



PROJECT UBIN PHASE 5

Enabling Broad Ecosystem
Opportunities

POWERED BY

accenture

J.P.Morgan

— FOREWORD —

The Monetary Authority of Singapore (MAS) and Temasek are pleased to present the report **“Project Ubin Phase 5: Enabling Broad Ecosystem Opportunities”**.

Project Ubin has been an impactful journey of experimentation and innovation with the industry since it first started in 2016. Working with a broad group of participants from Singapore and around the world, the project has published five reports during its first four phases. The continued research efforts of Project Ubin and other projects by the industry, and the unprecedented sharing and contribution to the global body of knowledge, have rapidly advanced the maturity level of blockchain technology.

The next leap will be in implementing live commercial solutions to solve real-world challenges. Phase 5 brings a generation of Project Ubin’s blockchain technology experimentation to a formal close, and this sixth report is intended to be a springboard for this next leap.

This phase saw the successful development of a domestic multi-currency payments network prototype, which addressed immediate business needs for cross-currency exchange and foreign currency transactions, and demonstrated clear value for the use of blockchain technology. More interestingly, it showed that the model can be implemented as an international settlement model, which could bring about cheaper, faster and safer cross-border payments.

Beyond technical experimentation, Phase 5 sought to determine the commercial viability and value of the blockchain-based payments network. Bringing together a broad ecosystem of FinTechs, blockchain companies and financial institutions, the project explored how blockchain-based payments networks can enhance cost efficiencies and create new opportunities for businesses. The inclusion of non-financial services companies also demonstrated the applicability of blockchain technology beyond capital markets and trade finance. Technical specifications for connectivity interfaces will be made publicly available to encourage further developments.

We would like to express our appreciation to J.P. Morgan and Accenture for their contribution to this unprecedented collaborative work with the industry.

We encourage FinTechs, financial institutions, and the broader technology community to understand the opportunities that blockchain technology brings, and take the leap of bringing meaningful applications to life. As more blockchain-based applications are rolled out, there will be growing interest in deploying payment systems that can fulfil their needs. Lastly, we hope these developments will encourage other central banks and financial institutions to conduct similar and advance existing trials.

Chia Song Hwee

Deputy CEO,
Temasek

Sopnendu Mohanty

Chief FinTech Officer,
Monetary Authority of Singapore

— EXECUTIVE SUMMARY —

Phase 5 was the final experimental phase of Project Ubin, and focused on proving value and building a foundation for future live pilots and trials by the industry.

In continuing the work done in Phase 4, it successfully developed a blockchain-based multi-currency payments network that enables payments to be carried out in different currencies on the same network.

This “Ubin V” network was developed to a high level of production fidelity by:

- Using production-grade infrastructure;
 - And developing it to banks' production standards.
-

In other words, although still a prototype test network, it was developed to be *production-ready*.

The first part of the report provides an architecture overview and describes the key features of the Ubin V network.

With a focus on proving value, the project engaged the broader blockchain ecosystem to understand the broad opportunities and benefits in integrating with the Ubin V network. Past phases of Project Ubin focused on efficiencies within payments and settlement, which left unexplored the opportunities at the intersection of payments and business use cases. Phase 5 sets out to understand the potential efficiency gains for the broader economy that could be attained through better connectivity and integration, and the provisioning of additional payment-related and other supporting functionalities that could simplify operational processes.

Close collaboration with commercial blockchain applications revealed gaps in the functionalities provided, including those required for the critical operational needs of the interfacing blockchain applications. A series of workshops involving industry helped to generate a user-driven set of functionalities that the Ubin V network can provide, including those that can service existing unfulfilled needs as well as features that can enable new, untapped opportunities in the industry.

The second part of the report describes the blockchain use cases and how they benefit from the functionalities provided by the Ubin V network.

Project Ubin started as an experiment to understand blockchain and distributed ledger technology (DLT), and how those could be applied to new models of the clearing and settlement of payments and securities. Taking a blue-skies view about payments meant the project was not shackled by the constraints of existing systems or by legacy processes and an archaic way of thinking. In this way, the experiments carried out over the five phases of Project Ubin have shaped our views on the future of payments, and crystallised design ideas about what could form the basis of this vision.

The final part of the report describes design ideas and concepts for a payments infrastructure of the future, with a retrospective view of how some of these design concepts could be applied to today's payment architectures.



— CONTENTS —

01 Introduction	6
1.1 Background	6
1.2 Phase 5: Proving Value of Blockchain Technology	9
02 Architecture Overview	11
03 The Ubin V Payments Network	13
3.1 Functional Considerations	13
3.2 Technical Specifications	13
04 Use Cases	17
4.1 Cross-Industry View	19
4.2 Capital Markets	23
4.3 Trade and Supply Chain Finance	38
4.4 Insurance	50
4.5 Beyond Financial Services	57
05 Future of Payments	64
5.1 Improved Connectivity through Common Platforms	65
5.2 New Models of Platform Connectivity	65
5.3 Payment and Process Automation	66
5.4 Additional Functionalities and Rapid Prototyping	67
06 Conclusion	68
07 Appendix	73
7.1 Project Ubin (Phase 1 - 5)	73
7.2 Technical Details of the Ubin V Payments Network	74



Fig 1: Overall journey of Project Ubin

1.1 BACKGROUND

Project Ubin is a collaborative project with the industry that started in 2016 to explore the use of blockchain and DLT for the clearing and settlement of payments and securities. The project aims to help MAS and the industry better understand this technology and the potential benefits it may bring through practical experimentation. This is with the eventual goal of developing simpler-to-use and more efficient alternatives to today's systems based on central bank-issued digital tokens.

1.1.1 PROJECT UBIN

Project Ubin has taken a multi-phase approach, with each phase defined and scoped based on the prevailing challenges and concerns faced by the industry. The first two phases focused on building technology capabilities in the context of a domestic payments network; the next two focused on the interoperability of blockchain-based networks for Delivery-versus-Payment (DvP) and cross-border Payment-versus-Payment (PvP). From an innovation-adoption perspective, the underlying blockchain technology has advanced to a good level of maturity, with key technical challenges already resolved. This fifth phase of the project therefore shifted from proving

technical concepts towards proving value, including understanding how such new models could improve settlement efficiencies, and the potential benefits for the broader ecosystem.

1.1.2 EFFICIENCIES THROUGH COMMON PLATFORMS

Common platforms and common standards are key approaches towards improving efficiencies in payments processing. In an earlier joint report on examining challenges in cross-border payments, the fragmented development of the international financial system was found to be the primary cause behind the high costs and slow processing of cross-border payments.

Frictions inevitably arise from the need to coordinate the movement of value across multiple dissimilar settlement systems and ledgers. The intuitive solution would be to shift multiple ledgers to a common platform and allow parties to transact with each other directly on that platform. This would inherently reduce the number of intermediaries required to process a transaction.

This concept of a common platform has been successfully implemented in many developed economies as domestic, single-currency central-clearing and settlement infrastructures – and with clear benefits: domestic payments are highly efficient and usually complete in a matter of seconds and at low marginal cost. It is arguable that, if such a model were extended to an international scale, cross-border payments could be made as efficient as domestic payments today.

The key challenge in achieving a common international platform for cross-border payments relates to the questions of governance and ownership. In a domestic scenario there is a natural, trusted central party: as the party responsible for the issuance of domestic currency, the central bank is trusted to perform the functions of maintaining and updating the ledger that

records the assets held by transacting parties. A hypothetical international network would consist of central banks and banks from different countries transacting in multiple different currencies on a common platform. Central banks would not be comfortable with having their currencies – essentially their liability – freely issued and recorded by a third party outside their control.

There is also no natural single party that is trusted by all central banks to maintain and update the ledgers.

That said, trust is not a binary “all-or-nothing” concept, and it should be viewed in the context of the criticality of the functions performed and the adverse consequences that may result if performed poorly or maliciously. While there may be no single party trusted sufficiently to maintain ledgers recording central banks’ liabilities, there may still be sufficient trust to have a single party perform functions that are considered less critical, especially where there are strong economic incentives to do so.

Although there is no common international settlement infrastructure, financial institutions have shown that it is possible to come together to develop a common messaging platform to coordinate across different settlement systems, as well as to push for a common messaging standard to ease communications between these systems. The Society for Worldwide Interbank Financial Telecommunication (SWIFT), a cooperative society, links more than 11,000 financial institutions in more than 200 countries and territories to coordinate the exchange and transmission of payment messages.

1.1.3 NEW GOVERNANCE MODELS OF ENABLING TRUST ON COMMON PLATFORMS

With the belief that a common settlement platform improves transactional efficiencies, the challenge would be to design a governance model that engenders sufficient trust to participate and transact on such a platform.

Governance is conventionally assessed in the context of ownership, with an underlying assumption that ownership equates to full control over the platform. Trust would then correspond directly to participants' trust in the owner and operator of the platform. In a traditional architecture where one party owns the full solution stack right down to the physical hardware layer, this works sufficiently well in simplifying the considerations to a single proxy of ownership.

However, unbundling the solution stack, where different layers are offered as services by different parties, the construct of ownership becomes less relevant. The underlying needs of participants are better viewed from the perspective of control:

1. Segregated control: The ability to exert and retain control over their designated domain and scope. For example, for a specific digital currency, only the appointed issuer has the ability to create and issue the digital currency.

2. Limits on control: No single party, including any designated operator, is able to exert control over areas outside of its designated domain and scope. For example, no party other than the appointed issuer can issue the digital currency.

3. Procedural control and trusted execution: No single party is able to manipulate the execution of processes, which are executed faithfully and unbiasedly based on a pre-agreed and pre-defined set of rules.

4. Collective control: The ability to collectively validate and agree on transactions and processes that are being performed.

Blockchain technology was specifically designed for public networks to operate in a decentralised manner, in the absence of a trusted central party. The ability to fulfil the requirements of controls can help to alleviate contention around ownership structures, yet provide sufficient trust between participants to transact on a common platform.

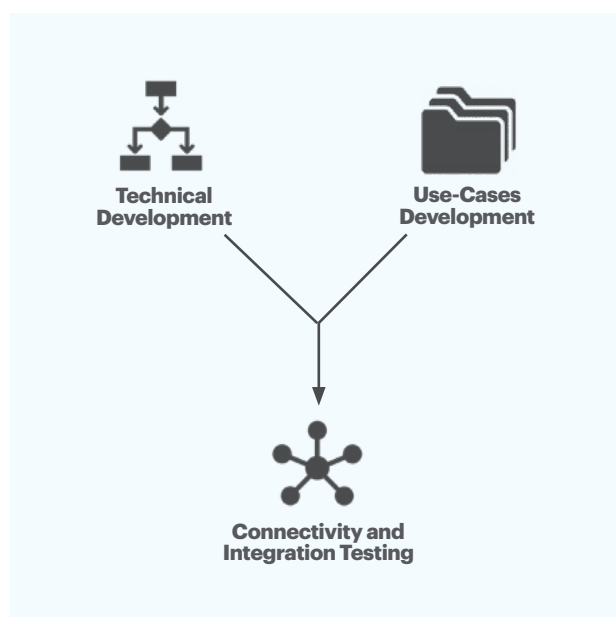
This creates a possible path forward for implementing a common international settlement platform on which central banks and banks can participate and directly transact.

1.2 PHASE 5: PROVING VALUE OF BLOCKCHAIN TECHNOLOGY

Phase 5 is intended to be the last experimental phase of Project Ubin. With the advanced maturity level of blockchain technology and a good level of understanding of the technology and its applications within the global financial industry, there are only limited technical concepts yet to be proven or explored. Phase 5 therefore focused on proving value and building a foundation for future live pilots and trials by the industry.

1.2.1 MOTIVATION AND OBJECTIVES

As a collaborative project with the industry, the project brings together different motivations by MAS and the financial industry. Phase 5 is designed with a set of objectives that fulfils the collective motivations of the project partners:



Technical Development:

- Develop a prototype network to a high-level of production fidelity, using production-grade infrastructure, and developed to a bank's production standard– essentially a production-ready prototype network.
- Develop a technical architecture that is flexible, where services and roles are unbundled and modularised.
- Develop a payments model that is applicable in a domestic context, and which could be extended as a reference for international multi-country, multi-currency settlement.

Use-cases Development:

- Understand use cases with clear and immediate business needs such as transacting in multiple currencies, and settlement of securities and other assets.
- Explore new and emerging use cases, particularly blockchain applications that are live or going live.

Connectivity and Integration Testing:

- Develop additional functionalities and connectivity interfaces to support integration with use cases.
- Conduct integration testing with selected use cases to refine functional and connectivity specifications.
- Release and publish specifications under open-source licence.

1.2.2 PROJECT APPROACH

Phase 5 started with two concurrent workstreams, with J.P. Morgan leading the technical development workstream and Accenture leading the use cases development workstream. The two workstreams subsequently merged for connectivity and integration testing.

As part of the technical development workstream, J.P. Morgan leveraged the Quorum platform (an enterprise-grade blockchain), the production-grade capabilities developed as part of the Interbank Information Network® (IIN), and its JPM Coin product to develop a production-ready payments network. This provides a closer simulation to real-world needs and offers an appropriate environment for industry-level testing.

The result of the technical development workstream is the successful development of the production-ready “Ubin V” payments network that enables payments to be carried out in different currencies on the same network.

For the use cases development workstream, Accenture conducted secondary research to identify blockchain applications and 124 projects with use cases that could benefit from integrating with the Ubin payments network. This effort was supported by MAS, Temasek and the broader Project Ubin community, which helped to identify and reach out to companies with relevant use cases.

Accenture’s Liquid Studio Singapore team subsequently led and conducted four interactive design-thinking workshops with more than 40 financial and non-financial firms. These workshops were designed to brainstorm, refine and validate use cases that could potentially integrate with the Ubin V payments network.

An initial cohort of four industry partners (1exchange, Digital Asset, Digital Ventures, STACS) were selected for integration and testing with the Ubin V network, with the prototypes all successfully developed, tested and showcased at the Singapore FinTech Festival in November 2019. The partners had use cases catering for different industries, which enabled the testing of different additional payments functionalities such as DvP settlement, escrow services and conditional payments.

[These four use cases and details of the technical integration will be shared as case studies in this report.](#)

ARCHITECTURE OVERVIEW

02

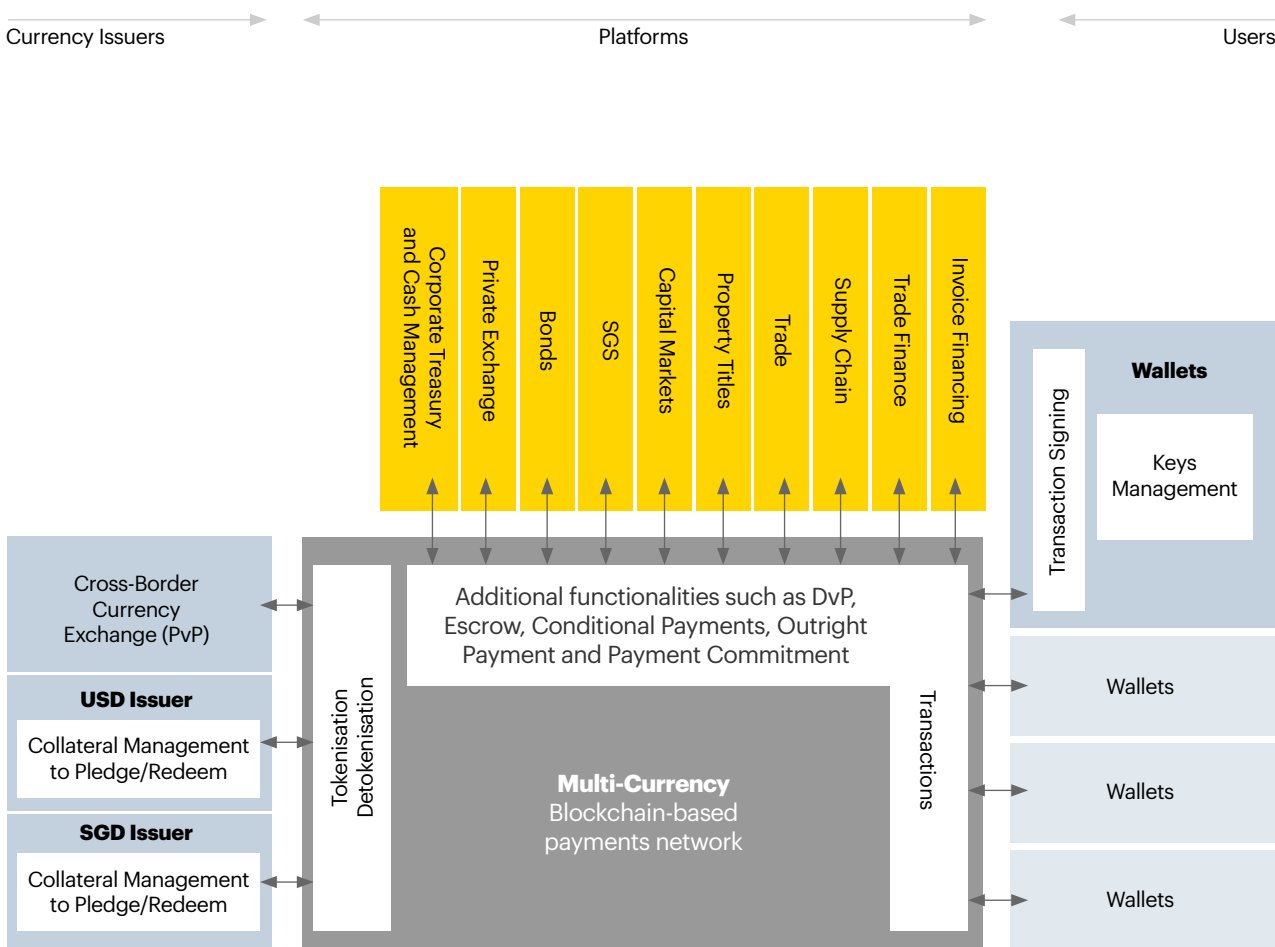
The Ubin V payments network is designed to facilitate easy and open access for participants on the network, including currency issuers, third-party platforms and users.

Ubin V provides connectivity to “currency issuers” for the issuance or distribution of digital currencies on the network. This function can be performed by a number of trusted parties such as central banks and commercial banks. Where the issuer is a central bank, the corresponding digital currency on the network would be a central

bank digital currency. Where the “issuer” is a commercial bank, the corresponding digital currency would be commercial bank money and would operate in a manner similar to offshore foreign currency clearing.

With multiple currencies issued on the network, participants can transact directly with each other using the different currencies. The network enables PvP settlement on a common network, which would reduce the settlement risks of foreign currency exchanges on the network.

Fig 2: Ubin Connectivity Interface



Ubin V allows for integration with different platforms to support various use cases across multiple industries.

Along with the basic functionalities of initiating payments and viewing transaction statuses, Ubin V provides additional functionalities such as DvP settlement, escrow and conditional payments. Ubin V enables direct transaction initiation by participants, with controls imposed by financial institutions on the network.

Ubin V is designed to enable access by different “wallets”, which provide the front-end interfaces for users. The intention is to enable interoperable wallets that can connect to Ubin V, as well as other platforms. For example, a multi-national corporation (MNC) will likely connect to multiple different platforms and networks such as Ubin V for payments in Singapore, separate payments networks for payments in other countries, and other blockchain applications for different use cases. The MNC would be able to do so directly through interfaces to the networks, ideally with common interface standards, without relying on specific proprietary applications.

A future world, where blockchain business networks gain ubiquity, would likely comprise multiple blockchain networks connecting different ecosystems, providing different services, and operating on different platforms and technical infrastructures. With this vision in mind, the Ubin V network is designed with the principles of open architecture, open connectivity and interoperability to enable ease of integration across these networks for seamless, end-to-end transaction processing.

3.1 FUNCTIONAL CONSIDERATIONS

To facilitate varied types of payments required across different blockchain networks, the Ubin V network supports wholesale interbank and corporate payments. The network was developed and tested with two currencies: Singapore Dollars (SGD) and United States Dollars (USD), with the intention of working with other central banks and commercial banks to include other currencies.

3.2 TECHNICAL SPECIFICATIONS

This Ubin payments network uses J.P. Morgan's Quorum blockchain protocol as the base infrastructure, coupled with the network and application capabilities developed as part of the IIN and JPM Coin product, and provides API connectivity to interfacing applications.

3.2.1 PLATFORM

Quorum was developed as a fork of the Ethereum blockchain and was open-sourced by J.P. Morgan.

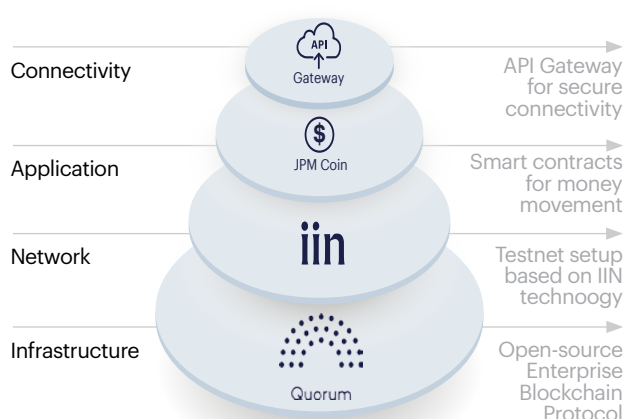
The primary features of Quorum – and therefore extensions over public Ethereum – are:

- Transaction and contract privacy
- Multiple voting-based consensus mechanisms
- Network/peer permissions management
- Higher performance
- Settlement finality

IIN is a production-grade, scalable, peer-to-peer (P2P) network powered by Quorum, which has been deployed as a live network since 2019. The Ubin V network utilises a separate test instance of the IIN network.

JPM Coin is a blockchain application that provides token issuance and money movement capabilities through a set of smart contracts. The Ubin V network leverages and extends the base capabilities developed from JPM Coin to provide the additional functionalities required for multi-currency payments and integration with the blockchain applications.

Fig 3: Interactions between Quorum, IIN and JPM Coin



3.2.2 ARCHITECTURE

The architecture diagram of the Ubin payments network, with the set of inter-related components, is shown below:

The Ubin payments network consists of five interrelated components:

1. Ledger Interoperability Service:

A software application that facilitates balance transfers between the issuing bank's standard deposit account operating ledger and the blockchain ledger for issuance and redemption of the digital currency.

