BIS Innovation Hub

Hong Kong Centre

Project Genesis – Report 3

A prototype for green bond tokenisation by Digital Asset and GFT

November 2021

HONG KONG MONETARY AUTHORITY
香 港 金 融 管 理 局

Table of Contents

In collaboration with:

With support of:

Abstract

In many countries, issuing and investing in bonds can be cumbersome and complex, involving numerous steps and parties, and typically requiring a considerable financial commitment from the investor. For those investing in environmentally friendly projects, there is uncertainty about whether the bond issuer is delivering the positive green impact it committed to at issuance. Also, there are typically no liquid and transparent secondary markets for retail investors. Genesis, the BIS Innovation Hub's first green finance project, explores the green art of the possible through combining blockchain, smart contracts, internet-of-things, and digital assets. Together with six partners, the project achieved two prototypes that bring to life the vision that an investor can download an app and invest any amount into safe government bonds, which will develop a green project; over the bond's lifetime, the investor can not only see accrued interest, but also track in real time how much clean energy is being generated, and the consequent reduction in CO_2 emissions linked to the investment; further, the investor can sell the bonds in a transparent market. The present report shows the technical infrastructure of the prototype created by Digital Assets. This report was drafted with the technical inputs of Digital asset and GFT. As such, the views given in this report are not necessarily those of the BIS or the HKMA. The present report is a sister report to Project Genesis – Report 1 "A vision for technology-driven green finance".

Executive Summary

With an influx of green bond programs aiming to support global climate initiatives, businesses require a more transparent model for communicating the delivery of ESG covenants to regulatory bodies and investors.[1] Genesis, the BIS Innovation Hub's first green finance project in collaboration with the Hong Kong Monetary Authority (HKMA), was created to explore the use of novel technology to improve efficiencies in the distribution of green bonds, as well as to facilitate more insightful reporting on the environmental impact of green bond proceeds. Conceptually, such efficient distribution and enhanced reporting will not only ensure greater transparency for green bond initiatives, but also improves public participation and engagement with green businesses.[2] The present report shows the prototype produced by Digital Asset[3] in partnership with GFT[4] (referred to as the Daml prototype or the prototype).

The Daml prototype seeks to accomplish the following goals:

1. Bring greater efficiency and transparency across the end-to-end bond issuance and lifecycle workflow.

2. Ensure licensed institutions can comply with current regulation schemes.

3. Create a reference Utility for the design and implementation of a production-grade system used in the Hong Kong green bond issuance process.

4. Increase transparency and ensure delivery of ESG covenants to better showcase green impact through the combination of blockchain, smart contracts, and the Internet of Things (IoT).

The goals set out by Project Genesis were achieved through an innovative approach to the underlying infrastructure, application framework, and overall implementation which this paper outlines in detail. At a high level, the Daml prototype uses enterprise deployments of Hyperledger Fabric and Hyperledger Besu.

The prototype provides ledger optionality through an interoperability protocol that enables the communication between applications running on a Fabric or Besu network. This interoperable solution enables participants to streamline interconnected workflows while improving real-time data sharing and system reconciliation through a shared system of record that hosts permissioned data across all stakeholders. The prototype uses an instance of Digital Asset's multi-party application platform and smart contract language – Daml[5], Digital Asset's open-source Finance Library, and Digital Asset's cross-chain interoperability protocol.

In concept, the Daml prototype involves multiple entities for the issuance, depository, data feed, and actual utility/ investor interface to concept test a government issued tokenised green bond to retail investors in Hong Kong. The HKMA is the representative of the HKSAR Government in implementing green bond issuances, while the Hong Kong Stock Exchange (HKEX) is one of the channels of secondary trading of retail government bonds. The Green Bond Application (the Utility) developed by Digital Asset and GFT provides an API to enable third-party applications and data providers to seamlessly integrate with the HKMA and HKEX workflows. Allinfra, a green data provider, operates its own network and sends a real-time data feed to the Utility via the API.

---

[1] See Section 2 of the sister report Project Genesis – Report 1 "A vision for technology-driven green finance"

[2] See https://www.bis.org/about/bisih/topics/green_finance/green_bonds.htm and https://www.bis.org/press/p210824.htm.

[3] See https://www.digitalasset.com.

[4] See https://www.gft.com.

[5] Daml is Digital Asset's core technology platform for building multi-party applications. Daml allows tokenization of any asset class, automation of complex workflows, and frees businesses from legacy technology silos. With Daml, organizations can create a virtual, shared system of record for digital assets to cross data and stakeholder boundaries and can build applications that remain in sync where entitled participants have access to reliable, real-time information and transaction status at all times.

Highlights of the Daml prototype for Project Genesis or similar issuances:

- Simulates a fully tokenised bond lifecycle through its preparation, subscription, settlement, secondary trading and corporate action management on a Daml smart contract enabled DLT platform.

- Digitises the preparation phase of the Retail Green Bond tokenization and origination process by giving access to all stakeholders to interact with the standardised and highly automated workflows.

- Synchronises the retail investors' (Retail Investor(s)) bond subscription records across placing institutions and the debt securities clearing and settlement system (Central Moneymarkets Unit, CMU) by automatically conducting subscription duplication and correctness checks on retail investor orders, and by eliminating the subscription failure rate which is currently at 0.5%.

- Reduces the overall bond issuance and settlement timeline by eliminating manual reconciliation steps during the subscription and closing period, and introduces the ability to maximise subscription amounts for the Retail Investor so no pre-funding of the bond purchase is required.

- Harmonises the subscription records among the HKMA network participants including CMU as the depository, arranger(s) who manage the underwriting of the government bond, and the placing institutions. This replaces traditional operations that use email for updates across the reporting line while enabling all parties to have real-time visibility of their subscription portion during the bookbuilding period.

- Provides real-time updates to the ultimate beneficial ownership of the government bond across all HKMA and HKEX network members, allowing each participant to access a "golden source of truth," to potentially shorten transaction times from T+2 to T, and eliminate settlement failure.

- Allows for traditional, fiat-based settlement, as well as atomic delivery versus payment (DvP) settlement by using native, on-ledger payment modes[6], e.g. stablecoins to eliminate counterparty risk and increase settlement efficiency.

- Enables Retail Investors to access green impact data via the prototype with verifiable data provided in real-time by Allinfra.

- Integrates with other service and data providers, e.g. Octopus App for conveniently checking green bond token balance.

This research report introduces Project Genesis and the prototype in four sections:

1. The first part of the report provides an overview of the Daml prototype describing the key functions of Digital Asset and GFT's design of a DLT-based securities issuance, lifecycle and trading infrastructure.

2. The second part of the report explains the benefits realised from each major workflow step, including bond origination and issuance, subscription, allocation, payment, secondary trading, lifecycle management, and green impact. This section also outlines how each stakeholder can potentially reduce cost, risk, and improve overall efficiency.

3. The third section addresses the technical and architectural aspects of the project, providing answers to how interoperability is realised across multiple platforms with guarantees of privacy and synchronization to ensure each stakeholder's ledger is in a valid state.

---

[6] Subject to regulations in respective jurisdictions.

1. Overview

1.1. Objectives

Unlike other digital bond proof of concepts (POCs), the prototype deploys multiple technologies and extends the access directly to Retail Investors. While some DLT-based bond issuance prototypes focus on institutional adoption among investment banks, there are few initiatives where a Retail Investor can join market stakeholders in the retail bond workflow. While the inclusion of Retail Investors introduces a new layer of complexity, it also showcases how smart contracts and distributed ledger technologies (DLT) can streamline and bring efficiency to such a complex multi-party workflow. Through Project Genesis, Digital Asset and GFT developed a unique Utility (commonly referred to as the Retail Green Bond Application) which aims to bring awareness on the importance of green bonds and sustainable development goals (SDG) investing to the Hong Kong public.

Special to Hong Kong, government bond subscriptions can be done via banks and brokerages that act as placing institutions (Placing Institutions, Placing Banks and Brokers). While Placing Banks have their accounts with CMU – the debt securities clearing and settlement system in Hong Kong, brokerage houses are aggregated and registered under the Hong Kong Securities Clearing Company Limited's (HKSCC) account within CMU. The legal ownership of retail bonds is registered in the name of the Placing Banks or the HKSCC's account at the CMU, while the beneficiary interest is registered by the Placing Institutions on behalf of the Retail Investor. The Daml prototype strictly adheres to the legal requirements and market regulations associated with these processes, and automates the end-to-end settlement between these various accounts. Prior to the prototype, no technology offered this end-to-end settlement automation and required significant reconciliation between the siloed systems.

