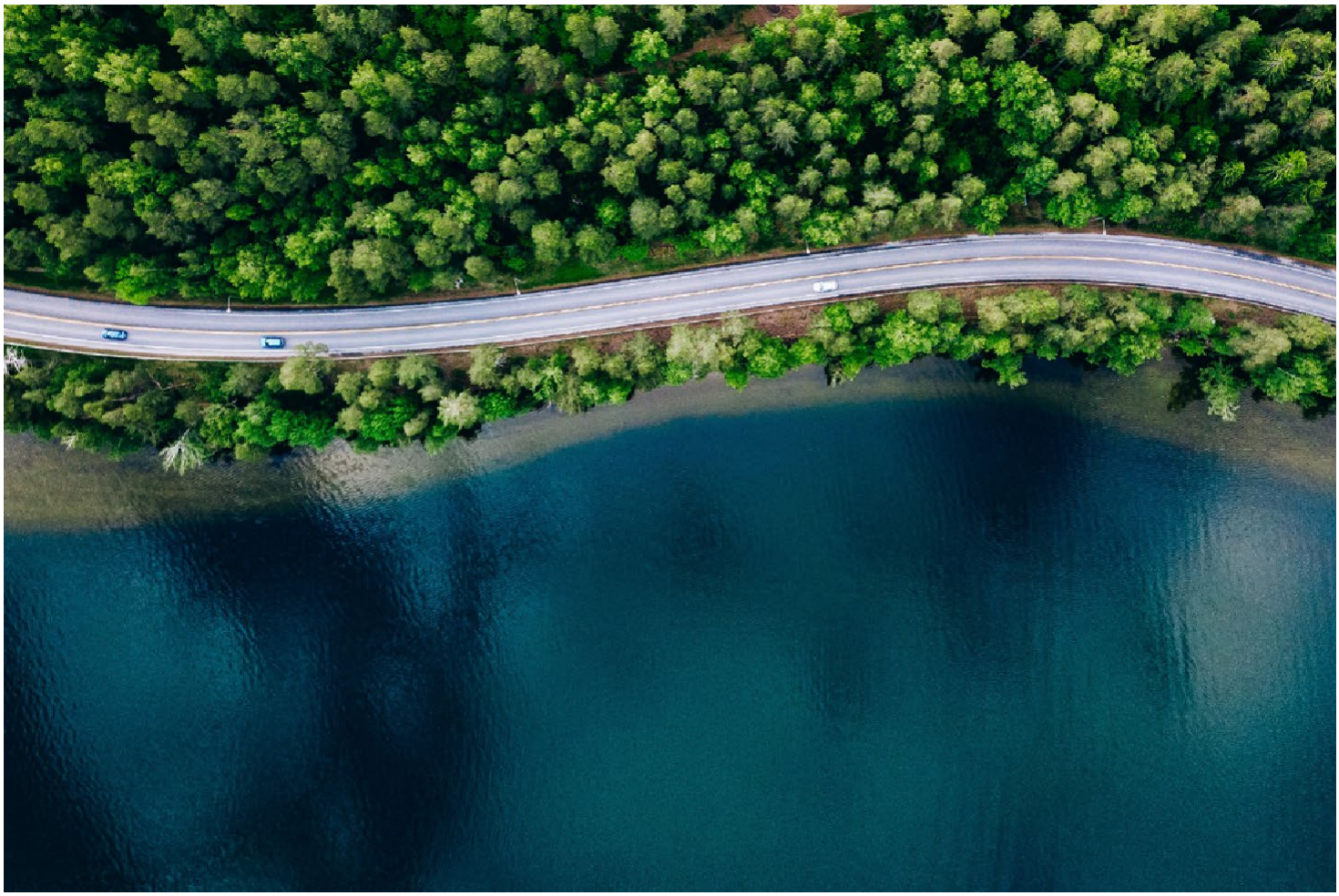


Enabling trust in water trading

A discussion paper on how blockchain technology can improve accountability and transparency within the Murray-Darling Basin

IBM

ARUP

Table of contents

A blockchain-enabled water platform to improve the accountability and transparency of the Australian water markets.

Introduction

Arup and IBM have co-developed this discussion paper with a view on how blockchain technology can improve accountability and enable trust within Australian water trading markets. This follows the release of two major reports - the Australian Consumer and Competition Commission's (ACCC) Water Market Inquiry on 26 March 2021, and the Department of Climate Change, Energy, the Environment and Water's (DCCEEW) release of Water Market's Final Roadmap Report on 11 October 2022. Furthermore, Arup have collaborated with industry leaders to research alternative trading models for addressing the recommendations outlined in the two reports. These recommendations are made to address some of the challenges that the have been identified in the Murray-Darling Basin's (MDB) water trading markets.

Although considered world leading, the Australian water market, specifically the Murray-Darling Basin's (MDB) water trading market, is encumbered with an aging digital trading architecture that is complex, carries incomplete information, and most importantly, does not provide users with adequate trust in the trading platform. Participants in those market enquiries acknowledge that this leads to a lack of transparency, inefficiency, and lost opportunities.

Nevertheless, the foundation exists to create an industry-leading platform for the water market; one that captures trades in real time, thereby ensuring complete information and accessibility as appropriate, and immutability of the transactions. Such a platform must cope with the inevitable complexities and be flexible enough to consider future trading modalities and a hierarchy of existing and new constraints. A secure and trusted water trading platform governed by a blockchain architecture[1] leveraging decentralized data providers, Internet of Things (IoT), and smart metering, would assist in placing Australia as a world leader in water management. This could be a single 'water platform' where all water use, in support of our environment and our economy, can be accessed and tracked by all relevant stakeholders and managed in a transparent manner to achieve agreed objectives within the natural limits of water availability.

1. Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. All network participants have access to the distributed ledger and its immutable record of transactions. With this shared ledger, transactions are recorded only once, eliminating the duplication of effort that's typical of traditional business networks. See definitions provided in the document below.

Through our engagements with the industry, we have a robust understanding of the challenges faced by the stakeholders[2]. However, we also observe Australia's unique position to lead the world in developing an industry-wide, comprehensive water market platform. To this purpose, this discussion paper outlines a vision for a decentralised, collaborative platform that addresses the key concerns expressed in the major reports mentioned above. Our perspective is about empowering people to access water, increasing market transparency, and building trust back into the management of the ecosystem.

Our discussion paper identifies reforms in the following four policy areas to ensure water markets have integrity safeguards, and participants have access to information to make informed trading decisions:

1. Integrity and transparency
2. Data and systems
3. Market architecture
4. Governance.

While discussing the merits of a blockchain-enabled water trading platform, this discussion paper provides case studies of other industries where blockchain solutions have solved challenges where conventional approaches have failed. These case studies bolster our case for a blockchain enabled water trading platform, demonstrating that there is tangible value in delivering this type of solution.

2. Arup and the NSW DPE worked together on a collaborative research project exploring the potential to use blockchain technology as an alternative architecture for water trading in NSW.

Challenges on the horizon: ACCC's investigation into the Murray-Darling Basin water markets

This section seeks to provide a high-level overview of the current situation, which has evolved from historic decisions and in essence has compounded some of the problems and inefficiencies we see today.

Water markets continue to evolve in their levels of sophistication and trading activity. Australia has been a pioneer in this space, with the early introduction of successful water trading. Australia has become a world leader in the management and operation of a rural water market. However, complex governance arrangements reflecting political realities, rather than physical water realities, and while piecemeal systems that lack transparency limit progress. These observations are underscored by the ACCC final report (the findings and recommendations of the ACCC report are summarised below in Table 1 and Table 2, respectively).

The evolution of Australia's water management can trace its history back to the 1914 River Murray Waters Agreement. One of the most significant changes came about in the 1980's, when water trading was first introduced. Water trading in the MDB started in different regions at different times to enable irrigators within the same valley to maximise the productive use of water resources by trading and helping to manage and mitigate the impacts of water shocks.

