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INVENIAM RESPONSE TO THE GERMAN BUNDESBANK'S "MONEY IN PROGRAMMABLE APPLICATIONS"

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Table of Contents

EXECUTIVE SUMMARY

A CENTRAL BANK'S VIEW ON PROGRAMMABLE MONEY

The digitization of the global economy is opening the door to new business models and fundamentally changing the way value is transferred around the world. A report recently published by the German Bundesbank, "Money in Programmable Applications," acknowledges the role Distributed Ledger Technology (DLT) plays in leading this transformation. This report explores various potential use cases of using DLT to automate and optimize traditional business processes. However, the Bundesbank's findings are largely payment-centric with less focus on the nature and function of the programmable functions. The institution makes several assertions about the leading role that commercial and central banks should have in the adoption of DLT in the economy. While many of the assertions made are valid, we believe that by focusing on payments, the report fails to recognize the role data plays in the assessment of value of goods and services, and trust in that data and in counterparties, plays in making economic transactions possible.

There is a chasm between current reality and central bank forecasts. What these positions do not consider is the role central banks play in the current debasement of the government-issued currencies that back the vast majority of the global economy. In the past several years, the supply of the United States has increased at an unprecedented rate. This debasement of the global reserve currency adds serious concern to the wisdom of using tokenized commercial bank money as the basis for programmable payments. Regardless, the world's biggest banks clearly see themselves as the solution. However, it is essential to recognize that money itself is not what makes economic transactions possible — it is *trust*. What these institutions fail to recognize is that trust is the essential prerequisite for all financial transactions. If you have verifiable, credentialed data that is digitally certified and can be shared on-demand, then you have the building blocks for a transparent system where parties can transact seamlessly — whether they are friendly allies or fierce competitors.

SOLUTIONS FOR TRUST AND DATA IN A DECENTRALIZED ECONOMY

Today, investors need an operating system for on-demand access to verified private data. Because this kind of operating system is not currently within the purview of central banks, its significance has been overlooked. It is this private data operating system that allows both payment and value to be commuted during a digitized asset transaction. Rather than focusing narrowly on payments, Inveniam understands the importance of value. Smart contracts, proof of ownership, and value commutability can be used to unlock trillions in private market assets. Historically, these markets have provided investors with inferior outcomes due to opaque and asymmetric asset performance information. DLT represents a transformational opportunity for private market participants through data-driven solutions.

The viability of decentralized economies relies on two critical factors: trust and data. Successful transaction execution requires trust that agreed upon flows of value will be exchanged as expected. This is the problem the Bundesbank elucidated in its paper but was unable to fully articulate. The paper left unanswered a solution that requires a third-party addendum. The Bundesbank refers to programmable money or central bank-sponsored currencies capable of executing agreed-upon rules in response to "reference data." For programmable money to be a new steward of value transfer, certain precedent requirements must be met. There are four elements to establish trust for digitized programmable money: 1) reference data, 2) undisrupted online availability, 3) complete record-keeping, and 4) correct record-keeping. DLT has well established digital exchange and consensus capabilities. Consequently, it provides the necessary reference data in an undisrupted, complete, correct manner. Since this reference data is immutable, it provides a source of digital provenance that further drives trust. The digitized trust enabled by DLT opens beneficial new use cases like bank-sponsored DAOs (Decentralized Autonomous Organizations) with governed lending and state-sponsored escrow bots.

In a decentralized economy, it is important to understand that asset performance data is also distributed. The complexity of data in decentralized economies can be characterized by the "Four V's": 1) velocity, 2) veracity, 3) volume and 4) variety. Tokenization utilizing elements of Inveniam's solution provides immediate benefits in the form of data portability and integrity, thereby increasing velocity of data-enriched assets. Resulting digital financial instruments represent proportionate asset ownership and auditable performance data sources. Inveniam solutions go beyond the concept of KYC (Know Your Customer) by establishing a platform for "KYA" – know your assets – which allows for more robust discussions of asset value. In addition, Inveniam Investor Calculations provide automated, end-to-end waterfall calculations for investor allocations and sub-ledger recording. In this way, DLT facilitates automated transaction processing and real-time performance monitoring, enabling private markets to transact with greater velocity. With the Inveniam.io platform, data veracity is ensured through the Inveniam event series and "valuation-as-a-service." With data completeness and correctness playing such a central role in digitized trust, Inveniam's ability to provide auditable records of data integrity is key.

