FIC Network

Fixed Income Infrastructure for Blockchain Assets

Whitepaper

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1. Executive Summary

FIC Network is an end-to-end decentralized fixed income securities network that enables the listing, exchange, and securitization of fixed income financial instruments. FIC Network is an asset-agnostic, multi-currency distributed ledger primarily focused towards institutions using traditional currencies and adapting to cryptocurrency markets. Crypto hedge funds and traditional asset managers will greatly benefit from cost savings and expanded market opportunities.

Problem

1. Existing crypto tokens are operating as currencies or stocks and there is no real fixed-income offering. As the crypto markets mature, earning interest on your assets and paying interest to borrow assets will become the largest financial market in crypto beyond currencies and securities.

2. Conventional fixed income security markets based on centralized third parties are known for many inherent drawbacks in terms of friction, illiquidity, lack of interoperability, asymmetry of information and operational risks. On the other hand, these markets only support fiat currencies and there is no such market for the cryptocurrency space, which is growing at a rapid pace.

Solution

Our team has been building the network since early 2016, attracting seed funding from three institutional investors: Boost VC, Startupbootcamp Fintech NYC, Bialla Venture Partners.

We are building a blockchain-based fixed income market that will operate similarly in concept to the traditional systems, but will reduce costs, operational friction, and risks along with improved auditability and transparency. Our technology will allow the users to list, buy, and sell any type of fixed income securities/financial instruments, including loans, bonds, collateralized loan obligations (CLOs), asset-backed securities (ABS), syndicated loans, credit default swaps (CDS), and futures.

The network is primarily meant for financial institutions such as crypto asset managers, banks, investment banks, lending companies, hedge funds, credit funds, insurance companies, family offices, and corporations, as well as for service providers like valuation firms, auditors, law firms, and ratings agencies. The solution will be opened to individuals in later iterations.

This will also open the door to a cryptocurrency fixed income market, a growing need in the crypto space. In addition, the currency exchange is integrated into the system, enabling the seamless trading of financial instruments among different currencies.
FIC Network will support the consumer and business loan market in its first phase of implementation and it will then expand into other fixed income financial instruments.

**FIC Token**

FIC token is a utility token, used to perform activities on the network, such as listing, trading, and holding financial instruments. It is not backed by, and cannot be exchanged against, any financial instruments.

**Our Team**

We have been working on a blockchain based fixed income market model for over a year. Our team consists of the right mix of talents, which has been through renowned startup accelerators along with VC support.

**Our vision**

Our vision is to become the de facto financial network for the global fixed income market.

**Our mission**

Our mission is to build an end-to-end, blockchain-based fixed income network that enables the participants to source, buy, and sell financial products in a secure, easy, inexpensive, transparent, and accessible way.
2. The Team

Our team provides the right mix of talents that are vital to the success of our company. Our core team includes members with proven track records of entrepreneurial and technical skills. A world class advisory board provides the necessary expertise in multiple disciplines including entrepreneurship, technology, business development. All members have prior experience in either founding or working for startup companies.

In addition, Factury Inc. is backed by a group of renowned venture capitalists.

Core team

Arturs Ivanovs, Founder/CEO

Arturs is a mission-driven founder and CEO of Factury Inc. In the wake of the 2008 financial crisis, he began researching the problems, and potential solutions, facing credit markets. While studying law and economics, he worked at Latvia’s Ministry of Economy covering online lending regulation.

After finishing his undergraduate thesis on problems and remedies in the predatory lending sector, he worked as a marketing executive and senior project manager at Porter Novelli Latvia, where he represented some of the most prominent organizations in the Baltics, including the European Investment Fund, the region's largest real estate project Z-Towers, and brands like Mercedes-Benz. He has also represented business interests in Latvian and European Parliament.

Arturs became fascinated with blockchain technology in 2014. In 2015 he left his job and later moved to the United States to create a more efficient and transparent financial market.

Arturs holds an LLB in Law and Business from Riga Graduate School of Law. In his free time, he enjoys studying chess strategies and riding motorcycles.

Alvar Soosaar, Co-founder/COO

Alvar is an experienced executive in the structuring and management of fixed income securities and portfolios. He previously managed a $7.8 billion portfolio of fixed income securities, handling origination, structuring, monitoring, and workout of loans and other securities in several countries for nearly a decade. He is an investor with over 20 years of experience in a
variety of asset classes, including a particular interest in and involvement with early-stage startups.

Alvar holds an MBA from the University of Oxford’s Saïd Business School and BA from the University of Virginia.

In his spare time, Alvar volunteers with a number of Estonian educational and policy organizations, as well as organizations involved in historic preservation and providing educational opportunities for underprivileged kids in Philadelphia. He also enjoys the sport of Court Tennis. Alvar is fluent in English, Estonian, and French.

Aigars Staks, Co-founder & Senior FIC Network Architecture Advisor

Aigars has top-level management experience with a number of companies, and spent the early part of his career at Microsoft and PWC. He has built his career around large scale IT project management and strategic planning, including the delivery of enterprise-level technologies and the recovery of troubled ICT projects. He is a veteran of the Agile and Lean techniques to challenge the limits of possibilities and expectations.

He received his M.Sc. in Computer Science from the University of Latvia in 2002 and also holds an MBA from the Riga Business School-University of Buffalo joint program.

Kalvis Kalnins, Co-founder, Software Developer

Kalvis is an entrepreneur and self-taught programmer from a young age. Since high school, he has been involved with startups in the IT, AI, and education spaces and more recently, in finance and blockchain. Before joining Factury Inc. he founded Stellarmus, a blockchain-based bank-to-bank payment network.

Kalvis holds a Bachelor’s Degree in Economics and Business from the Stockholm School of Economics.
Anatoly Ressin, Temporary Head of Technology

Anatoly has a strong background in software development, working as a core developer and in senior software development positions. He is currently the CEO of BlockVis, a company involved in organizing blockchain competence and education opportunities and structuring the blockchain market in Latvia and abroad. He has co-founded several companies in his career including Fastr, a reading-training application development firm, and AssistUnion which builds intelligent and performing web-enabled systems. Anatoly obtained his M.Sc. in computer science from Transport and Telecommunication Institute in 2004.

Agnese Kerubina, Chief Scientist & Product Support Manager

Agnese holds a Master’s degree in physics from the University of Latvia. Previously, she served as a Laboratory Assistant at the University’s Theoretical Quantum Nanoelectronics research group.

Agnese is deeply interested in mathematics and is highly skilled in analytical and numerical computations. She has participated in International Mathematical Olympiad multiple times, winning a bronze medal in the first European Girls’ Mathematical Olympiad in 2012 and also placed second in the International Team Olympiad in 2011.

In her spare time Agnese loves photography, swimming, and kayaking.

Peteris Ratnieks, Backend & Blockchain Developer

Peteris is a software developer with experience in Python, C/C++, Javascript, Matlab/Octave, Pascal, and Bash. He was previously involved in a startup which developed a blockchain based transaction engine for banks.

Peteris has accolades from International Mathematical Olympiads in Argentina and Colombia. He has participated in several international programming camps and holds a B.S. in Mathematics from the University of Latvia.
Investors & Accelerators

Boost VC

Boost VC (www.boost.vc) is considered the #1 accelerator for blockchain/crypto, VR/AR, and AI startups. Boost has made investments in companies from more than 35 countries and its portfolio companies have gone on to raise over $250M. Boost VC invests in 20+ startups twice a year. They have a 3-month accelerator program that includes housing and office space in Silicon Valley.

Bialla Venture Partners

Bialla Venture Partners, LLC (BVP) (www.bialla.com) is a venture capital firm specializing in startups and early-stage investments. Bialla also runs an executive search firm with access to world-class talent in the financial industry.

BVP’s managers, Vito Bialla and David Uri, have a collective experience of over 70 years as active investors, providing both angel and private equity funding to more than 50 companies. BVP principals have been hands-on investors/managers and have a solid track record of creating value for the companies they work with.

Startupbootcamp Fintech NYC

Startupbootcamp (www.startupbootcamp.org) Fintech New York is the leading program supporting innovative companies in the financial services industry. They have an intensive 3 month program that provides 10 selected Fintech companies with hands-on mentorship from over 100 industry experts, office space in the heart of New York, seed funding, and access to a global network of investors and corporate partners from across the Fintech industry. Factury was selected from more than 300 applicants worldwide.
3. Company background

An initial draft of the concept for a blockchain-based secondary loan market was conceived in February 2016 and Factury Inc., the company behind FIC Network, was incorporated in April 2016.

Factury was selected by Startupbootcamp to join their New York-based accelerator in March 2016. Factury was also selected by to Boost VC to join their accelerator in Silicon Valley.

Since its inception, FIC Network has widened its scope from a purely loan-market platform to a full-fledged fixed income securities network supporting both fiat and cryptocurrencies.