Water trading is a complex market in which water brokers complete water trades with limited transparency. Trades occur across farmers, irrigators, towns, and government to meet the diverse needs for allocation. Trading within valleys allowed irrigators to build a resilient ecosystem and foster community success. Based on the earlier successes of water trading, the water trading market has evolved as part of a wider component of water management reform in the MDB.

Despite these early successes, the modern roles and responsibilities of state and federal governments, coupled with the inconsistency of laws and their associated enforcement across state boundaries within the MDB, have contributed to market inefficiencies[3]. The ACCC's inquiry's findings are summarised in Table 1.

Based on these findings, the ACCC made several recommendations. These were covered extensively in the report and are summarised into four key areas in Table 2.

Findings

1. Water markets have major deficiencies
   MDB water markets are extremely complex.
   The result is considerable uncertainty and increased sovereign risk. The inquiry found:
   - Market information is fragmented, incomplete, and neither timely nor comprehensive.
   - Minimal regulation of water market intermediaries, resulting in irrigator confusion and conflicts of interest.
   - Market architecture is coming under increasing stress as water supply and demand changes and markets develop.
   - In combination, market deficiencies are resulting in a loss of fairness within markets.

2. Investors and agribusiness trading
   The ACCC closely examined trading by 4 large investors, 4 small investors and 11 major agribusinesses.
   - Large investors held 7% of high reliability/security entitlements in the Southern Connected Basin.
   - The large and small investors accounted for 11% of allocation volumes purchased and 21% of those sold in 2018-19.
   - Major agribusinesses were buyers of 25% of allocation volumes traded in 2018-19 and 38% in the first part of 2019-20.

3. Lack of oversight and market transparency
   The ACCC did not find evidence that investors exercised market power or manipulated prices.
   The inquiry found:
   - It is very difficult to regulate what is inaccessible or not recorded.
   - Lack of public data contributes to misconceptions, misinformation, and low market confidence within the public at large.
   - There is currently no single entity responsible for ongoing, effective monitoring of trading in the Basin.

Table 1 — Summarised findings from the ACCC final report

3. System problems also lead to market inefficiencies. Some would argue that inconsistency in law and enforcement is a problem, but not so much an efficiency one, rather a transparency and inequality problem. Transparency / platforms and information access for small versus large business are also a problem (and perhaps point to the position that there should not be a need for brokers at all if possible).

Our Observations

Some of these recommendations require policy & legislative changes to be met, which will inevitably lead to extended timelines and a need for inter-governmental agreements.

However, in the short term there are several practical endeavours that can be implemented to develop a water trading platform solution that speak to the following recommendations: transparent, simplified market architecture; improved trade processes; clear reporting; and appropriate market announcements.

Over time, such a water platform will serve as a basis to address in time the other reforms proposed in the ACCC final report.

Recommendations

1. Trade processes and information
   - Digital solutions to improve trade processes and interoperability.
   - Improve inter-zone trade processes.
   - Implement common water markets data standards.
   - Create a public-facing water markets information. Platform, including trade information and market announcements.
   - Create a water markets education program.

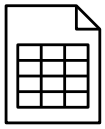
2. Lack of oversight and market transparency
   - Create a water markets agency focused on:
     - Market regulation and surveillance
     - Market information
     - Market evaluation
     - Market advisory and advocacy
   - Incorporate requirements for advice from Water Markets Agency to inform decision-making.
   - Improve transparency of roles of MDB councils and committees.

3. Market Integrity
   - Centralised, basin-wide market conduct and integrity legislation, including a mandatory industry code for intermediaries.
   - Comprehensive reporting requirements and digitisation to support market surveillance.
   - Standardised rules and processes for market announcements.

Table 2 — Summarised recommendations from the ACCC final report

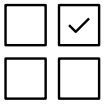
What is blockchain technology?

Blockchain is a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network. An asset can be tangible (a house, car, cash, land) or intangible (intellectual property, patents, copyrights, branding). Virtually anything of value can be tracked and traded on a blockchain network, reducing risk and cutting costs for all involved [Refer to Figure 1].



As each transaction occurs, it is recorded as a "block" of data
Those transactions show the movement of an asset that can be tangible (a product) or intangible (intellectual). The data block can record the information of your choice: who, what, when, where, how much and even the condition such as the temperature of a food shipment.

Each block is connected to the ones before and after it
These blocks form a chain of data as an asset moves from place to place or ownership changes hands. The blocks confirm the exact time and sequence of transactions, and the blocks link securely together to prevent any block from being altered or a block being inserted between two existing blocks.



Transactions are blocked together in an irreversible chain: a blockchain
Each additional block strengthens the verification of the previous block and hence the entire blockchain. This renders the blockchain tamper-evident, delivering the key strength of immutability. This removes the possibility of tampering by a malicious actor and builds a ledger of transactions you and other network members can trust.

Figure 1 — How blockchain works

Why blockchain is important: Business runs on information.

The faster it's received and the more accurate it is, the better. Blockchain is ideal for delivering that information because it provides immediate, shared and completely transparent information stored on an immutable ledger that can be accessed only by permissioned network members. A blockchain network can track orders, payments, accounts, production and much more. And because members share a single view of the truth, you can see all details of a transaction end to end, giving you greater confidence, as well as new efficiencies and opportunities [Refer to Figure 2].

Distributed ledger technology
All network participants have access to the distributed ledger and its immutable record of transactions. With this shared ledger, transactions are recorded only once, eliminating the duplication of effort that's typical of traditional business networks.

Immutable records
No participant can change or tamper with a transaction after it's been recorded to the shared ledger. If a transaction record includes an error, a new transaction must be added to reverse the error, and both transactions are then visible.

Smart contracts
To speed transactions, a set of rules called a smart contract is stored on the blockchain and executed automatically. A smart contract can define conditions for corporate bond transfers, include terms for travel insurance to be paid and much more.

Figure 2 — Key elements of a blockchain

The benefits of blockchain.

The benefits of blockchain stem for a need to optimise business operational inefficiencies such as duplication and third-party validations. Record keeping systems can be vulnerable to fraud and cyber-attacks. Limited transparency can slow data verification, and with the arrival of the IoT, transaction volumes have exploded. All of this slows business, drains the bottom line – and means we need a better way. Enter blockchain [Refer to Figure 3].

Greater trust
With blockchain, as a member of a members-only network, you can rest assured that you are receiving accurate and timely data, and that your confidential blockchain records will be shared only with network members to whom you have specifically granted access.

Greater security
Consensus on data accuracy is required from all network members, and all validated transactions are immutable because they are recorded permanently. No one, not even a system administrator, can delete a transaction.

More efficiencies
With a distributed ledger that is shared among members of a network, time-wasting record reconciliations are eliminated. And to speed transactions, a set of rules called a smart contract can be stored on the blockchain and executed automatically.

Figure 3 — Benefits of a blockchain[4]

4. Source of Figures 1-3: https://www.ibm.com/topics/blockchain

Roadmap recommendations for water market reform

The table below details the recommendations in DCCEEW's Water Market Reform Roadmap Report that directly align with Arup & IBM's contention that a blockchain-enabled water trading platform could deliver solutions to problems identified in the ACCC's Water Market Inquiry.

The following recommendations identified in the table below are ones that will be directly serviced by the water trading platform. The recommendation points from the roadmap that do not feature in the table, we believe, do not have an alignment with the proposed water trading platform solution. Within our suggestions for taking our recommendations forward, we believe that the Lower Darling, Wimmera/Mallee and South Australian Murray catchment will provide the most robust test for the technology as it is cross-jurisdictional. Furthermore, it provides the best way to demonstrate the different trading rules working in a common water trading platform environment [Refer to Table 3].