2. Gateway Communication Service:

A general purpose mechanism for connecting non-blockchain external systems with blockchain platforms.

3. Blockchain ledger:

The blockchain ledger serves two primary functions:

- A ledger reflecting individual client digital currency balances.
- A payments rail using blockchain technology to allow clients on the network to perform transfers.

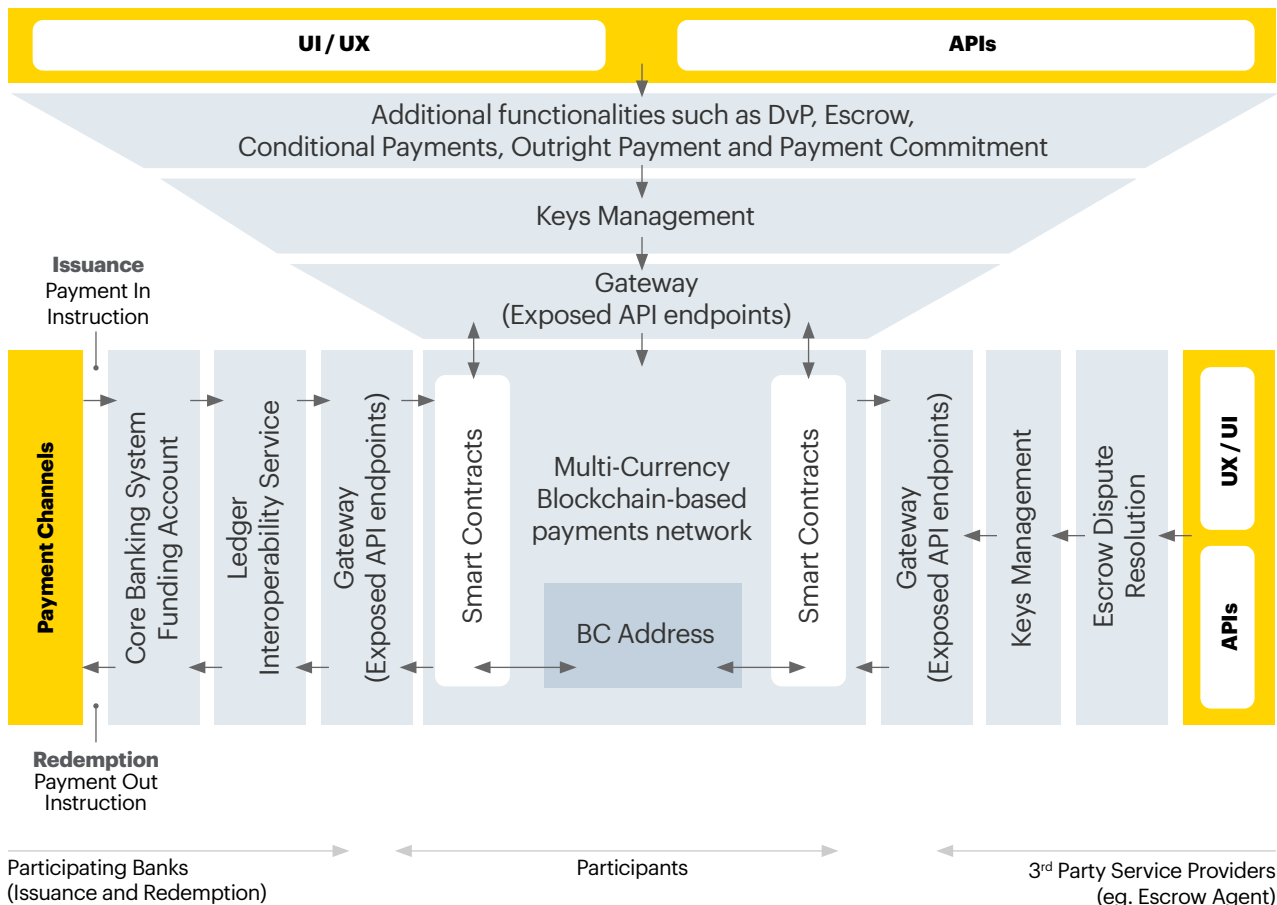
4. User Connectivity Interfaces:

The means by which the user can access and send instructions regarding its digital currency balances. This is accessible through traditional web-based User Interface (UI) and exposed Application Program Interface (API) endpoints.

5. Digital Currency:

The blockchain-based digital token representing the underlying fiat currency liability of the issuing bank.

Fig 4: Technical Architecture Diagram



3.2.3 KEY FEATURES

There are five key features in the Ubin payments network: Issuance, Transfer, Redemption, Conditional Payments and Reconciliation. These features have the following capabilities:

Issuance: Commitment of deposits in a designated account in exchange for the equivalent value of digital tokens such as JPM Coin USD and digital SGD on the network.

Transfer: Transaction of digital tokens over the Ubin payments network with other network participants.

Redemption: Conversion of digital tokens back to fiat currency.

Conditional Payments: Smart contracts that hold funds and release payment upon fulfilment of pre-defined conditions. An example would be a Multi-Signature (Multi-sig) Escrow Service, which is a digital escrow service utilizing the Multi-sig model, to hold funds while a transaction is completed on the delivery network.

Reconciliation: Matching the total outstanding tokenised balance with the actual deposit balance by issuer banks, and tracking transaction records by non-issuer banks.

Issuer Banks: For reconciliation purposes, the Ubin payments network provides the total outstanding coin balance to the issuer banks on a periodic basis using APIs. This can be used by the banks to verify that the currency balances are in sync with the corresponding digital currency balance in the Ubin payments network.

Non-Issuer Banks: Participants can access their digital currency balance and their transaction history via traditional web-based UIs (including wallets), APIs or other secure methods. This can be used to perform transaction-level reconciliation and reporting.

3.2.4 KEY MANAGEMENT AND CONTROLS

Communication with the network is secured using two sets of keys – messaging keys and blockchain keys. Messaging keys are used to encrypt and decrypt the transaction payload, while blockchain keys are used to sign the transaction submitted to the blockchain network.

To enable open access, Ubin V supports three different models for the custody of blockchain keys:

1. Directly by the end user: The end user custodies the keys and signs the transaction before sending it to the payment network.

2. By a third-party wallet service: A third-party wallet service custodies the keys and signs the transaction on the user's behalf before sending it to the payment network.

3. By the corresponding relationship bank of the end user: The relationship bank custodies the keys and signs the transaction on the end user's behalf before submitting it to the payment network.

In a conventional architecture, a user initiates a transaction with the bank, which performs its requisite control processes such as transaction screening, before the transaction is processed on the payments network. Allowing users to initiate transactions directly on the network bypasses the process of going through the bank. While it is possible for control processes to be built directly within smart contracts, this will likely incur significant processing overheads. It is likely that control processes will be built as a combination of on-network and off-network processes, with basic processes performed on-network and additional processes performed off-network for higher-risk transactions.

3.2.5 SMART CONTRACTS FOR RAPID DEPLOYMENT OF ADDITIONAL FEATURES

The project is also exploring additional functionalities that can be provided by deploying smart contracts on the Ubin V network in the near future. Smart contracts enable the codification of business rules or logic as a set of programming codes that will execute fairly and faithfully without the need for a trusted third party.

The flexibility provided by smart contracts enables rapid prototyping, testing and the deployment of additional functionalities such as Payment Commitments, Request-to-Pay and Pull Payments.

One example is the Payment Commitment feature. While escrow functionalities can help to reduce settlement risk by providing greater certainty for buyers and sellers, it requires funds to be locked up in the interim period. This locking up of funds is an inefficient use of capital and incurs opportunity costs for transacting parties.

Consequently, a feature is needed that can provide some level of certainty while offering flexibility on the usage of funds.

In the traditional world, a cheque is one instrument that can be used to facilitate such transactions. In the digital form, this could be modelled as a Payment Commitment, which is an assignable "promise to pay" at a specified future date. Such a feature would be helpful for use cases like accounts receivable factoring where the buyer commits to pay on a future date and the seller assigns or sells the right to this commitment at a discount.

Past phases of Project Ubin focused on efficiencies within payments and settlement, leaving unexplored the opportunities at the intersection of payments and business use cases. Potential efficiency gains for the broader economy could be attained through better connectivity and integration, and by providing additional functionalities that could simplify the internal processes of users. Phase 5 is designed to test out this hypothesis and understand the broad opportunities and benefits from integration with the Ubin V network.

While such benefits are likely to be cross-cutting around industries and technologies, the project chose to focus on blockchain applications and use cases that are more likely to be capable of using these additional functionalities. In fact, many blockchain applications have been designed to tap on tokenised forms of value such as stable coins, which allows them to integrate easily with the Ubin V network.

Through initial secondary research, the project team identified 124 projects with use cases that were deemed interesting and that would potentially benefit from integration with Ubin V. From this pool, 16 were selected for further exploration. The research into these use cases is not intended to determine commercial success, and across the projects identified there are often multiple parties offering similar services and competing in a common space. As the success of such projects depends heavily on network effects, it is likely that there will be market consolidation, leaving only a small number of players in each space. It is unclear at this stage which of the projects will be successful, or whether there will be a second wave of projects that could capture the market better due to improvements in technology or other business factors.

The 16 use cases are broadly categorised into four areas: capital markets, trade and supply chain finance, insurance, and beyond financial services.

This categorisation is to facilitate detailed discussions workshops with relevant industry experts and partner organisations to identify the benefits of integrating use cases with a blockchain-based payments network like Ubin.

The following sections delve into various industries and sectors to understand some of the challenges faced in these areas, how technology can resolve some of these challenges and, lastly, their relevance to the Ubin payments network.

The ideas selected were further categorised based on their readiness for technical integration with the Ubin payments network. A case study will also be included in each section to detail the technical integration with the Ubin payments network.

Fig 5: Summary of Use Cases

Industry	Area	Description	Use Case
Capital Markets	Private Equities	Private exchange to facilitate trading of equities in privately held companies	1exchange
	Private Equities	Platform for issuance, custody and trading of digital securities	iSTOX
	Bonds	Trading and settlement platform for issuance and lifecycle management of digital securities	STACS
	Syndicated Loans	Primary syndication and secondary trading of syndicated loans	iLex + IHS Markit
	Multi-Stage Investments & Disbursements	Infrastructure assets funding, in a low-cost and secure manner	Allinfra
	Cross-border Settlement	Cross-border securities settlement and dividend payments using digital currencies	Sygnum
Trade and Supply Chain Finance	Supply Chain Digitalisation	Procure-to-Pay platform for exchanges of trade documents, with automated document verification and payment processing	Digital Ventures
	Supply Chain Digitalisation	Unified platform to connect buyers and sellers for orders, logistics and payments	Invictus
	Supply Chain Digitalisation	Exchange, verification and automatic matching of trade data to obtain digital payment obligations	Marco Polo
	Supply Chain Digitalisation	Electronic matching of trade data for bank payment obligation transactions	essDOCS
	Supply Chain Financing	Supply chain financing for SMEs with non-bank institutional capital	Crediti
Insurance	Healthcare Insurance	Lifecycle management of healthcare insurance claims	Digital Asset
	Automobile Insurance	Sharing and recording of information across participants for automobile insurance claims	Inmediate
Beyond Financial Services	Media & Advertising	Streamlining digital supply chain of programmatic advertising	Aqilliz
	Salary Payments	HR payments solution for real-time, accurate salary payments for gig workers and organisations	Octomate + Adecco

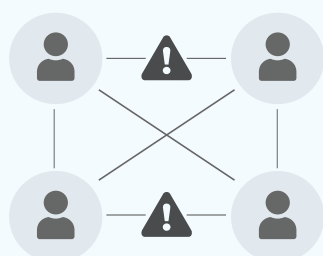
4.1 CROSS-INDUSTRY VIEW

Reviewing the blockchain use cases across these four areas yields an interesting insight.

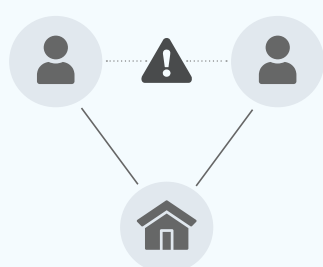
4.1.1 DIFFERENT CHALLENGES WITH SIMILAR UNDERLYING ROOT CAUSES

While these use cases assess and aim to address different challenges, they share common roots. These can be broadly summarised as:

Poor information flow between transacting parties.



A need for intermediaries to facilitate transactions due to a lack of trust between transacting parties.



4.1.1.1 POOR INFORMATION FLOW

In capital markets, the poor flow of information manifests as challenges of poor price discovery, where details of past transactions are not readily available, and poor liquidity due to difficulties in finding and matching buyers with sellers. There are also transactional inefficiencies because ownership of assets is recorded by multiple levels of custodians on different systems and ledgers. A transfer of ownership of a single asset may require updates on three sets of ledgers by the top-level custodian and the sub-custodians of the buyers and sellers. This is exacerbated for cross-border securities settlement, as foreign ownership of securities' assets often requires additional layers of custody through global custodians.

In trade and supply chain finance, trade documents are typically issued and endorsed by multiple different parties. While there are attempts to digitise such documents, these are typically performed at an individual organisation level. Therefore, even where there are digitised documents, these are often recorded on multiple different platforms. Paper documents and manual processes continue to be common in the industry as it remains the sole universal means of communicating across multiple parties. The paper documents are difficult to authenticate, and the lack of trusted information makes it difficult for banks to rely on such documents to make financing decisions. A lack of a common repository also makes financiers susceptible to fraud such as duplicate financing.

In insurance, the claims process typically involves multiple parties such as the insured, insurer, surveyor/assessor and contractor. The process can be further complicated through additional parties such as a co-insurer for national healthcare insurance, or a separate claimant for third-party claims. Information required for the claims process is created and held by the different parties across different platforms, often requiring the insured to manually collate and submit documents to the insurer in paper form. The paper documents are again difficult to authenticate, resulting in the process being susceptible to fraudulent and duplicate claims.

Beyond financial services, the use cases identified are focused on the provision of services in exchange for payment, such as delivery of online advertisements, or the provision of short-term staffing services. Similar to trade where goods are exchanged for payment, there is a need to validate the services rendered before payment is made. Providers and consumers of services are likely to maintain their own records on different platforms, therefore requiring that records are manually processed and reconciled before payment is made.

4.1.1.2 NEED FOR INTERMEDIARIES

Across the different use-cases, the processes are generally centred around an economic transaction, which is an agreement between a buyer and a seller to exchange goods, services or value. This could be an exchange of securities or financial assets for value in capital markets, an exchange of goods for value in trade, an exchange of receivables for value in supply chain finance, or an exchange of services rendered for value.

All such transactions carry counterparty risks between the transacting parties or the risk that one or more of those parties may default or fail to meet their obligations as part of the exchange. The general solution to mitigating these risks is to use trusted third-party intermediaries.

This could be in the form of a central counterparty (CCP) serving as the counterparty to each side of a transaction, or an escrow temporarily holding the objects of exchange in the process of completing a transaction. These intermediaries typically charge a fee to compensate for the risks incurred and the operational needs of facilitating the transactions.

Transacting parties therefore have a choice of taking on the counterparty risks or paying a fee to trusted intermediaries to mitigate the risks. There are also instances where parties choose not to transact at all – when the fees outweigh the economic benefits of the transaction.

4.1.2 COMMON PLATFORM FOR TRANSACTION EFFICIENCY

The typical solution to the issue of poor information flow is to digitise information. This has been implemented widely and successfully for intra-organisation coordination and information flows. For example, trade-related documents that are issued or processed by different departments within an organisation are usually recorded on a common platform, with automation of processes such as matching of documents, updating of accounting books and routing across departments.

Information and coordination across organisations, however, still tend to be manual. Documents may flow in electronic forms such as by email or in PDF documents, but they are not digitised in a way that enables seamless system-to-system integration. If organisations could coordinate and share information on a common platform, they could significantly improve process efficiency.

Similar to the concerns and considerations for a common payments settlement platform, the key question for a common platform is who owns and operates it. In the case of domestic payments, there is a natural trusted party in the central bank. But for many of these use cases, there is no natural trusted party, even in a domestic setting. The closest parallel would be industry associations, to which many transacting parties in the various use cases already belong. However, such associations are usually loose collections of members with common interests, and are not designed to be trusted parties operating industry infrastructures on behalf of their members.

Some industry associations have seen relative success in promoting common standards to improve communications between transacting parties. However, while common standards do improve bilateral information flows, they do not engender sufficient trust in the information and its flow to enable seamless multi-party collaboration – especially when additional parties need to process or rely on the information exchanged between the original transacting parties. Such needs would still be best served through the use of a common platform connecting all of the transacting parties.

4.1.3 BLOCKCHAIN-ENABLED COMMON PLATFORMS

The use cases observed generally look at developing common platforms as cooperative industry infrastructures that bring together transacting parties with the intention of improving the flow of information. This boosts information-transparency and dissemination, and enables full end-to-end process digitisation and automation.

Blockchain technology is used to implement such common platforms primarily due to its ability to enable multi-party coordination without relying on a trusted central party.

The technology also enables the use of smart contracts, or self-executing and self-enforcing contracts, where pre-defined codified contractual terms are executed fairly and faithfully.

Marketplaces, or common avenues where people gather to transact and exchange goods and services, have existed for as long as trade itself, due to their inherent efficiency. In the absence of such common venues, or where it costs too much to participate, transacting parties rely on their limited network of a small number of trading counterparties, or expend effort in broadening their network, or pay fees to brokers and middlemen to leverage their network. Enabling a low-cost model of bringing parties together on a common platform inherently improves counterparty discoverability and reduces search costs.

Such a platform, with transactions performed on it, serves as a system of record – essentially the authoritative data source for such transactions and their “histories” or audit trails. This trusted and definitive source of data enables full end-to-end process-digitisation even when that process involves multiple parties and organisations. For example, should a third party require information from two original transacting parties, it can verify that the information that it has is accurate and up to date. With information that is digitised, trusted and complete, parties can automate their internal processing without the need for manual verification or intervention.

Inter-organisation automation of processes is made possible through the use of smart contracts. As these codified contracts are executed fairly and faithfully, transacting parties can trust them and rely on their performance, allowing for inter-organisation processes to be automated. This enables the possibility of full end-to-end process automation even when the process cuts across the multiple different parties involved in the different parts of the overall process flow.

4.1.4 BENEFITS AND OPPORTUNITIES FROM UBIN V INTEGRATION

The Ubin V network will enable multi-currency payments, or the ability to transact in different currencies. This is particularly useful in cases such as trade where transactions are often performed in foreign currencies, as well as for securities settlement where securities can be denominated in other currencies. With parties holding and transacting in different currencies on the network, FX liquidity and spreads would likely improve, especially for previously illiquid FX pairs, which would have required the use of an intermediate currency.

The ability for direct settlement on a common platform, even in foreign currencies, would enable such transactions to be performed faster and cheaper.

The network also enables interfaces for DvP settlement and escrow services, providing transacting parties with better certainty and trust on the completion of their transactions. Such services will be provided by smart contracts, which require no human interventions except in the case of exceptions or failures. The operational efficiency of automating these processes enables services to be provided at low cost, with integrating platforms able to provide faster, safer and cheaper services for their users.

Tighter integration between the platforms and the Ubin V network will bring improved transaction visibility and less need for reconciliation. A conventional approach sees transacting parties' systems being integrated separately with the use-case platform and the payments network, necessitating reconciliation and verification to ensure all legs of the transactions have been successfully completed. Direct integration between the platform and Ubin V eliminates this need, allowing for the visibility and certainty of transactions, and reducing the need for reconciliation. Its open architecture also enables the development of common User Interfaces (UIs), where a user can have a single UI to view and control their actions across different platforms, providing a better and seamless user experience.

4.2 CAPITAL MARKETS

Capital markets play an essential role in supporting economic growth, facilitating and connecting those seeking capital and those seeking to invest. Companies raise capital by issuing securities in the form of debt or equity in the primary market. These securities can then be transacted with other investors on the secondary market.

There are two main types of secondary markets: exchanges and over-the-counter (OTC) markets. Exchanges are a form of centralised market, and characterised by transparent, fair and orderly trading. This is achieved by the routing of buy and sell orders through a central exchange to efficiently match trades and ensure price transparency. Counterparty risk is further mitigated by having a CCP or clearing house serving as the central counterparty across all sellers and buyers for the clearing and settlement of the trades.

Exchanges and clearing houses are highly regulated financial institutions due to the risks and criticality of their functions. As compliance and operating costs are high, they are typically used for liquid assets with high transaction volumes to keep unit costs low.

The use cases identified in the capital markets space are generally looking at new operating models and technologies to provide similar functions and services currently offered by public exchanges with the view that, by doing so more efficiently, they can target financial assets and investors that are currently underserved.

OTC markets are characterised as decentralised markets with trades being conducted directly between participants. Such transactions carry settlement risks, which is the risk that a counterparty fails to deliver on its obligations. This could be a buyer failing to make payment or a seller failing to transfer the assets.

Price discovery is typically poor for OTC transactions. As transactions are conducted privately, details such as transaction price and size are not made public. Even when information exists, such as financial statements that could be used for price derivation, there is no common repository and there are no common standards for reporting. Lack of market liquidity and visibility of interest amongst various market participants are also issues that hinder the OTC markets.

4.2.1 PRIVATE EQUITY

Access to private company equity is usually limited to investors who are more financially sophisticated and able to meet high investment thresholds, such as accredited or institutional investors.

4.2.1.1 INTRODUCTION

Recent trends have shown a heightened appetite for private equity as investors seek higher returns and more diversified portfolios.

4.2.1.2 EXISTING CHALLENGES

The key challenges facing the private equity market today can be classified into the following areas: poor price discovery; lack of liquidity; counterparty risk; and operational inefficiencies.

Poor Price Discovery: Private companies are typically not subject to the same level of regulation as public companies, such as mandatory audits and disclosure. Furthermore, as private equities are typically negotiated and transacted on a bespoke basis between counterparties, transaction details such as the last transacted price and trade size are not publicly available. This lack of information coupled with the limited number of participants in the private market leads to poor price discovery, which makes it difficult for investors to arrive at an appropriate price for the securities.

Lack of Liquidity: Private equities tend to have long holding periods due to: a lack of exit opportunities; and lock-up periods, which prevent investors from early withdrawal of funds. The limited number of market participants and the absence of a common marketplace also make it difficult for sellers to find buyers for their shares and vice versa. These factors lead to comparatively lower volumes of trade and lower liquidity in the private equities market.