Another key component of the Inveniam platform is the Federated Data Room (FDR). In principle, the FDR allows source data to remain in situ, rather than necessitating a copy to a central oracle. This is akin to a virtual database that spans multiple domains. In a world where the volume of data is growing exponentially, the FDR pipes in data from any source into a single user interface and re-permissioning structure so it can be gathered, Verified by Inveniam and passed along to third-party oracles and transaction participants. Finally, Inveniam is deploying several solutions to handle the increasing variety of data. A blockchain "hub," enables single sign-on and canonical access to multiple public and private chains, and associated wallets,

via a common interface. This also includes a natural language processing (NLP) engine that will enable the Inveniam platform to process unstructured data that comes in various formats since it is not governed by any underlying data model. With a proliferation of chains and data sources, all of these tools will be required to fully support the future of money, banking, and lending.

1. THE BUNDESBANK'S VIEW ON PROGRAMMABLE MONEY: THE GOOD, THE BAD AND THE VALUABLE

The German Bundesbank is one of the most important and well-respected central banks in the world. For decades, it has set the benchmark for prioritizing low inflation. It is also known for innovation, risk management and global financial leadership. In December 2020, the Bundesbank issued a [groundbreaking report](#) on blockchain and digital assets entitled "Money in Programmable Applications: Cross-Sector Perspectives from the German Economy." The report is the result of a joint analysis undertaken by experts from 19 German enterprises and institutions. These experts analyzed the potential of new programmable payment solutions and explored innovative business cases for these solutions. This effort was initiated in response to the rising demand for programmable payments in the German economy. While the Bundesbank report offers several relevant insights, it also reflects some of the central bank's potential blind spots. In the following section, we share our perspective on the Bundesbank report. This includes assertions with which we agree and disagree. It also includes discussions we think the banking system should be having – the good, the bad, and the valuable.

There are four major takeaways from their document:

1. Rapid digitization of the global economy has put pressure on trading processes, business models and workflows to adapt. Traditional payments infrastructure prevalent today is unable to meet rising demand of automated and programmable payments. This is primarily because settlement is completed in traditional, non-digital currency.
2. DLT has the potential to reduce transaction costs, settlement time, and "generate greater added value through improved services and products." This improvement in services would largely be a result of the programmable nature of DLT, allowing new use cases in M2M (Machine-to-machine) payments, automated settlement, bidirectional clearing, cross-border payments, and many other services that are currently restricted by slow and manual traditional payment settlement.
3. Volatility, lack of intrinsic value and liable issuer of privately created crypto tokens, such as Bitcoin and Ethereum, limits usability in payment solutions. The Bundesbank proposes tokenized commercial bank money (TCBM) as a potential solution. TCBM will facilitate widespread adoption and innovation in programmable payments and contract execution systems.

4. The Bundesbank believes that the "basic principles of the current monetary system should definitely not be changed." Monetary stability, maintaining a fixed nominal value (i.e., a 1:1 conversion ratio with the government-issued currency), and creating a regulatory framework are all necessary for new programmable payment solutions to be adopted.

Read in the light of recent publications from organizations such as the Federal Reserve Bank of St. Louis, BNP Paribas, and Bain & Company, it becomes clear that this conversation can no longer be ignored by anyone in the capital markets sector.

1.1. THE GOOD: THE BUNDESBANK RECOGNIZES THE TRANSFORMATIVE NATURE OF DLT

As highlighted in the Bundesbank report, DLT is increasingly being used in the German economy as part of a drive to go digital. DLT enables decentralized, automated transaction processing via smart contracts, in which real goods and services are represented as tokens. In addition to providing a mechanism for decentralized transactions, this technology also enables immutable data traceability. The report duly recognizes that DLT has the potential to remove transactional frictions, build trust, and unlock new value across businesses and industries. Because a digitized economy must enable money from around the world to enter and exit the digitized system, there is a need for a payment solution that integrates with DLT-based decentralized networks and accepts multiple global currencies.