Progress to date

Given below is a timeline of milestones of the project so far.

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Milestone</th>
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<tbody>
<tr>
<td>Feb 2016</td>
<td>Initial draft of the concept was prepared</td>
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<tr>
<td>Mar 2016</td>
<td>Received investment and support from Startupbootcamp New York City Fintech accelerator</td>
</tr>
<tr>
<td>Apr 2016</td>
<td>Delaware corporation was established</td>
</tr>
<tr>
<td>July 2016</td>
<td>Initial prototype on ERIS blockchain was created</td>
</tr>
<tr>
<td>Aug 2016</td>
<td>Received investment and joined Boost VC accelerator in Silicon Valley</td>
</tr>
<tr>
<td>Nov 2016</td>
<td>Changed blockchain tech to Stellar and demonstrated working prototype</td>
</tr>
<tr>
<td>Feb 2017</td>
<td>Attracted seed funding from Bialla Venture Partners</td>
</tr>
<tr>
<td>Mar 2017</td>
<td>Full Time core team assembled</td>
</tr>
<tr>
<td>Aug 2017</td>
<td>Launched application for internal testing, first loans are published on blockchain</td>
</tr>
<tr>
<td>Sep 2017</td>
<td>Launched distributed application (dApp) for beta testing</td>
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</table>
The first native distributed app (dApp) eDepository for FIC Network has already been developed and deployed on our Test Network. It allows publishing and managing assets on the blockchain network.
4. Introduction

Financial markets are in the midst of a revolution, with the traditional trust mechanisms built around centralized third parties being replaced by distributed ledger protocols. Entire financial ecosystems are emerging on distributed ledgers and the technologies built around them.

Cryptocurrency and the token market are rapidly growing, with a market capitalization now over $160 billion.

Factury Inc. introduces a blockchain-based fixed income securities model that reduces costs, operational friction, and risks while improving auditability and transparency for the industry. With the introduction of the instant settlement, investors will be able to allocate their capital more efficiently and with higher velocity.

The network will cover every financial instrument in the fixed income space, starting with consumer and business loans, followed by bonds, structured products, and other financial instruments. FIC Network will accommodate any type of currency, including cryptocurrencies, and financial instrument.

The FIC Network token is a utility token to be used as a service fee, but also prevents network spam and denial of service attacks.
5. Market overview

Fixed-income securities market

A fixed-income security is typically a loan made by an investor to a borrower, often a government or corporate entity. The borrower, or issuer, promises to pay a set amount of interest, called the coupon, on a predetermined basis until a set date. The issuer returns the principal amount, also called the face or par value, to the investor on or before the maturity date. The typical role of fixed-income securities in a portfolio is to generate regular income, reduce overall risk, and protect against volatility. The securities can appreciate in value and offer more stability of principal than other investments.

As of Q1 2017, the size of the worldwide bond market was estimated at nearly $90 trillion, of which the share of the U.S. bond market debt was $38.4 trillion according to Bank for International Settlements (BIS).

There are two types of markets for fixed-income securities: Primary and Secondary. A Primary Market occurs when the proceeds from the sale of securities go directly to the issuer, while the Secondary Market is the market where previously issued securities are traded. Proceeds from transactions in the Secondary Market do not go to the issuer, but to the seller of the security.

Secondary Trades occur on the Exchange Market or Over-the-Counter Markets (OTC). The Exchange Market is a market where listed securities are bought and sold. “Listed Security” refers to any security that meets certain criteria, prior to its being allowed to trade on an exchange. The OTC market is an interdealer market in which the main function is to provide a marketplace for securities that are not listed on any exchange. There are no central marketplaces in the OTC market.

Cryptocurrency market

There is currently no fixed income market for the cryptocurrency space. That means there are no cryptocurrency fixed-income securities that can generate a regular income for an investor to reduce a portfolio’s risk exposure and or protect against volatility of prices; nor is there an exchange platform where such cryptocurrency securities can be traded.

However, there is a large and fast-growing market for cryptocurrencies. The total market capitalization of cryptocurrencies recently (as of August 2017) surpassed US$160 billion. This figure represents a more than 850% increase from their value of $17.7 billion at the start of this year.

Graph: Cryptocurrency market compared to other markets
Driving factors of cryptocurrency growth

The growth of the cryptocurrency market is driven by several factors:

**Increasing ICO activity**: Companies raised close to $1.3 billion through ICOs during the first half of 2017, according to figures reported on by CNBC. Fintech firms raised far more through ICOs during the first half of 2017 than they did through venture capital investment. These innovative token sales are reducing interest in more traditional methods of raising capital and driving crypto markets higher.

**Rising Adoption**: Analysts have indicated a growing acceptance of cryptocurrencies. As investors flock to digital currencies, some of them like Litecoin and Monero have reached record price levels this year.

**Institutional entrants into cryptocurrency**: Demand for cryptocurrencies has increased as hedge funds and other institutional investors focus on these digital assets. There are more than 50 hedge funds that focus on these currencies, according to data provided by a Fintech analytics firm reported on by Business Insider.

**Shifting Investor Perception**: Some investors have described crypto assets are safer, more secure, and easier to use.
6. FIC Network Benefits
We are building a blockchain-based network that will enable the users to list, buy and sell any type of fixed income financial instruments including loans, bonds, collateralized loan obligations, loan syndication, credit default swaps, and futures.

We are both introducing the concept of fixed income securities for the cryptocurrency space and addressing the shortcomings of the current fiat-currency fixed income markets by using blockchain to remove the need for intermediaries and the friction they create.

FIC Network Benefits

General benefits of FIC Network

• **Immutability:** Historic transactions cannot be changed on FIC Network. Any confirmed transactions on the blockchain are irreversible.

• **Removal of intermediaries:** The P2P nature of the blockchain does away with the need for intermediaries and allows participants to interact directly with one another. Intermediaries are removed from the process, the distributed ledger is updated in real-time by the node holders, and any data inputted on the blockchain is transmitted and stored automatically.

• **Decentralization of consensus:** No central authority acts as a clearinghouse for transaction validation. Instead, the effort required to reach consensus is shared between the miners.

• **Transparency (pseudonymity):** Public blockchains can offer full transparency of the transactions carried out on the network, while safeguarding the privacy of its users through pseudonymity since only the transacting addresses are shown.

• **Speed:** Speed of transaction settlement is reduced from days (and in some cases weeks) to 3-10 seconds.

• **Lower costs:** The removal of intermediaries results in lower transaction costs.

• **Security:** With encryption through cryptography, no one other than the sender and recipient can access the data sent across the blockchain.
7. Business Implications and Innovation on FIC Network

We project that better transparency, increased security, and reduced costs will lead to wide adoption amongst market participants. Technologically-oriented market participants with higher costs are likely to adopt it faster than more conservative ones, but even the latter group will make the move as execution speeds, auditability, and transparency make their work easier.

Financial instruments on FIC Network

As each iteration of our network is rolled out, the new financial instruments that can be traded can be structured to closely resemble their current equivalents to encourage market adoption. Members will be able to make, list, buy, and sell any of those financial instruments while enjoying network benefits of minimal costs, instant settlement, transparency, and auditability.

The network is primarily meant for financial institutions such as banks, investment banks, lending companies, hedge funds, credit funds, insurance companies, family offices, and corporations, as well as for service providers like valuation, audit, legal, and insurance companies.

The current list of planned financial instruments:

Loans
Corporate bonds
Securitization and Asset-Backed Securities (ABS)
Large Syndicated Loans
Credit Default Swaps (CDS)
Futures Options

Loans
The loan category encompasses consumer loans, factoring loans, small/medium enterprise (business) loans, residential mortgages, small-scale commercial mortgages, student loans, and others. The main characteristic of this category is that the borrower has no relationship to the FIC Network and is not directly related to it. Instead, an originator publishes an already-originated loan to the network, and an assigned loan servicer (can be and often is the originator) collects and brings borrower repayments to the network. This has the benefit of leaving already established originator-borrower relationships in place while adding a new sales/funding channel and liquidity to originators and investment opportunities to traders.

Corporate bonds
Corporate bonds are similar to loans, and in fact can to be originated with the help of intermediaries like investment banks, who would simply pass along cost savings of using FIC Network to their clients. However, the FIC Network will allow corporate borrowers, initially
large firms, onto the blockchain themselves. In such cases -- with input from network observers like analytics firms, auditors, valuation companies and rating agencies -- the firm structures its own corporate bond, lists it on the chain itself, and makes payments via the chain to investors, without the need for or cost of a servicer. This approach has the obvious benefit of even lower friction than an originator in the middle would bring, and provides an opportunity for anyone to issue corporate bonds themselves.

