A Global Standardized Approach to Combating Duplicate Financing Fraud in Trade Finance

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Abstract

Duplicate financing, through the reuse of the same documents with multiple lenders, is a hidden problem in trade finance. Many such frauds go undetected due to the lack of a detection mechanism.

The use of digital deduplication registries provides a solution to the problem.

A natively global solution that is interoperable between markets is necessary because duplicate financing fraud for international trade happens across borders.

It is difficult to achieve interoperability between disparate, local deduplication registries built on different technology platforms without common standards and specifications. Therefore, a deduplication system capable of preventing cross-border fraud must be global from the outset.

Recognizing that this kind of global deduplication service ought to be industry-led, MonetaGo is working with key international organizations and associations to provide a universal, standardized utility.

The challenges created by information silos, private-private data sharing and data confidentiality can be effectively solved through the use of currently available digital technologies.

A global standard solution is the lowest-cost option. With costs defrayed worldwide, this system results in the lowest possible cost for lenders in every jurisdiction. Affordability reduces economic barriers to adoption, helping drive network effects to combat duplicate financing fraud domestically and internationally.

Additional anti-fraud solutions such as local or international document authentication and physical tracking services, can be built on as additional modules to the base layer of a global deduplication service. These services can be provided by multiple vendors.

Contents

1. Duplicate Financing Fraud in Trade Finance

Trade finance is financing extended for or linked to the inventory, receivables, or payables (working capital components) of a business. Evidence for these working capital components includes invoices, purchase orders, transport documents (such as bills of lading) and warehouse receipts. Financing of genuine underlying trade transactions and assets is deemed fundamental to trade finance.

Lenders use paperwork to secure their trade finance transactions and security interests and rely on the representations, warranties, and undertakings of their customers that the transactions or assets for financing are not already financed by other lenders or pledged or assigned to another party. Despite these formalities and promises, duplicate financing occurs.

It is difficult to estimate the total amount of duplicate financing fraud, as many occurrences go undetected due to the lack of a detection mechanism. Fraudsters use duplicate financing to raise liquidity and keep the fraud concealed by repaying the financing so that they can continue to make use of fresh (duplicate) financing. Such schemes can be perpetrated over long periods of time before they are found out. They are usually discovered at the point where the perpetrators are unable to repay, due to cashflow issues or disruptions to their activities.

An unfortunate consequence of the discovery of trade finance fraud is the reduction of financing made available to legitimate borrowers or financing applicants. Recently uncovered large scale trade finance frauds have had this effect, where a number of large global banks reportedly decided to curtail their trade finance activities.

Since 2013, the Asian Development Bank (ADB) has been publishing its estimate of a "trade finance gap", defined as one institution's inability to meet the demand for any form of trade finance, and represents the amount of trade finance that is not available to support imports and exports resulting in less trade than would be if there was no gap.[1] The ADB estimated a US$ 1.5 trillion trade finance gap in its latest (2019) published survey. The shortfall in financing vis-à-vis demand was found to disproportionately (albeit unsurprisingly) affect small and medium enterprises (SMEs) and women-owned firms.[2] The trade finance gap is expected to have expanded during the COVID-19 pandemic.[3]

International trade is an important contributor to economic growth, poverty reduction, and private financial flows across countries. Access to affordable trade finance is a condition for successful international trade. Trade finance is normally a high-volume and low-cost source of finance.[4] The World Trade Organization (WTO) estimates that some 80 to 90% of world trade relies on trade finance.[5]

SMEs are the backbone of the global economy, representing around 95% of the world's companies and 60% of private sector jobs; the shortage of trade finance hurts SMEs the most, thus having negative knock-on effects for economies and families across the globe.[6]

The need to prevent fraud, including duplicate financing fraud, ought to apply to large and small transactions alike. The integrity of the entire trade finance landscape is vital for the flow of trade finance not only to large corporations, but also to midcaps and MSMEs (micro, small and medium enterprises), all of which play a crucial role in the economy.

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[1] Beck, S., Zhang, Q.F., Shinozaki, S., Mangampat, E., Ferino, M. I., 2013. *Asian Development Bank Trade Finance Survey: Major Findings. ADB Briefs* [Online], No. 11. Available from: https://www.adb.org/publications/asian-development-bank-trade-finance-survey-major-findings [Accessed June 17, 2021].

[2] Kim, K., Beck, S., Tayag, M. C., Latoja, Ma. C., 2019. *2019 Trade Finance Gaps, Growth, and Jobs Survey. ADB Briefs* [Online], No. 113. Available from: https://www.adb.org/publications/2019-trade-finance-gaps-jobs-survey [Accessed June 17, 2021].

[3] See, as examples: Starnes, S.K., Nana, I., 2020, *Why Trade Finance Matters – Especially Now. International Finance Corporation* [Online]. Available from:https://www.ifc.org/wps/wcm/connect/be423213-dd33-418f-b41a-09882f529cff/Trade-Finance-matters-COVID-19.pdf?MOD=AJPERES&CVID=nnxGNyA [Accessed June 30, 2021], and Auboin, M., 2021. *Trade finance, gaps and the covid-19 pandemic: a review of events and policy responses to date. World Trade Organization* [Online]. Available from: https://www.wto.org/english/res_e/reser_e/ersd202105_e.htm [Accessed June 30, 2021].

[4] United Nations, Inter-agency Task Force on Financing for Development, 2020. *Financing for Sustainable Development Report 2020* [Online]. Available from: https://developmentfinance.un.org/fsdr2020 [Accessed June 17, 2021].

[5] World Trade Organization, *The Challenges of Trade Financing* [Online]. Available from: https://www.wto.org/english/thewto_e/coher_e/tr_finance_e.htm [Accessed June 17, 2021].

[6] International Chamber of Commerce, *Access to trade finance* [Online]. Available from: https://iccwbo.org/global-issues-trends/banking-finance/access-trade-finance/ [Accessed June 17, 2021].

2. Challenges in Detecting Duplicate Financing Fraud

The main challenge to overcome in order to prevent duplicate financing fraud is information silos between lenders. A lender has no visibility as to whether transactions submitted by its clients for financing have been already financed by other lenders.

It is possible that a lender might even be unaware if it has itself previously financed the same transaction. The lender's information systems may not prevent duplicate financing. Some lenders may have different business lines or departments that finance trade, with separate operations teams and different back-office systems. Some lenders may not capture sufficient details of transactions in their back-office systems to enable automated detection of duplicates.

Information sharing between lenders does not happen for several reasons:

- They may have contractual, legal and regulatory duties to protect the confidentiality of their clients' information.
- They may be protective of their own interests and not wish to disclose details of their business and activities with clients to their competition.
- There are operational challenges to sharing of information between lenders – proper mechanism(s) are needed, and none may be available.

Even if lenders in a location were willing to share information with each other and had the means to do so, the effectiveness of such measures would be limited to prevention of duplicate financing of domestic trade finance (where buyers, sellers and lenders are all in the same country). They would prove inadequate when applied to international trade (where buyers and sellers are in different countries and where financing could be provided by lenders in the country of the buyer or the country of the seller or in countries different from the buyers or sellers').

An example of cross-border duplicate financing would be where a foreign supplier's invoices are financed by the buyer's bank as part of a buyer-led supply chain finance (SCF) program and the supplier also obtains financing on the same invoices from a lender in its own country.

The Secure Financing solution described in this whitepaper overcomes all the aforementioned challenges for lenders to combat duplicate financing fraud. The solution will be set out in more detail in the sections that follow.

3. Combating Duplicate Financing Fraud: The Need for a Unified Solution for the Entire Financial System

A lender may prevent duplicate financing within its organization by implementing its own deduplication system. It may work with other lenders to prevent duplicate financing fraud across organizations. Even if not all lenders participate in a collaborative effort at deduplication, the effort by two or more lenders to prevent duplicate financing between themselves would still be useful, as there is value in every duplicate financing attempt prevented. The participation of more lenders would improve the efficacy of the fraud prevention system.

A unified deduplication solution used by all lenders in international trade would be the most effective way to solve the problem of duplicate financing fraud. By working together for the common good, each lender's interests in achieving more secure financing are served. Fragmentation, on the other hand – by way of different isolated local deduplication solutions used by various communities of lenders – would reduce the efficacy of all solutions in solving the problem.

A single, natively global deduplication system, built for use in all locations, presents a cohesive solution. Building disparate localized solutions and attempting to interconnect them after-the-fact, results in tremendous challenges in terms of detecting financing uniqueness. This is due to lack of standardization, common process and rule books, in addition to performance and scalability issues.

4. Deduplication Registries to Prevent Duplicate Financing

"Deduplication" is defined as identification of duplicate data (repeat data or copies), and elimination and/or prevention thereof, in a database.

A “deduplication registry” is defined as a computer system that prevents repeat registration of duplicate data. A deduplication registry works by determining inline whether a new registration should be accepted or prevented, based on whether the data duplicates data that already exists in the system.

As applied to duplicate financing, a deduplication registry prevents the registration of identical financing transactions.

- When new data is submitted, it is compared to extant data of financed transactions in the system, and exact matches are identified.
    - When exact matches are found, users are informed that there is already a financing transaction bearing identical data in the system.

The use of deduplication registries can prevent duplicate financing because they detect identical financing transactions already registered. This deters a lender from proceeding to finance the same transaction because the lender is made aware that the requested transaction is a duplicate financing attempt.

The decision as to whether to finance a transaction, based on the information received from the deduplication registry, is for a lender to make.

The bottom-line recommendation is that a lender should finance a transaction only if it can successfully register a financing transaction with a unique status on the deduplication registry.

A Global Standard Utility

The MonetaGo Secure Financing platform is a global standard utility that will be made available to lenders worldwide as a way of preventing domestic and cross-border duplicate financing fraud in trade finance.

Duplicate finance fraud in international trade cannot be fully mitigated by deploying local registries as transactions can be and are financed in different countries.

The notion of building standalone local registries for deduplication amongst local lenders, and eventually linking or interconnecting with other similarly purposed local registries to prevent cross-border duplicate financing fraud, will be difficult to realize. This is because technical compatibility is a major challenge when trying to achieve interoperability between disparate systems built on different technology platforms without common standards and specifications.

The vision for a global risk mitigation solution to combat financing fraud led MonetaGo to partner with SWIFT. SWIFT is working with its global community to overcome the fragmented implementation of APIs that has proliferated in financial services in recent years, and to bring standardized APIs to its ecosystem. SWIFT has developed a platform to enable service providers to offer services to their business partners and customers (see Figure 4.1 and *https://www.swift.com/our-solutions/interfaces-and-integration/swift-api-programme* *https://developer.swift.com/* for details).

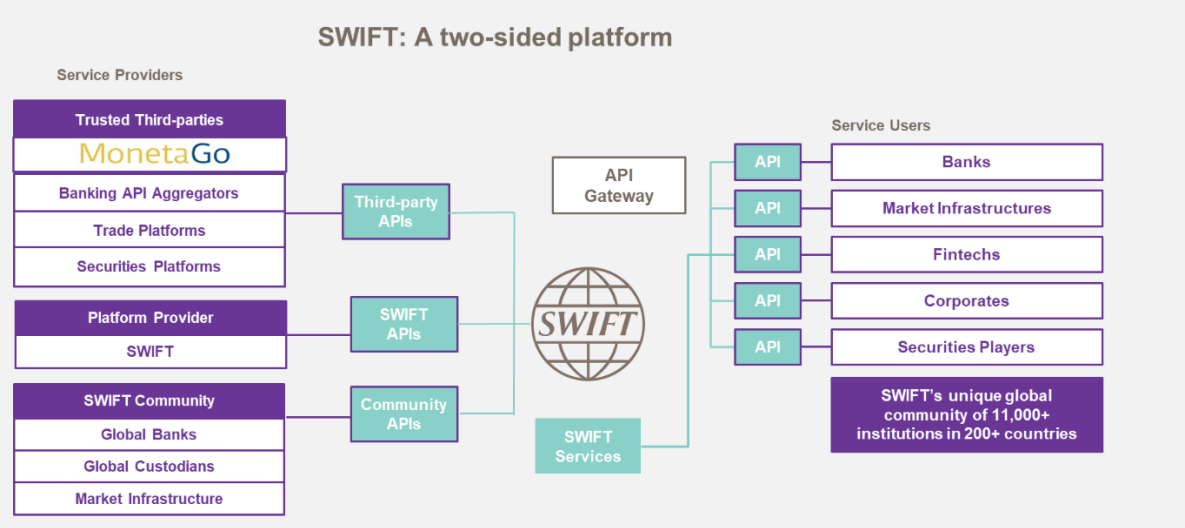

Figure 4.1: SWIFT: A Two-sided Platform

SWIFT provides useful central infrastructure such as identity management, authentication, security, network reach and connectivity whilst MonetaGo provides the deduplication service.

