Distributed Ledger Technology

The genesis of a new business model for the asset management industry

May 2017

pwc

FUNDCHAIN

Foreword

In 2016, we took part in the Luxembourg-based blockchain initiative, Fundchain.

Ten founding members representing major financial institutions including BIL, BNP Paribas, CACEIS, European Fund Administration, HSBC, ING Luxembourg, Pictet, RBC Investor & Treasury Services, Société Générale Bank & Trust, and PwC Luxembourg have joined forces with Scorechain, a Luxembourg-based blockchain company.

The initiative began in summer 2016 and has been exploring how distributed ledger technology may help the fund industry improve efficiency and create new business opportunities.

After several weeks of interviews, training sessions, workshops and a two-day hackathon, Fundchain unveiled, at the end of 2016, a first insight of a Blockchain Proof-of-Concept (PoC) for the investment funds industry: The Smart Transfer Agent (TA).

Running on a ten nodes private blockchain, the Smart-TA allows the consortium of key players to simulate fund subscriptions and redemption processes, as well as shares transfers. Thanks to smart-contracts, relationships between investors, fund administrators, asset managers and regulators can be direct, since processes are automated and information is immutably written into the distributed ledger.

At the beginning of April 2017, Fundchain released a final deliverable in the form of a White Paper. This paper highlights the genesis of a new business model for the asset management industry based on distributed ledger technology including:

- Analysis of the current fund distribution value chain
- High-level description of blockchain technology
- Description of a potential revamped fund distribution business model
- Presentation of Fundchain initiative and its PoC: The Smart TA

As a participant to this initiative, we're pleased to provide you with this White Paper in an exclusive brochure format.

Hoping that this paper will generate stimulating discussions on the future of the investment funds industry, and in particular asset servicing, we wish you pleasant and interesting reading and encourage you to engage with our experts or to volunteer to participate in the future phases of the initiative.

François Génaux
FS Consulting Leader

Steven Libby
Asset Management Leader

Fundchain

a Luxembourg initiative with key players from the fund industry

Introduction

This White Paper is the main public outcome of a six-month initiative called Fundchain.

This initiative managed to create a common understanding of the Distributed Ledger Technology between ten key players, as well as the development of a proof of concept using Blockchain technology in the area of asset management, and in particular in the fund-distribution value chain. It has generated a lot of enthusiasm from all participants, who recognise the disruptive nature of the technology and the exercise, as well as the high potential for the future.

The objectives of this document are to:

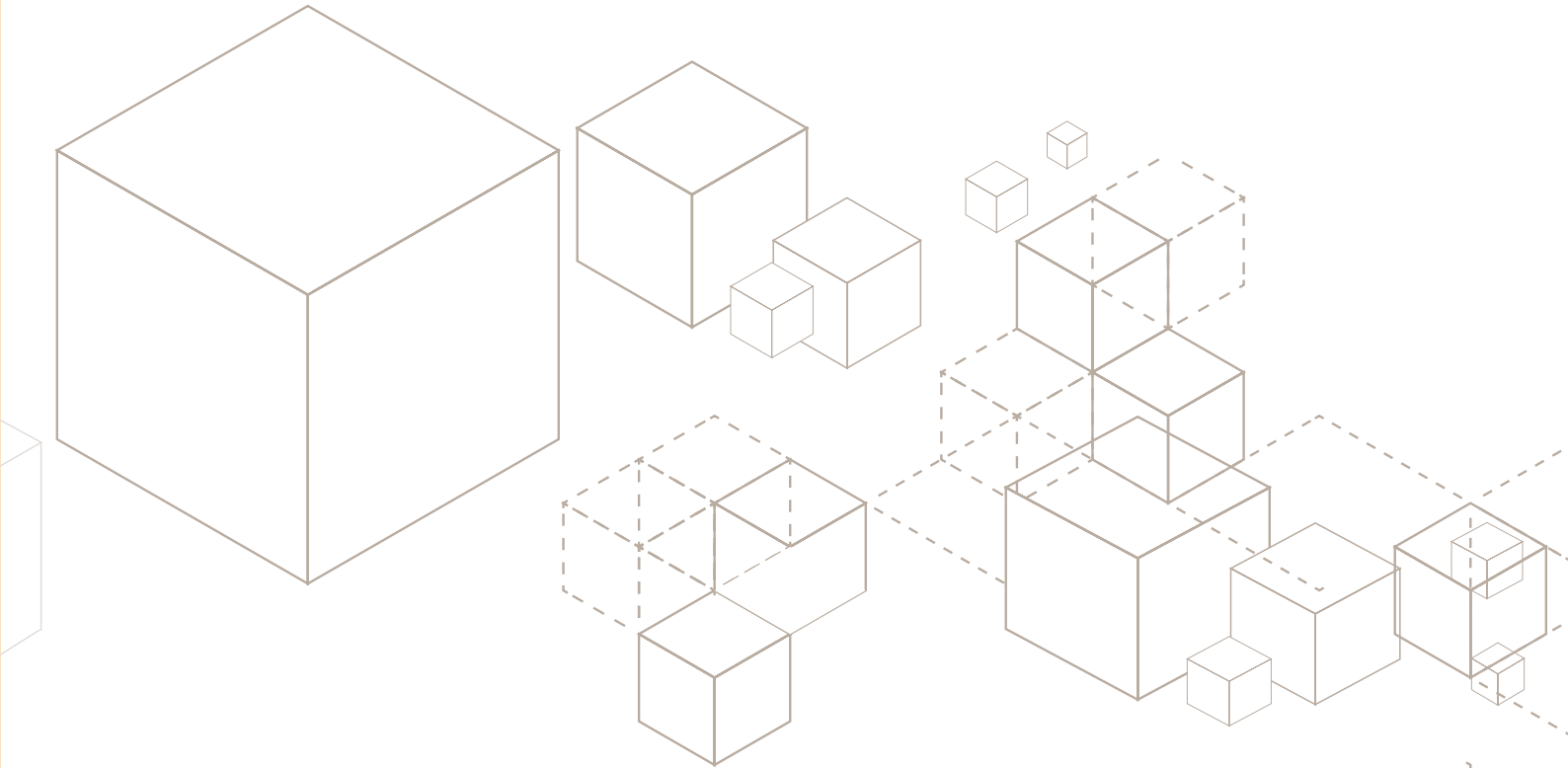
- present fund distribution today and showcase the main pain points of the industry;
- provide a high-level description of Blockchain technology;
- describe a potential revamped fund-distribution business model by using Blockchain technology;
- describe the evolution of potential market players' roles by using Blockchain technology;
- present the Fundchain initiative and its proof of concept: the SMART TA (transfer agent);
- suggest a potential way forward.

The authors of this document are conscious that even though Blockchain is high on the radar of many financial-sector players, it is crucial to keep in mind that it is a distributed ledger technology, and as such, the proposed vision in this document for a revamped business model will strongly depend on a large number of market players adopting the new technology. This currently represents the main challenge for us going forward, more than the technological aspects.

Finally, the adoption of this technology, if it is sufficiently attractive to market players, will require additional proofs of concept at various parts of the value chain. The technology is expected to be used in a parallel-mode approach and a trial-and-error approach, and not as a "big bang" approach, as it involves significant changes in the players' roles and responsibilities, as well as potential changes to the current regulatory framework.

We hope you enjoy reading this White Paper and that it will generate ideas and discussions around the future of the industry.

Content



Market trends

Megatrends will change fund distribution

In the last 30 years, the landscape of the fund industry has reshaped itself many times. This transformation has been driven towards the increasing use of intermediaries.

From an investor's decision to invest into a mutual fund, to asset managers, many players (and their respective roles) are involved in the chain.

A few factors dictate that it is highly probable that the fund industry's current business model will be affected by fundamental changes in the short- to mid-term future.

Why are we so sure about this? Today, many studies are talking about the so-called megatrends of the future and are analysing their potential impact. Those megatrends will not only impact on different areas of our lives, but also our business and investment behaviour.

Megatrends – the drivers of the future

We have identified four megatrends that will have a significant influence on the fund industry.

These megatrends will bring many opportunities for all players in the fund-industry value chain (custodians, transfer agents, fund administrators, management companies, regulators, auditors, etc.). However, several challenges must be overcome in order to turn them into advantages.

These megatrends have a common influence on our future and will redefine the fund-industry landscape.

But what are these megatrends?

Demographics

Demographic factors must be considered, since they will have a material impact on the fund industry and its distribution value chain.

These factors are population growth, the aging population, longer working careers, the changing role of women, increasing urbanisation, a growing middle class, and a growing economic influence in the developing world and increasing life events.

By 2020, millennials will form 50% of the global workforce.

By 2020, 78 million baby boomers, born between 1946 and 1964, will reach retirement age.

Technology

The digital revolution, along with its inherent disruption on existing business models, acts as the major driver of social, economic and environmental change. It continues to change every aspect of our social and business lives.

The main areas of this megatrend are: the speedy pace of technological change, increasing connectivity, big data and

breakthrough innovations, open-source frameworks, scaled cloud computing and developments on demand.

Environment

The current generation will face resource penury in the mid-term future, which is already leading to a change in investment opportunities and higher demand for risk protection. Increasingly socially responsible behaviour is already on asset managers' agenda.

The environmental trends are: increasingly socially responsible behaviour, increasing resource insecurity, and rising environmental risks.

Social values, behaviour and ethics

Technology and connectivity have revolutionised the way in which a large proportion of the world's population interacts, communicates and behaves.

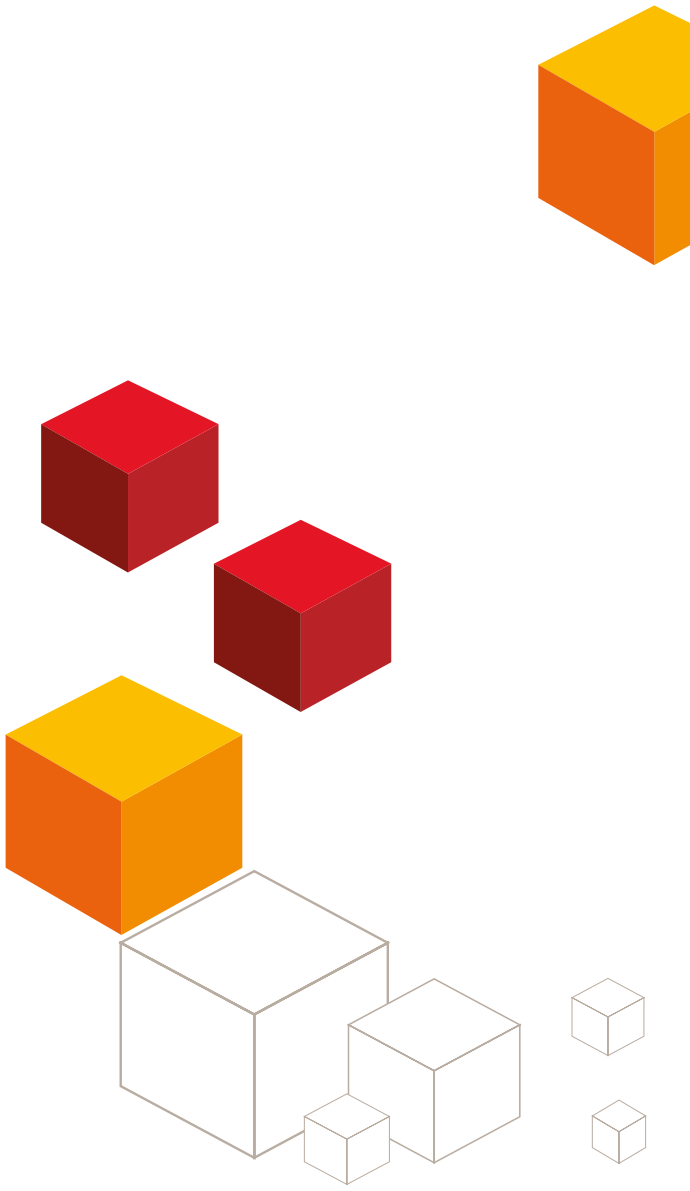
The main areas of this megatrend are: the growth importance of social media, the importance of trust and integrity, the desire for immediacy, demand for simplicity and transparency, the importance of networks and social relationships, growing demand for customisation, and cultural differences.

The impact for the fund industry

The coming together of these four megatrends will have a significant impact on the fund industry in the future.

In the following pages, we will provide an overview of the current fund-distribution process, highlighting the numerous challenges that the fund industry is facing and giving us the necessary input to develop our vision on one aspect, which is the most significant impact area for us: **the fund-distribution value chain.**

> "These megatrends will not only impact on different areas of our lives, but also our business and investment behaviour"



Fund distribution today

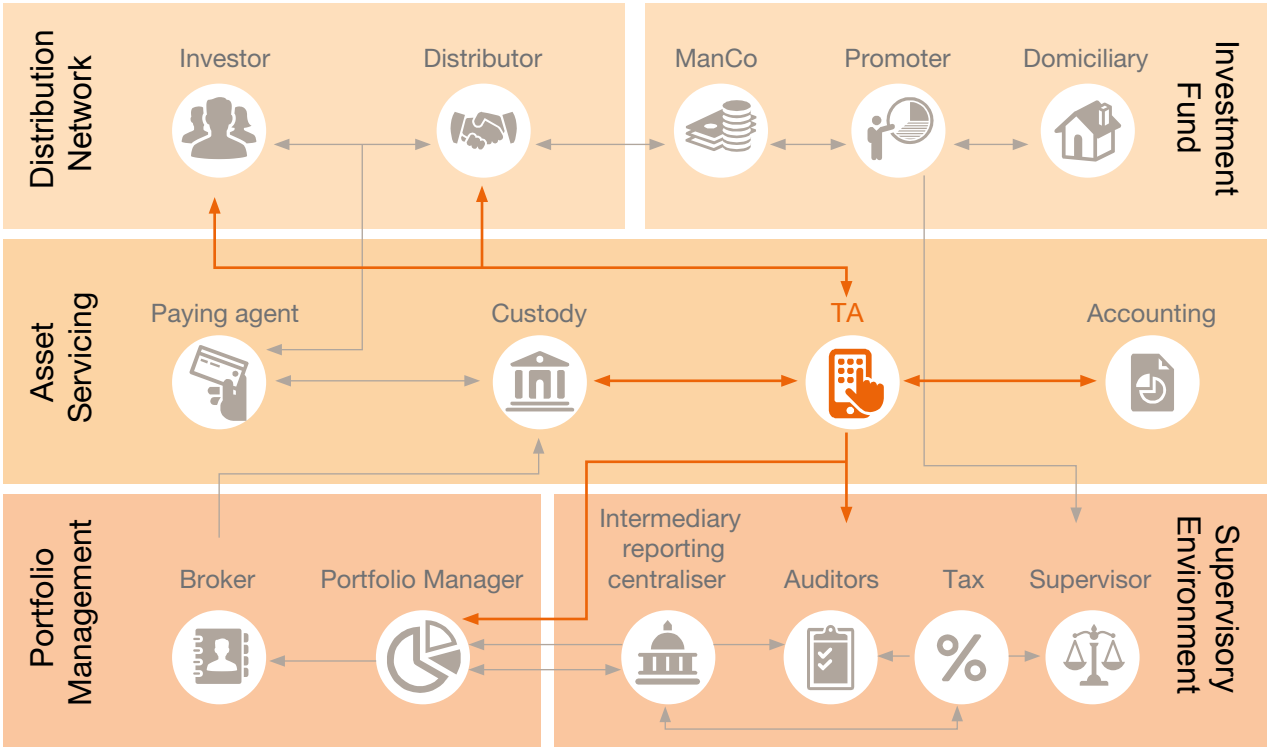
An activity facing many challenges today

Many intermediaries

The fund-distribution value chain is very complex, primarily due to the high number of intermediaries and operational processes involved in daily activities. Advising, identifying, instructing, acknowledging, processing, checking, confirming, monitoring, reconciling, reporting, storing, regulating, auditing, etc. are just a few items on the long list of actions and services delivered by and to all players in the fund industry.