ADDRESSING THE NEED FOR PROGRAMMABLE PAYMENTS

The Bundesbank acknowledges that crypto tokens and stablecoins are technically capable of processing cash payments for many DLT use cases. However, it also notes that usage of these alternative currencies is limited by high volatility and a lack of interoperability. The report therefore concludes that tokenized commercial bank money and central bank digital currency demonstrate the greatest potential for settling programmable payments as they offer monetary stability, issuer credibility, and a binding legal framework.

Although both solutions are still in development, they could ultimately address programmable payment needs across a broad spectrum of use cases.

The Bundesbank report is a step in the right direction as it focuses on concrete and practical use cases that include machine-to-machine payments, payments in the internet of things (IoT) and pay-per-use payments. This contrasts the approach of many other DLT publications that revolve around abstract discussion of requirements, tech specs and complicated economic effects. Instead, the Bundesbank

provides a thorough review of the current state of DLT, with clear insights into needed additional work. However, no matter which universal payment solutions are ultimately developed, acceptance relies on technological interoperability. This is where a tokenized commercial bank money or central bank digital currency solution may fall short.

1.2. THE BAD: DOES THE BUNDESBANK FULLY UNDERSTAND THE ROLE OF DATA?

Central banks move slowly. This applies to digital payments. The Bundesbank white paper draws the conclusion that, due to their size and strength, commercial banks and central banks are best suited to offer digital payments to the marketplace. The paper also argues that Bitcoin and Ethereum cannot serve as this universal payment medium due to excessive volatility and lack of intrinsic value. The Bundesbank asserts: "BTC and Ether are prominent examples of volatile crypto-tokens, which have limited usability as a means of payment. Moreover, they generally have no intrinsic value and no liable issuer." The Bank's solution: some form of tokenized commercial bank money or central bank currency. Such solutions are in the very earliest stages of exploration with no real application in sight. As former Chairman of the CFTC Christopher Giancarlo commented, "Governments are hurrying to catch up."

There is a chasm between current reality and central bank forecasts. Today, there are almost two trillion dollars circulating globally in digital assets. "Issuers" are real, legitimate, and growing. Coinbase has filed its S-1 for a 2021 IPO. Wall Street banks are in talks with leading custodians to secure assets digitally. PayPal and Square have legitimized digital assets on their platforms, while MassMutual, Tesla, and MicroStrategy have added BTC to balance sheets.

IN RELIABLE HANDS?

Despite this chasm, the Bundesbank paper maintains that digital payments should be left in the hands of the too-big-to-fail commercial banks, stating that "tokenized commercial bank money and digital central

bank money brings the greatest functional benefit in terms of settling programmable payments" due to issuer credibility and binding legal framework. With this assertion, the Bundesbank ignores the role that better data can play in allowing economic actors to trust one another in the digital realm. Similarly, a 2019 report by the Bank of International Settlements noted:

"Digital currencies may also cause an upheaval of the international monetary system: countries that are socially or digitally integrated with their neighbors may face digital dollarization, and the prevalence of systemically important platforms could lead to the emergence of digital currency areas that transcend national borders. Central bank digital currency ensures that public money remains a relevant unit of account."

What these positions do not consider is the role central banks play in the current debasement of the government-issued currencies backing most of the global economy. In the past several years, the supply of United States dollars has increased at unprecedented rates. The U.S. Federal Reserve separates this supply into two metrics: "M1," which are funds that are readily accessible for spending (i.e., currency outside the U.S. treasury) and "M2," which is a broader set of financial assets held principally by households (e.g., savings deposits and money market mutual funds). Since 2008 M1 money stock has increased 320% and M2 money stock has increased 135%. This trend has gone into hyperdrive since the start of the global pandemic, with a 67% increase in M1 and 26% increase in M2 in the past year alone. This debasement of the global reserve currency adds serious concern to the wisdom of using tokenized commercial bank money as the basis for programmable payments.

Regardless, the world's biggest banks clearly see themselves as the solution. However, it is essential to recognize that money itself is not what makes economic transactions possible — it is *trust*.