SWIFT is considered uniquely positioned as a channel partner of MonetaGo to exchange data between multiple parties in real-time by providing access to:

- A community of over 11,000 institutions in more than 200 countries connected to SWIFT.
- Community management and governance to share best practices and meet legal requirements.
- Identity and security frameworks to protect customers and lenders' data confidentiality.
- One validated format, one rulebook, one SLA globally to ensure interoperability.

In Q4-2021, MonetaGo will start testing delivery of its Secure Financing service over SWIFT's API channel to a group of SWIFT customers. If the pilot proves successful, the service will be deployed as a Trade Finance Validation Service over SWIFT.

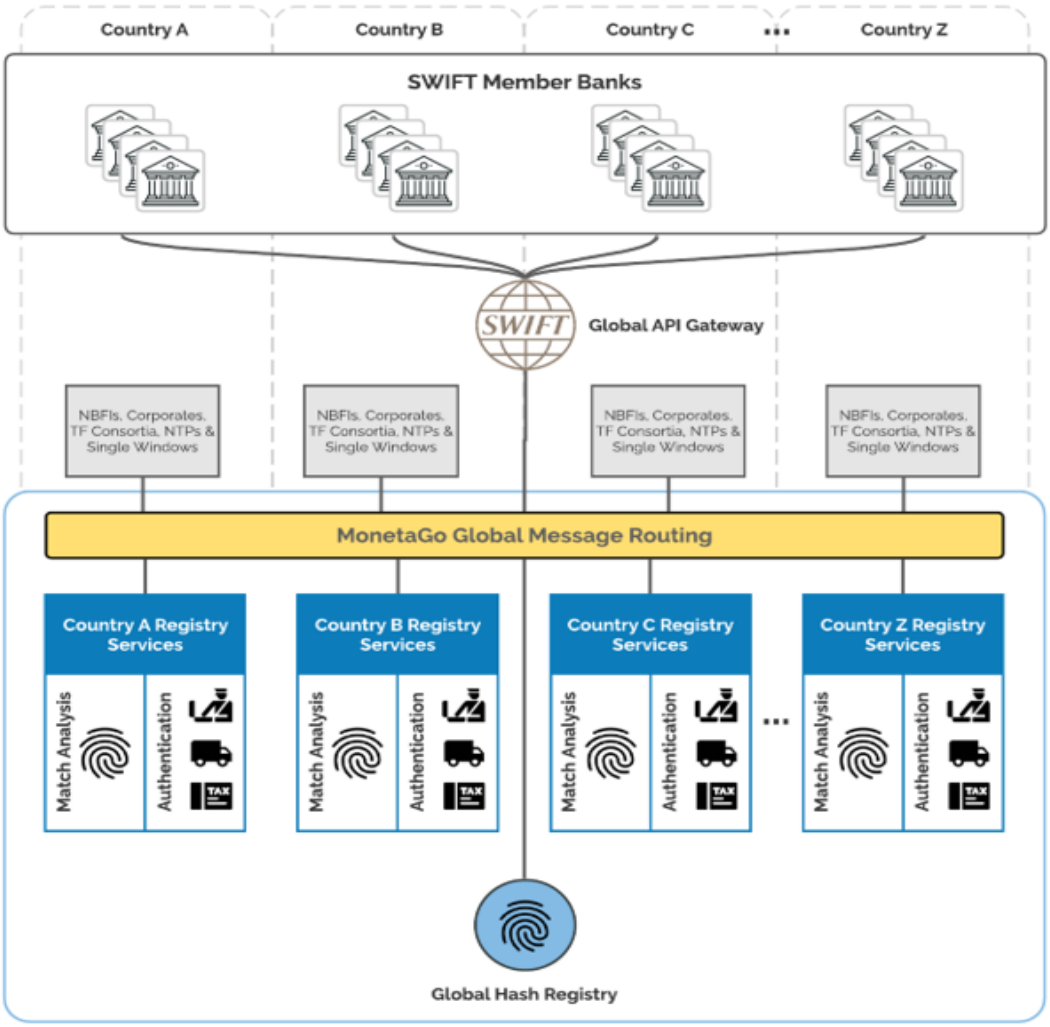

Figure 4.2: Proposed Solution for a Global Standard Utility

Consuming the MonetaGo API over SWIFT will enable users to access mutualized capabilities that today are typically provided, and invested in, by each financial institution individually. SWIFT centrally manages the data and common services to ensure end-to-end efficiency and reduce total costs. Offering the MonetaGo service over SWIFT also brings new business value to its customers: Participating banks will be able to immediately validate documents to mitigate risk against duplicate financing fraud by leveraging their existing API connectivity to SWIFT, without the need for further integration work.

MonetaGo's Secure Financing platform can also be accessed by lenders who are not users of SWIFT by alternative means (see Figure 4.2).

A document to be registered is uniquely represented by a “Document Fingerprint” which is created by cryptographically hashing specified data points from the document. Only the document fingerprint or cryptographic hash is recorded in the registry. No actual data relating to the documents or the transactions is stored in the registry, protecting the privacy of the lenders and financing applicants’ data.

The registry is impartial in relation to the locality of the lender and applicant. As an example, a lender in Hong Kong is financing an invoice where the supplier is in Hong Kong and the buyer is in the United States, and where the financing applicant is the supplier. If a lender in Singapore registers the same invoice for the same financing applicant in Hong Kong, the system routes the registration to the same common registry for deduplication checks and prevents the attempted fraud.

5. Technique

When the document fingerprint is inserted into the document registry, if there is already the exact same document fingerprint in the system, it indicates that the document has been registered by another lender.[7] The system indicates the status of a registered document as “registered” or “financed”, the latter indicating that a lender has already provided financing against the document.

The MonetaGo Secure Financing platform identifies whether financing using the same document(s) is for the same financing applicant or different financing applicants. The same document(s) may be legitimately used for financing by more than one financing applicant. Examples: (1) An export discounting transaction (for an exporter) and an import financing transaction (for an importer) may be supported by the same bill of lading that is issued for the goods shipped by the exporter to the importer. (2) A receivables finance transaction (for a supplier) and an invoice financing transaction (for a buyer) may be based on the same invoice(s) issued by the supplier to the buyer.

If the status of a document is “financed”, a new registration of the same transaction for the same financing applicant will be prevented, and both the lender who has already financed the transaction and the lender whose registration was prevented will be notified of the duplicate financing attempt. They will, however, not be notified of the identity of the other lender.[8]

Besides preventing registration of duplicate financing, the global registry identifies suspiciously similar documents used for other financings registered. When there is no exact duplicate in the data between two transactions, the platform does not prevent financing; however, the system informs the lender that there is a “fuzzy match” and provides the lender with information on the data fields on the document(s) that match. This allows the lender to perform additional due diligence to assess the financing request, if it deems it necessary, before approving or refusing the transaction.

6. Description of Technology and Functionality

The platform’s Document Fingerprinting capabilities prevent duplicate financing in near real-time, identifying duplicate and similar registrations as an “in-line” process with the lender’s financing approval workflow.

The platform analyses combinations of hashes of various document fields to identify any Document Fingerprints matches against the already registered documents. All suspected duplicate financing attempts will be immediately flagged to lenders submitting the document before financing, for additional due diligence and risk assessment. The privacy of lenders and financing applicants is always guaranteed by industry tested enterprise-grade cryptography based on the SHA-256 algorithm.

Trade finance by lenders may run on different applications, employ different technologies and operate across segregated ecosystems. MonetaGo's Secure Financing platform is designed to be agnostic and is strategically positioned above and between Trade Finance platforms and consortia, acting as a digital bridge to create a robust anti-fraud risk mitigation solution.

[7] The deduplication is also effective when the document(s) have been registered by the same lender. When this is detected, the lender is notified that it is an internal duplicate for the lender.

[8] The option for a lender to disclose its identity is provided. This functionality provides lenders the ability to investigate the attempted duplicate financing by exchanging information on a voluntary basis.

Lenders register select document information to the registry before disbursement.[9] With each new document, the document's critical information is hashed to create “digital fingerprints” to guarantee everyone's privacy and these digital fingerprints are pushed to the registry.

Standardization of the fields submitted by the lenders is essential. The platform automatically obscures all of the information to protect privacy and competitive concerns.

The platform acts as a secure, unified data repository across lenders. When the same document is submitted to the registry by multiple lenders, the system will flag all duplicates after the first unique instance is marked as financed on the system.

The registry does this with atomicity, consistency, isolation, and durability (ACID properties) of the financing data. These ACID properties are essential for real-time duplicate identification in the asynchronous, distributed, and parallel workflows of the entire trade finance industry, and provides a serializable isolation guarantee to ensure financing uniqueness and accuracy during concurrent operations.

In cases where a financing applicant may intentionally manipulate document fields to bypass duplication detection, the system may link similar or near records (e.g. fuzzy matching Document Fingerprints).

The digital fingerprints are SHA256 hashes of the document information. The document fields are hashed, concatenated, and rehashed in various permutations to create multiple unique hashes. Each of these hashes will represent a specific combination of fields and will be used to identify precisely identical and similar documents being financed.

6.1 Exact Match Duplicate Checking

The document repository database will provide a linearizable transaction isolation guarantee, so that only a single copy of a document can be inserted. This provides the first layer of deduplication, so that any duplicate financing of an exact match is guaranteed to be identified. This provides a solution to scenarios where the same document is submitted to two or more lenders for financing. The definition of which fields will constitute an “exact match” must be set globally for each document type.

6.2 Fuzzy Match Engine

Financing applicants may try to avoid being detected by the duplicate financing check by modifying the documents slightly, or the data may have accidental typos and variation in the field inputs (e.g. invoice number = 13650A and invoice number = 1365OA). It is important for the solution to be able to detect when it is highly probable that two documents are related to the same underlying trade transaction. This is a complex task to achieve at scale. Data is pre-processed to maximize the probability of duplicate identification with hashes. Any small variation in the input data such as capitalization or typos will result in completely different hash values, in turn producing false negatives. Pre-processing ensures that common variation in inputs result in the same hashes. Beyond pre-processing, the “fuzzy match” field combinations allow for the detection of documents with a subset of mismatching fields. Once a similar document has been identified through these hashes, further comparison analysis can be performed on the actual document data within trusted environments to help determine the risk of fraudulent duplication, as “fuzzy matches” may often be legitimate in nature.

6.3 Risk Analysis and Fraud Detection

Via its deduplication solution in India for domestic invoices (used in-production since March 2018), MonetaGo has found cases of fuzzy matches that are legitimate requests, such as a single large order being split into consecutive invoices between a seller and buyer. In order to avoid these false positives, the Secure Financing solution performs some additional risk analysis and fraud detection on fuzzy match results. Initially this analysis is heuristic in nature – such as defining simple rules like assigning a low risk when invoice numbers are near consecutive but applying a higher risk when invoice numbers

[9] A lender is able to register documents at any time, including after disbursement. If a post-disbursement registration fails because there exists a duplicate prior registration, the lender may have the opportunity to recall or roll back the financing although the lender may face certain risks that this may not be possible. It is therefore recommended that lenders register their transactions prior to financing and only proceed with the financing if they are able to successfully register the financing transactions on the Secure Financing platform. Post-disbursement registration may lead to other lenders making duplicate disbursements under the false pretext of a unique financing.

are the same but only one other field differs, or if amounts are very close but one may be obviously rounded up or down.

The global deduplication tool includes a range of document types other than invoices: the initial deployment is for invoices, purchase orders, bills of lading and warehouse receipts. The global deduplication platform allows registration of document combinations – e.g. an invoice and a bill of lading in a transaction. As more data is ingested into the solution, it will be possible to train more sophisticated models to identify and infer higher risk matches. The exact inference model type used for more complex and accurate fraud detection will be unknown until there is sufficient data with which to test and train the models to a high accuracy. It is important to note that the more data and types of data that are captured in the solution, the better the opportunity to train effective models. The risk analysis score will be added to the fuzzy match record for the lenders to take into account in their own risk analysis.