**Securitization and Asset-Backed Securities (ABS)**
Securitizations can be constructed of any underlying cash-flowing asset: a loan, a single-issuer bond, or even other securitization bonds. The creation of a securitization on the FIC Network is simple and transparent, with every underlying asset that goes into the structure being easily traceable to the last cent. This elegantly solves many of the opacity problems that arose during the 2008 crisis -- indeed, CLOs and CDOs would never have become the problems they did because the FIC Network would have provided such transparency that initial and subsequent pricing would have more appropriately represented the real value of the underlying securities.

**Large Loan Syndication**
The ability to syndicate through FIC Network provides a new level of functionality to loans, larger-scale commercial mortgages, securities, and corporate bonds. The process seamlessly scales from syndicating small-scale personal loans, such as in P2P lending platforms like Lending Club, to billion-dollar corporate issuances. Every participant finally has a tamper-proof cryptographic guarantee to receive back his funds if the initial syndication target is not met and the loan remains undistributed. The ability to syndicate financial instruments of all sizes allows investors to deploy capital more efficiently across different asset types since scale requirements in each asset type are dramatically reduced.

**Credit Default Swaps (CDS)**
Credit Default Swap (CDS) can be created against any of above-mentioned financial instruments - loans, corporate bonds, CDOs, syndications, futures, options, and other CDSs. In FIC Network, above-mentioned instruments are standardized, and automatically and irreversibly enables all CDS owners to unilaterally claim the compensation in the event of default. For loans and corporate bonds, default occurs when the borrower fails to pay for the pre-agreed amount of days, for CDOs default occurs when the pre-agreed share of underlying assets have defaulted, for syndication default occurs if syndication fails, and for future options or CDSs default occurs when the seller fails to fulfill his side of the contract.

**Future Options**
Future Options are flexible financial instruments. They can be used to defer an exchange of currencies to future in order to hedge currency exposure (for example when investing BTC but buying USD loans) or to defer an exchange of currency versus any financial asset mentioned above in order to speculate with leverage. FIC Network brings standardization,
transparency, and cryptographic security to future options, to increase liquidity in the market and eliminate selective default risk.

**Portfolio management and risk diversification**

In FIC Network, it is possible to buy single repayments via the Expected Cash Flow (ECF) financial asset. Please see “Technical Concepts” section for more details. With ECFs investors can replicate all current investment strategies, and access even greater functionality. ECF can offer significant advantages for companies that perform daily Asset-Liability management, like insurance companies, banks, and pension funds.

In an environment where all loans are broken into their component ECFs, it remains simple to buy a whole loan: an investor would just need to buy all of its ECFs.

To buy a share of larger loans (i.e. 25%), an investor might buy every n-th ECF (i.e. every fourth) ECF. If the loan has been published using flexible granularity (see Concepts > ECF) with 4 ECFs for each repayment, an investor might simply buy one ECF for each scheduled payment. If originator did not leverage flexible granularity or it was set to another ratio, then total cash flow and risks would approximately align nevertheless albeit with slightly greater variance.

With ECFs, investors are not bound to buying every repayment from a single loan. Investors may select several loans with similar schedules and buy the first ECF of the first loan, the second ECF of the second loan, etc. as to diversify risk across multiple counterparties, and possibly across asset classes.
ECFs also mean investors are not bound to hold the whole spectrum of risk over loan’s lifetime. For example, investors may choose to buy only the few first cash flows if risk averse, or the last few cash flows if risk hungry.

With ECFs, Investors may fine-tune their cash flow requirements. For example, if an investor requires large cash flow in December, they can exclusively buy ECFs that are expected to mature in December.

In addition, any portfolio of ECFs can be securitized to create new ECFs at a fraction of current costs, allowing savvy investors to precisely construct their portfolio with their exact preferred cash flow schedule, risk, and exposure to asset classes.

**Multi-currency solution for crypto and fiat currencies**

FIC Network, has no base currency, with users able to do business in their own preferred currency. Obviously, most trade will transact via more popular currencies, such as USD. The agnostic currency handling allows for inclusion of financial instruments assets in both fiat and cryptocurrencies. In FIC Network this is accomplished in three ways.

First, creator of financial instrument declares what currency it will use. This way the network does not impose any restrictions or pressures to prefer one currency over other.

Second, currency exchange is built into the network. As the network handles the exchange of currency on behalf of users and at competitive rates, parties can easily buy and sell financial assets in any currency of their choosing. FIC Network allows users to trade between currencies that do not have a direct exchange rate (or unattractive rates) and by finding the best exchange-via-exchange up to six hops afar. With trustline system users are always in control as to what currencies they are exposed to, at the same time free to buy assets in currencies they don’t necessarily want to hold, i.e. have trustline to (more details in Technical Concepts> Gateways & Trustlines). In short, Trustline system let's you deal with network currencies you have explicitly expressed trust to.

Third, users can hedge their exchange rate exposure to financial instruments within the FIC Network. Currently, planned are Future Currency Options (see details in Use cases>Future Option), and other financial instruments to be announced. For example, a BTC holder wants to invest in USD loans, so they buy ECFs from the loan via BTC->USD exchange, and then buy future options to hedge currency exchange rate risk.

In FIC Network, any fiat or cryptocurrency investor can invest in other currency fixed income instruments with ease. That also means investors in mature markets can have instant access to all other markets, provided that this easy-to-deploy and cheap-to-operate infrastructure is in place. In conclusion, FIC Network has been built to be global and works best in that way.
Operational costs & settlement

The P2P nature of the blockchain technology does away with the need for intermediaries to interact directly with one another. With the removal of intermediaries and the distributed ledger being updated in real-time by the node holders, any data input on the blockchain is transmitted and stored automatically. Therefore, commissions and fees of such intermediaries can be avoided with the use of blockchain technology leading to lower operational costs. In addition, the currency exchange is built-in in FIC Network enabling the seamless exchange of different currencies both fiat and crypto at cheaper rates than anywhere elsewhere because of minimized operational costs.

On the other hand, consensus mechanism (more details in Technical Concepts> Consensus mechanism) allows for settlement of 0 days, more precisely between 3 - 10 seconds, thus giving the liquidity in the market and providing investors with ability to invest with higher velocity.

Transparency and auditability

Given the immutability of the blockchain technology, nothing on the blockchain can be changed without the consensus of the network. Any confirmed transactions on the blockchain cannot be changed. A blockchain will act as a public ledger, meaning that as long as the blockchain remains operative, the data on it will be accessible. Therefore, every transaction on FIC Network will be traceable back to the source and provides a state of truth about the asset performance, without the possibility of tampering.

In addition, blockchain technology provides a document verification process commonly known as hashing function or proof of existence. In simple terms, when a user presents a document, the blockchain technology converts or encodes the document into a cryptographic digest or cryptographic hash. In the document verification, submitting the same document more than once, for verification, will have the hash match each time. If the document contains any changes, verification will fail. This enables organizations to perform document verifications while maintaining a higher level of auditability.
8. Technical concepts and explanations

Abstract model

FIC Network uses an adapted clone of Stellar\(^1\) protocol for its distributed ledger. There are only two main concepts in the Stellar protocol terms: **accounts**\(^1\) and **assets**\(^1\). In FIC Network these are interpreted based on context.

- **ECF, expected cash flow**, is an **asset** that can be exchanged for its nominal value at the financial instrument or sold to another user for currency tokens.
- **Currency token** is an **asset** that is issued by a so-called Gateway user when fiat or cryptocurrency is deposited with them. Currency tokens can be sent back to the Gateway in exchange for fiat or cryptocurrency.
- **The user** is an **account** that belongs to one of many different user types. Based on this type, a user can create financial instruments, modify financial instruments, issue currency tokens and hold currency tokens.
- **Financial instrument** is an **account** that creates ECFs. It is not allowed to modify itself and may have a user that holds signing rights for it.

Users never create ECFs. Users can only create financial instruments that in turn create ECFs. Typically, when a user creates a financial instrument they will make themselves the owner of all ECFs issued by this instrument.

Users never buy financial instruments. A user can only buy cash that will be generated by the instrument. In blockchain terms, the owner of an instrument is the person who can **sign** for it. Following this logic, the owner of the loan account (who signs for it) is the Servicer, however, the owner of the money can change freely. From a technical standpoint, it is highly important to distinguish between the **creator** of the instrument, the **owner of the instrument** and the **owner of cash** generated by this instrument.

When an instrument defaults, only its owner can publish that on FIC Network by making it give out **default tokens** in exchange for a tiny amount of FIC. This token serves as proof that the instrument has defaulted and can be used to trigger other conditions such as claiming a CDS contract.

Financial instrument exchanges currency tokens for ECFs. This can happen automatically when the instrument has no owner (Servicer) or this can be done by the owner if one exists. The instrument does not discriminate between users and will give currency tokens to whoever will provide a corresponding ECF.

