MATTEREUM PROTOCOL: TURNING CODE INTO LAW

commercial infrastructure to turn smart contracts into legal contracts that can be efficiently enforced all over the world, without needing new legislation, creating liquidity for $50 trillion of assets globally

What if code really did have the force of law behind it? Mattereum has solved the problem of bringing real world assets under the full, legal control of the blockchain, opening the floodgates for the next phase of blockchain integration into the real world.

Until now, it was impossible to (for instance) buy a house using bitcoin/ether in a process that works better than just converting the bitcoin to fiat money and doing it the old way. That process takes months, requires payment of substantial professional fees, and often requires updating state-operated property registers. We cannot transfer the house instantly, as soon as the payment has enough confirmations, because that's just not how houses are legally transferred. The blockchain has been stuck on this issue until now.

Mattereum has created the *legal, technical and commercial infrastructure layer* for on-chain property transfer and control. We can actually move assets in a way the law recognizes. Mattereum Protocol is the enabling technology for the real blockchain revolution.

One of our first on-chain assets will be a $9,000,000 Stradivarius violin. It will not simply be tokenized and sold in a crowd sale. The governing committee for the instrument will have legal decision-making powers over the instrument, protecting and curating it on behalf of the token holders and posterity, in accordance with a written constitution. Unique records which validate the instrument will create an indestructible title deed and register of interests in the violin. Smart property is now a reality. Finally

blockchains can support the legal operations which realize their transformative potential.

Mattereum gets real world assets on-chain. Not just tokens backed by a securitized class of assets, but specific assets and real-world contractual rights such as booking hotel rooms, transferring assets down a supply chain, or commercially licensing intellectual property such as copyrights and patents.

The revolution can now begin.

WHAT'S NEW?

Mattereum, from the beginning, has been about getting real world assets on-chain. Our early work focused on dispute resolution, in the classical Ricardian Contract model pioneered by our Chief Scientist, Ian Grigg. This is the right model, but it still leaves the problem of how to enforce the outcome of a dispute. This can be difficult, time-consuming and expensive, and very different depending on the jurisdiction.

Over the summer, our Chief Legal Officer and his research team radically reframed the problem in two ways. Firstly, an emphasis on dispute avoidance over dispute resolution, and secondly a razor-sharp focus on enforcement – removing the legal obstacles between an arbitrator making an award and the successful counterparty actually receiving compensation.

This direction of research revealed a fundamentally new business process and legal entity class which enables concrete, tangible use cases for blockchain smart contracts: the concept of an *automated custodian*.

MATTEREUM PROTOCOL: AUTOMATED CUSTODIANS

An automated custodian is the perfect legal counterparty to a smart contract.

An automated custodian becomes an asset's legal owner and **registrar**, maintaining the authoritative register of interests in the asset. This enables the unbundling of legal ownership, financial beneficial interest, and possession or use of the asset. The tokenized beneficial interest in the asset becomes tradable, and use becomes licensable using smart contracts or utility tokens.