As an ongoing development, the solution will authenticate documents against external data to assist in fraud detection, such as validating the data on the documents against customs, tax, warehouse and shipping service repositories.

6.4 Pre-Processing and Deduplication of Entity Names

Unlike the current solution in India. which uses unique Goods and Services Taxpayer Identification Number (GSTIN) for buyers and sellers on domestic invoices, use of unique entity identities is not common for international trade and financing thereof.[10] As the global solution uses names and not unique identifiers for legal entities in the documents, the solution will pre-process entity names going into the document repository. This will ensure more robust exact duplicate matching. All information in the document (field-value entries) will be validated and normalized. Whitespace, capitalization and special characters will be removed from document identifiers such as invoice number.

6.5 Partial Drawdown

When documents are financed, the registration flow will allow for an amount to be provided in those cases where only a portion of the relevant amount indicated on the document has been financed. This amount will be held in the document repository and will be represented as a percentage on the fingerprint records. Recording this amount will allow the same lender or another lender to fully or partially finance the remaining amount of the invoice not previously financed.

6.6 Allowable Financing of the Same Documents

It is important to note that the type of financing and who the financing applicant is determine whether duplicate financing is being attempted. For example, an invoice that was used for receivables finance by a supplier can also be subsequently used for financing by the buyer in order to pay the supplier on the due date. This would not be considered duplicate financing, even though the same document is presented by both seller and buyer for financing at different times. These financings can be done sequentially, and do not serve the same purpose, as the seller's financing is settled by the buyer's financing. These business rules are taken into account to avoid denying legitimate financing to a financing applicant.

6.7 Batch Processing Logic

Lenders may process large numbers of documents for financing. To facilitate more efficient processing, the MonetaGo Secure Financing platform supports batches of documents (CSV upload to UI or JSON list to API). Together with batch processing, some lenders will securitize groups of transactions into single units, where the lender does not want to proceed with financing unless ALL documents in the batch are unique. The Secure Financing tool provides a "batch-booking" flag that signifies whether the batch process should be atomic (one fails all) or individual.

[10] MonetaGo supports the use of the Legal Entity Identifier (LEI), a 20-character code based on the ISO 17442 standard, enabling clear and unique identification of legal entities participating in financial transactions. MonetaGo is a member of the Global Legal Identifier Foundation (GLEIF) Vendor Relationship Group: https://www.gleif.org/en/about/gleif-engagement/gleif-stakeholder-groups/gleif-vendor-relationship-group

6.8 Registration Sequence

The registration sequence on the MonetaGo Secure Financing platform provides for (a) document registration, (b) financing registration and (c) cancellation of a document registration or a financing registration. (a) and (b) may be sequential or combined in the workflow. (c) makes the document available for financing again by other participants of the solution.

7. Proof of Concept

MonetaGo Asia Pacific Private Limited was awarded the Proof-of-Concept (POC) grant on December 8, 2020, which provides funding support for experimentation, development and dissemination of nascent innovative technologies in the financial services sector. The POC grant is part of the Financial Sector Technology and Innovation (FSTI) scheme under the Financial Sector Development Fund administered by Monetary Authority of Singapore (MAS).

Project duration was from January 1, 2021, to June 30, 2021.

The goal of the POC was to prove that institutions can prevent duplicate financing fraud relating to Invoices, Purchase Orders, Warehouse Receipts and Bills of Lading. Participating members ran test data through an enhanced duplicate financing registry and had the opportunity to test different domestic and cross-border fraud scenarios, learn about the solution functionalities, and suggest additional features.

Originally conceptualized as a POC involving two banks in Singapore, the POC evolved into a project that garnered the participation of 25 organizations worldwide. Organizations that participated in walk-through and testing of the solution were:

- Sumitomo-Mitsui Banking Corporation
- Macquarie Bank
- HSBC
- Citi
- State Bank of India
- India Factoring
- ICICI Bank
- Rabobank
- National Australia Bank
- ScotPac
- Maybank
- CIMB Bank
- Standard Chartered Bank
- Lloyds Bank
- A US bank
- TradeFlow Capital Management
- TradeIX
- Contour
- Bolero
- R3
- Marketnode (demo)
- Global Legal Entity Identifier Foundation
- FCI (formerly known as Factors Chain International)
- International Chamber of Commerce
- International Trade and Forfaiting Association

Scheduling for a number of other interested organizations to test the solution was not possible before the end date of the POC, and the engagement with them continues outside the auspices of the POC.

Participating organizations in the POC capitalized on an excellent opportunity to lead the fight against finance fraud around the world. Their feedback was essential to shaping the global solution which will be deployed to prevent fraudulent trade finance transactions.

MonetaGo has been working with strategic partners globally to extend connectivity to the entire trade finance ecosystem around the world. The POC represented a “pre-production” phase with production deployments to begin in 2021 in targeted regions.

Detailed information on the POC is provided in Annexes A, B and C.

8. Denouement

This whitepaper has proposed the use of technology to combat duplicate finance fraud in trade finance. The technology described provides a way for lenders to perform deduplication checks without compromising the confidentiality of their transactions, allowing for confident private-private sharing of transaction status without involuntary disclosure of actual transaction data, including the identities of lenders.

The paper argues that the prevention of duplicate financing for international trade requires a global approach, because duplicate financing for the same transaction and financing applicant can happen in different countries. Local registries can only mitigate the risk amongst local lenders and are inadequate at detecting and preventing cross-border duplicate financing. The creation of a global network of registry services built on a common standard, capable of mutualizing deduplication across jurisdictions is by far the most effective solution to prevent duplicate financing attempts across different countries. The building of local registries independent of the global standardized solution would fragment prevention capabilities and be ineffective and counterproductive to combatting duplicate financing for international trade.

This whitepaper touched on the issue of economics. The costs of building and operating a local registry are shared between and paid for within the confines of local stakeholders in the country concerned. The costs of a local registry are not necessarily lower than those of a standardized global solution comprising a network of identical registries. A global solution can prove most economical, as its cost can be defrayed worldwide resulting in the lowest possible cost for lenders in every jurisdiction. This provides a better economic incentive for adoption, driving network effects.

To achieve the widest possible adoption of a global deduplication solution, it cannot be solely the enterprise of a singular company. The drive for adoption needs to happen at the industry level, meaning a broad base of industry stakeholders should be responsible for the solution. Working with SWIFT alongside various international associations representing businesses and financiers, deployment of a natively global standard solution layer that is interoperable between markets will be enabled. Additional services can be built by various local or international vendors on top of this platform to meet specific locally defined requirements.

The ability to effectively detect, deter and prevent cross-border and domestic duplicate financing fraud concurrently would result in the reduction of risks and improved profitability for trade finance providers. At the same time, it would help narrow the trade finance gap, by making more financing available to business enterprises – large and small – that need it to support their bona fide trade and working capital requirements. This would also allow lenders to extend their books of business into new markets and underserved sectors.

The vision for a unified global risk mitigation solution to combat the risk of duplicate financing fraud is hereby cast. And it is being built.

Annex A

Proof of Concept

Contents

A.1 Purpose

The goal of the POC was to demonstrate to participants that duplicate financing fraud relating to Invoices, Purchase Orders, Warehouse Receipts and Bills of Lading can be prevented with MonetaGo's Secure Financing platform.

As the base functionality of the Secure Financing platform has already been proven in India, this POC was intended to validate the requirements needed for an enhanced deployment to the Singaporean market and beyond.[11]

A.2 Marketing and Joining the Program

All banks and non-bank lenders were eligible to join, with no fees required. The only prerequisite for participation was a mutual non-disclosure agreement to be executed between the participant and MonetaGo.

As a project emanating from Singapore, banks based in Singapore were the first to be invited. Invitees were provided an overview of the Secure Financing solution, a presentation deck that included various use case scenarios for the solution, and information about MonetaGo and GUUD.[12] Online and in-person meetings with banks and other institutions were conducted to present the project. With eventual participation by institutions in various countries, the project evolved to become international in scope.

The take-up by invited banks to participate in the project was initially slow, which was understandable given that the invitations were launched in Q1 2021 when the priorities and agenda of many banks for 2021 had already been set without this project in view. To encourage more participants to join the project, two phases for the project were created:

- Phase I testing via UI.
- Phase II testing via API.

It was envisaged that Phase I would allow more participants to join, as they would not need to expend IT resources to participate. Participation in Phase II would be by a limited number of banks who were

[11] The MonetaGo Secure Financing platform has been used in production since March 2018, for deduplication and authentication for domestic invoice financing in India. Its user base in India comprises commercial banks, non-banking financial companies and the Trade Receivables e-Discounting System.

[12] GUUD Pte. Ltd. (https://guud.company/) is the operator of the CamelONE™ Trade Finance Application Portal, Singapore's multi-bank trade finance portal, and partnered with MonetaGo to build the User Interface platform deployed for Phase I of the POC.

prepared to invest some technical resources. Subsequent development of the test plan for Phase II allowed participants to witness or perform an API test via Stoplight, an OpenAPI specification tool, without the need to integrate their systems with the API – this enabled more institutions to participate in Phase II.

The project was organized on a "rolling" basis to allow new participants to be added within the project duration.

The two phases of the project and the path to production are shown in Figure A.2.1.

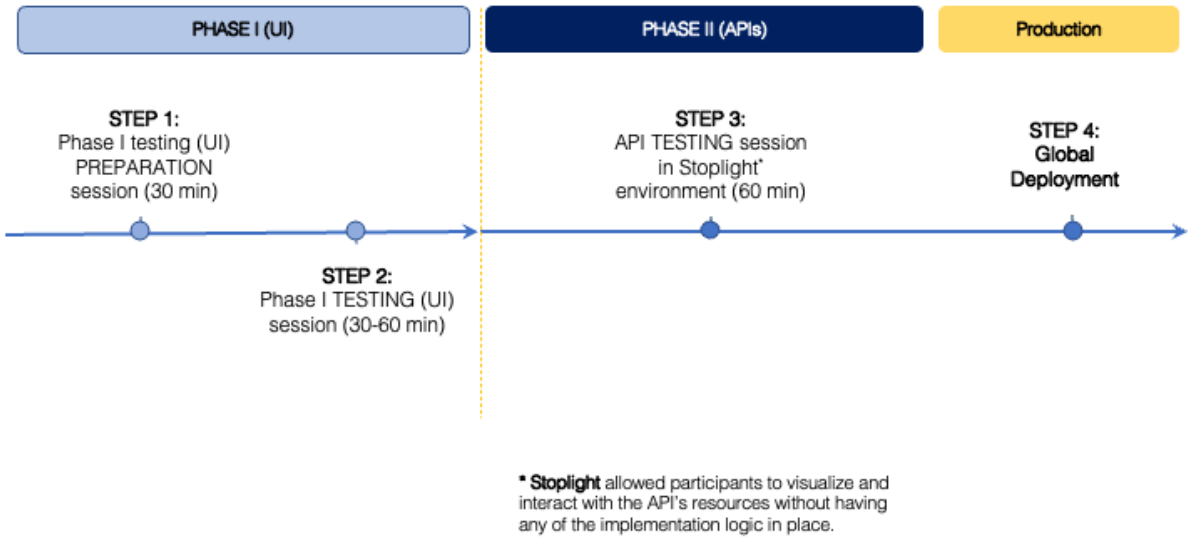

Figure A.2.1: Secure Financing POC and Project Timeline

Examples of Duplicate Financing Fraud use case scenarios shared with invitees are presented in Figures A.2.2 to A.2.7.