Within this complex network of intermediaries, the role of the transfer agent has developed over time as a specialist in intermediation between two groups of players: on one hand, the investors and distributors, and on the other hand, the fund and its asset managers and service providers. The trend towards an increasing number of intermediaries has consequently expanded the fund-industry network and its value chain.

The classic fund-distribution value chain



In this context, TAs have developed a catalogue of services, such as identifying investors and distributors, transaction management, settling cash and fund shares, calculating distribution fees, and operational and regulatory reporting.

As illustrated in the following examples, most of these TA services materialise in operational processes comprised of many steps and interactions.

Investor and distributor identification: a time-consuming, manual and risky exercise

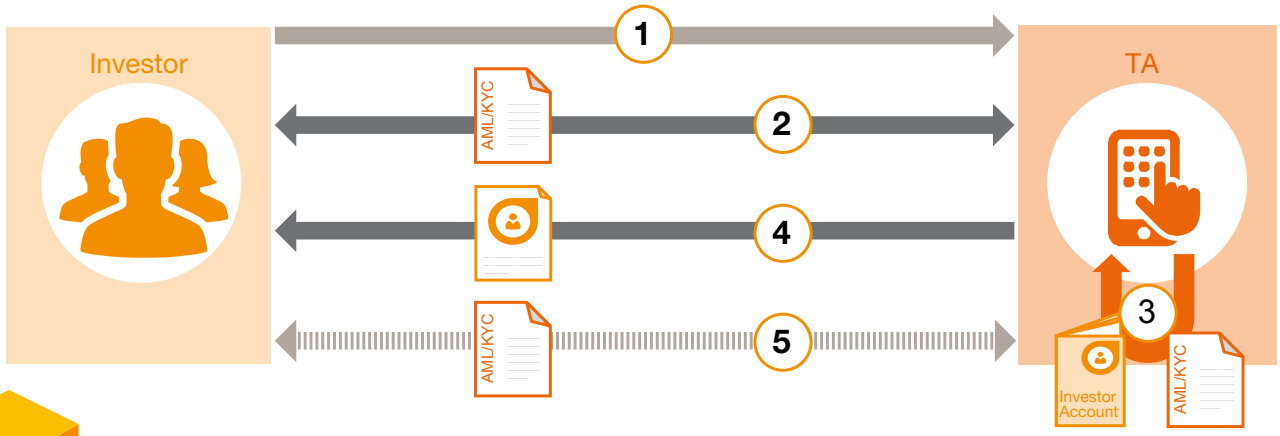
To invest in a fund, an investor must provide the TA, either directly or through an intermediary such as a distributor, with a list of AML/KYC documents and information, in line with international and local laws.

Process model 1: the investor is in direct contact with the transfer agent

1. The investor asks the transfer agent to invest in a fund.
2. The transfer agent collects the AML/KYC documents from the investor.
3. The transfer agent checks the AML/KYC documents, opens the account and archives the documents.
4. The transfer agent confirms to the investor that the account has been opened.
5. On a regular basis, the transfer agent checks the validity of the AML/KYC documents and requests updates from the investor.

> “Identification is time-consuming and a redundant burden”

The current AML/KYC process flow (without distributor)



Process model 2: the investor uses a distributor to liaise with the TA

1. The investor asks the distributor to invest in a fund.
2. The distributor collects the AML/KYC documents and sends them to the transfer agent.
3. The transfer agent checks the AML/KYC documents, opens the account and archives the documents.
4. The transfer agent confirms to the distributor (and investor) that the account has been opened.
5. On a regular basis, the transfer agent checks the validity of the AML/KYC documents and requests updates from the distributor and/or investor.

In this process, transfer agents face several challenges:

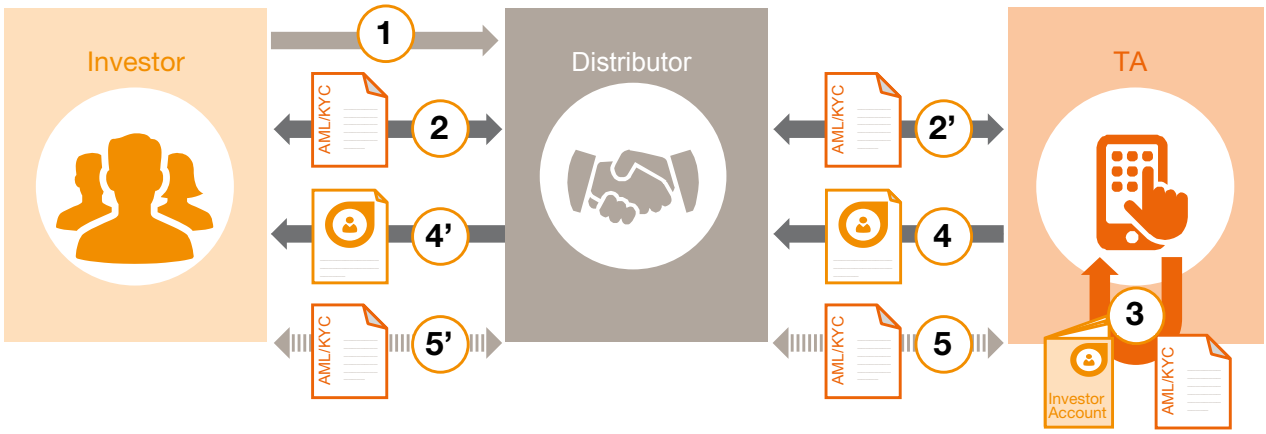
No international standards: it is difficult to apply AML/KYC rules to investors (and distributors) who reside in many different countries, and therefore whose identification documents are in different languages, in different formats and with different content.

Qualified staff needed: the validity (date and content) of all AML/KYC documents must be constantly monitored and investors (and distributors) must be chased for updates. This usually requires state-of-the-art transfer-agent software and many actions to be taken by the transfer agent's AML/KYC staff.

Low profitability: recruiting enough staff with the right skills to perform AML/KYC activities is expensive. This cost can put the transfer agent's profitability at risk, depending on their size, the economy of scale achieved and the level of automation.

Financial and reputational risks: there is a risk of financial penalties and reputational damage if an investor manages to launder money via a transfer agent.

The current AML/KYC process flow (with distributor)



Transaction management: a multi-step process

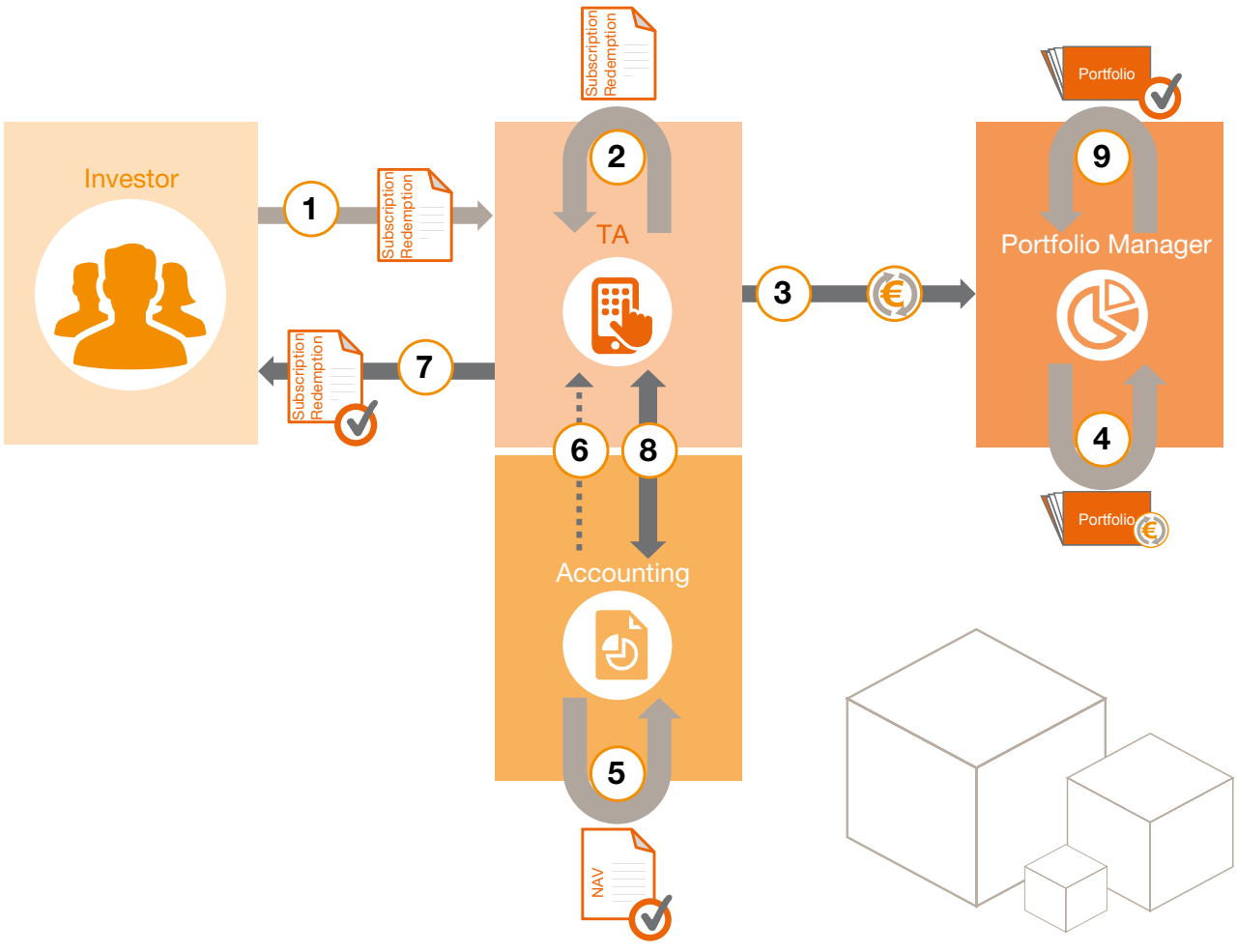
Investors can send their investment instructions either directly to the transfer agent, or via one or several intermediaries such as a distributor, a CSD (Euroclear/FundSettle, Clearstream/Vestima, NSCC, etc.) or an operational platform (Allfunds Bank, Calastone, Fundsquare, etc.).

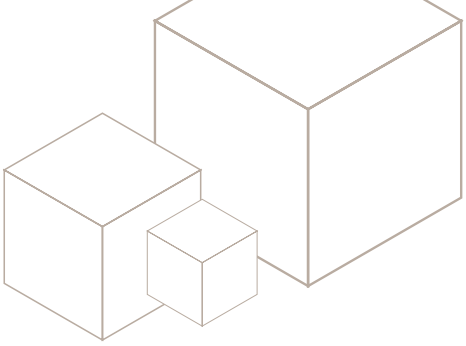
The order-routing model opted for by the investor is usually in line with their country of residence's market practice. For instance, German and British investors are keen to liaise directly with the TA, while southern European investors will usually use one or several banks as intermediaries. Asian investors use a lot of nominee accounts (i.e. an account opened by an intermediary to bulk the fund balances of thousands of underlying retail investors), and Chilean investors have their investments managed by pension-fund administrators.

Process model 1: the investor is in direct contact with the TA

1. The investor instructs the Transfer Agent to carry out a subscription or redemption.
2. The transfer agent checks the instruction and if OK, books it in its system.
3. The transfer agent sends the cash-flow forecasts to the portfolio manager.
4. The portfolio manager prepares to invest/disinvest as per the cash-flow forecasts.
5. Right after the dealing cut-off time, Fund Accounting calculates the NAV.
6. The transfer agent applies the NAV to all subscription/redemption deals.
7. The transfer agent sends the deal confirmations to the investor.
8. The transfer agent and/or Fund Accounting reconcile the fund's outstanding shares.
9. The transfer agent completes the dealing process and the portfolio manager confirms planned investments/dis-investments.

The current subscription process flow (without distributor)





Depending on the transfer agent's level of automation on the market, managing investors' transaction instructions can represent a tough challenge for transfer agents, especially regarding the risk of operational errors.