In addition to workflow optimization, the prototype concept tested a government bond financing green projects and enhancing the reporting of its green impact. This real-time reporting is accomplished through a direct API-based data stream (powered by Daml) with an IoT powered green data provider (Allinfra) to a distributed network (Hyperledger Besu and Hyperledger Fabric). Through the prototype, Retail Investors can invest in green bonds to finance government green projects and access the real-time impact of those projects (e.g. anti-pollution initiatives, clean energy projects, and more), if compatible hardware devices or sensors are installed.

To ensure the Project Genesis prototype meets all strategic and legal expectations, Digital Asset and GFT have worked along the following principles:

- **Employ blockchain, Daml smart contracts, and state of the art technologies**
  By using Daml smart contracts, blockchain, and IoT, the Daml prototype brings real-time data visibility, automated workflows, and creates a single source of immutable truth across the entire green bond lifecycle.

- **Increase privacy protection while enabling seamless multi-party communication**
  The Digital Asset and GFT team deployed their prototype networks on two enterprise blockchain platforms: Hyperledger Fabric and Hyperledger Besu. Leveraging Digital Asset's interoperability protocol, the Daml prototype has achieved real-time synchronization across these two ledgers while preserving the level of privacy demanded by regulated bodies.

- **Leverage multiple payment rails**
  Project Genesis explored payment through two channels:

  ◊ *Traditional, fiat payment rails:* The prototype initially only planned to integrate with Hong Kong's traditional fiat payment systems. For the Placing Banks, this means the real-time gross settlement system (RTGS). For Retail Investors, the prototype also demonstrates the possible use of the Hong Kong Faster Payment System (FPS) directly through the Utility's (i.e. the Green Bond Application) mobile interface.
  ◊ *On-chain, stablecoin payment rails:* To future-proof for settlement on-chain, Digital Asset and GFT explored stablecoins (extensible to CBDC) to prepare for a truly tokenised future, not only on the asset leg but also for the payment gateway.

1.2. Scope and project approaches for Project Genesis

The current bond issuance process is fragmented and involves complex multi-party workflows. For example, HSBC has identified in other studies 2,500 steps across the stages of a bond issuance workflow.[7] Inefficiencies are present in all phases of the bond lifecycle because stakeholders lack a single source of data, non-standardised and paper-based processes, and little to no automation. For example, during the subscription period of retail government bonds in Hong Kong, Placing Institution(s) receive applications from retail investors via e-banking system and paper-based forms, which require manual data cleansing and data aggregation before passing to the Issuer. Manually handling of application information involves reconciliation costs, opens up processes for manual errors, and prevents real-time visibility and data processing.

The prototype for Project Genesis uses the following approaches to address these issues experienced along the bond issuance lifecycle, taking the retail green bond issuance process in Hong Kong as an example:

Approach 1: Utilizing Daml smart contracts and distributed ledger technology

Today, manual processes and siloed systems serve the purpose of maintaining private and commercially sensitive information from the various players involved in the issuance, trading, and overall lifecycle of green bonds. This results in a highly fragmented and reconciliation intensive process between all stakeholders, including issuers, placing institutions, and government bodies.

With the prototype, Daml smart contracts create a standardised representation of tokenised assets as well as model and automate the lifecycle of such assets.

Daml is a purpose-built, functional language specialised in describing composable, distributed business workflows. Smart contracts running on a blockchain network allow multiple parties to have shared business processes that can be standardised and automated. The blockchain network enforces these business processes, significantly reducing risk, and creating value for the entire multi-party network.

Using the attributes of distributed ledger technology, the bond issuance, subscription process, and associated lifecycle events were modelled from bond creation to maturity across stakeholders including investors, placing institutions, issuers and green data providers. Critical functionality is retained but improved through the following features:

- Market rules and processing rules are embedded, allowing every step to be validated in an observable and auditable format.

- The legal terms of real-world agreements are encoded and preserved in Daml smart contracts which clearly define the roles, rights, and obligations of all stakeholders interacting across the workflow.

- Privacy and data segregation are strictly enforced via Daml's need-to-know data model enforced via the smart contract coding framework and the integration with the underlying, cryptographically protected blockchain platform.

- Settlement takes place simultaneously across the entire holding chain, improving asset mobility while removing counterparty risk from the process.

---

[7] See https://www.business.hsbc.com.sg/en-sg/insights/innovation-and-transformation/fixed-income-digital-assets-unpacking-digital-bond-issuance

By leveraging Daml's multi-party application platform and smart contract language along with two separate distributed ledgers (i.e. Hyperledger Besu and Hyperledger Fabric), the Daml prototype drives market efficiency with a unified view of the entire trade lifecycle and a single source of truth that automates market rules and adheres to market regulations. The ability to complete multiple actions concurrently improves operational efficiency and minimises fails and disputes.
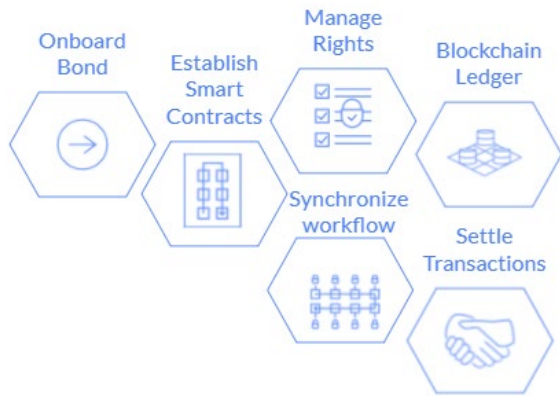

Figure 1.1: Bond Onboarding with Smart Contracts

Approach 2: Composable interoperability

Current infrastructure and market practices require complete trust in the central operator to validate transactions, offer finality, and distribute the right information to the correct party, such as the proper rights and obligations outlined for each party. For example, a post-trade architecture needs to guarantee a shared state across all members in real-time without revealing information that should remain private to a particular entity.

Contrary to current infrastructure with a single point of failure, the Daml prototype leverages Digital Asset's interoperability protocol to create an interoperable network of domains, deployed to two separate blockchain platforms: Hyperledger Fabric and Hyperledger Besu. To avoid having a single operator responsible for the entire end-to-end workflow and to host all participants, this interoperability protocol allows for the creation of interconnected, yet distinguished, permission-based domains.

In the prototype:

- The HKMA governs the rules of bond issuance and depository. The HKMA is also one of the operators of the Hyperledger Fabric domain.

- The HKEX sets the rules of secondary trading and provides finality to transactions that take place on the exchange, and acts as the operator of the Hyperledger Besu domain.

- Each domain operator hosts multiple participant nodes that enforce need-to-know data visibility, while also ensuring physical data segregation between participants.

Role	Example in this Prototype
Issuer	HKMA
Placing Institution 1	HSBC
Placing Institution 2	Standard Chartered
Stock Exchange	HKEX
Green Data Provider	Allinfra
Widely used App	Octopus

Figure 1.2: Example of an overlapping interconnected network

This design strengthens market participant adoption, as each market participant can maintain their own logical and physical data segregation. Market participants also benefit from having shared, automated workflows and a single source of truth at the infrastructure level.

The prototype for Project Genesis enforces these privacy settings by consistently segregating data between parties and controlling data access based on defined data rights across multiple DLT networks through Digital Asset's interoperability protocol.

How was the prototype able to strengthen data privacy?

Digital Asset's interoperability protocol was designed so participant nodes could join one or many domains depending on the workflow.

This protects privacy, commercially sensitive information/relationships, and enables multiple sources of truth while gaining the benefits of distributed STP.

Table 1.0: High-level comparison of privacy-preserving features among various blockchain systems[8]

	Public Blockchain	Enterprise Blockchain	Digital Asset Interoperability Protocol
Pro	Transaction ordering guaranteed on-ledger Distributed STP through smart contracts Improved network participation	Privacy between participants Flexibility to support specific network and product requirements Performance optimizations	Interconnected permissioned domains that align with how business is done today Supports many network architectures
Con	Performance and efficiency constraints Ledger and meta-transaction details available to all network participants[9] Data locality concerns	Operators/committer nodes see all transaction details Requires ecosystem bootstrapping	

---

8 See more detail in the annex.

9 This does not apply to participants' personal identity data. These are not publicly visible.

Approach 3: Multiple payment rails

The Green Bond Application (commonly referred to as the Utility) made possible by the Daml prototype was designed to provide flexible payment options for Retail Investors while allowing for settlement via traditional payment methods as well as other on-ledger payment modes like stablecoins.