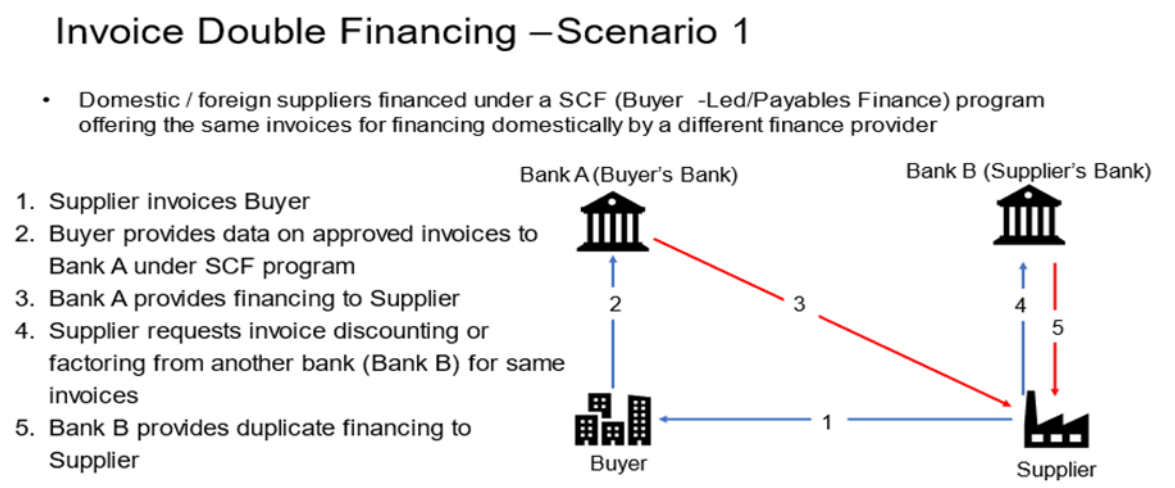

Figure A.2.2: Duplicate Financing Fraud Use Case Scenarios – Invoice Double Financing

Invoice Double Financing – Scenario 2

- Same suppliers are enrolled in two or more SCF (Buyer -Led/Payables Finance) programs of the same Buyer, and same invoices are financed by different SCF providers

1. Supplier invoices Buyer
2. Buyer provides data on approved invoices to Bank A under SCF Program A
3. Bank A provides financing to Supplier
4. Buyer provides duplicate data on approved invoices to Bank B under SCF Program B
5. Bank B provides duplicate financing to Supplier

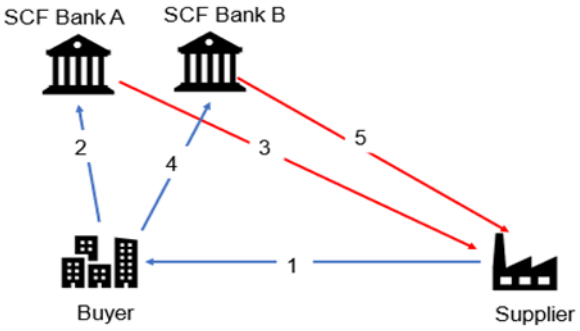

Figure A.2.3: Duplicate Financing Fraud Use Case Scenarios – Invoice Double Financing

Invoice Double Financing – Scenario 3

- Supplier obtaining domestic / international factoring of the same invoices from two or more finance providers

1. Supplier requests factoring from Bank A
2. Bank A provides financing to Supplier
3. Supplier requests invoice discounting from Bank B
4. Bank B provides duplicate financing to Supplier

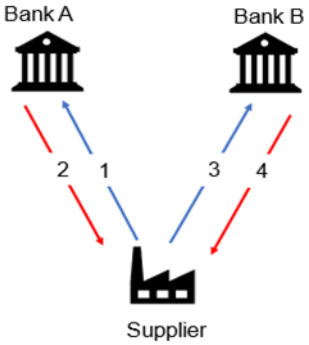

Figure A.2.4: Duplicate Financing Fraud Use Case Scenarios – Invoice Double Financing

Purchase Order Double Financing – Scenario 4

- Same Purchase Orders offered to two or more banks for PO finance or pre-shipment financing

1. Buyer issues Purchase Order to Supplier
2. Supplier requests pre-shipment financing from Bank A
3. Bank A provides pre-shipment financing to Supplier
4. Supplier requests pre-shipment financing from Bank B
5. Bank B provides duplicate pre-shipment financing to Supplier

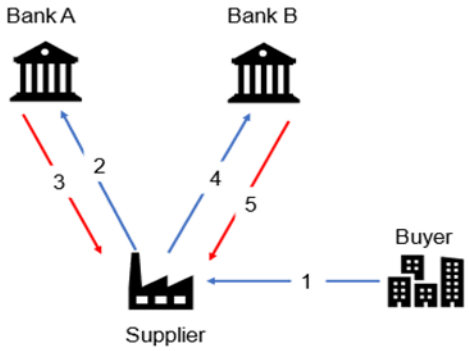

Figure A.2.5: Duplicate Financing Fraud Use Case Scenarios – Purchase Order Double Financing

Warehouse Receipts Double Financing– Scenario 5

- Same warehouse receipts offered to multiple banks in different locations for inventory financing

1. Warehouse issues warehouse receipts
2. Borrower requests inventory financing from Bank A
3. Bank A provides inventory financing to Borrower
4. Borrower requests inventory financing from Bank B
5. Bank B provides duplicate inventory financing to Buyer

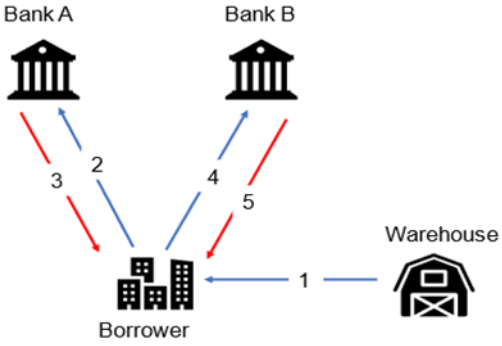

Figure A.2.6: Duplicate Financing Fraud Use Case Scenarios – Warehouse Receipts Double Financing

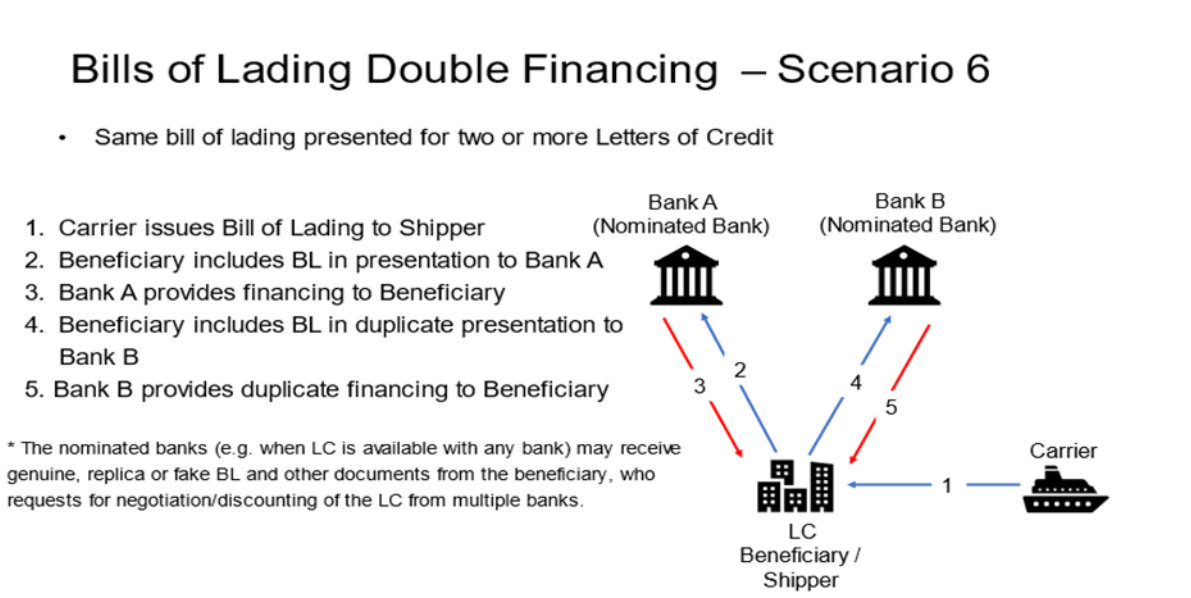

Figure A.2.7: Duplicate Financing Fraud Use Case Scenarios – Bills of Lading Double Financing

The examples provided were neither exhaustive nor restrictive. Participants were welcome to share additional duplicate financing fraud scenarios.

The tests for duplicate financing would follow the same logic for each document type.

A.3 Technical Development

Phase I

Development of the UI by GUUD was completed and made available for testing by participants at the end of March 2021.

Phase II

Development of the API was completed at the start of June 2021 and was made available for participant testing using an API testing tool (Stoplight). The API was designed to maximize ease of integration for banks by adopting open standards. Wherever possible data structures use existing ISO 20022 standards, with the intent to submit new definitions to the ISO 20022 repository where no appropriate pre-existing definitions exist. Adopting ISO 20022 standards makes it easy for banks to implement the appropriate database schemas. The API specification is also defined using the OpenAPI 3 standard, allowing banks to easily generate client-side code and SDKs automatically, reducing the programming effort required to implement the API.

A.4 Testing Overview

Phase I testing was done on a simple testing UI that allowed participants to step through the workflow without having to perform any integration on their own end.

- This phase allowed participants to test the UI functionality and observe the outcomes and served to educate participants on the workflow for deduplication and to validate the business need of the solution.
- By ensuring that the workflow and results in the UI were simple and easy to understand, participants could quickly gain an understanding of the functionality offered, provide feedback as to how this would fit in their existing processes, and establish the value of such a system in their business.
- This phase did not require a high level of technical knowledge, allowing MonetaGo to receive feedback from the likely end users of such a system, as well as from the broader technical and business teams.

Phase II was done on Stoplight, an OpenAPI specification tool that allowed participants to directly interact with and observe the API requests and responses without having to perform any integration on their own end.

- ❖ This phase allowed participants to step through the workflow and observe the actual information that is sent back and forth on the API level.
- ❖ Technical teams from participating organizations had the opportunity to observe the technical specification of the Secure Financing solution, to view the overall API workflow, schema and code examples to deeply understand the API itself. The "Try It Out" feature allowed the participants' operators to submit sample data and review real-time responses from the API.
- ❖ This phase involved members of the participants' technical teams (such as engineering, technical product etc.) to operate or observe the operation of the same workflow from Phase I but through the back-end API.

The effort required by institutions for Phase I and Phase II tests were designed to be minimal, avoiding heavy resource consumption and to so encourage participation.

A.5 Test Plan

The test plan for each session took into account the preferences for test scenarios indicated by the participants and was customized accordingly. Participants were requested in advance of their test sessions to choose from a menu of test scenarios (*see Figure A.5*).

SELECT ONE TRANSACTION TYPE	+	SELECT ONE DOCUMENT TYPE	=	TEST SCENARIO CHOSEN
1.Domestic *(borrower and lender in same country)*		1.Invoice		1.Domestic Invoices (DINV)
2.Domestic *(buyer and supplier in same country)*		2.Bill of Lading		2.Cross-Border Invoices (CBINV)
3.Cross-Border *(buyer and supplier in different countries)*		3.Purchase Order		3.Cross-Border Bill of Lading (CBBL)
4.Cross-Border *(borrower and lender in different countries)*		4.Warehouse Receipt		4.Domestic Purchase Order (DPO)
				5.Cross-Border Purchase Order (CBPO)
				6.Domestic Warehouse Receipt (DWR)
				7.Cross-Border Warehouse Receipt (CBWR)

Figure A.5: Menu of the Test Scenarios

Participation in Phase I involved two sessions for each participating institution:

- A preparation call to discuss the purpose and goals of the POC, provide an overview of the testing procedure, share the choices of documents and scenarios to test, and answer participants' questions.
- The test session. Each organization would be paired with another organization to test the scenarios selected in the preparation session. Prior to this session, each organization would be provided the following: (1) user guide with detailed instructions inclusive of screenshots, (2) data sets tailored to each organization's preselected test scenarios, and (3) login ID and password for the test portal.

The test operator for Phase I could be a non-IT staff member (e.g. from the front office, middle office or back office) of the participating institution.

A sample test plan for Phase I shared with participants is provided in Annex B.

Participation in Phase II was recommended to involve a participating institution's staff member with a technical background (i.e. engineering, technical product etc.) due to the nature of the JSON data with which the operator would be interacting to review and test the platform's back-end APIs. This enabled interaction with the code and nuanced discourse about the API. Non-technical observers from the participating organizations were welcome to observe.

