aotearoa to "leapfrog" itself to significantly higher standards of living and improved wellbeing for us all. The Decentralised Finance sector (DeFi) brings together two of the highest margin/highest wage domains to create a new industry that is entirely weightless, fully globalised and highly sustainable. It's also profoundly egalitarian because no country has any innate advantages that allow it to capture more of this market than others. The "winners" in this new industry are likely to be determined by their ability to attract and keep talent and by the extent to which they can create attractive and stable environments for exploring this technology. There are no natural barriers to New Zealand satisfying these criteria.

Our country is perhaps the most desirable location for the global tribe of tech-savvy digital nomads – talent that wants to live and work in Aotearoa. We are already the easiest place in the world to do business [Worldbank Ease of Doing Business Report] and among the least bureaucratic, most stable political systems.

This is not a pipedream; we have done this before. For example, rapid, unbureaucratic legislation and regulation enabled New Zealand's booming aerospace sector. Few countries could go from no significant involvement in an industry to joining heavyweights like NASA and SpaceX in just 10 years. Rocket Lab and other Kiwi aerospace companies are perfect examples of capturing high-value, high-wage market opportunities with comparatively little effort or investment from our government.

We can replicate this success story for the emerging DeFi industry in New Zealand. Let's take up the challenge to shift our economy towards high-tech and high-wage industries that can help raise the standard of living and allow us to fund public services that contribute to our social wellbeing.

The main purpose of this paper is not to offer specific solutions or recommendations. It is designed to ignite a discussion and encourage a plan for action that enables the New Zealand Government to take advantage of the opportunities this disruptive technology presents.

“New Zealand's strength lies in the weird stuff

Sir Paul Callaghan

Ngā mihi

Dr Stefan Korn
CE Callaghan Innovation

¹ Callaghan Innovation (2017). Distributed Ledgers and Blockchains Opportunities for Aotearoa New Zealand. www.callaghaninnovation.govt.nz/sites/all/files/distributed-ledgers-and-blockchains-report-december-2018.pdf.

Chapter 1

Introduction

From the rise of cryptocurrencies like Bitcoin and Ethereum, to marketplaces selling artwork as non-fungible tokens (NFTs) and blockchain-based lending, digital assets and decentralised finance have gone mainstream.

In 2022, the world had over 12,000 cryptocurrencies. Billions in venture capital funding has poured into blockchain ventures and several countries are considering launching their own Central Bank Digital Currencies (CBDCs).

But volatility in this fast-moving new market remains high. The value of cryptocurrencies crashed in the first half of 2022 from a record of US\$3 trillion to under \$1 trillion. As with any ascending technology, we are in the midst of a period of trial and error. Many projects will fall by the wayside as the technology matures and a sustainable innovation ecosystem develops.

The lack of regulation of digital assets and decentralised finance poses major risks to consumers and businesses and a dilemma for governments seeking to ensure the integrity of their financial systems. But the underlying Distributed Ledger Technology (DLT – see Appendix 2), which refers to the infrastructure and protocols that allow for simultaneous access and validation of transactions in an immutable manner across a dispersed network, is expected to transform most industries in some form. From innovative new peer-to-peer lending services to supply chain traceability and better transparency in governance systems, DLT is an answer to some of the technological constraints we face today.

The New Zealand Government therefore has a prime opportunity to facilitate the best use of DLT by providing appropriate support, regulation or stimulation of technologies and applications, particularly as they apply to the financial sector that is at the heart of our economy.

This paper seeks to lay out the various technological, economic and regulatory issues relating to DLT and blockchain that need to be considered as New Zealand formalises its approach to using these technologies.

Let's talk about the blockchain

For the purpose of this paper, the term "blockchain" (see Appendix 2) is used to refer to a particular type of distributed ledger composed of unchangeable, digitally recorded data in packages called blocks² that are then 'chained' to the next block, using a cryptographic signature.

This process allows blockchains to be used like a ledger, which can be shared and accessed by anyone with the appropriate permissions.³ The easiest way to think of a DLT/blockchain, is as a type of "network computer" that stores and processes information across many nodes in parallel. In most cases the information stored in ledgers is publicly accessible and as such provides a level of transparency not currently possible across most other technologies.

Thus, blockchains have significant advantages over information processing protocols currently in use that ultimately store and process data in centralised hardware. As with many innovations, the underlying concepts and technologies can initially be difficult to grasp for those not intimately involved with developing them.

However mass adoption of new innovations does not rely on detailed understanding of underlying technologies as has been the case with many inventions to date, including TVs, computers and the internet.

² <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>

³ <https://www.acs.org.au/insightsandpublications/reports-publications/blockchain-2030.html>

Distributed Ledger Technology — a brief history

To understand why adoption of DLT, and related investment from venture capitalists and large corporations is potentially reaching an inflection point, it is useful to reflect on the relatively short history of this technology and its growth over the last decade.

In 2009, DLT and Blockchain Technology were applied to create the first cryptocurrency “Bitcoin” - a digital currency...based on an influential white paper authored by the anonymous person(s) Satoshi Nakamoto⁴. For the past 13 years, Bitcoin and related “cryptocurrencies”⁵ have been in the process of experimentation and development as practitioners from all sectors of society explored the potential of financial services based on decentralisation, blockchains and encryption.

The initial publication of Nakamoto’s Bitcoin paper has spawned a wide range of other digital currencies with different protocols, as well as a host of diverse financial services, mechanisms and applications. An indication of the scale of experimentation and adoption is provided by the total market capitalisation of DLT based digital currencies, which exceeded US\$3 trillion in late 2021⁶. Major market corrections have since triggered a “crypto winter” that depressed investor appetite for cryptocurrencies throughout 2022.

The underlying protocols

At the heart of DLT and blockchain-based protocols is the facilitation and automation of financial transactions. The specific mechanisms provided by DLT enable a system of transactions that is not necessarily reliant on centralised brokers of authentication and trust, such as banks or government agencies, which provide that service in the current financial system.

As such, some DLT-related digital currencies choose to operate outside of the mainstream financial system.⁷ The decentralised nature of DLT also means that the infrastructure required to run the entire system is not reliant on any particular piece of hardware. In other words, a DLT-based system can continue to operate if parts of its infrastructure become unavailable, as information is stored in parallel across many nodes of the network. Blockchain networks don’t have any single points of failure.

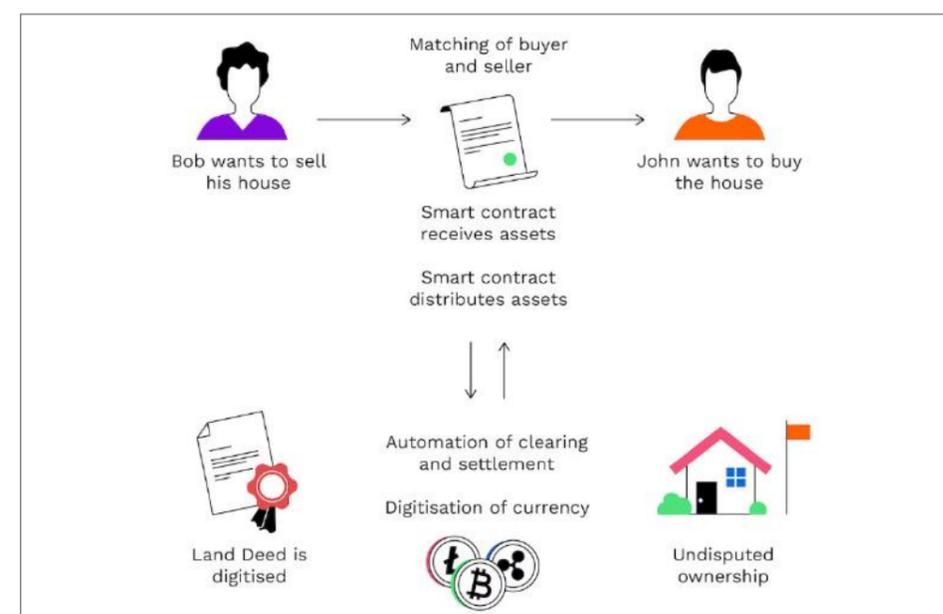
An example of DLT applied outside of financial transactions is provided by the concept of “non-fungible tokens” (NFTs)⁸. Whilst digital currencies use blockchains to encode financial transactions, NFTs use blockchains to encode any type of digital information – typically images, videos or music. The invention of NFTs has created an entirely new market for digital assets that can be authentically owned, distributed and traded by individuals. Moreover the protocols used in NFTs can also provide value distribution mechanisms to reward the original creators for the entire lifetime of a digital asset. In other words, every time a digital asset is traded the original creators of that asset can benefit from any value uplift at the time of the trade. This is a unique feature of NFTs that has not been possible to date.

Given the protocol-based nature of DLT, the application of these technologies can extend much further than facilitating basic ledger entries. The invention of “smart contracts”⁹, as first discussed in the “Ethereum” white paper published in 2014¹⁰, is an example of a much wider application of DLT.

Smart contracts

Smart contracts are contracts recorded on a blockchain network that are automatically executed when certain conditions are met¹¹. Simply put, smart contracts provide an automated and agnostic mechanism for all parties to settle or execute agreements that have been made. In principle, the concept of smart contracts can be applied to any type of transaction or record keeping (e.g. land titles, electricity markets, identity records, etc)¹².

A further extension of DLT-based digital currencies and smart contracts is provided by the concept of “decentralised applications” (dApps), which combine and orchestrate a range of processes (typically run on blockchain network infrastructure) to offer services to users. Unlike most current computer applications that run on centralised servers and store personal information, dApps run on blockchain networks across many computers and do not store specific user-related information in centralised databases.¹³



Source: www.bitpanda.com/academy/en/lessons/what-are-smart-contracts-and-how-do-they-work/

In summary

The most important innovations related to DLTs over the last 10 years have been:

- Digital currencies
- Non-fungible tokens
- Decentralised applications – dApps
- Smart contracts

Appendix 1 and 2 provide further explanations of these concepts and applications. The remainder of this paper provides an overview of current states of adoption of these innovations and approaches to regulation or stimulation.

⁹ <https://www.investopedia.com/terms/s/smart-contracts.asp>

¹⁰ <https://ethereum.org/en/whitepaper/>

¹¹ <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>

¹² <https://www.mckinsey.com/industries/financial-services/our-insights/the-promise-of-blockchain>

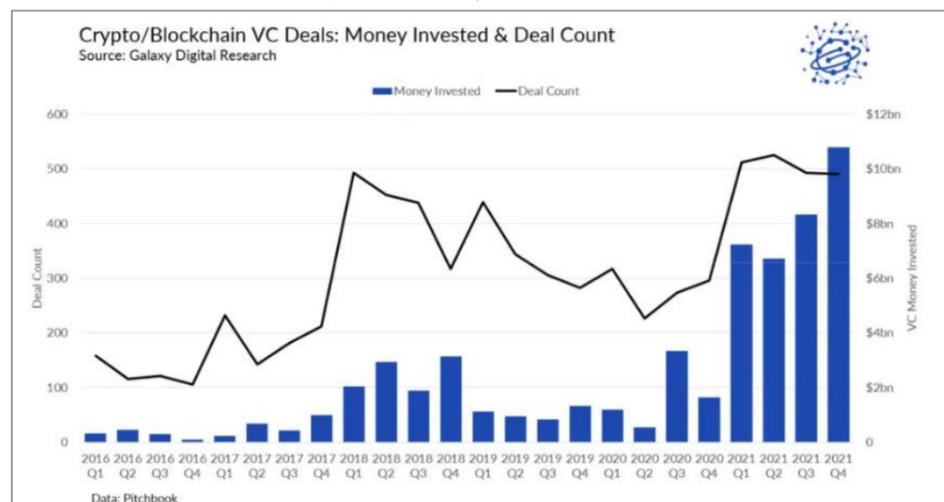
¹³ <https://www.investopedia.com/terms/d/decentralized-applications-dapps.asp>

The digital assets boom – emerging global adoption

To get a sense of the scale of adoption of DLT-related applications, it is useful to look at key metrics of digital currencies, NFTs, smart contracts and decentralised applications (dApps).

By November 2021, digital currencies grew by 600% over 12 months and had a total market capitalisation of US\$2.8 trillion (NZ\$3.98 trillion)*¹⁴. At the time of writing, the crypto market cap has plummeted 70% from those 2021 market highs. In October 2021, decentralised finance applications (DeFi), reached US\$219.8 billion (NZ\$313 billion) in total value locked (TVL)¹⁵, with a market capitalisation of US\$168 billion (NZ\$238 billion)* across all DeFi tokens¹⁶. As at November 2021, all traded NFTs had an estimated market capitalisation of US\$65 billion (NZ\$92 billion)*.¹⁷

There are other observable metrics that point to further widespread adoption of DLT. DApps within the blockchain ecosystem recently saw more than 2 million daily users¹⁸. According to the new International Data Corporation (IDC) Spending Guide, global spending on blockchain solutions was estimated at around US\$6.6 billion (NZ\$9.38 billion) in 2021 (an increase of 50% from 2020) and forecast to reach US\$19 billion (NZ\$27 billion) per annum by 2024.¹⁹



Source: [www.https://finance.yahoo.com](https://finance.yahoo.com)

Venture capital (VC) investment in DLT and blockchain technologies has already reached US\$16 billion (NZ\$22.74 billion), outpacing 2020's peak of US\$3.7 billion (NZ\$5.26 billion).²⁰

One of the world's most renowned venture capital firms – Andreessen Horowitz – announced a dedicated US\$2.2 billion “crypto fund” in June 2021, followed by a US\$2.5 billion crypto fund established by VC firm Paradigm in November 2021.²¹

¹⁴ <https://coinmarketcap.com/>

¹⁵ <https://www.nasdaq.com/articles/what-is-total-value-locked-2021-09-29>

¹⁶ <https://coinmarketcap.com/view/defi/>

¹⁷ <https://coinmarketcap.com/view/collectibles-nfts/>

¹⁸ <https://dappradar.com/blog/dapp-industry-overview-october-2021-on-nfts-defi-and-games>

¹⁹ <https://www.idc.com/getdoc.jsp?containerId=prUS47617821>

²⁰ <https://news.crunchbase.com/news/crypto-blockchain-top-vc-investors-a16z-tiger-global-coatue/>

²¹ <https://www.nytimes.com/2021/12/01/business/dealbook/crypto-venture-capital.html>

Meanwhile, in mainstream capital markets, exchange traded funds (ETFs) for cryptocurrencies are emerging as well. On 19 October 2021, trading began on the ProShares Bitcoin Strategy ETF, making it the very first bitcoin-related ETF²².

US a hotbed of DLT activity

In the US, actual spending by companies (not including investment raised) on blockchain solutions (not including cryptocurrency organisations) is expected to reach nearly \$2.6 billion in 2022²³.