4.2.1.3 TECHNOLOGY-ENABLED OPPORTUNITIES

Recent years have seen the emergence of marketplaces in the form of private exchanges that provide accessibility to private equity. Examples include 1exchange, a private exchange that is designed to facilitate the trading of equities in privately held companies, and iSTOX, a digitised security platform that integrates the issuance, custody and trading of digitised securities such as private equities.

The platforms provide centralised marketplaces for private equities, which are more accessible to buyers and sellers. Furthermore, investors can view information like the date, number of shares and transaction price of each trade completed. This manner of trading is more efficient than traditional private markets, where the sourcing and negotiation of deals tends to be conducted on a bilateral basis. Some private securities exchanges are also looking to leverage blockchain technology to realise further benefits.

Enhance Greater Liquidity Through Greater Accessibility: Blockchain technology can be used to create fractional and tradeable digital assets. With asset tokenisation, assets are digitally represented in the form of tokenised securities. These tokenised securities are divisible, and enable the fractional ownership of high-value illiquid assets such as private equities. This also suggests that minimum investment amounts could be lowered as investors could purchase tokens that represent smaller units of the underlying asset. This creates the possibility of opening the market to investors with small amounts of capital and/or the need for shorter holding periods. A higher number of market participants would likely see more trades take place, which could help to improve liquidity.

Additionally, the ability for private exchanges to integrate with public blockchains opens up the possibility of a wider investor base, as access to private equities might no longer be restricted to geographical boundaries. The global market could further improve price discovery, which could ultimately boost liquidity.

Improve Operational Efficiency: Given that blockchain technology provides a common ledger across all parties, it can act as a single source of truth where transacting parties, including potential private equity investors, can rely on the same set of data. This would also improve communication flows and eliminate the need for multiple bilateral information flows as parties could share information on the blockchain in a trusted and secure manner. In addition, parties could be assured that the information held on the blockchain was reliable as participants would have to verify any data before it could be added to the blockchain.

Smart contracts can also be used to facilitate transactions that are currently performed by several parties. For instance, a smart contract may be used to ensure the simultaneous exchange of securities and funds. Essentially, this enables a buyer and seller to transact with each other without the need of a trusted intermediary, thereby reducing the costs associated with facilitating the transaction.

4.2.1.4 BENEFITS AND OPPORTUNITIES FROM UBIN V INTEGRATION

The DvP functionality can help to facilitate the atomic exchange – where the underlying transactions constituting the exchange either succeed together or fail together – of private equity securities and corresponding payments. This reduces principal risk, or the risk of losing either the funds or securities due to the counterparty's failure in fulfilling its obligations.

There is also an opportunity to improve the user's experience by using a single UI for transaction initiation, without compromising on security. A buyer typically initiates the securities purchase on the securities platform, and a separate payments transaction on the payments platform. This is because the securities platform does not have the ability to make payments on the buyer's behalf, which is done for security reasons. The integration model for Ubin allows the buyer to sign the payment transaction digitally while making the securities purchase on the securities platform. This reduces the number of steps required for the transaction, and provides a better user experience.

This case study showcases how a private securities exchange can use the functionality offered by the Ubin payments network to enable the atomic DvP of private securities and corresponding payments between buyers and sellers.

1exchange, which was granted its Recognised Market Operator licence by MAS in December

2018, is the country's first regulated stock exchange for the trading of Singaporean private companies' securities. Investors who trade in private securities listed on the platform will have digital representations of their shareholdings created and registered via smart contracts on a public blockchain network.

Fig 6: DvP of Private Securities

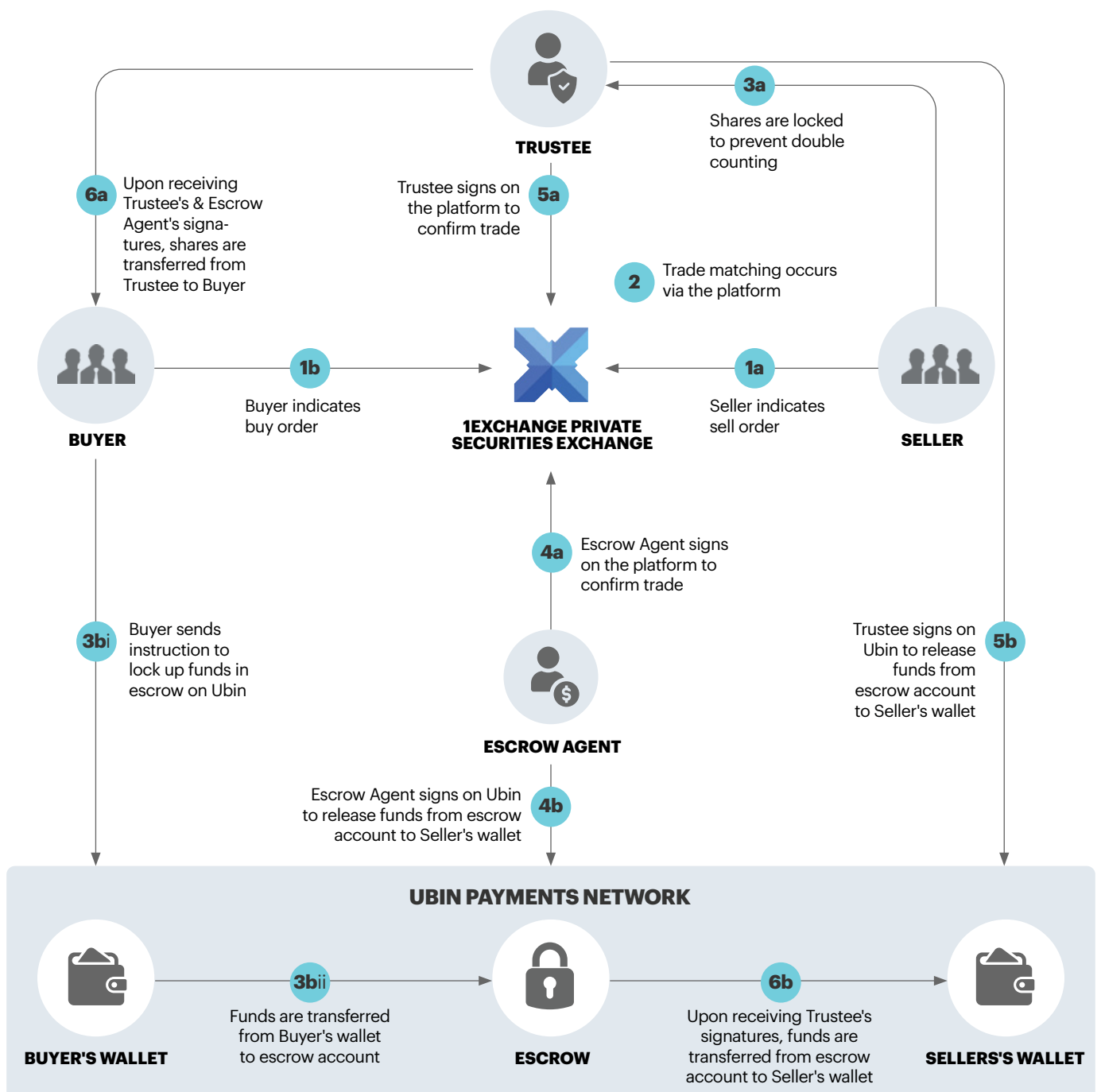


Fig 6 depicts the following flow:



- 1a Sell order:** Seller indicates sell order on the platform.
- 1b Buyer order:** Buyer indicates buy order on the platform.
- 2 Trade Match:** Trade match between seller and buyer occurs via the platform.
- 3a Lock-up of Shares:** Seller's shares are locked to prevent double counting.
- 3b Lock-up of Funds:**
 - 3bi** Buyer sends an instruction to lock up funds in Escrow on Ubin.
 - 3bii** Funds are transferred from the buyer's wallet to the Escrow account.

Escrow Agent verifies:

- 4a** After checking that the buyer and seller are of good standing, the Escrow agent signs on the platform to confirm the trade.
- 4b** Simultaneously, the Escrow agent signs on Ubin to release funds from the escrow account to the seller's wallet.

Trustee verifies:

- 5a** After checking that the buyer and seller are of good standing, the trustee signs on the platform to confirm the trade.
- 5b** Simultaneously, the trustee signs on Ubin to release funds from the Escrow account to the seller's wallet.

DvP Settlement:

- 6a** With both the trustee's and Escrow's signatures, shares are transferred from the trustee to the buyer.
- 6b** With both the trustee's and Escrow's signatures, funds are released from the Escrow account to the seller's wallet.

4.2.2 BONDS

Bonds are primarily traded OTC due to the greater diversity in deal economics, larger average trade sizes, as well as a smaller pool of institutional or accredited buyers and sellers compared to public equities.

4.2.2.1 INTRODUCTION

Given the bespoke nature of the debt capital markets and the profile of the investor base, both information asymmetry and a lack of sufficient liquidity in the secondary markets continue to be concerns for market participants.

4.2.2.2 EXISTING CHALLENGES

The inefficient sharing of information affects primary issuance, secondary trading and asset-servicing processes. During the issuance process for example, an issuing company will typically approach a bank (or a group of banks for risk mitigation or investor reach) to underwrite a bond issuance who in turn will work with additional service providers such as rating agencies, legal counsel, listing agent, trustees and paying agents. All such participants play crucial roles in the issuance process, and discrepancies in bond or investor records that can arise due to lack of a common, up to date information source, can result in a time-consuming and costly reconciliation process.

The ability to identify bond ownership is critical for effective asset servicing. This is so that corporate actions – both mandatory and voluntary – can be processed in an accurate and timely manner. Typically, when a corporate action event is announced by the issuer, information about the event must be cascaded across numerous intermediaries that operate between the issuer and bondholders such as financial data vendors, messaging networks, custodians, trustees, paying agents, depositories and exchanges (if the bond is listed). In the case of voluntary corporate actions like maturity extension and conversion of convertible bonds, bondholders that opt to participate are required to submit their instructions (via custodians) by a stipulated deadline. Next, the custodian must be notified by its respective deadlines before reverting to the issuer by the cut-off date. Each intermediary sets its own deadline to cater for sufficient time to handle the instructions.

Multi-party involvement as described above requires gathering & reconciliation of corporate action information and instructions, which can be effort-intensive and costly. Should bondholders' instructions be misinterpreted or mishandled, this complex chain of communications can cause a domino effect of errors and potential financial losses. The need to manage multiple deadlines across several parties also increases the scope for failure.

4.2.2.3 TECHNOLOGY-ENABLED OPPORTUNITIES

There have been a growing number of initiatives seeking to enhance efficiency throughout the lifecycle of a bond. For instance, there are platforms that aim to improve communication and information-sharing between parties during the issuance process, as well as solutions that look to automate certain aspects of bond servicing.

Greater Efficiencies and Lower Costs:

A common platform would enable the multiple parties involved throughout the lifecycle of a bond to access a common ledger of records, subject to pre-agreed parameters.

This ledger would serve as an audit trail spanning the bond's entire lifecycle, from issuance to secondary trading till the maturity of the bond.

There would no longer be multiple records with different bond ownership details, eliminating the need for reconciliations. The transparency in data would contribute to further downstream efficiencies like asset servicing and administration, as well as regulatory reporting. Furthermore, since data could not be altered retroactively without the consensus of the involved participants, which would adhere to predefined rules, the record of bondholders on the blockchain could be trusted and relied upon.

With real-time dissemination of information on a common platform, decision-making and execution can be further improved and automated using smart contracts. This is particularly useful for bond servicing, with the terms of a bond coded into smart contracts during the issuance phase. During the bond-servicing phase, this would allow for the automatic calculation and payment of periodic coupons, as well as the principal upon maturity expiration. This could streamline traditional bond-servicing processes that spread across multiple parties, thereby reducing costs and the risk of human error.

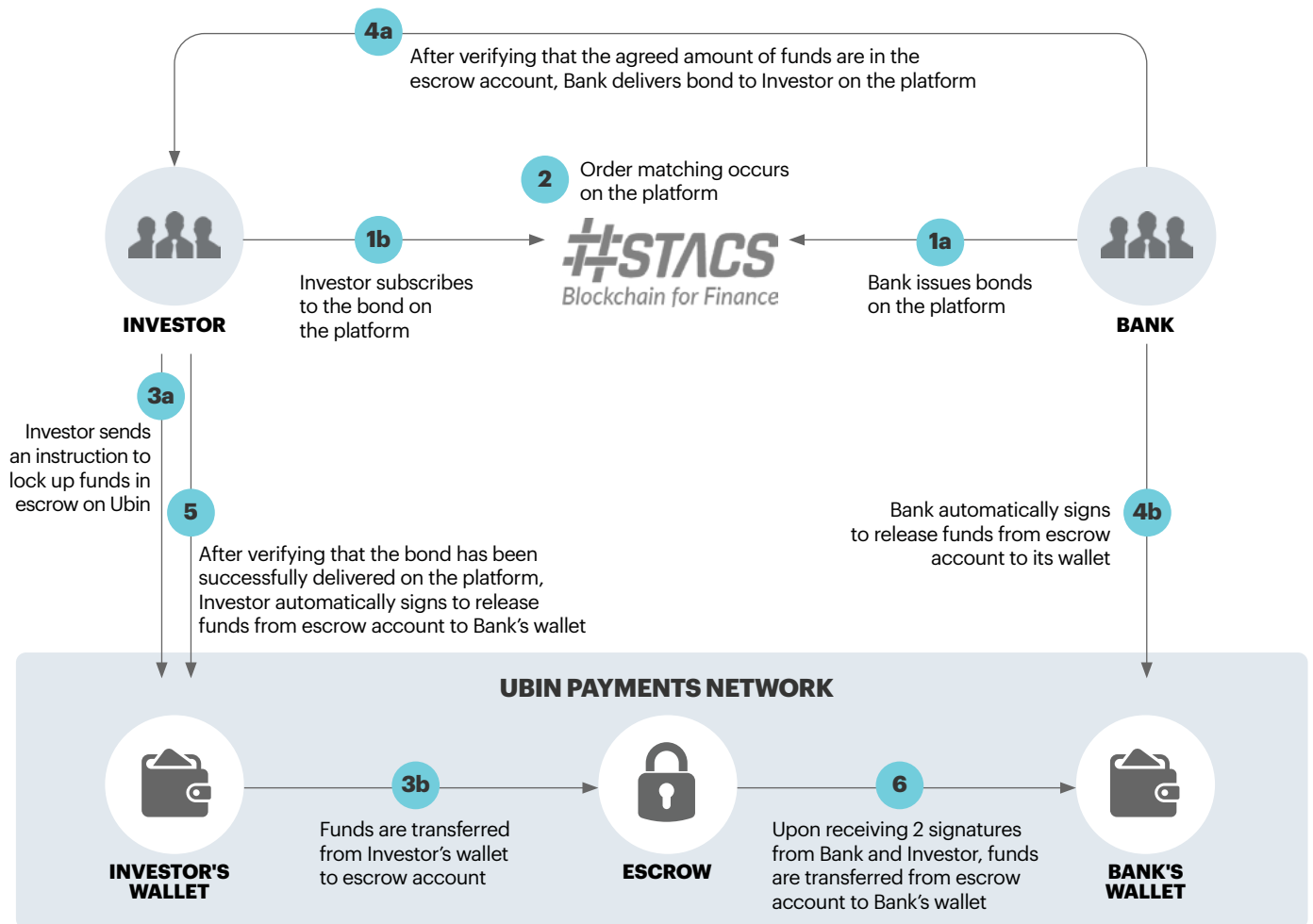
4.2.2.4 BENEFITS AND OPPORTUNITIES FROM UBIN V INTEGRATION

DvP functionality could help to facilitate the atomic transfer of bonds and corresponding payments, thereby reducing principal risk. Apart from the use of the DvP and escrow functionalities in bond issuance, the conditional payments functionality may also be applicable in the post-issuance process. For instance, the distribution of interest payments and the repayment of principal could be made conditional on the prespecified periodic intervals and maturity date of the bond respectively, thereby achieving efficiency via the automatic transfer of funds.

Separately, such bond payments today are often made by the issuer via a paying agent, which is typically a large international bank. After that, the paying agent makes onward payment via a traditional payments system, where it eventually reaches the investor. The issuer will be able to make direct payments to the investor if both the issuer and investor have a wallet on the Ubin payments network.

Fig 7: DvP Issuance of Bonds

This case study demonstrates how the functionality offered by the Ubin payments network could be used to enable the atomic DvP of tokenised bonds and payments. STACS has developed a securities trading asset clearing and settlement platform based on blockchain technology, which financial institutions can use for the issuance and lifecycle management of digital securities.



Specifically, this case study models the origination of a bond on the platform, whereby an investment bank can issue bonds on behalf of a company on the platform and can accept payment of funds from the Ubin payments network. Investors would refer to other banks looking to purchase bonds on behalf of their clients, using funds in the Ubin payments network.

Fig 7 depicts the following flow:



1a Bonds Issuance: On the platform, the Bank issues bonds on behalf of the issuing company.

1b Subscription: Investor subscribes to the new bond issuance on the platform.

2 Order matching: Upon receiving the Investor's order, order matching occurs on the platform.

Lock-up of funds in escrow:

3a Investor sends an instruction to lock up funds in an escrow account on Ubin.

3b Funds are transferred from the Investor's wallet to the escrow account on Ubin.

Bond delivery and Bank signs:

4a After verifying that the agreed amount of funds is in the escrow account, the Bank delivers the bond on the platform.

4b Following, the Bank signs to release funds from the escrow account to its Ubin wallet.

5 Investor signs: After verifying that the bond has been successfully delivered on the platform, the Investor automatically signs to release the funds from the escrow account to the Bank's Ubin wallet.

6 Transfer of funds from escrow to Bank: With both the Bank's and Investor's signatures, funds are released from the escrow account to the Bank's wallet.

4.2.3 OTHER OPPORTUNITIES IN CAPITAL MARKETS

While the industry tends to focus on private equities and bonds, there are other emerging applications in capital markets that could benefit from integrating with the Ubin payments network.

4.2.3.1 SYNDICATED LOANS

Syndicated loans are a form of debt financing where a group of lenders jointly shares the risk in providing a high-value loan to one or more borrowers. Over the years, syndicated loans have garnered interest as an alternative asset class from non-bank investors including mutual funds, insurance companies, pension funds, hedge funds and structured vehicles. The secondary market, where syndicated loans are traded, has also grown tremendously as banks seek to manage their portfolios for various reasons, including mitigating credit risk concentration, exiting non-strategic markets and rotating assets with higher capital charges.

A syndicated loan transaction typically involves a lead arranger and sometimes co-arrangers. The lead arranger is often also the administrative agent, who is responsible for tasks such as arranging for the disbursement of loan proceeds and keeping records of payments or any changes during the life of the loan. However, each arranger is required to maintain their own books and tends to spend a significant amount of time and effort reconciling its records with that of the administrative agent. This can result in “a cumbersome, costly and labour-intensive process, especially with the sharing of information still taking place via archaic methods such as fax, email and phone”.¹

With a common platform, syndicate members would have access to the same pre-validated data such as credit agreements, accrual balances, position information and transaction data. Apart from providing a common set of data, a platform built on DLT would bring additional benefits such as being tamper-evident, thereby uplifting the level of trust that users would have in the information. For example, a set of financial information from a borrower could be validated on-chain and then shared between lenders. After the loan was issued, the ledger would act as a source of truth and provide timely information for lenders, thereby enabling the efficient tracking of loan payments and obligations.

The Institutional Lending Exchange (iLex) and IHS Markit have collaborated on a solution for the primary syndication and secondary trading of syndicated loans, which could use the DvP functionality offered by the Ubin payments network to mitigate settlement risk.

iLex allows arrangers to list primary syndicated loans and potential buyers to submit their indications of interest on its electronic platform. After matching trade intentions on the platform, details of terms negotiated in the virtual dealing room are transmitted to IHS Markit's ClearPar platform, where a smart contract is used to confirm whether the necessary steps for loan asset delivery and associated payment have been performed. After verifying that buyers have sufficient funds to meet their payment obligations, the smart contract initiates the delivery of loan assets from arrangers to buyers on IHS Markit and the corresponding payment from buyers to arrangers on Ubin.

¹https://www.r3.com/wp-content/uploads/2018/07/US_11_Finastra_CS_JUN26_final.pdf

A similar process would apply in the context of the secondary trading of syndicated loans, whereby sellers can list syndicated loan participations and buyers can submit their buy orders on iLex. Following the matching of trading intentions, trade confirmation details are sent to IHS Markit's ClearPar platform, where a smart contract is used to confirm whether the necessary steps for loan asset delivery and associated payment have been performed. Upon verifying that buyers have sufficient funds, the smart contract initiates the atomic delivery of loan assets from sellers to buyers on IHS Markit and the corresponding payment from buyers to sellers on Ubin.

4.2.3.2 MULTI-STAGE INVESTMENTS AND DISBURSEMENTS

A typical investment process involves the investor committing a sum of capital to the investee, with staged disbursements upon the fulfilment of pre-agreed conditions. A third party is often engaged to manage the disbursements, incurring administrative costs. The investee is also exposed to the default risk of the investor, which may fail to disburse funds even when conditions are met. The conditional payment functionality in the Ubin payments network could provide the opportunity to optimise the investment process.

Another instance where the conditional payment functionality would be useful is for infrastructure asset financing, which often involves a large amount of capital. In a typical arrangement, investors or lenders provide a certain amount of capital upfront, with the balance drawn down over time upon completion of pre-specified milestones. To mitigate the potential default risk, a custodian may be involved in looking after the funds – however, this adds administrative complexity and cost.

Allinfra Ltd seeks to streamline the stages of funding of infrastructure assets in a low-cost and secure manner. In this example, Party A commits US\$10m of funding upfront to Party B, with the ability to draw US\$1m immediately for certain uses. The remaining balance may only be drawn when an additional US\$40m has been raised from other investors prior to a specified date. Smart contracts in-built with escrow functionality would allow Party A to provide US\$10m in capital, with US\$9m held in escrow. When the condition is met, the US\$9m balance from Party A is released to Party B. If the US\$40m is not raised in full by the specified date, the US\$9m is returned to Party A. Additional conditions can be specified allowing for staged disbursements based on the completion of milestones.