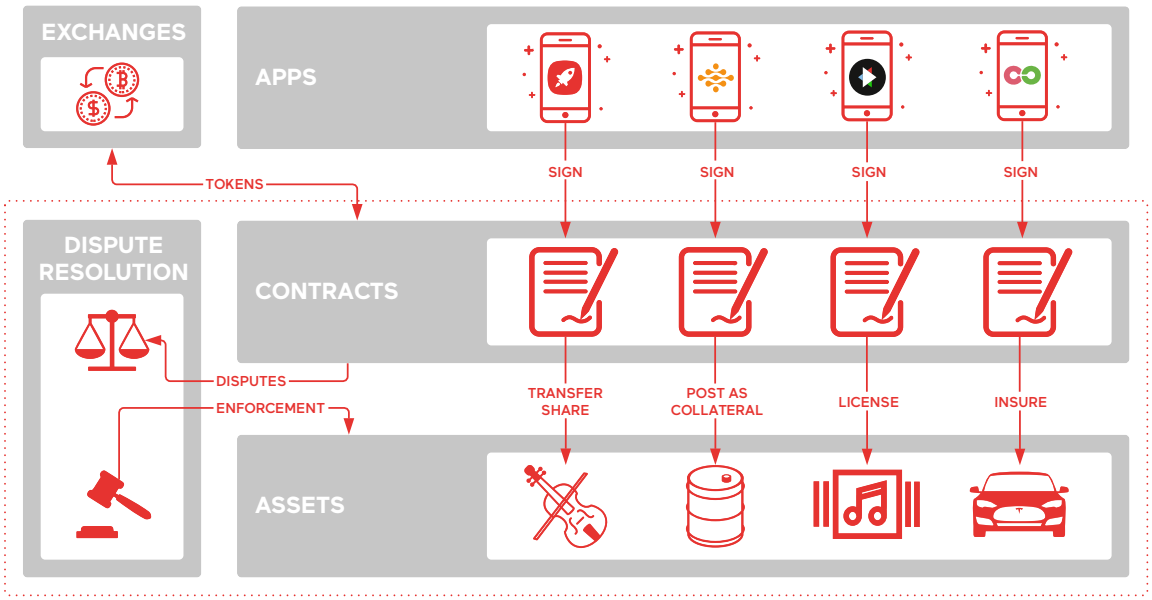
Governance of the underlying assets is defined when the asset is on-boarded; for example, there might be a requirement for a user to maintain a certain level of insurance or, in the case of the violin, to ensure that it is played in at least 6 concerts in 3 countries over the course of a year. Being the asset's legal owner, the registrar is in the strongest position to enforce these constitutional requirements in respect of the asset.

This provides the platform for tokenization, DAOs, curation markets, and enforceable smart contracts. The registrar is a legal extension of the blockchain into everyday reality.

The blockchain itself provides for programmable payments – programmable money, if you will. For assets defined purely by their existence on the chain – existing ERC20 or ERC721 tokens – their smart contract code is the asset itself. But in the world of physical/intellectual property and financial instruments, we cannot program the assets directly. So instead we program their *owners* – the registrars – which take legal title to the assets for (at least) the duration of the contract's execution, and which are bound to honour the smart/Ricardian contracts which control the assets in accordance with the Mattereum Protocol.

This approach enables enforcement of a smart contract based on the registrar's property rights, without requiring any new legislation.

What we get from this is a simple API for the control of off-chain assets. We



can buy things, wholly or as a percentage, create licenses for use, or stake assets as collateral. We can build complex systems of utility tokens, curation markets or any other smart contract system on top of it. We can create entire programmable economies for controlling the real world.

MATTEREUM PROTOCOL: ASSET PASSPORTS

A registrar must identify precisely which assets it owns, including information about who holds various kinds of legal interests in each asset. An *asset passport* is a unique contractual container (legal and smart contracts together) that records and manages the rights and obligations associated with a given asset. Objects are placed into these legal containers by their original owners as part of the asset on-boarding process. Asset passports identify property in the same way that URLs identify information.

Together, all asset passports maintained by all registrars in accordance with the Mattereum Protocol comprise the **Smart Property Register**, the authoritative record of the registered assets' legal status, including all active smart contracts, tokens, and rules governing the assets' maintenance and use. No contractual right or interest in a registered asset is valid unless recorded here. The Smart Property Register is authoritative because the registrars hold legal title to the registered assets and act in respect of those asset – recognising, updating and ultimately enforcing parties' rights or interests – only in accordance with the Mattereum Protocol and the binding commitments entered into by the parties and recorded on the Register.

MATTEREUM SMART PROPERTY REGISTER

For many classes of asset, someone can "double-spend" them by, for example, using them as collateral in multiple loan agreements without acknowledging prior charges against the asset, or purporting to sell the same asset to multiple buyers who are unaware that the seller no longer has legal title. Any credible "tokenization" of real world assets must overcome this challenge. Without an authoritative register of all the encumbrances upon an asset, preventing double-spending is impossible. This is why, in jurisdictions that have official registries for real estate, the register entry is definitive. If the register says you acquired legal title, you did, and any other claim which is not recorded on the register is disregarded.