- **Traditional, fiat payment rails with value-added innovation:**
  Retail Investors have the option to pay for retail green bonds via the Hong Kong Faster Payment System by connecting their traditional bank accounts and setting up electronic direct debit authorization (eDDA) in the Utility. Placing Banks will settle the allocated amount through the real-time gross settlement system.

- **Novel, on-ledger payment rails, such as stablecoins:**
  Investors can also select their on-ledger stablecoin fiat or stablecoin account to bypass off-ledger payment rails and leverage atomic settlement features.

Approach 4: Integration via the Daml Ledger API

A key principle and expectation of the Green Bond Application (Daml prototype) was to allow for dynamic extension of existing network participants and to allow extension for new network participants. By leveraging the Daml Ledger API, third-party service providers can easily and seamlessly integrate with the Utility:

- **Allinfra integration:** Allinfra connects to the Utility and provides asset performance details to green bond holders over the life of the instrument, increasing transparency while providing greater detail on the use of green bond proceeds and green impact of the underlying initiative.

- **Octopus App integration:** The Daml prototype and Octopus Cards Limited partnered to conceptually demonstrate features in the Octopus App that connect Octopus users to the Green Bond Application utility and underlying blockchain infrastructure. Since most of the Hong Kong population uses the Octopus App for small value payments, there is significant opportunity to facilitate exposure of Retail Investors to increase green investing. Through these features, Retail Investors can check their bond value and the green efforts directly from the Octopus App anywhere anytime.

- **Real-time KYC verification (Jumio):** The prototype also adopted commonly used know your customer (KYC) systems such as Jumio, and can also provide simulated integration with iAM Smart[10]for authentication. A major goal for Project Genesis is to ease Retail Investor onboarding while increasing transparency and ensuring compliance.

---

[10] See more about iAM Smart on https://www.iamsmart.gov.hk/en/.

2. Functional Scope and Process Design

2.1. Key stakeholders

The following list identifies expert panel members[11] and other stakeholders involved in Project Genesis and the associated benefits for them:

- **Central securities depository (CSD):** The Daml prototype eliminates the reconciliation need of HKIDs and automatically prevents duplicative applications. Allocation is also ensured via a built-in fair mechanism.

- **Legal Counsel:** The prototype provides efficient term sheet generation for workflows between the legal counsel, issuers, and arranger(s).

- **Arranger(s):** The Utility created by the Project Genesis initiative reduces the workload to aggregate subscription amounts from Placing Institutions.

- **Beneficial Owners – Investors:** Retail Investors have real-time visibility of beneficiary interests from the source of truth (underlying blockchain) and experience atomic DvP transactions without the need of locked cash for settlement (no loss of interest). In addition, Retail Investors also enjoy an investment of smaller denominations (HKD 100), better access to the secondary market and traceability of green impact data in real-time.

- **Stock Exchange:** The Utility enables better access to support trading between banks and brokers.

- **Placing Banks/Brokers:** The Utility also reduces the workload to manage bond ownership records among the Placing Banks and Brokers.

- **Green Companion – Octopus App:** The retail green bond application brings green bond tokens closer to Hong Kong citizens by displaying green digital assets and green efforts in the Octopus App.

- **Green Data Provider – Allinfra:** The Utility integrates with the green data provider, providing transparent green data at the project level which can be viewed by all ecosystem participants.

Stakeholders are granted real-time visibility into the bond registry and beneficiary interest on a need to know and permission basis. This feature enables atomic DvP settlement which enhances efficiency for both closing and secondary trading phases in a compliant manner. The ability to settle currency using traditional payment rails or directly on-chain is another innovative approach that ensures greater liquidity for the placing banks as well as greater investment opportunity and participation from Retail Investors. Finally, the built-in privacy and interoperability made possible by Daml guarantees that beneficiary interest is shared only on a need-to-know basis.

---

[11] See https://www.bis.org/about/bisih/topics/green_finance/green_bonds.htm.

2.2. Functional scope

The Daml prototype showcases the following functionalities:

1. **Retail Investor direct access:** Retail Investors can invest with as little as HKD 100 (approximately USD 13) through a dedicated Retail Investor mobile application (not the Octopus App). The Daml-driven permissioned blockchain network streamlines the workflows and reduces issuance and transaction costs for green bonds. This increases Retail Investor participation in financing green projects. Driving down costs will be critical for increasing market demand for provable green investment products.

2. **Traditional and on-ledger stablecoin payments:** Digital Asset and GFT designed workflows that support both traditional payment options as well as stablecoins. With the traditional fiat-based approach, the prototype demonstrates the value of building a Daml smart contract layer on top of the existing infrastructure adopted by financial institutions. The goal of leveraging Daml across current infrastructure deployments is to enable rapid adoption of the Green Bond Application as well as include settlement options via stablecoins with extensibility to CBDC.

3. **Tokenised secondary market trading:** The prototype models the complete lifecycle of the tokenised retail government green bond, which helps stakeholders realise the end-to-end benefits. The project uses Digital Asset's open-source Finance Library which helps organizations bootstrap their digital asset journey and use standardised elements from the Finance Library such as the Secondary Trading marketplace workflow.

4. **Streamlined corporate action workflows:** Past attempts to tokenise bonds usually neglected to consider the risk of default. Daml does not self-execute and requires issuers to allocate funds to the payment account as well as approve pay-outs. This is a highly pragmatic approach for eliminating default risk amongst tokenised bonds.

5. **Real-time tracking of actual/estimated green impact of capital markets products:** As the nascent area of investment in provable green initiatives continues to grow, businesses will also see demand for transparency and auditability increase. Due to the native strengths of blockchain and Daml as well as following the examples set by BIS through Project Genesis, industry participants have several opportunities to lead global change in the technologies defining green claim trust and credibility.

2.3. Detailed retail green bond issuance and lifecycle workflow design

2.3.1. Issuance preparation: bond tokenization and origination

The current bond preparation and origination process is cumbersome, yet ripe for innovation. Each time data flows from one entity to another, e.g. through the agreement of term sheets, the book building of investor subscription, or the bond registration at the central depository, data is re-entered and workflows are constantly repeated. These highly manual, paper-based processes lead to small corrections that require multiple reviews and constant reconciliation among participants. The entire origination phase can take one to two months to finalise. These manual processes along with a lack of standardization increases the costs of bond issuance.

The Daml prototype improves the bond origination process by:

- Creating a standardised, reusable bond term sheet that is captured in the Daml layer, increasing processing efficiency and speed.

- Providing a flexible, customizable tokenised asset template that can be used for different variation of bonds and tokenised assets.

- Involving the experience of key stakeholders in the process, i.e. the issuer, legal counsels, and arranger(s) to provide highly automated workflows where participants can follow in real-time the actual state of the bond preparation and origination.

- A digitised, immutable audit trail of all actions taken during the preparation phase.

- A registry for tokenised bonds and all future tokenised assets.

The following steps outline how the Daml prototype streamlines the bond preparation steps:

- The issuer fills out a digital, simplified retail green bond term sheet and selects arranger(s).

- The issuer finalises the term sheet. Then the legal counsel and arranger(s) are notified in real-time, and review/approve the term sheet on their platform operating across the DLT network.

- An ISIN is assigned to the retail green bond, and the bond to be issued to the Retail Investors is tokenised via the Utility.