4.2.4 CROSS-BORDER SETTLEMENT

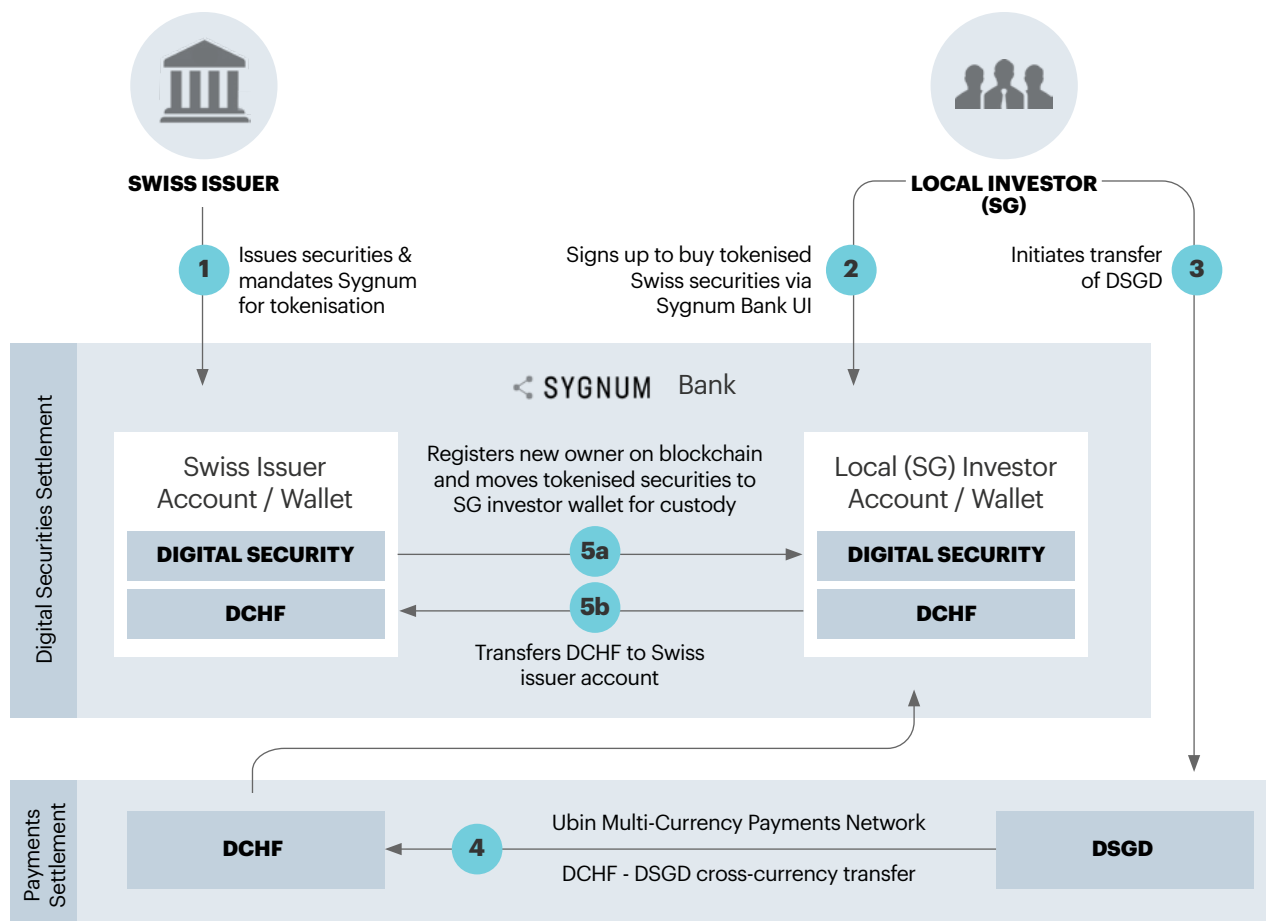
The term “cross-border securities settlement” is used to refer to “a securities settlement that takes place in a country other than the country in which one trade counterparty or both are located”² – in other words, involving investors buying securities from issuers in foreign markets. Usually, investors of foreign securities engage with intermediaries like local agents, global custodians, Central Securities Depositories (CSD) or International Central Securities Depositories (ICSD) to conduct a cross-border transaction and hold custody of the foreign securities. For payments, correspondent banks are used to facilitate international money transfers, which usually takes between three and five working days.

These intermediaries' involvement is due to the impracticalities, legal framework and regulations brought by direct remote access, defined as “the ability to participate in or use the facilities of a system located in another country, without the need to have a legal presence in that country”.³

² <https://www.bis.org/cpmi/publ/d12.pdf>

³ https://ec.europa.eu/economy_finance/publications/pages/publication1950_en.pdf

Fig 8: Cross-border settlement of a digital security transaction – Primary Placement



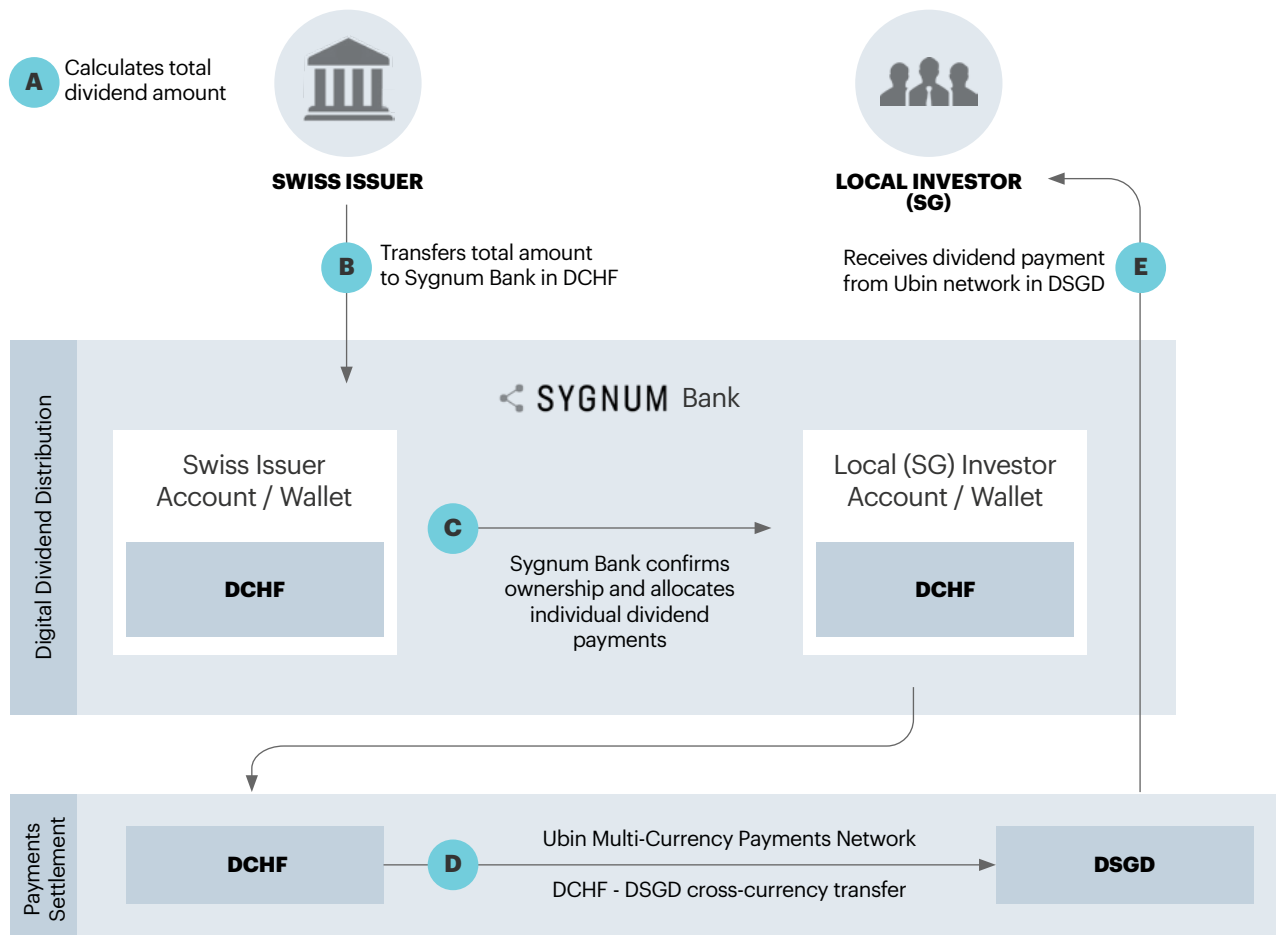
Sygnum Bank AG (Sygnum) has provided two case studies that could be involved in the Ubin payments network. These are cross-border settlement of a digital security transaction in the primary market, and cross-border dividend payment using digital currencies. Integrating with the Ubin payments network will bring quicker settlement of digital securities, as clearing is conducted real-time on-chain.

Moreover, the conditional payment functionality on the Ubin payments network will allow dividend payments to be released based on certain conditions such as time or percentage of shareholding, thereby reducing manual processes while increasing the speed of payment.

The example above illustrates the DvPvP process involving an overseas investor buying a digital security, such as a tokenised stock, directly from the issuer in Switzerland via primary market placement, and settling the transaction using digital SGD (DSGD). The DvP process is the simultaneous exchange of securities and digital Swiss Franc (DCHF) on Sygnum's platform, while the Pvp process refers to the exchange of DSGD to DCHF on the Ubin payments network.

The case study assumes that a Singaporean bank would be part of the Ubin payments network to facilitate the conversion from fiat SGD into DSGD and initiate the cross-currency transfer. The overseas investor would keep a bank account and two digital

Fig 9: Corporate actions cross-border dividend payments using DCHF and DSGD



asset wallets with Sygnum – one for the digital security and one for the DCHF. Once payment in DCHF has been received, the investor would be registered as the owner of the digital security on the distributed ledger, and the digital security would be moved into his wallet. At the same time, the issuer would receive the DCHF in his wallet.

After depositing the total amount of dividends with Sygnum, the issuer would initiate the conversion from fiat CHF into DCHF in his wallet. Ownership records of the stock would be extracted from the blockchain using smart contracts.

The dividend payout would then be determined and paid to individual investors in DCHF from the issuer's wallet to the investors' wallets. Subsequently, the DCHF-DSGD cross-currency transfer would be processed through the Ubin payments network, and the local investor would receive the dividend in DSGD.

Intermediaries help to resolve impracticalities, such as an investor's lack of direct access to a foreign bank account, which is necessary when settling securities in the local market. However, the involvement of intermediaries to hold and settle foreign securities and payments increases the complexity of cross-border securities transactions, and results in higher costs and longer settlement periods.

Cross-border settlement of securities is also complex, involving multiple parties such as the originating bank, the correspondent bank, the beneficiary bank and custodians. In particular, each bank across the payment value chain has separate processes to meet regulatory requirements such as sanctions screening. Matters become more complex when multiple correspondent banks in different time zones are involved. Factor in banks' processing times, and there is an unavoidable time lag in cross-border payment processing.

Cross-border securities transfers face similar complexities, and require the interaction of different settlement systems to complete a transaction. Gaining access to these systems usually sees investors approach intermediaries, who are typically a member of the foreign CSD concerned, ICSD or global custodian. The presence of these intermediaries interacting across different networks delays settlement due to the added processing time required for each.

There are further issues in cross-border transactions, especially in the realm of asset servicing. First, the share records held by the issuer trace only to the first level of ownership, which means the issuer records the number of shares held by the custodian and not the ultimate investor. The share records of these investors are kept with the intermediate custodian, and are not immediately available to the issuer. This indirect ownership model creates an issue for compliance checks and audits as it is difficult to trace the share ownership records to the ultimate beneficial owner.

This is further aggravated when organisations outsource their asset servicing duties to third parties and such information is often withheld by these parties.

Second, micro-payments – such as dividend payments – are largely impractical due to the high cost involved. Every international transaction is associated with a fee, usually in the form of flat charges, with the high cost due to the underlying complexity and regulatory constraints of the transactions. Such charges make such cross-border micropayments unfeasible. To avoid such unnecessary costs, the ICSD usually consolidates multiple dividend payments before redistributing to the end investors. However, batching dividend payments makes reconciling difficult as investors and ICSDs must match each dividend payment by the issuer with the total dividend amount received to ensure accuracy.

Given our increasingly globalised world, significant resources have been invested to explore the potential for seamless cross-border transactions. One example is the Shanghai-Hong Kong Stock Connect, where investors in Hong Kong and Mainland China can directly access each other's stock markets, allowing Hong Kong-based investors and other international investors to buy stocks in Mainland China via Hong Kong brokers. While this may allow for widened access to Mainland China's stocks, the underlying infrastructure is convenient only for brokers in Mainland China and Hong Kong. Other international investors investing in Hong Kong or Mainland China shares must still contend with operational inefficiencies because of the need for intermediaries, such as their local broker and their Hong Kong broker, to complete a transaction.

Placing transacting participants on a safe and common platform, on the other hand, would mark an improvement as it would allow a secure, cross-border trading, clearing, settlement and custody space, with the potential to increase operational efficiencies. This is made possible through asset tokenisation and traceability of transactions. This entails that transactions can be traced to the ultimate beneficial owner in cases of indirect ownership, while ensuring that transactions are seamless. When the assets are tokenised on a digital platform, manual book-running processes will be digitised through an issuance platform, providing a discovery platform for investors and issuers. This reduces the time and costs associated with the capital issuance process, creating an ideal environment for seamless transactions to take place.

Asset tokenisation has the potential to increase transparency and ensure certainty and integrity of transaction and ownership record-keeping. That, coupled with the use of smart contracts to automate custody-related processes – such as tracing the ultimate beneficial owner on-chain – means less need for intermediary roles and better visibility over the actual ownership record of the issuing company.

This approach would also pave the way for micropayments to be made on-chain, given the lower transaction costs incurred.

However, in order to reach the full potential of cross-border settlement on-chain, all participants in the value chain should be connected and enabled to conduct direct transactions with each other. For instance, a common solution for asset tokenisation implemented across the entire value chain of issuance, primary placement, secondary markets, settlement and custody, and that records transaction data on-chain, could in the long run allow for faster transactions and reduced reconciliations required for cross-border settlement.

4.3 TRADE AND SUPPLY CHAIN FINANCE

A trade transaction is where a seller provides goods and services to a buyer in exchange for value. For this to occur, multiple parties including logistics service providers, risk-rating providers and accredited institutional lenders, are involved. In addition, for cross-border transactions, there are additional parties such as customs, ports, insurers and carriers. The involvement of these multiple parties has resulted in a lengthy trade process, which includes other sub-processes such as procure-to-pay.

The procure-to-pay process consists of both intra- and inter-organisational processes. Each involves different challenges and requires different solutions. Within the organisation, the procurement and finance department must work closely to manage payment and cash flow planning. Across different organisations, buyers and sellers must share trade documents such as purchase orders (POs) and invoices to ensure the smooth delivery of goods.

Documentary trade finance “generally refers to the traditional trade finance market relating to instruments such as letters of credit”.⁴

Letters of credit are relatively cumbersome and paper-intensive instruments that can take several days to process and settle. Typically, a seller will not ship goods unless the buyer’s bank provides a letter of credit guaranteeing payment. However, in order to receive payment, the seller is required to submit a significant amount of documentation. It is also common for sellers to provide attractive sales terms to buyers such as extended payment terms. Such arrangements result in high cash flow needs for sellers, with sellers turning to trade and supply chain financing in order to meet those needs. The following section explores the challenges in the procure-to-pay process and supply chain finance that are persistent across the industry.

⁴ <https://iccwbo.org/content/uploads/sites/3/2017/01/ICC-Standard-Definitions-for-Techniques-of-Supply-Chain-Finance-Global-SCF-Forum-2016.pdf>

4.3.1 SUPPLY CHAIN DIGITALISATION

The procure-to-pay process, is a key part of supply chain processes, and includes ordering, purchasing, approving, receiving, paying for, accounting for and reconciling for goods and services.

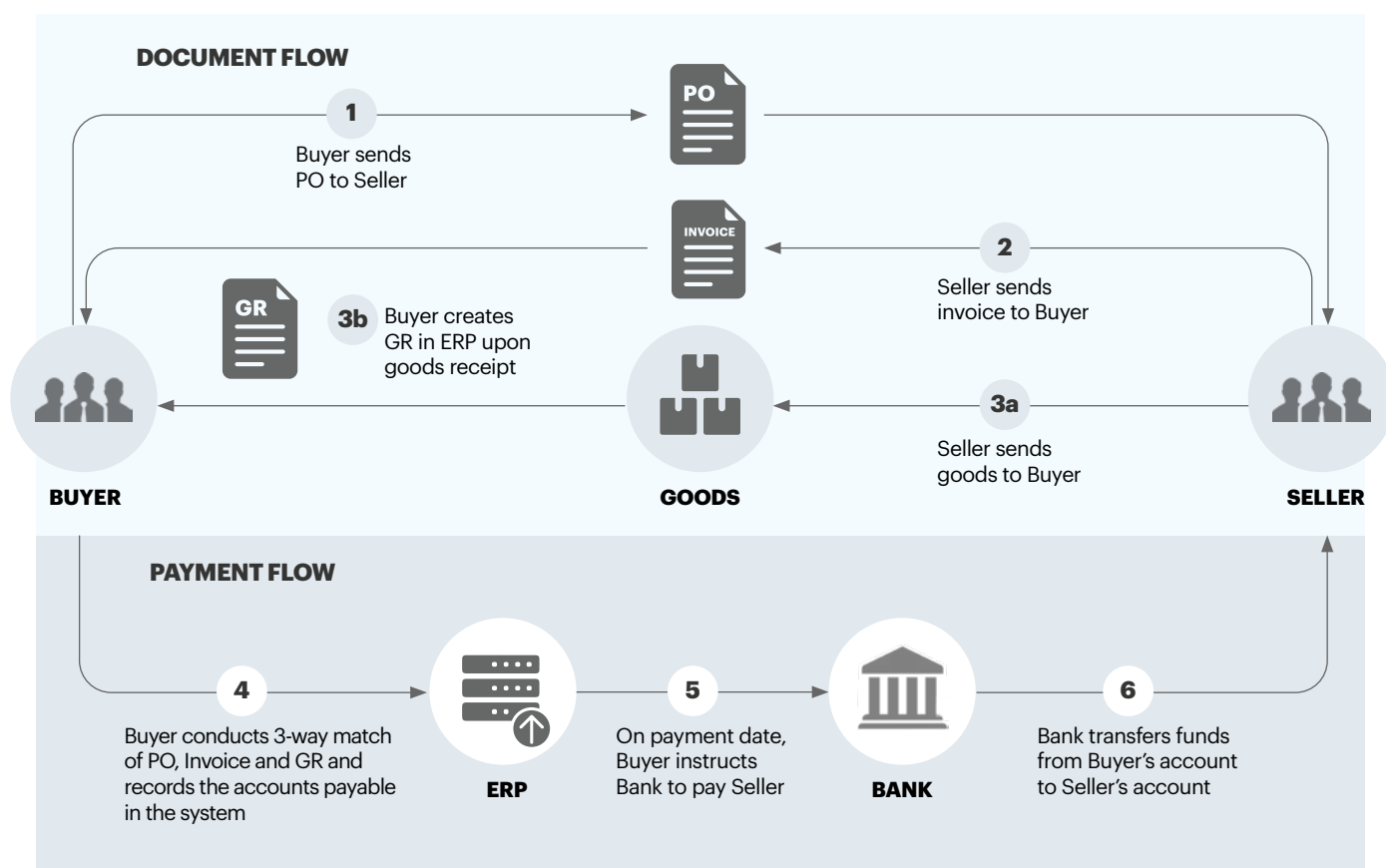
4.3.1.1 INTRODUCTION

A buyer would pay the seller at a pre-determined date, upon invoice approval. Payment terms are typically set at 30, 60 or 90 days, but can vary depending on industry and jurisdictions.

The procure-to-pay process is still largely segregated across the various parties. The fragmented nature of these systems and processes means a significant amount of manual effort is needed to exchange and verify the mostly paper-based documents.⁵ This is further complicated by the need to investigate incidents, resolve disputes and manage supply chain disruptions across the various parties throughout the value chain.

A typical procure-to-pay process looks like this:

Fig 10: Typical Procure-to-Pay Process



⁵ https://www.r3.com/wp-content/uploads/2019/11/R3.SCB_B2P_CS_2019.pdf

4.3.1.2 EXISTING CHALLENGES

The challenges are a lack of standardisation of processes and documentation, as well as manual processes needed to verify the underlying transactions. These have added complexities with the rise of cross-border transactions and the large number of participants in the supply chain.

Lack of Standardisation of Processes and Documentation:

The supply chain consists of a large number of participants, each of whom maintains their own set of processes, documentation, data and ledgers – a lack of standardisation that makes it difficult to reconcile information across the value chain. In a trade transaction, documents come in different structures as these are generated by different parties. For instance, the PO and goods receipt (GR) are generated by the buyer, whereas the seller generates the invoice. This raises problems in reconciling trade documents, especially when buyers have more than one supplier, and vice versa. Additionally, when it comes to cross-border transactions, many trade documents are still paper-based.

Buyers typically consolidate the paper-based trade documents and manually conduct the three-way match – the process of reconciling the trade details of the GR, invoice and PO by the buyer, to ensure goods are received in good condition, in the right amount and quantity, and at the pre-agreed price, prior to making payment to the seller. This process is highly labour-intensive and prone to errors. Alternatively, buyers may record the invoice in their enterprise resource planning (ERP) system before conducting the three-way match automatically. However, this also requires manual intervention when it comes to recording invoices, and carries a risk of data errors. While there are initiatives to create standards for this process, such

as the Pan-European Public Procurement On-Line (PEPPOL),⁶ the industry has yet to adopt them widely. Consequently, the lack of standardisation in trade documents persists.

These labour-intensive procedures lead to high costs and time invested to ensure trade transactions are successfully completed, to investigate exceptions – such as mismatches in price and quantity in the PO and invoice – and to ensure transactions are legitimate.

4.3.1.3 TECHNOLOGY-ENABLED OPPORTUNITIES

There have been some efforts to digitise and automate certain processes – such as by using smart warehousing, where inventory is updated in real-time using embedded sensors and video analytics. This assists in the regular assessment of inventory levels in a buyer's warehouse and indicates when supplies are low. Even so, such digitisation efforts are largely limited to activities within an organisation, and create a series of disconnected networks that are bridged by manual processes to complete a transaction between buyers and sellers.