The Mattereum Smart Property Register extends this concept to all asset classes, not just real estate, without requiring any changes to the current legal framework in any jurisdiction.

Double-spending assets becomes just as impossible as selling the same house to multiple buyers at the same time. As the sole legal owner of the asset, with definitive records of all related contracts and encumbrances, the Smart Property Register is the single source of truth in the same way the blockchain is the definitive record of who owns which tokens.

THE REVOLUTION WILL BE TOKENIZED

Mattereum exists to give physical matter digital interfaces which exponentially increase its value.

Over the past 30 years, computerization has made information profoundly more useful, and therefore more valuable. Clichés like "data is the new oil" conceal a fundamental truth: efficient discovery of availability and price radically changes the value of assets. Auctions on eBay gave value to enormous seas of illiquid assets (roughly $24bn of transactions per year). But we still have no real provenance, warranty or other rich data insights into the majority of the assets on sale. Even now, the world is filled with assets which are detached from their histories and contexts, dramatically reducing the value of those assets.

Some classes of illiquid assets, such as idle cars and briefly empty flats, found markets through Uber and Airbnb, liberating billions in value; but reputation systems leave a lot to be desired, and often the legal basis is questionable (i.e. subleasing not permitted by tenancy agreements in the case of Airbnb, and carrying passengers in unlicensed vehicles in the case of Uber).

But the pattern is very clear: assets with a proper digital interface and history are more valuable than assets without them. The blockchain promises to revolutionize the utility and thereby the value of assets, and Mattereum has a vital role to play in that transformation.

Current models prioritize the platform rather than the assets: Airbnb has a market cap around $40bn, and Uber may IPO at $120bn, based on the value of running a marketplace which brings physical assets to new customers. Uber has around 2m drivers, and Airbnb has as many as 4m hosts, meaning the marketplace operators are valued at tens of thousands of dollars per vendor in the marketplace. That money is almost entirely trapped by information scarcity: why do you have to go through a branded app to figure out who might rent you a house? Today, that's the only place that offer exists. Tomorrow that will not be the case, and the assets being brought to market through these limited exchange apps will publish

their offers on decentralized marketplaces. Tens of billions of dollars currently trapped by marketplace operators will be split between buyers and sellers as the underlying assets become linked to smart contracts rather than proprietary apps to bring them to market. Many billions more will be created as assets for which no current marketplace provides full digital liquidity become fully accessible.

Furthermore, the current generation of marketplaces sell services from assets, not the underlying assets themselves. Uber will not sell users a car, or let them hire a long-term chauffeur. Airbnb will not let customers take out a one-year lease on the house they are staying in for a single night, even if they fall in love with it. But if the full range of marketplace offers associated with an asset were instead tied to individual assets, somebody might rent a car on a given night, rather than the owner of the car driving it as an Uber, or lease it for a couple of months. A house might be rented for days, months or years, or even sold, whole or in (tokenized) part. A revenue share associated with the rental income from the property could also be for sale in the same marketplace.

The more convenient it is to make commercial offers for the use of assets in a wide range of formats, the more use those assets will see. In B2C settings many of these use cases have separate services attempting to support them, but in the B2B space most assets have no interface to the market (i.e. components in a workshop usually are not also listed for sale) and certainly cannot be rented, bought at short notice in quantity of one, or otherwise used to provide grease for the occasionally sticky commercial supply chain. But, in fact, everything is for sale if the information about it is available, and an urgent need creates a mutually acceptable sale price. With the right interfaces, there are no sleeping assets: everything is on sale all the time. Everything is both in use, and also being warehoused for other potential users.