- Data providers (AllInfra) can be notified in real-time of the newly issued green bonds such that a green data stream can be prepared for ongoing reporting and verification of the project.
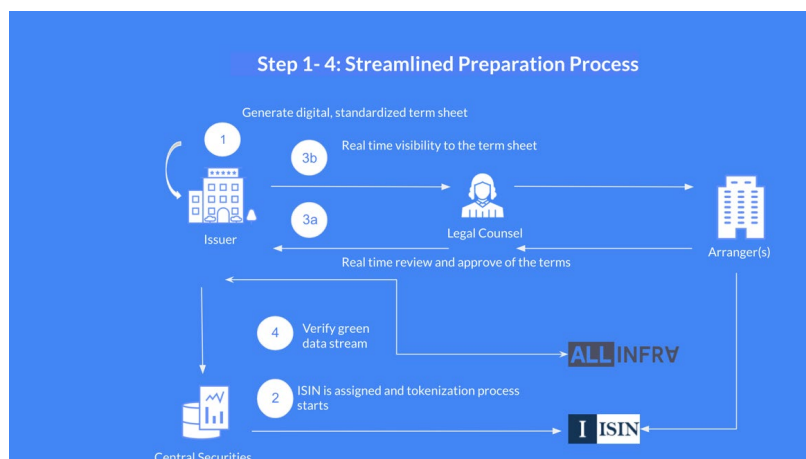

Figure 2.1: How smart contracts streamline the bond preparation process

2.3.2. Subscription and allocation

The subscription and allocation period are the most reconciliation intense phase of the bond lifecycle. By using Daml smart contracts, the prototype brings significant benefits and process improvements to this phase, while adding additional functionality such as:

- Setting a minimum and maximum order quantity for the Retail Investor.

- Creating a permission-based, straight-through-processing (STP) subscription order from the Retail Investors all the way back to the issuer.

- Preventing the possibility of duplicative orders.

- Performing bond allocation at the Placing Institutions as well as with the Retail Investors in a fully automated way.

- Maintaining the transparency and fairness of the allocation logic.

Main issues of the current retail government bonds subscription process that Project Genesis aims to address:

- During the subscription period, the Placing Institution aggregates applications, conducts data cleansing, summarises application, and uses the appropriate form to update issuer, the HKMA in the context of Hong Kong retail government green bonds. Due to the highly manual nature of this process, the Placing Institutions are exposed to the risk of human error and do not provide ample visibility to the issuer (which DLT can provide).

- Compared to corporate issuance, retail government bond allocation in Hong Kong requires a higher level of fairness. However, duplicate applications do exist. It is estimated that the subscription rejection rate stands at 0.5% during the latest inflation-linked government bond issuance in Hong Kong. This is attributed to no direct access to a single subscriber source list that could stop duplicate subscriptions.

The Daml prototype eliminates issues outlined above as well as automates processes while maintaining fairness and transparency of the bond allocation process. The following workflow steps demonstrate how the prototype improves the subscription and allocation process**:**

1. The issuer finalises bond parameters (maximum order size, coupon, etc.) with the arranger(s) and initiates the subscription phase. Real-time notifications are sent simultaneously to all participants entitled to receive them.

2. Then the Retail Investors study the bond term sheet, submit their order with the Placing Institutions and select their payment method: traditional, fiat (via FPS) or, subject to regulatory permissibility on-chain tokenised cash (e.g. stablecoin or CBDC).

3. The Placing Institutions validate the Retail Investors' applications and check the following in real-time (via logic coded by the Daml smart contract layer):

   a. Check that the Retail Investor is valid (HKID).

   b. Check for duplicate orders, i.e. has the same Retail Investor subscribed with other Placing Institutions. The Utility ensures duplicative orders are not able to be processed.

4. At this point in the workflow, orders are automatically sent to the central securities depository.

5. The Daml smart contract confirms that the respective Retail Investor has sufficient funds available.

6. Any exceptions are notified in real-time to the Retail Investors, the Placing Institutions and the central securities depository, and any other stakeholders entitled to observe the subscription process as defined in the Daml smart contract.

7. Valid orders are automatically recorded on the ledger and confirmed with the Retail Investor in real-time. At this point the cash balance is locked and the digital assets and relevant green efforts are visible via the Octopus App.

8. The issuer, central securities depository and the Arranger(s) have visibility on the issuance quantity based on the subscriber list size and order book in real-time via the Daml-defined workflow.

In addition to the Daml-driven workflow outlined above, the Green Bond Application integrates with existing KYC solutions (i.e. Jumio) and authentication solutions (i.e. iAM Smart) to verify the Retail Investors' identity. This enables the Placing Institutions to pre-screen and approve Retail Investors following standard KYC/AML processes.

Figure 2.2: How smart contracts increase subscription efficiency

2.3.3. On-ledger and off-ledger payments

The Daml prototype for Project Genesis provides a legally compliant, yet innovative approach to payment options in the Hong Kong market with no pre-funding required among Retail Investors and multiple payment rail options.

This innovation in payments is first defined at settlement. The Utility supports the processing of Delivery-versus-Payment (DvP) settlement for securities and cash. Cash settlement can flexibly occur through the existing payment rails and SWIFT networks or could, subject to regulatory permissibility, leverage the tokenised cash (i.e. CBDC or stablecoin)[12]. With Daml, multiple settlement models can be realised as per the definitions of the BIS. Furthermore, Retail Investors can choose to pay for the bond subscription by selecting traditional off-ledger fiat payment rails (Faster Payment System (FPS) of Hong Kong is demonstrated) and emerging, new on-ledger payment methods such as stablecoins.

Retail Investors will have the benefit of directly making a payment through their mobile application (not Octopus App), and by setting up eDDA FPS authorizations. They can receive the value of their coupon payment or redemption payment directly to their FPS bank account.

---

[12] Implementation subject to regulations in respective jurisdictions.

Primary retail closing and settlement process steps:

- Automatic closure of subscription period on the closing date, allocation logic encoded in Daml smart contract runs (multiple runs of allocation to subscribed investors) to determine allocation for each investor.

- Investors receive real-time notification of their final allocation and the amount of expected interest earned on locked cash (if any).

- Placing Institutions receive real-time notification of finalised allocation results for their clients only and summarised across all clients.

- Arranger(s) receive real-time notification of finalised allocation results for their placing banks only.

Functionality on the actual date of issuance:

- Settlement using fiat (RTGS)

  a. Placing Banks create net RTGS direct debit requests for cash settlement legs on ledger.

  b. The issuer confirms RTGS direct debit triggering DVP settlement between issuer and Placing Institutions.

- Settlement using on-chain tokenised cash (e.g. stablecoin or CBDC)

  c. Atomic DvP settlement between issuer and Placing Bank

- The retail bond is credited to the Placing Institution's account at the central securities depository while the Retail Investor has real-time visibility of cash debit, interest paid on locked cash, and bond credited to their account.
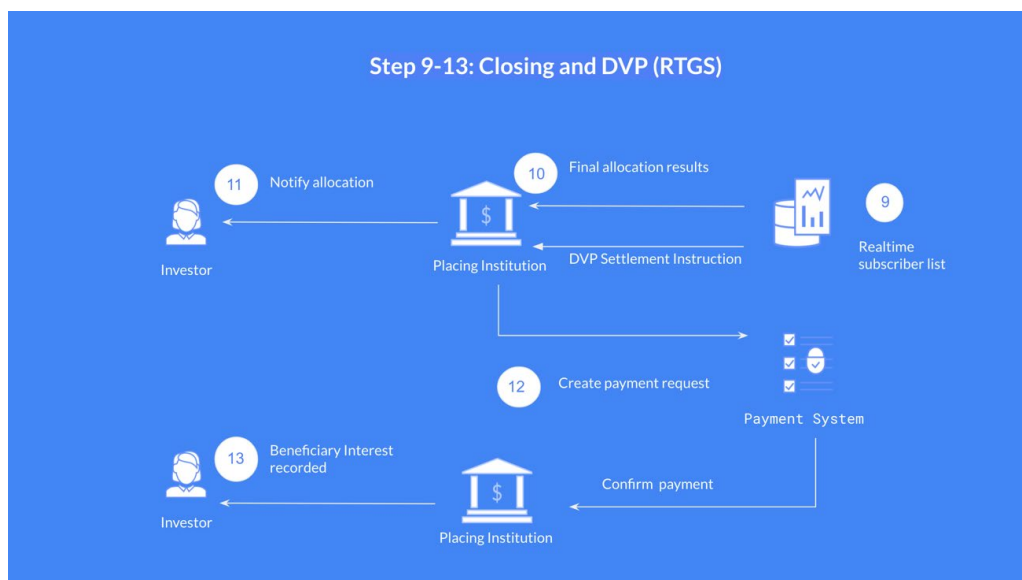

Figure 2.3: How smart contracts ensure efficiency in closing and payment

2.3.4. Improved secondary market trading

Bonds generate higher yields than time deposits and are still relatively safe. The current minimum investment threshold is high. In the context of Hong Kong, past retail government bonds are sold at multiples of HKD 10,000 (approximately USD 1,282). The Daml prototype enables Retail Investors to invest in bonds with a fraction of the current amount, only HKD 100 (approximately USD 13). The prototype demonstrates a fully smart contract driven secondary market processing: from order placement to trade matching and execution, all steps are executed completely on-ledger by relying on Daml smart contracts. In addition, the application can also be connected to the already working, robust traditional HKEX trading and matching engines, and a real-time data feed by utilizing the Daml Ledger API.