These disconnected networks could be resolved by using existing technologies such as centralised platforms operated by trusted parties like governments or banks. This could see participating organisations' ERP systems connected to centralised platforms that facilitate the submission and matching of POs, invoices and GRs to the portal, which then releases payments once the documents are verified.⁷ Building these supply chain networks and systems on blockchain could bring a wider range of participants onboard, generating greater efficiency and transparency in the procure-to-pay process, and providing additional trigger points to

⁶ <https://peppol.eu/what-is-peppol/peppol-profiles-specifications/>

⁷ http://www.citibank.com/transactionsservices/home/about_us/online_academy/docs/erp_integration.pdf

offer easier financing options to participants. Some solutions-providers include Digital Ventures, Invictus, essDOCS and Marco Polo. These distributed and open supply chain and supply-chain finance networks can bring better interconnectivity, efficiency gains, improved transparency, traceability and security, easier auditability and improved collaboration between trading partners, including financial institutions.

Better Interconnectivity: Participants that connect via a common platform would adhere to common standards, which would allow trade data to be consistently recorded.⁸ In this way, three-way matching could be automated and easily identify mismatched documents. It could also prevent incidents such as double-paying an invoice.

Participants using a common platform can efficiently access and update a common set of data, which simplifies the information-sharing process. In addition, amendments to the records held on-chain would require the authentication of all participants, enhancing trust, authenticity and the integrity of data records. This single source of truth also increases efficiency and reduces costs by automating labour-intensive tasks. Furthermore, with the entire procure-to-pay process conducted on-chain, underlying processes such as invoice-processing would be simplified, because paper-based invoices could be replaced by electronic ones on a distributed ledger. Thus, all parties participating in the transaction could review the same underlying information without the need for reconciliation.

With trade data on a common platform in a common digital format, the three-way matching process can be better automated. When coupled with the simplified information-

sharing process, the enhanced trust and certainty of the three-way matching process enables further integration with payment initiation. Smart contracts can be embedded to allow for immediate release of payments based on pre-defined rules, with subsequent updates on transaction statuses conducted automatically. This reduces the need for reconciliation and allows for faster transactions.

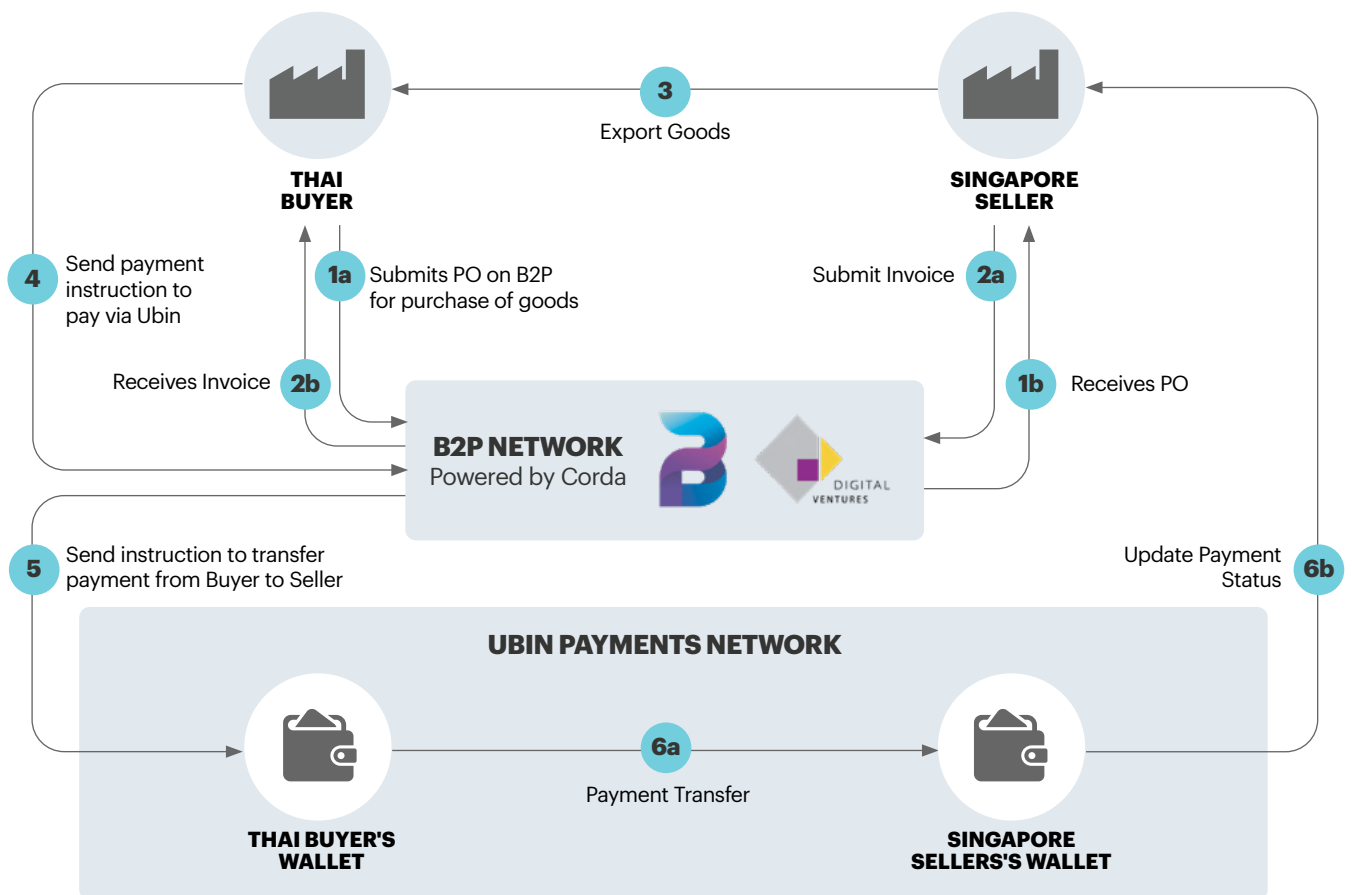
4.3.1.4 BENEFITS AND OPPORTUNITIES FROM UBIN V INTEGRATION

End-to-end process automation can be achieved through integration with the Ubin payments network. One common usage is conditional payments, which allow payments to be automatically initiated upon the fulfilment of pre-defined conditions. The Ubin payments network would facilitate the transfer of payments and be integrated with blockchain-based supply-chain solutions on a distributed ledger to ensure easier information-sharing. In the procure-to-pay context, such integration enables the entire process to be automated, bringing improved visibility of the overall transaction and greater efficiency – and cutting time and costs.

⁸ https://www.accenture.com/t20170103T200504Z_w_/us-en/_acnmedia/PDF-37/Accenture-How-Blockchain-Can-Bring-Greater-Value-Procure-to-Pay.pdf

Fig 11: Procure-to-pay Process


Digital Ventures, a subsidiary of Siam Commercial Bank, has developed a platform called Blockchain for Procure-to-Pay (B2P) to enable trade document exchanges with automated document verification and payment processing. This platform⁹ improves process efficiency and delivers cost savings to buyers; it also provides sellers with easier and faster access to supply chain financing.



The B2P platform was integrated with the Ubin payments network to facilitate supply chain trading and financing. Buyers, sellers and banks exchange trade documents over the platform, with payments settled through the Ubin payments network. This integration shows the potential for achieving more efficient means of cross-border, single-currency settlement.

⁹ <https://newsroom.accenture.com/news/accenture-and-digital-ventures-co-develop-and-launch-first-of-its-kind-blockchain-solution-in-thailand.htm>

The example shows how the business scenario simplifies trade compared to the traditional procure-to-pay process:



- 1 A Thai company (buyer) places an order to buy goods from a Singapore company (seller).
- 2 The seller sends an Invoice to the buyer, using the B2P platform.
- 3 The seller delivers the goods to the buyer.
- 4 The B2P platform validates the trade documents, and the buyer confirms the payment.
- 5 The B2P platform triggers payment in the Ubin payments network via a direct-API call to Transfer API, as provided by the Ubin payments network.
- 6 The Ubin payments network transfers the payment from the buyer's wallet to the seller's wallet and updates the corresponding completion of payment on the platform.

Note: all transactions in this case study are in USD, i.e. there is no currency exchange involved.

By embedding the payments leg in the B2P platform using the Ubin payments network, transactions will be verified on both the B2P platform via a three-way match and the Ubin payments network, where payments are recorded on the blockchain. Participants share a common view of the transactions on the shared ledger, which removes the need for payment reconciliation.

4.3.1.5 ADDITIONAL BENEFITS TO BE EXPLORED

Supply chain solutions can be further enhanced by providing additional functionalities such as early financing options for sellers. The ability to establish an end-to-end relationship from procure-to-pay to financing would bring a wider range of opportunities for the supply chain industry. In fact, multiple parties in the industry are seeking to address an array of issues throughout the value chain. One example is Invictus, whose platform was developed to increase accessibility to financing for small- and medium-sized enterprises (SMEs). It achieves this by providing a unified platform to connect buyers and sellers for orders, logistics and payments.

Using blockchain technology gives the additional assurance on the authenticity and integrity of transactions on the platform, which increases the likelihood that financial institutions will provide funding for them.

Other applications include essDOCS' Cmatch platform, a fully digitalised and centralised engine that electronically matches trade data for bank payment obligation transactions. Another is Marco Polo's Payment Commitment solution, a trade finance instrument that leverages blockchain technology to secure payment against the automated matching of electronic trade data.

Given the heightened interest in these areas, we see potential in applying conditional payment functionality. It helps in the automatic release of funds once pre-defined conditions are fulfilled, which can bring greater efficiencies in today's processes.

Beyond the current integration, there are numerous opportunities that could further enhance the use case. Having multiple currencies on the Ubin payments network

could support cross-currency trades, allowing a Thai buyer to pay in Thai Baht, with the Singapore seller receiving payments in SGD. Further process automation could be undertaken, with the availability and accessibility of trusted data, including the use of Artificial Intelligence (AI) and advanced analytics for risk management, fraud detection and to enhance decision-making. Internet of Things (IoT) devices could also provide an added dimension of data for conditional payments, such as the tracking of inventory movement and deliveries.

Escrow services provide certainty of payment, but require that funds are locked up in the interim period. An instrument that could provide a liquidity-efficient way to offer some level of assurance on payments would, therefore, be of interest. The project explored the concept of payment commitment, which is an irrevocable commitment by a party to release payment of a fixed amount on a later date. The payment commitment is assignable, with payee details that can be updated. This means it can be sold and re-sold – essentially selling the rights to a future payment, for up-front cash at a discount. Such an instrument could simplify the payments portion of the supply chain finance process flow, which would otherwise require that the payer be informed of a change in beneficiary every time an assignment took place.

The Ubin V network is prototyping different models of payment commitments to explore how these can be used to fulfil such business needs. One model would be for the supply chain platform to update the payee only on value date. This provides the greatest flexibility for the interfacing platform, but does not give traceability of assignments on the payments network itself. The other models require that assignments be recorded on the payments network. One model updates the payee details each time an assignment takes place, with funds flowing directly from the payer to the payee on value date.

The other model creates a new linked payment commitment each time an assignment takes place. On value date, the chain of “linked” transactions is completed as a set, essentially moving funds across the chain of parties before they reach the final payee.

Further research is required on these different models in order to evaluate various other factors. These factors include technical complexities, the perspectives of platforms and users, business and operational processes, and legal and regulatory implications.

4.3.2 SUPPLY CHAIN FINANCING

Supply chain finance covers “the use of financing and risk mitigation practices and techniques to optimise working capital and liquidity invested in supply chain processes and transactions”.¹⁰ Typically, a seller would prefer the buyer to pay upfront for the goods to avoid the situation where the latter might refuse to pay after receiving the goods. In contrast, the buyer would prefer to pay the seller as late as possible.

4.3.2.1 INTRODUCTION

The use of supply chain finance solutions such as receivables discounting, forfaiting and factoring can help overcome this risk by reconciling the conflicting needs of buyers and sellers.

4.3.2.2 EXISTING CHALLENGES

Challenges facing the supply chain finance industry include the lack of information on borrowers and invoice fraud.

Lack of Information on Borrowers: While supply chain finance is a large and growing industry, it is not equally accessible by all organisations. Large firms tend to enjoy easier access to multiple financing options given their scale and financial standing. By contrast, SMEs often struggle to access bank financing,

“contributing to an estimated USD \$1.5 trillion global trade finance gap”.¹¹ This is largely due to SMEs being more “opaque” than large firms as they typically have less publicly available information. The lack of reliable information about SMEs’ performance makes it difficult for banks to assess their creditworthiness accurately. As a result, lenders may charge higher interest rates, impose more stringent collateral requirements or simply reject applications. All of that limits SMEs’ ability to participate in the trading system, and sees them forego trade and development opportunities.

There are different methods that banks adopt to evaluate the credibility of borrowers. For instance, a bank might request that a borrower provide invoices and their buyer’s PO to prove a legitimate economic transaction had occurred – as opposed to an invoice that the prospective borrower could issue. However, these POs and invoices tend to be paper-based, which means manual effort is needed to validate their authenticity. An alternative is that banks extend credit to the strategic SME suppliers of large corporates, as they would have greater confidence that these SMEs could meet their debt obligations – in which case, SMEs and their large corporate customers would enjoy access to loans and heightened supply chain stability respectively.

Fraudulent Invoices: Supply chain financing depends heavily on paper-based documents that can be forged. One example of fraud is double invoicing, whereby a supplier issues more than one invoice for the same goods or documents to secure financing from multiple banks. This risk is down to the fact that banks typically lack the means to share information due to confidentiality reasons and are thus unaware that the same transaction has been financed by another bank. Additional fraud risks include false invoicing, where an invoice is created for goods or services not rendered, and tampering of invoices in which invoices are manipulated to misrepresent the underlying economic transaction.

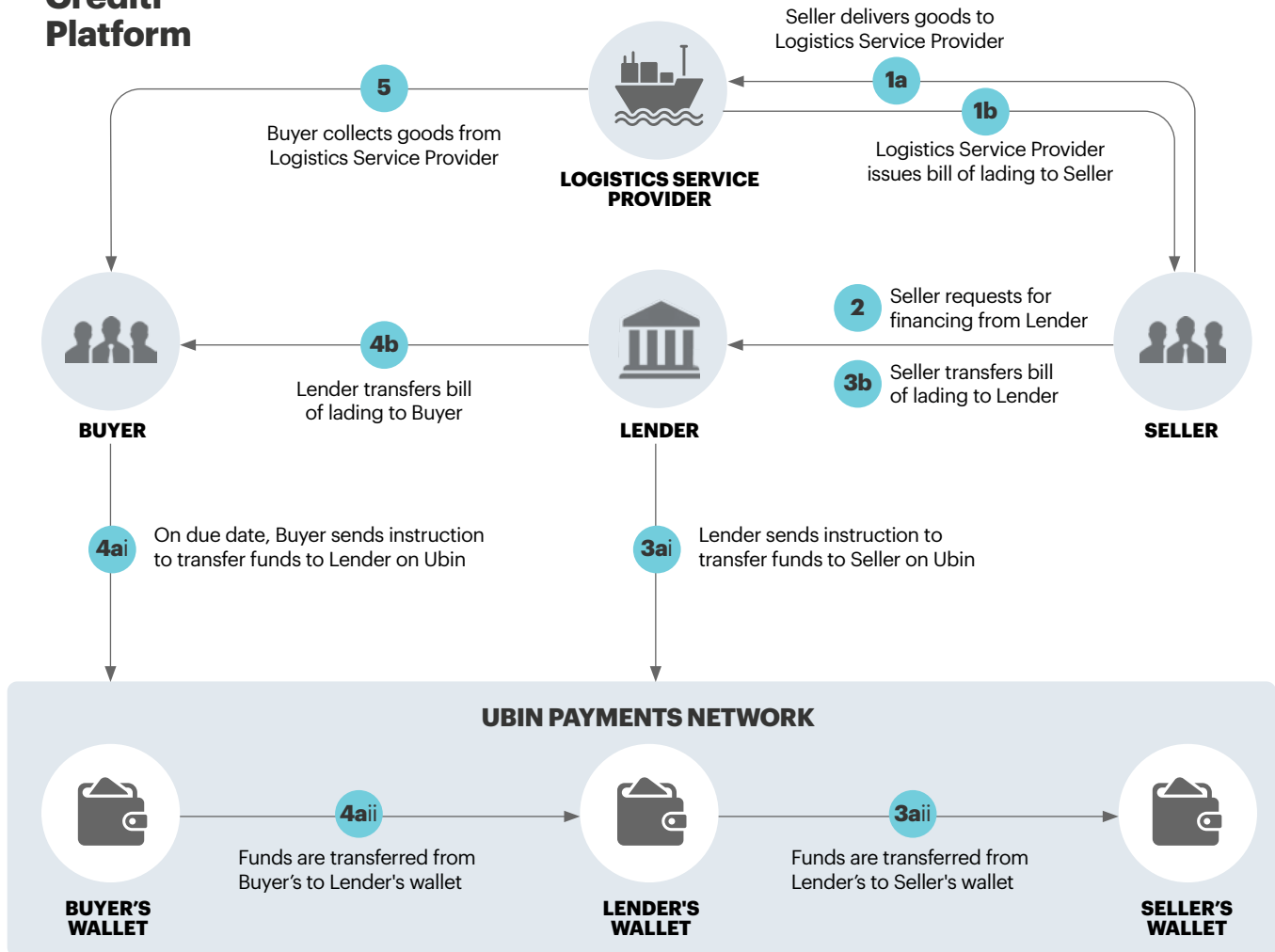
¹⁰ <https://iccwbo.org/content/uploads/sites/3/2017/01/ICC-Standard-Definitions-for-Techniques-of-Supply-Chain-Finance-Global-SCF-Forum-2016.pdf>

¹¹ <https://iccwbo.org/content/uploads/sites/3/2018/05/icc-2018-global-trade-securing-future-growth.pdf>

Fig 12: Supply Chain Financing

This case study explores how the Ubin conditional payment functionality may be used by Crediti, a Singapore-headquartered blockchain-enabled trade credit and supply chain financing platform that engages non-bank institutional capital as an alternative source of funding to SMEs seeking finance.

Crediti Platform



Every exposure is tokenised and recorded in an immutable registry, which prevents ownership title documents such as bills of lading and invoices from being financed by multiple lenders on the platform.

In this case study, it is assumed that a seller requests financing on the platform by transferring the bill of lading, which serves as a document of title to a commoditised product, to the lender.

Fig 12 depicts the following flow:



Steps 1a and 1b occur automatically:

- 1a** The seller delivers goods to the logistics service provider.
- 1b** The logistics service provider issues a tokenised bill of lading to the seller.
- 2** After checking that the tokenised bill of lading has not been financed by another lender, the platform matches the seller (borrower) with a potential lender. Next, the seller requests financing from the lender.

Steps 3a and 3b occur automatically:

- 3a** The lender sends a payment instruction via the platform to transfer funds from the lender's wallet to the seller's wallet on the Ubin payments network.
- 3b** Upon receiving the funds from the lender, the seller transfers the tokenised bill of lading to the lender.

On due date, Steps 4a and 4b occur automatically:

- 4a** The lender sends a payment instruction via the platform to transfer funds from the lender's wallet to the seller's wallet on the Ubin payments network.
- 4b** Upon receiving the funds from the buyer, the lender transfers the tokenised bill of lading to the buyer.
- 5** With the tokenised bill of lading, the buyer is able to collect the physical goods from the logistics service provider.

4.3.2.3 TECHNOLOGY-ENABLED OPPORTUNITIES

Most global and regional banks have developed proprietary platforms providing payables and receivable financing products to their buyer and seller clients. For example, a large corporate can onboard its suppliers into a bank's supply chain finance program. Once onboarded, the suppliers can upload invoices to the platform for verification by the buyer, which will then be sent to the bank for immediate financing. Further, many third-party providers have come up with solutions that are bank-agnostic, providing flexibility to corporates in their banking needs.

Although banks have traditionally been the primary source of SME financing, technology has enabled new solutions such as equity crowdfunding and P2P lending that connect borrowers and lenders directly without relying on traditional intermediaries. Crediti is an example of an organisation that connects SMEs seeking finance with non-bank institutional capital. There are also innovative solutions like Big Data analysis that leverage data from sources like credit card purchases, public records, and reviews and ratings from business directories like Yellow Pages to build a more complete picture of a borrower. Additionally, reliable past transaction data can also serve as useful information about borrowers, as we shall see below.

The industry has also made efforts to circumvent the risk of fraudulent invoices. For example, six banks have joined forces to establish the Trade Information Network (TIN), a global multi-bank platform where corporate clients can submit and verify POs and invoices to request trade financing from the bank of their choice. Banks can also share useful information with one another – such as whether an invoice has already been financed, which mitigates the risk of double invoicing.

Other solutions aim to curb double invoicing by leveraging the immutability functionality of blockchain technology, as explained below.

Enhance Transparency: A repository of trusted and reliable data on blockchain gives banks greater confidence in assessing an SME borrower's performance and ability to repay. This could help to assess whether "a borrower can fulfil its financial obligations, whether the borrower can deliver the goods or services within the agreed timeframe, or whether the borrower will remain solvent for the duration of its obligations".¹² Access to past transaction history, albeit subject to permission, would also allow banks to assess whether there had been legitimate economic transactions between a borrower and its supplier. And, because these data would be in digital form, banks could use a more efficient electronic review process as opposed to assessing it manually.

Reduce Chances for Fraudulent Transactions: There are several aspects of blockchain technology that can help to reduce the likelihood of fraudulent transactions. For instance, certain attributes from an invoice can be used to generate a unique hash of the invoice itself. It would be difficult for an adversary to tamper with data in any block in the entire chain as he would have to change the hash of all previous blocks in order to disguise the tampering. Furthermore, the consensus mechanism used in blockchain helps to ensure a robust transaction ledger, such that only authentic transactions are approved and become permanent.

¹² <http://www.r3.com/wp-content/uploads/2018/07/Can-Blockchain-Make-Trade-Finance-More-Inclusive-1.pdf>

The conditional payments functionality may be integrated with an external blockchain-based platform connecting borrowers and lenders to facilitate the automatic transfer of funds from lenders to borrowers upon the fulfilment of pre-defined conditions.

Examples of conditions include whether a borrower meets credit score requirements, whether a borrower's invoices match its corresponding suppliers' invoices, and whether a borrower is indeed the supplier of a "large" corporate.