DRIVING RESPONSIBLE GLOBAL ECONOMIC GROWTH

As Mattereum extends its services into developing economies, the benefits of collateralizing movable property will become extremely important because it fuels economic growth. Being able to secure transactions using collateralized assets (e.g. vehicles, machines, cows), small businesses in developing economies will have the same, easy access to growth capital currently enjoyed only by their much larger, land-owning competitors. This levels the playing field, stimulates growth and puts more assets in the hands of those most strongly incentivized to preserve the environment. Hernando de Soto's work on the "mystery of capital" makes it very clear that strong, clear, enforceable property rights for land are huge facilitators of economic development because it allows the poor to borrow money to make investments in their own productive capacity, bringing them out of poverty. Mattereum extends this logic even to non-landowners, as it brings hard, internationally legible titles to the full range of assets, not just real estate. Close, careful work will be required to maintain enforceability standards in many jurisdictions, but we are prepared for these challenges.

STAKING OFF-CHAIN ASSETS

Current staking models in the cryptocurrency space often involve counterparties staking, in effect, cash. If it is not fiat money, it is bitcoin, ether, or tokens native to the system. But, as a business, tying up your working capital as stakes to underpin deals makes no sense. Working capital should be working.

Instead, you want to stake things you already have, and intend to keep for the long term. If you are a manufacturer, staking a share in your factory makes perfect sense. Staking cash (or bitcoin or ether) that you could be using to buy supplies or pay for marketing is much less desirable. And being required to go out and buy a token, simply so that you can stake it, is not credible.

With the Smart Property Register, you can credibly stake your assets and continue to use them. Working capital is preserved, but your ability

to sign contracts with counterparties around the world has dramatically increased, because your stake signals credibility. This solves many of the core problems with smart contract enforcement – in fact, it provides more direct enforcement than is available with the standard commercial arbitration agreements currently underpinning hundreds of billions of dollars' worth of transactions every year.

This is no small problem to have solved. Lack of enforcement or ability to secure contracts against assets costs between 5-10% of GDP in countries such as Argentina, according to estimates from World Bank economists. Hernando De Soto also puts the estimate of "dead capital" in third world countries at $10 trillion. We are not the first to notice this problem, but we are the first to propose a solution that does not depend on major legislative change.

TOKENIZING ASSETS

There are two kinds of right that are obvious candidates for tokenization. The first is the financial beneficial interest – the right to be paid a portion of the asset's value if it is sold, or to receive a portion of any income the asset produces. These are commonly referred to as security tokens. The second is the right of use – to access, possess, play, remix, display, or otherwise interact with the asset. These are commonly referred to as utility tokens.

For assets in the Smart Property Register, both kinds of tokenization are possible. Security tokens are of interest to investors, allowing them to build portfolios of assets according to their needs. For many assets, just being able to tokenize and trade the beneficial interest will produce a "liquidity premium" – an increase in the value of the asset simply due to the fact that it's easier to trade. The means to construct more fine-grained portfolios of interests in individual assets, not just a securitized class of assets, and to subject them to fully automated control opens up new possibilities for investment.

For some assets – or groups of assets – a utility token can also be created. For instance, a network of autonomous vehicles might allow utility token-holders the right to discounted journeys. We can make the connection

between these tokens and the assets they give access to explicit; it is not hard to imagine that token wallets containing these utility tokens could also help their owners to find assets that accept the tokens in return for access.

Regulatory clarity on utility tokens is missing in some jurisdictions, and so we expect security tokens to be the primary use-case in the short term. In the long run, however, there is more utility to unlock in the real world than is represented by all of the utility tokens issued to date. Memberships, discounts, loyalty schemes, reputation systems and access tokens are all sensible models for controlling access to assets, and our explicit aim is to support them.

ASSET GOVERNANCE

The Mattereum Smart Property Register breaks down the traditional concept of ownership, separating out legal title, financial beneficial interest, and possession or use of an asset. At the point where an asset is on-boarded to the Register, the owner defines the governance model attached to the asset. This enables assets to be traded while ensuring that any non-monetary, or longer term issues are considered.