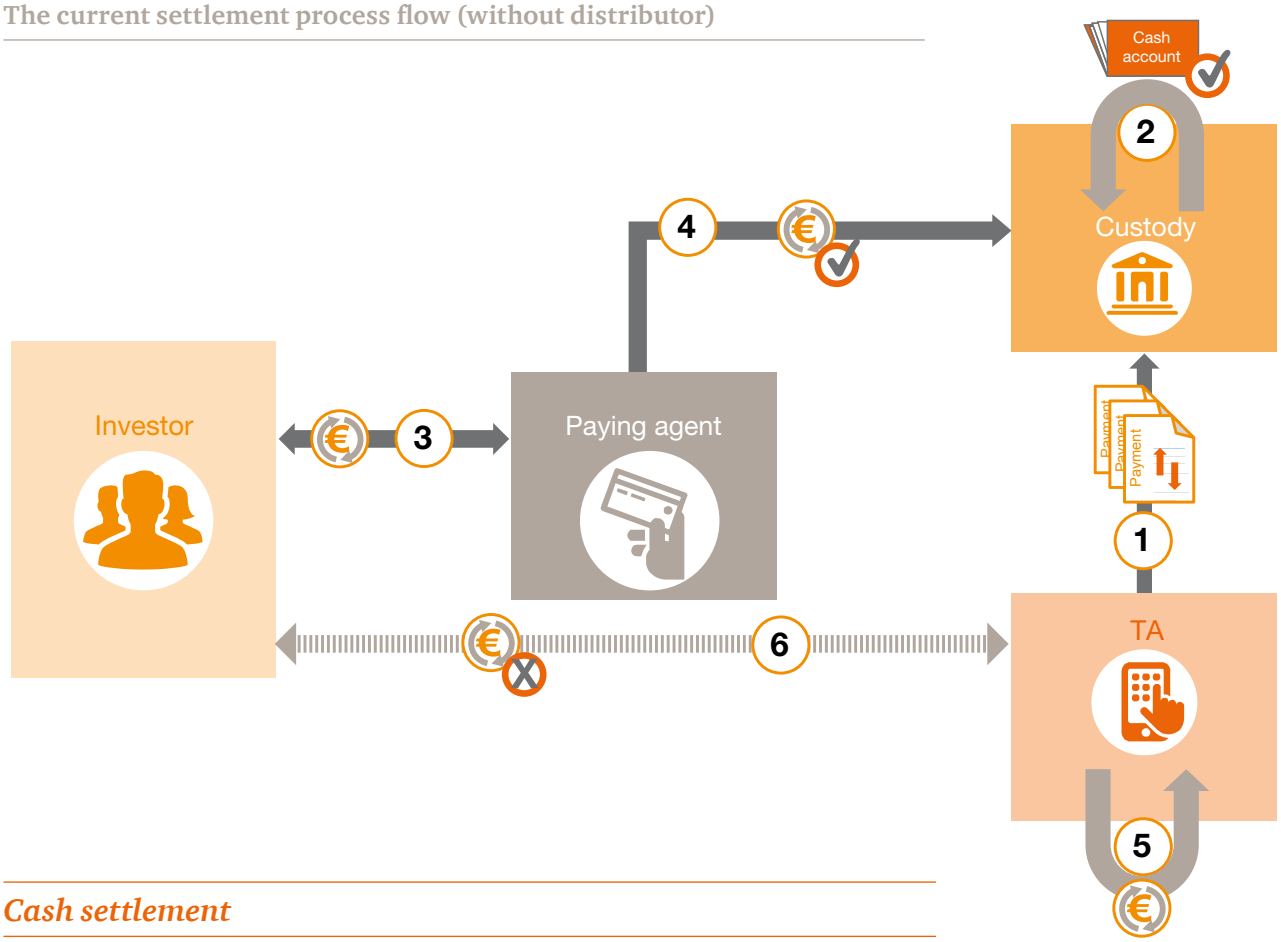
Meeting fund cut-off times puts constant pressure on TAs who have not achieved a high level of STP. They must organise and constantly monitor the timing of each step of the transaction-management process: acknowledging the receipt of the transaction, booking it, checking it, escalating it to the fund manager when it has a high value, sending the cash-flow forecasts and final reports, applying the NAV to the transaction and sending the final confirmation to the investor. The typical day for a TA's transactions team is split into many steps, depending on sub-funds' mandatory timings. It is an operation that becomes difficult to organise in contingency situations such as a system outage or staff unavailability.

When TAs are responsible for missing a cut-off time and applying a wrong NAV, or for incorrectly booking a key component of a transaction (the value, the fund, the investor or the fees), they have to correct their error and bear the financial cost of it. In the event of a high transaction value or rapid NAV changes, the cost can be very high. This forces TAs to implement strong operational double-checking and monitoring of their transaction-management activities. It also requires them to have enough staff, with the right balance of language skills, enabling them to read transaction instructions received by fax if there is a lower automation level.

Overall, we can say that the challenge for TAs in transaction management is that, of all the counterparties involved in this process, they are the ones responsible for the most risky steps. The operational risk is centralised around the TA.

> "Managing investors' transaction instructions represents a tough challenge for transfer agents"

The current settlement process flow (without distributor)



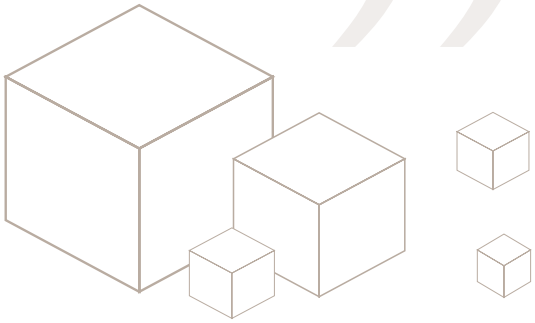
Cash settlement

Most transfer agents manage payments related to transactions, dividends and fees. They are in charge of setting up and maintaining the payment details of investors and distributors, and these can vary depending on the payment purpose.

Process model 1: the investor is in direct contact with the TA

1. The transfer agent informs the custodian of payments due as per transaction, fee or dividend processes.
2. The custodian checks and instructs a debit from/credit to the fund's cash accounts.
3. The paying agent pays/is paid by the investor. The paying agent is the last intermediary and actively initiates the payment to/from the beneficial owner (i.e. the investor).
4. The paying agent informs the custodian of all payments.
5. The transfer agent reconciles the cash movements with the transaction, fee or dividend amounts.
6. The transfer agent chases the investor if any payments are overdue.

"Cash settlement is actually a multi-day process"



Process model 2: the investor uses a distributor to liaise with the TA

1. The transfer agent informs the custodian of payments due as per transaction, fee or dividend processes.
2. The custodian checks and instructs a debit from/credit to the fund's cash accounts.
3. The paying agent pays/is paid by the distributor, who pays/is paid by the investor.
4. The paying agent informs the custodian of all payments.
5. The transfer agent reconciles the cash movements with the transaction, fee or dividend amounts.
6. The transfer agent chases the distributor, who chases the investor, if any payments are overdue.

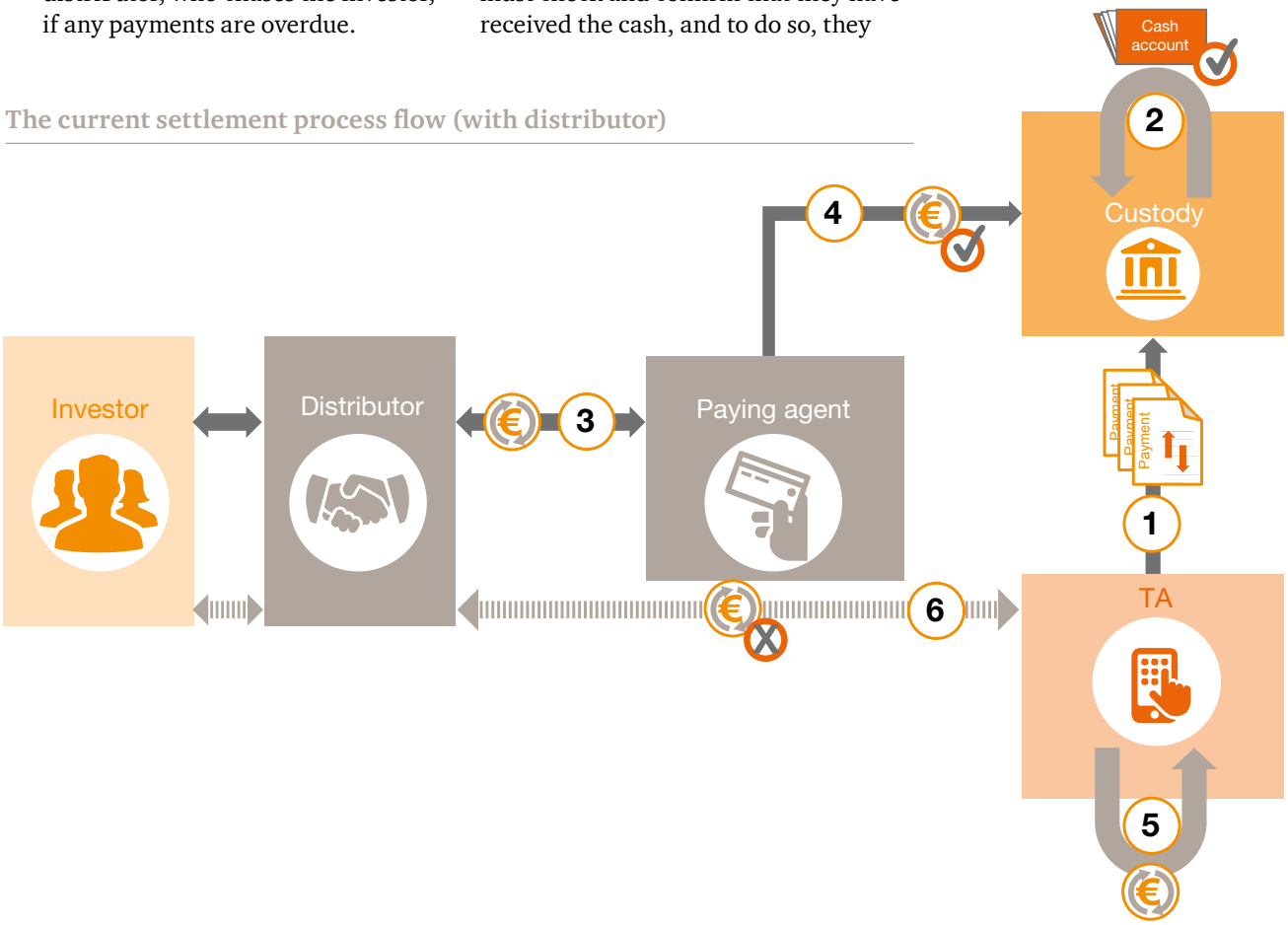
The payment process faces two types of challenges, triggered by the high number of counterparties involved.

Firstly, there is the operational burden of reconciling payment instructions between numerous counterparties. The TA, custodian, paying agent, distributor and investor are all receiving and giving payment instructions using their own its own ledger. Nowadays, payment reconciliation is highly automated, but there are still many cases of manual reconciliation. Transfer agents are thus expected to fix all missing-payment situations, which results in costs and effort being multiplied. This often forces transfer agents to dedicate up to 30% of their total staff to cash reconciliation.

Secondly, the time required to make payments related to a fund process is usually a minimum of three working days. This is due to the fact that all counterparties involved in the process must check and confirm that they have received the cash, and to do so, they depend on the previous link in the payment chain being confirmed. During these three working days, the cash is in transit and is used by neither the investor nor the fund.

The fund is exposed to liquidity risk throughout the settlement period.

The current settlement process flow (with distributor)



> The challenge for TAs is to put in place a reporting process that will be both cost-efficient and convenient for their many different addressees

Reporting: data that exists but needs to be prepared and sent

Most transfer agents offer investors, distributors, portfolio managers and management companies a range of reporting operations (confirmations, cash flows and statements of account), which vary from the minimum acceptable (faxed) to a top-quality catalogue of reporting services (tailor-made and downloadable from a reporting platform, or fully automatic SWIFT messages).

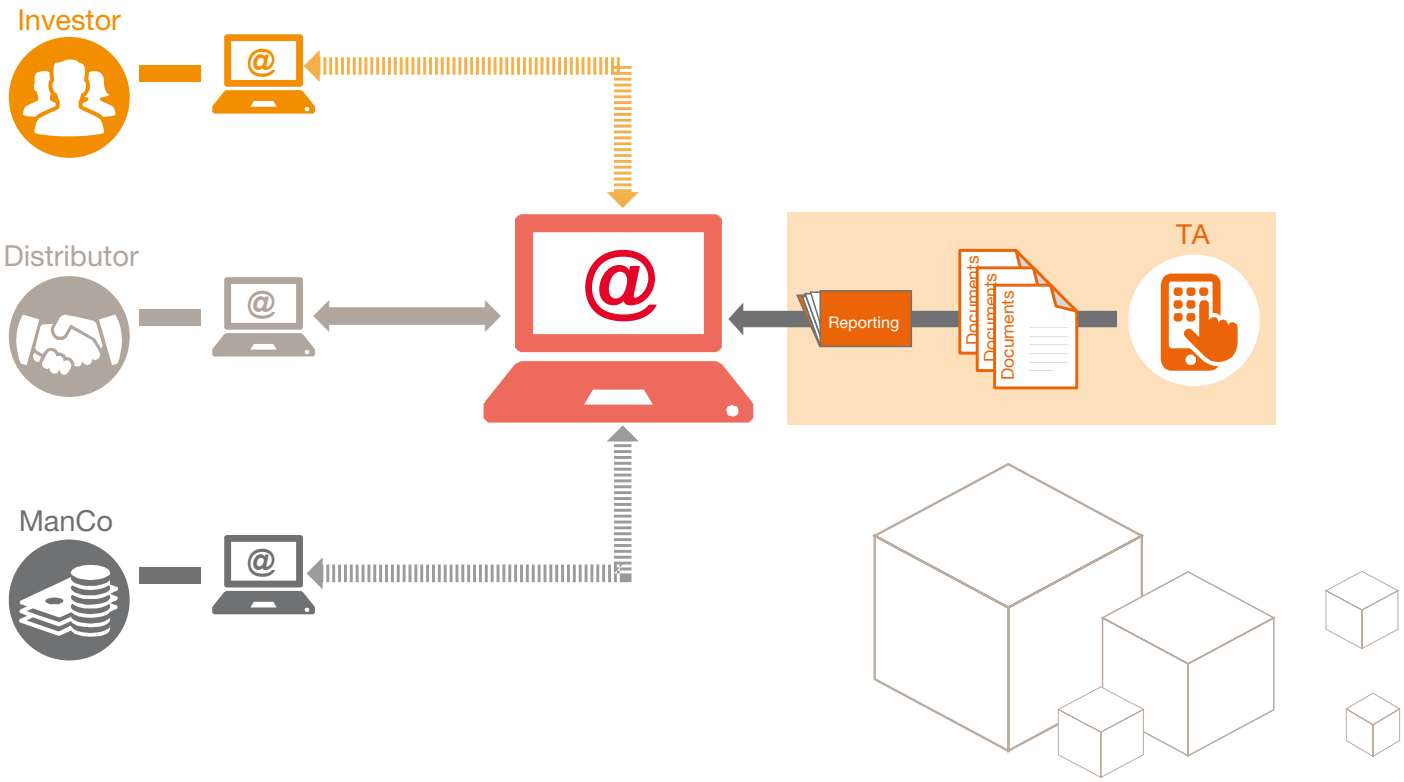
However sophisticated the reports are, one principle applies in all cases: the TA is in charge of extracting the data from its systems, preparing the report and sending it through a channel and in a format that will be convenient to the addressee.

The challenge for TAs is to put a reporting process in place that will be both cost-efficient and convenient for their many different addressees. TAs are rarely able to impose their own format and delivery channel, and usually dedicate significant manual effort on a monthly basis to setting up and generating reports in accordance with their addressees' preferences.

Many TAs have invested in a solid reporting website that allows their counterparties to access and download all the reports that they have been receiving.

Despite the convenience of these websites, they do not satisfy the increasing demand for real-time communication and data access, as they still depend on the TAs setting up, producing and uploading the reports.

The current reporting process



Structural challenges for transfer agents

Recruiting internationally

Luxembourg funds are distributed all over the world, which means that management companies expect TAs to deal with the regulatory, tax and cultural specifics of multiple different jurisdictions.

Such multifunctionality requires the expensive recruitment of professionals from all over the world, with multilingual skills and a knowledge of laws and tax rules applied by many different countries. This variety of jurisdictions can also result in specific reporting and exceptional processes.

Recruiting alternative-fund specialists

Another prevalent characteristic of Luxembourg TAs is their capacity to administrate all existing fund types, offering expertise in both mainstream mutual funds (UCITS) and alternative funds (hedge, private equity and real estate).

Over the last five to ten years, Luxembourg has increased its market share in alternative-fund domiciliation, and fund administrators – including transfer agents – have invested strongly in staff and technology to support this product development, covering the operational processes of all fund types and allowing management companies to rely on one unique service provider to administrate all their fund types.