With the advent of Ubin, end-to-end digitalisation of a trade transaction can occur on blockchain, from the matching of trade documents to the transfer of funds from lenders to borrowers, as well as the final payment from a buyer to the supplier.



4.4 INSURANCE

Insurance is a form of supplementary instrument used to hedge against the risk of financial losses that may result from damage to the insured or the property insured. The insurance process and value chain are relatively fragmented with multiple parties involved. Some common participants include the insured, the insurer and the third-party claimant. The insured is the person who is covered against risk under the insurance policy. The insurer is the insurance company that provides the insurance cover. The third-party claimant includes parties such as hospitals or car repair workshops that provide services and that bill the insurer directly for services rendered.

4.4.1 HEALTHCARE INSURANCE

The process of hospitalisation claims typically involves the hospital, the patient, the national health insurer and, where applicable, the private insurer. The national health insurer provides insurance coverage to citizens against the cost of healthcare. The private insurer is an optional “add-on” that provides additional healthcare coverage to individuals.

4.4.1.1 INTRODUCTION

When a patient is hospitalised, he/she would submit a claim to the national health insurer. If the patient has a private hospitalisation plan, the patient would also make a claim to the private insurer. The claims disbursement process would usually begin when the patient’s insurer, with authorisation from the patient, submits a letter of guarantee (LOG) to the hospital. This LOG serves as an assurance of payment by the insurer to the hospital for the portion of the patient’s hospital bill covered by insurance. This allows the patient to obtain a waiver of the upfront cash deposit required by the hospital. The patient then authorises the hospital to submit an e-file to the national health insurer.

Thereafter, the private insurer is notified and liaises with the national health insurer to process the component claimable against the national health insurer. Once the claims are finalised, the private insurer pays the hospital the amount payable by the insurance company and the national health insurer. This process brings challenges to the claims disbursement process, which will be discussed in the following section.

4.4.1.2 EXISTING CHALLENGES

Healthcare delivery and payment often require repetitive processes, bill adjustments, manual claims submission and lengthy claims-adjudication processes. Payment is thus often slow, taking weeks for the cycle to complete. Claims-processing times vary across different insurers and it may take weeks for the final bill to be processed and paid to the hospital. In addition, multiple parties are involved in the claims process, which causes complexity in coordinating the claims process. These parties include the national health insurer, the hospital, the patient and the private insurer. Challenges include a lack of industry standards and the lack of a central communications platform.

Differences in Claims Procedures across Insurers:

Different insurers have different sets of claims forms and processes, posing an administrative challenge to hospitals that must collate and submit different types of information in different formats to claim against different insurers – for example, the preparation of pre-authorisation forms. The Life Insurance Association, Singapore, tackled this by introducing a standard form for the “pre-authorisation of hospital and surgical bills, resulting in a unified practice” that cut the hospital’s administrative burden.¹³ Such common standards can reduce administrative procedures in the claims submission process, and be replicated to improve operational efficiency in other processes.

¹³ <https://www.businesstimes.com.sg/government-economy/singapore-insurance-body-offers-standard-form-to-simplify-pre-authorisation-of>

Additionally, differences in the level of underwriting, as well as product features such as the amount of coverage and type of coverage, create difficulties in determining actual coverage. This is because such differences tend to be complex, with some patients not fully aware of the coverage offered by their insurance policies – for example, the group health insurance provided by their employer and how that overlaps with different policies they have purchased. While hospitals may be able to check if the patient holds a private insurance policy, certain details of the coverage are not reflected to the hospital – say, pre-existing conditions that are not covered by insurance or the remaining amount of coverage for the financial year. This can result in the hospital being unable to advise the patient how much is covered by their private insurer and how much the patient must pay directly.

Lack of Central Communications Platform:

Most patient documents – like identity, medical records and insurance plans – are not shared across different parties. For instance, medical records are usually held by the hospital while details of the insurance plans are kept with the insurer – with no common platform to facilitate communication across different parties. This poses a huge difficulty in providing real-time information like the amount claimable with regards to the policy plan, as well as ensuring that records are up to date. Given the confidentiality of the information, communications often take place between two parties rather than with all parties involved. For instance, the hospital needs to communicate to the private insurer and patient separately to get updated notifications on the payment. This gives rise to operational inefficiencies that arise from manpower costs and the time incurred in communicating and keeping track of the status of payments.

4.4.1.3 TECHNOLOGY-ENABLED OPPORTUNITIES

These underlying inefficiencies have caused many organisations to try and introduce new technologies. For instance, e-claims solutions were brought in to ease the claims-disbursement process for patients who paid upfront, with the patient required only to upload the relevant medical documents; the insurer would process the disbursement in days. And some industry players like Prudential have explored using AI to cut the time it takes to settle healthcare claims.¹⁴ Using a machine-learning-based solution allows a claim's validity and the recommended decisions and payment amounts to be processed in seconds. Having a common platform to allow for agreement across parties with regards to standard data fields and data-sharing would also cut the administrative procedures to process claims. One such a platform is provided by an organisation called Digital Asset, which seeks to provide solutions like standardised procedures and shorter disbursement times.

Standardised Procedures: Having insurers provide certain sets of records on a common platform removes the administrative burden on hospitals when conducting e-filing for patients during the pre-authorisation process. Records may include the policy plan that the patient is holding, the amount claimable and the conditions required for claim under a policy. Including payment information would provide visibility on the status of transactions. In this way, hospitals can track the status of payments of the different parties, resulting in easier follow-ups on the claims-disbursement process – with a simplified workflow providing greater transparency into the status of transactions.

¹⁴ <https://www.todayonline.com/business/prudentials-new-e-claims-platform-speed-processing-time>

Additionally, this brings the hospital improved transparency about information such as bill size, insurance plans and amount claimable against the private insurer and national healthcare insurance, which means better financial counselling services for the patient. In this way, the patient is more aware of the hospital bill-size and the amount that he/she would need to pay upfront, all of which helps to facilitate better financial planning.

Reduced Disbursement Time: Having all participants connected on the same network enhances efficiency as participants do not need to communicate with one another bilaterally. For instance, when the hospital updates the exact bill-size on-chain, all registered participants in the network can view the bill instantaneously and make the corresponding payment. And with patient documents like medical records and policy plans recorded on-chain, every transaction is automatically updated. This provides certainty on the record's accuracy and means different parties spend less time on processing claims.

4.4.1.4 BENEFITS AND OPPORTUNITIES FROM UBIN V INTEGRATION

The Ubin payments network can provide the ability to conduct conditional payments on-chain, which can support the automated release of payment upon completion of healthcare services provided by the hospital. The Ubin payments network facilitates the payments transfer and integrates with blockchain-based insurance claims solutions to track the interaction of the patient, hospital, private insurer and national health insurer as ledger events on-chain. This ensures that the progress of delivery of healthcare services and payments are closely integrated, avoiding a mismatch between them.

To address the abovementioned challenges, Digital Asset automates the healthcare claims process by leveraging smart contracts and integrating with the Ubin payments network.

4.4.1.5 ADDITIONAL BENEFITS TO BE EXPLORED

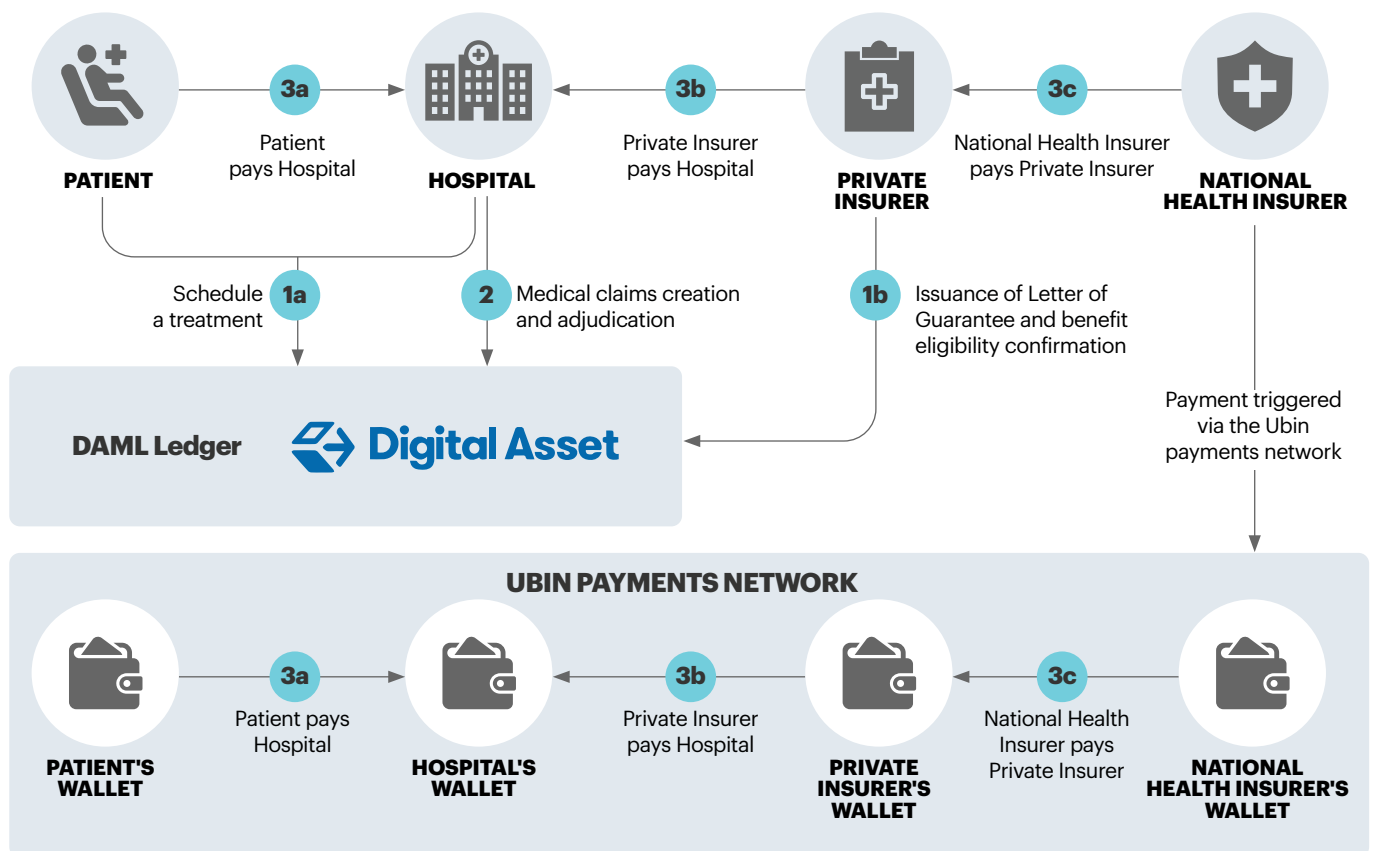
While the use case below allows for greater efficiency in healthcare payments, there are opportunities to further enhance the proposed capabilities and existing healthcare claims processes:

1. An additional workflow can be incorporated to cover patient transactions, such as the selection and enrolment of an insurance policy to further streamline the overall healthcare claims lifecycle. In this example, patient selection and payment completion can be performed via the Ubin payments network, with a DAML smart contract used to record the patient's enrolment status.
2. Individual patient deductible accumulations can be tracked in real-time, which means any amounts owed by the patient for subsequent medical treatments are known in real-time. Such transparency can empower patients in making better-informed healthcare decisions and, ultimately, improve the patient experience.

Fig 13: Healthcare Insurance Claim Process

Digital Asset helps enterprises design, create, and run the next generation of distributed ledger applications using Digital Asset Modelling Language (DAML), an intuitive, open-source, smart contract programming language. The firm has developed a prototype for a proposed healthcare claims application, which is modelled on the lifecycle of a hospitalisation claim in Singapore involving a patient, a hospital, a private insurer and a national health insurer.

Healthcare Insurance Claim Process



The interactions between the parties are tracked as ledger events and governed by DAML smart contracts. The application integrates with the Ubin payments network for balance enquiries and the transfer of payments.

Fig 13 depicts the following flow:



Eligibility and prior authorisation:

- 1a** A patient schedules a medical treatment at the hospital
- 1b** DAML requests for a LOG and benefit eligibility confirmation from the Private Insurer.
- 2 Healthcare claims creation and adjudication:**
After delivering the medical treatment, the hospital submits a healthcare claim to the Private Insurer and sends the bill to the patient.

Healthcare claim and payment:

- 3a** The patient makes payment to the hospital via the Ubin payments network.
- 3b** The Private Insurer verifies and approves the healthcare claim. This triggers a payment authorisation via the Ubin payments network, and the hospital receives payment from the Private Insurer.
- 3c** The private insurer submits a claim for the amount covered under the national insurance plan. After approval, the national health insurer makes payment to the private insurer via the Ubin payments network.

4.4.2 OTHER OPPORTUNITIES IN INSURANCE

The insurance industry is also exploring the use of blockchain technology in areas such as parametric insurance, travel insurance, and automobile insurance.

4.4.2.1 AUTOMOBILE INSURANCE

When two car-owners have an accident and decide to make an insurance claim, multiple transactions take place across multiple parties, such as exchanges of documents, invoices, evidence, notices, and payments information. The relationship across the different parties is complex and results in an inefficient claims process that requires multiple interactions and payment settlement across different parties. However, car insurance claims could be processed on a single common platform where the different participants reside on the same network. This would ensure the easy sharing of information such as the identities of the parties, photos of the damage, and the insurers of the car owners; it would also eliminate manual reconciliation and enable process-tracking of the claim.

It is also the case that, when it comes to claims against the counterparty's insurer, payment is typically less straightforward. For instance, the claimant might need to pay their workshop upfront and later claim against the defendant's insurer. On a common platform, direct relationships could be established between the insurer and the workshop to facilitate direct payment between these parties, with automated rules engines specifying how to deal with "defined" situations.

Immediate has developed a common platform that connects all participants such as insurers, the insured and car-repair workshops. Its platform allows the sharing and recording of information, such as invoices from the workshops, the amount of insurance coverage and evidence of damage. That allows participants to verify records easily on a single distributed database and settle defined workflows between participants in real-time – boosting efficiencies and improving the user experience.

Such platforms could be integrated with the Ubin payments network to allow for settlement of financial claims between participants upon the fulfilment of pre-defined conditions. This would bring about faster payments and remove the need for reconciliations as the transactions would be recorded on-chain with the platform acting as a single source of truth to all participants. In this way, a fully integrated insurance process could be conducted on-chain, bringing about a more efficient, cheaper and data-driven insurance process for all those involved.

4.5 BEYOND FINANCIAL SERVICES

The project also explored the benefits for use cases beyond financial services, with those use cases centred around providing services in exchange for value. Such transactions are similar to trade use cases where physical goods are exchanged for value. However, services are different from goods in that they are non-physical and intangible, which is why recording and verifying services rendered is performed differently from that of physical goods.

4.5.1 MEDIA AND ADVERTISING

We can look at programmatic advertising as “the automated buying, selling, placement and optimisation of digital advertising”.¹⁵ The value chain involves multiple partners to ensure advertisements are successfully delivered and payments are accurate.

In this value chain, the partners are:¹⁶

- **Advertiser:** The company that pays for the advertisement.
- **Media Agency:** An organisation placing advertisements in the media on behalf of advertisers.
- **Demand Side Platform (DSP):** A technology platform providing centralised and aggregated media-buying for media agencies.
- **Supply Side Platform (SSP):** A technology platform aggregating ad impression inventory, providing outsourced media-selling and ad network management services for publishers.
- **Publisher:** A creator and/or aggregator of online content that displays advertisements on their online platforms.
- **Verification Party:** An independent company that verifies measured activity such as ad impressions, page impressions, clicks, total visits and unique users.

Having multiple parties involved brings operational inefficiencies and extended payment settlement times. In addition, the industry is vulnerable to fraud attacks, such as the use of internet bots to create fake publishers or to increase the number of impressions for an advertisement. Such fraudulent acts can cost advertisers millions of dollars.¹⁷

The many intermediaries involved also drive up the cost of advertising and reduce publishers’ margins. In addition, it is often difficult to verify payments across the intermediaries as doing so requires checking “different sets of information across multiple siloed organisations”.¹⁸ All of this results in a largely inefficient process with a long payment lead-time.

Bringing these parties on to a common platform could allow better visibility of the end-to-end impression lifecycle while making it easier to share information between parties. For example, advertisers can use smart contracts to specify requirements for ad impressions, such as target audience profiles, while publishers can use smart contracts to state the properties of an ad space such as audience user-profile. These smart contracts would undergo a matching algorithm to instruct ad content delivery, record evidence of claimed impressions and facilitate payment settlement according to the agreed terms between the advertisers and the publishers.

In addition, the record of transaction details creates an audit trail at every stage of the advertising process, which can be useful to accurately measure an advertisement’s performance. This can then be used to ensure accurate payments by advertisers while maintaining an ecosystem that enables transparency and accountability to all participants.

¹⁵ <https://www.imda.gov.sg/-/media/Imda/Files/Industry-Development/Infrastructure/Technology/Factsheet-for-Blockchain-Innovation.pdf>

¹⁶ <https://www.iab.com/insights/glossary-of-terminology/>

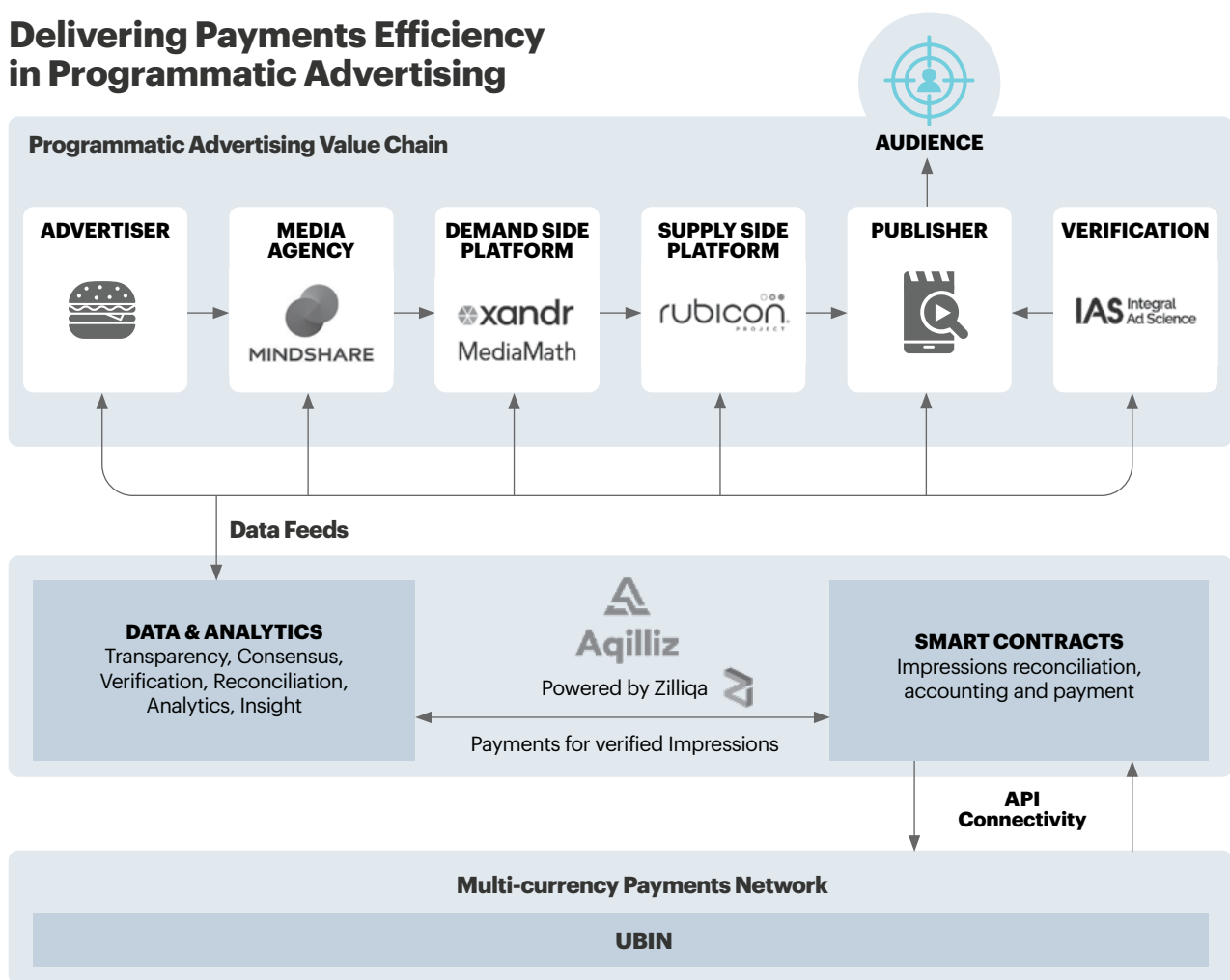
¹⁷ <https://www.asiatimes.com/2019/04/article/blockchain-to-battle-ad-industrys-bad-bots/>

¹⁸ <https://docs.zilliqa.com/positionpaper.pdf>

Fig 14: Delivering Payments Efficiency
in Programmatic Advertising


Aqilliz has developed a product, Proton, which leverages on the Zilliqa platform to streamline the digital supply chain of programmatic advertising by connecting multiple parties on a single platform. This network could be integrated with the Ubin payments network to better facilitate the payment process.

Delivering Payments Efficiency in Programmatic Advertising



The current model looks at the net settlement via the Ubin payments network. However, if the Ubin payments network supports cheap and fast micropayments, the amount payable may be automatically calculated and payment be made directly via the Ubin payments network.

The process flow to settle payments for programmatic advertising via the Ubin payments network would look like this:



- 1** Advertisers and programmatic partners submit recorded impressions into Zilliqa smart contracts.
- 2** Upon receiving the log-level impressions, Aqilliz's protocol consolidates the data before sending it to the Zilliqa blockchain where smart contracts can reconcile impressions that are viewable, brand-safe and fraud-free based on pre-agreed rules.
- 3** Payouts are automatically dispensed to relevant stakeholders across the digital media supply chain once impressions have been validated. The payouts are denominated in the Native Alliance Token (NAT) on the Zilliqa blockchain, a token that mirrors deposits in a bank account.
- 4** The Ubin payments network could be included to facilitate actual payment of digital currencies from one account to another on a net basis. For instance, the NAT may be redeemed in exchange for digital currencies in the Ubin payments network on a periodic basis.