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#1	2. Market conduct prohibitions	The Commonwealth should pass a law to prevent price manipulation and insider trading for all types of tradeable water rights. The mandatory water announcement requirements should continue and be expanded to include irrigation infrastructure operators, with the details to be defined during the drafting of the legislation.	3. Prohibit price manipulation, broaden price reporting, and broaden and strengthen insider trading obligations. 9. Implement rules and processes for water announcements.	Blockchain architecture provides rules and functions that can control for market manipulation. Ledger technology requires all participants in the market to verify the trade processes. Announcements pertaining to trading is a feature of a blockchain enabled water market that has been implemented previously (refer to documented case studies within).	IBM and ARUP have the joint capabilities to enable the realisation of a macro solution that crosses State boundaries. Our recommendation is to test a blockchain enabled water market for the Lower Murray Catchment. The test should consider elimination of insider trading and price manipulation.	Discussions between relevant stakeholders on a co-design and development of an appropriate proof of concept in the Lower Darling, Wimmera Mallee, and SA Murray catchments with a view to fast-tracking the requirements before regulatory decisions are tabled by leveraging blockchain technology & prototyping frameworks.
#2	3. Water market intermediary code	The Commonwealth should establish a mandatory code of conduct for water market intermediaries across the Murray-Darling Basin, with obligations extended to all tradeable water rights.	2. Incorporate key obligations as part of an enforceable mandatory code for water market intermediaries.	Governance model is created to support the code of conduct. Furthermore, Blockchain architecture provides the opportunity for rules to be embedded into the code to ensure that water market intermediaries operate according to the recommendations of this report.	Our recommendation is to engage with all relevant stakeholders to develop collaboratively the code of conduct to support the governance model and that it can be hard-wired into the architectural framework, i.e., rules-base decision trees. Create trust through transparency, not anonymity.	A workshop on understanding how blockchain works and the benefits of blockchain for the MDB covering key topics such as: trust, security and efficiency. It would also explain the different kinds of blockchain networks and case studies that have utilised this technology to deliver positive outcomes that seemed implausible for other stakeholders for many years. A workshop with stakeholders to determine the features of the code of conduct to support the Governance model as well as hard-wired into the blockchain architecture.

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#3	4. Broaden and strengthen price reporting requirements for trade data	Trade approval authorities and irrigation infrastructure operators should report price data for all tradeable water rights, including water delivery and irrigation rights, with de-identified data made publicly available.	3. Prohibit price manipulation, broaden price reporting, and broaden and strengthen insider trading obligations. 9. Implement rules and processes for water announcements.	Similarly, to the market conduct prohibitions recommendation, price reporting requirements could be broadened and strengthened using a blockchain architecture. The blockchain architecture can be coded to the requirements of the water market functionality and provide the necessary transparency and auditability. Blockchain architecture ensures that no participant can change or tamper with a transaction after it's been recorded to the shared ledger.	Test a blockchain enabled water market in the Lower Darling, Wimmera Mallee, and SA Murray catchments, which crosses the NSW, SA and VIC borders.	Develop proof of concept delivery plan for Lower Darling, Wimmera Mallee, and SA Murray catchments with stakeholders. Objectives should include the broadening and strengthening of price reporting.
#4	5. Price reporting requirements for pre-trade data	Water market intermediaries should report pre-trade price data in a phased manner, with de-identified data made publicly available.	3. Prohibit price manipulation, broaden price reporting and broaden and strengthen insider trading obligations.	Refer to #2	Refer to #2	Refer to #2
#5	6. Transparency of decisions about water allocations and drivers of water availability	The Bureau of Meteorology's (BoM) Water Information Portal should be linked to decisions about Basin state water allocations and information about the drivers of water availability to increase transparency.	15. Increase the transparency of allocations decisions and the drivers of water availability.	Linking trade announcements pertaining to decisions about water allocations and information about the drivers of water availability can be easily made more transparent with a blockchain enabled water market. Trading can be paused temporarily to allow for market communications to be released for full transparency.	Test the interoperability between the BoM's Water Information Portal's repository and how the water trading platform will facilitate the water market dynamics (access to key data driving real-time trading information).	Develop a conceptual architecture including a data and process map with stakeholders as part of the proof of concept.

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#6	7.* Transparency about conveyance losses	The Murray-Darling Basin Authority and Basin states should improve transparency and understanding of conveyance losses, with the Authority continuing to publish information on conveyance losses in the Summary of River Operations annual report, and Basin states improving communication on conveyance losses to aid understanding and access.	21. Improve transparency of conveyance losses and other delivery impacts.	Blockchain provides opportunities for new systems of trading. For example, overheads for trading (gas fees) from peer-to-peer network systems could provide a clip fee for conveyance losses shared by the market in conjunction with other supply chain stakeholders. This would hold stakeholders accountable to conveyance losses and increase transparency.	To address systemic issues surrounding conveyance losses with a blockchain water trading platform. We recommend that alternate pricing structures could be modelled to increase market participant trust.	Work with stakeholders to develop a list of requirements for the proof of concept, which includes transparency of conveyance losses.
#7	10. * Data and systems reforms to support integrity and transparency recommendations	The Bureau of Meteorology (BoM) should develop and implement a data and systems framework that includes new water market data standards, data sharing agreements, a system for regulators and intermediaries to interact with, a National Water Data Hub, a web application providing pre-trade and trade information, and aggregated trade statistics published on the Murray-Darling Basin Water Information Portal. The water market data standards should include unique identifiers and transaction identifiers to enable effective tracing of trades.	4. Require identifiers on trade forms, 6. Reshape current information portal initiatives, 7. Implement Water Market Data Standards to provide a clear and fit-for-purpose framework for water market data and water trade services, 10. Adopt a comprehensive Digital Messaging Protocol for the capture, storage and transfer of water market data and trade applications, 11. Implement a digital platform ('Backbone Platform') to act as a single repository for water market data and a single hub for trade approvals, 12. Implement a public facing Water Market Information Platform which harnesses improved data collection and quality.	As part of deploying a blockchain enabled water market, data governance and standards will be developed. Clear standards for reporting of information, validation of market participants including trading information, participant credentials and registration will all be necessary to ensure the integrity of the system. With all transactions, unique identifiers of hashes are created, which both anonymises the trade, but contributes to the ledger of trades. This provides security to the water market and allows real-time auditing of the market to control for manipulation and market failure.	Our recommendations are to take the ACCC's recommendations, which advocate more strongly for a blockchain enabled water market. Arup and IBM believe that the water markets are complex by their nature, with federal management having fallen short historically. As such, Arup and IBM contend that a decentralised approach is taken for developing the data and systems framework. This will be overseen by the BoM and MDBA, but delivered by the state government supported by private industry.	Engage BoM and MDBA to develop a delivery plan for the proof- of-concept water market in the Lower Murray Catchment.

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#8	12. Monitor trade approval authority and irrigation infrastructure operator timeframes for processing trades	Trade approval authorities and irrigation infrastructure operators should regularly report processing times to the Bureau of Meteorology for publication.	8. Implement mandatory trade approval service standards.	A blockchain enabled water market would operate only through codified trade approval authorities provide both by market participants and by administrators. Processing time would be made available in real-time to all market participants eliminating the need for reporting.	Test a blockchain enabled water market with the in the Lower Darling, Wimmera Mallee, and SA Murray catchments, which crosses NSW, SA and the VIC borders.	Develop a conceptual architecture including a data and process map with stakeholders as part of the proof of concept.
#9	14.* Improve intervalley trade (IVT) mechanisms	The roadmap suggests ways to improve the efficiency and access to inter-valley trade opportunities, such as removing grandfathered tag provisions, providing clearer guidance, and improving equity of access. It also recommends evaluating the impacts of carry-over parking trade and increasing transparency about how environmental water trade, transfer, and delivery is managed and communicated.	8. Implement mandatory trade approval service standards.	Trade processing is an integral part of any blockchain enabled market. There are several case study examples where suboptimal trading mechanisms have been improved leveraging blockchain including cross borders payments. Arup and IBM contend that the issues pertaining to carry-over parking trade, environmental water trade transfers and delivery will all be improved through a blockchain enabled water market.	Test a blockchain enabled water market in the Lower Murray Catchment, which crosses NSW, SA and the VIC borders.	Blockchain is well known to provide fast and transparent trading mechanism starting with Bitcoin to more complex system such clearing process for DTCC. We suggest developing the appropriate structure to support the need of the inter-valley trade.
#10	15. Evaluate the impacts of carry-over parking trade	The Basin states and the Murray–Darling Basin Authority should evaluate the impacts of carry-over parking trade.	16. Improve efficiency in accounting for the costs of carry-over.	Considered as part of #9	Considered as part of #9	Considered as part of #9