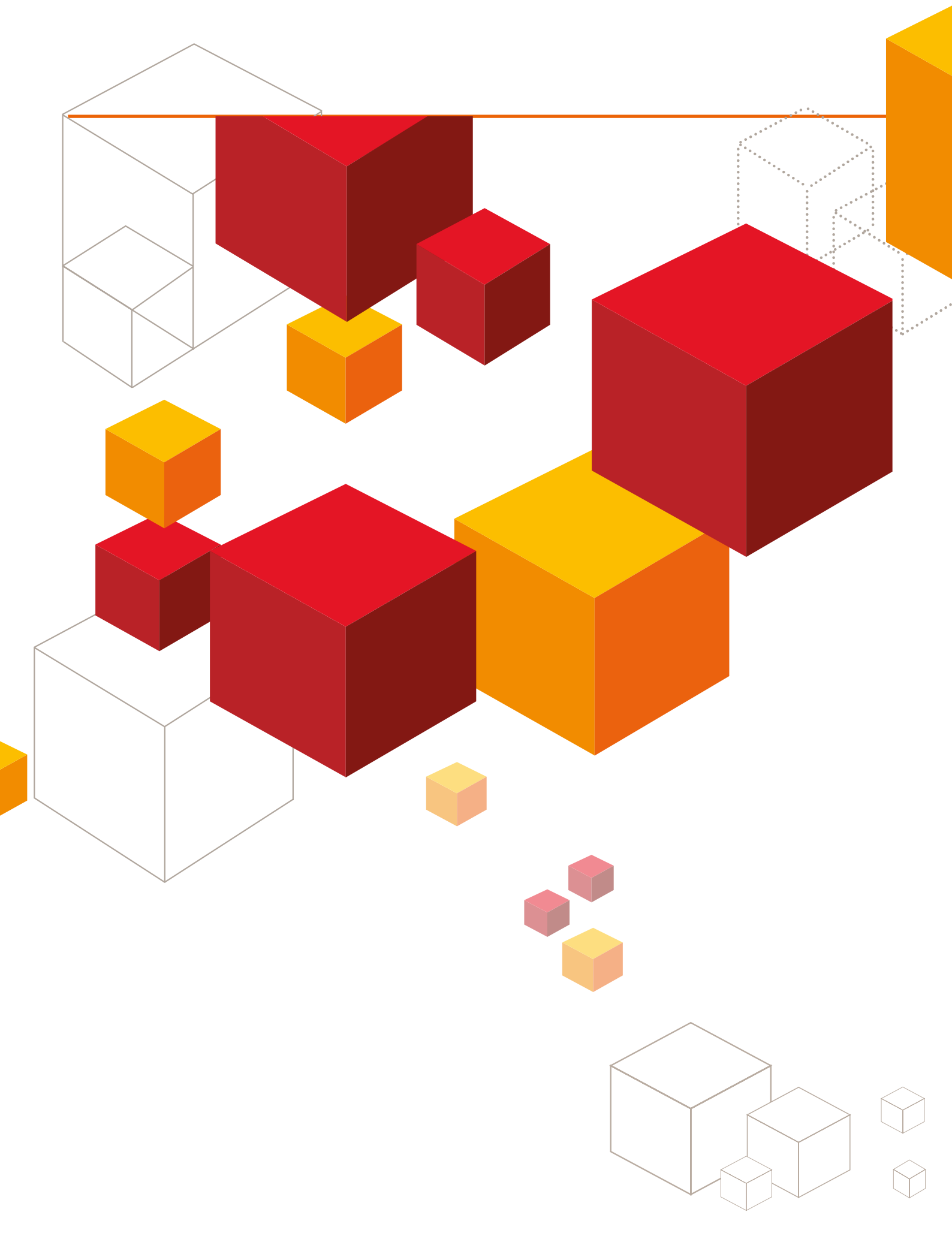
Difficult profitability

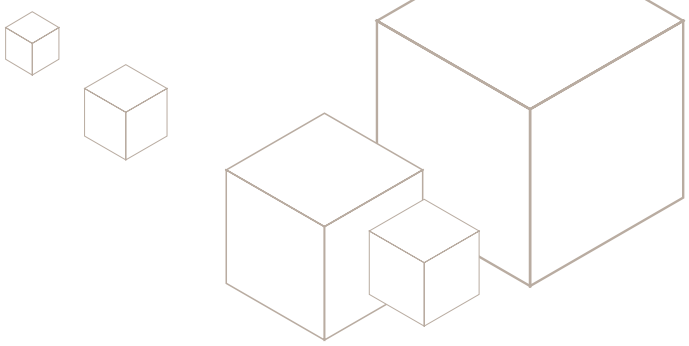
Over the last 30 years, Luxembourg transfer agents have successfully dealt with all challenges by adapting their business models.

Their flexibility and constant search for added value have warranted Luxembourg TAs' right to be seen by asset managers as distinct service providers, far beyond their original function of fund-register owners.

By creating a wide catalogue of complex "fund-distribution services", Luxembourg TAs have raised the bar high, often at the expense of their own profitability.

Their next challenge will be to adapt – again – to the evolving fund-distribution paradigm if they want to maintain an important role in the value chain.





Blockchain

What is it all about?

Distributed Ledger Technology (DLT), most commonly known as Blockchain, could be the next step in the digital transformation and could have the most disruptive impact on the financial industry for decades. Blockchain is the underlying technology created in 2008 for powering bitcoin creation and transfers.

The main features of any Distributed Ledger Technology are:

A distributed database

This is the concept of a system of server capacity, which is collectively maintained by all of the system's participants, rather than by one central authority. Each participant is considered a "node" of the distributed database. In essence, the nodes are the computers or servers of individual participants, and each node contains a complete and identical set of transaction records. In reality, the transaction ledger is identical on each node. All participants contribute towards building and maintaining the distributed ledger, based on peer-to-peer technology. The DLT is a suitable solution to three main characteristics of the megatrends previously discussed: transparency, since transactions are publicly available, traceable and permanently stored in the network.

> "DLT could have the most disruptive impact on the financial industry for decades"

The consensus

This is a guarantee for the immutability of validation and for adding ay transaction to the distributed ledger. The principle is that a majority of participants must agree on a proposed transaction.

Validating and adding a transaction through consensus is the only trigger to update the ledger. The consensus mechanism also ensures that the same transaction does not occur more than once.

Secure authentication through cryptography

The earliest known form of cryptography is the carved cypher text on a stone in Egypt (around 1900 BC). Today, the cryptography methodology used is called "Hash". This is a mathematical one-way function that summarises any piece of data and calculates a unique fix-size value in the form of a trunk of random characters, called the "Hash". Blockchain uses the concept of asymmetric cryptography based on a public and private key.

Stamping mechanism

With Blockchain, it has become possible to securely timestamp information in a decentralised and tamper-proof manner. Digital data can be hashed, and the hash can be incorporated into a transaction stored in the Blockchain, which serves as secure proof of the exact time at which that data existed. The proof is to the result of a tremendous amount of computational effort performed after the hash is submitted to the Blockchain. Tampering with the timestamp would also lead to the entire integrity of the transaction data being broken.

Near real-time

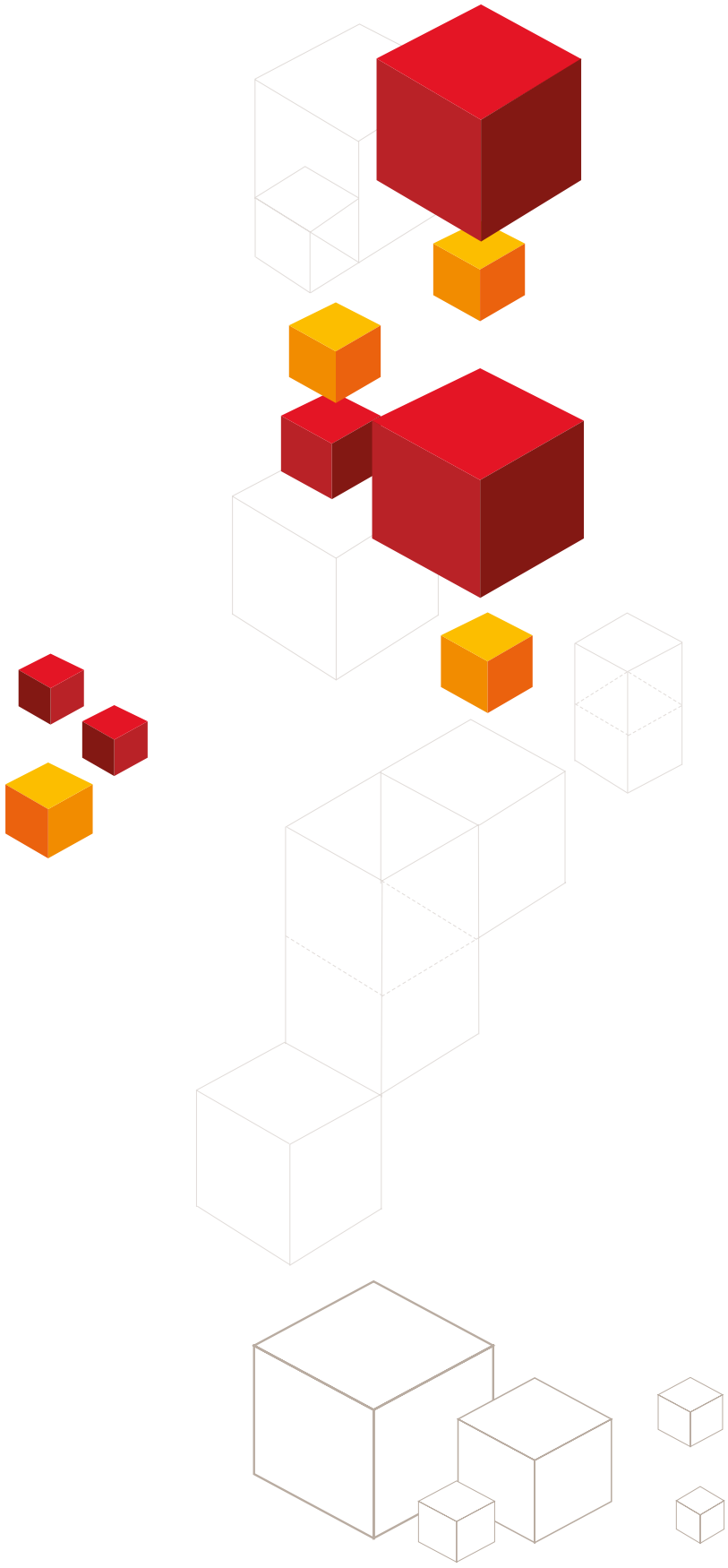
This new technology is expected to make it easier to use simpler payment products, which settle quickly and cost very little. The most important improvement involves settlement. It means that settlements will be confirmed in almost real-time, without relying on a central counterparty. This means no more silos. Blockchain is moving from a settlement that takes two to three days to one that takes a few minutes. This almost real-time settlement will fundamentally change the capital-market value chain.

Smart contracts

These are computer codes that automatically verify, enforce and execute contracts or agreements between participants on the Blockchain. A smart contract – a computable agreement between two or more parties – is signed digitally. Triggers for the execution of a smart contract are events that can be designed and built into the smart contract.

Permission-less and permissioned Blockchain

While bitcoin is based on a permission-less distributed ledger, for which contribution to the ledger is not conditioned by any previous relationship/transaction or identification process, a permissioned ledger may also be considered. In a permissioned distributed ledger, transactions would only be validated and processed by parties who have already been recognised by the ledger.



The revamped business model

Blockchain and smart contracts will reshape the fund-distribution value chain

Blockchain is high on the agenda of most of the players in the fund industry, and the adoption of Blockchain technologies is in progress.

Blockchain still creates misunderstanding and confusion, and is certainly underexplored in the fund industry. The hype of early 2015 has certainly slowed down, but a remaining unreducible force is analysing use cases and working on viable and implementable products.

On Gartner's Hype Curve, we are certainly on the path to disillusionment, but the future will provide access and a chance to reach the plateau of productivity.

Currently, the impact of Blockchain could have three graduations, known as:

Augmentation: Increase the efficiency of existing processes

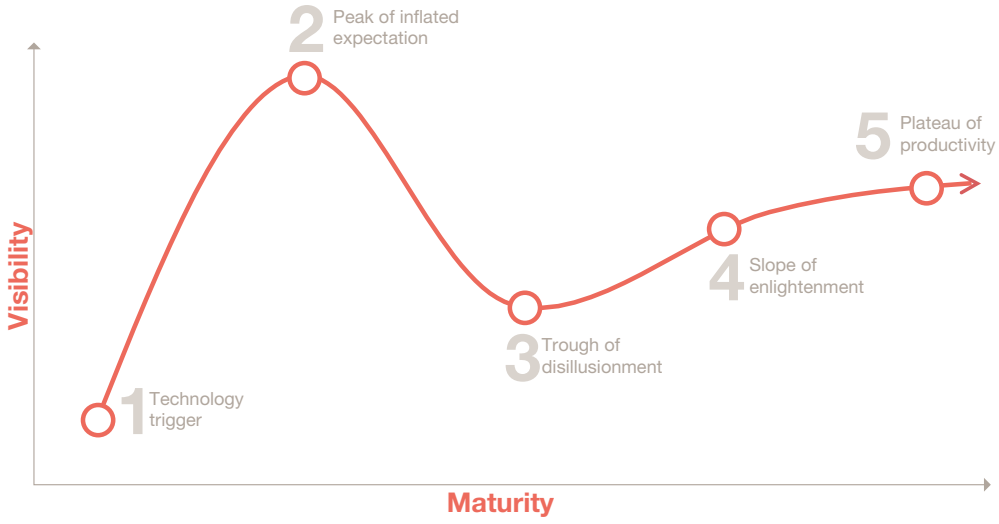
Evolution: Larger parts of the value chain will change significantly

Revolution: The whole business model will change

Our vision: a revolutionary model that will be the result of progressive evolution

At the end of this outlook, we will present you with a fully reshaped fund-distribution value chain based on Blockchain. We strongly believe that due to its revolutionary dimension, this model will emerge only by progressive evolution through the trial-and-error method.

Gartner's Hype Curve



Source: http://contentmarketinginstitute.com

A decentralised identification process

Identification is better known in fund-industry vocabulary as AML/KYC, which refers to the process performed to identify or verify a client's identity.

Our vision of the future AML/KYC process is based on different key players: trusted parties, identification Blockchain and AML/KYC smart contracts. The whole model would be based on the principle of "You own your own you".

How will it work?

One must start with the assumption that the future investor will have direct access to a mobile transaction platform to perform any transaction into funds that s/he is willing and eligible to invest in.

First of all, to gain direct access to the platform, the investor must be identified. S/he needs to receive a digital identity. This will be achieved in various steps:

1. The investor stores all of his/her personal identification details (ID card, passport, utility bill, company chart, etc.) in a storage medium and generates a private and public key.