\(^1\) https://www.stellar.org/blog/stellar-consensus-protocol-proof-code/
Gateway & Trustlines

FIC Network has taken a different approach to assets, a feature provided by Stellar protocol, shaping this feature for fixed income network needs. In Stellar network, any type of assets can be issued in any quantities by any account. It is an object which can be traded with, sold, or just given away for free. Each asset has two pieces of information attached to it:

Asset type: e.g., USD or BTC
Issuer: the account that created the asset

When users hold an asset in Stellar, they are holding a credit agreement from a particular issuer who will trade any issued asset for the asset it stands for off-network. That is why the network introduces another object in network – trustline. In order to hold anything by a particular issuer, users first need to establish a trustline between themselves and the issuer’s asset. This way users are not able to hold any “untrusted” assets, only the ones they trust they can receive credit for. Moreover, users are able to set a limit on how much of a particular asset they are willing to hold.
FIC Network, however, narrows this Stellar protocol feature by introducing **Gateway** – the only account that is allowed to create **Currency tokens** that can be used for trades and exchanges in FIC Network. Thus, Gateway is the one who is in charge of network currency value and of pinning issued currency to real life currency.

Currency token properties still work as implemented by Stellar - anyone (apart from Gatekeeper and Observer) can own assets issued by Gateway, but it has to be received from a trusted Gateway upon the establishment of a trustline. This asset can be freely traded between parties, just like fiat currencies, and the real exchange of money will happen outside of the network, thus this network-issued currency helps to track the flow of money, easing transactions between vastly different currencies off-network.

A direct bridge bypassing Gateway users for cryptocurrencies on FIC Network is included in our development plans.

**Exchange System**

Yet another feature offered by Stellar and implemented for FIC Network is the exchange system ([https://www.stellar.org/developers/guides/concepts/exchange.html](https://www.stellar.org/developers/guides/concepts/exchange.html)). It allows for an exchange of different types of assets easily between participants of the network. Pathfinding supports up to six exchanges in between the intended exchange.

FIC Network makes use of this system by allowing Issuers to put on sale ECFs from financial instruments they have originated and allowing investors to see offers posted and bid new offers. The issuer can later choose to whom to sell the single ECF. In similar fashion, anyone who holds ECFs will be able to put them on sale.

It will be possible to automatically sell the asset at a predetermined price as well. When a user makes a bid offer (e.g. $100 for 1 ECF), it will be checked against outstanding offers that are already in the ledger for the particular asset combination. If there is a match, the order is filled (e.g. you immediately are debited $100, but credited 1 ECF). If there is no match in the system, the offer is left outstanding in the ledger and kept there until accepted, fulfilled, canceled or revoked.

As users can hold only currency tokens that they have made a trustline for, **pathfinding** is
possible for cross-asset payments. In situations when you are holding dollars but want to buy something from the user that accepts only euros (Example cases: Image 1a and Image 1b), FIC Network helps to find the path of exchanges from outstanding orders at the best available rate. The path can be as complicated or as simple as the user chooses. Pathfinding supports up to six exchanges in between the intended exchange.

Image 1a: Example case. **Black arrow** - trustline. **Blue arrow** - As $ Gateway and € Gateway have expressed trustlines against each other’s currency tokens, those who accept these currency tokens can trade via pathfinding. **Red arrow** - as ¥ issuing Gateway has not made a trustline with other Gateways, Users accepting only ¥ can’t trade with those accepting only $ or €.

Image 1b: Example case. A Gateway issuing different currency assets also becomes a pathway for two users wishing to interact. Since the trustline is expressed against the currency token, not the Gateway itself, those who accept different assets from the same Gateway can still trade via pathfinding.

**Expected Cash Flows (ECFs)**

Traders currently trade either whole financial instruments (i.e. a loan) or a *share* of a financial instrument (e.g. 5% of the loan). This means that when any payment comes in, the trader gets his *share* of it, (i.e. 5% of first payment). It also means that if loan defaults, his losses equal his *share* of unpaid payments (i.e. 5% of the remaining defaulted loan).

The basic building block of every instrument in FIC Network are Expected Cash Flows (ECF), which are inspired by STRIPS (Separate Trading of Registered Interest and Principal of Securities) in the bond market.
Just like a share, an ECF is a means of splitting a financial instrument into smaller parts. To understand the difference, let’s visualize incoming cash flows of a loan on a chart with time on x-axis and value on y-axis.

![Diagram of ECFs]

The share effectively is the horizontal slice over this graph - a portion of value over all time. The ECF is the vertical slice - a point in time with all value in it.

While it is tempting to think of an ECF as a payment, it is actually an innovative financial instrument closely related to the payment. While the repayment has a date, usually an interest component, often a principal component, and all three may change after origination, as might the number of payments. A payment is a maximally mutable, or changeable, object with very little certainty or predictability about it.

However, an ECF has a set amount and a set location in the overall sequence of ECFs (i.e. between two specific other ECFs), and neither the amount nor the location ever change. With an ECF, only two aspects are not fully clear: fulfillment, or payment risk; and payment date. An ECF is a very simple, standardized, and understandable financial asset on its own, and is thus tradable in global markets. Every asset, loan, corporate bond, et al., can be broken into - and hence can be built on -- ECFs.

**ECF connection to underlying payments**

All ECFs of the same loan can be described as a glass split into horizontally cut slices, with the first ECF being the bottom-most portion, and the last ECF being the top-most portion. When payment comes in, both the principal component and interest component is poured into the ECF column. If that fills the glass enough to cover the next ECF portion, then that ECF is ready to be paid out.
Example: A $1200 1-year maturity loan is originated in January with a 10% coupon\(^2\), paying $120 principal and $10 interest on each payment date. As an originator, we will break that loan into 12 ECFs of $130 each. After publishing the loan, the ECFs are sold to different investors. In February when payment #1 comes in, it is poured into the bucket, paying off ECF #1.

But if no payment comes in for March and April, then the owners of ECF#2 and ECF#3 are kept waiting because there is nothing to pay out. Then in May the borrower pays $300 -- that amount is poured into the glass, filling and paying off the second and third ECFs (second and third investor gets their repayment), but ECF#4 remains outstanding (and next in queue) even though part of its payment has been poured into the glass.

**Pros and Cons of ECFs vs. Fractionalization**

(+) Specific. With ECF, you can invest in, for example, December ECFs but nothing in ECFs in other months. With shares, you usually have exposure to months or even years before or after the December. Therefore, with ECFs investors have different, but more specific portfolio construction tools that allows greater diversification options and results in better risk management.

(-) No implied diversification. With ECFs, you do not have implied diversification over time that fractionalization provides. With some effort, however, you can replicate or even improve

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\(^2\) Assuming for illustrative simplicity that interest is determined off of principal at origination, not outstanding.
on that diversification by deliberately allocating over time and securities, getting access to a diversity of assets.

**Partially paid ECF**

In case payment came only partially, or there have been changes to the schedule, ECF can be paid instantly but only partially. When the next small payment will come in, ECF owner also will be compensated instantly, but partially. This will occur until the ECF is fully paid, at which point the remainder is directed towards the next ECF. This property of ECF ensures that no value “hangs in the system” but is available instantly to its owner.

If underlying asset pays more than the size of an ECF, i.e. loan prepayment, then multiple ECFs can be paid fully and be ready to collect by their owner simultaneously. That is, the second investor has access to claim their ECF and does not need to wait to the first investor claim theirs ECF.

**Flexible granularity**

ECF provide ability to structure payments in whatever way most suits the originator and investors, without changing the borrower’s obligations. For example, since ECF amounts do not need to equal the payment schedule, the originator can control how many ECFs she constructs, as long the sum of payments and ECFs matches. This has twofold benefits - privacy and liquidity.

If ECFs matched the payment schedule precisely, the originator would be telegraphing information about her business processes to competitors. With flexible granularity, this is countered -- if an ECF does not necessarily match the payment schedule, then publicly available information about any given loan or originator process remains only available to those deserving of that information. On top of that, FIC Network has three layers of privacy, and this ensures that competitors can deduce the least possible information based on public data.

The freedom to control ECF creation leads to increased liquidity, as it breaks down large amounts into more manageable components when desired.

At one end of the spectrum, for example, if the originator sells a loan whole to a single buyer, he can just create a single ECF for the entire loan. This has the benefit of low operational fees for both originator and investor, as network costs scale up as the amount of ECFs increases. In such a case, Investor would buy and keep that sole ECF and observe it partially paid over time.

At the other end of the spectrum, an originator can break up a large loan into smaller ECFs based on her judgment about market demand. A simple change in configuration transforms non-liquid bulky ECFs into liquid, manageable ECFs, providing overall increased liquidity (via better execution) to all participants.
Trading ECFs
Our blockchain technology has a built-in exchange system, making trading ECFs for currency tokens efficient and simple. In FIC Network, we will utilize the exchange to trade single ECFs, and introduce standardized inventory all-or-nothing trading.