The test scenarios covered in Phase II via Stoplight were conceptually the same as those in Phase I via the user interface, but with visibility into the back-end API. The Phase II scenario was a trade financing validation batch containing one invoice and one bill of lading with an exact match and a fuzzy match to demonstrate potential fraud as well as a match with different financing applicants to demonstrate a potentially legitimate sequential financing using the same document.

Phase II was intentionally designed to require no development resources or engineering implementation from the participating organizations due to the time and cost-intensive nature of API integration.

A.6 Test Outcomes

Phase I:

- Phase I sessions were conducted commencing April 23, 2021, and the last session was held on June 24, 2021.
- 19 sessions were organized, for a total of approximately 16 hours of testing. Each session was for either a pair of participating organizations, or for a single participating organization.
- 84 unique sample data sets of invoices, purchase orders, warehouse receipts and bills of lading were created.
- The sample data for Phase I contained 777 unique documents including invoices, purchase orders, warehouse receipts, and bills of lading.
- Within the 777 unique documents tested in Phase I, there were 84 exact matches (10% of all documents) and 84 fuzzy matches (10% of all documents) for a total of 20% of all documents tested demonstrating the match detection capability.

Phase II:

- Phase II sessions were conducted commencing June 18, 2021, and the last session was held on June 30, 2021.
- 6 sessions were organized, for a total of 6 hours of testing. Each session was for a single participating organization which was more conducive to discussions on specifications and aspects of the API.
- 6 unique sample data sets for of invoices and bills of lading were created. Data sets were kept small because the primary purpose of Phase II was to provide a walkthrough of the API rather than to demonstrate the match detection capability.

In both Phases I and II:

- Users were able to successfully register, mark as financed and cancel documents of all four types of documents in the system.
- The platform accurately identified unique documents, exact matches and fuzzy matches for all data uploaded during test sessions.
- The platform identified duplicate registered documents and users observed near real time intervention of duplicate financing.
- Users could identify if registered document matches were internal (within their own organization) or external (with another lender).
- Users could identify if documents had been financed within their own organization, or by another lender through the Match Status feature.
- Users were able to identify suspiciously similar registered documents (fuzzy matches) and perform analysis on the match types in order to make a financing decision.
- Users were able to see that exact matches of cancelled documents could subsequently be financed, demonstrating that once a document was cancelled, any subsequent registration of the same data would be considered unique.

Annex B

Secure Financing Testing Plan

Secure Financing Testing Guide

This document provides a user guide for testing MonetaGo's Secure Financing platform.

Please visit the Support Page on the Secure Financing website for questions and contacts.

If you are not familiar with the Secure Financing platform, please visit the User Guide for step-by-step instruction on the fundamentals.

Updated May 2021.

Contents

B.1 Overview

B.1.1 Test Instructions

(1) Download the necessary files below to your computer. If you are unable to upload CSVs, the data is also provided at the bottom of each scenario and can be manually inputted.
(2) Access the Secure Financing platform at https://securefinancing.com/
(3) Login to the platform using your given credentials.
(4) Select your desired test scenario from the table below.
(5) Scroll to the page number at left of the scenario type to view instructions for that test.
(6) Follow the steps below each specific test scenario. Expected results are at right of table.

B.1.2 Users

- USER A and USER B are intended to represent cross-company operators.
- The USER A and USER B data can be tested for inter-company operators on different login credentials: fuzzy and exact matches will be the same as cross-company results.
- The USER A and USER B data can be tested for inter-company operators on the same login credentials: matches will indicate "Internal" on the match type label.

Table B.1: Scenario Steps

Page #	Test Scenarios	USER A Sample Data	USER B Sample Data
1	1) Domestic Invoices (DI)	1) A_D_ inv1	1) B_D_inv1
2	2) Cross-Border Invoices (CBINV)	2) A_CB_ inv2	2) B_CB_ inv2
3	3) Domestic Purchase Order (DPO)	3) A_D_po1	3) B_D_po1
4	4) Cross-Border Purchase Order (CBO)	4) A_CB_po2	4) B_CB_po2
5	5) Warehouse Receipt (DWR)*	5) A_wr1	5) B_wr1
6	6) Cross-Border Bill of Lading (CBBL)*	6) A_CB_bl2	6) B_CB_bl2

*Note: Warehouse Receipts do not specify the country of the borrower, making domestic or cross-border not relevant for this testing scenario. Bills of Lading are most often cross-border transactions, making a domestic scenario not relevant.

B.1.3 Notes

(1) Note that the fuzzy matching analysis runs once per minute, so fuzzy matches will show if present once that process has completed.

(2) The expression “financed” indicates that documents have been marked on the MonetaGo platform as having been financed by the lender, and it does not mean that the MonetaGo platform is used to effect financing.

(3) All company names, transactions, and values in the test data provided below are fictional.

B.2 Test Scenario 1 – Domestic Invoices

Domestic is defined here as buyer and supplier in the same country.

(1) A first batch of invoices is registered and financed by **USER A**.

(2) **USER B** registers a second batch, containing some identical and some similar invoices to the first batch, and observes that:

- the identical invoices will fail to register and be identified as Exact Matches, and
- certain similar invoices will be identified as Fuzzy Matches.

(3) **USER A** finances the batch, observing that exact matches will not be available for financing.

(4) **USER A** will then cancel the financing of an invoice.

(5) **USER B** will refresh the invoice, attempt financing and observe that it is successful.

Table B.2.1: Scenario Steps

	Participant	**Action**	**Anticipated Outcome**
1.	USER A	Register A_T1_inv1	Success
2.	USER A	Finance A_T 1_inv1	Success
3.	USER B	Register B_T1_inv1	Success with Fuzzy Matches; Financed Exact Matches Fail
4.	Both	Refresh Page after 1 min	Fuzzy Matches Appear
5.	USER B	Finance inv_009	Success
6.	USER A	Cancel inv_009	Success
7.	USER B	Retry and Finance inv_009	Inv_009 Available for Financing; Financing Success

Expected Match Flags		
1.	inv_009	
2.	inv_013	Fuzzy Match

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.2.2 USER A Data

Invoice #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
inv_008	Pine Petroleum	AU	Teal Tech	AU	2021-02-13	200000	AUD
inv_009	Pine Petroleum	AU	Light Corp	AU	2021-04-13	430000	AUD
inv_013	QR Industries	AU	Circle Chemicals	AU	2021-03-27	106000	AUD

Table B.2.3 USER B Data

Invoice #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
inv_009	Pine Petroleum	AU	Light Corp	AU	2021-04-13	430000	AUD
inv_008	Mills Materials	AU	Ultra Tech	AU	2021-01-13	650000	AUD
inv_013	QR Industries	AU	AB Incorporated	AU	2021-03-27	106000	AUD

B.3 Test Scenario 2 – Cross-Border Invoices

Cross-border is defined here as buyer and supplier in different countries.

(1) A first batch of invoices is registered and financed by **USER A.**

(2) **USER B** registers a second batch, containing some identical and some similar invoices to the first batch, and observes that:

- the identical invoices will fail to register and be identified as Exact Matches, and
- certain similar invoices will be identified as Fuzzy Matches.

(3) **USER A** finances the batch, observing that exact matches will not be available for financing.

(4) **USER A** will then cancel the financing of an invoice.

(5) **USER B** will refresh the invoice, attempt financing and observe that it is successful.

Table B.3.1: Scenario Steps

	Participant	Action	Anticipated Outcome
1.	USER A	Register A_T1_inv1	Success
2.	USER A	Finance A_T 1_inv1	Success
3.	USER B	Register B_T1_inv1	Success with Fuzzy Matches; Financed Exact Matches Fail
4.	Both	Refresh Page after 1 min	Fuzzy Matches Appear

5.	USER B	Finance inv_109	Success
6.	USER A	Cancel inv_109	Success
7.	USER B	Retry and Finance inv_109	Inv_109 Available for Financing; Financing Success
Expected Match Flags			
1.	inv_109	Exact Match	
2.	inv_113	Fuzzy Match	

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.3.2: USER A Data

Invoice #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
inv_109	Polar Petroleum	SG	Accelerate Inc	IN	2021-04-13	430000	SGD
inv_120	Mills Materials	SG	Hydro Tech	IN	2021-01-13	650000	SGD
inv_113	NB Industries	SG	MB Incorporated	IN	2021-03-27	106000	SGD

Table B.3.3: USER B Data

Invoice #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
inv_108	Polar Petroleum	SG	Teal Technologies	IN	2021-02-13	200000	USD
inv_109	Polar Petroleum	SG	Accelerate Inc	IN	2021-04-13	430000	USD
inv_113	NB Industries	SG	Circle Chemical	IN	2021-03-27	106000	USD

B.4 Test Scenario 3 – Domestic Purchase Orders

Domestic is defined here as buyer and supplier in the same country.

(1) A first batch of domestic purchase orders is registered and financed by **USER B.**

(2) **USER A** registers a second batch, containing some identical and some similar purchase orders (POs) to the first batch, and observes that:

- the identical POs will fail to upload as they are identified as Exact Matches, and
- certain similar POs will be identified as Fuzzy Matches.

(3) **USER A** finances their batch and observes the successfully registered POs will be successfully financed.

(4) **USER B** will then cancel the financing of a PO.

(5) **USER A** will retry the PO, attempt financing and observe that it is successful.

Table B.4.1: Scenario Steps

	Participant	Action	Anticipated Outcome
1.	USER B	Register B_T2_po1	Success
2.	USER B	Finance B_T2_po1	Success
3.	USER A	Register A_T2_po1	Success with Fuzzy Matches; Financed Exact Matches Fail
4.	Both	Refresh Page after 1 min	Fuzzy Matches Appear
5.	USER A	Finance A_T2_po1	Success
6.	USER B	Cancel po_003	Success
7.	USER A	Retry po_003	Success
8.	USER A	Finance po_003	PO_003 Available for Financing; Financing Success
Expected Match Status			
1.	po_003	Exact Match	
2.	po_004	Fuzzy Match	

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.4.2: USER A Data

PO #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
po_003	First Agriculture	AU	JP Technologies	AU	2021-04-30	150000	AUD
po_004	SG Energy	AU	Infotech	AU	2021-03-31	460000	AUD
po_005	Newton Materials	AU	Blue Ocean	AU	2021-01-30	250000	AUD

Table B.4.3: USER B Data

PO #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
po_003	First Agriculture	AU	JP Technologies	AU	2021-04-30	150000	AUD
po_004	SG Energy	AU	Infotech	AU	2021-03-30	220000	AUD
po_007	AgriTech	AU	Blue Sky Inc	AU	2021-04-15	300000	AUD

B.5 Test Scenario 4 – Cross-Border Purchase Orders

Cross-border is defined here as buyer and supplier in different countries.

(1) A first batch of domestic purchase orders is registered and financed by **USER B.**

(2) **USER A** registers a second batch, containing some identical and some similar purchase orders (POs) to the first batch, and observes that:

- the identical POs will fail to upload as they are identified as Exact Matches, and

- certain similar POs will be identified as Fuzzy Matches.

(3) **USER A** finances their batch and observes the successfully registered POs will be successfully financed.

(4) **USER B** will then cancel the financing of a PO.

(5) **USER A** will retry the PO, attempt financing and observe that it is successful.

Table B.5.1: Scenario Steps

	Participant	Action	Anticipated Outcome
1.	USER B	Register B_T2_po1	Success
2.	USER B	Finance B_T2_po1	Success
3.	USER A	Register A_T2_po1	Success with Fuzzy Matches; Financed Exact Matches Fail
4.	Both	Refresh Page after 1 min	Fuzzy Matches Appear
5.	USER A	Finance A_T2_po1	Success
6.	USER B	Cancel po_103	Success
7.	USER A	Retry po_103	PO_103 Available for Financing
8.	USER A	Finance po_103	Success
Expected Match Status			
1.	po_103	Exact Match	
2.	po_104	Fuzzy Match	

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.5.2: USER A Data

PO #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
po_103	First Agricole	IN	SS Technologies	SG	2021-04-30	1500000	SGD
po_104	CA Energy	IN	InforTech	SG	2021-03-30	2200000	SGD
po_107	AgriTech	IN	Blue Sky Inc	SG	2021-04-15	3000000	SGD

Table B.5.3: USER B Data

PO #	Supplier	Supplier Country	Buyer	Buyer Country	Date	Amount	Currency
po_103	First Agricole	SG	SS Technologies	IN	2021-04-30	1500000	USD
po_104	CA Energy	SG	InforTech	IN	2021-03-31	4600000	USD
po_105	Newton	SG	Blue Ocean	AU	2021-01-30	2500000	USD

B.6 Test Scenario 5 – Warehouse Receipts

Warehouse Receipts (WRs) could be offered as collateral for financing locally or in a third country. The testing therefore need not identify whether financing is cross-border or local. As we do not specify country of the borrower(s), it is possible that the financing will be domestic or cross-border between lender and borrower. Cross-border is defined here as borrower and lender in the same country, warehouse in different countries.