Private capital has been used to develop DLT and blockchain applications across supply chain monitoring, security, data sovereignty, digital identity/record keeping, and general process efficiency among others.

It is also worth noting that the new US administration has appointed Gary Gensler as head of the US Securities and Exchange Commission (SEC). Gensler, an MIT Sloan professor and previous lead of the Commodity Futures Trading Commission under the Obama administration, has spent time at MIT teaching and researching blockchain technology, digital currencies, financial technology and public policy²⁴.

In 2020, the Australian Department of Industry, Science, Energy and Resources (DISER) published *The National Blockchain Roadmap* a document outlining the country's position and overall strategy around regulating, investing in and developing blockchain technology from current state into the future²⁵. Since the publication of the roadmap, the Australian Government has been lending significant support for and investments in blockchain technologies. In 2021, the government issued AU\$5.6 million* (NZ\$5.8 million) in grants to support blockchain pilot projects²⁶, and the Australian Stock Exchange (ASX) became the world's first stock exchange to move its monitoring systems over to blockchain technology management.²⁷ However the ASX project may have since been discontinued.

Governments moving on DLT worldwide

Other countries have also been laying the groundwork to support DLT/blockchain-based technologies for future economic activity.

In China, President Xi gave a 2019 speech emphasising the opportunities that blockchain presented and the importance of realising these opportunities for China's future.²⁸ Through September 2021, IDG Capital, a Chinese-based VC, which currently holds US\$20 billion in assets under management, has made 29 major investments in blockchain companies.²⁹

²² <https://www.investopedia.com/investing/bitcoin-etfs-explained/>

²³ <https://www.idc.com/getdoc.jsp?containerId=prUS47617821>

²⁴ <https://mitsloan.mit.edu/ideas-made-to-matter/biden-sec-pick-gary-gensler-fintech-regulation-and-blockchain>

²⁵ <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>

²⁶ <https://www.coindesk.com/markets/2021/07/13/australian-government-grants-41m-to-2-blockchain-pilot-projects/>

²⁷ <https://www.minister.industry.gov.au/ministers/karenandrews/speeches/adc-global-blockchain-summit>

²⁸ <https://www.cnn.com/2019/12/16/china-looks-to-become-blockchain-world-leader-with-xi-jinping-backing.html>

²⁹ <https://www.blockdata.tech/blog/general/venture-capital-funds-investing-in-blockchain-companies>

In July 2021, the Bank of Korea awarded Ground X, a blockchain subsidiary of Korea's largest social media platform Kakao, with a 4.96 billion* won (NZ\$5.88 million) tender to develop a central bank digital currency (CBDC – see Appendix 2)³⁰. In the UK, 15 government agencies are actively involved with blockchain initiatives and 150 blockchain companies have collectively received £1.6 billion in total funding³¹.

In 2021, despite warnings from the International Monetary Fund (IMF)³², El Salvador became the first country to adopt Bitcoin as legal tender³³, and as of early 2021, in Switzerland, local taxes for the canton of Zug can be paid in either Bitcoin or Ether³⁴.

*All figures converted into NZD based on an exchange rate as of 30 November 2021.

When considering the current investment landscape for DLT/blockchain-related applications, it seems plausible that this technology is progressing well beyond the early adopter stage. When it comes to the adoption of cryptocurrencies, a 2020 study of 154 countries found statistically relevant usage of DLT/blockchain in 142 of the countries studied³⁵. The same study in 2021 concluded that:

“**At the end of Q2 2021, (the data is) suggesting that global adoption has grown by over 2300% since Q3 2019 and over 881% in the last year. Our research suggests that reasons for this increased adoption differ around the world – in emerging markets, many turn to cryptocurrency to preserve their savings in the face of currency devaluation, send and receive remittances, and carry out business transactions, while adoption in North America, Western Europe and Eastern Asia over the last year has been powered largely by institutional investment.**”³⁶

Based on current adoption rates and the general state of the DLT/blockchain industry, it seems that much of the innovation and development in this space is yet to take place. There are a number of interesting parallels between the current state of DLT/blockchain and the emergence of the internet towards the end of the last century.

As with most disruptive innovations, there are obvious challenges, also discussed later in this paper, which must be addressed urgently before mainstream adoption of DLT/blockchain-related applications can take place. In particular, cryptocurrencies have been used to facilitate scams, create new types of cyber attacks, disrupt digital privacy and identity, and have created major regulatory challenges³⁷.

However the rate of current adoption in relation to capital deployed and investments made, highlights that despite the risks, there is substantial interest in further developing these technologies, and it seems less likely that DLT/blockchain will simply be a temporary technology fad.

³⁰ <https://www.ledgerinsights.com/bank-of-korea-blockchain-cbdc-simulations-ground-x/>

³¹ <https://analytics.dkv.global/Blockchain-in-the-UK-2021/Full-Report.pdf>

³² <https://www.ft.com/content/c36c45d2-1100-4756-a752-07a217b2bde0>

³³ <https://www.reuters.com/world/americas/el-salvador-approves-first-law-bitcoin-legal-tender-2021-06-09/>

³⁴ <https://www.coindesk.com/markets/2021/02/18/switzerlands-crypto-valley-has-started-accepting-bitcoin-ether-for-tax-payments/>

³⁵ <https://blog.chainalysis.com/reports/2020-global-cryptocurrency-adoption-index-2020>

³⁶ <https://blog.chainalysis.com/reports/2021-global-crypto-adoption-index>

What makes DLT and blockchain unique?

Despite the significant investment and capital deployed across DLT and blockchain applications, the underlying technology is still in its early stages of development.

As companies and developers attempt to work out which business models and applications are likely going to provide the most lucrative opportunities, it is useful to consider what differentiates DLT and blockchain technology from other approaches, systems or architectures.

In its 2018 report on blockchain³⁸, McKinsey summarised the core advantages of DLT/blockchain as:

- Decentralisation
- Cryptographic security
- Transparency
- Immutability

“**The technology allows information to be verified and value to be exchanged without having to rely on a third-party authority. Rather than there being a singular form of blockchain, the technology can be configured in multiple ways to meet the objectives and commercial requirements of a particular use case,”** McKinsey pointed out.

When considering the attractiveness and commercial opportunities for various applications and use cases it is worth bearing unique characteristics in mind as it is often relatively easy to gauge whether there are truly unique advantages for using DLT/blockchain over other (established) approaches.

In summary



- US firms are leading in terms of investing in DLT/blockchain technology.
- Many governments, including Australia's are funding early-stage DLT projects.
- DLT/blockchain is moving beyond the early adopter stage.

³⁸ Blockchain beyond the hype: What is the strategic business value? (<https://www.mckinsey.com/industries/financial-services/our-insights/the-promise-of-blockchain>)

Chapter 2

A deep dive into sector-specific applications

Distributed ledger technology and blockchain have potential applications across virtually every industry and sector of the economy. But the early innovation and deployment of the technology have reached maturity in a handful of areas, which we explore in this section.

Banking and Financial Services

The first generation of the internet brought about a massive shift in how banking and financial services functioned. Within a generation, paper cheques and retail banking services, in general, were reduced significantly (and are being phased out completely in many countries in the OECD) as people and businesses began to do the majority of their banking online.

Even governments made it easy for citizens to pay taxes online, and phrases like “the cashless society” have entered the mainstream vocabulary. With the emergence of DLT/blockchain-based applications, it seems possible now that a second wave of innovation will significantly affect financial institutions and services.

Cross-Border Transactions and International Payments

While DLT/blockchain is still in its early stages of development, the technology is already regarded as a promising way to address existing cross-border payment issues. Most of the current issues³⁹, ultimately a consequence of legacy IT systems built in the 1960-70s, translate into lengthy processing times and considerable transaction costs to consumers for simple financial transactions.

One of the most popular emerging DLT applications in this space is Central Bank Digital Currencies (CBDC – see Appendix 2).

“CBDCs can slash the time needed for cross border payments to seconds from days and cut costs,” says the Bank of International Settlements (BIS).⁴⁰

The concept of CBDCs has widespread appeal because of the involvement of existing institutions rather than their circumvention. With CBDCs, governments and governmental institutions can provide/enforce a regulatory framework whilst making use of the advantages of decentralised transactions and infrastructure. According to a 2015 study by Bank Santander and Oliver Wyman, DLT could reduce banks’ infrastructure costs attributable to cross-border payments, securities trading and regulatory compliance by US\$15-20 billion per annum by 2022⁴².

Financial Services – lending, payments, exchanges, derivatives

Historically, the global financial sector has relied on central authorities and intermediaries operating as “honest brokers” to hold information and facilitate operations when transacting assets, currencies and legal tender.

The application area of “decentralised finance” (DeFi) has emerged to address some of the challenges that inevitably appear with centralised authorities and intermediaries, such as vulnerability to attacks, equitable access issues, scalability/flexibility of processing infrastructure, etc.

DeFi applications closely resemble products, functions and services in traditional financial marketplaces, but the central points of authentication are removed and all transactions are processed by a blockchain network of distributed nodes. Popular forms of DeFi applications include decentralised exchanges (DEXs), lending platforms, payment transfers, treasuries and reserve currencies (in the form of “stable coins”⁴³), derivatives, futures markets and yield-earning financial instruments⁴⁴. See Appendix 2 for more detailed information on these concepts.

⁴⁰ <https://www.scmp.com/economy/china-economy/article/3150405/central-bank-digital-currencies-can-make-cross-border>

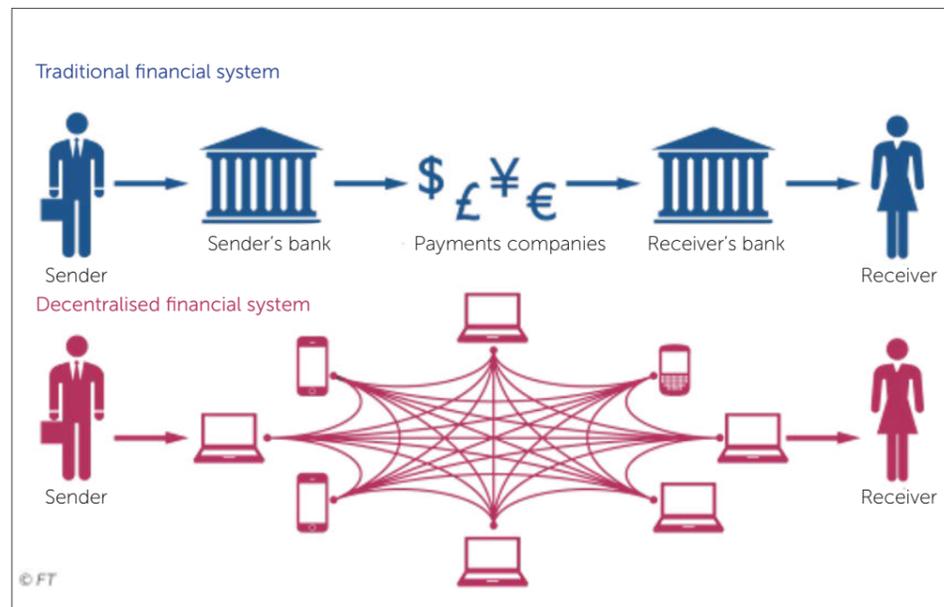
⁴¹ <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0252489#sec002>

⁴² <https://www.finextra.com/finextra-downloads/newsdocs/the%20fintech%20%20paper.pdf>

⁴³ <https://en.wikipedia.org/wiki/Stablecoin>

⁴⁴ <https://www.investopedia.com/decentralized-finance-defi-5113835>

How decentralised finance works



Focus point: US — opportunities and obligations

While DeFi offers a range of opportunities to address systemic issues of current mainstream financial systems, there are risks and challenges that must be considered by regulators, policy makers, investors (individuals and businesses) and financial markets.

A recent SEC announcement by Commissioner Caroline Crenshaw released in November 2021 concludes that:

“Reimagining our markets without appropriate investor protections and mechanisms to support market integrity would be a missed opportunity, at best, and could result in significant harm, at worst. In conceiving a new financial system, I believe developers have an obligation to optimise for more than profitability, speed of deployment, and innovation. Whatever comes next, it should be a system in which all investors have access to actionable, material data, and it should be a system that reduces the potential for manipulative conduct.”⁴⁵

⁴⁵ <https://www.sec.gov/news/statement/crenshaw-defi-20211109>

Logistics and Supply Chain Management

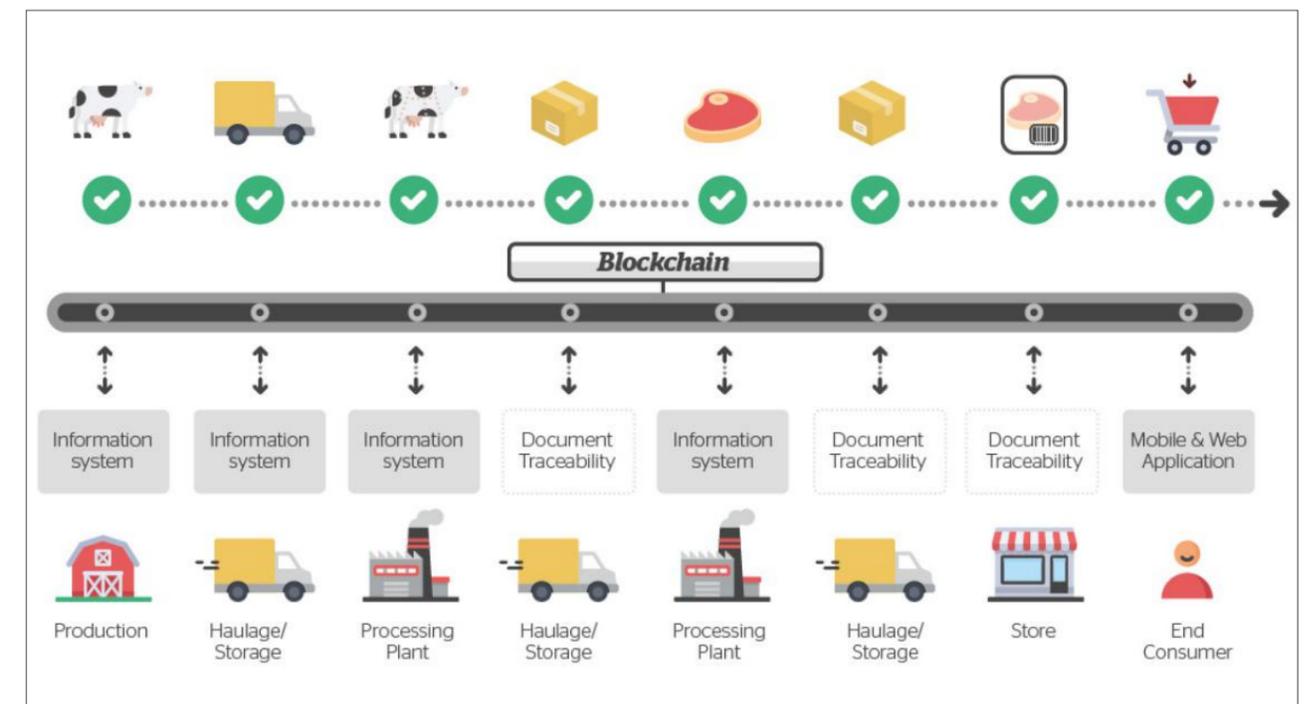
DLT and blockchain technologies offer viable options for more transparent and resilient supply chains that allow tracking, tracing and verifying goods from their original source all the way to consumers.