In traditional bond processing, a general lack of standardization exists in the primary market which increases information asymmetry and results in inefficient pricing, high costs, and long settlement times in the secondary market. By utilizing Daml smart contacts and DLT to bring liquidity, transparency, and efficiency to secondary bond trading, the prototype was able to accomplish the following in the conceptual secondary market trading:

- Leverage the Daml matching engine for retail green bond secondary trading, mitigating liquidity risk from a business perspective.

- Improve post-trade processing and bond custody facilitation via atomic settlement.

- Remove the manual processing present in a bond transaction and lower transaction fees.

- Shorten settlement and transaction times to bring greater transparency for the issuer in transactions.

Secondary trading workflow steps:

- **Listing the green bond on HKEX**
  After the closing period of bond issuance, the issuer selects the issued green bond and sends the listing request to the stock exchange. The stock exchange confirms the listing request, and the green bond is available for secondary trading on the stock exchange, and the real-time order book is activated.

- **Retail Investors can buy/sell bonds**
  An investor can place buy-sell orders, input the price and quantity of the bond, and select a payment account (fiat money account or stablecoin account) in their mobile app. With sufficient balance in the mobile app, the Retail Investor can place the order, check the real-time order book, and check the order status (unmatched, matched in the stock exchange). Placing buy-sell orders in the Octopus App is not possible due to regulations with regards to Stored Value Facilities.

- **The real-time visibility on the order book**
  Placing Institutions or Brokers have real-time visibility on investor order books. Daml ensures privacy on the level of subtransactions.

- **Automatic order matching and atomic settlement**
  After orders are placed in the stock exchange, the exchange automatically matches the orders and the settlement process is seamlessly processed on-chain.
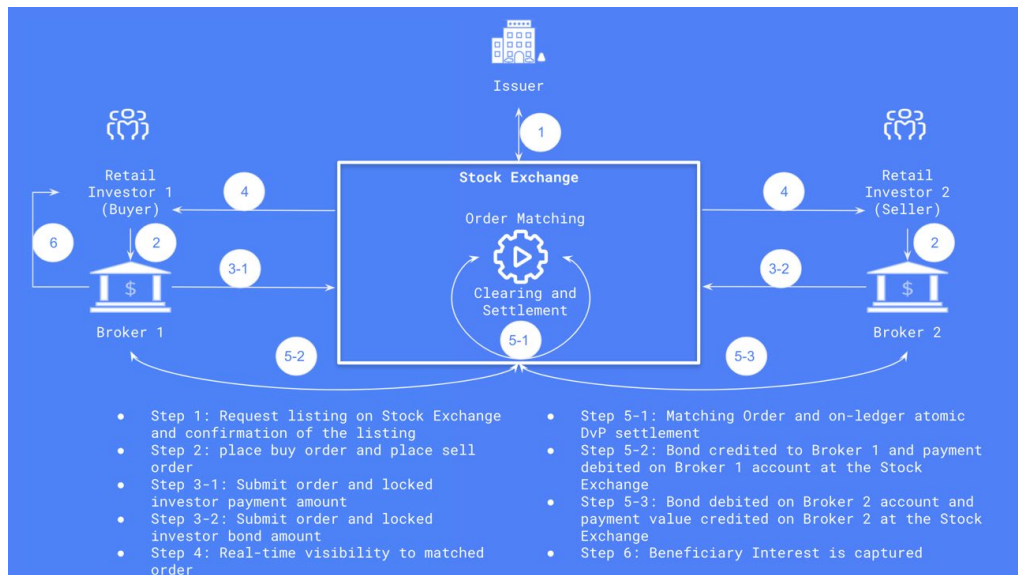
Figure 2.4: Title: Prototype secondary market envisioned workflow

2.3.5. Bond lifecycle events: automated coupon payment and redemption

Even the simplest corporate action can be a challenge from a processing perspective because it demands highly accurate event details to be received in a timely manner combined with fully reconciled and accurate holding records to ascertain controlled and risk-free processing.

Coupon payment and redemption processing steps:

1. Coupon and redemption payment is calculated by leveraging Digital Asset's open-sourced Finance Library Contingent Claim module.

2. On coupon payment/redemption date the issuer makes payment.

3. Bond holders can see their expected coupon and redemption payment details in real-time.

4. Money is transferred atomically on-ledger between accounts.

5. At redemption, the bond is taken out of circulation and the final coupon and redemption payment is made.

Benefits of automated corporate actions through smart contracts:

• Daml models the full behaviour of tokenised assets and automates the lifecycle of the asset. It is critical that the smart contract tools used in tokenizing assets are sufficiently sophisticated to capture the richness and complexity of the assets traded in modern capital markets.

• The elimination of the corporate action processing multiplication along the securities custody chain drastically reduces the asset servicing cost and risk.

• No more costly corporate action engine at each chain link, but rather a single source of ultimate beneficial ownership (UBO).

• No more reconciliation is required at each chain link thanks to the simultaneous settlement mechanism.

• No more complex message-based processes.

2.4. Third-party integration with real-time data feed through the Daml Ledger API

By leveraging the Daml Ledger API, the prototype fosters ecosystem developments. Retail Investors will benefit from a verified green data feed where they can follow the green impact of their green bond investments. The conceptual Octopus App integration allows for tracking green bond balance assets and the green data directly from the Octopus mobile application, creating a never seen opportunity for public education and involvement

Retail Investors can onboard easily by selecting one of the major a KYC provider (i.e. e.g. Jumio) to verify their identity before starting using the Project Genesis Retail Green Bond Application Utility.

2.4.1. Applying DLT and Daml to enable provable green investing

For those investing in environmentally friendly projects, there is uncertainty about whether the bond issuer is delivering the positive green impact it is committed to at issuance. Buyers of environmental financial products and other green or ESG-labelled instruments have very limited access to timely, reliable data on the performance of assets financed by those instruments and the impact generated by their investment.

Through integration with AllInfra, we demonstrated that DLT, Daml and IoT can be integrated together to not just synchronise accrued interest calculation and its payment, but also track in real-time how much clean energy is being generated, and the consequent reduction in CO_2 emissions linked to individual investments.

Allinfra's solution provides transparent and reliable data to investors, asset owners and other third parties. When data is integrated to power through a single Utility with other databases and ledgers, investors and value chain stakeholders such as the stock exchange can obtain real-time updates. This level of transparency can hardly be achieved with traditional technology.

Real-time green data integration with Allinfra[13]

For each green bond issued, Allinfra can implement data capture, storage and access system that sits alongside the tokenised green bond. The system is intended to provide asset performance details to green bondholders over the life of the instrument, increasing transparency, providing greater detail on the use of proceeds and greater certainty regarding the green impact of the underlying financing.

The Allinfra platform can ingest many data sources across one or multiple assets, providing the user of the underlying data a rich and reliable data repository, where primary source data can be further supported by other alternative devices or non-metered data.

The proof-of-concept asset setup includes a simulated network connected, revenue grade metering device, able to be used for the monitoring of asset performance, with data fully accessible to the asset owner.

The Allinfra platform allows the asset owner to register assets and other asset specific features based on static components on a public blockchain (e.g. the Ethereum mainnet). Metered and other non-metered data collected is maintained and referenced across various private services including Hyperledger Besu and other cloud-based storage.

Collected data can be accessed and queried in various ways. Green data providers such as Allinfra can operate their own participant node and maintain their ESG-relevant intelligence within the node and join the authority domain(s) on a request basis in order to provide a green data feed. Following this approach, all the real-time data will be shared amongst each participant in the DLT network.

The data can also be integrated into the DLT network via the Daml Ledger API. For the Project Genesis prototype implementation, Allinfra provide the green data feed and writes it into the ledger via the Daml Ledger API. The Utility accesses the real-time green data via the Daml API so it can be displayed through dashboards, web, and mobile applications.

With the Daml Ledger API, Daml is flexible enough to connect and operate with other platforms, whether or not they are DLT-based. This removes important barriers to adoption for the organizations to start benefiting from smart contracts without immediately jumping into a DLT structure on Day 1.