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#11	16.* Transparency of trade considerations in river-operations	The Murray–Darling Basin (MDB Authority should increase transparency about how held environmental water trade, transfer, and delivery is managed and communicated.	20. Refine river operations guidance to more effectively and transparently balance trade-offs.	All trade information, including environmental water and river operations can be made more transparent with a blockchain enabled platform. Different types of water trades, pertaining to river operations, can be separated from more traded parts of the market. This will allow interested parties to be able to filter for the trade processes relevant to their needs and provide greater transparency.	Test, as part of the proof-of-concept blockchain enabled water market, filtered trading information and experiment with different ways for providing transparency to stakeholders.	Develop a conceptual architecture including a data and process map with stakeholders as part of the proof of concept. One of the key aspects will be to maintain data ownership and privacy but still allow for a transparent trading system.
#12	18.*Transparency of environmental water delivery	The Basin Officials Committee, in consultation with relevant parties, should increase transparency around the management of environmental water trade and communication. This includes disclosing the volume of environmental and other water flows in the system.	23. Implement clear and integrated mechanisms for delivery of environmental water.	Considered as part of #11	Considered as part of #11	Considered as part of #11
#13	19.*Conduct research to inform future water market reforms	A long-term research agenda should be developed and implemented to inform potential improvements in market architecture and water management. The agenda will be guided by improved data collected through the implementation of recommendations in the roadmap.	25. Develop a reform roadmap for designing and operating efficient markets now and into the future.	When considering the future of water market reforms, emerging technology and the impact it can have on the market is imperative. Blockchain enabled markets ought to be considered in future water market reforms, especially when transparency of trading, validation and verification of participation is issues in the existing market.	This discussion paper provides an evaluation of the current water market and reviews the ACCC's final report and the water market reform roadmap. As such, findings from this paper should be considered as part of future water market reform research.	Advocate for further research for future water market reforms off the back of this discussion paper.

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

ID	DCCEEW Recommendation #	Details	ACCC Recommendation #	Blockchain applicability	Our Recommendations	How to move forward
#14	22.*Implement better rule-making and decision making processes	To improve decision making processes, all decision-making bodies in the Murray–Darling Basin should review their processes for assessing the implications of proposed decisions. The review should consider a range of interests, including operational water management, social, cultural, environmental, and commercial implications Improved consultation processes should also be established to ensure decision makers understand the implications of their decisions.	27. Implement better rule-making process.	A blockchain by design requires all participants in the market to reach consensus on market activities, which includes streamlined decision-making processes, trading activity across a range of interests. Blockchain allows open discussion and voting on changes to the market, where all interests are considered. Furthermore, it automates the process and decisions transparently.	Map the decision making processes and ensure that the interests of the broader stakeholder group are baked into the business logic of the solution and its relevant smart contracts.	Blockchain leverages smart contract and the ability to embed rules and processes within the system itself. Large and complex systems are already in production starting with Bitcoin to more complex system such as Equigy https://equigy.com/ a crowd balancing platform across the European electricity ecosystem. We suggest developing the appropriate structure and its associated business logic (rule-making) to support the need of the inter-valley trade.

Table 3 — DCCEEW's recommendations compared to the ACCC's and the path forward

DCCEEW Recommendations with a '' indicate 'not' a direct linking recommendation to a blockchain enabled water market. Included as there are interdependencies and cross-overs that are worth considering when comparing the Water Market Reform Roadmap with the ACCC's Murray-Darling Water Market's Inquiry reports.

Improving the Murray–Darling Basin market architecture

Our Contention on Market Architecture

Arguably, a water trading platform has the greatest potential to address the first recommendation pertaining to market architecture. It has the potential to provide purpose- built platform to manage all the water-related challenges by leveraging new technologies such as blockchain, AI, automation, and edge computing to facilitate access to trusted information across all states and participants as required.

Blockchain could, for example, enable trust by creating a shared, immutable ledger that facilitates the process of recording transactions and tracking assets in a business network, as these occur. Permissioning and data governance is set in accordance with the needs of the platform participants and provides clear visibility across the entire ecosystem. The ledger becomes the single source of documented truth that cannot be tampered with. This digital assurance enables organisations to innovate together in ways that were previously hindered by trust issues and lengthy validation processes.

The water trading platform will work alongside the water balance dashboards for managing water in the MDB, which are in development as part of the Hydrometric Network and Remote Sensing (HNRS) package of works led by the MDBA. This package of works seeks to account for the unaccounted differences in the MDB so that water information can be tracked more effectively. The knock-on effects will be increased data availability, greater insights into water balance at various scales, a better understanding of non-compliance instances, and market participation. The water trading platform would dovetail with the HNRS platforms to increase transparency with the complete history of each transaction available to all permitted users in the network immediately. Our companies are well placed to support the innovation and engagement required in a Proof of Concept for the water trading platform through the work and partnerships in place.

More fundamentally, the environment can be clearly identified as a beneficiary in the water trading platform, and all users can gain access to allocated flows. This can support and assist the different participants that compete for water allocation in a system – such as the complex negotiations of the MDB in Southeast Australia. Since the transactions recorded using blockchain technology are immutable, it becomes a simpler process to verify information and allows recording of unrecorded informal trades. In turn, this allows the Water Markets Agency to determine if there is market failure occurring empowering them to immediately provide a remediation path. For an example of how blockchain has transformed a complex trading market, refer to Case Study 1.

Market architecture

- Improve transparency of allocation decisions and communicate plans for managing shortfalls.
- Develop robust accounting for carry-over and storage losses.
- Strengthen metering and monitoring, and improve modelling for use, delivery, and trade.
- Improve inter-valley trade mechanisms and remove ‘fastest finger’ advantage.
- Clarify rules for delivery of environmental water.
- Develop and implement a careful reform roadmap.

Case Study 1: Enabling Renewable Energy Grid Management with Equigy

Overview
Equigy is a blockchain-based platform that enables the management of decentralised renewable energy grids. By using blockchain technology, Equigy enables stakeholders in the energy industry to coordinate and manage the supply and demand of energy from distributed renewable energy sources. This use case demonstrates how blockchain technology can help address the challenges of managing decentralised renewable energy grids and enable a more sustainable energy system.

Problem Statement
The rapid growth of renewable energy sources has led to an increasingly decentralised energy system, with energy being produced and consumed at various locations across the grid. This decentralisation creates challenges for energy grid management, as it requires coordination between multiple stakeholders to ensure that energy supply and demand are balanced. In addition, renewable energy sources are often intermittent, making it challenging to predict and manage energy supply and demand.

Solution
Equigy addresses the challenges of managing decentralised renewable energy grids by providing a transparent and secure platform for energy grid management. The platform enables stakeholders to coordinate and manage the supply and demand of energy from distributed renewable energy sources using blockchain technology. This ensures that energy supply and demand are balanced and that renewable energy sources are used efficiently.

Implementation
Equigy uses blockchain technology to create a transparent and secure platform for energy grid management. The platform is used by energy producers, grid operators, and energy consumers to coordinate and manage the supply and demand of energy from decentralised renewable energy sources. Each transaction is recorded on the blockchain, creating a tamperproof record of energy supply and demand. Equigy also uses advanced analytics to provide insights into energy production and consumption, enabling stakeholders to predict and manage energy supply and demand more effectively.

Client References
- Enel, one of the largest energy companies in the world, uses Equigy to manage its distributed energy resources across Europe.
- Terna, the operator of the Italian electricity grid, uses Equigy to manage the supply and demand of energy from distributed renewable energy sources.
- Energinet, the Danish transmission system operator, uses Equigy to integrate and manage energy from renewable sources.