By 2023, it is estimated that blockchain will support the global movement and tracking of US\$2 trillion worth of goods and services annually⁴⁶. This shift in how trade goods are tracked is happening because the current systems in place fall short of meeting the needs of a highly globalised society. Blockchain applications can potentially be used to produce better product quality, supply chain efficiency, protection against counterfeit, and timely defect containment and resolution.⁴⁷

Supply chain authentication appears to be a natural fit for DLT/blockchain-based solutions, as evidenced by the emergence of a number of credible and innovative startups around the world such as Everledger, LuxTag and AirSwap. There are now established use cases for a range of products (e.g. in apparel, art, diamonds and gemstones, luxury goods and wines/spirits) that use DLT/blockchain-based supply chain authentication solutions⁴⁸.

This application is perhaps particularly relevant for high-value goods and those where ethical and/or environmental credentials need to be tracked and verified.

How blockchain can enable better product traceability through the supply chain



Source: <https://worldline.com/en/home/knowledgehub/blog/2018/january/blockchain-the-technology-set-to-shake-up-the-logistics-ecosystem.html>

⁴⁶ <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>

⁴⁷ Frost & Sullivan. Global Mega Trends to 2030, Futurecasting Key Themes that will Shape Our Future Lives. Mega Trends / K1D4 / 00. 25 September 2019.

⁴⁸ <https://everledger.io/industry-solutions/>

Focus points: Australia and China value traceability

In Australia's national roadmap⁴⁴, blockchain technology is highlighted as an enabler to support export of Australian products and produce. A key focus for the Australian Government remains on authentication and verification of original Australian produce and exploring how DLT/blockchain technologies can be used for that purpose.

The roadmap states that "... the costs to Australian food and wine producers of direct product counterfeiting and substitution, was estimated to be over AU\$1.68 billion (NZ\$1.74 billion) in 2017 alone."

China has been at the forefront of implementing blockchain-based supply chain solutions for a number of years. In 2018, Alipay launched the first blockchain-based drug prescription service in China,⁴⁹ which has subsequently been reported to facilitate a significant volume of prescription-related procurement in several provinces in China.⁵⁰

“ This project tracks prescriptions throughout the supply chain to ensure a tamper-proof process and prevent misuses of prescriptions and unauthorised refills.⁵¹ ”

In 2019, Walmart China's food safety traceability platform, powered by VeChain's Thor blockchain technology, was launched, and it was the first platform to apply blockchain technology to food traceability that now hosts over 100 products⁵².

Gaming and Esports

Over the last few years, online gaming and esports have seen tremendous growth rates around the world and 2021 witnessed the convergence of gaming with cryptocurrencies.

In particular, the emergence of the "metaverse"⁵³, with its various online gaming worlds that started to use cryptocurrencies to manage in-game purchases, is a significant development. The convergence of virtual reality, gaming and blockchain-based technology could become a mega trend throughout the 2020s-2030s.

In late 2021, several high-profile companies announced their advances into metaverse technology including Microsoft, NVidia and Facebook (famously rebranding itself to "Meta").

The metaverse is seen as an entirely virtual ecosystem, which has a game-like appearance but could eventually be extended to an all-encompassing virtual marketplace to transact practically all products and services we use today in actual reality.

DLT and blockchain technologies offer elegant solutions to a range of challenges in the metaverse that originate from the need to facilitate proof of ownership and transfer of assets, make governance decisions that affect metaverse users, or to verify the uniqueness of collectables.

As of mid-2022, some of the most popular metaverse projects that make use of DLT and blockchain-based technologies include Decentraland, The Sandbox, Enjin, Bloktopia, Roblox and Star Atlas. The combined market capitalisation of the currencies used by these projects exceeded US\$14 billion in 2021.⁵⁴

Many other "pay-to-play" online gaming platforms with cryptocurrencies as payment mechanisms exist but are also often short-lived and hard to distinguish from online gambling.

Focus points: Asia is a hub for blockchain-based games

Three out of the five projects listed above are based in Asia (China, Singapore and Hong Kong) while one company is based in the US and one in Europe. However, since China's outright ban of all cryptocurrency-related transactions⁵⁵, it is unclear to what extent metaverse or online gaming platforms that use cryptocurrencies will continue to thrive in China.

Given the interest in and attention on metaverse-related projects around the world, it seems likely that this intersection of virtual worlds and DLT/blockchain technologies will continue to develop, albeit potentially outside of China for the foreseeable future.

⁴⁹ <https://www.ledgerinsights.com/ant-alipay-drug-prescription-blockchain/>

⁵⁰ <https://www.ledgerinsights.com/chinas-zhejiang-processed-5-billion-medical-bills-using-ant-blockchain-alipay/>

⁵¹ <https://www.stimson.org/2021/blockchain-in-china/>

⁵² https://www.europeanchamber.com.cn/en/members-news/3303/walmart_china_blockchain_traceability_platform

⁵³ <https://en.wikipedia.org/wiki/Metaverse>

Energy and Utilities

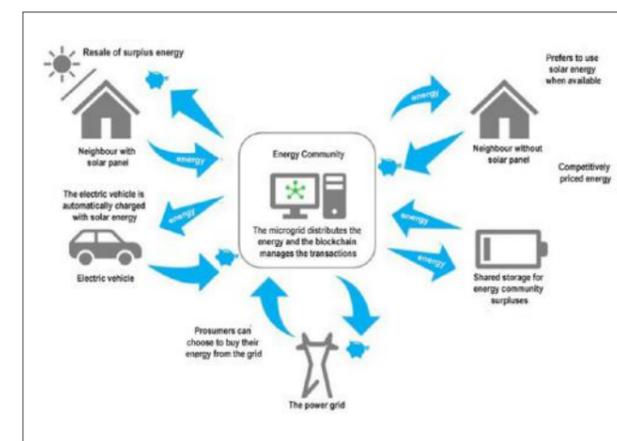
The use of DLT and blockchain technologies in the energy and utilities sector has mostly focused on five key use cases:

1. Peer-to-peer energy trading
2. Renewable energy certificates
3. Automatic settlement of trades
4. Microgrids
5. Smart meter data access

Due to the complexity of energy supply and assurance of supply, energy markets have traditionally been highly regulated and centralised. With recent developments in decentralised generation, demand-side management and renewable energy systems, new forms of energy distribution have become possible and potentially viable.

DLT and blockchain technology provide useful mechanisms to the requirements of reimagined energy trading and distribution solutions. Hence blockchain-based systems have been developed for peer-to-peer electricity trading or the setting up of localised "microgrids".

Companies like Energy Blockchain Labs, Grid Singularity and Australia-based Power Ledger, provide solutions for the various use cases in energy trading and distribution.



Source: www.encyclopedie-energie.org

⁵⁴ <https://coinmarketcap.com/>

⁵⁵ <https://www.bbc.com/news/technology-58678907>

⁵⁶ <https://www.sciencedirect.com/science/article/pii/B9780081022078000102>

The transparent and distributed nature of DLTs make their application particularly useful in energy systems as centralised preparation and aggregation of relevant data does not need to be performed by an intermediary (e.g. a lines company).

Blockchain-based solutions enable grid participants to publish consumption or generation data directly on a blockchain, which can then be used for pricing or supply/demand balancing.

Focus points: active hotspots worldwide

Over the last five years several early-stage pilot implementations of blockchain-based energy distribution or trading systems have been documented (e.g. the Brooklyn Microgrid by TransActive⁵⁶). However, it is often not clear what has happened to these projects since their inception.

Based on startup activity it appears that active hotspots of this application area originate out of the US, Australia and the UK. Given the small scale of most projects and the startup nature of companies driving these solutions, it seems DLT-based applications are still in the early stages of development.

Cleantech

A 2019 study that sampled 85 different blockchain applications across the DLT landscape gives an indication of how blockchain technology can be used in the cleantech/ envirotech space and highlights the key challenges and concerns.

The applications in the study ranged from peer-to-peer trading (29 applications) to crowdfunding, data verification and emission rights. The sectors in which the applications operated were renewable energy and sustainability. It was found that the main areas of benefit were peer-to-peer trading of renewable energy, smarter renewable energy deployment, improved access to electricity, efficient and sustainable energy creation, and distribution.

The study noted:

“The possibility of creating digital assets by converting sustainable projects and global public goods into tokens and creating a market for these investments demonstrates the suitability of blockchains for emission rights in the general sustainability sector. However, the current contribution to climate protection can be regarded as marginal as in practice the majority of these applications is still in the planning phase.”⁵⁷

While these “green” applications are being built, governments are recognising and harnessing the potential of blockchain technology. The European Commission’s Blockchain Strategy roadmap outlines that, “the EU recognises the potential of blockchain and supports the use of blockchain technology in fostering sustainable economic development, addressing climate change, and supporting the European Green New Deal.”⁵⁸

Other countries have been running projects that have demonstrated success. “Blockchain-based renewable energy projects such as SkyCoin in Singapore, Community Power on the island of Samsø or Power Ledger in Australia successfully demonstrate positive effects on society, economy, and the environment.”⁵⁹

When it comes to the potential of DLT / blockchain in this sector the obvious issues of earlier protocols (such as the “proof of work” protocol used by Bitcoin) need to be addressed, as the environmental impact of energy consumption required by these protocols is significant (see below).

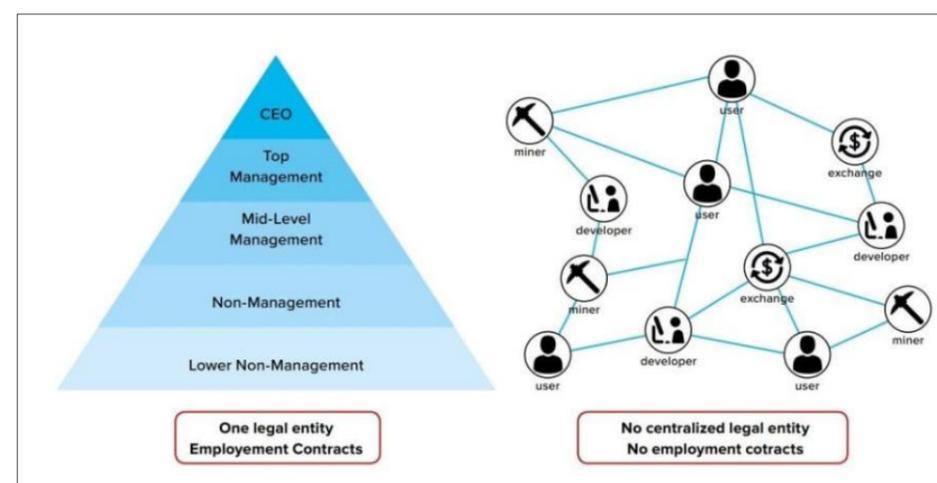
As such it seems imperative for DLT/blockchain-based applications in cleantech to use other protocols (such as consensus mechanisms, “proof of stake”, etc).

Alternative business models and the future of work (DAO)

Whilst not a sector in itself, it is worth noting the emergence of the “decentralised autonomous organisation” (DAO – see Appendix 2), which is linked to DLT and blockchain technologies as the concept requires highly distributed models of trust and decision making.

A DAO is like an investor-directed venture capital fund without a management team. Investors gain the right to vote, but no ownership⁶⁰. Ever since “venture” investment became the preeminent vehicle for startup funding, issues with this model have become apparent to a range of startups. Hence, many entrepreneurs are keen to explore alternative models, such as creating a DAO.

In a wider sense, many established companies have started experimenting with new organisation structures and work allocation models.



Source: <https://dev.to/3scava1i3r/what-s-a-decentralized-autonomous-organisation-dao-6dj>

Over the last 15 years, more adaptive and flatter organisational governance models⁶¹ and ways of working such as Agile⁶², Sociocracy 3.0⁶³ and Holacracy⁶⁴ have emerged and taken shape.

Terms like “future of work”⁶⁵ and “teal”⁶⁶ have provided inspiration and guideposts to organisational executives globally. The values that are underpinning these shifts, like trust, transparency and adaptability are congruent with those underpinning DLT and blockchain technology.

It is no surprise that after the development of Ethereum, the concept of the DAO emerged, which brought blockchain, smart contracts and organisation structures together to allow capital to be raised without centralised VCs. Transparency, shareholder control and autonomous governance could now be built into the new decentralised organisational structure.

The top DAO cryptocurrencies and tokens represent a market capitalisation of US\$12.6 billion (NZ\$19 billion) as of 25 June 2022⁶⁷. A list of notable DAO projects includes Aave Dao, Curve Dao and Maker Dao.

It is worth remembering that the concept of DAOs has been tainted somewhat by the first-ever DAO, which emerged in 2016. The organisation, which also called itself DAO, became very popular and crowdfunded a total of US\$150 million (NZ\$222 million) worth of Ethereum coins from 11,000 investors through an ICO (initial coin offering⁶⁸). This demonstrated the market’s appetite for the unique offerings of this type of organisation. However, in June 2016 the DAO was attacked through a code loophole in the Ethereum network, which led to the loss of approximately US\$44million worth of ether (coins)⁶⁹ which meant that many initial investors lost their investment.