2. The investor grants a trusted party access to his/her identification details in order to receive a digital identity.

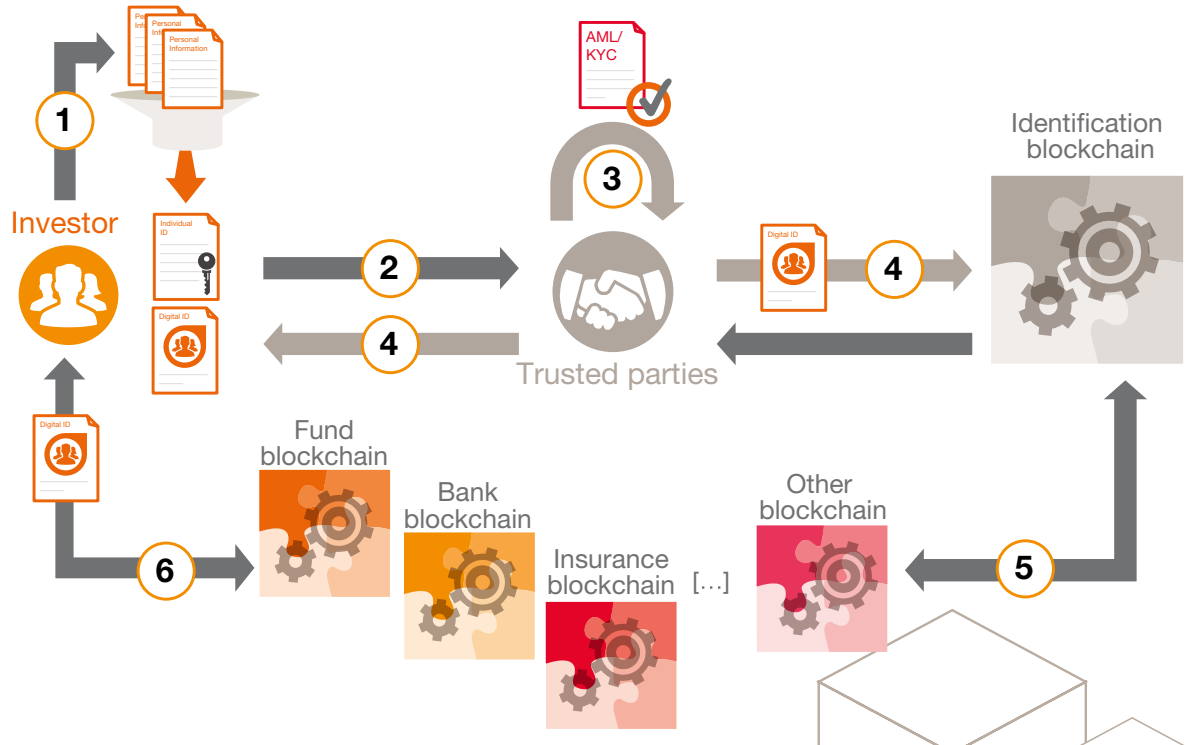
3. For the initial identification, the trusted party provides all necessary AML/KYC checks and creates a unique digital identity. As such, a new open market for AML/KYC is created by all players willing to be active in that area.

4. The trusted party then sends the digital identity back to the investor and broadcasts it through the identification Blockchain to all trusted parties.

5. Recurrent AML/KYC processes can be performed by all trusted parties and broadcasted through the identification Blockchain to all trusted parties and applications using the digital identity.

6. The investor can use his/her digital identity with all applications that require one, without going through the whole AML/KYC process each time.

The revamped AML/KYC process



The disintermediate subscription model

In the new business model based on Blockchain, the investor has access to the fund through his/her respective Blockchain. Once furnished with a digital identity, s/he is able to subscribe without the need for an intermediary, simply by using the associated smart contract and Blockchain.

Who will the players in/drivers of this model be?

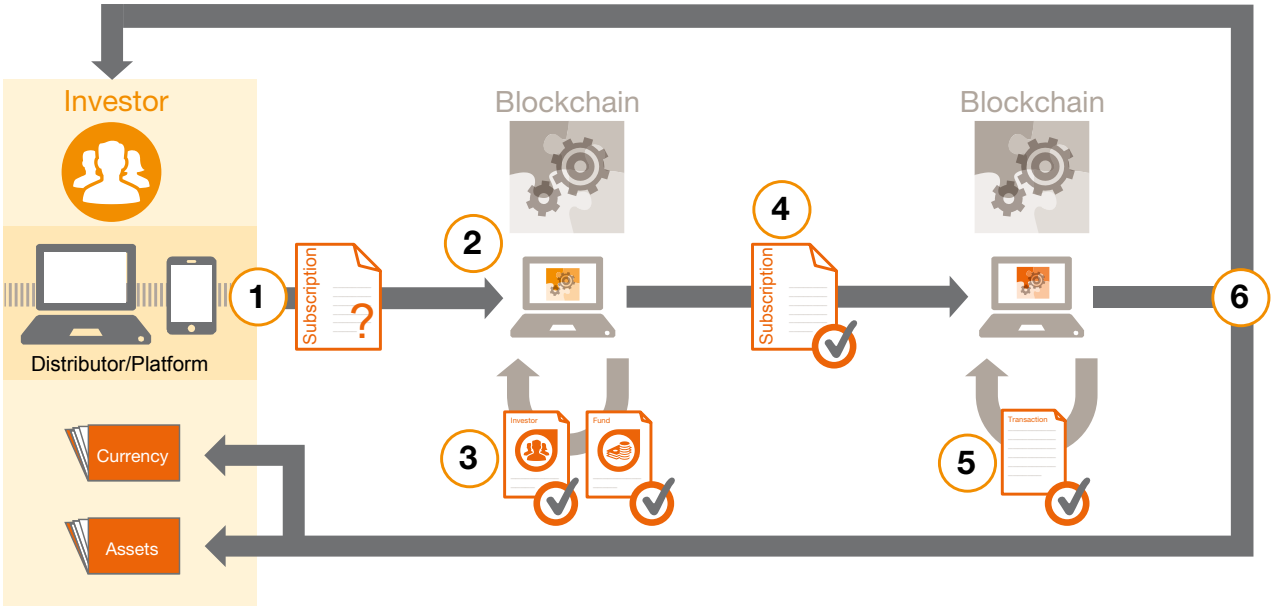
In order to run this business model, the following players/elements are necessary: the fund and the investor need to have a digital wallet, managed by smart contracts. The digital wallet contains, for both parties, an account for digital currency and digital assets. The fund characteristics are set up in smart contracts and the investor's eligibility criteria are retrieved in smart contracts provided by distributors or platforms.

The model will disrupt with the omnibus-account concept. Account management will be simplified by single fund wallets or multi-asset wallets. Distributors will not actively intervene and investors will themselves be able to initiate transactions, however using a platform or marketplace.

How will it work?

1. The investor sends a subscription order through an application (smartphone or web) provided by a distributor or platform.
2. The order triggers the smart contracts.
3. All static data (fund and investor) is retrieved in smart contracts. The smart contracts perform checks based on fund and investor characteristics (cut-off, investor profile, AML/KYC checks, minimum investment, etc.).
4. Once the checks are performed and validated, the order is accepted and ready for settlement.
5. Once the NAV is computed, a smart contract is once again triggered and performs a series of checks. Once performed and validated, the transaction is settled, and both the currency wallet and the asset wallet are updated.
6. A transaction confirmation is sent to the investor using a smart contract.

The revamped subscription process flow



Perform near-real-time settlement

Digital decentralised settlement

In our future business model, settlement will be decentralised and nearly real-time.

What players/drivers are needed to make this model reality?

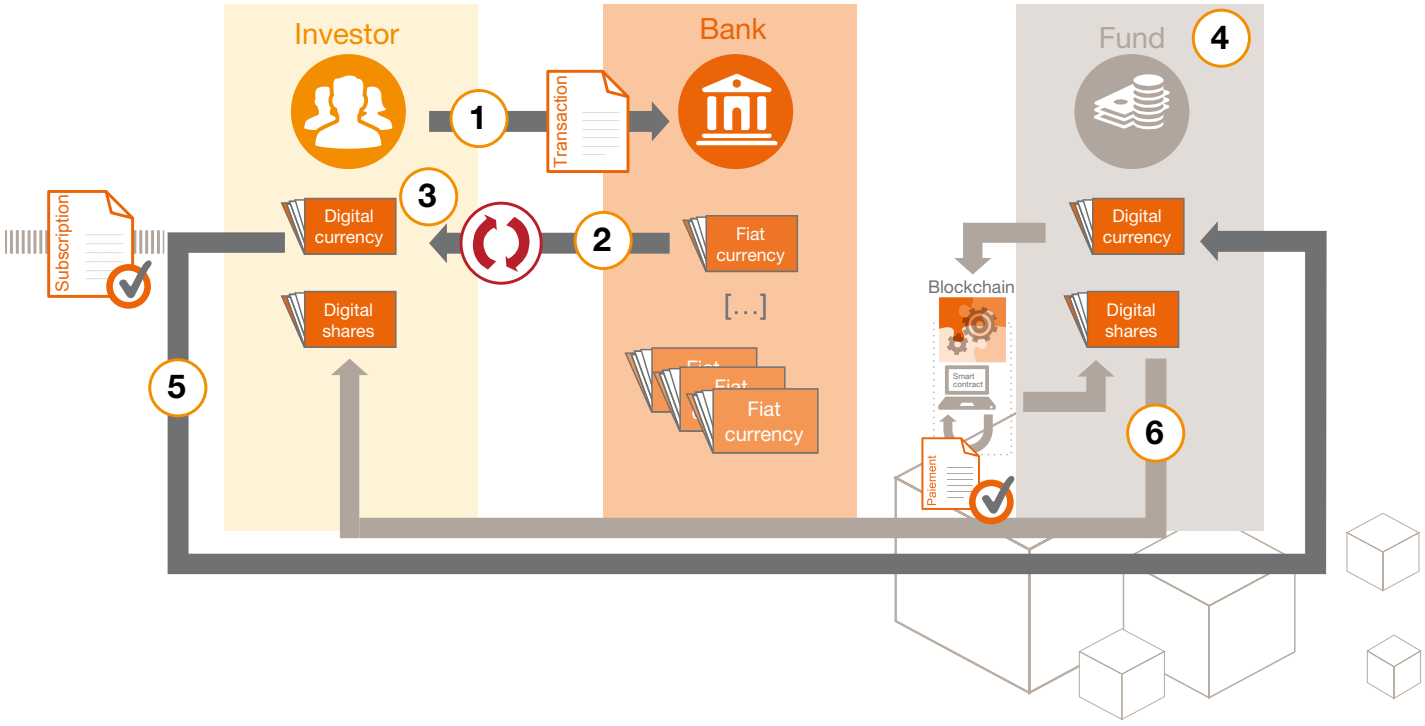
First of all, all involved parties need a digital currency wallet. This wallet will be pre-filled or filled on demand by the required amount in order to place and execute transactions on a Blockchain.

How does it work?

1. The investor needs to fill a digital currency wallet. S/he initiates a transaction from his/her fiat currency account held with a trusted-party bank.
2. His/her fiat currency account is debited by the order amount once a series of checks are performed by a smart contract.
3. The transferred amount is now available for all types of transactions on applicable Blockchains.
4. The investment fund also has a digital currency wallet.
5. Once a subscription is settled by the NAV injection, the investor's wallet is debited and the fund's wallet is credited.
6. The share settlement works analogously. Once the payment is confirmed through a smart contract, the fund's asset wallet is debited by the respective number of shares and the investor's wallet is credited by the respective number of shares.

Payment and share settlement is fulfilled in almost real-time once the NAV is injected and all of the smart contract's checks are fulfilled successfully.

The revamped settlement process flow



Real-time reporting

Implementing our business model enables reporting duties to be performed in a more efficient way through access to reconciled real-time data. As financial information is saved on the Blockchain, there are no reconciliation issues, since a unique database exists and is shared by all participants, fully eliminating mistakes and thus enhancing data quality.

Since data is shared throughout the Blockchain, access can be customised in order to enable each of the parties – namely investors and fund managers, but also regulators and auditors – to directly access the reconciled data in order to perform reporting. Therefore, the business model increases both transparency and investor protection.

"Quorum remains very much in its infancy"

Reporting and level of confidentiality

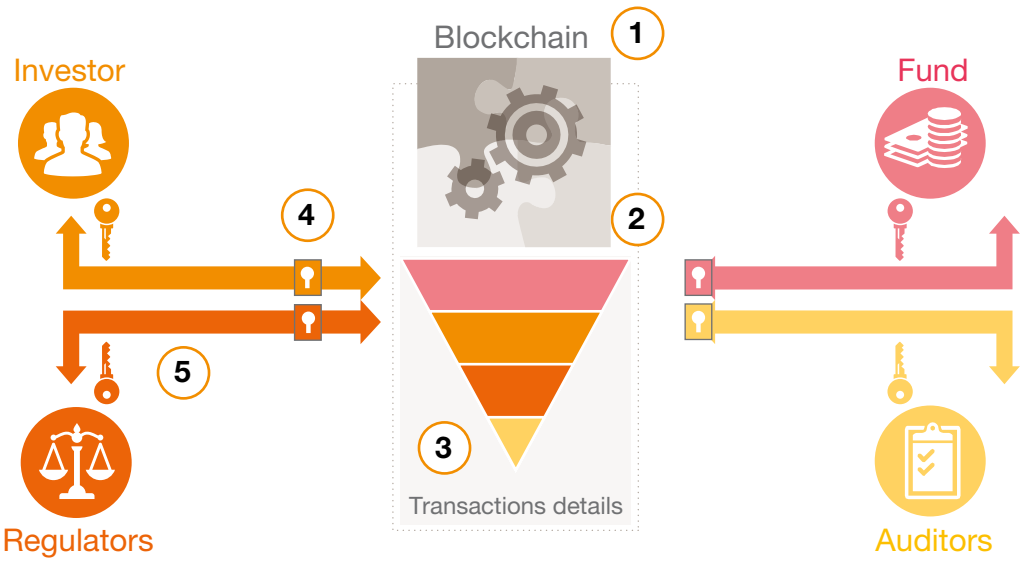
Parties involved in a distributed ledger can access the information regarding validated transactions, which are permanent and immutable, using their key. While there is no restriction concerning the public distributed ledger (such as the one used for bitcoin), companies may consider a private ledger in order to monitor and restrict access to a distributed ledger designed for a specific purpose.

Each party accessing the distributed ledger can be identified; access to information can be customised depending on the identity of the requestor. Therefore, a distributed ledger ensures a customised level of confidentiality: specific reporting requirements could easily be managed via smart contracts, which would be free from calculation mistakes and human error.

How does it work?

1. All transactions regarding fund activities are sent to the Blockchain and shared with all participants.
2. Since transactions are shared, reconciliation is automatically performed within the Blockchain. Details are updated.
3. Transactions are made up of several pieces of information (digital ID, amount of shares, NAV per share, etc.) disclosed in the Blockchain.
4. Specific access to the transaction details is defined for each of the parties involved, disclosing a specific level of details regarding the transactions performed.
5. Parties use their private key in order to access the information. The private key grants access to a certain level of details.