The built-in exchange is best suited for the secondary market. First, either seller or buyer places a bid on FIC Network. If a counterparty places an offer within their bounds they are matched at the best rate and the traded is executed instantly. This method offers the best liquidity and price discovery but comes at cost of large required deposits and a risk of not selling some of the ECFs at all.

Inventory trading is best suited for primary market or large trades in the secondary market. A seller creates an inventory account and sends to it all ECFs he wishes to sell together. Seller may optionally put an informative ask price on inventory. Then, a buyer signals interest in the inventory by publishing a price for it. Next, the seller reviews offers for his inventory, chooses a buyer (likely the highest bidder), locks the inventory with a timeout and publishes a pre-signed all-or-nothing trade transaction. It is necessary to lock the inventory so that buyer is sure that the content of inventory is not changed during the trade. Finally, the buyer confirms the trade by signing the trade transaction and submitting it before the timeout expires. If the buyer does not sign and the timeout expires, the inventory is unlocked and seller may attempt to sell to another buyer. This method offers an efficient way to sell from two to thousands of ECFs at constant technical costs and provides means to bundle them together for sale, but comes at cost of lower liquidity and blurred price discovery.

Taxonomy of ECF types
There are several types of ECFs on FIC Network. Here is the exhaustive list:

Expected Cash Flow (ECF): the most basic form of cash flow that will also be most common one. These are created by financial instruments (anything from loans to ABS), and they are destroyed via claiming currency tokens.

Final Cash Flow (FCF): this is a special ECF -- the last one in any series of ECFs. It behaves like an equity tranche, in that if previous ECFs are not fulfilled, it receives nothing, but if all previous ECFs are fulfilled, it receives the entirety of excess payments. This excess would most likely result from fees, but can be due to any number of reasons.

Conditional Cash Flow (CCF): this cash flow is created by particular financial instruments (such as CDS or futures options) and is special in that there is a financial decision required from the owner (condition) in order to collect the claim. Uses of CCFs for particular instruments are discussed under the Use Cases section.

Syndication campaign placeholder for Expected Cash Flow (sECF): this is not a real ECF but only a placeholder for it, exchangeable to the real ECF after a syndication campaign is successful, or exchangeable back to currency tokens if the syndication campaign is unsuccessful.
 Syndication campaign placeholder for Final Cash Flow (sFCF): the same as sECF, but related to FCF instead of ECF

Privacy, P2P data exchange, security

FIC Network users form an open peer-to-peer network where various protected data about users and financial instruments can be exchanged. The data received by peers is hashed and validated against a value written in a related account on FIC Network. For example, each loan account has two hashes: one for a loan’s non-public data, such as schedule, purpose, FICO score, etc. and another for borrower’s private data, like his name and social security number. When an originator shares a loan’s protected data with a potential investor, the investor will first check if the computed hash representing received protected data matches that on the loan account on FIC Network, which is public. Note that only hashes and not the data are public. Private data is not shared except with authorized parties by the user itself.

Figure: The data split between Public, Protected, Private layers. Applications transmit relevant information P2P while relying on FIC ledger for verification and settlement of assets.

On a technical level, not only is data validation handled by FIC Network, but so is peer discovery and public key exchange, thus most of the problems and complexity related to P2P data exchange are solved by FIC Network.

Each user’s FIC Network account holds his public key under which data will be encrypted to elegantly solve the man-in-the-middle (MITM) attack problem. If we assume that only the
user can sign his FIC Network account and other users can receive the correct version of the ledger, then a MITM attack is not stronger than a denial-of-service (DoS) attack.

Any means of data transport between peers can be easily used by having users publish protocol-endpoint pair as additional metadata on their user account in FIC Network. In-app SMTP will be implemented because it has a stable API and efficient spam filters.

For encryption, we will use the same crypto library that Stellar protocol uses because our P2P relies on the accuracy of the ledger for peer discovery and public key exchange.

**FIC Network token**

The nature of the FIC token is threefold.

1. **Utility value.** As a user on FIC Network, you need FIC tokens to do your business -- publish financial instruments, bid for ECFs, etc. This value is different from the coin’s exchange value. For example, a smart contract on the Ethereum chain can save your business thousands of dollars a month in administrative costs, even though the creation of this smart contract might have cost you a hundred dollars. Naturally, a coin’s average utility value is reflected by its exchange value.

2. **Technical.** A given number of FIC tokens in existence limits the number of financial instruments that can simultaneously be kept on a chain. Since the fixed income market is estimated at nearly $90 trillion globally, and if modern computers and the internet’s overall infrastructure cannot handle these amounts, then the reasonable solution would be to put an upper bound on how many loans can be on the chain at any one point in time. Moreover, this upper bound is hard to estimate in the future, especially when considering that faster internet infrastructure and more powerful computers will likely move this upwards in the future.

3. **Cryptocurrency:** all the properties of a cryptocurrency. The most similar cryptocurrencies to FIC are XRP by Ripple and XLM by Stellar.

In FIC Network there is a required deposit for every account and trustline made, and every published financial instrument consumes some of this deposit. When that instrument ceases to exist, the deposit is returned to the owner of the instrument. The amount of this deposit is agreed upon by FIC Network nodes. Since the total amount of FIC tokens is constant, the capacity of the network can be increased by lowering the deposit amount.
The following actions require Deposits and Fees:

<table>
<thead>
<tr>
<th>Business action</th>
<th>Technical explanation</th>
<th>Deposit FIX (you receive it back when action is finished)</th>
<th>Fees FIX (spent and gone forever)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create Firm</td>
<td>Have (x) firm account, max (4) metadata, reasonable amount (3) of multi-signers, trustline to Member token and reasonable low amount (2) of workers able to spend 100K fees each.</td>
<td>123</td>
<td>0.00015</td>
</tr>
<tr>
<td>Create User</td>
<td>Have (x) firm account, max (3) metadata, exactly 2 entries of signers, trustline Member token, and reasonable medium amount (12) of workers able to spend 100K fees each. Have bundle account.</td>
<td>200</td>
<td>0.00002</td>
</tr>
<tr>
<td>Trust ECFs</td>
<td>Trustlines to all (x) cashflows</td>
<td></td>
<td>0.00001</td>
</tr>
<tr>
<td>Publish loan</td>
<td>Have (x) loan accounts, max (3) metadata, exact 2 signers, send ECF to yourself.</td>
<td>50</td>
<td>0.00007 0.00001</td>
</tr>
<tr>
<td>Publish repayment</td>
<td>Optionally metadata</td>
<td></td>
<td>0.00001</td>
</tr>
<tr>
<td>List whole loan for sale</td>
<td>Have 1 separate bundle, fee (1-3) metadata, trust &amp; move all ECFs, untrust from user.</td>
<td>40</td>
<td>0.00004 0.00003</td>
</tr>
<tr>
<td>Bid on whole loan</td>
<td>Announce all-or-nothing offer (1-4 metadata) to transfer separate bundle to me.</td>
<td>40</td>
<td>0.00004</td>
</tr>
<tr>
<td>Sell whole loan</td>
<td>Sign &amp; execute all-or-nothing offer</td>
<td></td>
<td>0.00002</td>
</tr>
<tr>
<td>Have open bid on ECF</td>
<td>Trust ECF, make bid offer</td>
<td>20</td>
<td>0.00002</td>
</tr>
<tr>
<td>Publish Corporate Bond</td>
<td>Have (x) loan accounts, max (3) metadata, exact 2 signers, send ECF to IB that gave principal.</td>
<td>50</td>
<td>0.00007 0.00001</td>
</tr>
<tr>
<td>Create ABS (pre-auth)</td>
<td>Have (2x) ABS accounts, avg (3) metadata, send all ECFs in, offer for current ECF in queue, exact 1 signer, lots of presigned magic, send ECF's back</td>
<td>1000</td>
<td>0.00013 0.00004</td>
</tr>
<tr>
<td>Create ABS (pre-sign)</td>
<td>Have (2x) ABS accounts, avg (3) metadata, send all ECFs in, offer for current ECF in queue, exact 1 signer, lots of presigned magic, send ECF's back</td>
<td>90 10</td>
<td>0.00013 0.00004</td>
</tr>
<tr>
<td>Create CDS (pre-auth)</td>
<td>Have (1x) CDS account, const 91 pre-auth txs in the same time, 0 signers, 1 metadata. Requires Vault.</td>
<td>30 30</td>
<td>0.00004 0.00003</td>
</tr>
<tr>
<td>Create CDS (pre-sign)</td>
<td>Have (1x) CDS account, exact (3y) pre-signed txs, 2 signers, 1 metadata. Requires Vault</td>
<td>60</td>
<td>0.00004 0.00003</td>
</tr>
<tr>
<td>Syndicate / Crowdfund</td>
<td>Have Syndication account, exact 3 pre-auth txs, 0 signers, some metadata.</td>
<td>60</td>
<td>0.00004</td>
</tr>
<tr>
<td>Future Option</td>
<td>HaveFO account, exact 2 pre-auth txs, 0 signers, 1 metadata</td>
<td>60</td>
<td>0.00006</td>
</tr>
</tbody>
</table>

**Figure: Deposit and Fee amounts for actions to perform on FIC Network**

Note that there will be approximately one signer, one metadata file, and many ECFs for any financial instrument. Also, note that there will be many more financial instruments than user accounts. Therefore, most of the deposit on FIC Network will be consumed by owning an ECF.