⁶⁰ https://www.economist.com/sites/default/files/economist_case_comp_livey.pdf

⁶¹ <https://www.forbes.com/sites/jacobmorgan/2015/07/13/the-5-types-of-organizational-structures-part-3-flat-organizations/?sh=562c63f76caa>

⁶² <https://hbr.org/2016/05/embracing-agile>

⁶³ <https://sociocracy30.org/>

⁶⁴ <https://www.holacracy.org/>

⁶⁵ <https://www.gartner.com/en/human-resources/glossary/future-of-work>

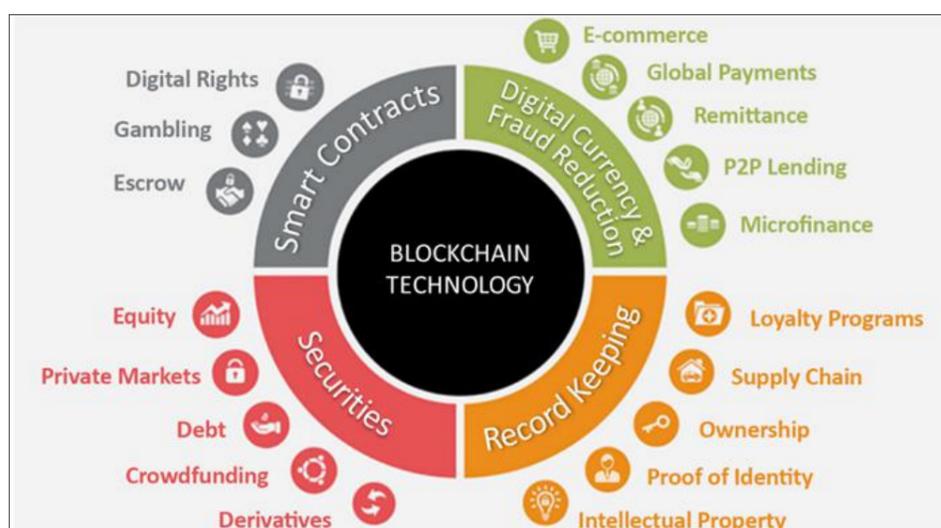
⁶⁶ <https://reinventingorganizationswiki.com/theory/teal-paradigm-and-organizations/>

Olympus DAO

Subsequently, the Ethereum network was updated and rolled back to prevent future attacks and reverse transactions related to the hack. Later in 2016 the original DAO (as in the organisation) became defunct and is no longer active. However, the concept of a decentralised autonomous organisation has survived and experienced a resurgence in 2022 through the projects listed above, as well as a range of decentralised reserve currency projects that started with the "Olympus DAO".

Emerging use cases

As the use of DLT and blockchain technology becomes more widespread, entrepreneurs and developers are continuously exploring and discovering new application areas and use cases. Even back in 2018, there were already over 30 established use cases for DLT/blockchain as outlined in a frequently referenced Medium article⁷⁰.



Source: <https://cri-lab.net/security-in-blockchain-applications/>

It is likely that some of these use cases will remain unvalidated while new use cases get added and become established. Just like with the early stages of internet development, it isn't entirely clear which use cases will be readily adapted and prove their inherent value throughout the adoption curve. However, given the fairly large and diverse set of use cases, it seems likely that some of these will be validated and that DLT/blockchain applications in those areas will become the preferred solutions/systems.

⁶⁷ <https://coinmarketcap.com/view/dao/>

⁶⁸ https://www.economist.com/sites/default/files/economist_case_comp_ivey.pdf

⁶⁹ https://www.economist.com/sites/default/files/economist_case_comp_ivey.pdf

⁷⁰ <https://medium.com/fluree/blockchain-for-2018-and-beyond-a-growing-list-of-blockchain-use-cases-37db7c19fb99>

In summary

- The use of distributed ledger technology is being applied across multiple industries.
- Application of the technology falls into four key areas: smart contracts, digital currency, securities and record keeping.
- Decentralised finance ventures have attracted considerable investment and are a key area of DLT development.
- Logistics and supply chain management is an emerging use case for DLT for New Zealand given our exporters' desire to prove the provenance of their goods.

Chapter 3

Cryptocurrency challenges

Ever since Bitcoin started gaining traction and other cryptocurrencies emerged, the entire domain has been troubled with a range of issues that are worth noting.

Extreme volatility and financial risk

After a boom in crypto asset values even as the world was plunged into the Covid-19 pandemic, 2022 saw a sharp correction of crypto markets, eroding over US\$2 trillion in value of cryptocurrencies alone in a matter of months.

Macro economic factors such as rising interest rates, inflation and uncertainty caused by the war in Ukraine have weighed heavily on riskier asset classes, with cryptocurrencies hit the hardest.

A serious loss of confidence in crypto assets has so far had limited spillover impacts on the wider economy. But the turmoil in the sector has exposed operational and financial integrity risks.

We have seen crypto exchanges freeze trading, digital asset investors face a liquidity crunch and so-called stablecoins, which are designed to reduce volatility by tying their value to underlying assets, prove to be anything but stable.

The collapse of the LUNA algorithm-controlled stablecoin and its associated token TerraUSD, wiped out over US\$40 billion in investor value in May, 2022. The use of leverage to maintain positions in cryptocurrencies saw many investors forced to liquidate their holdings and absorb deep losses.

Overall investment in crypto ventures and decentralised finance startups was expected to remain depressed in 2022 as the flight from risk to safer asset types deprived. The events of mid 2022 raised a number of concerning issues that point to the lack of consumer protection, transparency and confidence that exists in the digital assets space.

Cyber attacks

Unfortunately, every technological advance typically comes with its own variety of misuse — and so it is with DLT and blockchain.

One of the most notorious areas of misuse in the blockchain space is the criminal activity of ransom-based cyber attacks with cryptocurrency (usually Bitcoin) as an anonymous payment mechanism.

There have been numerous attacks on New Zealand-based organisations and companies that have highlighted the role cryptocurrencies play in the extortion efforts of cybercriminals.

In February 2021, the New Zealand Stock Exchange, (NZX) suffered distributed denial-of-service (DDOS) attacks that disrupted trading. The attackers had targeted the NZX and 100 other organisations around the world. As Bloomberg reported:

“The attacks have followed a familiar pattern, according to cybersecurity experts. Potential victims receive an email often personally addressed to the chief IT officer. It lists a Bitcoin address and a demand for what has typically been about \$200,000.”⁷¹

In May 2021, the Waikato District Health Board was hit with a ransomware attack that crippled IT systems across five hospitals, causing cancer treatments and elective surgery to be postponed or referred to other hospitals.⁷²

Meanwhile, the various cryptocurrency exchanges, wallets, applications and marketplaces where digital assets are stored and exchanged have become a focal point for cyber attacks aimed at stealing cryptocurrency. The Mt Gox hacking attack, which saw US\$460 million worth of Bitcoin stolen⁷³ from the Tokyo-based Bitcoin exchange, was a wake-up call for the fledgling industry.

The incident drove Mt Gox into bankruptcy. In 2019, Christchurch-based exchange Cryptopia was also hacked, resulting in around \$24 million⁷⁴ in losses to customers and resulting in Cryptopia's liquidation.

These cyber attacks are a significant problem globally. But it is worth noting that the attacks themselves are generally not related to the security of DLT/blockchain technology. Attackers exploit other vulnerabilities in an organisation's technology infrastructure and either seize control of coins held on exchanges and in wallets or use cryptocurrency to collect the ransom.

⁷¹ <https://www.bloomberg.com/news/articles/2021-02-04/how-a-dated-cyber-attack-brought-a-stock-exchange-to-its-knees>

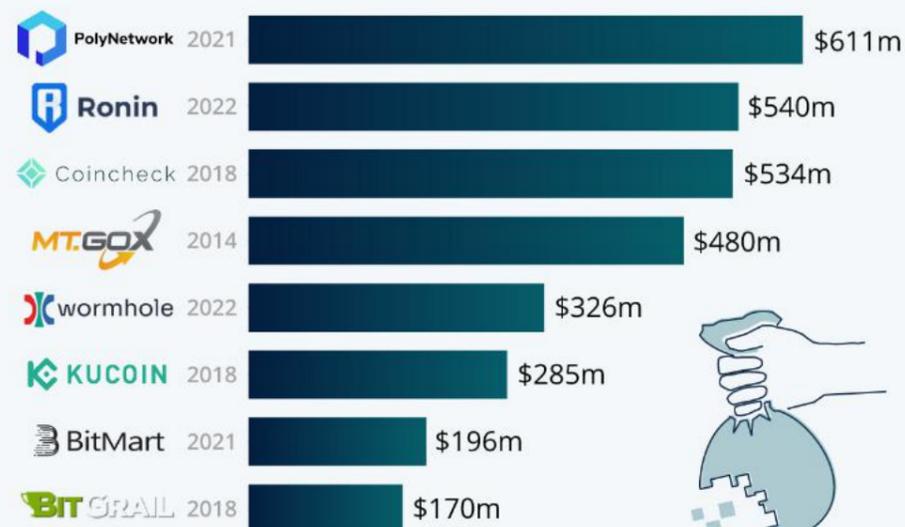
⁷² <https://www.stuff.co.nz/national/health/126898520/waikato-dhb-cyber-attack-old-software-susceptible-to-malware-was-being-used-by-some-staff>

⁷³ <https://www.wired.com/2014/03/bitcoin-exchange/>

⁷⁴ <https://www.stuff.co.nz/national/127401736/liquidation-of-hacked-cryptocurrency-firm-cryptopia-heading-towards-15m>

The Biggest Crypto Heists

Largest known crypto currency thefts by estimated losses*



* According to crypto currency exchange rates at time of theft
Sources: Reuters, Blockchain Companion, Decrypt



statista

Source: <https://www.statista.com/chart/12707/largest-known-crypto-currency-thefts/>

Arguably these types of attacks became more “feasible” for attackers with the anonymous nature of cryptocurrency transactions. While the blockchain can offer unprecedented transparency into transactions conducted on it, the lack of requirements to link cryptocurrency accounts to verified identities, as is required in conventional financial transactions, increases the risk of DLT being used for illegal activity.

It is difficult to find reliable sources to quantify the problem against other types of criminal activity (such as credit card fraud), but the problem is significant enough to warrant mention as a “downside” of the underlying technology (i.e. DLT) in any discussion on the opportunities and risks of blockchain.

The traceability issue of cryptocurrencies has at least been recognised by most major crypto exchanges (which are required to convert any cryptocurrency back into any legal tender) and it is now mandatory to complete “Know Your Customer” and “Anti Money Laundering” requirements to be able to use crypto exchanges.

Environmental impact

Bitcoin, Ethereum (original protocol) and many other cryptocurrencies currently run on a Proof-of-Work (PoW see Appendix 2) algorithm, which is computationally expensive and consequently requires significant amounts of electricity to power computers to complete blockchain operations.

Until mid 2021, China was responsible for hosting 75% of the world’s mining capacity⁷⁵. A subsequent government crackdown on mining operations saw operations decline, though reports suggest covert mining in China is on the rise again⁷⁶. As of October 2021, the US now leads in Bitcoin mining, with Kazakhstan and Russia other centres of mining activity⁷⁷. This is bringing to light a new set of challenges. In October 2021, environmentalists wrote a letter⁷⁸ to the US Congress highlighting the negative climate and environmental impacts of Bitcoin mining⁷⁹.

As mining operations move out of China and diversify to the US and elsewhere, there are equally significant shifts in the market happening. Renewable energy suppliers that are now mining Bitcoin, and cryptocurrencies like Ethereum, which currently run on a PoW consensus mechanism, are in the process of shifting to a Proof-of-Stake (PoS – see Appendix 2) consensus mechanism or other environmentally friendly mechanisms⁸⁰.

Most new cryptocurrencies are being launched based on protocols that do not require computationally heavy algorithms. Since Bitcoin mining is going to be around for the foreseeable future, and the two largest cryptocurrencies, Bitcoin and Ethereum, are currently running on PoW consensus mechanisms, opportunities exist for operators who can power crypto mining operations based on clean energy generation.

This is potentially particularly interesting to New Zealand in light of ventures like Datagrid⁸¹, a Southland-based data centre cluster that will be powered by renewable energy and take advantage of the region’s cool climate to reduce cool requirements for high-capacity computing.

Anonymity

Directly related to the issue of cyber attacks is another area of concern that arises from the essential characteristic of DLT/blockchain technology – the lack of a central “trust authority” to verify transaction parties.

While the current established financial system can potentially only operate through a system of authorised/trust brokers who establish and verify the identity of individuals and organisations who are interacting, a blockchain-based system can operate entirely without this requirement. In fact, in the early days of cryptocurrencies most exchanges and parties completed trades and transactions without any identity verification. More recently the KYC and AML requirements have changed the landscape for cryptocurrency holders. However it is still potentially possible to exchange currencies or move funds anonymously.

With more stringent legislation and regulation in place over time it is possible that the problem of total transaction anonymity will be pushed to the fringes of the entire system, just like counterfeit money and money-laundering practices are still happening in the current traditional financial system as well.

Regulation and taxation

In many countries legislation or regulation for cryptocurrencies, (or other DLT instruments) is not yet fully in place or is still in the early stages of development with some temporary workaround rules in place.

There appears to be a lot of confusion internationally as to what extent the entire DeFi space, including cryptocurrencies, is actually fully allowed or whether traders are at risk of conducting illegal practices.

Even less clear is the situation around taxation of DeFi assets as well as the treatment of potential capital gains from investment or trading activities.

⁷⁵ <https://time.com/6051991/why-china-is-cracking-down-on-bitcoin-mining-and-what-it-could-mean-for-other-countries/>

⁷⁶ <https://fortune.com/2022/05/17/china-bitcoin-mining-surge-despite-ban/>

⁷⁷ <https://www.theguardian.com/technology/2021/oct/14/us-leads-world-in-bitcoin-mining-after-china-crackdown-sends-industry-overseas>

⁷⁸ https://static1.squarespace.com/static/5e449c8c3ef68d752f3e70dc/t/615f1567488c6f6a85de8eee/1633621351960/Congressional_Sign_On_Letter_Crypto_Climate_Risks.pdf

⁷⁹ <https://www.theguardian.com/technology/2021/nov/18/cryptocurrency-bitcoin-environmentalist-alarm-us-politicians>

⁸⁰ <https://www.axios.com/2022/06/27/ethereum-new-version-2022-eth-ether>

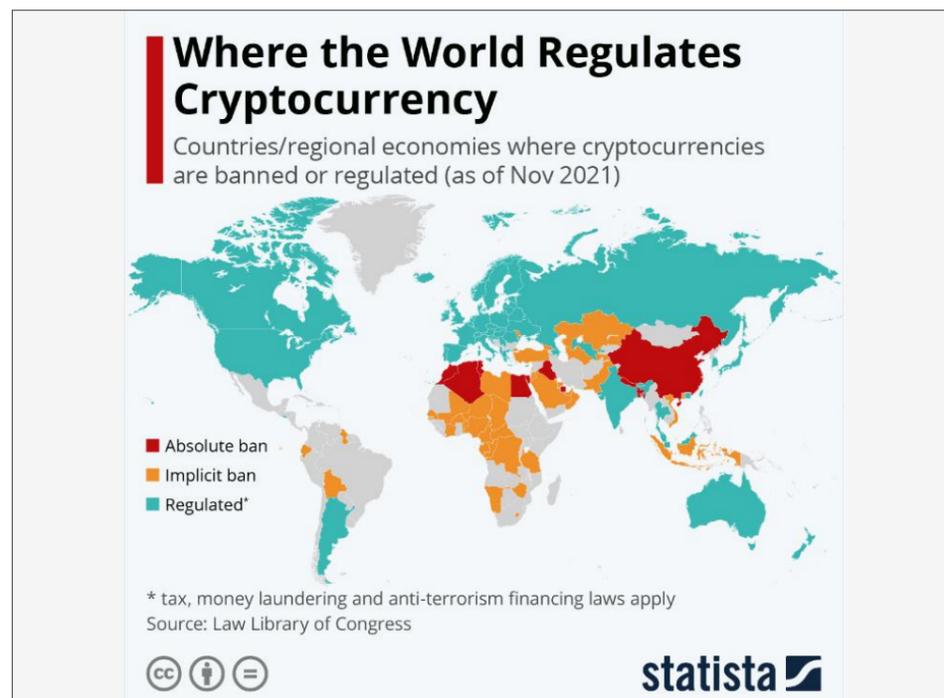
⁸¹ <https://www.stuff.co.nz/business/127020332/land-bought-for-1-billion-bid-to-turn-southland-into-global-it-hub>

An unprecedented opportunity for New Zealand

Providing clarity on regulation and taxation of DLT/Digital Asset-related activities might represent the most impactful and lowest-effort intervention the New Zealand Government may consider. Given the current relative uncertainty that exists for blockchain-related business activities, there exists a window of opportunity for any country to step into this uncertainty and provide clear guidelines on regulation and taxation. Any country providing certainty to the private sector in this space is likely going to become highly attractive as a location for international companies, investors and talent.