Through collecting, storing and making available this underlying data in a highly verifiable, auditable way alongside or linked to capital markets or environmental financial products, asset owners, investors and third-party users can be confident in that data's provenance and consequently the product reliant on that data.

---

[13] See Section 4.1. of the sister report Project Genesis – Report 1 "A vision for technology-driven green finance"

2.4.2. Applying DLT and Daml to integrate via API with Octopus App

For investors, there is a need to easily maintain visibility on the green token balance and the green efforts. DLT, Daml and the Octopus App can be integrated together to not just to show the green token balance and green efforts impacts, but also to raise transparency and sustainability awareness.

Octopus App Implementation

As part of the prototype Octopus have built a prototype App enabling investors to monitor their green efforts through this implementation with just a simple click in the Octopus App, anytime, anywhere. This innovative service will hopefully provide Retail Investors, the Hong Kong citizens, a fresh experience in tracking their investment and at the same time raise their sustainability awareness.

Once the Octopus App user clicks the "Check Balance" button, the Daml Ledger API feeds the bond token balance and relevant green efforts into the Octopus App.
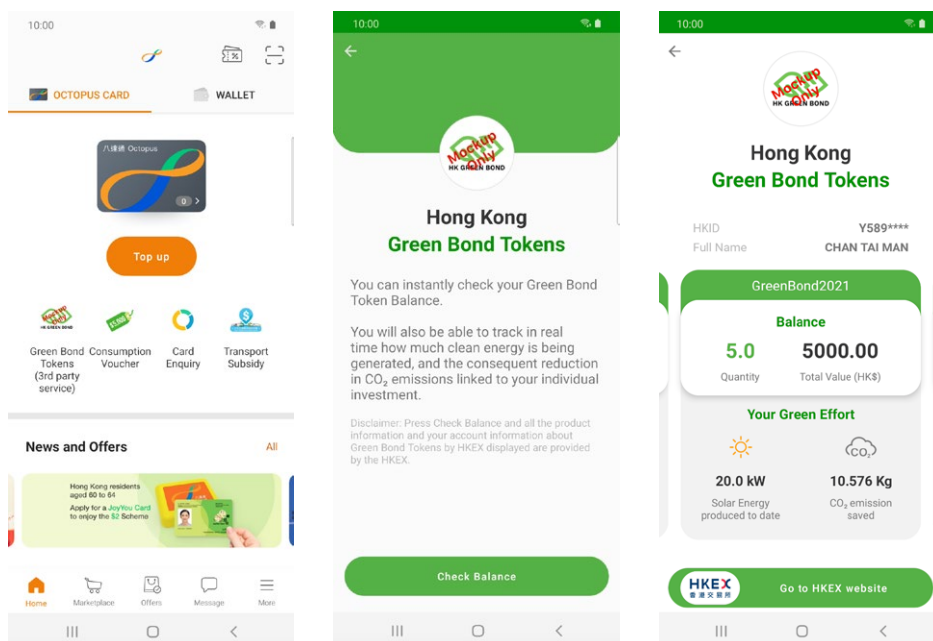

Figure 2.5: Green Companion – Octopus App Prototype

The Octopus App acts as a channel for displaying the information on the user's bond investment and related green impact. The Octopus App does not involve subscribing, holding, or trading of any green bonds.

2.4.3. Applying DLT and Daml to enable e-KYC

Digital Asset can enable e-KYC through digitalising workflows natively written in Daml fed by data from third party Identity Verification (IDV), name screening, and transaction monitoring engines via third-party solution providers. Through the use of Daml and Daml ledger API (e.g. connect via Ledger API), the Project Genesis prototype is able to integrate with third party KYC solutions such as Jumio or authentication systems such as iAM Smart.

The Daml Driven e-KYC workflows can be developed to be fully compliant with regulatory expectations. The diagram above shows a Daml driven e-KYC/AML workflow which allows the compliance operations teams to handle IDV (Identity verification) workflows.

2.5. Summary of cost analysis: cost reduction and efficiency gain

We have previously summarised the benefits for each of the stakeholders in 2.1 Key stakeholders. The Digital Asset and GFT Genesis prototype significantly reduces the timeline and costs of issuing and managing a retail green bond through its lifecycle.

The bond preparation and origination phase can be reduced by an estimated 50% from 1-2 months to 2-4 weeks by introducing standardised, Daml smart contract driven workflows, and tokenised bond definition. Additionally, 2-3 business days can be saved when the green bond is listed for secondary market trading.

By streamlining the current subscription process and eliminating all currently manual reconciliation work, an estimated 800-1,000 person hours can be saved during the subscription phase performed by placing institutions and the issuer.

Furthermore, retail investors will benefit from a fully mobile application enabled subscription process which saves considerable time spent at physical bank counters and commuting time. The social savings of the direct retail investor access is estimated to be a minimum of 2,500 – 3,000 person hours saved.

Cost Benefit Analysis

In addition to shortening the timeframe required for issuing, closing, secondary trading of bonds and paying coupons, we estimate cost savings of at least 18 bps, or 0.18%, throughout the bond lifecycle by moving to a Daml-enabled DLT-based infrastructure. The figures below are based on the interviews the Digital Asset and GFT team performed with market participants involved in retail government bond issuances in Hong Kong and are indicative only. The calculation takes into account both the man-days saved, as well as the gains measured in dollar value. We summarise the cost saving in the table below.

Assumptions applied to the cost benefits analysis:

    a. We used the latest Hong Kong government retail iBond's issuance size of HKD 20 billion (USD 2.57 billion), announced on June 21, 2021 as a measurement for a future retail green bond issuance.

    b. We used a 2% annual return for the government's retail green bond issuance, based on the previous retail government bond's offerings.

    c. We used the latest HK government iBond as a proxy for the retail green bond's subscription and allocation amount.[14]

    d. For all the man-days required, we applied an hourly rate of HKD 200 (USD 25.64).

---

[14] See https://www.hkgb.gov.hk/en/news/press_20210621.html

Stage	Subscription	Closing	Secondary	Green Impact
Benefits impact (bps)	0.3 bps	10 bps	4.8 bps	2.58 bps
Details				
Hours saved	2216 hours			
Monetary Gains		HKD 20,980,081 (USD 2,689,754)	HKD 9,554,780 (USD 1,224,972)	HKD 5,160,000 (USD 661,538)

- **Subscription phase (0.3 bps):** rejected applications by retail investors is estimated to be 0.5% of overall subscriptions. It implies around 3,000 hours lost for investors and placing institutions for processing unsuccessful applications.

- **Secondary market trading (4.8 bps):** Secondary market efficiency can improve by consolidating liquidity in fragmented markets. Currently, banks and the HKEX offer different pricing to investors who want to trade government bonds. We used the current brokerage firm's charge of government bonds and the subscription percentage of iBonds through broker-dealer firms to estimate the potential benefits. Still, it did not capture the full benefits of the entire secondary trading spectrum.

- **Green impact (2.58 bps):** As evidenced through the blockbuster launch of UK's first green sovereign bond in Sep 2021, issuers enjoy a green premium of 2.5 bps[15] .

---

[15] FT article link

3. Architecture and technology overview

3.1. Architecture design

For the Genesis tech stack the teams focused on the use of scalable, resilient and production ready technologies to facilitate easy development and deployment of the final solution during development and testing. There was a heavy focus on automation and testing and the quality of the final solution has been of utmost importance during the whole development process. The team has also used modern development methodologies (scrum, TDD, SOLID principles) to ensure that the design and development met the strict standards required by banks and financial services entities.

For the backend development Digital Asset and GFT team chose Java and made our API services available via Spring Boot. We also used RX-Java reactive programming libraries to interact with the Daml interoperability protocol. The use of Java is an industry standard in the financial services market and this is due to the fact that it through its approach to object-oriented programming it is possible to easily set up and securely deliver production grade code, it is a fully featured language with hundreds of plugins and extensions. RX-Java is a reactive library for Java that allows a simpler approach to multithreading through the addition of asynchronous streams, improves cache management and in general increases the responsiveness and scalability of your application. Spring Boot makes it easy to create Spring applications and provides a variety of features required for production systems such as advanced metrics, external configurations and API health checks.