4.5.2 SALARY PAYMENT

In recent years, there has been a rise in the gig economy, with a new form of labour introduced into the market. A gig is a temporary work engagement in which the company pays for the services rendered by an independent contractor instead of a full-time employee. It is expected that the global gig economy will grow 17 percent annually to 2023, with Singapore exhibiting the greatest growth in the Asia-Pacific region.¹⁹ The gig economy provides firms with a way to recruit talent on a fixed-term basis without incurring long-term fixed costs; however, gig economy workers are typically bounded by unstable income and would prefer to be paid as quickly as possible.

A report by the Singapore Business Review showed just one in 10 firms had the processes or technology in place for gig economy workers,²⁰ which means paying salaries is often inefficient. As a result, companies must make extra efforts to process gig workers' pay, yet those payments are often late and sometimes wrong. In addition, because of the difficulty of preparing payments upon job completion, companies often seek to run batch payments with salaries usually paid on a monthly basis.

Similar to trade platforms that match buyers and sellers in exchange for goods, online platforms like Blocklancer and Ethlance provide staffing services by matching gig workers to companies. Direct models like this see gig workers and organisations establish a direct relationship. However, trust can still be an issue if services are not delivered or payment fails. That challenge can be addressed if an escrow is used, with the payment released only upon job completion.

Alternatively, participants can use an indirect model in which recruitment agencies like Adecco are engaged as specialised and credible counterparties to mitigate the trust issue between gig workers and companies. These agencies become the legal employer of the gig workers and provide manpower for jobs listed by organisations.

In both direct and indirect models, salary payments can be made more efficient by providing an integrated human resources (HR) payment solution like Octomate. Gig workers use the solution to submit their timesheets on-the-go, and those are recorded on-chain. Once the manager has verified the timesheet, the solution automatically triggers smart contracts to match the salary payable against the hours worked for specific job listings, records the salary payable and sends the payment instruction to the Ubin payments network for instant salary disbursement to the gig worker. This common platform makes it easy to share information and records between all parties, which removes the need for reconciliation. That means reduced lead times for payments – from the traditional month-end pay to instant salaries on a daily basis for gig workers.

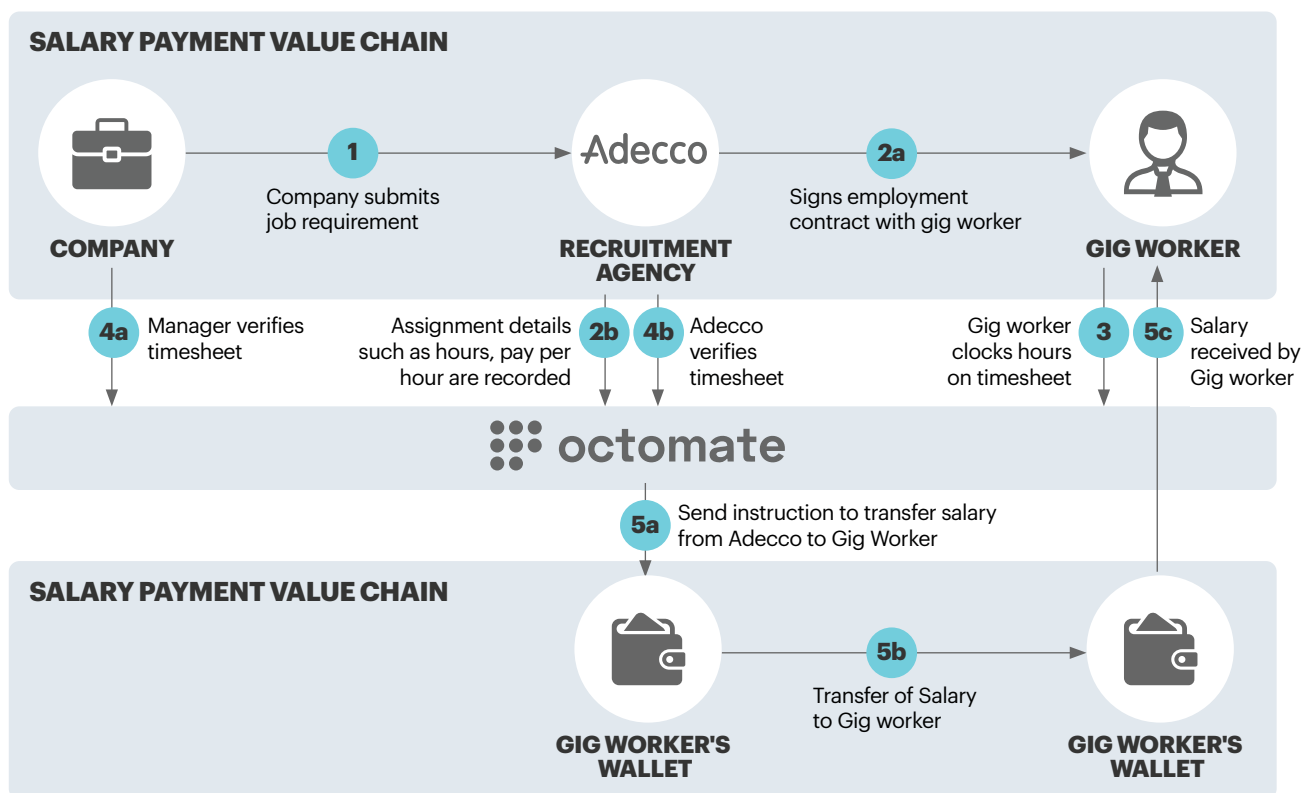
¹⁹ <https://newsroom.mastercard.com/wp-content/uploads/2019/05/Gig-Economy-White-Paper-May-2019.pdf>

²⁰ <https://sbr.com.sg/hr-education/news/only-1-in-10-firms-have-policies-gig-economy-workers>



Fig 15: Operational Efficiency
in Salary Payments

Octomate provides a blockchain-based HR payments solution that allows real-time, accurate salary payments for gig workers and organisations upon work completion. In Adecco's case, workers and companies can view and track work done on a front-end application. Once the gig workers complete their assignments, the payments are released automatically. To ensure completeness in the process, these platforms can be integrated with bank payment platforms to allow for seamless transactions and the release of payments.



When a worker is legally employed with Adecco to work for its clients, assignment details such as scope of work, hours worked and salary payable are agreed prior to commencement of work.

These pre-defined agreements are recorded on Octomate's platform, with smart contracts created to govern the conditions for payment. Upon fulfilment of work with pre-defined conditions met, such as verification of a timesheet by a manager, payment is automatically triggered to the gig worker. This further streamlines Adecco's payment process to achieve speed and efficiency, allowing workers to receive pay faster.

Fig 15 shows a potential integration with the Ubin payments network to achieve real-time, accurate payment for gig workers in the context of an indirect transaction.

Having every work transaction recorded on a common platform encourages trust and transparency for all parties involved in the transaction, minimising potential disputes. This sets up a foundation for instant payments to take place. Integrating Octomate and the Ubin payments network could allow for conditional payments where funds can be released to gig workers when a job is completed.

For example, once a manager has verified the timesheet, the salary payable is automatically calculated and recorded on Octomate's platform. A message is then sent to the Ubin payments network to facilitate the transfer of payment from Adecco's account to the gig worker's account in real-time. This further supports the rise of the gig economy where salary payments are paid in a shorter cycle once work is completed.

Project Ubin started as an experiment to understand blockchain and DLT, and how those could be applied to new models of clearing and settlement of payments and securities. The cross-border payments infrastructure today has been built over decades and upon layers of requirements, constraints and workarounds. By taking a blue-skies view of how payments could look like in the future, the project was not shackled by the constraints of existing systems or by legacy processes and an archaic way of thinking.

In this way, the experiments carried out over the five phases of Project Ubin have shaped our views on the future of payments, and crystallised design ideas on what could form the basis of this vision. Technology enables these design ideas and concepts, which form the building blocks for the development of next generation payments infrastructure. Technology will continue to improve and evolve, and it is likely that there will be better means of implementing these design ideas in the future.

Taking a technology-neutral view, the key design ideas and concepts for a payments infrastructure of the future would incorporate:

**Better connectivity between:**

- Transacting parties
- Platforms for the underlying economic transactions and payments infrastructure
- Users and their platforms

**Payments and Process Automation with:**

- Trusted data
- Secure exchange of data
- Automation using trusted data

**Additional payments-related functionalities and rapid development of prototyping of such functionalities**

While the starting point was in exploring blockchain technology, many of the design concepts are applicable beyond blockchain-based networks, and could also be implemented on more traditional architectures.

5.1 IMPROVED CONNECTIVITY THROUGH COMMON PLATFORMS

The Ubin V domestic multi-currency settlement network takes the view that a common platform, where banks and their corporate customers are able to hold and transact in multiple different currencies, would improve transactional efficiency. FX liquidity would improve as more parties were able to directly exchange different currencies, while FX spreads would correspondingly improve – especially for previously illiquid FX pairs, which would have required the use of an intermediate currency.

Building on the Phase 5 lessons learned, banks are now exploring the viability of operating this model as a private commercial enterprise. In such a model, all currencies will be distributed by commercial banks, and banks' customers will be able to transact directly with each other in all of the different currencies.

If proven successful and viable, the commercial model can be elevated to an international settlement model where currencies are issued by central banks. If a group of commercial banks can come together to implement such a network in the absence of a trusted central party, a group of central banks should be able to do the same. Such a network would allow banks from different countries to transact directly with each other in central bank-issued digital currencies, enabling cheaper, faster and safer cross-border transfers.

5.2 NEW MODELS OF PLATFORM CONNECTIVITY

The Ubin V network is designed for open connectivity and ease of integration with third-party platforms, where economic transactions on these platforms are accompanied with payment transactions on the Ubin V network. Tighter integration of the platforms improves the visibility and certainty of transactions, and reduces the need for reconciliation across platforms.

One key concern on such integration is the level of permissions granted to the third-party platforms. In our early iterations in Phase 5, third-party platforms held the private keys of users, enabling the platforms to initiate transactions on their behalf on the Ubin V network. This poses a security risk for users, as the platforms would have full control over their accounts.

Phase 5 explored different models of providing platforms visibility and certainty over the transactions without compromising on security and controls over the user accounts. A few options have since been explored:

1. Funds are moved to single-use accounts at initiation, and the “secret” granting access to the account is released upon fulfilment on the third-party platform. This is conceptually similar to the use of hashed time-locked contracts (HTLCs) for atomic swaps across blockchain networks.
2. Transaction instructions are digitally signed and held with the third-party platform at initiation. Upon fulfilment, the platform uses the pre-signed instructions to initiate payments on the Ubin V network. An analogy would be a pre-signed cheque that is physically held by a third party.
3. Transaction instructions are pushed to a user's wallet, which is essentially a key management service. Upon confirmation by the user, the instructions are digitally signed, and the signed instructions are used to initiate payments on the Ubin V network.

The third model is particularly useful for open access and connectivity, and borrows heavily from concepts used in public blockchains. With the open nature of public blockchain networks, there have been various wallet applications and solutions developed to manage crypto-assets on public blockchain. As many of the crypto-assets are built to common standards, such as ERC-20, the wallets are typically capable of managing multiple crypto-assets issued by different parties.

Blockchain and tokenisation aside, the role of the wallet is primarily an interface to gain access to the different platforms and services to which the user has access. If banks and other platform providers develop their interfaces to a set of common specifications, such wallets could be a single common interface to manage funds, securities and other assets. This would provide users with a much easier way of accessing services by different providers, and improve integration across different platforms.

5.3 PAYMENT AND PROCESS AUTOMATION

Better connectivity and tighter integration of platforms would enable the automation of processes across platforms. As payments are an integral part of most process flows, the ability to initiate payments and verify transaction statuses is important to enabling full end-to-end process automation.

For example, a platform might request that a supplier commence work when notified that payment of a deposit has been received on the payments network, and subsequently initiate payment when goods have been successfully delivered – which would be evidenced by the acceptance of a delivery order or when a goods receipt was generated.

There is also interest in more complex automation with the use of conditional payments, where payments are released upon fulfilment of a set of conditions.

[The Ubin V network enables conditional payments through the use of smart contracts.](#)

While these smart contracts are executed securely and faithfully on the network, they require external inputs to validate whether the conditions have been met. The ability to secure the data from creation to transmission, ensuring that no one can create or tamper with data prior to processing by the smart contracts is still in the early stages of development.

Initially, trusted data is likely to be provided by trusted parties, such as a port authority or a logistics company. IoT devices are another avenue for providing trusted data to enable such automation. A possible use-case would be the use of IoT temperature sensors for temperature-sensitive perishable goods, with discounts automatically applied based on the temperature variation recorded during shipment. Payment, with the updated payment amount, would be released automatically and based on conditions fulfilled, such as endorsement of the bill of lading and the digitally signed temperature data from the IoT device.

Another consideration is where the logic for conditional payments should reside: should it be primarily on the payments platform or on the third-party platform? Having the logic reside on the payments platform would increase certainty and trust on the validation and fulfilment of conditions, but might put additional strain on the payments platform. There is also a security concern as to whether the flexibility of smart contracts could introduce vulnerabilities on the payments network.

This is an exciting area that has significant opportunities for further innovation, and we expect to see further research in the area of smart contract automation.

5.4 ADDITIONAL FUNCTIONALITIES AND RAPID PROTOTYPING

Smart contracts on the Ubin V network have proven to be very useful for prototyping additional functionalities. The flexibility of the smart contract programming language enables most conceivable functionalities to be developed easily. Deployment and usage on the network are also simple, and permit rapid development and testing directly with other participants. Functionalities that have been explored include pull payments or direct debit authorisations, escrow functionalities and payment commitments.

Pull payments essentially involve granting permission to a specific third party to debit or pull funds from the account, subject to a set of conditions. Functionalities for direct debit authorisation exist today, but usually involve simple conditions such as monthly limits. However, using smart contracts could see the account-holder include additional conditions, including internal budgetary and cashflow management requirements, which would provide greater confidence in enabling the use of pull payments. In addition, as pull payments are initiated by the invoice issuer, there is no need to reconcile funds' receipt with the invoice, which could make this a more efficient mode of payments, especially for recurring transactions.

Escrow functionalities developed on Ubin V are based on a multi-signature model. If buyers and sellers agree, they could initiate the disbursement of funds without manual intervention by the escrow agents – who would be needed only to arbitrate in cases of dispute. Automating the larger part of successful transactions would improve operational efficiencies, and allow such services to be provided for less.

Payment commitments are essentially an irrevocable commitment by a party to release a fixed payment amount at a later date. In this manner, they operate like a digital equivalent of a post-dated cheque, which constitutes a commitment to pay on a later date without locking up liquidity in the interim. While simple payments are shifting towards the use of electronic payments, companies still rely on cheques for such purposes as there is no digital alternative. Post-dated cash cheques with no specified payee are sometimes used as a supply chain financing tool, where they can be sold and re-sold at a discount for up-front cash. The Ubin V network is prototyping different models of payment commitments to explore how these can be used to fulfil such business needs.

While the additional functionalities have been prototyped on the Ubin V network, they could be replicated and implemented for wider usage should they be found useful. The Ubin V network is therefore valuable for rapid prototyping, testing and validating additional functionalities before they are considered for implementation on existing payments infrastructure.

The completion of Phase 5 marks the end of Project Ubin, a five-year journey of practical experimentation on blockchain technology with the industry, and understanding how it could be applied to payments and settlements.

It has been a fruitful journey for project participants, and an impactful one for the broader blockchain ecosystem. With six reports published over the five phases, we take pride in our contribution to the global knowledge base, and are pleased to have made a lasting mark on advancing the maturity of the technology and understanding how it could be applied to different use-cases.

Having started as a “garage” project, with a small group of volunteer technologists reusing and recycling hardware resources from other projects, Project Ubin’s accomplishments have exceeded our expectations and its success today bears testament to the commitment of the team. While accomplishments and recognition were crucial for continued management support to allocate time to work on the project, those were never a priority for the people directly involved. Creative discourse and open exchange of ideas were the primary reasons for the active and continued support of the participants.

Project Ubin meetings were opportunities to discuss new and innovative ideas – ideas that could radically change how we view systems design, but that would never be discussed in a business-as-usual environment for that very reason. They were a place to talk about seemingly frivolous ideas and then, through the collective expertise of the many bright minds from different functional areas, develop those ideas into concrete, implementable designs.

Simply put, Project Ubin was driven by passion, innovation and collaboration.

As with all innovation adoption, there is a time for experimentation and prototyping, and a time for commercialisation. The end of blockchain experimentations is a step into the next phase of commercial adoption. Multiple large-scale commercial projects have already gone live in the past year. In areas like trade and supply chain financing, there are already a number of live projects, each transacting in trade documents valued at hundreds of millions of dollars annually.

With a clearer understanding of the benefits and the business value, there will be further commercial adoption and live implementation of the technology for viable use cases.

As the industry gears up towards commercialisation and live projects, the paths of those involved will definitely cross again. Many will be in complementary areas, where there are clear benefits to collaborate. Some will be competitive, working in similar areas, and trying to be the best in their space. Regardless, we will face similar technical challenges in the journey to production, and there will be areas for continued collaboration – interoperability being a key one.

We hope that the spirit of passion, innovation and collaboration that we hold so dear as part of Project Ubin will continue even as the industry move into commercial and production mode. We also hope that open-sharing and collaboration continue too, with the community moving as a group towards a common goal.

—ACKNOWLEDGMENTS—

Project Management Team

Name	Role	Organisation
Toh Wee Kee	Project Director	Monetary Authority of Singapore
Pradyumna Agrawal	Project Director	Temasek
Chen Sijia	Project Manager	Temasek
Kevin Lim	Project Manager	Temasek
James Gan	Project Director	Accenture
Judy Ng	Project Manager	Accenture
Naveen Mallela	Project Director	J.P. Morgan
Akshika Gupta	Project Manager	J.P. Morgan
Debidutta P. Samantaray	Technology Lead	J.P. Morgan

Industry Engagement & Application Team

Name	Role	Organisation
William Lim	Subject Matter Advisor	Accenture
Daniel Ngo	Subject Matter Advisor	Accenture
Venkat Ramaswamy	Subject Matter Advisor	Accenture
Laks Aravamudhan	Subject Matter Advisor	Accenture
Bhushan Kowshik	Subject Matter Advisor	Accenture
Terence Soo	Subject Matter Advisor	Accenture
Wong Juin Nik	Subject Matter Advisor	Accenture
Angeline Tan	Lead Business Analyst	Accenture
Lim Wen Ling	Lead Business Analyst	Accenture
Yvonne Liang	Business Analyst	Accenture
Pearlyn Woon	Business Analyst	Accenture
Dharmendran Subra	Business Analyst	Accenture

Platform Team

Name	Role	Organisation
Shekhar Gahlot	Member	J.P. Morgan
Mark Attard	Member	J.P. Morgan
Louise Long	Member	J.P. Morgan
Raunak Rajpuria	Member	J.P. Morgan
Sumit Sengar	Member	J.P. Morgan
Zhou You	Member	J.P. Morgan

Participating Partners for Use-case Development and Industry Testing

Name	Organisation
Kenneth Kwek	1exchange
Manasa Gutha	1exchange
Vikas Reddy	1exchange
Haritha Malasani	1exchange
Haiping Choo	1exchange
Corey Todaro	Digital Asset
Jon Rout	Digital Asset
Meetanshru Wadhwa	Digital Asset
Yuval Rooz	Digital Asset
Paisal Kiattananan	Digital Ventures
Archariya Sivanart	Digital Ventures
Pawinee Amonnuntarat	Digital Ventures
Jittawat Thanawatcharangkul	Digital Ventures
Jirot Tapananon	Digital Ventures
Jin Ser	STACS
Lim Chuan Ji	STACS

Name	Organisation
Aaron Soh	STACS
Nigel Lam	STACS
Jace Er	STACS
Prateek Dayal	Aqilliz
Edison Lim	Aqilliz
Dave Sandor	Allinfra
Bill Kentrup	Allinfra
Ajay Sawhney	Crediti
Alexander Goulandris	essDOCS
Angela Zhang	essDOCS
Elaine Leong	Sygnum
Roland Schwinn	Sygnum
Bertrand Billon	iLex
John Olesky	IHS Markit
Otbert De Jong	Inmediate
Sathiya Karuppiah	Inmediate
Darius Liu	iSTOX
Danny Toe	iSTOX
Jeffrey Lam	Invictus
Lim Chor Kiang	Invictus
Leon Scott	Marco Polo
Andrew Coles	Marco Polo
Zoey Tong	Octomate
Jonathan Tan	Octomate

Project Partners

We acknowledge and appreciate the continued support from the industry across the five phases of Project Ubin, and for providing their inputs to the report.

Organisation
Association of Banks in Singapore
Bank of America Merrill Lynch
Bank of China
Citi
Credit Suisse
DBS Bank
Industrial and Commercial Bank of China
Hongkong and Shanghai Banking Corporation Limited
Mitsubishi UFJ Financial Group
OCBC Bank
Singapore Exchange
Standard Chartered Bank
United Overseas Bank
ConsenSys
IBM
Microsoft
NETS Solutions
R3

7.1 PROJECT UBIN PHASE (1 – 5)

Project Ubin is a collaborative project with the industry to explore the use of blockchain and distributed ledger technology for the clearing and settlement of payments and securities. The project aims to help MAS and the industry better understand the technology and the potential benefits it may bring through practical experimentation. The eventual goal is to develop simpler-to-use and more efficient alternatives to today's systems, and that are based on central bank-issued digital tokens.

Phase 1

MAS partnered with R3 and a consortium of financial institutions on a proof-of-concept project to conduct inter-bank payments using blockchain technology, and published a report that covered the aspects of the technology best-suited to settlement systems and that detailed the design principles used for the prototype.

Phase 2

MAS and the Association of Banks in Singapore (ABS) led the successful development of software prototypes of three different models for decentralised inter-bank payments and settlements with liquidity savings mechanisms. MAS and ABS released a report describing the prototypes developed and the findings and observations from the project. The source codes and technical documentation were also released for public access under Apache Licence, Version 2.0.

Phase 3: Delivery versus Payment (DvP)

MAS and Singapore Exchange (SGX) collaborated to develop Delivery versus Payment (DvP) capabilities for settlement of tokenised assets across different blockchain platforms, and jointly published an industry report which provides a comprehensive view of automating DvP settlement processes using smart contracts. The report also identified key technology and operational considerations to ensure resilient operations, and defined a market framework that governs post-trade settlement processes such as arbitration.