More importantly, providing this clarity can be achieved at a relatively low cost to the government (i.e. at the cost of a “think tank” team of policy makers and tax experts to provide clear advice to Government on potential changes to regulation, taxation or legislation. If blockchain-related technologies turn out to be superseded by different technology, or the current trend is not sustainable, the regrettable investment is limited to the cost of creating the regulation and taxation” with “the think tank”.

However if the technology goes mainstream and becomes a cornerstone of economic activity over the next few decades the upside of such an investment would be massive (and the return on investment for the government would probably outperform most other economic interventions the government may consider).



Source: <https://www.statista.com/chart/27069/cryptocurrency-regulation-world-map/>

Potential uses for blockchain in government



Source: <https://101blockchains.com/blockchain-government-transformation/>

DLT and blockchain in Government

Governments already use many different digital applications to provide modern and convenient services to the public. These digital applications have helped speed up the rate at which public services can be accessed and completed.

This switch to a more digital public service has come with a lot of positives but also some increased risks around privacy, security and data protection. In light of the ongoing digitisation of public services around the world, a range of interesting application areas are being explored for the use of DLT/blockchain technology in government.

Governments are researching and piloting CBDCs

Countries all over the world are moving away from cash payments, and the Covid-19 pandemic has accelerated this change in consumer behaviour. A recent article in the *Guardian* reports that by 2024, it is expected that only 7% of in-store payments will be made in cash. The research quoted also showed that in Sweden, Canada and Australia, in-shop cash payments were already less than 10% of the total⁸².

⁸² <https://www.theguardian.com/money/2021/jun/01/just-7-of-uk-shop-payments-predicted-to-be-in-cash-by-2024-report>

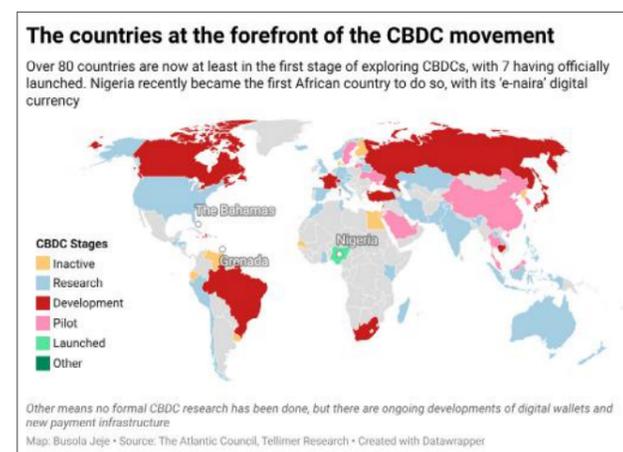
⁸³ <https://www.pwc.com/m1/en/media-centre/2021/documents/central-bank-digital-currencies-and-the-future-of-money-part1.pdf>

⁸⁴ <https://www.pwc.com/gx/en/industries/financial-services/assets/pwc-cbdc-global-index-1st-edition-april-2021.pdf>

Governments are beginning to take note of this shift in the way goods and services are transacted and many central banks have been rethinking and redesigning their systems for a digital, and even cashless future. In June 2021, it was reported that “85% of the central banks in the world are currently either studying or piloting CBDCs.”⁸³ A 2021 Report by PwC highlighted key trends in CBDC development and notably stated,

“**More than 60 Central Banks have been exploring CBDCs since 2014. Progress has been accelerating with some CBDC projects now entering implementation phases. Institutional involvement in CBDC continues to strengthen the ecosystem at large, with public stakeholders such as the Bank for International Settlements, the World Bank, the International Monetary Fund or the World Economic Forum, active on the topic.**”⁸⁴

That same report highlights that some of these CBDC projects are using blockchain technology.



Source: <https://tellimer.com/article/central-bank-digital-currencies-to-disrupt-gl>

Digital identity – records, verification, privacy and security

In 2018, McKinsey published a paper that showed that the top (highest impact and highest feasibility) use cases in the public sector for blockchain innovation were: identity and civil registry data, government records, cybersecurity and critical infrastructure protection, welfare payments, and blockchain-enabled e-voting:

“**Governments’ key record-keeping and verifying functions can be enabled by blockchain infrastructure to achieve large administrative savings. Public data is often siloed as well as opaque among government agencies and across businesses, citizens, and watchdogs. In dealing with data from birth certificates to taxes, blockchain-based records and smart contracts can simplify interactions with citizens while increasing data security. Many public-sector applications, such as blockchain-based identity records, would serve as key enabling solutions and standards for the wider economy. More than 25 governments are actively running blockchain pilots supported by startups.**”⁸⁵

Notable countries that have been leading the charge in digital identities are Estonia and Switzerland. Estonia is using “blockchain technology for integrity verification of government registries and data. No data is saved to the blockchain.” In 2018, Zug Switzerland ran a trial using an electronic ID system, and while the scale of the test was small, it turned out to be successful.⁸⁷

E-voting

Blockchain enabled e-voting has come about as a proposed solution to the problem of eroding trust in elections and voting systems integrity.

An academic study published in August 2021 assessed how blockchain might enhance an electronic voting system and identified the risks involved. Like many of the blockchain application use cases today, while on the surface blockchain technology looks like an ideal solution, many of the projects have been small pilots and have not been scaled, and the risks are high.

The report states that “the most often-mentioned issues in blockchain applications are privacy protection and transaction speed. For a sustainable blockchain-based electronic voting system, the security of remote participation must be viable, and for scalability, transaction speed must be addressed.”⁸⁸ The report concluded by saying, “Blockchain-based technology is still in its infancy as an electronic voting option.”

Public healthcare

DLT/blockchain-based applications might hold the potential to increase data protections and privacy in healthcare. A 2018 article from McKinsey states:

“**Within healthcare, blockchain could be the key to unlocking the value of data availability and exchange across providers, patients, insurers and researchers. Blockchain-based healthcare records can not only facilitate increased administrative efficiency, but also give researchers access to the historical, non-patient-identifiable data sets crucial for advancements in medical research. Smart contracts could give patients more control over their data and even the ability to commercialise data access. For example, patients could charge pharmaceutical companies to access or use their data in drug research. Blockchain is also being combined with IoT sensors to ensure the integrity of the cold chain (logistics of storage and distribution at low temperatures) for drugs, blood, and organs.**”⁸⁹

⁸⁵ <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value>

⁸⁶ <https://e-estonia.com/wp-content/uploads/e-estonia-200121-eng.pdf>

⁸⁷ <https://fortune.com/2018/07/03/blockchain-voting-trial-zug/>

⁸⁸ <https://www.mdpi.com/1424-8220/21/17/5874/htm>

With the use of blockchain, patients could feel particularly empowered by being able to define access rules for their individual medical data. Because of the technology's transparency, it is a secure method for storing and exchanging information⁹⁰.

“ **Blockchain offers a wide range of healthcare applications, including mobile health apps, monitoring equipment, electronic medical records for sharing and storing, clinical trial data, and cloud storage of insurance information. Because anybody wishing to modify a block once it has been added to the chain would have to refigure the altered block and all following blocks, which would take an impossibly large amount of computing power, blockchain is stable.**⁹¹

The Covid-19 pandemic has uncovered weak spots in the healthcare system globally. There have been many organisations and partnerships emerging that are exploring blockchain-based solutions. In August, 2021, Canada launched a blockchain-based decentralised identity solution for issuing and verifying Covid-19 test results.⁹²

Several companies have launched vaccine passports that use blockchain technology in some form. The blockchain-based vaccine passport allows information to be stored securely and the user can protect their privacy while providing their proof-of-vaccination record.

The OnePass vaccine passport is being developed by OneLedger Technology Inc.⁹³ Other players in the market include an NFT-based vaccine passport called VeChain.⁹⁴ In April 2021, South Korea announced that it would issue its own vaccine passport app called COOV, using “blockchain technology to prevent counterfeit.”⁹⁵

“ **The app uses blockchain technology to prevent forgeries, and to encrypt sensitive personal information like social security numbers or other identifying factors. It also includes decentralised identity (DID) – a method the company says will not only help standardise the system around the world, but will also address privacy fears as it does not allow governments to access or store the data.**⁹⁶

As it has only been used on a smaller scale, it is still unclear if blockchain is able to keep extremely sensitive data secure.⁹⁷ This insecurity around medical records already exists in the current system, but it is yet to be seen if blockchain holds the solution to the problem.

⁸⁹ <https://www.mckinsey.com/business-functions/mckinsey-digital/our-insights/blockchain-beyond-the-hype-what-is-the-strategic-business-value>
⁹⁰ <https://www.mdpi.com/2504-2289/5/3/41/html>
⁹¹ <https://www.mdpi.com/2504-2289/5/3/41/html>
⁹² <https://www.prnewswire.com/news-releases/indicio-and-liquid-avatar-technologies-launch-canadas-first-privacy-preserving-decentralized-technology-for-sharing-health-data-301353144.html>
⁹³ <https://www.forbes.com/sites/forbesbusinesscouncil/2021/08/10/key-considerations-when-using-blockchain-for-vaccine-passports/>
⁹⁴ <https://cointelegraph.com/news/san-marino-approves-vechain-enft-vaccination-certificate-that-s-verifiable-worldwide>
⁹⁵ <https://www.reuters.com/article/us-health-coronavirus-southkorea-idUSKBN2B043W>
⁹⁶ <https://www.telegraph.co.uk/global-health/science-and-disease/digital-vaccine-passports-aim-help-south-koreans-get-back-road/>
⁹⁷ <https://www.mdpi.com/2504-2289/5/3/41/html>

In summary



While adoption of digital assets and cryptocurrencies has increased rapidly, consumers and governments looking to harness the underlying technology face myriad challenges:

- Digital assets markets are volatile and have just experienced the largest decline in value in the history of cryptocurrencies.
- Cyber attacks, the anonymous nature of cryptocurrencies and the environmental impact of Proof-of-Work based blockchain systems are major barriers to broader adoption of the technology.
- Regulation of digital asset markets specifically is limited in most countries but virtually every government is considering regulatory options.
- Providing certainty to blockchain based-business through regulation and taxation might represent one of the most significant opportunities for New Zealand to leapfrog to the centre of an emerging technology and reap the rewards of an early-mover advantage in the digital domain.
- Blockchain technology offers huge potential to improve efficiency, transparency and trust in government in areas like E-voting, public health, digital identities and the creation of central bank digital currencies.

Chapter 4

Approaches to regulation and regulatory frameworks

Given the accelerated speed of advancements within blockchain technology, governments around the world are exploring how to carefully balance potential interventions to allow for both innovation in the private sector while also providing protection and guarantees to mitigate risks for citizens and the state.

Being prepared and having infrastructure in place before significant technology shifts happen is key to experiencing the full potential (and related benefits to societies) that the shift might bring.

Ravi Menon, Monetary Managing Director of Singapore, recently made a strong public statement in favour of his country adopting blockchain:

"We (the Government of Singapore) think the best approach is not to clamp down or ban these things. But not to get into this game, I think, risks Singapore being left behind. Getting early into that game means we can have a head start, and better understand its potential benefits as well as its risks."⁹⁸

With blockchain currently being one of the fastest-growing technologies globally, and one of the four fastest-growing industries in the world, without actively engaging in blockchain technologies, it might become difficult to retain or attract talent across New Zealand.^{99 100}

Government legislation, communications and taxation

As with all "cutting edge" technologies, governments are using legislation, regulation or taxation to indicate to the private sector where it is safe to pursue development of the technology.

At the time of writing, New Zealand does not have any direct DLT/blockchain-related laws or regulations. The government currently classifies digital assets and cryptocurrencies as an asset class where potential gains get taxed through the standard income tax declaration of individuals.

At present it is somewhat unclear how the holding and trading of digital assets is treated from a government perspective. Other countries have taken a stronger stance on this technology, ranging from significant endorsement and support (such as in Singapore) to making all transactions of blockchain-related financial instruments illegal (such as in China).

In June, 2021, Thomson Reuters published a comprehensive paper highlighting the current state of regulation and legislation across the globe.¹⁰¹ (See Appendix 2 for further detail.) Some countries are leading the charge and some are taking a "wait and see" approach. An example of progressive legislative action is in Zug, Switzerland.

In an area now commonly referred to as "Crypto Valley", Mayor Dolfi Müller specifically expressed his desire to attract more financial tech firms to the region and in order to do that, he supported a pilot programme that allowed local citizens to pay for public services using digital currency.¹⁰² "Crypto Valley's" talent creation strategy paid off, and it is now home to 960 blockchain companies and employs over 5,000 tech specialists in the region.¹⁰³



⁹⁸ <https://www.bloomberg.com/news/articles/2021-11-01/singapore-has-grand-ambitions-to-become-a-global-crypto-hub?srnd=cryptocurrencies>

⁹⁹ <https://www.inc.com/gabrielle-bienasz/global-startup-ecosystem-report-robotics-artificial-intelligence.html>

¹⁰⁰ <https://startupgenome.com/report/gser2021>

A nation state crypto gamble

Perhaps the most extensive nation-level embrace of digital assets is El Salvador's move last year to adopt Bitcoin as legal tender alongside the US dollar and to encourage citizens to use the state-issued crypto wallet and make transactions in Bitcoin.

El Salvador's President Nayib Bukele has been directing the country's treasury to buy Bitcoin, a risky move and one that worked against the country when the price of Bitcoin plummeted 55% from the purchase price, costing El Salvador around US\$50 million in paper losses. Bukele sees bitcoin as a way to reduce the country's reliance on the US dollar and to reduce fees paid on remittances—payments made by El Salvadorans outside the country who are sending money home to support their family.