Impact
Equigy has had a significant impact on enabling renewable energy grid management and promoting sustainability. By providing a transparent and secure platform for energy grid management, the platform has helped to ensure that energy supply and demand are balanced and that renewable energy sources are used efficiently. Equigy has also enabled stakeholders to predict and manage energy supply and demand more effectively, reducing waste and inefficiencies in the energy system.

Equigy has grown significantly since its launch in 2020, with over 40 companies currently using the platform and continues to innovate and expand its capabilities, with recent developments including the integration of machine learning algorithms for more accurate energy demand forecasting.

Source: *https://equigy.com*

Improving trade processes and information

Our point of view on trade processes and information

This new type of business platform does not just change an organisation's business model; instead, it has the potential to provide a new, external ecosystem operating model. Shared business platforms knock down the walls between organisations and, sometimes, the barriers between industries.

The ACCC report called out the need for an interoperable platform to streamline trade processes and provide transparent access to market announcements and trade information across borders. Currently, processes are convoluted and a mixture of automated and manual processes, many of which cannot communicate with each other. Traders themselves called for simplification during the ACCC investigation; for example, the complexity of an inter-valley trade was mapped in the final report [Refer to Figure 4].

Trade processes and information

- Digital solutions to improve trade processes and interoperability.
- Improve inter-zone trade processes.
- Implement common water markets data standards.
- Create a public-facing water markets information Platform, including trade information and market announcements.
- Create a water markets education program.

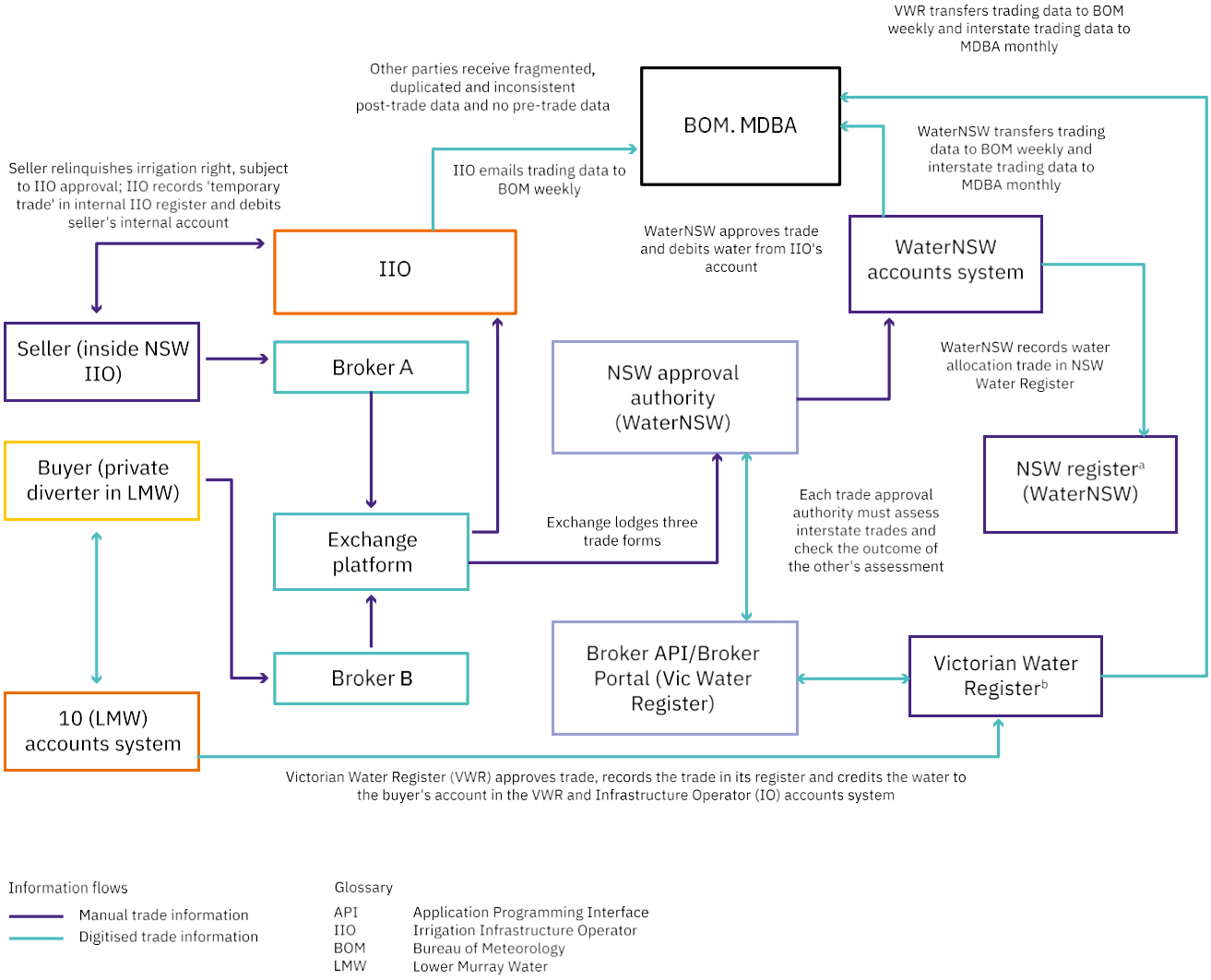


Figure 4 — Processes required to complete an inter-valley trade – Source: ACCC Final Report (figure 2.6)

A common platform has the power to provide these interoperable, transparent, and streamlined processes by transforming the ecosystem's operating model and blocking silos. Distributed ledger technology dissolves silos by giving actors access to the same trade updates at once. Trade participants can see exactly where their trade is sitting in an approval flow and validators can quickly and securely approve trades digitally.

Removing silos drastically simplifies the process to access and validate current and correct information. Leveraging a single source of truth, participants in the platform will have access to near real-time data to enable much faster processes and remove unnecessary steps. In the context of Figure 4, it will flatten the complex process flows, leading to faster processing times and greater transparency. Figure 5 shows the 'beta' system enabled by distributed ledger technology. For an example of how blockchain enables increased traceability, refer to Case Study 2.

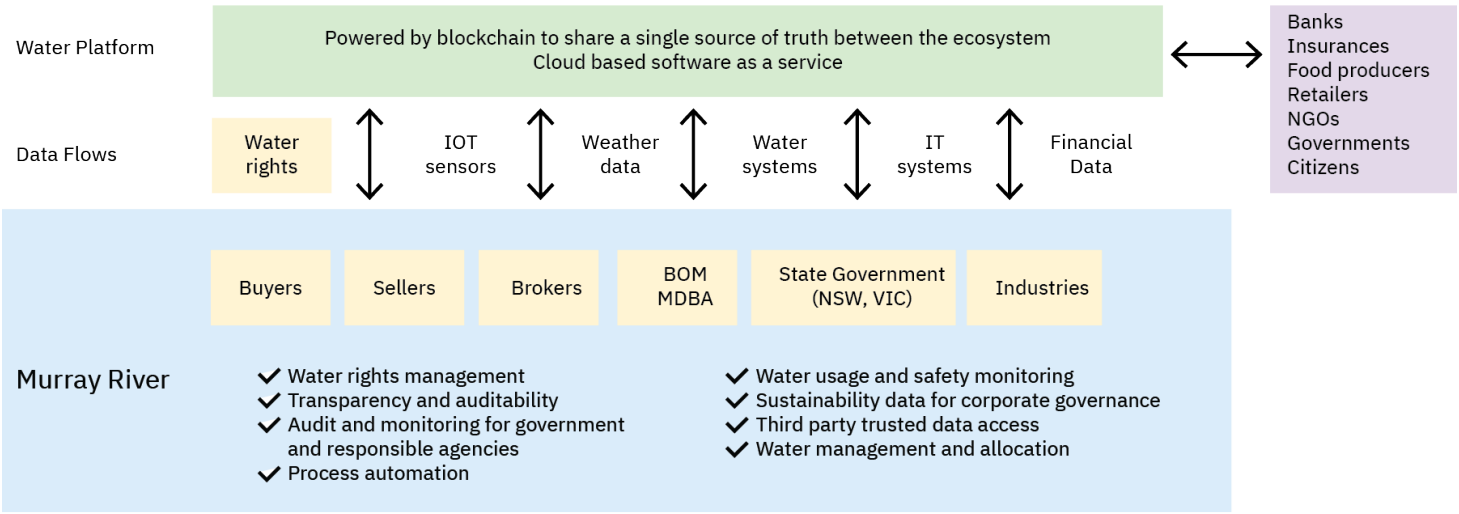


Figure 5 — Conceptual view of a blockchain powered Water Trading platform

Case Study 2: Ensuring Food Safety and Transparency with IBM Food Trust

Overview
IBM Food Trust is a blockchain-based platform that ensures food safety and transparency by providing end-to-end traceability of food products. By using blockchain technology, IBM Food Trust enables stakeholders in the food supply chain to track and trace the origin and movement of food products from farm to table. This use case demonstrates how blockchain technology can help address food safety challenges and create a more transparent and sustainable food system.