For example, in the case of the Stradivarius, it is both an appreciating, high-value asset, and a cultural treasure. The current owner may want to factor that into a trade. Someone might want to buy the violin purely as an investment, and lock it away in a vault where nobody will ever play it or hear it played. By attaching a system of governance to the asset when it is on-boarded to the Register, the owner can guard against this kind of outcome.

In the case of the violin, the governance structure is likely to include a separate curatorial board who will make decisions about which violinist should perform with the instrument, in which countries, at what events. They will also ensure that regular maintenance is carried out by qualified specialists. Without the Smart Property Register, this kind of asset stewardship would not be possible. But since the Register will continue to hold legal title to the asset indefinitely, it becomes possible to take a long term view of the best way to manage the asset.

Today, we are talking about governance for fine instruments. Tomorrow, we will be ensuring that forests, rivers and oceans are maintained and managed for generations to come.

THE SMART ECONOMY

By supporting both *investment in* and *use of* an asset, we can see the economic ecosystem around that asset. We are not limited to treating the asset as a "black box" that emits dividends or royalties; instead we can know what is being produced and how. Asset use could be paid for with utility tokens, or bundles of tokens, as well as fiat currency or pegged stablecoins.

This opens up new solutions to problems such as climate accounting. These tokens could represent carbon offsets or credits, and assets could be set up to allow use only if the user has paid in enough carbon credits to offset the carbon produced in typical usage. By fully accounting for carbon costs over the asset lifecycle, we enable carbon-neutral or carbon-negative usage to be built right into the legal structure of the asset itself.

OUR PARTNERS

In developing these ideas, we are grateful to the contributions of our various partners, who have helped to shape our understanding of the market and its needs, the technology and legal landscape, and the problems we can solve.

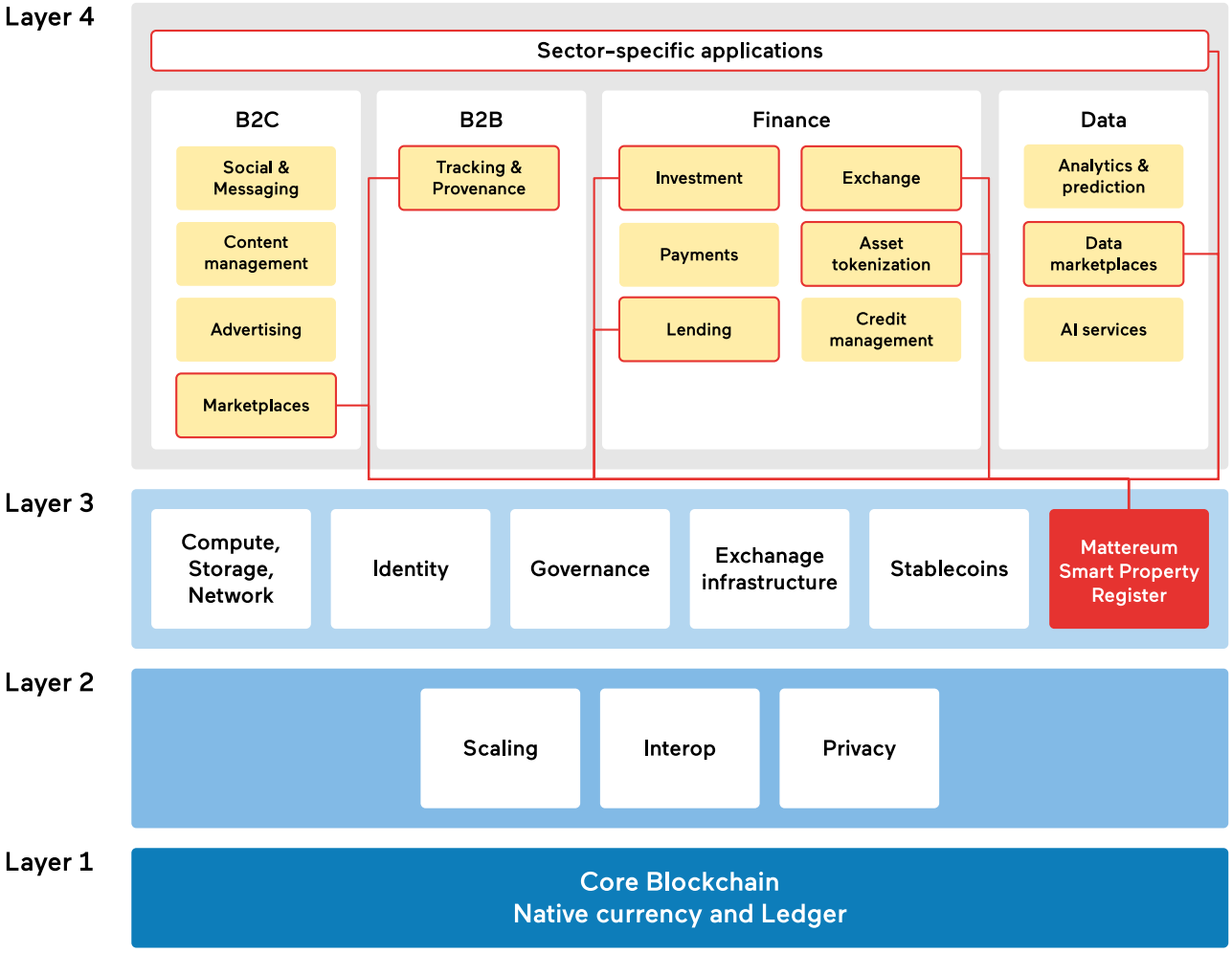
In no particular order, these are:

- **Sweetbridge**, with whom we are working on contract enforcement, asset locking, and trade finance
- **VouchForMe**, with whom we are working on asset-secured insurance deductibles and social proof-backed insurance
- **Mycelia,** with whom we have developed a solution to register shares in a royalty stream from music recordings
- **CoinFund**, who have provided valuable advice, inspiration and connections
- **FEMOZA**, with whom we are working on the tracking and passporting of assets through special economic zones
- **BeamWallet**, with whom we are working on loyalty and rewards for retail, including tracking purchase records through thousands of Point-of-Sale systems worldwide
- **ImpactPPA**, with whom we are working on a combined investment/utility model for energy networks
- **Ocean Protocol**, with whom we are working on dispute resolution, management of copyrighted data assets, and constitutional network governance

These early partners have been invaluable in shaping our thinking and giving us real-world problems in which to ground our product development.

MATTEREUM FOR DEVELOPERS

With each new generation of technology, code gains new capabilities: sound



and graphics in the '70s, printing and networks in the '80s, 3D graphics and global communication in the '90s, cloud servers, GPS, accelerometers and touchscreens in the '00s. In the last few years we have gained programmable money, and Mattereum wants to enable software to reach into ownership, contractual rights, and control of assets of all kinds.

The Mattereum Protocol sits below the application layer in the stack and is designed to support a wide range of potential applications. We are already working with a range of partners, and will open these capabilities up to the community as soon as possible. To this end, we will be publishing a series of EIPs, a software development kit, and open source tools to build on top of the Mattereum Protocol.

CONCLUSION

As we have described, the potential for value creation is large. The Smart Property Register creates opportunities for ownership, investment, use and management of assets in ways that increase their value and utility substantially, and the addressable market of assets can be measured in trillions of dollars.

Mattereum is creating an open source decentralized network, to be used by a global community of application developers, and the legal and software tools needed to operate registrars in accordance with the Mattereum Protocol. This is critical infrastructure serving diverse contentious interests, and it must be developed and managed appropriately. We have assembled a team of lawyers, cryptographers and programmers, completed the initial legal and technical research and development, and prepared for registration of the first assets. We are now ready to ask the community for its support.

The Mattereum Team, London, October 2018