But El Salvador has been heavily criticised for its embrace of Bitcoin by the International Monetary Fund, which had been preparing to issue a US\$1.3 billion loan to El Salvador but expressed concern at the stability of the country's financial system as it made Bitcoin legal tender. Small nations, including some of our neighbours in the Pacific, are carefully watching events in El Salvador to see if the model adopted by Bukele is worth considering.

Taxation of digital assets and cryptocurrencies

Given the significant investment, capital deployed and high volume of trading activity in cryptocurrencies and NFTs, many governments are actively looking into potential taxation or regulation of this space. In 2019, Tom Emmer, a US congressman from Minnesota noted:

“Taxpayers deserve clarity on several basic unanswered questions regarding federal taxation of these emerging exchanges of value. Guidance is long overdue and essential to proper reporting of these emerging assets.”¹⁰⁴

According to OECD.org: “Most countries lack comprehensive guidance or a framework for the treatment of these assets for tax purposes, with any guidance generally being partial or incomplete.”¹⁰⁵

This reality has left most governments in the position of needing to develop their own clear policies that meet the needs of their citizens.

Inland Revenue has issued guidance for New Zealand taxpayers around crypto assets noting:

“Cryptoassets are treated as a form of property for tax purposes. While there are different types of crypto assets, the tax treatment depends on the characteristics and use of the crypto assets. It does not depend on what they are called.”¹⁰⁶

OECD.org has provided a simple framework to assist governments aiming to create a clear and balanced policy:

OECD's six questions for approaching taxation of crypto assets¹⁰⁷

1. How should the income created by crypto assets be treated for direct and indirect tax purposes?
2. If considered to be property, should the stock of crypto assets be included in countries' net wealth taxes (where they exist) or other capital taxes? If so, how should they be valued?
3. How should VAT systems treat the creation, acquiring, holding and transfer of these assets?
4. What are the policy implications of the different tax treatments available?
5. How can governments effectively detect and address the risks of tax evasion and other financial crimes posed by crypto assets, including what are the existing legal frameworks and tools that tax administrations can use?
6. How to improve tax transparency, including what information tax administrations need to know about transactions for purposes of compliance and enforcement? In addition, the OECD is addressing the need for greater tax transparency in this area, in particular in light of the tax compliance risks posed by crypto assets. In this respect, the OECD is currently developing technical proposals in order to ensure an adequate and effective level of reporting and exchange of information with respect to crypto assets.

Towards the end of 2021 several countries decided to take a tough stance on blockchain-based digital currencies/assets, with some banning any related activity altogether. In September 2021, China declared that all digital currency transactions, other than the Communist Party's own state-run efforts, were to be deemed illegal.¹⁰⁸ The *Guardian* comments that regulators in China fear the cryptocurrency would weaken the party's control over its financial system and incentivise criminal activity.¹⁰⁹

In November 2021, India subsequently announced its preparations and plan to ban cryptocurrencies.¹¹⁰ Despite providing the country with a detailed DLT/blockchain technology roadmap for the future, Australia is currently placing tax burdens on individuals that earn profits on crypto assets, even if transactions have not been made.¹¹¹

¹⁰⁴ <https://www.theguardian.com/technology/2019/apr/17/bitcoin-taxes-congress-irs>

¹⁰⁵ <https://www.oecd.org/tax/tax-policy/taxing-virtual-currencies-an-overview-of-tax-treatments-and-emerging-tax-policy-issues.pdf>

¹⁰⁶ <https://www.ird.govt.nz/cryptoassets>

¹⁰⁷ <https://www.oecd.org/tax/tax-policy/taxing-virtual-currencies-an-overview-of-tax-treatments-and-emerging-tax-policy-issues.pdf>

Consumer protection

When the first cryptocurrency was invented in 2009, Japan quickly became a mining centre for Bitcoin and home to the world's first major crypto exchange, Mr Gox, which handled nearly 70% of the world's Bitcoin transactions at the time.¹¹²

For many disruptive technologies it is often difficult to anticipate where the weaknesses of a new technology and/or application might emerge until they've been implemented. When Mr Gox was hacked it became clear that the blockchain technology itself was not the main vulnerability, but rather the common practices and restrictions (at the time) for the handling of private keys (which are used to access cryptocurrency accounts).¹¹³

Rather than intervening through strict regulation (or prohibition), the Japanese Government introduced consumer protections for cryptocurrency and recognised crypto assets as legal property (under the Payment Services Act).¹¹⁴ To date, Japan might be most progressed in its desire to find a suitable approach to the treatment of crypto assets.

It seems likely that the US will aim to address questions around the trading and holding of cryptocurrencies and digital assets in the near future. In 2021 there have been several SEC hearings on cryptocurrencies and related assets, with analysts expecting a "landmark" ruling in late 2022 or 2023.

Rules for token-issuing businesses

South Korea recently raised the bar for token-issuing businesses (i.e. most cryptocurrencies or providers of NFTs) in an effort to create a supportive environment for this nascent sector, but also to prevent non-serious or malicious entities from forming. Some of the prerequisites required before organisations can issue tokens include submitting a white paper, obtaining a favourable rating from a government-recognized token evaluation service, getting the project legally reviewed, as well as meeting a defined cadence and quality of disclosure statements¹¹⁵.

Recently the German Government has commenced an initiative to create a "European financial market supervisory law" for blockchain-based businesses and crypto assets.¹¹⁶ This initiative highlights an intention to make the law "fit for digitisation and for complex group structures in order to ensure holistic and risk-adequate supervision of new business models."¹¹⁷

The European Commission (the executive branch of the EU) has been working to establish concrete legal frameworks for digital assets—from crypto assets to stablecoins. This regulatory proposal, titled Markets in Crypto-Assets (MiCA), is making its way through the legislative process, and is expected to be debated for many months before eventually being signed into European law. If and when it is passed, it will pose stricter requirements on token issuers.¹¹⁸

¹¹² <https://www.theguardian.com/world/2021/sep/24/china-declares-transactions-cryptocurrencies-illegal>

¹¹³ <https://www.theguardian.com/world/2021/jul/09/currency-and-control-why-china-wants-to-undermine-bitcoin>

¹¹⁴ <https://www.theguardian.com/world/2021/nov/24/india-to-ban-private-cryptocurrencies-and-launch-official-digital-currency>

¹¹⁵ <https://cointelegraph.com/news/australian-tax-office-report-crypto-profits-or-else>

¹¹⁶ <https://startupgenome.com/report/gser2021>

¹¹⁷ <https://cryptonews.com/news/how-japan-became-global-leader-in-cryptocurrency-blockchain-10419.htm>

¹¹⁸ <https://complyadvantage.com/knowledgebase/crypto-regulations/cryptocurrency-regulations-japan/>

All eyes on the US

As the country where both innovation in and adoption of digital assets is the most advanced, industry observers are closely monitoring moves to regulate digital assets in the US.

On 7 June 2022, Senator Kirsten Gillibrand (D-NY) and Senator Cynthia Lummis (R-WY) introduced the Responsible Financial Innovation Act (RFIA)—a piece of legislation that seeks to introduce a comprehensive regulatory framework for digital assets in the US. The RFIA, if passed by Congress, could serve as a benchmark for future legislation both in the US and around the world.

The legislation seeks to:¹¹⁹

- Introduce several digital-asset-related definitions
- Provide numerous changes and clarifications regarding the taxation of digital assets
- Introduce the concept of "ancillary asset," an asset presumed not to be a security if specified periodic disclosure requirements are satisfied
- Designate the Commodity Futures Trading Commission as the primary regulator of the digital asset spot market and create a new registration category for digital asset exchanges
- Establish various customer disclosure requirements for digital asset service providers
- Authorise depository institutions (both insured and uninsured), subject to obtaining prior regulatory approval, to issue, redeem and conduct all incidental activities relating to "payment stablecoins"
- Codify certain principles related to the custody of financial assets.

The legislation is unlikely to be passed before 2023.

In summary



- New Zealand does not have any specific DLT/blockchain-related laws or regulations.
- Most countries consider crypto assets a taxable asset class, but application of taxation rules varies widely.
- Consumer protections are limited without a regulatory framework in place.
- The US has introduced legislation to regulate the digital assets space.

¹¹⁵ <https://cointelegraph.com/news/south-korean-regulator-proposes-strict-new-rules-for-token-issuers>

¹¹⁶ <https://cointelegraph.com/news/new-german-government-cites-crypto-in-coalition-agreement>

¹¹⁷ https://www.spd.de/fileadmin/Dokumente/Koalitionsvertrag/Koalitionsvertrag_2021-2025.pdf

¹¹⁸ <https://cointelegraph.com/news/europe-awaits-implementation-of-regulatory-framework-for-crypto-assets>

¹¹⁹ <https://www.jdsupra.com/legalnews/lummis-gillibrand-responsible-financial-7053016/>

Chapter 5

Current state and opportunities for New Zealand

New Zealand has a thriving fintech sector, with the top 19 companies in this space generating \$1.8 billion in revenue in 2021, according to the Technology Investment Network.

Within our fintech ecosystem exists a subset of startups focused on distributed ledger technologies. They range from blockchain platform developer Centrality to cryptocurrency trading platform Easy Crypto.

“Digital currency is on track to become an important part of the broader digital transformation of financial services. As new forms of money movement emerge and evolve, Visa expects to see Kiwi fintechs enter this new currency paradigm and collaborate to explore innovative solutions.”

Anthony Watson
Visa Country Manager,
New Zealand and South Pacific

“While we are already seeing a diversity of fintechs in, for example, the crypto/NFT, insurance and payments domains, we are just beginning to see the promise of Open Finance focused companies appearing here. Perhaps these are the ones to watch in the coming years as they are certainly attracting enormous attention worldwide. Will these be our next high-growth, high-value companies?”

Jason Roberts
Executive Director,
FinTechNZ
Source: Tech Investment Network 2022

Attributes of our fintech sector

EMPLOYS

7,678

people globally



▲ 14.2%

AVERAGE SECTOR WAGE

\$102,860

(higher than the TIN200 average wage of \$88,005)



▲ 9.3%

AVERAGE REVENUE PER EMPLOYEE

\$238,460

(lower than the \$243,570 average for TIN200 companies)



▲ 8.9%

\$ INVESTED IN SALES & MARKETING

\$406.3m

▲ 0.4%



\$ INVESTED IN WAGES & SALARY

\$789.8m

▲ 24.9%



\$ INVESTED IN RESEARCH & DEVELOPMENT

\$374.6m

▲ 14.2%



Source: Tech Investment Network 2022

Callaghan Innovation assists this ecosystem through its grants and R&D Tax Incentive scheme. Below is a snapshot of grants awarded recently to startups working in the DLT space.

Callaghan Innovation — supporting blockchain and crypto innovation

Little Crypto platform R&D — Auckland Organisation Onomi Limited Cryptocurrency transaction processing Project Grant 2018—2019	Freeos — Auckland Onchain Software Limited DAO, blockchain, NFT, UBI Project Grant 2021—2022
Matrex Ethereum 2.0 — Auckland Trust Codes Limited Blockchain Proof—of—Stake development Project Grant 2019—2020	Verified credentials — Lower Hutt JNCTN Limited Digital identity management Project Grant 2021—2022
Venture Builders — Auckland Techemy Limited Portfolio of blockchain—related companies Growth Grant — 2018—2022	Brave New Coin — Auckland Techemy Limited Cryptocurrency media and market data Student Experience Grant 2019—2020
Centrality Phase 2 R&D — Auckland Centrality Investments Limited Blockchain and Dapp venture ecosystem Growth Grant 2017—2021	CENNZnet R&D — Auckland Centrality Limited Blockchain R&D Student Experience Grant 2021—2022
CentraPay — Auckland CentraPay Limited Digital assets payment systems Student Experience Grant 2019—2020	Centrapay Engineer — Auckland CentraPay Limited Digital assets payment systems Student Experience Grant 2020—2021
Centrapay R&D — Auckland CentraPay Limited 2021 — 2022 Digital assets payment systems Student Experience Grant 2021—2022	Blockchain Infrastructure — Auckland OnFinality Limited Blockchain infrastructure—as—a—service Project Grant 2021—2022
Trade Window R&D — Auckland Trade Window Limited Digital trade platform R&D Project Grant 2020—2021	Trade Window R&D — Auckland Trade Window Limited Digital trade platform R&D Student Experience Grant 2020—2021
Trade Window R&D phase 2 — Auckland Trade Window Limited Digital trade platform R&D Project Grant 2019—2021	Trade Window R&D — Auckland Trade Window Limited Digital trade platform R&D Student Experience Grant 2019—2020

Investment in DLT ventures

There are still very few local investment funds or incubation/acceleration programmes that specialise in DLT-related startups or tech development. Given the current situation, the question arises to what extent New Zealand could potentially benefit from creating a supportive environment to stimulate developments in the DLT space.

As with all new and emerging technologies, the New Zealand Government will have to carefully evaluate to what extent a supportive environment is warranted and what opportunities exist that justify the inherent risk in taking a position on DLT-related technologies in New Zealand.

Based on the current state of DLT/blockchain and the unique characteristics of this technology it seems a number of aspects make the emerging ecosystem of DLT and its related application potentially interesting for New Zealand to investigate a supportive environment further. These are:

- Low environmental impact/light on natural resource usage/weightless economy
- Purpose-led communities/digital native mobile workforce
- Early-adopter advantage (but not “bleeding edge”) with high likelihood of reaping significant rewards ahead of mass adoption

Fostering talent

The demand for tech workers has never been higher and many places are making the value of tech work clear through creating favourable conditions for blockchain innovation to thrive, and also through offering economic incentive and even government support and collaboration in blockchain initiatives. Every government has its own unique parameters set around how to create those favourable conditions, but most policies and actions taken aim to communicate an overall openness and support of blockchain initiatives.

Governments around the world have been making verbal and monetary commitments to attract investment and talent. In Australia’s national roadmap, between 2020 and 2025, it committed to creating conditions for talent to upskill and for startups to attract investment and programmes to grow and expand globally.¹²⁰

The UK Government made its commitments through tangible investments. In 2018, focusing on blockchain projects in energy, voting and charitable giving, the UK Government invested more than £10 million (NZD\$19.18 million). Around the same time, a £20 million (NZ\$38.36 million) GovTech Catalyst Fund was launched to incentivise tech companies to develop solutions to public sector challenges by bidding for an initial £50k (NZ\$95.71k) to explore innovative digital solutions and a further £500k (NZ\$957k) to prototype them.¹²¹ In December 2020 Singapore launched the Singapore Blockchain Innovation Programme (SBIP). Funded by the government, through the National Research Foundation, this project is investing SG\$12 million to invest in companies developing blockchain solutions for supply chain, trade and logistics.¹²²

New Zealand has already heavily invested in the tech sector and now produces some of the highest-skilled tech workers in the world.¹²³ In many ways, this wise investment into training future technology workers has primed New Zealand to be able to move both quickly and strategically for the next big technological shift.