For the front end application we have decided to use ReactJS. React is fast becoming the de facto language of choice for mobile applications, it is quick to develop and extremely flexible in terms of design. It is built with speed in mind and works well on a number of platforms due to its use of the virtual DOM making it easy to render on a number of different platforms.

When designing the infrastructure for the application we understood that security and scalability were paramount to the platform's success and this is why we chose to deploy our services to Amazon Web Services cloud platform. In this case our cloud approach was all encompassing as we had our backend services, website hosting and even our code repos and deployments hosted on the cloud. We used a Virtual Private Cloud with three public subnets where we hosted our backend application and three private subnets where our Daml interoperability protocol services ran. This meant that the security and accessibility of the interoperability protocol network was limited as much as possible and data on the Daml interoperability protocol network completely safe from attack and only accessible (via a secure connection) from EC2 instances running on the approved public subnets. Any data that was not saved to the Daml interoperability protocol website was persisted into an Aurora PostgresQL database that was also set up to span across all private subnets. The website itself was hosted on S3 to increase the speed and agility in which we could set up a website, which is considerably quicker than setting up a dedicated server. We used a mixture of Code Commit Repositories, Codebuild and CodeDeploy to ensure that our continuous integration pipeline worked smoothly at all times.
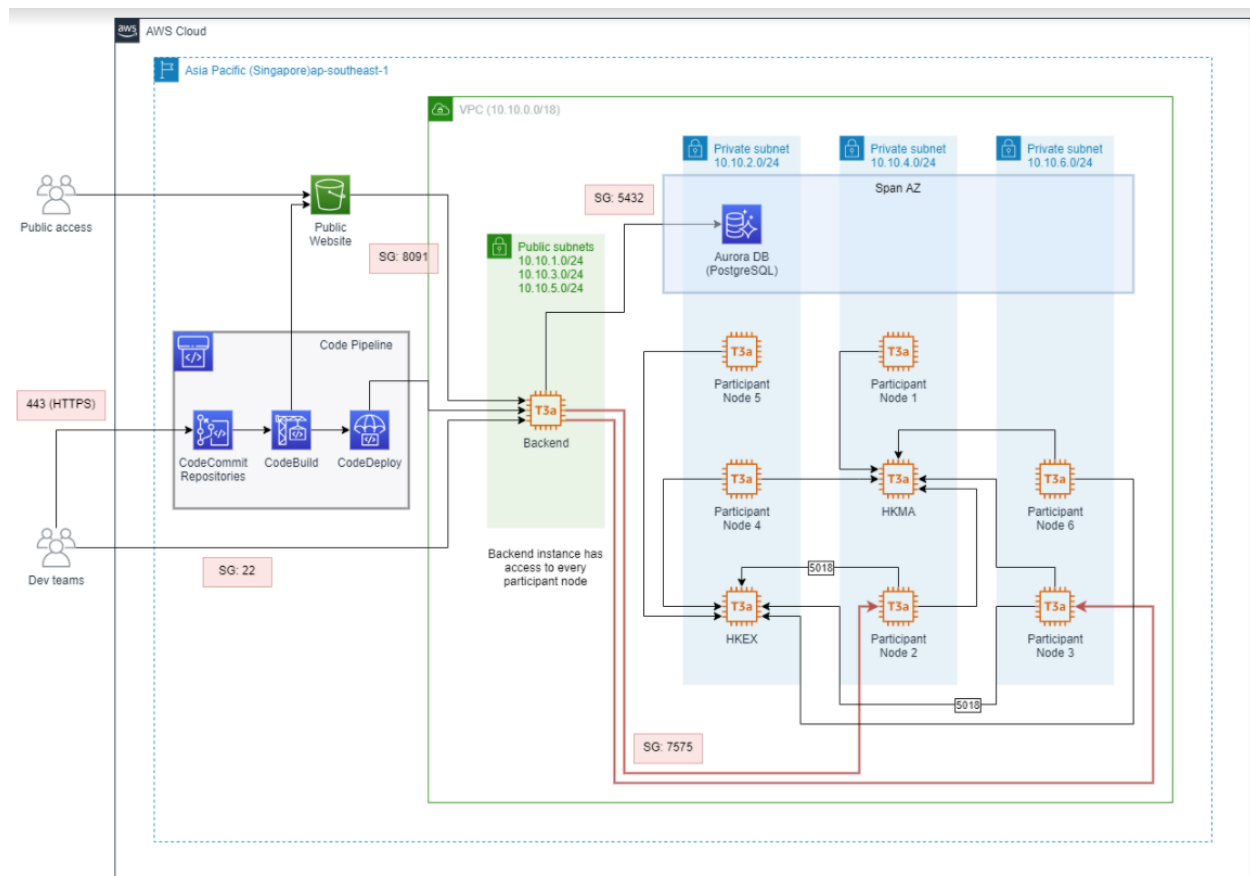
Figure 3.1: Architecture Design

As quality was of critical importance to the success of this project the teams worked with a focus on non-automated functional testing (including smoke, regression and exploratory testing) as well as automated testing. The automated testing framework used was Jest and it was accompanied by Axios which is a HTTP client for Javascript. Using this approach we were able to write TDD style tests in lightning-fast time and add them to our deployment pipelines.

The below testing metrics have been collected as part of the project:

Automated testing metrics

- Percentage of unit test coverage:

- Percentage of automated API test coverage:

- Average percentage of passed tests (over X period)

- Test execution/quantity of automated tests:

3.2. Privacy Protocol: Digital Asset Interoperability protocol

Building distributed applications that involve multiple organizations is hard with today's technology. For each application, all organizations must agree on the data encoding, transport mechanisms, and interaction rules, and all must implement their part of the interaction correctly, including authentication and authorization. Once implemented, such an application often becomes a silo: there is no general convenient, secure and privacy-preserving way to integrate such applications and compose the business workflows that they automate. Smart contract platforms such as Ethereum try to break these silos, but suffer from scalability, authorization and privacy problems.

Through past work with the industry, the Digital Asset team has learned that granular privacy, data segregation and trust are key requirements for adoption. So what we utilised for this project is Digital Asset Modelling Language (Daml), a smart contract programming language whose distinguishing features are the built-in models of authorization and privacy. Daml interoperability protocol is a next-generation distributed Daml runtime that implements these models faithfully. By partitioning the global state it solves both the privacy problems and the scaling bottlenecks of platforms such as Ethereum. It allows developers to balance auditability requirements with the right to forget, making it well-suited for building GDPR-compliant systems. The Daml interoperability protocol handles authentication and data transport through our so-called synchronization domains. Domains can be implemented in different ways depending on trust requirements. Domains can be deployed at will to address scalability, operational or trust concerns. They are permissioned but can be federated at no interoperability cost, yielding a virtual global ledger that enables truly global composition of business workflows.
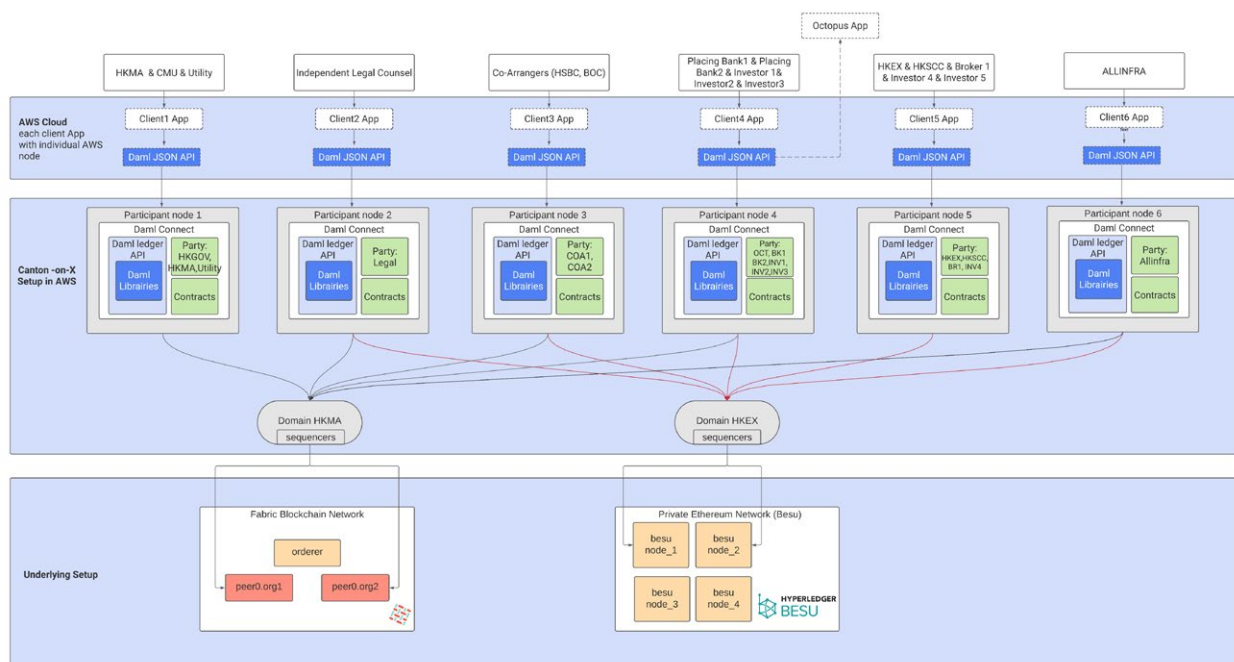

Figure 3.2: Infrastructure

3.2.1. Daml HTTP JSON API

The JSON API provides a simpler way to interact with a ledger than the Ledger API by providing basic active contract set functionality, such as creating contracts, exercising choices on contracts, querying the current active contract set, retrieving all known parties.