The revamped reporting process flow



Privacy of transactions

There are currently two secretive and emerging applications aiming to guarantee the privacy of transactions:

- Quorum;
- Enterprise Ethereum.

Quorum is an Ethereum-based distributed-ledger protocol that supports transaction and contract privacy.

The primary features of Quorum are:

- Transaction and contract privacy;
- Voting-based consensus mechanism;
- Network and peer permission management;
- Higher performance.

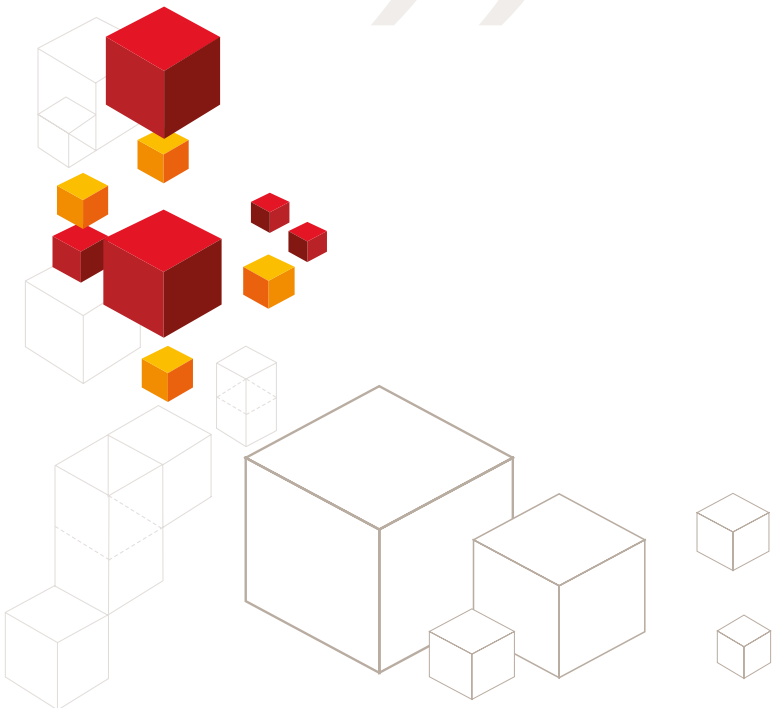
In addition to these features, Quorum includes a powerful support feature for private and public transactions.

Private transactions: Transactions whose payloads are only visible to the network participants whose public keys are specified in the "privateFor" parameter of the transaction. "privatefor" can take multiple addresses in a comma-separated list.

Public transactions: Transactions whose payloads are visible to all participants in the same Quorum network. These are created as standard Ethereum transactions in the usual way.

The **Enterprise Ethereum** project consists of an "enterprise-grade stack" and provides tools for users who demand to ensure the privacy of transactions – a major pain point for financial institutions today.

"The scalability, security and privacy that any enterprise Blockchain will want are being added or addressed"



Market players will see their roles evolve

A venue for new expertise and roles

"Blockchains' functions will drive the evolution of the fund-industry value chain"

As described before, market players will see their roles evolve depending on specific functions that arise due to new technology and processes.

The five main functions of Blockchain technology are common to all Blockchain applications. We will first describe them, before providing an outlook of the impact that those functions have on industry players and how their roles could evolve.

Identification

This is key for the Blockchain. Without identification, it is impossible to enter the Blockchain. For some use cases, identification is easier and does not require time-consuming and redundant KYC processes.

On the one hand, we can see that for permission-less Blockchain applications, no specific identification process is required.

On the other hand, in a permissioned Blockchain, environment identification and the issuance of a digital ID are crucial. In the fund industry, with its AML/KYC rules, identification is clearly a key point and requires attention. Thus, current players in the KYC area will clearly see their roles evolve.

Ownership

More and more insiders believe that Blockchain will be the biggest revolution in property ownership since the birth of capitalism. Blockchain is a different way of keeping track of a normative set of information. Instead of having the information in one central database, the information is in multiple copies across all the nodes on the network, which synchronise with each other periodically.

It enables users to know who the owner of an asset is. For fund shares, a specific transaction is hashed, gets its digital identity and is linked indefinitely to its owner, who is also identified on the Blockchain by a private key. The ownership is recorded by a smart contract, which approves and certifies the ownership only if certain conditions are met.

Transfer of ownership

The transfer-of-ownership process through Blockchain technology will clearly make the processing and settlement of transactions more efficient. Once the update to the distributed ledger is agreed, trade is complete. Cash transactions will settle in near-real time, embedding the transfer of ownership of an asset or amount of money. This will also remove the need for post-trade confirmation. The settlement and the transfer of ownership on the distributed ledger is the confirmation.

Smart contracts

This technology of code logic allowing terms and conditions to be executed automatically could be embedded into current value chains. Proper use should lead to a large cost reduction, improved efficiency and reduced risk.

Markets

A business model based on Blockchain technology will clearly redefine market

roles. This is essentially due to the fact that Blockchain organises the market in a systemic way. The key players in the market itself will interact differently from in the current world market.

Today's world is made up of markets of intermediaries. The future in the nascent Blockchain world will see marketplaces without intermediaries and direct venues between offer and demand.

The genesis of new markets

It is obvious that such a disruptive and revolutionary vision of the fund-distribution value chain will have an impact on the current activities of fund-industry players.

The objective of this White Paper is certainly not to answer all questions, but it does intend to give some food for thought. It does not describe future business plans, detailed new roles or activities, but rather presents a description of future roles and activities. It is up to each player to reflect on their preferred option or future role.

We must also bear in mind that any shift to an asset-management industry driven by Blockchain technology will be a step-by-step adoption rather than a big-bang revolution.

The AML/KYC process

Data on Blockchain is akin to being carved in marble. Client information accessible through this technology would enable a financial organisation to have direct access to the Blockchain rather than relying on a third party to undertake KYC or AML duties.

As data stored on a Blockchain is indelible, it would provide a single source of truth, thereby minimising the risk of error and avoiding data redundancy.

Blockchain would also clearly achieve cost reduction. If personalised data were available on a Blockchain, it would ease and systemise client onboarding processes.

The information could be accessible through rights, which means that data would only be available to trusted third parties.

AML/KYC as described above will give rise to new market infrastructures and utilities. In such a scenario, AML/KYC will clearly become a marketplace with an offer and demand consisting of multiple players acting as trusted "certifiers" and offering their services to anyone who is ready to accept their standards of certification at the proposed price.

Reference-data management

Reference-data management is crucial and a major pain point for financial institutions. Under R3, major banks like Citi and HSBC have already carried out a Blockchain experiment to look into how Distributed Ledger Technology could simplify reference-data processes.

The asset-management industry also bears this major pain point due to a lack of automation and up-to-date and reliable data, and due to complex infrastructures of multi-system environments.

Almost every department, player and role has its own system, but with the same (or almost the same) reference data. For example, fund reference data is stored in TAs' systems, fund-administration systems, trailer-fee systems, etc.

On a Blockchain, data will be created by a trusted party, but can then be viewed by all authorised parties in real time.

Other trusted parties can create, issue or propose amendments to data records.

Reference data will be stored through smart contracts, and the future role of current market players could be right here, since smart contracts need to be created, issued and maintained.

Cash and settlement

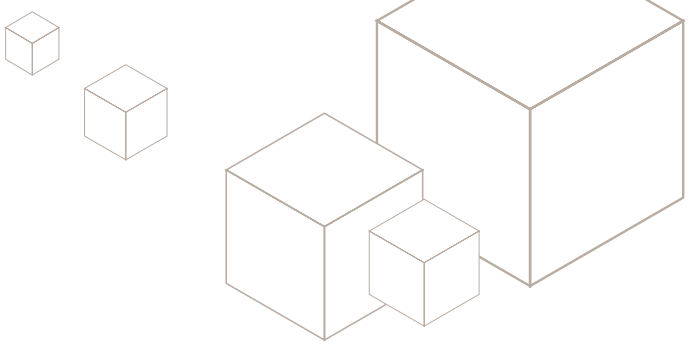
The cash and settlement process completely changes on a distributed ledger. First off, it will eliminate all risk from the settlement process through a real-time operational network, due also to the fact that transactions are based on consensus and are immutable. But what are the future roles for current industry players facing time consuming and high-risk settlement processes on a daily basis?

Their role will clearly be to manage and operate smart wallets, for both cash and securities.

New markets could evolve by inventing new types of credit lines between fiat currency accounts and digital currency wallets.

Smart clearing houses for cash and securities issuing smart wallets for cash and securities could be the right answer for changing the settlement process under Blockchain.

One of the main problems identified when we want to integrate cash transfers – between corporate banks and/or individuals – with transactions or processes managed in a Blockchain is the guarantee that the cash movement written into the Blockchain has actually been executed. Various solutions, such as multi-signature certification or interaction with oracles – in the context of the new API framework of PSD2 – can be envisaged.



Blockchain will be implemented step-by-step and differently depending on each player

Several DLT- or Blockchain-based projects and companies are already starting to provide solutions to solve this cash-management problem. For instance, **Ripple** (ripple.com) offers a settlement infrastructure technology that includes fiat currencies. **tether** (tether.to) offers a service converting cash into digital currency and guarantees assets backed in USD. We can also add **Interledger** (interledger.org), which aims to connect Blockchain, digital wallets and payment networks.

Thus, we believe that we will soon see effective solutions that will make it easier for Blockchain processes to integrate with the traditional bank system.

Custodian

Distributed Ledger Technology with embedded e-wallets for fund shares and cash positions could remove some of the functionalities for custodians and sub-custodians.

The role of custodian could change into a role of safekeeper or notary of the keys. Furthermore, s/he can become the manager of automated securities-servicing operations and can manage the holding of information through smart wallets.

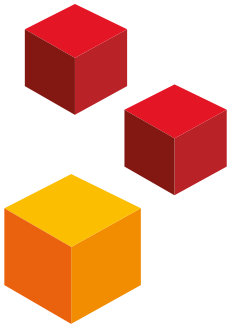
Transfer agent

The transfer agent will clearly see his/her role evolve. Automated and direct investment processes have no need for additional manual and human intervention.

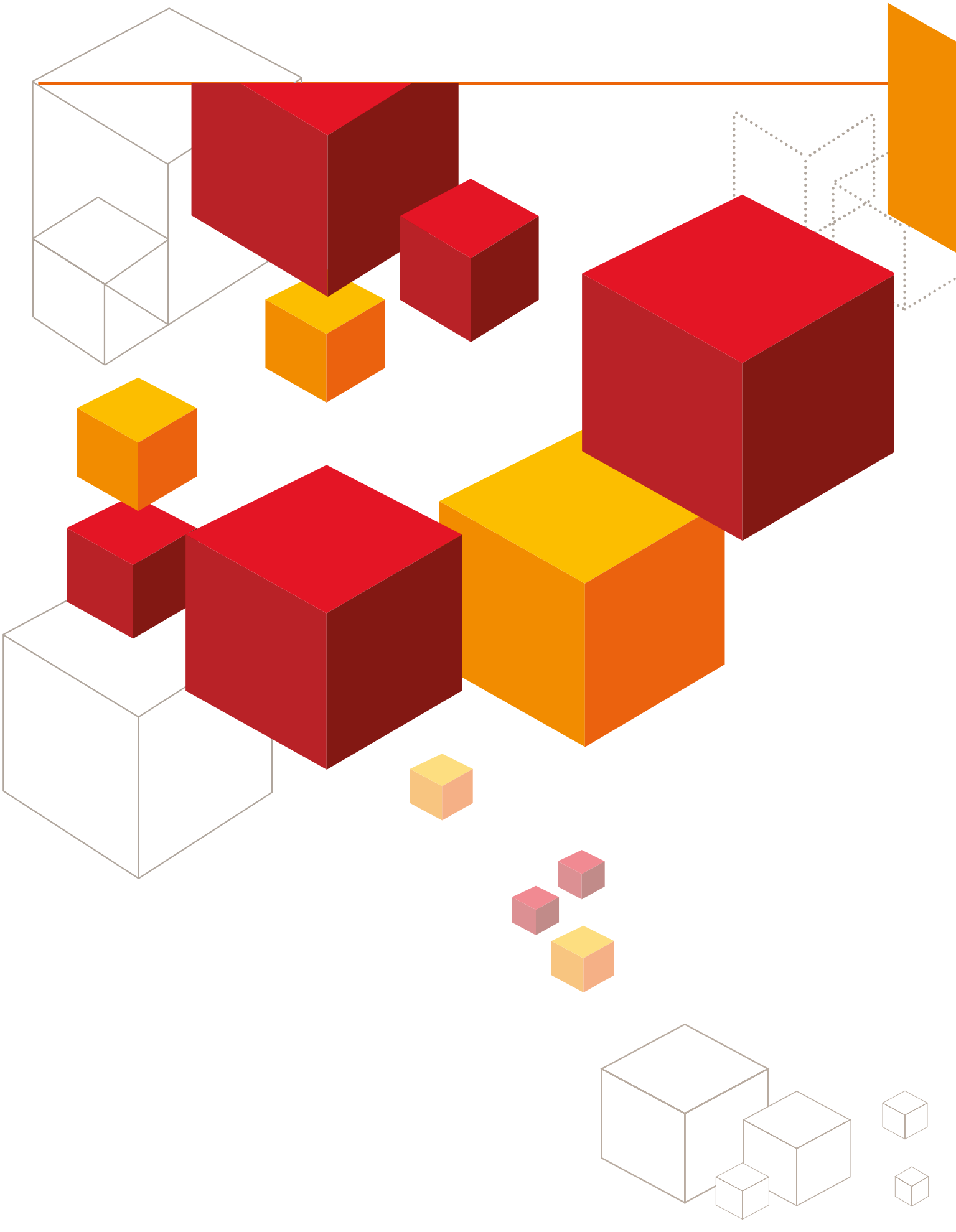
The transfer agent's role will be more like that of a venue provider. Smart contracts must be hosted and counterparties must receive a venue through applications, facilitating price publication, the creation of cryptographic keys and the increasingly popular topic of AML/KYC management, providing digital identities.

Distributors

The distributor's role will also evolve. As we have already mentioned for the TA, direct investment will be the future. However, like the TA, the distributor's future role will be in the area of venue provision, performing smart-contract maintenance for AML/KYC, and even AML/KYC management, providing digital identities.



This is the beginning of a journey during which technology will be used in parallel, with no Big Bang



Fundchain

The genesis of future fund distribution

Press release 15/12/2016

The Fundchain initiative was launched in summer 2016 with 10 key market players in the fund industry — BIL, BNP Paribas, CACEIS, the European Fund Administration, HSBC, ING Luxembourg, Pictet, RBC Investor & Treasury Services, Société Générale Bank & Trust, professional services firm PwC Luxembourg, the University of Luxembourg (SnT) and Blockchain start-up Scorechain. The aim is to prove the potential of Blockchain in the investment-fund area and to develop solutions using Distributed Ledger Technology and smart contracts to act as innovation pioneers for the fund-distribution value chain in Luxembourg.