TRUST IS THE KEY

What these institutions fail to recognize is that trust is the essential prerequisite for all financial transactions. If you have verifiable, credentialed data that is notarized and can be shared on-demand, then you have the building blocks for a transparent system where parties can transact seamlessly — whether they are friendly allies or fierce competitors. Today, investors need an operating system for on-demand access to verified private data. Because this kind of operating system is not currently within the purview of central banks, its significance has been ignored. It is this private data operating system that allows both payment and value to be commuted during a digitized asset transaction. Here, we must also call attention to the difference between payment and value.

1.3. AND THE VALUABLE: THE IMPORTANCE OF VALUE MUST NOT BE IGNORED

The premise of a central-bank digital currency (CBDC), as posed in the Bundesbank paper, is largely tied to a central bank's monetary policy mission, which includes regulating currency stability and inflation. In many ways, it views CBDC as simply another fiat currency, or proxy for fiat currency. This is what stablecoins essentially seek to provide by indexing to a fiat currency or other asset.

Therefore, it stands to reason that the Bundesbank paper focuses on payments, rather than value. In contrast, Inveniam primarily focuses on value. For example, in the analog world, you purchase goods and services with fiat currency every day. No data is attached to the currency that validates the value of said goods and services; you could pay $5 for a cheeseburger, or you could pay $5,000. The actual currency and payment infrastructure is largely indifferent, apart from a credit card company potentially flagging such an unusually high-value transaction for potential fraud.

The value of such a purchase is entirely based on empirical data independently gathered by both buyer and seller. If both parties agree to value, the transaction will proceed. However, if the buyer disagrees, it is likely the transaction either will not proceed or will be further negotiated. Therefore, it is important to draw a distinction between payments and value: they are complimentary, but also independent.

WHY VALUE MATTERS

In the above example, information symmetry would help the buyer ascertain value in advance of the transaction instead of leaving this buyer to his or her own devices. In this way, programmable money and digitized trust represent more than a payment mechanism. New technologies allow buyers to access information about value in a more transparent, decentralized way. Data asymmetry exists most clearly in private market sectors such as real estate, private equity, private credit, and infrastructure. Digital provenance and value commutability will someday allow a skyscraper in Manhattan to be sold to a Los Angeles hedge fund in the morning, with the transaction settling in the afternoon with secure transmission of verified asset performance data, including clear title and all related legal documentation.

The Bundesbank paper makes it clear that a leading central bank considers blockchain technology to be a transformative, positive economic force in global society. That recognition demonstrates how far DLT innovation has come, yet there is still much work to do. Smart contracts, proof of ownership and value commutability can be used to unlock trillions in private market assets — the biggest marketplace on the

planet. Historically, these markets have provided investors with inferior outcomes due to information asymmetry and a lack of transparency. By increasing transparency and flow of data, DLT represents a groundbreaking opportunity for private market participants around the world. This vast potential should not be limited to tokenized commercial bank money and central bank digital currency. It is true that programmable money solutions face complex issues related to stability and credibility in a decentralized world. However, solutions to these issues can be found by applying a data-driven lens.

2. SOLUTIONS FOR TRUST AND DATA IN A DECENTRALIZED ECONOMY

The viability of any decentralized economy relies on two critical factors: trust and data. Transactions succeed when parties trust the value of goods and services to be exchanged. Traditionally, this transactional trust has been conferred by large, systemic institutions like central and commercial banks. However, technological advances have enabled new actors to enter as trust becomes programmatic and digital. A result is that trust is becoming democratized. In this new digital paradigm, data becomes key to conferring trust. The Bundesbank understands trusted money but overlooks trusted data. Because the Bundesbank is flummoxed by data problems, they conclude that programmable money is primarily suitable for central banks and Tier 1 commercial banks. From its perspective of limited data, responsibility of programmable money should be maintained by highly trusted parties.

However, Inveniam believes commercial banks cannot be fully trusted to handle vexing counterparty issues. Imagine leaving programmable money in the hands of pre-2008 Lehman Brothers. Why are "Too Big to Fail" parties and counterparties qualified to build programmable money in the Bundesbank's eyes? Because the Bundesbank cannot envision a mechanism for digitized trust. In this section, we explain digitized trust and data, which can unlock the potential of programmable money. We also explain how Inveniam's solutions are leading the way by enabling the creation of data-driven digitized trust.