The goal of this API is to get the distributed ledger application up and running quickly, and therefore it excludes complicating concerns including, but not limited to inspecting transactions, asynchronous submit/completion workflows, temporal queries (e.g. active contracts as of a certain time), and for these and other features, it is suggested to use the Ledger API instead.

3.2.2. Daml Ledger API

The Ledger API is structured as a set of services. The core services are implemented using gRPC and Protobuf, but most applications access this API through the mediation of the language bindings. The API is structured as two separate data streams:

- A stream of commands to the ledger that allow an application to submit transactions and change state.

- A stream of transactions and corresponding events from the ledger that indicate all state changes that have taken place on the ledger.

- Commands are the only way an application can cause the state of the ledger to change, and events are the only mechanism to read those changes. For an application, the most important consequence of these architectural decisions and implementation is that the ledger API is asynchronous. This means: the outcome of commands is only known some time after they are submitted.

- The application must deal with successful and erroneous command completions separately from command submission. Ledger state changes are indicated by events received asynchronously from the command submissions that cause them. The need to handle these issues is a major determinant of application architecture. Understanding the consequences of the API characteristics is important for a successful application design. Under the context of the Tokenization platform the Daml Ledger API receives and redirects the various requests coming from the Daml HTTP JSON API to affect or retrieve information from the underlying ledger technology.

3.2.3. Daml Interoperability Protocol Domain Node

The Daml interoperability protocol[16] domain node provides total ordered, guaranteed delivery multi-cast to the node participants. This means that participant nodes communicate with each other by sending end-to-end encrypted messages through the domain. The sequencer service of the domain orders these messages without knowing about the content and ensures that every participant receives the messages in the same order. The other services of the domain are the mediator and the domain identity manager.

---

[16] Digital Asset: Daml Ledger Interoperability Protocol https://www.canton.io/

3.2.4. Daml Interoperability Protocol Participant Node

The Daml interoperability protocol participant node represents a server that provides users a consistent programmatic access to a Daml based ledger through the Ledger API. Users trust their participant node. Participant nodes assume that other participant nodes are malicious. The participant node can be configured individually to connect to many domains at the same time, presenting a unified view over all domains. The participant node handles transaction signing and validation, such that users don't have to deal with cryptographic primitives but can trust the participant node that the data they are observing has been properly verified to be correct. Together with the interoperability protocol domain these containers provide for the core infrastructure and software on which the Daml smart contracts operate and save the various tokenised assets.

What Daml interoperability protocol helps to achieve:

- **Multi-ledger technology:** The ability to deploy and connect systems across disparate networks regardless of the underlying IT infrastructure.

- **Cross-ledger atomicity:** If one leg of a transaction fails, all sides fail. By ensuring atomicity, systems can achieve payment versus payment and delivery versus payment without the risk of handing over the goods when the payment leg fails and without the need for a central authority acting as an escrow. The counterparty risk or delivery risk are eliminated.

- Daml enables **sub-transaction privacy,** ensuring that parties only see the subset of an atomic transaction that directly affects them.
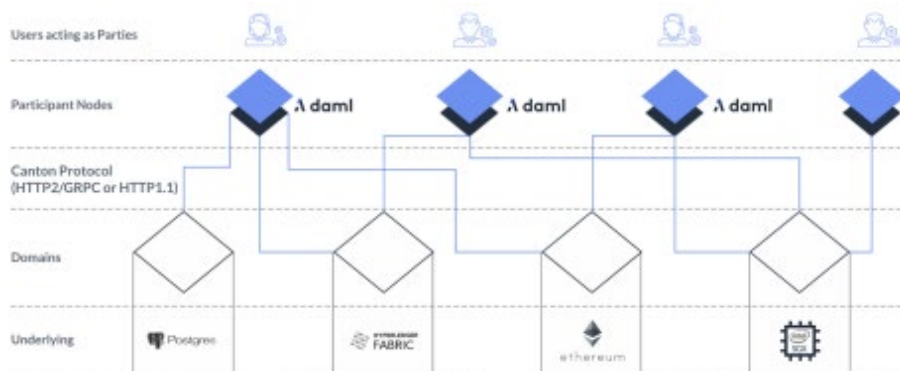

Figure 3.3: Daml Interoperability among database and distributed ledgers

3.4.5. Future consideration

Stable integration with live financial services systems and payment systems is a requirement for a project to move from MVP to production. There are many ways to approach this, but the majority of times this is obtained by setting up an oracle that calls out to these systems and pulls the data into the smart contracts. The security of the connection with these systems is paramount and using private or encrypted channels is a must. As well as this it is also important to bind responsibility for obtaining this data to a network participant, doing so means that there is a complete audit trail when obtaining data from such systems.

Conclusion

Project Genesis and the Daml prototype achieved many notable milestones for both financial institutions and the general population of Hong Kong. Through the prototype, the Retail Investor can support green projects financed by green bonds and leverage Hong Kong's financial system to power a more sustainable and green future. Through the Retail Green Bond Application (the Utility), market participants have access to a prototype that can lay the groundwork for future innovation in traceability, reporting, and investing in green bonds.

The Utility leverages current market practices and logic where the issuer manages issuance and depository processes, and the stock exchange conducts transaction finality of secondary trading. The Utility also conceptually integrates with the Octopus App, Hong Kong's widely adopted payment platform, to display bond investments and green impact in the app. Furthermore, the prototype demonstrated integrations with Allinfra and with KYC/AML solutions via the Daml Ledger API. The prototype demonstrates how tokenization can potentially be done in a fully compliant manner with current regulations while also granting the Retail Investor access via current investment channels. Further study and observation of relevant regulations is required to validate the compliance with regulations.

Finally, the Utility demonstrated reduction in process times and costs without changing the existing regulatory frameworks governing the Hong Kong market. The Utility honours how regulated securities are marketed and custodied with intermediaries such as banks and brokerage houses. With Daml defining the rights and obligations of each stakeholder, the Utility can fulfil the strict legal requirements and market regulations associated with each step of the green bond lifecycle. The immutable nature of distributed ledger technology adds further confidence and enables the Utility to provide an audit trail for regulatory bodies.

Table of Definitions

Acronym	Description
API	Application Programming Interface
APP	Application
Daml	Digital Asset's core technology platform for building multi-party applications that extracts and simplifies business processes to make data more accessible while optimizing workflows using smart contracts
DLT	Distributed Ledger Technology
IoT	Internet of Things
PoC	Proof of Concept
Utility	Short name for the Retail Green Bond Application designed by Digital Asset and GFT for Project Genesis
MVP	Minimum Viable Product
STP	Straight Through Processing
SVF	Stored Value Facility

Project Participants

BIS Innovation Hub

Bénédicte Nolens, Head Hong Kong Centre

Marcel Bluhm, Project Lead

Asad Khan, Technical Adviseer

Digital Asset

Jon Rout, Head of APAC Business Development

Grahame Webb, Head of APAC Client Experience

GFT

David Creer, Global DLT and Crypto Lead, GFT

AllInfra

Dave Sandor, Co-founder & CEO

*Promoting global monetary
and financial stability*

Bank for International Settlements (BIS)
Innovation Hub

www.bis.org
email@bis.org