A two-day hackathon to achieve the development of a proof of concept

After several workshop sessions, the group decided to initially focus its research on the fund-distribution value chain. The aim was to introduce an easy-to-replicate proof of concept to the fund ecosystem. With the support of the University of Luxembourg, almost 80 people from every participating organisation came together to finalise the prototype during a two-day hackathon. The event mixed fund-industry professionals with business and technical backgrounds, Blockchain academic researchers and Blockchain specialists from Scorechain. For two days, business and technical teams worked together to finalise the ready-to-use PoC.

For Laurent Kratz, Scorechain co-founder, “It’s exciting to see how this initiative built up a real synergy between major financial institutions, not only with Scorechain but also between all of them. What is also promising is that the group is always improving the PoC with the use of our collaborative platform.”

The fully decentralised Smart TA, which has finally been unveiled internally, is running on a private Ethereum Blockchain.

The collaborative and inclusive approach to the hackathon led to the Smart TA prototype being presented.

Overcoming the main challenge of replicating the fund-distribution value chain specifications through a Distributed Ledger Technology (DLT) infrastructure, the Smart TA is a Blockchain-based platform enabling digital share transactions. Different roles were assigned to connect and act within the private Blockchain. An investor has access to Fundstore, while an asset manager or fund administrator can interact with the subscription process.

The Smart TA prototype shows how the DLT can facilitate and automate procedures while reducing operational inefficiencies and errors. Interactions between intermediaries are decentralised, faster and more transparent.

Ethereum (the selected technology) has been turned into a private Blockchain. In this peer-to-peer environment, each user connects via their unique Blockchain node for real-time synchronisation between all members.

This approach proves that the technology is operational and ready to target the fund industry's needs. Fundchain's efforts may be considered a major step forward for the Luxembourg investment-fund ecosystem, especially now that market leaders agree that DLT is an opportunity to consolidate the country's leading position in Europe.

The next step will be to assess the regulatory challenges of the Smart TA business model. Fundchain presented the outcomes of the initiative to the regulator in early February 2017.

Smart TA

Our proof of concept – the first step of our vision

The first step of our vision

The main objective of the Fundchain initiative was to implement a proof of concept to challenge the Blockchain technology and its capability to process fund-industry transactions.

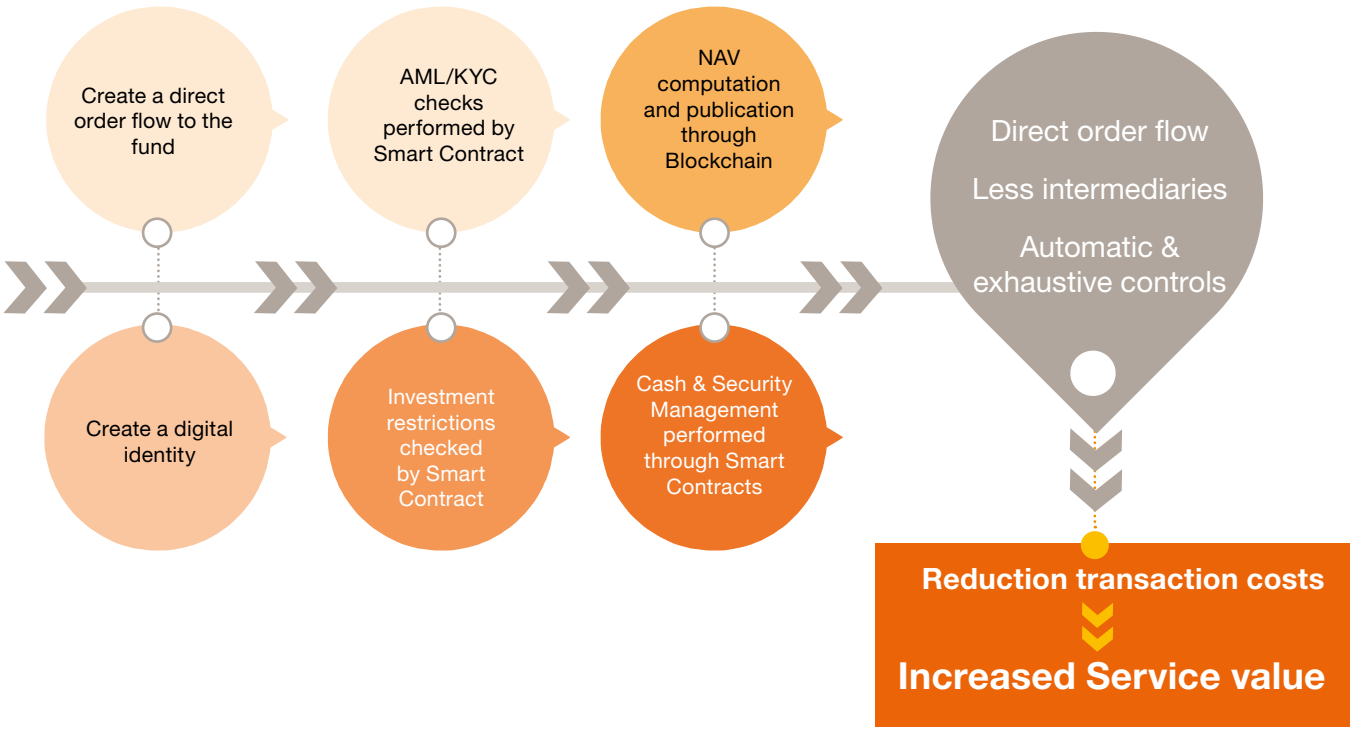
After a series of one-to-one meetings, Blockchain training sessions and specification workshops, the initiative's participants worked out a proof of concept based on a use case called the SMART TA.

In order to cope with time constraints and a proof-of-concept philosophy, the participants of Fundchain have made several assumptions.

The following assumptions have been agreed for the proof of concept:

- the PoC is based on a digital fund industry (only digital shares exist);
- only mono-currency funds will be considered;
- cash management will be simplified;
- the transaction process is based solely on subscriptions, redemptions and transfers; and
- the NAV is injected by an oracle into the Blockchain.
- Based on these assumptions, SMART TA v.1.0 has been developed in a collaborative work model.

The SMART TA in theory



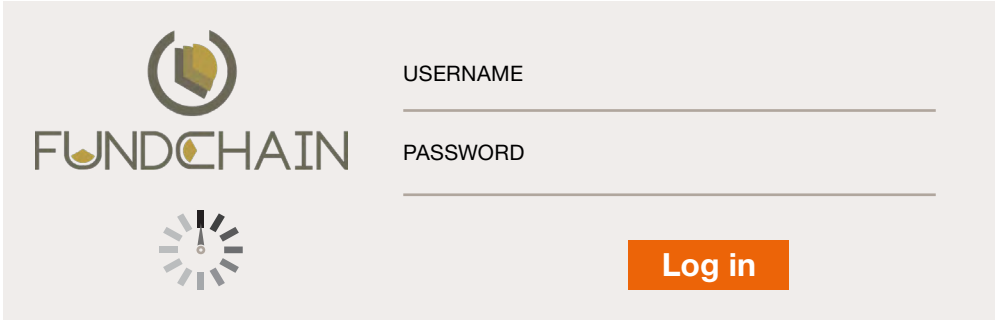
SMART TA v.1.0

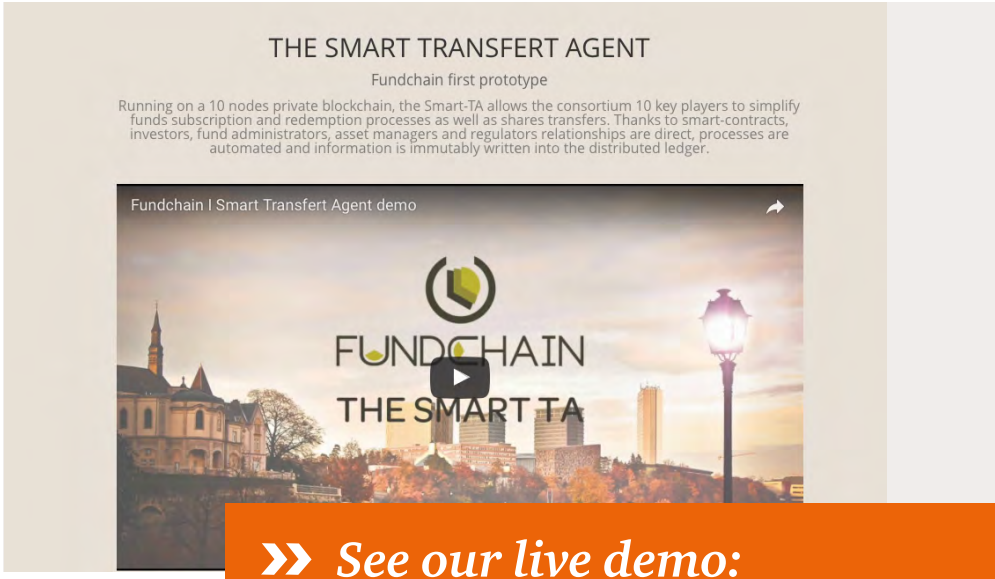
What are the main features of the SMART TA?

1. Smartphone and web access;
2. Username and password required to log in;
3. Access to a fund store (fund list, prospectus, KIID, performance data, NAV), portfolio and transaction history for investors;
4. Access to a real-time cash-flow forecast for asset managers;
5. Access to fund accounts for NAV injection;
6. Access to real-time reporting for the regulator.

Fundchain grants access to the following players in the fund-distribution value chain:

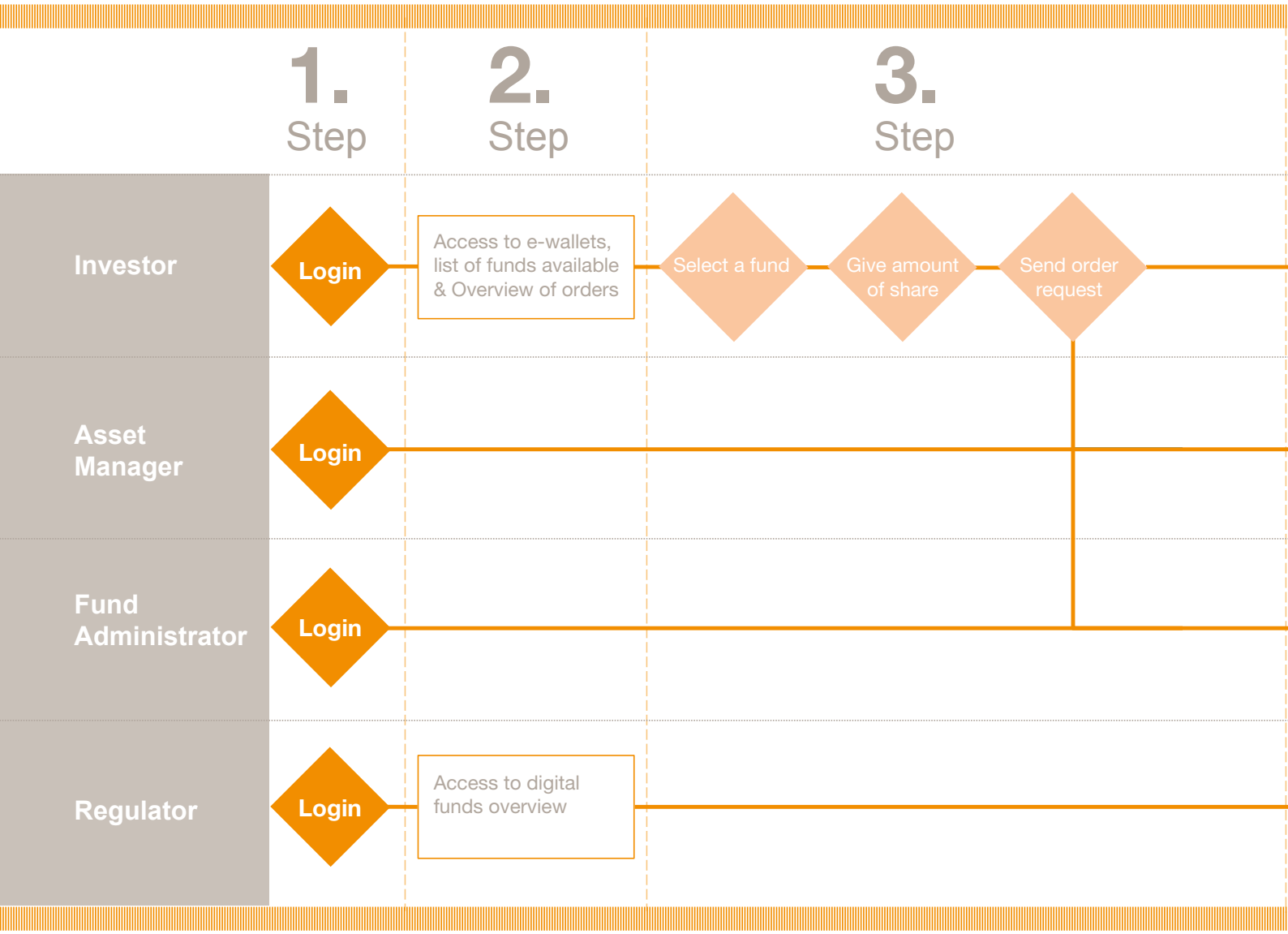
- Investors;
- Asset managers;
- Fund administrators;
- Regulator/auditors.