Phase 4: Cross-border Payment versus Payment (PvP)

The Bank of Canada (BoC), the Bank of England (BoE) and MAS jointly published a report which assessed alternative models that could enhance cross-border payments and settlements. The report examined existing challenges and considered alternative models that could in time result in improvements in speed, cost and transparency for users.

MAS and BoC subsequently linked up their respective experimental domestic payment networks, namely Project Ubin and Project Jasper, and conducted a successful experiment on cross-border and cross-currency payments using central bank digital currencies. MAS and BoC jointly published a report which proposed different design options for cross-border settlement systems.

Phase 5: Enabling Broad Ecosystem Opportunities

The final phase developed the multi-currency payments model described in Phase 4, and conducted connectivity testing with other blockchain applications. Beyond technical experimentation, this phase also aimed to explore and prove the business value of a blockchain-based payments network. The findings from Phase 5 is the subject of this report.

7.2 TECHNICAL DETAILS OF THE UBIN V PAYMENTS NETWORK

Fig 16a: System Flows Solution Schematic – Issue

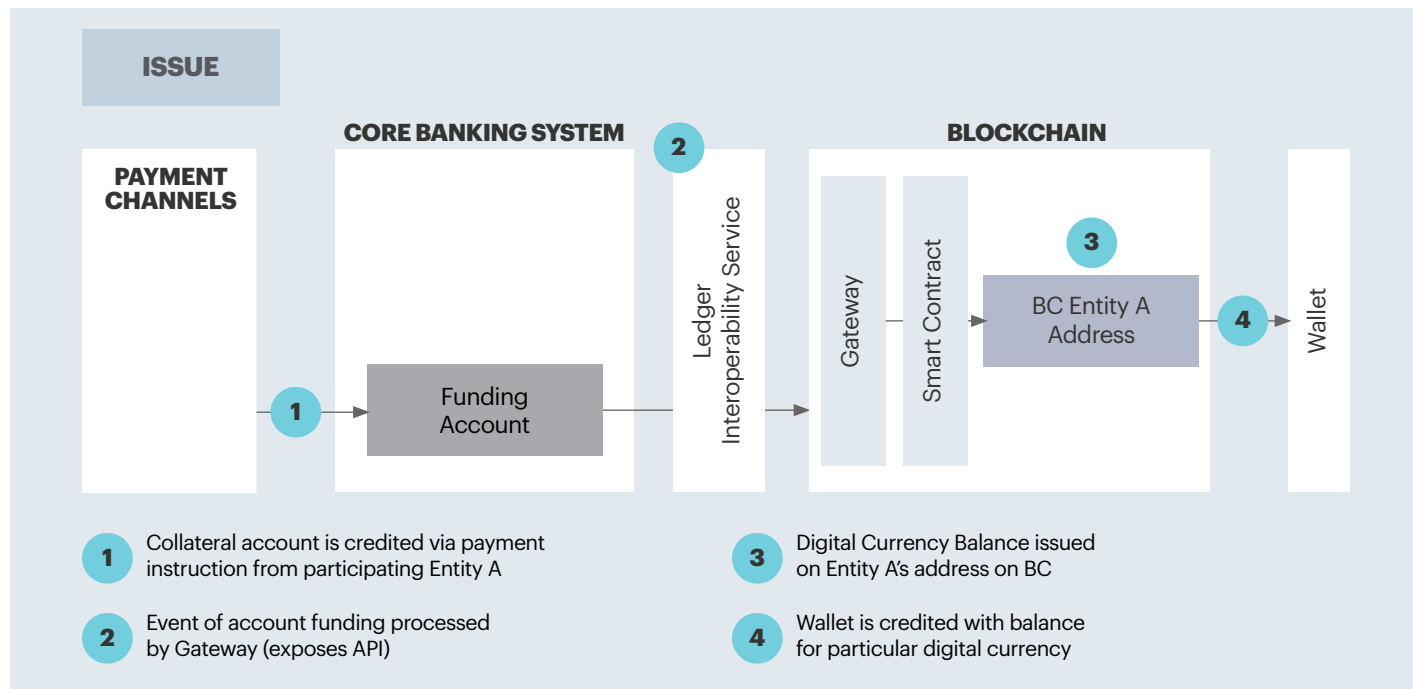
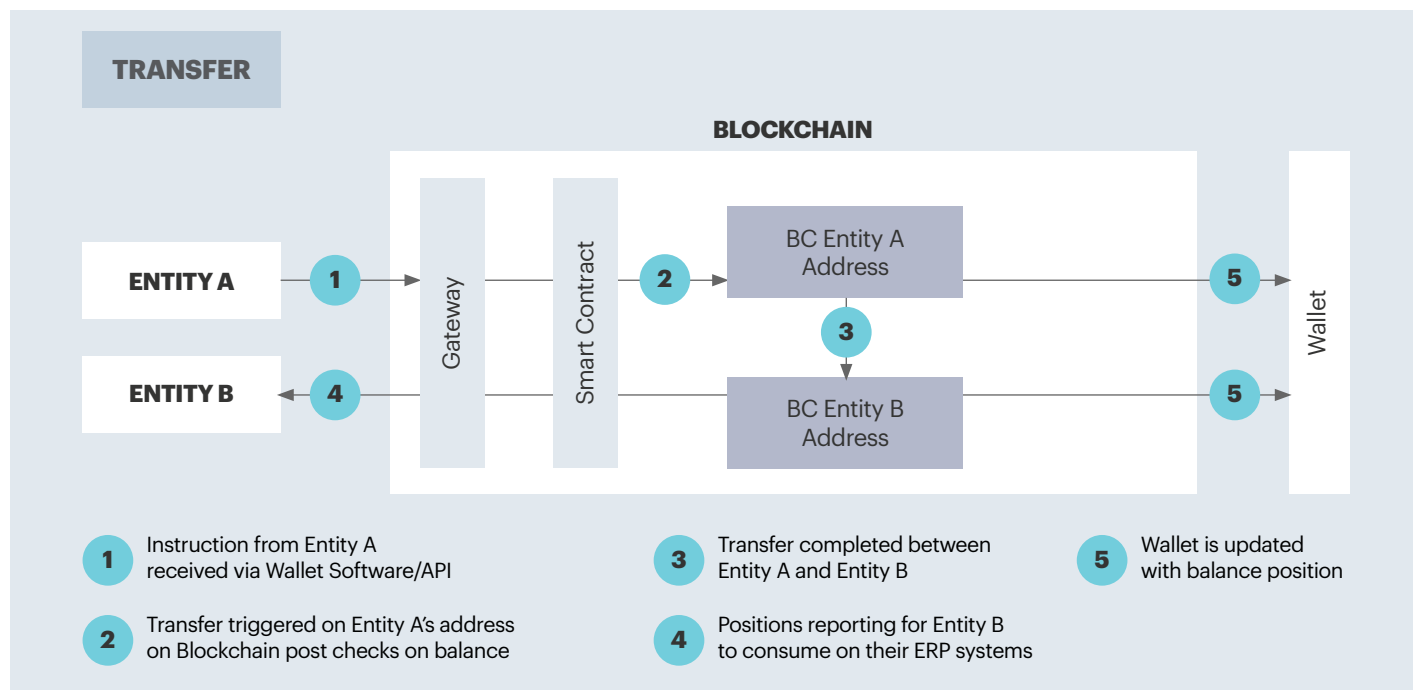
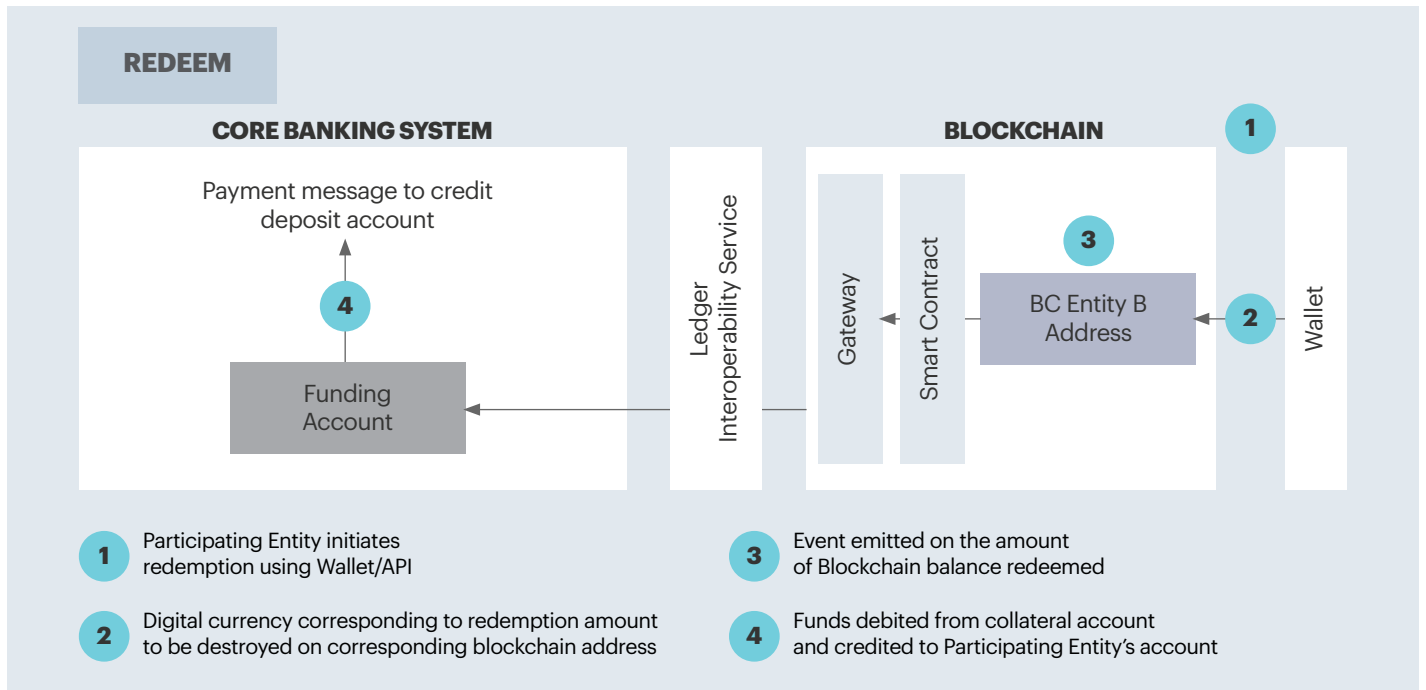


Fig 16b: System Flows Solution Schematic – Transfer



Bank Accounts Coin Accounts

Fig 16c: System Flows Solution Schematic – Redeem



ESCROW SERVICE

The Ubin payments network provides an escrow service that enables a smart contract to hold funds while a transaction is completed on the delivery network. The escrow model is an M of N MultiSig model that requires a majority of keys to authorise a payment transaction. For example, in a 2 of 3 MultiSig model, two keys are required to authorise a payment transaction, rather than a single signature from one key.

In an ideal scenario, only two transacting parties are required to complete a transaction, with no need for intervention by a third-party. However, in case of a dispute, a third-party escrow agent can step in to resolve the dispute off-chain and complete the transaction on-chain.

The diagram on the right is an illustration of a typical use case for a 2 of 3 MultiSig escrow payment.

It illustrates the following sample flow:

- Buyer initiates an escrow transaction by specifying three signing parties and the amount to be transferred.
- The Ubin payments network dynamically creates a MultiSig address and locks the funds at that address.
- Once seller sights the funds, it completes the delivery on the delivery network and signs the escrow transaction on the Ubin payments network. The smart contract evaluates the signature condition to 1 of 3 – funds are not released.
- Once buyer is satisfied with the delivery, the buyer signs the escrow transaction on the Ubin payments network. With 2 of 3 signatures received, funds are released to seller.
- Any party can raise a dispute via an exposed API or wallet interface at any point of time before the transaction is completed. Dispute requests are assigned to a third-party escrow agent, who will resolve the dispute and sign the transaction accordingly.

To cater to various use cases, slight adjustments may be made to the model. One example is to include a trustee that performs transactions on behalf of the seller.

Fig 17a: Sequence diagram for a typical escrow use case

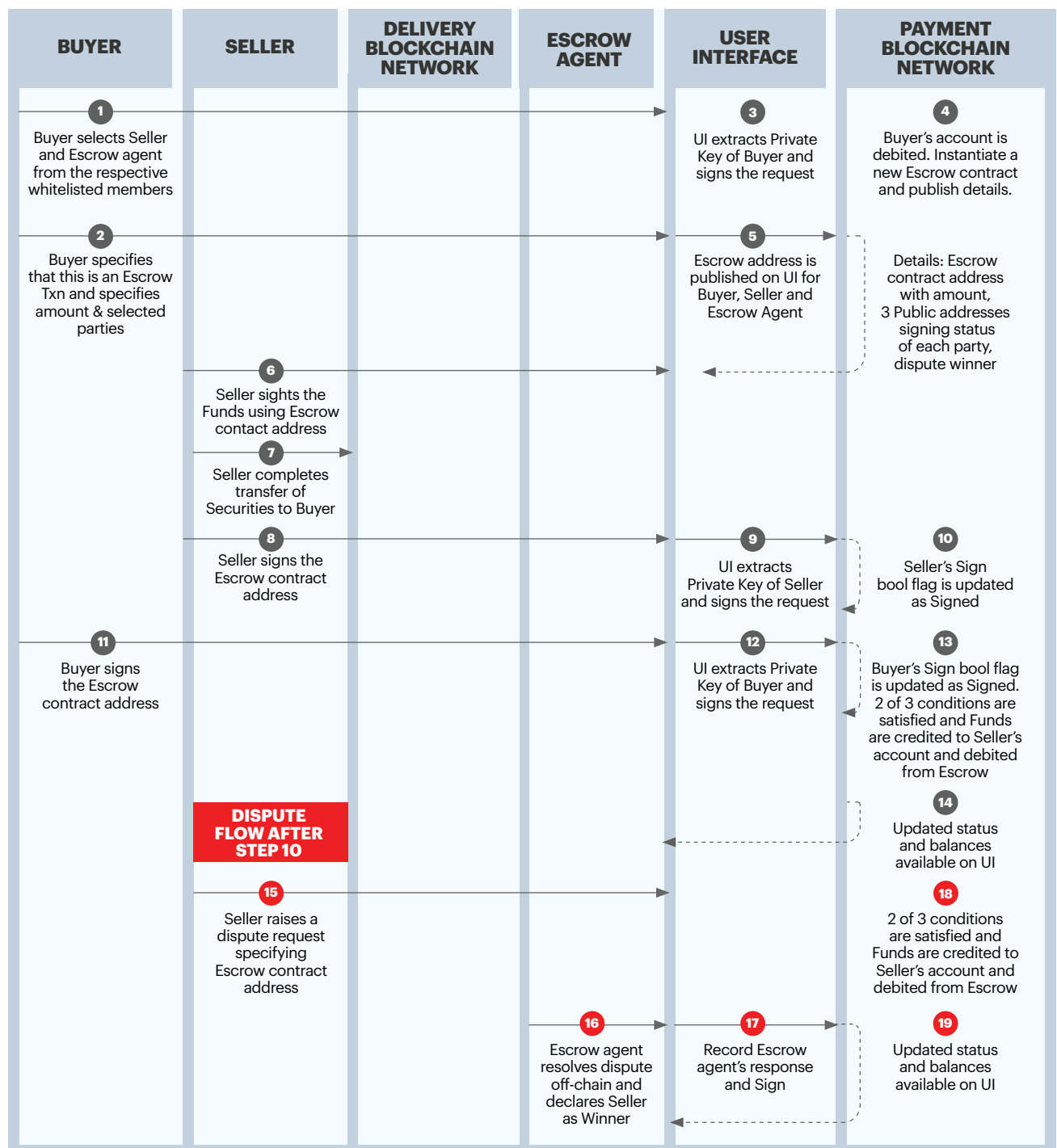
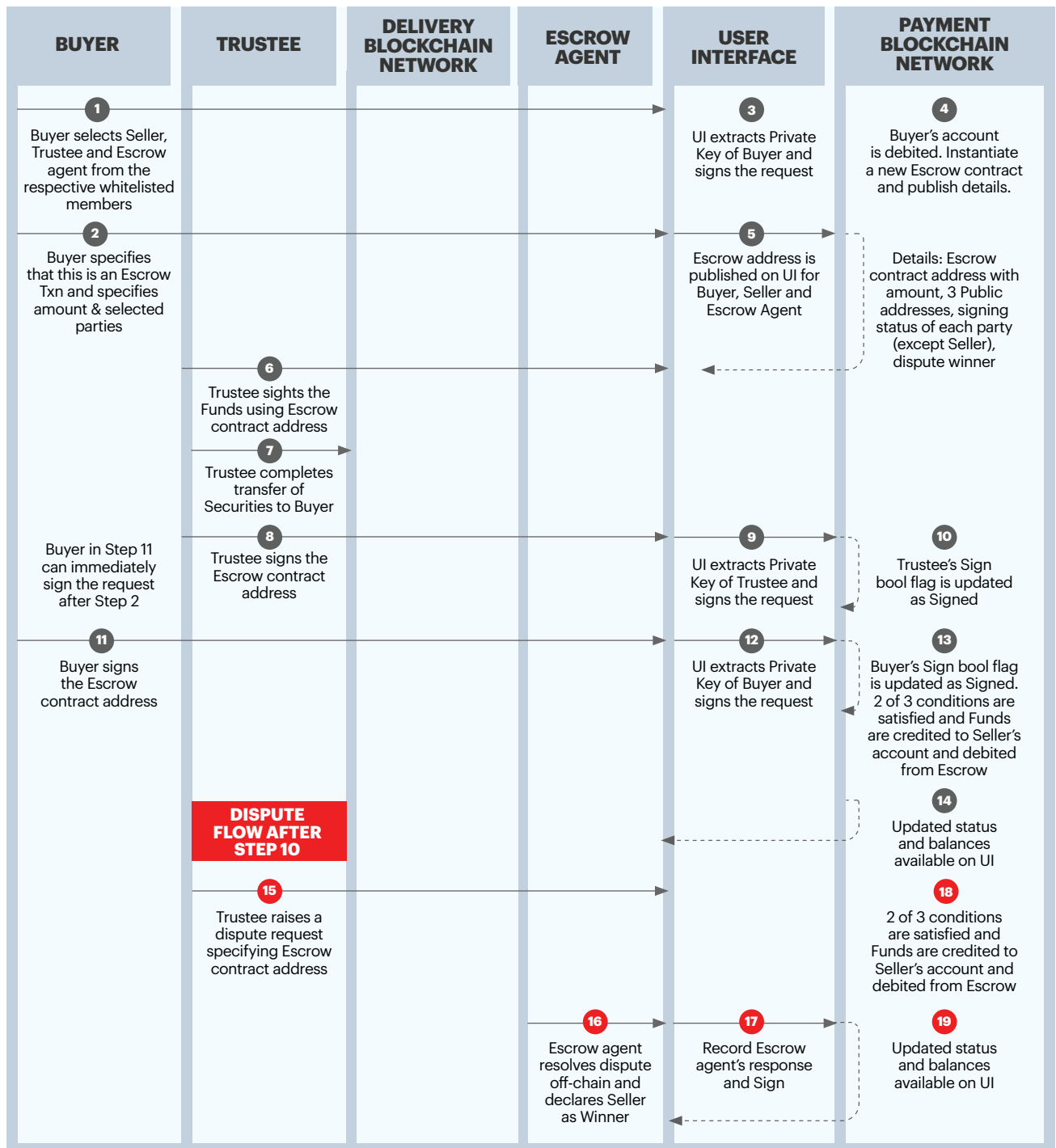


Fig 17b: 2 of 3 MultiSig model – Trustee



API DETAILS

The following Application Program Interfaces (APIs) were developed to facilitate the interactions between external systems and the Ubin payments network.

TRANSFER.INIT: This message is used to initiate a transfer of tokens between two accounts on the blockchain.

TRANSFER.NOTIFY: This message is used to notify the client systems regarding a token transfer event. The message is sent by the payments network when the token transfer is committed on the blockchain.

BALANCE.ENQUIRY: This message is used to retrieve the current coin balance for the address specified in the request.

BALANCE.NOTIFY: This message is used to provide the current coin balance for the address and currency specified in the corresponding request message.

TRANSACTION.ENQUIRY: This message is used to retrieve the transaction history for the address specified in the request.

TRANSACTION.NOTIFY: This message is used to provide the transaction history for the address and currency specified in the corresponding request message.

ESCROW.INIT: This message is used to initiate a new escrow transaction between the sender and receiver addresses. Based on this message, the specified amount will be locked in an escrow account.

ESCROW.SIGN: This message is used to sign an escrow transaction with a particular action. Based on this message, participants will indicate that they agree to release or revert or dispute this escrow transaction.

ESCROW.ENQUIRY: This message is to enquire regarding the status of an escrow transaction that has previously been initiated or released or reverted or disputed.

ESCROW.NOTIFY: This message is used to notify the external systems regarding the status and details of an escrow transaction based on the escrow ID provided in the corresponding request message. This message is sent for each escrow action message sent by the participants.

Details of the APIs can be referenced in Github²¹.

²¹ <https://github.com/project-ubin>

About Accenture

Accenture is a leading global professional services company, providing a broad range of services and solutions in strategy, consulting, digital, technology and operations. Combining unmatched experience and specialized skills across more than 40 industries and all business functions — underpinned by the world's largest delivery network — Accenture works at the intersection of business and technology to help clients improve their performance and create sustainable value for their stakeholders.

With 509,000 people serving clients in more than 120 countries, Accenture drives innovation to improve the way the world works and lives.

Visit us at www.accenture.com

This report is prepared and issued by MAS, Temasek, J.P. Morgan and Accenture. All intellectual property rights in or associated with this report remain vested in MAS, Temasek, J.P. Morgan, Accenture and/or their licensors. This report and its contents are not intended as legal, regulatory, financial, investment, business, or tax advice, and should not be acted on as such. Whilst care and attention has been exercised in the preparation of this report, MAS, Temasek, J.P. Morgan and Accenture do not accept responsibility for any inaccuracy or error in, or any inaction or action taken in reliance on, the information contained or referenced in this report. This report is provided as-is without representation or warranty of any kind. All representations or warranties whether express or implied by statute, law or otherwise are hereby disclaimed.

Copyright © 2020 Accenture. All rights reserved.
Accenture and its logo are trademarks of Accenture.