(1) A first batch of warehouse receipts is registered by **USER A**

(2) **USER B** registers their batch, containing some identical and some similar WRs to the first batch, and observes that:

- the identical WRs will be identified as Exact Matches, and
- the similar WRs will be identified as Fuzzy Matches.

(3) **USER A** will finance the batch.

(4) **USER B** will also finance the batch and observe that exact matches will not be successfully financed.

(5) **USER A** will then cancel the financing, and Participant A will repeat their attempt at financing and observe that it is successful.

Table B.6.1: Scenario Steps

	Participant	Action	Anticipated Outcome
1.	USER A	Register A_T3_wr1	Success
2.	USER B	Register B_T3_wr1	Success with Exact Matches
3.	Both	Refresh after 1 min	Fuzzy Matches appear
4.	USER A	Finance A_T3_wr1	Success
5.	USER B	Finance B_T3_wr1	Failure of WR with Exact Matches
6.	USER A	Cancel wr_001	Success
7.	USER B	Refresh and Finance wr_001	wr_001 Available for Financing; Financing Success
Expected Match Flags			
1.	wr_001	Exact Match	
2.	wr_002	Fuzzy Match	

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.6.2: USER A Data

WHR #	Issuer	Country of Warehouse	Date
wr_001	Orange Warehouses	SG	2021-05-01
wr_002	Sea View	SG	2021-04-29
wr_006	RT Warehouses	IN	2021-04-30

Table B.6.3: USER B Data

WHR #	Issuer	Country of Warehouse	Date
wr_001	Orange Warehouses	CN	2021-05-01

wr_002	Sea View	CN	2021-05-02
wr_003	VR Warehouses	CN	2021-05-03

B.7 Test Scenario 6 – Bills of Lading

Bill of ladings (BLs) are transport documents typically for cross-border trade. The location of the lender that provides financing against the BL could be in any location. It can be exporter/shipper getting financed by a local lender, importer/consignee getting financed by a local lender, or exporter/shipper or the importer/consignee financed by a foreign lender. The question of local or cross-border therefore is not relevant.

(1) **USER B** registers a first batch of bills of lading.

(2) **USER A** will upload a second batch, containing some identical and some similar BLs, and observe that:
- the identical BLs will be identified as Exact Matches, and
- the similar BLs will be identified as Fuzzy Matches.

(3) **USER B** will finance the batch.

(4) **USER A** will also finance the batch and observe that exact matches will not be available for financing.

(5) **USER B** will then cancel the financing of a bill of lading.

(6) **USER A** will repeat their attempt at financing this BL and observe that it is successful.

Table B.7.1: Scenario Steps

	Participant	Action	Anticipated Outcome
1.	USER B	Register B_T4_bl1	Success
2.	USER A	Register A_T4_bl1	Success with Registered Exact Matches
3.	Both	Refresh Page after 1 min	Fuzzy Matches Appear
4.	USER B	Finance B_T4_bl1	Success
5.	USER A	Finance A_T4_bl1	Failure of BLs with Financed Exact Matches
6.	USER B	Cancel bl_006	Bl_006 Available for Financing
7.	USER A	Finance bl_006	Success
Expected Matches			
1.	BL_006	Exact Match	
2.	BL_004	Fuzzy Match	

UPLOAD CSV OR MANUALLY INPUT DATA

Table B.7.2: USER A Data

BL #	Carrier	Shipper	Consignee	Date	Loading Port	Discharge Port	Vessel Name
bl_006	SF Group	Circle Shipping	To the order of Vision Bank	2021-02-20	Chennai	Singapore	Fast Wind

bl_004	Chelsea Carriers	Wolf Inc	To the order of HP Bank	2021-03-20	Singapore	Chennai	Seahorse
bl_007	Taylor Shipping	Power Traders	To the order of IC Bank	2021-04-19	Nhava Sheva	Singapore	Blue Sea

Table B.7.3: USER B Data

BL #	Carrier	Shipper	Consignee	Date	Loading Port	Discharge Port	Vessel Name
bl_004	Chelsea Carriers	Marshall Inc	To the order of HP Bank	2021-03-20	Singapore	Chennai	Seahorse
bl_005	Lily Holding	Kessler Marine	To the order of NB Bank	2021-03-21	Singapore	Chennai	Mermaid
bl_006	SF Group	Circle Shipping	To the order of Vision Bank	2021-04-20	Chennai	Singapore	Fast Wind

Annex C

Performance and Resilience Testing for MonetaGo Deduplication Registry

Contents

C.1 Performance Testing

C.1.1 Introduction

MonetaGo's de-duplication registry which is currently operating in India has been successfully identifying duplicate invoices since go-live in 2018. The solution which MonetaGo has designed and produced for the Secure Financing for Trade POC is the next evolution of this product, with significant additions in functionality over the first. This iteration brings significant scalability and performance gains over the first-generation approach and has expanded the scope to include additional document types. MonetaGo's proposed solution has been designed with the knowledge gained from our existing first-generation products, and would improve the process of identifying duplicates, while also comfortably supporting large-scale future growth.

C.1.2 Two Models

MonetaGo breaks down the duplicate search into two processes described as "Model 1" and "Model 2". The purpose of Model 1 is to identify documents which are certain to relate to the same transaction. The purpose of Model 2 is to identify documents which **could** relate to the same transaction. MonetaGo performs each of these checks sequentially because the Model 1 check is done at the time of insertion into the database, and the Model 2 check is performed in batches for parallelization on the information inserted into the database.

It is important to consider the meaning of a match in Model 1. An "exact" match means there is certainty that the document is a duplicate of another (probability of duplicate = 100%). We can take advantage of business domain knowledge in trade to create a definition for an exact match which does not need to involve all fields in the document. For example, it is the seller who creates an invoice, and a seller will never use the same invoice number twice in the same financial year. So, a combination of Seller Name, Seller Country, Invoice ID, and Invoice Date should be sufficient to determine uniqueness and an exact match. Even if the other fields are different, we can still consider the documents an exact match and reject them for financing. The definition of exact match criteria should be singular and represent only the minimum set of fields required to constitute an exact match (*see Figure C.1.2*).

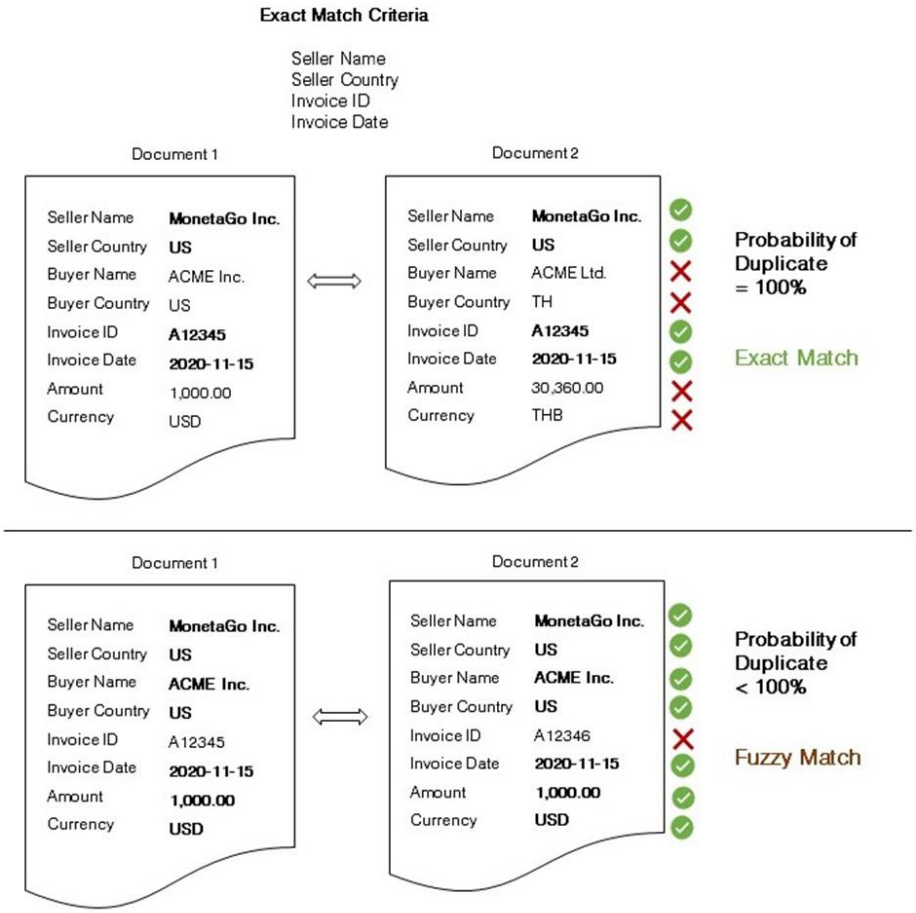

Figure C.1.2: Exact Match Criteria

Any match combination which contains the minimum exact match criteria fields as a subset is considered an exact match. Any match combination which does not contain **all** the minimum exact match criteria fields cannot be considered an exact match because there is less than 100% probability that the documents refer to the same business transaction, and therefore is classified as a fuzzy match.

C.1.3 Performance Testing Process

Please note that this testing process was run on an environment tailored for a proof of concept with significantly smaller machines than a production system would have. As such, test results are not reflective of results expected from a production environment.

We tested and provided answers as per the following metrics:

- Seeding time.
- Transaction per Second (TPS) for set batch size at increasing volumes.
- Transaction per Second (TPS) for increasing batch size at set volume.

C.1.3.1 Seeding Time

The initial step for this testing workflow involved seeding the environment with gradually increasing quantities of data. Requests of size N are batched into a single transaction in the ledger in order to increase throughput. If a request contains 10 documents, for example, only 10 documents are a part of that transaction in the ledger. If a request contains 500 documents, then all 500 are part of that ledger transaction. Total ledger volume was incrementally increased to levels of 1000, 5000, 10000, 25000, and finally a total volume of 50000 unique documents. Response times were recorded at each interval.

C.1.3.2 TPS for Set Batch Size at Increasing Volumes

At each interval in the above cycle, two batches of documents were uploaded to the system via the user interface. Each pair of batches contained a combination of unique documents, fuzzy matches and exact matches. The response times as well as the match counts were recorded. Each batch contained 50 documents, adding 100 documents to the total number of documents in the system at each interval.

C.1.3.3 TPS for Increasing Batch Size at Set Volume

Following the completion of the final seeding and UI batch uploading, with a total of 55,500 documents already in the system, a series of increasingly large batches were entered into the system. The batch sizes were 1, 10, 50, 100, 250, and 500. This process was repeated three times. The response times were recorded and the average TPS was calculated.

C.2 Documentation for Testing Methodology and Results

C.2.1 Environment Configuration

C.2.1.1 Data Dog Monitoring

The virtual machine (VM) will have a data dog agent running which captures CPU and RAM utilization. The captured statistics are shared in section C.2.7 below.

C.2.1.2 Test Environment Configuration

Test will be run in Fingerprinting-Singapore (FP-SG) multi-node configuration (integ) where a single VM hosts following services (*see Figure C.2.1.2*)

- Postgres agent node docker service.
- Postgres issuing node docker service.
- Fuzzy Match docker service.
- Agent node API docker service.
- Cordapp agent node daemon.
- Corda API agent node daemon.
- Cordapp issuing node daemon.
- Corda API issuing node daemon.
- Corda notary daemon.