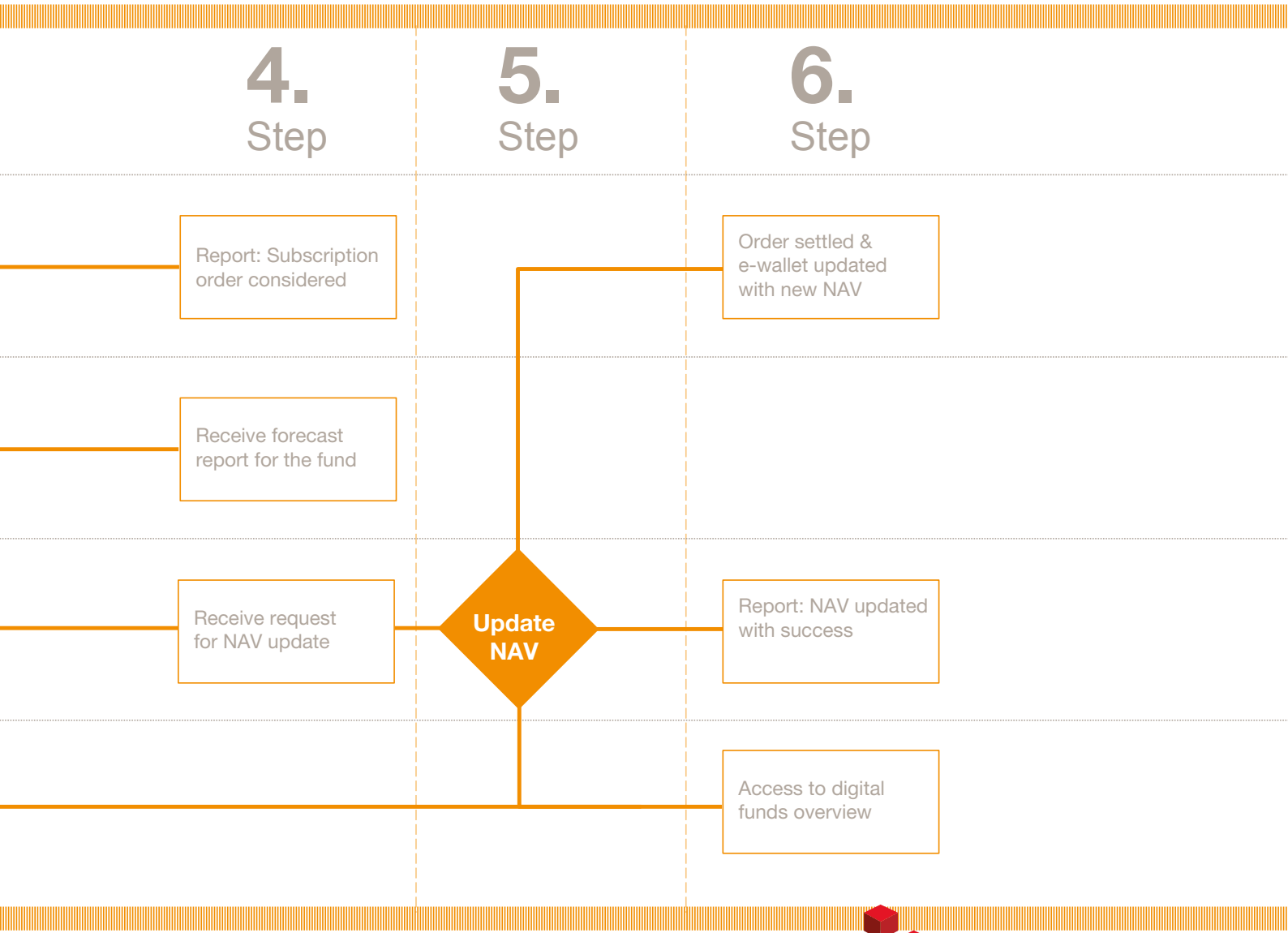


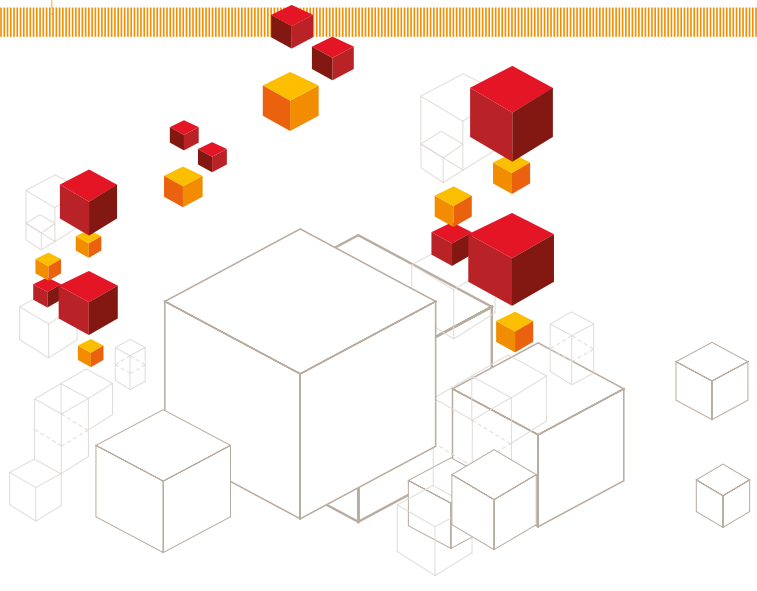


» *See our live demo:*
www.fundchain.lu

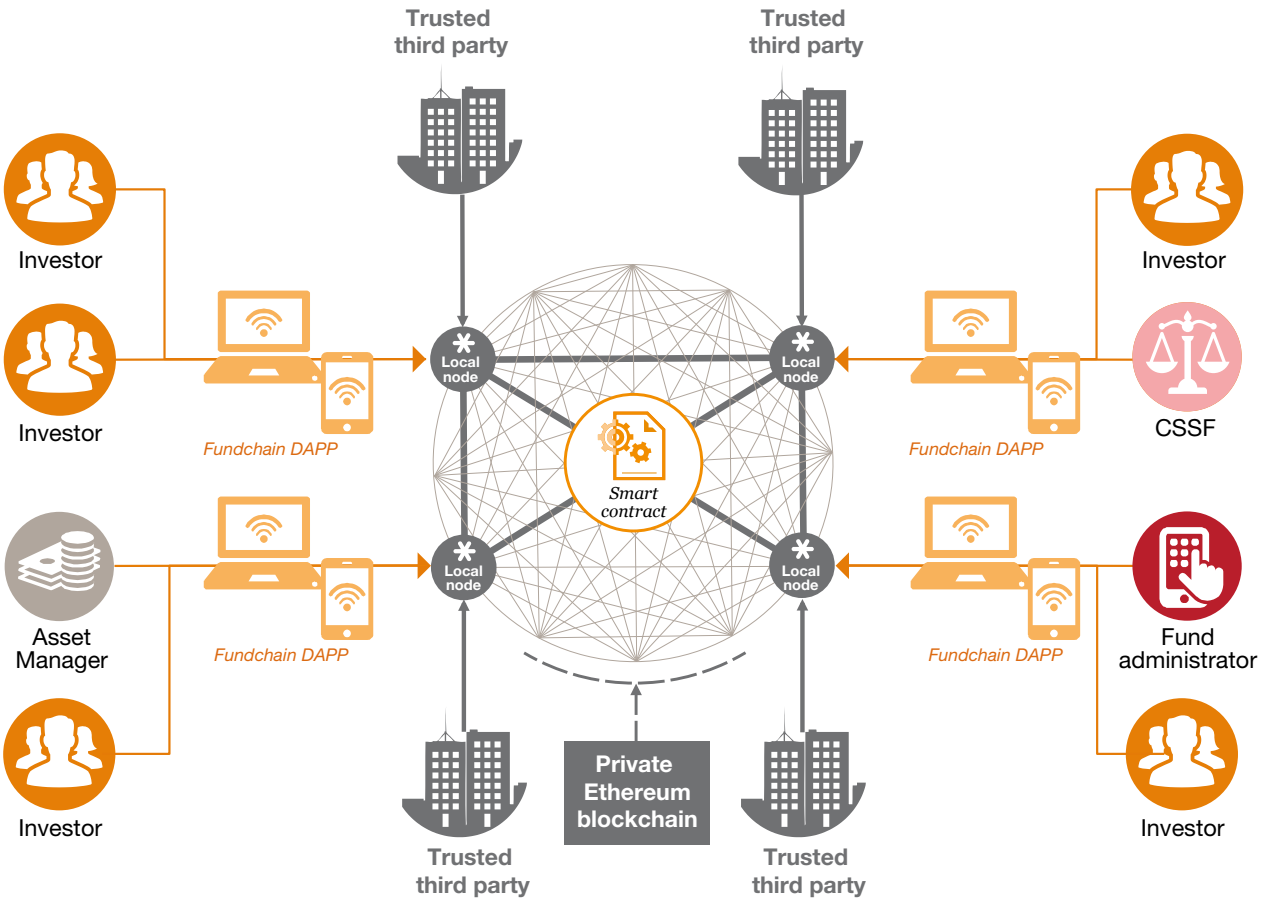
The main features at a glance




4.
Step
5.
Step
6.
Step
Report: Subscription order considered
Receive forecast report for the fund
Receive request for NAV update
Update NAV
Order settled & e-wallet updated with new NAV
Report: NAV updated with success
Access to digital funds overview



The architecture of SMART TA at a glance



What's next?

Let's move on!

"Act first, seek forgiveness later"

In other industries, players have adopted this approach by challenging regulation when they start their activity. The best-known companies with this attitude are Uber and Airbnb.

In the financial sector, which is governed by strict regulation and licensing, innovation and disruptive new technologies – especially relating to private data – require the explicit approval of the regulator.

"Several challenges still have to be overcome"

1st next step: Create the narrative of the technology and the outcome of Fundchain for the regulator and supervisory bodies

The regulator is one of the most important stakeholders in the adoption of this new technology and its application for the asset-management industry.

By way of regulatory working groups, participants must ensure that the regulator receives an exhaustive briefing on opportunities, legal hurdles, security and any other topic to be considered by it.

The current limitations of regulation have been identified during this PoC. An approach adopted in parallel to showcase the efficiency of the use of Blockchain will probably be a necessary step to convince the regulator and the different players about the necessary changes, reliability and cost efficiency of the solution for the various players. This is a cost-efficient and risk-free solution.

2nd step: Work on new concrete use cases

We consider that the HYPE peak has been reached and the objective of a proof of concept has been achieved. Now, the time has come to work out new concrete use cases, embedding a concrete business case, a technological and regulatory impact analysis and a budget.

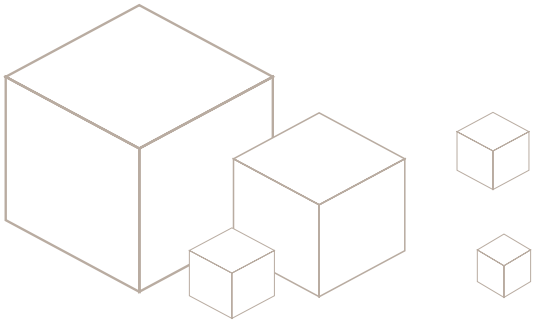
This includes a clear understanding of current operational cost schemes and must be in the economic interest of all participants.

3rd step: Onboard new participants

The current initiative revolved around a set of key market players in Luxembourg. Now it's time to seek the industry-wide engagement of various players, with a focus on asset managers and distributors.

The initiative should be internationalised, meaning that the adoption and engagement of other marketplaces could also be considered.

"The time has come to work out concrete use cases"



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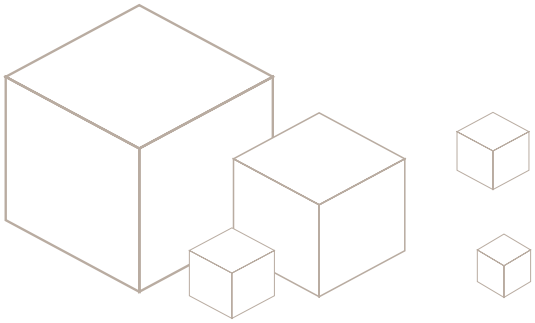

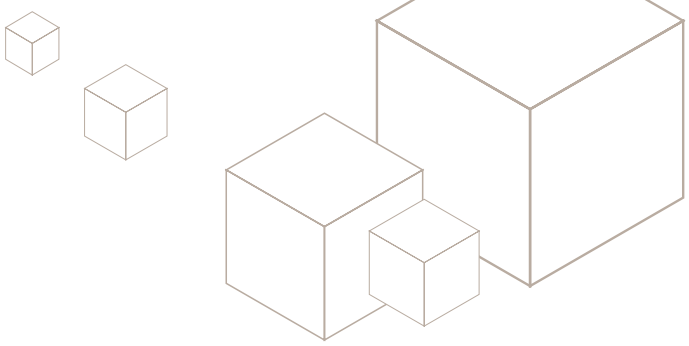

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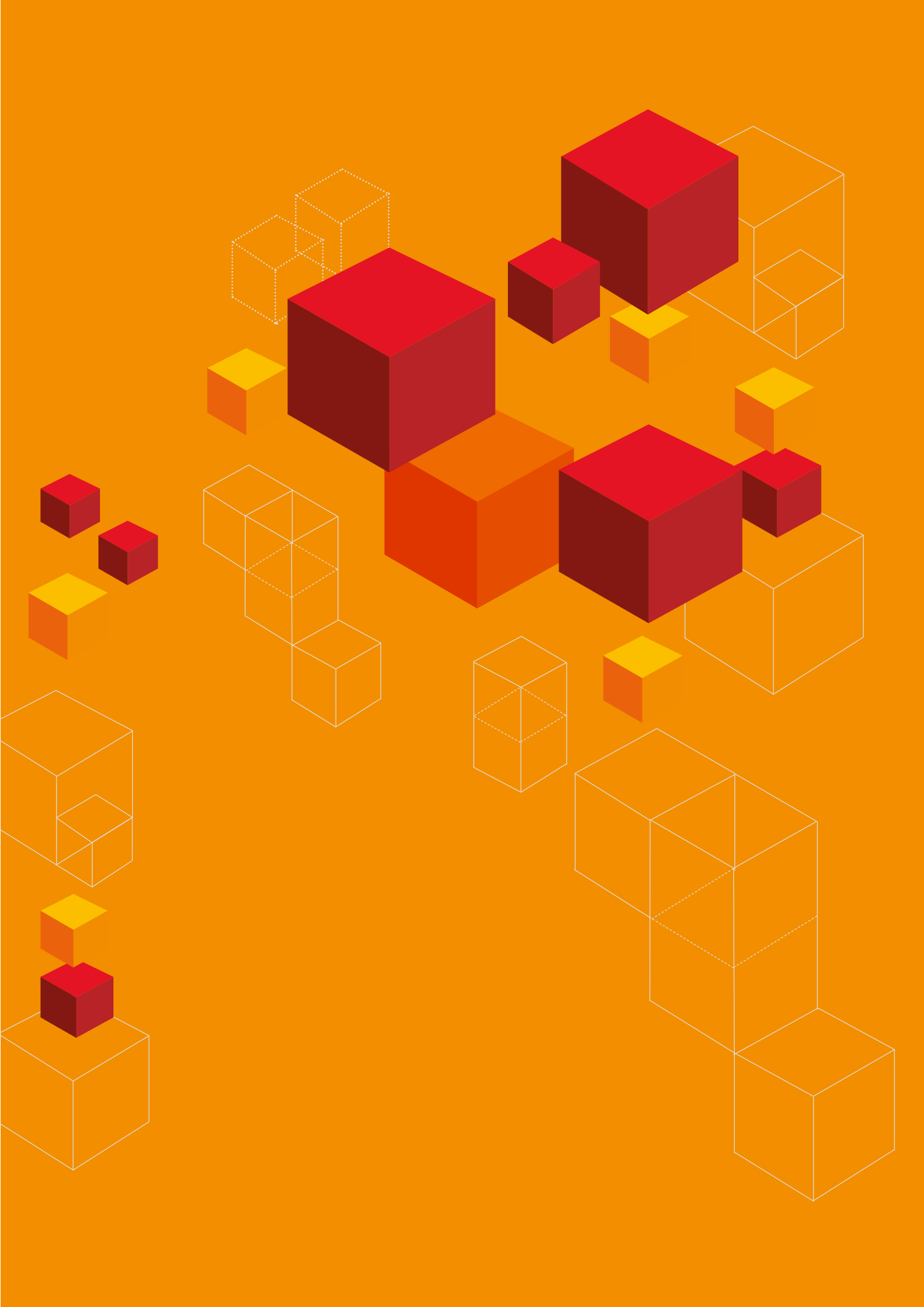

This White Paper has been edited on behalf of the Steering Committee of the Fundchain initiative.

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