To retain these highly skilled workers, it will be vital, through both public policy and financial support, for New Zealand to become a favourable environment for the continued innovation of DLT and blockchain to occur.

¹²⁰ <https://www.industry.gov.au/sites/default/files/2020-02/national-blockchain-roadmap.pdf>
¹²¹ <https://analytics.dkv.global/Blockchain-in-the-UK-2021/Full-Report.pdf>

Alternative pathways for fundraising and attracting investment

Over the last two decades New Zealand's startup ecosystem has been affected by the availability of scale-up capital. In the early 2000s the amount of available capital from angel investors and local venture capitalists was very limited.¹²⁴

Over the last few years there appears to have been an easing in early stage/venture capital constraints, however entrepreneurs and startups are continuing to look for other ways to raise funds that are in line with their approach to business and desires for equity distribution.

A noteworthy development in this space is the emergence of Distributed Autonomous Organisations (DAOs) as described in this report. DAOs are increasingly seen as an interesting alternative fundraising mechanism that potentially goes beyond "crowdfunding" initiatives that became popular in the 2010s.

DAOs provide a unique mechanism that combines fundraising and governance in self-regulating entities that provide rule-based or process-based opportunities for direct interaction (including decision making) between the executive team/management of an entity and a large base of investors/shareholders.

This model appears to be highly attractive to purpose-driven innovation businesses that appreciate direct interactions with a large number of individual backers (typically thousands or millions of individuals who have invested in key tokens issued by the DAO).

DAOs are also highly beneficial for individual investors/backers as their investments are comparatively liquid. Any holding of DAO-related tokens or coins are typically traded on decentralised or crypto exchanges. This form of investment is vastly different from the traditional private equity model, which typically locks up funds from a small pool of high-net-worth individuals over long periods of time with limited ability for investors to change shareholdings or divest their holdings.

DAOs are also highly likely to attract backers (investors) from around the world rather than being restricted to New Zealand or Australasia.

By providing regulatory certainty for New Zealand entrepreneurs wishing to use DAOs as an investment mechanism we will effectively channel additional international funds to support jobs in New Zealand.

Adding DAOs as a viable, alternative fundraising vehicle would further diversify New Zealand's investment capital landscape and complement existing pathways.

Potential for high return/low effort for New Zealand

Given the current state of the DLT/blockchain adoption curve (i.e. around 10+ years into the maturing of the underlying technology), an interesting opportunity exists for New Zealand to actively enable an emerging industry.

As outlined above, DLT/blockchain technology offers vast scalability without any drain on natural resources or negative implications when servicing distant consumer markets (such as "food miles", etc).

At the same time, DLT/blockchain is no longer a "bleeding edge" technology that is so early in its development that the risks of any potential investment far outweigh the benefits. The technology has been proven to be able to address a number of systemic issues and latent inefficiencies in a range of industries that cannot be solved using existing technology and protocols.

Currently the likelihood of DLT/blockchain becoming an accepted and entrenched technology is higher than the likelihood of DLT/blockchain disappearing again as a short-term trend (e.g. as frequently happens with technologies that don't offer a sustained advantage).

The "effort/investment" any government would need to make in further enabling this emerging industry is potentially small compared to other options for economic transformation. The most significant impact governments can have at present is in providing clarity in legislative treatment, regulation and taxation. While the exact cost of new regulation is difficult to assess, it largely comes down to staff time of policy makers and regulators (plus the political process that goes along with it).

Even using the most generous assumptions for the cost of new legislation, regulation and taxation, it seems small compared to the hundreds of millions of dollars governments typically spend on incentive and stimulation packages for large sectors such as agriculture, healthcare and construction.

Assuming that legislation, regulation and taxation changes are required to enable this emerging industry, the significant opportunity available to New Zealand is highlighted by this simple table.

	DLT/blockchain follows similar adoption curve as "the internet" or "mobile phone technology"	DLT/blockchain disappears
Incur effort to create legislation, regulation and taxation that enables DLT/blockchain technology in New Zealand	New Zealand able to capture early-adopter benefits, attract talent and capital. Return on effort for New Zealand's economy is likely to be vast (compared to the initial "investment" in legislation, regulation and taxation). Direct benefits in high-wage job creation, talent attraction and foreign investment	Loss of "investment" in legislation, regulation and taxation. Potentially incurring additional effort to changes to legislation/regulation that have been made. No other losses to New Zealand economy.
Do nothing	New Zealand will miss out on all early-adopter advantages, which are likely to be significant as has been the case for previous digitally driven disruptions. New Zealand will play "catch up" for the remainder of the life span of this technology.	No effort and no benefit

Assuming that we can follow a robust and high-quality process for developing new legislation, regulation and taxation, the potential opportunities and returns for New Zealand's economy appear to far outweigh the downside risks of incurring the required effort.

In summary

- Distributed ledger technology underpins a small subset of startups working in New Zealand's fast-growing fintech space.
- Venture capital funding is flowing to DLT ventures though there are very few investment vehicles focused on this area.
- Fintech in New Zealand is characterised by high salaries and levels of R&D investment.
- Callaghan Innovation has supported numerous startups working in the DLT space with Growth, Project and Student Experience Grants as well as the R&D Tax Incentive Scheme.
- Governments all over the world are investing in DLT R&D efforts and skills development to stimulate innovation and build capability.
- Relatively low effort legislation, regulation and taxation is required to enable DLT/blockchain to produce high returns for the economy.

Key policy reading from the New Zealand Government

Future of money – central bank digital currency – Te moni anamata – aparangi ā te pūtea matua – Reserve Bank of New Zealand¹²⁵

The Future of Business for Aotearoa – Ministry of Business, Innovation and Employment¹²⁶

Inquiry into the current and future nature, impact, and risks of cryptocurrencies – Finance and Expenditure Committee, New Zealand Parliament¹²⁷

¹²² <https://techcrunch.com/2020/12/06/singapores-government-launches-blockchain-innovation-program-with-8-9-million-in-funding/>
¹²³ <https://devskiller.com/wp-content/uploads/2019/02/Devskiller-Global-Technical-Hiring-Skills-Report-2019-v4.pdf>
¹²⁴ https://www.angelassociation.co.nz/wp-content/uploads/2017/07/young_company_finance_issue_2_december_2007.pdf
¹²⁵ <https://www.rbnz.govt.nz/have-your-say/closed-consultations/future-of-money---central-bank-digital-currency>
¹²⁶ <https://www.mbie.govt.nz/dmsdocument/20250-the-future-of-business-for-aotearoa-new-zealand>

Chapter 6

Distributed Ledger Technologies and regulatory settings

How should New Zealand proceed?

“ Our regulatory frameworks should be designed to support responsible innovation while managing risks – especially those that could disrupt the financial system and economy. As banks and other traditional financial firms become more involved in digital asset markets, regulatory frameworks will need to appropriately reflect the risks of these new activities.”

Janet Yellen, US Secretary of the Treasury

Aotearoa New Zealand is yet to embark on implementing direct regulation of cryptocurrencies and digital assets. The exploratory policy work referenced above will enable government officials and members of parliament to consider regulatory instruments that are appropriate to our financial system, existing regulatory environment and the needs of our citizens and businesses.

As we survey the regulatory approaches being taken around the world, we see that they range from relying on existing regulatory regimes (currently New Zealand’s position) to implementing an outright ban on owning and trading assets, which is China’s stance.

Some movement along the continuum towards regulation will likely be required as uptake of digital assets increases and other countries adjust their regulatory settings. The question now is how New Zealand best strikes the balance between stimulating innovation in financial services and use of distributed ledger technology, while offering adequate protection for consumers and maintaining the integrity of the financial system.

¹²⁷ https://www.parliament.nz/en/pb/sc/make-a-submission/document/53SCFE_SCF_INQ_111968/inquiry-into-the-current-and-future-nature-impact-and



The following table, in general terms, summarises the potential future regulatory scenarios available to us.

Scenarios for regulatory action

Policy setting	What it looks like	Benefits	Drawbacks
No changes	<ul style="list-style-type: none"> Market-driven Low barriers to entry 	<ul style="list-style-type: none"> Innovation flourishes 	<ul style="list-style-type: none"> Ongoing regulatory uncertainty Consumers at risk At odds with international standards
Opt-in regime	<ul style="list-style-type: none"> Pilot schemes to test market demand 	<ul style="list-style-type: none"> Moderate effort/cost compared to other options for economic transformation Flexible to change 	<ul style="list-style-type: none"> Risks still remain May not be fully compliant with international standards
Risk-based regime	<ul style="list-style-type: none"> Regulation to address risks in a targeted manner (e.g. through pilot schemes) 	<ul style="list-style-type: none"> Balances consumer and financial protection with innovation Common approach internationally 	<ul style="list-style-type: none"> Some risks may continue to exist Increased trust drives adoption
Catch-all regime	<ul style="list-style-type: none"> Wide regulatory change to address broad risks 	<ul style="list-style-type: none"> Reduces all potential risks 	<ul style="list-style-type: none"> High cost of regulation/oversight Slow to get regulation in place
Blanket ban	<ul style="list-style-type: none"> Outlawing cryptocurrency trading Crypto-related activity ceases 	<ul style="list-style-type: none"> Minimises risk to consumers and financial system 	<ul style="list-style-type: none"> Could stifle blockchain-based innovation in the financial sector

Callaghan Innovation's view

We believe New Zealand's interest will be best served by approaching regulation for cryptocurrencies and digital assets through adopting a **risk-based regime**. Such a regime would focus on outcomes, evaluating the "risk" and magnitude of harm that could emerge if activities were either left unregulated or subject to existing regulations. The highest risks should be addressed while maintaining sufficient room for private-sector innovation.

According to the Organisation for Economic Co-operation and Development:

“ Risk is understood as the combination of the likelihood of harm of any kind, and the potential magnitude and severity of this harm. Risk-based regulation is, crucially, about focusing on outcomes rather than specific rules and process as the goal of regulation.”

The OECD also points out that the "Covid-19 crisis has shown the obstacles that regulation can pose to response needs when it is not in line with a risk-based approach, nor flexible enough."¹²⁸

What are our objectives?

The Digital Strategy for Aotearoa,¹²⁹ which was published in its final form in 2022 after extensive consultation, has the following overarching goals:

- The ICT sector doubles its economic contribution to GDP by 2030
- All significant government services are available digitally
- New Zealanders increasingly feel safe online
- More secondary school students are taking technology standards
- The numbers of tech-related graduates increases
- Our small businesses are more digitally capable (as measured by the SME Digital Index).

As part of Callaghan Innovation's core mandate, our agency has a key role to play in helping the government meet some of these goals, particularly where they relate to the role of technology-based innovation in our startup and business sectors.

Innovation in distributed ledger technologies will open opportunities for New Zealand startups and larger-scale businesses to transform existing financial services, digital identity platforms, digital authenticity and verification for our export products, and digital services in the private and public sectors alike. Our Software-as-a-Service (SaaS) startups have a proven track record in building valuable enterprises that create high-paying tech jobs and return export earnings for the country.

This success could be replicated to some degree in the area of fintech, with decentralised finance, digital assets and blockchain-based services forming the basis of consumer, business to business (B2B) and public services locally and abroad.

A key aspect in enabling this innovation is to have appropriate regulation in place. Any new regulation of digital assets, cryptocurrencies and distributed ledger technologies should aim to achieve the following three key objectives:

1. **Monetary and financial stability: maintaining the integrity of the existing monetary and financial system is paramount. We must maintain and safeguard the infrastructure and processes integral to our currency, banking system and the financial processes that underpin our economy.**
2. **Consumer protection: Users of cryptocurrencies and decentralised financial products should enjoy an appropriate level of regulatory and legal protection. This will engender trust and ultimately speed adoption of the technology.**
3. **Legal certainty: Create certainty in the treatment of crypto assets, including taxation and private property laws."**

¹²⁸ <https://www.oecd-ilibrary.org/sites/9d082a11-en/index.html?itemId=/content/component/9d082a11-en>

¹²⁹ <https://www.digital.govt.nz/digital-government/strategy/towards-a-digital-strategy-for-aotearoa/>

Questions to inform policy development

The following questions are raised in order to inform policy makers around the key questions that still need to be addressed seriously and thoughtfully by community leaders, members of parliament, leaders of businesses, and individuals.

The quality of conversations held, relationships built, pilots and programmes invested in, and intentionality of decisions made now will greatly impact the future of how New Zealand is positioned in the area of distributed ledger technologies in the decades to come.

Framing question 1:	How might New Zealand envision distributed ledger technology as a source of economic growth and prosperity for its citizens?
Callaghan Innovation's view: We need regulatory settings that encourage innovation in design and implementation of distributed ledger technologies. We already have a small but vibrant group of companies working in this space. To give our efforts more critical mass, we can't afford to lag behind other jurisdictions in implementing best practice regulation that builds trust among the public and therefore speeds adoption. The balance, as outlined above, must be between protecting the integrity of the financial system and the rights of consumers, while offering enough freedom for the innovation that will lead to economic and social gains.	
Framing question 2:	How might New Zealand create clear regulatory frameworks and pathways towards investment that incentivise talent to start blockchain-based startups here and for established blockchain-based businesses to make their home in New Zealand?
Callaghan Innovation's view: New Zealand is considered an attractive place to innovate given its low levels of corruption and ease of doing business. But the looming prospect of regulation in the cryptocurrency and digital assets space creates uncertainty for local and overseas investors looking to fund innovation in the space. Progress towards regulation should be well signposted and communicated so there is clarity on the pathway forward and timeframes involved.	
Framing question 3:	How might New Zealand create a clear tax policy for crypto assets that incentivises individual and corporate investors in the blockchain space, but protects its citizens from fraudulent activity and malicious players?
Callaghan Innovation's view: Inland Revenue's tax advice for owners of cryptocurrencies, NFTs and other digital assets is a good starting point for clarifying taxation requirements in relation to this class of assets. We would like to see broader efforts to inform and educate digital assets owners about the tax implications of digital assets, given that nearly one in 10 New Zealanders are currently investing in crypto and one in five either plan to invest or have invested. It is important that ventures drawing on blockchain technologies are able to access innovation funding initiatives such as the R&D Tax Incentive scheme, startup grants and incubator and accelerator programmes.	
Framing question 4:	How might New Zealand approach the development of CBDCs?
Callaghan Innovation's view: Many countries around the world are laying the groundwork for piloting a Central Bank Digital Currency. New Zealand has an opportunity to apply its own innovative approach to the tokenisation of a digital Kiwi dollar with pilot projects drawing on expertise in the public and private sectors. These pilots would help develop a framework for the potential wider roll-out of a Kiwi CBDC further down the track, subject to the approval of lawmakers and regulatory authorities. A complementary pilot programme could look at interoperability between a New Zealand CBDC and other nations' official digital currencies. The Reserve Bank has started work on a 'Future of Money' initiative (cf. CBDCs in Appendix 2).	
Framing question	How might New Zealand use blockchain technology and the use case of digital identity to uphold its commitments to data privacy and security while improving provision of government services like voting or healthcare?
Callaghan Innovation's view: Blockchain technologies hold great potential to form the basis of trusted digital identity services used by New Zealanders to access public services. These technologies should be accommodated by the Government's Digital Identity Services Trust Framework while innovation in blockchain-based digital identity technologies should be encouraged.	