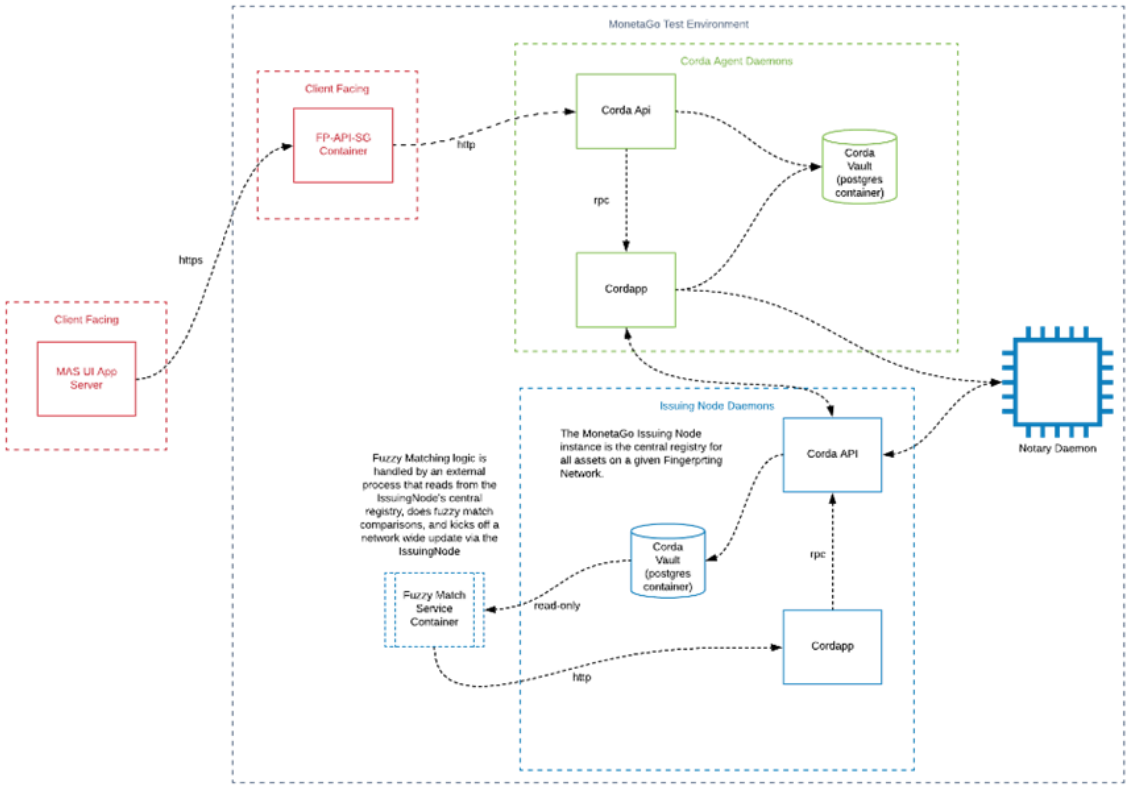

Figure C.2.1.2: MonetaGo Test Environment

C.2.1.3 Azure Cloud-based Virtual Machine

The test environment will be running exclusively on an Azure Cloud Virtual Machine, Standard D4s v3 (4 vCPUs, 16 GiB memory) (Dsv3-series), in the **East US** Azure Location.

The Standard D4s v3 (4 vCPUs, 16 GiB memory) (Dsv3-series)

The Dsv3-series run on Intel® Xeon® Platinum 8272CL (Cascade Lake), Intel® Xeon® 8171M 2.1GHz (Skylake), Intel® Xeon® E5-2673 v4 2.3 GHz (Broadwell), or the Intel® Xeon® E5-2673 v3 2.4 GHz (Haswell) processors in a hyper-threaded configuration, providing a better value proposition for most general purpose workloads. Memory has been expanded (from ~3.5 GiB/vCPU to 4 GiB/vCPU) while disk and network limits have been adjusted on a per core basis to align with the move to hyperthreading. The Dv3-series no longer has the high memory VM sizes of the D/Dv2-series, those have been moved to the memory optimized Ev3 and Esv3-series.

Example D-series use cases include enterprise-grade applications, relational databases, in-memory caching, and analytics.

C.2.2 Configure Fingerprinting Environment

Invoice Attributes:

- Seller – made up of Seller Name and Country Code
- Buyer – made up of Buyer Name and Country Code
- Invoice ID
- Invoice Date
- Total Amount – made up of Amount and Currency

Exact Match Fields:

- Seller
- Buyer
- Invoice ID
- Invoice Date

Fuzzy Match Types:

Type A

- Seller
- Invoice ID

Type B

- Seller
- Invoice ID
- Buyer

Type C

- Seller
- Invoice ID
- Buyer
- Amount

C.2.3 Test Runs

C.2.3.1 Test One: Seeding Data

Steps:

(1) Seed environment with data;

(2) Trigger Fuzzy Match Cycle.

Measurements:

- Registration Time
- Fuzzy Match Cycle Run Time (not including scheduling time – just the actual processing time)
- DB Statistics: db size, match_cnt, invoice_cnt, hash_cnt

C.2.3.2 Test Two: Batch Upload at Increasing Seeded Volume

Steps:

(1) Increase seeded volume as in Test One;

(2) Upload pairs of batches containing exact and fuzzy matches at each seeding increment.

Measurements:

- Batch Processing Times (translated to TPS)
- Fuzzy Match Cycle Run Times

C.2.3.3 Test Three: Increasing Batch Size at Max Seeded Volume

Steps:

(1) Use seeded data from Test One and Test Two;

(2) Load automated batches of increasing size into the system.

Measurements:

- Batch Processing Times (translated to TPS)

C.2.4 Test Data

For purposes of the test, we meet the requirements for generating unique invoices across all **matching criteria sets** by incrementing the Invoice ID, Seller Name, Seller Country, Date, and Amount attributes. We created 5 Batch A and 5 Batch B sets to be registered via unique login credentials. Each batch contained 50 invoices, with 10% of each batch being exact matches, 10% being fuzzy matches, and the remaining 80% unique. The third pair of batches entered into the system did not contain fuzzy matches, with the fourth pair of batches containing twice the number of typical matches. The data appeared in iterations as follows:


```
{
   "SellerName":"Seller 1",
   "BuyerName":"Seller 2",
   "SellerCountryCode":"SG",
   "InvoiceID":"inv_0001",
   "InvoiceDate":"2021-01-01",
   "Amount":"1000",
   "Currency":"SGD"
}
```


C.2.5 Registration Calls

Batch submission was automated using a Node.js script, which executed POST requests directly to the Bank1 (agent) agent node API docker service. All automated data was composed of unique invoices, with fuzzy and exact matches being added to the system through the batches uploaded via UI.

C.2.6 Performance Test Steps Details

C.2.6.1 Clean and Prepare

(1) Purge database;
(2) Measure db size;
(3) Turn on data-dog agents on all integ environment VM's and confirm CPU and RAM captured.

C.2.6.2 Baseline

(1) Register one invoice – note timing;
(2) Run Manual Fuzzy Match – note timing.

C.2.6.3 Set Batch Size at Increasing Seeding Volumes

(1) Run script to seed data into environment;
(2) Execute seeding script;
(3) Log timings from seeding script;
(4) Measure db stats (database size, invoice count, hash count, match count);
(5) Register batch of 50 via the user interface – note timing;
(6) Register second batch of 50 via the user interface containing exact and fuzzy matches – note timing;
(7) Repeat process at increasing seed intervals: {1k, 5k, 10k, 25k, 50k}.

C.2.6.4 Increasing Batch Sizes at Set Volume

(1) Complete previous seeding test, resulting in 50k documents seeded in the environment;
(2) Load batches of varying sizes: e.g. {1, 10, 50, 100, 250, 500};
(3) Log timings for each batch size, adjust starting id as offset of highest ID from previous batch;
(4) Graph Timings;
(5) Interpolate highest TPS.

C.2.7 Performance Test Results

C.2.7.1 Seeding TPS

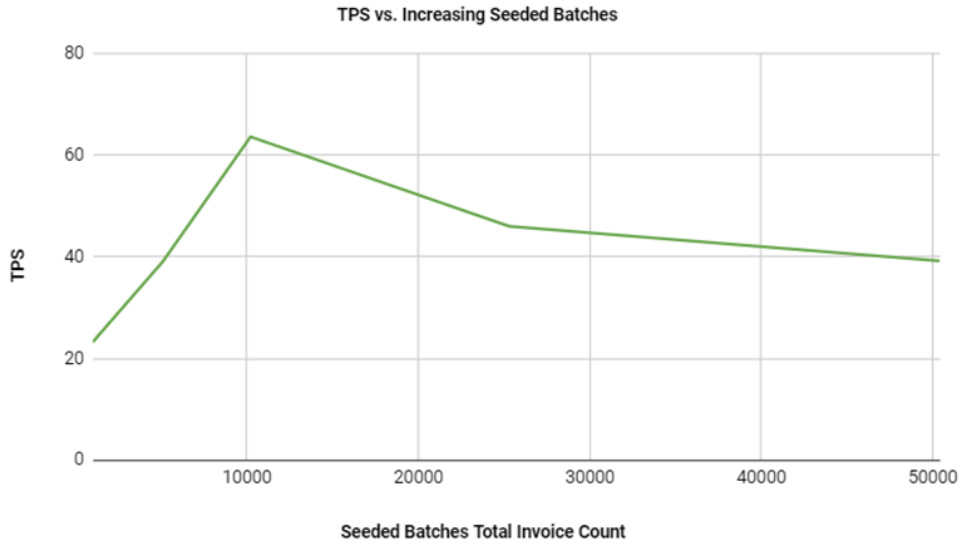

Figure C.2.7.1: Seeding TPS

C.2.7.2 TPS for Set Batch Size at Increasing Volumes

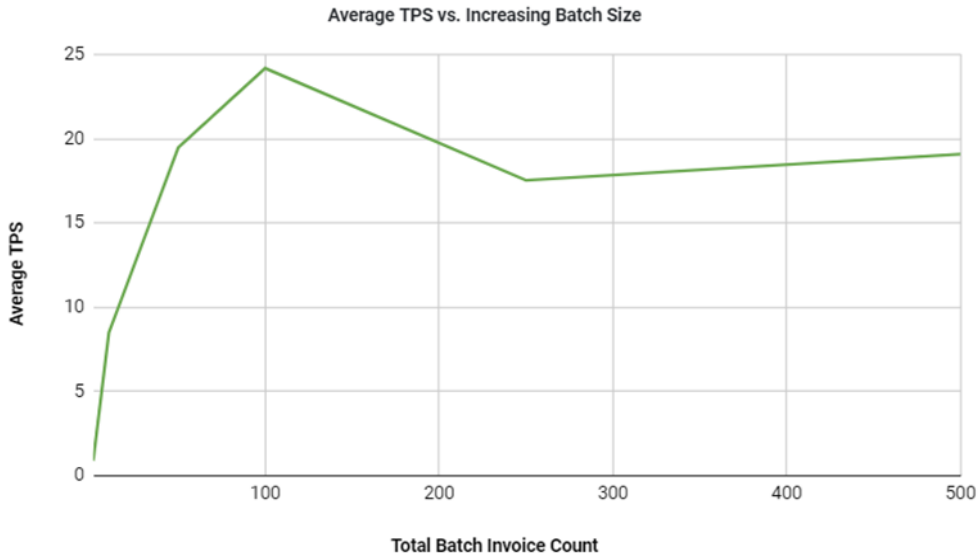

Figure C.2.7.2: TPS for Set Batch Size at Increasing Volumes

Table C.2.7.2: Fuzzy Match Cycles

id	id_queue_beg	id_queue_end	match_count	start_time	end_time
baseline	1	1	0	6/8/21 14:26	6/8/21 14:26
baseline	2	2	0	6/8/21 14:28	6/8/21 14:28
1a	1003	1052	0	6/8/21 14:34	6/8/21 14:34
1b	1053	1102	10	6/8/21 14:37	6/8/21 14:37
2a	5103	5152	0	6/8/21 14:51	6/8/21 14:51
2b	5153	5202	10	6/8/21 14:52	6/8/21 14:52
3a	10203	10252	0	6/8/21 15:00	6/8/21 15:00
3b	10253	10302	0	6/8/21 15:01	6/8/21 15:01
4a	25303	25352	0	6/8/21 15:20	6/8/21 15:20
4b	25353	25402	20	6/8/21 15:21	6/8/21 15:21
5a	50403	50452	0	6/8/21 15:50	6/8/21 15:50
5b	50453	50502	10	6/8/21 15:51	6/8/21 15:51