Problem Statement
Food safety is a critical concern for consumers, regulators, and food industry stakeholders. The lack of transparency and traceability in the food supply chain can lead to food-borne illness outbreaks, product recalls, and loss of consumer trust. In addition, the food system is often characterized by inefficiencies and waste, which have negative environmental and economic impacts.

Solution
IBM Food Trust addresses food safety challenges and promotes sustainability by providing end-to-end traceability of food products. The platform enables stakeholders to track and trace the origin and movement of food products using blockchain technology. This ensures that consumers have access to accurate information about the source and quality of the food they consume, while also enabling industry stakeholders to identify and address food safety issues more quickly.

Implementation
IBM Food Trust uses blockchain technology to create a transparent and secure platform for tracking the origin and movement of food products. The platform is used by food producers, manufacturers, distributors, retailers, and regulators to track and trace food products throughout the supply chain. Each transaction is recorded on the blockchain, creating a tamper-proof record of the food product's journey from farm to table. IBM Food Trust also uses advanced analytics to provide insights into food quality and safety, enabling stakeholders to identify and address potential issues more quickly.

Client References
- Walmart, one of the largest retailers in the world, uses IBM Food Trust to ensure the safety and transparency of the food products it sells.
- Carrefour, a leading European retailer, uses IBM Food Trust to track the origin and movement of its private-label products, providing consumers with greater transparency and trust.
- Antonello Produce, a large Australian producer of fresh fruits and vegetables, uses IBM Food Trust to ensure the freshness, safety, and quality of its food products.

Impact
IBM Food Trust has had a significant impact on ensuring food safety and promoting sustainability. By providing end-to-end traceability of food products, the platform has helped to reduce the risk of food-borne illness outbreaks and product recalls, while also increasing consumer trust in the food system. The platform has also helped to reduce waste and inefficiencies in the food system, leading to economic and environmental benefits.

IBM Food Trust has grown significantly since its launch in 2018, with over 1,000 companies currently using the platform. In addition to the clients mentioned above, IBM Food Trust has been adopted by a wide range of companies, including Dole, Nestle, Tyson Foods, and Unilever. The platform has also expanded its reach beyond the United States and Europe, with clients in Australia, Canada, and Japan. IBM Food Trust continues to innovate and expand its capabilities, with recent developments including the integration of IoT devices for realtime tracking of food products and the use of AI to identify potential food safety issues.

Overall, IBM Food Trust has become a key player in the food industry's efforts to ensure food safety and promote sustainability. With its growing ecosystem of clients and innovative technology, IBM Food Trust is helping to create a more transparent and sustainable food system for all.

Source: *https://www. ibm.com/products/ supply-chain-intelligence-suite/foodtrust*

Enabling trust through technologies – Arup & DPE's research 2018

A collaborative research project between DPE and Arup during 2018 revealed distrust in the MDB water markets ecosystem. This independent research found that stakeholders from the MDBA, DPE and WaterNSW had anecdotal evidence from irrigators that revealed some temporary allocation right trades were completed 'at the pub' in informal handshake deals and not officially on the exchange market. Further investigation found that sometimes these informal trades are '0 cent' trades with no exchange of money involved.

The team investigated the Upper Gwydir region of NSW. Major cotton farming was assessed as a case study example. This investigation engaged the participating government stakeholders and undertook subsequent research projects. The study included background research into blockchain architectures and use cases. Various process mapping workshops were completed with DPE Water, the Murray Darling Basin Authority, WaterNSW, and the Department of Agriculture. Senior water trading specialists were asked how intra-valley, inter-valley and across-state trades operated from a functional perspective. Key talking points were documented and the key risks and opportunities of moving to a blockchain based architecture were explored.

The stakeholders contended that the market complexity, difficulty in verifying market participants, and the 'fastest finger' advantage that large organisations had over smaller participants, opened the market up to potential failures. The ACCC investigation aligned with these findings but contended that while no evidence of market failure was identified, the complexity of the market made it difficult to understand the entire picture. The complexities of the trade processes were compounded by a combination of digital and analogue processes involving multiple stakeholders. These processes are made more complex in an inter-valley trade where different state agencies are required to work collaboratively. An example of the market complexities was mapped by Arup and DPE in 2018, highlighting the complexities of an intra-valley trade [Refer to Figure 6].

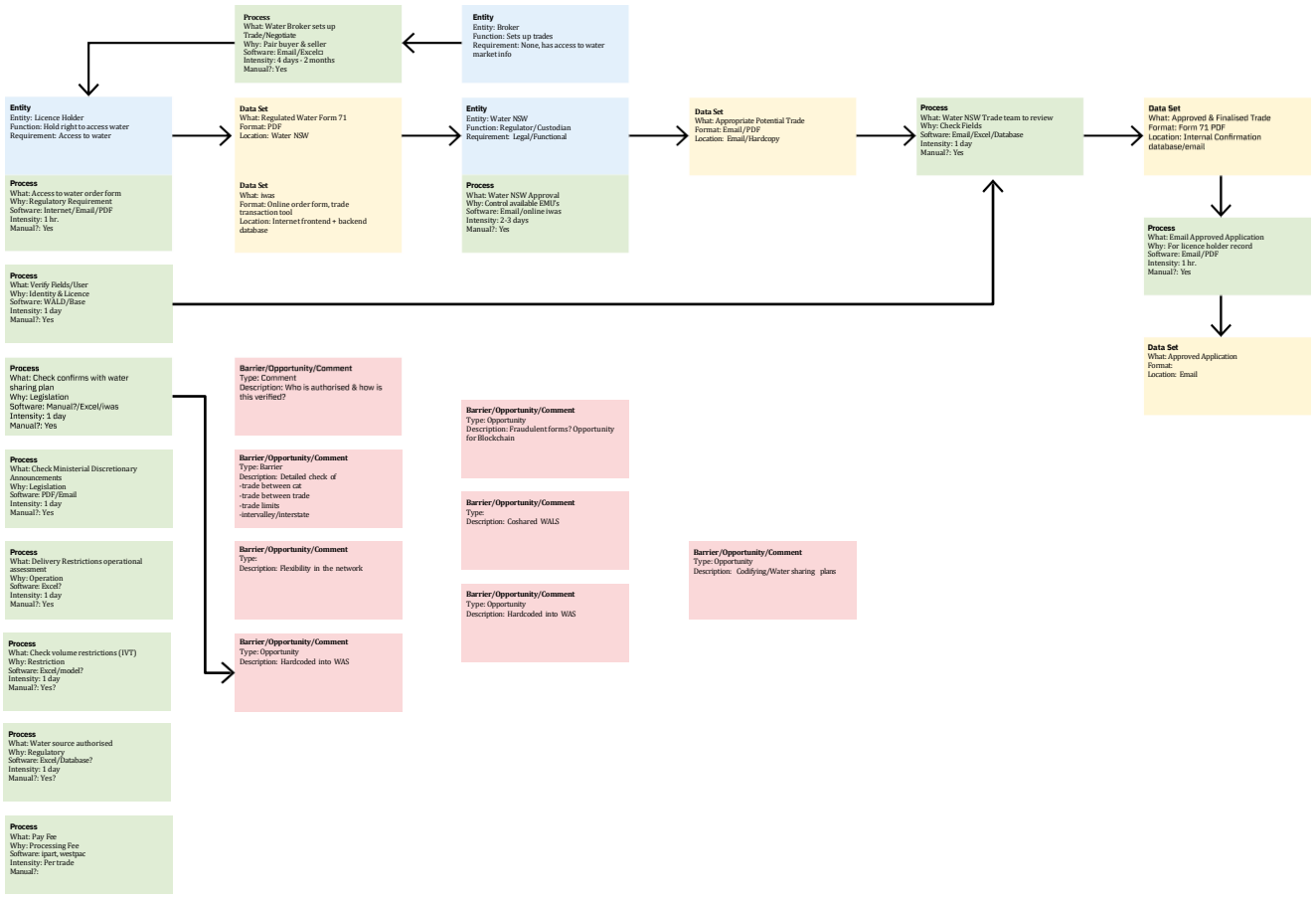


Figure 6 - Process map developed by Arup and DPE detailing the processes of an intra-valley trade (Stakeholders involved – blue; barriers / opportunities – red; outputs of water trading process – yellow; and processes – green