2.1. DIGITIZED TRUST

We think we have identified the problem that the Bundesbank has elucidated in their paper. The Bundesbank refers to programmable money as central bank-sponsored currencies capable of executing agreed-upon rules in response to "reference data." However, there is currently no universal solution for establishing and provisioning this trusted reference data across digital use cases envisioned by the Bundesbank.

REQUIREMENTS FOR DIGITIZED TRUST

Certain requirements must first be met for programmable money to be the new steward of value transfer. Inveniam thinks digitized trust for programmable money can be established if the following four elements are present:

- Reference Data (measured by agreed upon parameters that are defined in escrow conditions)
- 24/7 Online Availability (undisrupted access)
- Complete Record-keeping (sufficient for evidence)
- Correct Record-keeping (as certain conditions require)

Once measurement parameters have been agreed upon and defined by the escrow, they can be codified as reference data. Then, DLT can provide undisrupted, complete, correct reference data sets via digital exchange and consensus. Active multi-node DLTs should be capable of undisrupted operations and via consensus certified to be complete and correct. Parties must agree to what constitutes complete and correct data. With all these elements present, digitized trust can be established between any two counterparties via DLT.

Once defined by the escrow, the DLT is well suited to provide necessary reference data in an undisrupted, complete, correct manner given its digital exchange and consensus capabilities. Trust drives payments, and credentialed data offers integrity.

EXAMPLE: INVENIAM'S BANK-SPONSORED DAO-GOVERNED LENDING PROTOCOL

Digitized trust enabled by DLT creates opportunity for beneficial new use cases. Let us consider a novel innovation made possible by DLT: DeFi, or Decentralized Finance. DeFi is an umbrella term for a variety of experimental financial applications that do not rely on any single financial intermediary. With DeFi, financial services such as lending, currency exchange, and derivative financial instruments can be offered in a trustless environment and without a governing single authority. These financial applications are governed instead by a Decentralized Autonomous Organization (DAO). The concept of a DAO can be thought of similarly to a publicly traded company. A "governance token" enables holders to vote on proposals for new initiatives or changes to existing products and services that DAOs offer. This is like shareholders with voting rights. However, DAOs lack hierarchical organization. There is no board of trustees or executive team.

While DAOs, and DeFi represent new approaches to financial services, its practical uses are limited. Take lending and borrowing for example. While DAOs such as MakerDAO and Compound have successfully launched fully decentralized platforms enabling users to lend and borrow crypto-tokens, these services are available for a handful of highly liquid crypto-tokens. Furthermore, because these services rely on decentralized "lending pools" to provide liquidity, borrowers are required to be over-collateralized meaning they must lock up more value than they can borrow. Because this collateral, and any loans, can only be crypto-tokens, high volatility means loans can quickly become under-collateralized and subject to automatic liquidation. In November 2020, the DeFi protocol Compound experienced a significant automatic liquidation event of over $88 million worth of collateral. This was due to MakerDAO's USD-pegged

stablecoin DAI temporarily increasing to $1.30 at cryptocurrency exchange Coinbase, the source of pricing data utilized by the Compound protocol's smart contracts that enforce the protocol's rules. Although the price increase was momentary, it led to hundreds of loans becoming under-collateralized and instantly liquidated. While this is a known risk when collateralizing highly volatile crypto assets, the fact that DAI is considered a stablecoin gave many borrowers a false sense of security.

In its purest form, a DAO-governed decentralized lending platform is limited in scope and carries considerable inherent risk. But it also provides a working example of a use case of programmable money only possible with DLT technology. At Inveniam, we are taking the lessons learned from these decentralized protocols and building an entirely new type of service that takes advantage of the benefits, while mitigating the faults: a Bank-sponsored, DAO-governed decentralized lending platform.