C.2.7.3 TPS for Increasing Batch Sizes at Set Volume

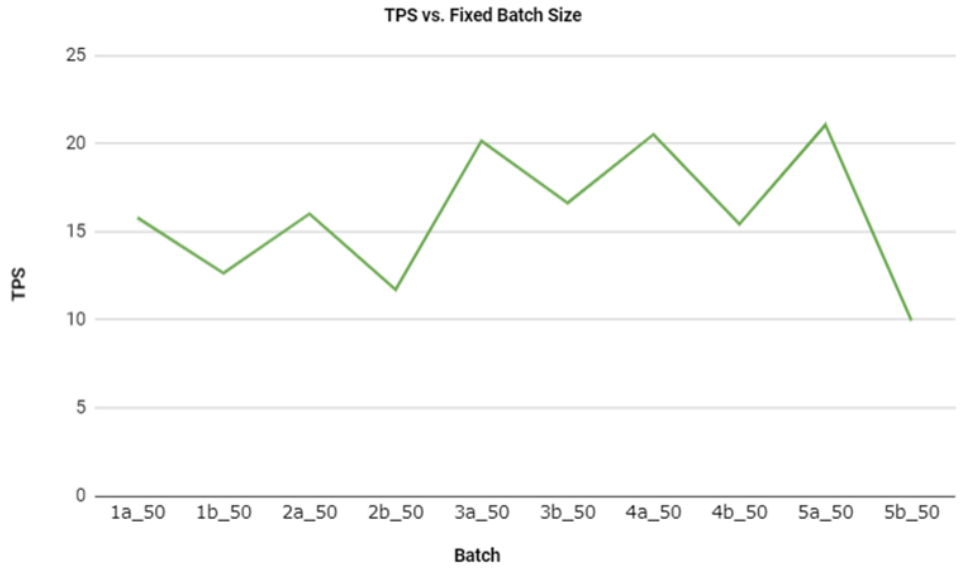

Figure C.2.7.3: TPS for Increasing Batch Sizes at Set Volume

Table C.2.7.3: TPS for Increasing Batch Sizes at Set Volume

Invoices in Batch	Run 1	Run 2	Run 3	Avg.	Avg. TPS
	Register (s)	Register (s)	Register (s)	Register (s)	Register (s)
1	0.72	0.71	2.03	1.15	0.9
10	1.00	1.09	1.43	1.17	8.5
50	2.28	2.37	3.04	2.56	19.5

100	3.83	4.15	4.40	4.13	24.2
250	20.10	10.66	11.98	14.24	17.6
500	26.25	27.35	24.96	26.19	19.1

C.2.7.4 Fuzzy Matching

Fuzzy Matching Cycles are required to identify similarities between submitted documents based on pre-defined criteria. These cycles are scheduled once a minute. Start and end times for each cycle captured below – all fuzzy match cycles completed in under 5 seconds.

Table C.2.7.4: Fuzzy Matching Cycles

id	id_queue_beg	id_queue_end	start_time	end_time	matches_found	documents_scanned	time_elapsed
1	0	0				0	0
2	1	1	2021-06-08 14:26:01	2021-06-08 14:26:01	0	1	0.00
3	2	2	2021-06-08 14:28:01	2021-06-08 14:28:01	0	1	0.00
4	3	1002	2021-06-08 14:31:01	2021-06-08 14:31:01	0	1000	0.00
5	1003	1052	2021-06-08 14:34:01	2021-06-08 14:34:01	0	50	0.00
6	1053	1102	2021-06-08 14:37:01	2021-06-08 14:37:02	10	50	1.16
7	1103	2602	2021-06-08 14:45:01	2021-06-08 14:45:01	0	1500	0.00
8	2603	4602	2021-06-08 14:46:01	2021-06-08 14:46:02	0	2000	1.16
9	4603	5102	2021-06-08 14:47:01	2021-06-08 14:47:01	0	500	0.00
10	5103	5152	2021-06-08 14:51:01	2021-06-08 14:51:01	0	50	0.00
11	5153	5202	2021-06-08 14:52:01	2021-06-08 14:52:01	10	50	0.00
12	5203	7202	2021-06-08 14:56:01	2021-06-08 14:56:02	0	2000	1.16
13	7203	9202	2021-06-08 14:57:01	2021-06-08 14:57:01	0	2000	0.00
14	9203	10202	2021-06-08 14:58:01	2021-06-08 14:58:01	0	1000	0.00
15	10203	10252	2021-06-08 15:00:01	2021-06-08 15:00:01	0	50	0.00
16	10253	10302	2021-06-08 15:01:01	2021-06-08 15:01:01	0	50	0.00
17	10303	12302	2021-06-08 15:09:01	2021-06-08 15:09:01	0	2000	0.00
18	12303	14302	2021-06-08 15:10:01	2021-06-08 15:10:01	0	2000	0.00

19	14303	15802	2021-06-08 15:11:01	2021-06-08 15:11:01	0	1500	0.00
20	15803	17302	2021-06-08 15:12:01	2021-06-08 15:12:02	0	1500	1.16
21	17303	19302	2021-06-08 15:13:01	2021-06-08 15:13:01	0	2000	0.00
22	19303	20802	2021-06-08 15:14:01	2021-06-08 15:14:01	0	1500	0.00
23	20803	22302	2021-06-08 15:15:01	2021-06-08 15:15:02	0	1500	1.16
24	22303	23802	2021-06-08 15:16:01	2021-06-08 15:16:03	0	1500	2.31
25	23803	24802	2021-06-08 15:17:01	2021-06-08 15:17:02	0	1000	1.16
26	24803	25302	2021-06-08 15:18:01	2021-06-08 15:18:02	0	500	1.16
27	25303	25352	2021-06-08 15:20:01	2021-06-08 15:20:01	0	50	0.00
28	25353	25402	2021-06-08 15:21:01	2021-06-08 15:21:01	20	50	0.00
29	25403	26902	2021-06-08 15:27:01	2021-06-08 15:27:01	0	1500	0.00
30	26903	28402	2021-06-08 15:28:01	2021-06-08 15:28:02	0	1500	1.16
31	28403	29402	2021-06-08 15:29:01	2021-06-08 15:29:01	0	1000	0.00
32	29403	30902	2021-06-08 15:30:01	2021-06-08 15:30:01	0	1500	0.00
33	30903	31902	2021-06-08 15:31:01	2021-06-08 15:31:02	0	1000	1.16
34	31903	33402	2021-06-08 15:32:01	2021-06-08 15:32:01	0	1500	0.00
35	33403	34402	2021-06-08 15:33:01	2021-06-08 15:33:01	0	1000	0.00
36	34403	35902	2021-06-08 15:34:01	2021-06-08 15:34:02	0	1500	1.16
37	35903	37402	2021-06-08 15:35:01	2021-06-08 15:35:01	0	1500	0.00
38	37403	37902	2021-06-08 15:36:01	2021-06-08 15:36:02	0	500	1.16
39	37903	39402	2021-06-08 15:37:01	2021-06-08 15:37:01	0	1500	0.00
40	39403	40402	2021-06-08 15:38:01	2021-06-08 15:38:02	0	1000	1.16
41	40403	41902	2021-06-08 15:39:01	2021-06-08 15:39:02	0	1500	1.16
42	41903	42902	2021-06-08 15:40:01	2021-06-08 15:40:01	0	1000	0.00
43	42903	43902	2021-06-08 15:41:01	2021-06-08 15:41:04	0	1000	3.47
44	43903	44902	2021-06-08 15:42:01	2021-06-08 15:42:03	0	1000	2.31
45	44903	45902	2021-06-08 15:43:01	2021-06-08 15:43:01	0	1000	0.00

46	45903	46902	2021-06-08 15:44:01	2021-06-08 15:44:01	0	1000	0.00
47	46903	48402	2021-06-08 15:45:01	2021-06-08 15:45:02	0	1500	1.16
48	48403	48902	2021-06-08 15:46:01	2021-06-08 15:46:01	0	500	0.00
49	48903	49902	2021-06-08 15:47:01	2021-06-08 15:47:05	0	1000	4.63
50	49903	50402	2021-06-08 15:48:01	2021-06-08 15:48:01	0	500	0.00
51	50403	50452	2021-06-08 15:50:01	2021-06-08 15:50:01	0	50	0.00
52	50453	50502	2021-06-08 15:51:01	2021-06-08 15:51:01	10	50	0.00

C.2.7.5 Hardware Activity Monitoring at Peak Load

The following graphs show CPU load, disk usage and RAM consumption for the VM configured for the performance test. For purposes of reviewing hardware activity, please cross-reference graphs with timestamps available in the database statistics table.

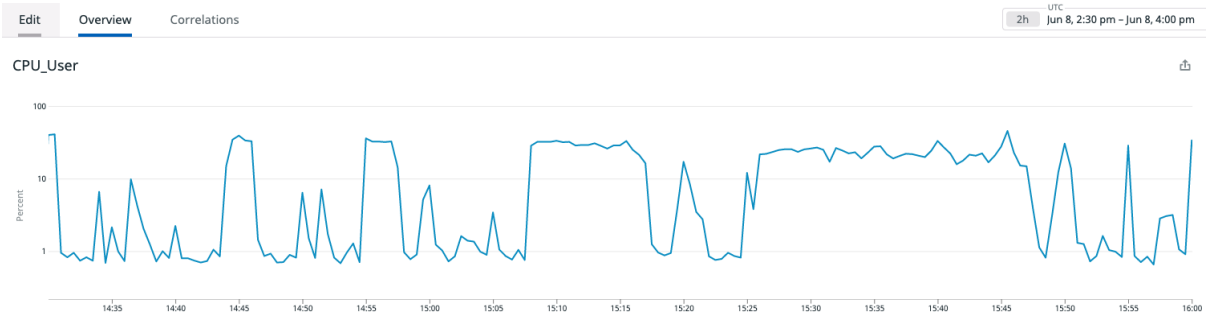

Figure C.2.7.5.1: CPU Usage

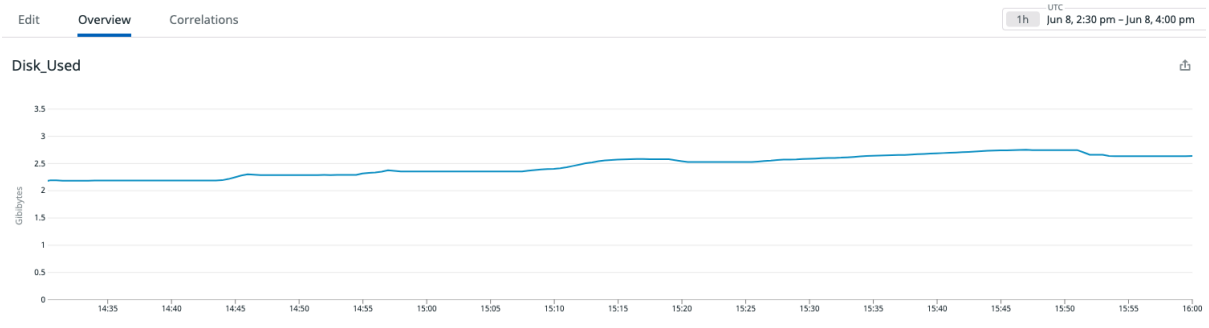

Figure C.2.7.5.2: Disk Usage

Figure C.2.7.5.3: RAM Usage

Table C.2.7.5.4: Database Statistics

Batch	Timestamp	Database Size (bytes)	Document Count	Exact Match Count	Fuzzy Match Count
seed_1000	2:31:47 PM	27,226,783	1,002	0	0
1a_50					
1b_50	2:37:23 PM	31,715,999	1,102	10	10
seed_4000	2:49:34 PM	92,656,287	5,102		
2a_50					
2b_50	2:52:57 PM	94,212,767	5,202	20	20
seed_5000	2:58:18 PM	172,946,079	10,202		
3a_50					
3b_50	3:02:23 PM	174,477,983	10,302	30	0
seed_15000	3:17:08 PM	696,046,239	25,302		
4a_50					
4b_50	3:21:28 PM	416,101,023	25,402	40	40
seed_25000	3:48:14 PM	1,386,951,327	50,402		
5a_50					
5b_50	3:51:40 PM	1,388,425,887	50,502	50	50