In addition, as more FIC Network tokens are locked in deposits, less will be in circulation, causing their market value to rise. That will motivate users to create loans with fewer, and thus larger, ECFs, lowering the overall number ECF amount in the network. This will in turn lower the number of FIC Network token in deposits and act as downward pressure to its market value. These forces will eventually settle at an equilibrium between the number FIC Network token in deposits and their market value.

For investment bank users their FIC deposits will be proportional to their portfolio size. Issuer users will need a lot of deposit to publish their loans; however, as soon as they sell...
those loans they will get most of that deposit back and will be able to publish again. Other deposits are small by comparison.

We are exploring a possibility of creating a FIC credit pool where every participant can temporarily lend with interest their FIC tokens to other members.
9. Use cases

Loans

The creator of the Loan instrument is the Originator, the instrument is signed by Originator, but, technically, ownership is given to the Servicer. Thus, the following actions on the Loan are signed by the Servicer. The owner of the loan payments from the borrower is the Originator at first, but this ownership can be further sold to Traders via ECFs.

For this instrument, the act of borrowing generally is done off-chain -- the Originator posts an already active loan (for loan syndication or P2P lending model, please see [link to Syndicated Loans]).

A loan’s lifecycle can be split into three parts:

Borrower borrows money from Originator Off-Network (*Image B*).
- Originator creates loan account on FIC Network
  - Pays sufficient FIC Network deposit
  - Uploads loan documents

- Assigns a Servicer user
- Chooses currency tokens, which will be used for repayments
- Chooses how to split loan into ECFs
  (Trustlines towards ECFs are automated)

- Originator receives ECF assets
- Originator puts ECFs on sale and/or sells ECFs to Investors

Borrower makes a repayment (*Image B*)
- Servicer exchanges repayment to Currency Tokens via Gateway
- Servicer collects payments and directs it to the network
- Those who hold ECFs receive repayment Tokens in first order basis

Borrower makes a final repayment/Loan Defaults
- Servicer makes final payment
- Last ECFs are repaid
- Any leftover fees are turned into Final Cash Flow (FCF).
- If the Loan Defaults, Loan issues Default Tokens (if other instruments are used).
- Loan wait until all unpaid unpaid ECFs are returned, if any
- Loan is cleared from FIC Network
Corporate bonds

Corporate Bond is a financial instrument very similar to the Loan schema, with the difference that the borrower is represented on-chain and principal & interest payment can be done on-chain as well. The creator of the instrument is the Borrower, but the instrument is co-owned by both Creator and Collector (Collector’s role is assuring repayment of the Bond), and owner of ECFs -- can be either Borrower or Investment Bank at first, but this ownership can be further sold to Traders.

Bond lifecycle can be split into four parts

Bond Preparation Off-Chain
- Investment Bank prepares Prospectus document
- Auditor performs audit checks and creates documents
- Any necessary filings with regulators
- Rating agency assessments
- Add other documentation

Borrower creates Bond account on-chain (Image Ca)
- Pays sufficient FIC Network deposit
Uploads Prospectus and other documents
ECFs can now be sold to other willing parties

Borrower repays *(Image Ca)*
Bond can be repaid by either Borrower directly, or via another Collector/Servicer. The collector can be a third party guarantor of the Bond, ensuring repayment. Those who hold ECFs receive repayment Tokens in first order basis

Borrower makes a final repayment/Bond Defaults
Final payment is made
Last ECFs are repaid
Any leftover fees are turned into Final Cash Flow (FCF).
If Bond Defaults, Bond issues Default Tokens (if other instruments are used).
Bond wait until all unpaid ECFs are returned, if any
Bond is cleared from FIC Network

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**Image Ca**: Generic Corporate Bond Schema, where the creator is the cash holder.

In case it is necessary to make someone else a cash holder (such as Investment Bank) and principal payment can be done on-chain, technical schema is precisely the same as Syndication Campaign (see Syndicated Loans chapter), with the difference that this Syndication has only one Investor. In that case, in order to make a Bond active on the chain
and receive ECFs from Bond, the Investor (like Investment Bank) pays into the bond the full principal payment (which borrowing party immediately receives), and in return receives ECFs, that can be further sold to other interested parties (see Image Cb).

![Image Cb: Corporate Bond Schema including Investment Bank as cash holder](image)

**Securitization and Asset-Backed Securities (ABS)**

In FIC Network, an ABS securitization structure is a financial instrument that holds ECFs and CCFs from other instruments such as loans. We refer to the ECFs issued in this manner as **tranche-ECFs**, though they are not similar to tranches at all. There is a servicer for the ABS who cashes in ECFs from underlying loans and repays currency tokens to its tranche-ECF holders. A **black box AI is under development by Factury to handle this process automatically so that the ABS is a trustless entity.**

An ABS is created by the arranger who is a user on the FIC Network. Other FIC Network users involved in the creation of ABS are the warehouse, investment bank, and servicer. In this case, the servicer would be someone who in real life would be managing the SPV. After the ABS is created, the warehouse has given up its ECFs in exchange for currency tokens, the investment bank has given up currency tokens in exchange for tranche-ECFs, the arranger has collected a fee and the servicer has signing rights over ABS.
On a technical level, the transaction has these operations.

Arranger creates a new account with sufficient FIC deposit.
Investment bank sets up trustlines to ABS for each of its tranche-ECFs.
ABS sets up trustlines for ECFs in the warehouse.
Warehouse sends ECFs to ABS.
ABS sends tranche-ECFs to the investment bank.
Investment bank sends currency tokens to Warehouse.
Someone (investment bank and/or warehouse) sends a fee to the arranger.
ABS makes servicers signature valid.
ABS makes its own signature invalid.

This transaction should be signed by four key-pairs: arranger, ABS (whose keys were generated by the arranger), warehouse, and investment bank. It is the arranger's responsibility to collect these signatures.

During the lifetime of the ABS, its performance is based on the performance of its underlying assets. The expected dates of tranche-ECFs are directly calculated from expected dates of underlying ECFs. Other transparent ECF metrics can be calculated as well.
Syndicated loans

For syndication of both Loans and Corporate Bonds, the process flow is similar. The Originator (of the loan to be syndicated) is the creator of a Syndication Campaign on FIC Network. Once created, a financial instrument stays locked until the deadline, thus the Syndication Campaign itself has no owner, making it a trustless instrument. Therefore, campaign conditions are determined before the account is created.

This financial instrument creates *syndication-ECFs* (they are essentially placeholder ECFs while the campaign is still ongoing), which is received by anyone who participates in the campaign. As a result, cash holders, in this case, are Investors.
Upon the completion of a successful campaign, the Syndication Account, according to initial conditions, creates a new Loan/Bond account, and all Syndication-ECFs (or sECF for short) are exchanged for actual ECFs, issued by the newly created Loan/Bond Account. This Account does have an owner - it is signed by the Syndication Campaign account and further ownership rights are given to an earlier-designated Servicer. From now on, this Loan (or Bond) functions like discussed in above chapters. Crowdfunded currency tokens as principal payment are sent to Originator’s account.

If the Syndication Campaign fails to gather the required amount by the deadline, the Loan/Bond Account is not created and Investors receive a full refund by returning sECFs.

Credit Default Swaps (CDS)

This section explains how a CDS is implemented; however, the given schema applies for anything similar to insurance as long as the claim condition can be tokenized. In our case, a default token is used to validate that default occurred.
A CDS is a trustless instrument (does not have an owner on the FIC Network) so any transactions and their sequence are determined before account creation. Once it is created, no one including its creator can change it.

As per Dodd-Frank Act we expect that clearing houses will use FIC Network as a network and continue to be a counterparty on these trades. Courts shall enforce parties to ignore or refund the effects of CDS contracts executed over FIC Network.

The creator of CDS is **CDS seller** *(Image Fa: 0. CDS is created).* Cash from this instrument is billeted as a Conditional Cash Flow or **CCF** (conditions will be discussed later). The Creator chooses an underlying instrument, sets conditions, fee schedule, and **Vault** account, which will deal with CDS transactions. The Creator locks the CDS account and receives CCFs that can be sold to the buyer.