Arup and DPE worked collaboratively on developing decision trees with stakeholders to determine whether blockchain could be deployed [Refer to Figure 7]. Consequently, the research team contended that the use of blockchain technology as an alternative architecture to build trust back into the water allocation trading market could be successful. The potential benefits of using blockchain technology as an alternative form of governance in line with frameworks and rights established by government, include increased transparency, decentralisation, real-time auditing, equal opportunity for participation, identification of market participants and decentralised regulation.

The benefits of distributed ledger technology speak to the ACCC's recommendation for setting up a 'backbone platform' to instil greater transparency and governance in the market. Arup has been on a long journey of collaboration with DPE and the various stakeholders of the MDB and are well placed to work to develop potential solutions with IBM to alleviate the challenges faced.

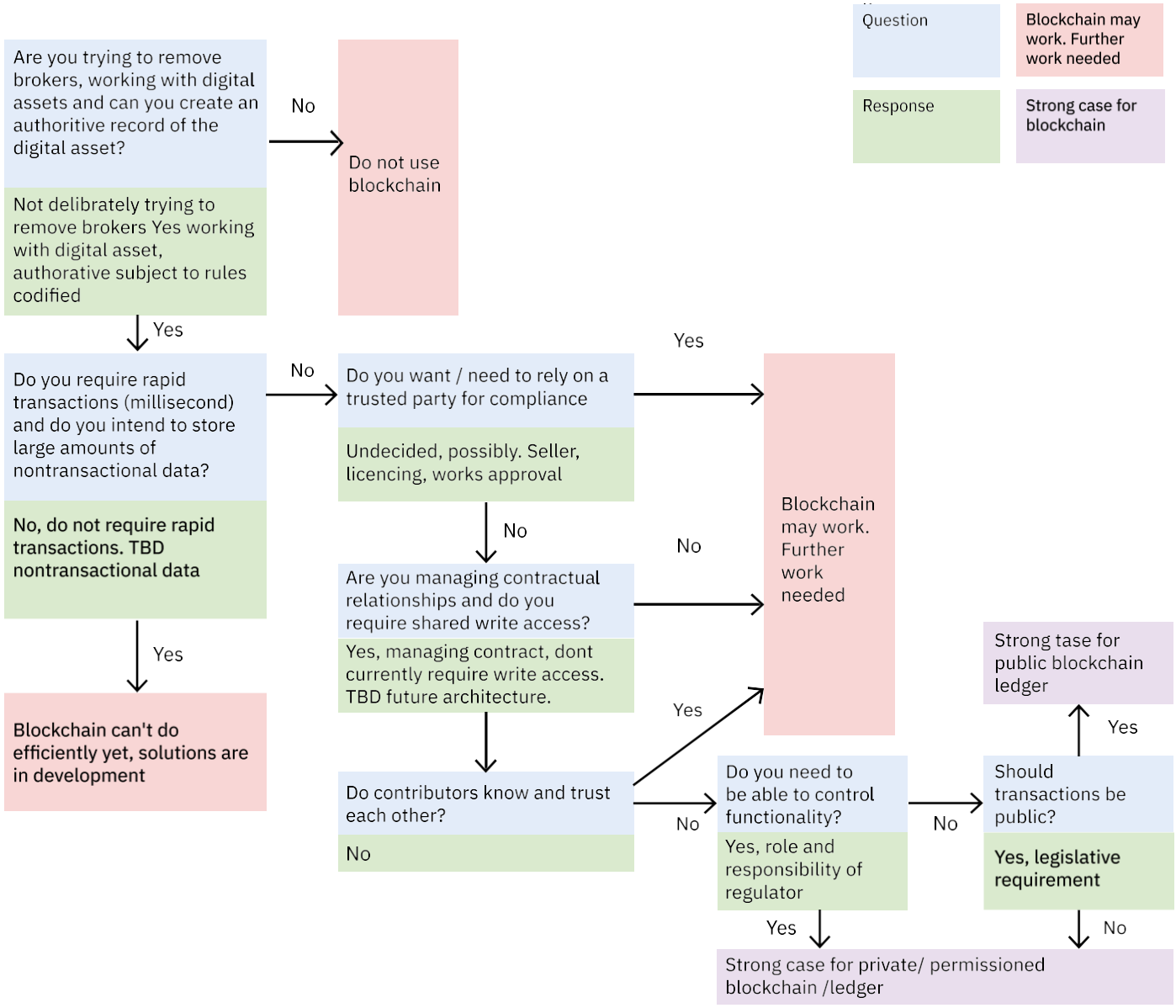


Figure 7 - Process map developed by Arup and DPE decision trees with stakeholders to determine whether blockchain could be deployed

Leading the way for change

Sustainability has become one of the top priorities of boardrooms, cabinets, and households. Water is one of our most essential and precious resources and must not be taken for granted. Using our resources as efficiently as possible, within the capacity limits of the environment and the ecology, will help alleviate some of the key challenges including reducing waste and optimising utilisation. Water is not sheltered from that process, and we need to find a solution to make its use both more efficient and sustainable.

In the end, the complexity of water management is a worldwide challenge. The World Water Reports by UNESCO and the 2030 Water Group Report outlines the fragility of our global situation. In Australia, despite our problems, our water fortunately lies within one national boundary. Australia can lead the way solving the water management problem here. It could serve as a case study to help tackle more complex situations (from a socio-political-economic point of view) that exist elsewhere.

Arup

Arup takes pride in the firm's ability to solve complex problems and in its positive working relationship with various utilities globally. Arup provides strategy, advisory, planning, engineering and thought leadership services in Australia and has been working closely with the NSW Department of Planning and Environment (DPE) for several years. As previously mentioned, Arup collaborated on the initial research piece that investigated the potential for blockchain to provide an alternative architecture for water trading in the MDB.

Arup has been working collaboratively with DPE on the Hydrometric Network and Remote Sensing Package of works to improve water resource management in the MDB. Arup has been working with NSW, QLD, MDBA and the BoM, to operationalise water balance tools for improved water resource management under Package 4. The outcomes from the delivery of this work will support NSW and QLD to improve how they partition loss and reduce unaccounted differences in water balance plans. Ultimately, this will increase the level of transparency for water resource management in
the MDB for stakeholders by building trust. Furthermore, the operationalised water balance tools will allow inference of water balance at the farm, reach and catchment scale. The variable levels of granularity will allow operational teams to pinpoint non-compliance events, ensure environmental flows reach the intended locations and help to build public trust. The project is one of five other packages to improve water management in the MDB, which will ultimately open the door for enhanced water platform trading software solutions.