Recommendations

Based on the key objectives and guiding principles outlined above, Callaghan Innovation offers five recommendations to help advance the country's approach to guiding the future development of digital assets and distributed ledger technologies.

Risk-based regulation: Whatever form of regulation the New Zealand Government applies to digital assets and distributed ledger technologies, it should be applied in proportion to the risks they pose to the financial system and to consumers. This approach would prevent regulatory overreach, duplication of existing regulatory measures and allow for innovation in financial services.

Gathering the data: The government, via Stats NZ, should collect metrics and key indicators tracking developments in the digital assets space, volumes of cryptocurrency trading, the value of digital asset classes and levels of fraud associated with these asset classes. This will allow all stakeholders to make regulatory decisions and explore market opportunities with accurate data to hand. The data should extend, where possible, to measuring the potential macroeconomic impacts of pursuing various regulatory scenarios.

Regulatory flexibility: Any regulatory regime should be technology-neutral, but be flexible enough to accommodate experimentation with new technologies through pilot programmes. The use of a 'regulatory pilot programme' would allow innovators to experiment in a controlled environment with adequate oversight by regulators.

Blockchain working group: While various parts of the New Zealand Government are considering the implications of greater use of cryptocurrencies, digital assets and central bank digital currencies, there is no one forum in this area for discussion and collaboration between government agencies, businesses, startups and researchers. A Digital Assets Working Group featuring representatives from the Reserve Bank of New Zealand, the Ministry of Business, Innovation and Employment, Department of Internal Affairs, New Zealand Treasury, industry body FintechNZ and other interested parties, would encourage collaboration

between stakeholders. A key early project of the working group should be to work with the Reserve Bank and existing initiatives to co-develop a CBDC for New Zealand or a kind of digital Kiwi dollar.

Regulatory one-stop shop: Regulation of digital assets, cryptocurrencies and stablecoins has the potential to be complex for citizens, businesses and government departments to navigate. A one-stop shop approach to regulation should be pursued, making it very clear what the rights and obligations of digital asset owners and businesses operating in this space are. This would reduce transaction costs and improve compliance with regulations.

Conclusion

Since the release of Satoshi's influential Bitcoin whitepaper over 12 years ago, the distributed ledger technology and blockchain space has significantly grown in value and in user adoption.

From the peak of the 'initial coin offering' boom in 2017 to the tumultuous market contraction of early 2022, it is clear that the space has evolved to attract major investors, from VCs to corporations. Consumers have added cryptocurrencies to their investment portfolios.

Governments around the world are now attempting to figure out what blockchain technology will mean for them and how they will strike a balance between supporting innovation in this space while also keep their citizens safe from harm.

Though the answers to these questions are unknown, this hasn't stopped the technology from progressing into business and governments. New Zealand is in a prime position to start making clear, intentional decisions to move forward with engagement with blockchain and distributed ledger technologies.

This paper aims to stimulate discussion among key stakeholders interested in the future development of digital assets and distributed ledger technologies. With strong collaboration across the public and private sectors, clear regulatory guidelines and an environment that promotes innovation, New Zealand can reap the social and economic benefits of embracing this technology in a responsible manner.

Appendices

Appendix 1

Key events in the history of DLT/blockchain

(citation) 1982 – first blockchain-like protocol proposed by David Chaum in his dissertation titled “Computer Systems Established, Maintained, and Trusted by Mutually Suspicious Groups”

(citation) 1991 – first blockchain outlined by Stuart Haber and W. Scoot Stornetta

(citation) 2009 – (Origin) Bitcoin whitepaper released by Satoshi Nakamoto. This was the first major blockchain innovation, the creation of a digital currency.

(citation) May 2010 a pizza was bought for 10,000 BTC; 22 May is now Bitcoin Pizza Day

(citation) Jul 2010 – Mt. Gox (Japan) was established as an FX exchange

Feb – Apr 2011 – 1 BTC = 1 USD. Bitcoin and USD parity!

(citation) 2012 – Proof-of-Stake (PoS) model was introduced in a paper, aimed at reducing the energy consumption of PoW mining

(citation) 2013 – Market Cap of Bitcoin reached \$1 billion

(citation) Ethereum whitepaper released by Vitalik Buterin; creation of the Smart Contract

(citation) July 2013 – First ICO raised by Mastercoin

(citation) 2014 – Ethereum blockchain funded through crowdfunding

(citation) 2014 – Mt. Gox Bitcoin exchange (Japan) lost just shy of \$0.5 million of Bitcoin, declared bankruptcy

(citation) 2015 – Launch of Ethereum blockchain, taking blockchain from purely crypto to platform and decentralised application functionality, ability to support smart contracts

(citation) December 2015 – Hyperledger launched by Linux Foundation – an enterprise blockchain hub

(citation) May 2016 – The DAO (Decentralised Autonomous Organisation) raises more than \$150 million in a crowdfunding campaign (11.5 million Ether)

(citation) June 2016 – The DAO loses approximately \$50m (over 13% of the Ether) in an attack

(citation) April 2017 – Digital currencies are recognised in Japan

(citation) 2018 – The crypto market crash

(citation) 2019 – Libra (the Facebook coin) was launched, project was delayed due to regulatory concerns

(citation) Feb 2021 – Switzerland accepting tax payments in Bitcoin and Ether

(citation) September 2021 – El Salvador became the first country to make Bitcoin legal tender

(citation) September 2021 – China declares cryptocurrency transactions illegal

(citation) November 2021 – India announces intention to ban cryptocurrencies

Appendix 2

Glossary

(citation) Bitcoin (BTC) - Bitcoin is a peer-to-peer payment system. It is a decentralised digital currency without a central bank or single administrator that can be sent from user to user on the peer-to-peer bitcoin network without the need for intermediaries

(citation) Blockchain - A blockchain is a type of distributed ledger (see DLT), composed of unchangeable, digitally recorded data in packages called blocks. Each block is then 'chained' to the next block, using a cryptographic signature. This allows block chains to be used like a ledger, which can be shared and accessed by anyone with the appropriate permissions

(citation) CBDC (Central Bank Digital Currency) - a digital representation of a sovereign currency issued by and as a liability of a jurisdiction's central bank or other monetary authority. (citation) Conceived as a digital representation of fiat currency, CBDCs are a liability of the central bank in the same way as physical currency. The Reserve Bank in NZ has started an initiative to explore the use of CBDCs - Te moni anamata - including the potential for a CBDC: <https://www.rbnz.govt.nz/money-and-cash/future-of-money>.

(citation) Retail CBDC - CBDCs can be directly held by citizens and corporations as a form of digital cash. Retail CBDC projects appear to be more advanced in emerging economies with financial inclusion stated as an expected outcome

(citation) Wholesale CBDC - Interbank or wholesale applications, where CBDC use is restricted to financial institutions, namely for interbank transactions and financial settlement. Wholesale efforts are mostly conducted in more advanced economies with more developed interbank systems and capital markets

(citation) Consensus algorithms (overview) - To update the ledger, the network needs to come to consensus using an algorithm. Arriving at consensus on a distributed network means that everyone agrees on the current state of the ledger (e.g., how much money does each account have) and confirms that

no one is double-spending their money. Coming to consensus is a computer science problem in fault-tolerant distributed systems. Generating a consensus means that multiple servers on the distributed network agree on the current truth state of the system, or in the basic Blockchain case, values in the ledger. Once the network computers reach a decision on a value, that decision is final. In Blockchain networks, the three main kinds of consensus algorithms for arriving at consensus in a distributed manner are Proof-of-Work (POW), Proof-of-Stake (POS), and Practical Byzantine Fault Tolerance (PBFT)

(citation) Cryptocurrency(ies) aka Crypto - A form of digital currency based on mathematics, where encryption techniques are used to regulate the generation of units of currency and verify the transfer of funds. e.g. Bitcoin, Ethereum

(citation) Decentralised Autonomous Organisation (DAO) - DAOs are organisations without a centralised entity like traditional corporations. Governance of DAOs is driven by the coded terms of smart contracts maintained on the blockchain ledger, rather than top-down by a management team. And rather than having a hierarchy of control, all DAO stakeholders with tokenized voting rights are considered equals, proportional to tokens held.

(citation) Decentralised exchanges (DEXs) - DEXs allow users to swap one currency for another, such as USD for BTC or Ether (ETH) for Tether (USDT). DEXs are a popular sort of exchange that links users directly, so they can trade cryptocurrencies without entrusting their funds to an intermediary

(citation) Decentralised Finance (DeFi) - Decentralised finance, or DeFi, is a system by which financial products become available on a public decentralised blockchain network. That makes them open to anyone to use, rather than going through middlemen like banks or brokerages. Unlike a bank or brokerage account, a government-issued ID, Social Security number, or proof of address are not necessary to use DeFi. More specifically, DeFi refers to a system

by which software written on blockchains makes it possible for buyers, sellers, lenders, and borrowers by which software written on blockchains makes it possible for buyers, sellers, lenders, and borrowers.

to interact peer to peer or with a strictly software-based middleman rather than a company or institution facilitating a transaction

(citation) Digital asset - A digital asset is anything that is stored digitally and is uniquely identifiable that organisations can use to realise value. Examples of digital assets include documents, audio, videos, logos, slide presentations, spreadsheets and websites

(citation) Digital identity - A digital identity is an online or networked identity adopted or claimed in cyberspace by an individual, organisation, or electronic device

(citation) Distributed Ledger Technology (DLT) - DLT is a digital system for recording the transaction of assets in which the transactions and their details are recorded in multiple places at the same time. Unlike traditional databases, distributed ledgers have no central data store or administration functionality

(citation) Ethereum (ETH) - Ethereum is the first public Blockchain that allowed for the development of smart contracts that could solve any codable problem given enough time and money. This gives it the ability to perform a variety of functions that Bitcoin could not. As of writing, it is the 2nd largest cryptocurrency by market cap

(citation) Initial Coin Offering (ICO) - ICO is an event in which a new cryptocurrency sells advance tokens from its overall coin base, in exchange for upfront capital. ICOs are frequently used for developers of a new cryptocurrency to raise capital

(citation) Lending platforms - Smart contracts are employed by these platforms to eliminate the need for middlemen such as banks to manage lending

(citation) Market capitalization (Market Cap) - Market capitalization is the total dollar market value of a company's outstanding shares of stock. It is calculated

by multiplying the total number of shares by the present share price

(citation) Mining - Is the process of validating transactions in order for them to be added to the Blockchain

(citation) (citation) Non-Fungible Token (NFT) - NFT is a digital asset that represents real-world objects like art, music, in-game items and videos. They are bought and sold online, frequently with cryptocurrency, and they are generally encoded with the same underlying software as many cryptos. NFT stands for non-fungible token. This is a digital token used to represent unique digital assets that aren't interchangeable with any other asset. NFTs came to Ethereum in early 2017 and commonly use the ERC-721 token standard. They stand in contrast to fungible tokens such as ETH where one ETH can be interchanged with another

(citation) Peer-to-peer (P2P) - Is the connection and interaction between two individuals/computers that doesn't require a centralised server to facilitate it. Networks with this property are called P2P networks which is the case with decentralised Blockchains

(citation) Permissioned blockchains - Permissioned blockchains can be seen as an additional blockchain security system, as they maintain an access control layer to allow certain actions to be performed only by certain identifiable participants. For this reason, these blockchains differ from public and private blockchains

(citation) Practical Byzantine Fault Tolerance (PBFT) (a consensus algorithm) - some of the next-generation Blockchains are considering PBFT as a longer-term solution that would allow 1 million distributed machines (clients) on a network to come together in a common and secure truth state of the system

(citation) Prediction markets - Markets where people can gamble on the result of future events, such as election results, prices of various assets, sports results, etc. The purpose of DeFi versions of prediction markets is to provide the same functionality as traditional prediction markets, but without the need for intermediaries.

(citation) **Proof-of-Work (PoW)** (see consensus algorithm) - A consensus algorithm that operates the distributed system to reward miners (client machines on the system) who solve mathematical problems. New transactions executed on the network are routed from the software wallets executing them to all of the mining clients on the network. In Bitcoin, for example, each mining client has a memory pool (mempool) to collect incoming unconfirmed transactions. The mining software validates the new transactions and batches them into a block (every 10 min in Bitcoin, and every ~ 12 s in Ethereum). The financial incentive for each mining client is to be the one to create the new block of transactions that the other machines will all take as the new truth state of the network and append to the decentralised copy of the Blockchain they maintain on their peer node. It is lucrative to record these transactions ("discover a block" or "mine a block"), and thus many dedicated mining operations (running custom ASICs) exist for Bitcoin. Proof of Work consensus mechanisms are criticised for the wasteful use of computation to produce the cryptosecurity

(citation) **Proof-of-Stake (PoS)** (a consensus algorithm) - The consensus algorithm is based on owning a stake in the network. In PoS systems, the creator of a new block is chosen in a deterministic way, depending on its stake, or degree of commitment (wealth) in the network. However, PoS systems are perhaps unnecessarily convoluted with voting tiers and not necessarily more efficient than Bitcoin in terms of what might be considered wasteful computation

(citation) **Smart contracts** - Smart contracts are contracts whose terms are recorded in a computer language instead of legal language. Smart contracts can be automatically executed by a computing system, suitable distributed ledger system

(citation) (citation) **Stablecoins** - any cryptocurrency designed to have a relatively stable price, typically through being pegged to a commodity or currency or having its supply regulated by an algorithm. Read a more detailed paper on smart contracts here. A cryptocurrency that is linked to a non-cryptocurrency asset (USD, EUR, GBP, etc.) in order to keep its price stable.

(citation) **Tokenisation** - The process of replacing sensitive data with unique identification symbols that retain all the essential information about the data without compromising its security

(citation) **Total Value Locked (TVL)** - used as an indicator or metric in the DeFi space. It reflects the value of fund that users have collectively locked into DeFi projects

(citation) **Use case** - In software and systems engineering, a use case is a list of actions or event steps, typically defining the interactions between a role (or actor) and a system, to achieve a goal

(citation) **"Wrapped" bitcoins (WBTC)** - A method of transferring bitcoin to the Ethereum network so that it can be utilised in Ethereum's DeFi mechanism directly. WBTCs allow users to earn interest on bitcoin they lend out through the above-mentioned decentralised lending networks.

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