![Image Fa: Creation of CDS and Fee payment (Transaction A)](image)

Note that the **CDS buyer** (the CCF holder) must pay a monthly fee (i.e. a premium payment) to the **CDS seller** to keep the contract active. The agreement usually is that if the underlying instrument defaults, then compensation is paid to the CDS buyer.

The CDS Seller pre-defines three transactions (A - Fee, B - Default Claim, C - Cancellation of the instrument) with schedule windows. Transaction A will always be attempted and has
sequence number $N$. Transactions B and C have the same sequence number of $N+1$ and only one of them will be attempted depending on whether A was successful. Every month, only two out of three transactions will be attempted and successfully published.

**(N) Fee** - CDS tries to send a fee in currency tokens to seller's Vault account.

If A was successful: **(N+1) Default Claim** - CDS tries to buy default token from underlying instrument.

If A failed: **(N+1) Cancellation** - CDS is made invalid (revoking CCF).

Example of successful transaction A can be seen in *Image Fa: A. Fee: Payment in time*. Transaction A will not fail if CDS owns currency tokens (i.e. if CDS Buyer has paid the monthly fee on time) and Vault trusts the currency tokens. Putting currency tokens in CDS is the buyer's responsibility; however, Vault management is under seller's discretion and will be discussed later in detail. Normally this transaction will not fail.

Upon successful transaction A, Transaction B will be attempted. It will fail if CDS does not own a default token, which is usually the case. Then the next transaction that will be submitted is transaction A of the subsequent period. If the transaction succeeds and the default token is bought, then the CDS buyer (holder of the CCF) receives insurance coverage according to the schedule from the Vault.

Upon failure of transaction A, transaction C can be executed. This transaction always succeeds.
Thus CCF asset created by CDS holds following conditions

If fee is paid to CDS by schedule and Loan/Bond defaults => holder receives insurance amount according to schedule
If fee is not paid => CCF can be canceled

More technical detail transactions could be explained as follows (Image Fc). Let A, B, and C be transactions of this month, A' and C' be transactions for next month, B* the transaction for last month (that failed). Let us call the underlying financial instrument a loan for brevity and
vault is a special account that somehow belongs to the seller. Now we formally describe operations in the three transactions.

Transaction A (Fee):
Send fee in currency tokens to vault.
Make transaction B* invalid for this account.
Make transaction C invalid for this account.
Make transaction A' valid for this account.
Make transaction B valid for this account.
Make transaction C' valid for this account.

Transaction B (Default Claim):
CDS makes a path payment to itself sending loan default token and paying a small amount of FIC. (if loan has not defaulted this operation fails).
Make transaction A' invalid.
Offer to exchange CDS's temporary tokens for currency tokens. (this is how CDS gets tokens from vault)
Add seller as a signer for CDS. (to perform cleanup and delete CDS)

Transaction C (Cancellation):
Add seller as a signer for CDS. (to perform cleanup and delete CDS)
Note that at the beginning of a new month transactions A and C are valid. If A does not fail and B does fail then only transactions A' and C' are valid. This is the loop invariant. The new transactions A’, B’ and C’ can be different from A, B and C if loop invariant holds. This allows having a flexible schedule of fees and compensation amounts. If B or C is a success then the seller is made a signer for CDS and is able to invalidate it.

Now we will examine how a CDS is created.

The seller creates a new account with sufficient FIC deposit.
Vault offers currency tokens in exchange for temporary tokens from CDS.
CDS offers (lots of) currency tokens in exchange for its CCF.
CDS sends a CCF to the seller (in order to sell to the buyer).
CDS validates transaction A.
CDS validates transaction C.
CDS invalidates its own signature.
So far vault account has not been discussed. This is a potential point of trust that seller will not go bankrupt and vault will have currency tokens to pay in compensation. To mitigate this the vault account should be locked or at least multi-signed by independent parties.

Future Options
Future option (FO) is another trustless instrument (locked account without owner) that issues Conditional Cash Flows (CCFs). It allows a price to be set for a future exchange of goods. Buyers still must trust that the vault set up by the seller will have the desired asset in the future.

One FO account issues one CCF that may succeed or may fail depending on the buyer. There are two transactions: transaction A will make an exchange at some fixed rate to the holder of CCF, while transaction B will clean up and delete the FO. These are separate transactions so that B could not fail.

Suppose that X€ is exchanged for YBTC then seller creates a FO with these operations:

The seller creates an account for FO with lumen deposit.

FO sets up trustline for X€.

FO sets up trustline for YBTC.

FO sends CCFs to the seller.

FO makes transaction A valid.

FO makes transaction B valid.

FO makes its own signature invalid.

Vault offers BTC in exchange for FO temporary tokens.

Transaction A (FO usage):

Try to send X€ to the vault. (if this fails option is not called)

Offer temporary token in exchange for BTC up to amount Y.

Offer BTC in exchange for CCF.

Transaction B (Cleanup):

Set seller as signer (to perform cleanup and delete FO)

When a buyer wants to use his option to exchange CCF for BTC he makes a payment to FO so that A does not fail. When A succeeds, he will be able to make the exchange. If he does not pay money into FO then A fails and CCF becomes worthless.
10. **Addressing Weaknesses in the Credit Markets**

Credit markets generally have similar weaknesses to the broader fixed income market, including:

- Friction
- Disconnection (separation)
- Operational risks
- Illiquidity
- Asymmetry of information
- Lack of interoperability

**Friction and disconnection in lending market**

The transfer of loans requires many intermediaries. Special purpose vehicles (SPVs), trustees, rating agencies, auditors, and others all are involved with the stated purpose of protecting investors. This creates significant costs and separation between investors and the underlying assets, particularly during the securitization process.

*Figure: Friction and disconnection between investor and underlying asset in the process of securitization (simplified).*

**Illiquidity**

Loans are illiquid assets in current secondary markets, often even when securitized.

FIC Network introduces a novel approach to fractionalizing loans to allow for increased diversification in both quality and timing of cash flows.
Inspired by STRIPS (Separate Trading of Registered Interest and Principal of Securities) derivatives in the bond market, FIC Network allows for the trading of individual repayments towards an asset, with each discrete installment titled an Expected Cash Flow (ECF). More information regarding ECFs is provided under Technical Concepts.

Separating a series of repayments into their component ECFs lowers the barrier of entry, as assets are split into smaller packages requiring less capital from each particular investor. These smaller units also allow for the creation of a more detailed and diversified portfolio.

**Asymmetry of information**

We introduce several novel approaches to assessing credit and business risks in the medium- and long-term. The introduction of immutable record keeping allows for the tracking of two new qualitative data points, creating opportunities for granular credit analysis.

FIC Network has a new standard to gauge the analytical/predictive abilities of originators on the system: the Borrower Expected Repayment Rate, or BERR, which allows investors to determine how accurately any given originator predicts the total expected return (including default rate but also other aspects) on the loans they originate. What this means is that every loan on the system will have two percentage figures associated with it:

- an estimate of the total payments a borrower is expected to make that an originator has given to a particular loan, and
- the same originator’s historical estimation accuracy.

**BERR Score**

Borrower’s Expected Repayment Rate. Prediction evaluated by the Originator at the moment of origination for every loan. Ratio of total expected repayment (principal + interest + any fees) to loan’s initial principal amount expressed in percentage terms.

\[
BERR = \frac{expected\_principal + expected\_interest + expected\_fees}{initial\_principal} \cdot 100\%
\]

This percentage can be anything from 0% to 200% or greater.

*Example:* If principal amount is $1,000.00, but originator predicts that $1,050.00 will be repaid total, BERR in this case is 105%.
**BARR Score**

Borrower’s Actual Repayment Rate. Evaluated at the moment when loan is canceled -- either paid off or collected after the default. Ratio of total actual repayment (principal + interest + fees) to loan's initial principal amount expressed in percentage terms.

\[
BARR = \frac{actual\_principal + actual\_interest + actual\_fees}{initial\_principal} \cdot 100\%
\]

This percentage can be anything from 0% to 200% or greater. Used only for evaluating Originator's BARR.

*Example:* If principal amount is $1,000.00, but borrower has paid off $1,050.00 total at the end, BARR in this case is 105%.

**Originator's BERR**

Annualized measurement of Originators’ accuracy in predicting BERR. Weighted Average Difference between BERR and BARR for all loans Originator has posted on the FIC ledger that are finished -- either paid off or collected after the default during the last year.

\[
oBERR = \frac{(BARR_1 - BERR_1) \cdot initial\_principal_1 + \ldots + (BARR_n - BERR_n) \cdot initial\_principal_n}{initial\_principal_1 + \ldots + initial\_principal_n}
\]

If the number is positive, Originator overperforms (loans on average repay more than originator expects). If it is negative, Originator underperforms (loans on average repay less than originator expects).