Arup has been working collaboratively with DPE on the Hydrometric Network and Remote Sensing Package of works to improve water resource management in the MDB

IBM

IBM's deep-rooted technology and solution expertise brings technology-led transformation at centre of IBM's core services. The over 100-year-old technology company specialises in solving challenges with enterprise-grade technology solutions, focusing on 'open' technologies, interoperability and integration with existing systems and future-proof capability. IBM has been rated as the number one enterprise blockchain service provider by IDE market reports for the past four years. This paired with having collaborated on over 400 blockchain projects globally establishes them as a clear choice to help convene MDB ecosystem members as a trusted subject matter expert on delivering blockchain enabled business platforms.

IBM is a world-renowned global hybrid cloud and AI, and business services provider, helping clients in more than 175 countries capitalise on insights from their data, streamline business processes, improve cost efficiency, and gain the competitive edge in their industries. All of this is backed by IBM's legendary commitment to trust, transparency, responsibility, inclusivity, and service. For more information, visit www.ibm.com

Having engaged in over 400 blockchain projects, IBM recognised conversations about how entities plan to work together were essential for standing up these digital business platforms

A trust-enabled business platform as a catalyst for ecosystem integrity

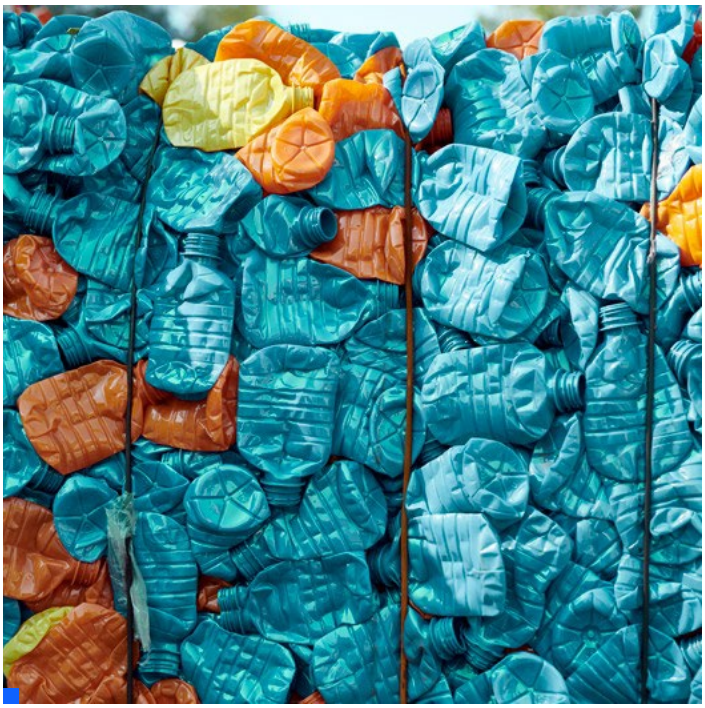
Blockchain is like a team sport; multiple parties must come together to transact value, verify information and/or agree on the platform's governance and business logic. Having engaged in over 400 blockchain projects, IBM recognised conversations about how entities plan to work together were essential for standing up these digital business platforms. Arup recognised through the stakeholder workshop discussions held in 2018, that the vast ecosystem of water allocation lacked the controls for participants to ensure trust. Only through trust can meaningful communication occur, and with meaningful communication comes accepted trading. Since 2018, Arup has been working with stakeholders of the MDB to alleviate the increased strains climate change is bringing. Arup has been working with these stakeholders in a collaborative approach, which has yielded insights.

To realise meaningful transformation at the scale of an industry, market, or ecosystem, it is paramount that the network's governance, business value and technology components work seamlessly together to solve real and valuable problems. If any of these components are not fully considered there is significant risk of developing a platform that does not bring about meaningful transformation or causes more complexity and pain. One of the main problems in the water market is allocation, or what capacity of water can be traded. The blockchain technology's underpinning data, combined with an understanding of climate, will provide valuable insights to determine the acceptable trading capacity of the water market in Australia.

It would be an overreach to suggest a technology platform on its own will solve all the systemic and political issues outlined by the ACCC. We realise that other technology could also play a role. However, ideating and convening a team of ecosystem players to discuss a potential business platform can play a role in catalysing the governance, and people process restructures that need to take place. In this way, blockchain's multiplayer requirements provide the perfect opportunity to house adjacent systemic discussions about governance and market integrity.

The team is cognisant of the ACCC's water market inquiry & DCCEEW's water market reform roadmap and believe that the platform approach is in line with the outlined plan. We recognise that the utilisation of Blockchain technology can effectively accelerate the delivery of the roadmap, ushering in the envisioned reforms in the water market. By adopting this platform approach, we anticipate enhanced transparency, trust, and efficiency in water transactions, which aligns directly with the objectives and goals set forth by the ACCC's and DCCEEW's reports. A final example of how blockchain promotes sustainability and empowers local communities is detailed in Case Study 3.

Case Study 3: Promoting Sustainability and Empowering Local Communities through Plastic Waste Reduction with the Plastic Bank



Overview
The Plastic Bank is a social enterprise that aims to reduce plastic waste pollution and promote sustainable practices by incentivising the collection and recycling of plastic waste. By partnering with IBM blockchain, the Plastic Bank has created a transparent and secure platform for managing the exchange of plastic waste for digital tokens, empowering local communities and reducing the impact of plastic waste on the environment.

Problem Statement
Plastic waste is a major environmental challenge, particularly in developing countries where there is often inadequate infrastructure for waste management. The lack of sustainable waste management systems disproportionately affects local disenfranchised populations, who are often the most vulnerable to environmental degradation and health risks associated with plastic waste pollution.

Solution
The Plastic Bank addresses the plastic waste problem by providing an economic incentive for the collection and recycling of plastic waste. Individuals and communities can exchange plastic waste for digital tokens that can be redeemed for goods and services, creating a circular economy that promotes sustainability and empowers local communities. IBM blockchain technology is used to create a transparent and secure platform for tracking the exchange of plastic waste for tokens and ensuring that the plastic waste is properly recycled.

Implementation
The Plastic Bank operates collection centres in developing countries where individuals can bring plastic waste to exchange for digital tokens. IBM blockchain technology is used to record every transaction, creating a transparent and secure record of the plastic waste that is being collected and recycled. The Plastic Bank works closely with local communities to establish collection centres and educate individuals on the benefits of plastic waste reduction and sustainable practices.

Impact
The Plastic Bank and IBM blockchain partnership has had a significant impact on reducing plastic waste pollution and promoting sustainability. By incentivising the collection and recycling of plastic waste, the Plastic Bank has helped to keep millions of pounds of plastic out of the ocean and landfills. The partnership has also had a positive impact on local communities, particularly disenfranchised populations who benefit from increased economic opportunities and a cleaner environment. The transparency and security provided by IBM blockchain technology have helped to build trust among stakeholders, leading to greater engagement and collaboration towards a more sustainable future.

Conclusion
The Plastic Bank and IBM blockchain partnership demonstrates the potential of technology to address global environmental challenges and promote sustainable practices. By incentivising the collection and recycling of plastic waste, the Plastic Bank has not only reduced the impact of plastic waste pollution but also empowered local communities, particularly disenfranchised populations. IBM blockchain technology has played a critical role in creating a transparent and secure platform for tracking the exchange of plastic waste for tokens, building trust among stakeholders, and creating a more sustainable and equitable world.

Source: *https://plasticbank.com/*

Arup and IBM intend to use this document to stimulate informed discussion on this new blockchain platform approach and seek to work with key stakeholders in the development of projects harnessing this new technology in providing benefits for active participants across the MDB.

Conclusion

Arup and IBM intend to use this discussion paper to stimulate informed discussion on this new blockchain platform approach and seek to work with key stakeholders in the development of projects harnessing this new technology in providing benefits for active participants across the MDB.

If these initial projects show promise in their ability to solve the identified problems in water trading within the MDB, then we could be looking at a bright future. A future where this technology and platform works in conjunction with new legislation and processes for a total overhaul of the water trading system in the MDB.

Our experiences on the global stage, including the case studies we provided within this paper provide evidence that we can achieve change and that we can use new technologies and approaches to make our planet and inhabitants smarter, safer, valued, and actively engaged in the change that will benefit future generations.

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