*Example:* If the oBERR for a particular Originator is +2%, then on average he underestimates BERR by 2%, thus loans yield 2% more than the originator expected.

As a result, it will be possible to calculate whether any given originator, on average, underestimates or overestimates actual repayment rate risk. Furthermore, FIC Network would track and calculate the standard error of this difference over time. With this information, an investor can better calculate a given loan’s actual repayment rate within a reasonably small margin.

**Friction & Lack of Interoperability**

Current loan markets have significant friction when effecting a transaction or cross checking information reliably between sources of data. Our solution, in essence, means independent and autonomous participants interact via the distributed ledger.

Distributed ledger technology allows for the formation of a perpetual and immutable record that is digitally signed by participants, recorded in the ledger, and preserved by a large group of willing verifiers (each with a “node”). Each node interoperates with the other nodes to reach, through consensus, a single version of truth agreed to by all participants. Thus, the
ledger will hold records of all transactions from all accounts. Transactions are processed automatically — once a trade has been initiated and accepted by the involved parties, it automatically clears and is written in the ledger.

The primary benefit of this approach is the decentralized control of the ledger. Everyone owns — or can access with relative ease — a credible copy of the ledger. As a result, the need to cross-check databases manually and access centralized databases is eliminated.

A secondary major benefit is speed. When users can rely on their personal versions of the ledger (provided they allow them to be updated, a process that occurs every few seconds and is near-instantaneous), what results is a universal, consistent and reliable source of information about what resides on the system, eliminating the need for the substantial loan tracking bureaucracy that currently exists, and hence for trading to occur at a significantly faster rate. Any participant can track the actions of members of the network, eliminating the friction and creating a more transparent, traceable and auditable market.

**Privacy and Data Provenance**

Blockchains are a powerful technology as they greatly increase the reliability of anything that is stored in them, but since they are accessible to everyone, most of the solutions come with great privacy issues.

FIC Network solves this issue by introducing three layers of privacy – public, protected, and private. The public layer is the only data layer that is explicitly written in the FIC Network. Sensitive data, however, is split into two layers, protected and private. They are hashed and only the hash of each of these layers will be published publicly. The hashes serve as a proof that particular data has not being tampered with.

Thus, parties who receives sensitive data are able to validate the integrity of received information based on information published in the distributed ledger. Any data attached to the network is visible to appropriate parties and protected from tampering or denial of existence.

While only identifiers and control data are stored in shared access environment, parties may decide to reveal their protected information selectively to parties they trust. Both sensitive data layers never leave local application of the user without its explicit concern. As the identity of the FIC Network use is stored in a protected layer, participants stay anonymous to the public and share the identity only as needed.
11. Infrastructure overview

FIC Network uses its own distributed ledger (blockchain) based on the Stellar protocol. Technically, Stellar consists of “native currency”, “accounts” and “assets.” Accounts and Assets are abstract objects in this network. FIC Network does not modify Stellar, but defines various special arrangements, so that these objects effectively represent financial instruments, loans, users, etc.

Launching a separate FIC Network blockchain is a necessary step to address fixed income market needs, adapt it to cryptocurrency market, distribute tokens effectively, and avoid scaling issues.

At this point, FIC Network consists of three components – FIC Network, eDepository, and Infrastructure services – that create a self-functioning, self-scaling, and self-regulating network of participants. This enables asset Issuers and investors to buy and sell assets in a simple, transparent, and cost-effective way.

**FIC Network** is a cryptographically secure distributed ledger for fixed income markets, whose core is the Stellar protocol. It acts as a single, permanent source of consistent information about registered assets without a need for 3rd party services.

**eDepository** is the software solution that communicates with the underlying infrastructure, the FIC Network. It allows network participants to publish, update, manage, and verify asset information throughout each loan’s life cycle as well as exchange information (see P2P data exchange).

**Infrastructure services** offer such services as asset exchange, analytics, audit, insurance.

**Consensus mechanism**

FIC Network participants are fully autonomous, but all databases across this network are consistent and up-to-date. As network participants are not necessarily all well behaved and rational, and thus their trustworthiness is questionable, it is vital that all new information is reviewed and confirmed by peers before being accepted. This review and approval is called consensus.

Stellar consensus protocol is created based on a concept called federated Byzantine agreement³ and relies on the principle of peer trust, also known as consensus slices.

Participants of the ledger can trust the ledger version they possess, as they trust the peers they selected for consensus agreement.

“SCP [Stellar Consensus Protocol] is the first provably safe consensus mechanism to enjoy four key properties simultaneously:

- **Decentralized control.** Anyone is able to participate and no central authority dictates whose approval is required for consensus.
- **Low latency.** In practice, nodes can reach consensus at timescales humans expect for web or payment transactions—i.e., a few seconds at most.
- **Flexible trust.** Users have the freedom to trust any combination of parties they see fit. For example, a small non-profit may play a key role in keeping much larger institutions honest.
- **Asymptotic security.** Safety rests on digital signatures and hash families whose parameters can realistically be tuned to protect against adversaries with unimaginably vast computing power.\(^4\)

FIC Network implementation of the Consensus protocol adds a semantic layer on top of the protocol by defining the term of a “verified entity”, whether Gateways, Regulators, or Factury Inc. itself.

Factury Inc. participates on the network as a participant holding consensus slices with all verified entities. For the rest of the distributed network participants, they are required to have a predefined minimal set of other nodes and set of verified entities in their quorum slices. This generates a fully interconnected network with flexible trust, guaranteed safety, decentralized control, and low latency.

**Software architecture**

FIC Network’s software architecture consists of three layers: node, application server, and application.

**Node**

Node — also called Stellar Core — a server which runs one replica of a full ledger. Everyone who wants to participate will be able to run their own replicas and choose which replicas to trust. The “consensus” of nodes is ensured via the federated Byzantine protocol\(^5\). This Protocol ensures immutable and perpetual records of data among all nodes.

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### Application server - Horizon

Application server — also called Horizon — a tool for interpreting data in the node network and to feed any changes to it. It comes bundled together with the node during installation. For a client, however, both of these layers can be treated similarly to the Internet: there is no need to know how the wires are connected underneath, only to know how to use the final result. This is the layer where the ledger — aka FIC Network — is created.

Figure: Software architecture

NB: The Horizon holder holds the “Horizon” application server -- the doors to the FIC Network. It communicates the node/FIC Network’s contents to the application and communicates the application’s actions to the node/FIC Network.

### Application

Application — eDepository is a software solution that communicates with the FIC Network. It allows network participants to publish, update, manage, and verify loan information throughout each loan’s life cycle as well as choose which Horizon Server to connect to.

### Types of Nodes

FIC Network has a self-regulating network of participants. Any party of the network acts on its own. It is the responsibility of the participant to establish trust line to any other party, thus becoming part of the network. The network is fully sustainable and can function irrespectively of any particular member.
**Node Holders**
This is any participant that wishes to check and maintain full integrity of the network independently and to submit their own activities to the FIC Network without intermediaries. Any party can become a Node holder by dedicating a server to the running of a node. A node holder can choose between two types of nodes or run both.

**Validation Node**
A server that validates all the transactions that happen in the ledger. These nodes submit transactions to the ledger and participate in the consensus protocol.

**Archive Node**
An archive of all the data that has ever been written in the ledger. Archives updates according to the consensus of Validation Nodes. Archive Nodes help new nodes to catch up with the most recent ledger update.

**Gatekeeper**
The Gatekeeper maintains the FIC Network blockchain user base solely for qualified participants. To preserve the highest degree of network security, the creator of the network, Factury, temporarily acts as a “Gatekeeper”. Factury is doing Know Your Customer checks and assigns rights to users in the network. This does not prevent FIC token owners from holding or trading tokens with their user accounts.

**Observer**
An Observer has read-only rights on the ledger. An Observer can request extended data from other participants. These could be analytics companies, government institutions, or investors prior to investing in an instrument.

**Trader**
Traders have the ability to own both network assets (Currency tokens and ECFs), trade with assets freely, make offers with them, and collect repayments for any ECFs it owns.

**Originator**
An Originator is the only user with the right to publish financial instruments. An instrument at origination automatically is divided into tradable assets: ECFs. The Originator can sell instruments or individual ECFs to Traders in exchange for Currency tokens. FIC Network tracks performance metrics based on instruments an Originator publishes, including the Borrower Expected Repayment Rate (BERR) for the lending market.
**Servicer**
The Servicer is the only user that can modify existing loans and bonds and is responsible for sending repayments into the system. The Servicer can own Currency tokens and freely trade with them, and use currency to fulfill ECFs of the loans it services.

**Gateway**
The Gateway user is the only party that is able to issue currency tokens in the network and register it on the ledger. The Gateway is able to distribute currency to whomever he has an agreement with. It is the sole member in charge of the integrity of currency it has issued.