Within Inveniam's solution, transparency, security, and liquidity of a decentralized lending protocol are integrated into traditional banking infrastructure. Lending and borrowing are structured in a more traditional manner. The bank has the power to approve loans, and borrowers are subject to KYC and AML (anti-money laundering) policies. However, execution is handled programmatically. Assets are collateralized via smart contracts. This is a significant advantage as it allows for hypothecation of collateral to be enforced programmatically by code. Disbursement of funds is encoded into smart contracts. When a borrower fully repays their loan including interest, the assets are automatically unlocked and returned. The biggest benefit to this hybrid system is that the required collateral is no longer limited to highly liquid crypto tokens. Borrowers can collateralize any digital asset. The sponsoring bank has the authority to underwrite any digital asset that cannot inherently be included in a liquidity pool. A token representing a large commercial office building, for example, which is valued at $100 million, can be programmatically collateralized, with the bank providing extra liquidity as needed by the liquidity pool to cover the loan.

Inveniam's bank-sponsored, DAO-governed decentralized lending platform will be open to multiple banks. Membership in the DAO will be open to all licensed financial institutions, with contribution to the liquidity pool being a requirement of membership. With Inveniam's solution, the lending platform is decentralized but ensures legitimacy and all financial regulations are met. However, this platform will not operate in a "trustless" environment. This is an example of digitized trust. Collateralized digital assets still require trusted reference data for their value to be ascertained. Data on the identity of borrowers and use of funds are still required to pass appropriate KYC/AML regulations. Because the lending platform is DLT-based, this trusted reference data can be encapsulated within the digital asset, enabling it to be sourced and transferred quickly and efficiently.

A STATE-SPONSORED EXAMPLE

While digitized trust can offer an alternative to traditional intermediaries, it can also be used to increase efficiency and effectiveness of intermediaries participating in programmable money transactions. Certain transactions may benefit from use of programmable money but may nonetheless need sponsorship and oversight from governmental or non-governmental institutions. In these cases, such institutions could use data driven DLT solutions to improve outcomes via digitized trust.

For example, consider a social enterprise that provides micro loans to residents and businesses in under-served rural communities. At present, hands-on, local monitoring practices are required to ensure that loans are repaid, and borrowers comply with loan terms. With DLT, a new solution could be imagined. Instead of spending time and resources to monitor borrowers on-site, data could be crowdsourced directly from local residents. For example, the following types of reference data could be captured and recorded on blockchain:

- "Yes" response texts from five randomly polled mobile phones known to reside nearby
- A social media post from two local residents showing the business in operation and containing the user's identity and geolocation
- IoT sensor data generated from within the business

To facilitate a digitized trust solution, programmable, central-bank sponsored currencies should provide free, state-sponsored escrow bots. These escrow bots could function as smart contracts that release funds when required conditions are met. In the example of a microfinance institution, those conditions could be satisfied via third-party and crowdsourced data from a variety of sources like mobile phones, social media, and IoT sensors. The state-sponsored smart contracts could be stored on a blockchain and fully integrated into the decentralized economy. These escrow bots could potentially offer the best of both worlds by providing automated oversight and processing for blockchain transactions and being sponsored by a trusted state institution.

Although this example paints the picture of a social enterprise project, data bottlenecks are obviously not limited to that sector. The global financial markets, which conduct billion-dollar transactions daily, face similar inefficiencies in the settlement process. Underlying bottlenecks are the same: 1) lack of trust between counterparties; 2) need to wait for ownership verification; 3) and proof-of-funds. Data is key to establishing trust in a decentralized economy. Mastering it requires a deep understanding of new data challenges.

2.2. THE FOUR V'S: NEW DATA SOLUTIONS FOR DECENTRALIZED TRANSACTIONS

In a decentralized economy, it is important to consider that the data required to derive asset values is distributed. This is true whether the data is sourced from an IoT device, a system that maintains performance data, or from a legal document that outlines terms and conditions. There is no single oracle that curates all such data making it readily available to interested parties. As a result, the decentralized economy faces new data challenges that require innovative solutions.

The complexity of data in a decentralized economy can be characterized by the "Four V's": 1) velocity, 2) veracity, 3) volume and 4) variety. Thanks to DLT, assets can now travel in tandem with their supporting data, and smart contracts enable these transactions to occur with greater **velocity** than ever before. Moreover, the immutable nature of data stored on blockchain enables the **veracity** of information to be irreversibly established and tracked over time. As more data is created across an ever-increasing number of decentralized sources, the **volume** of data is ballooning. According to IBM, people create at least 2.5 quintillion bytes of new data every day. Moreover, this data is created across a **variety** of different sources, from social media and personal communications to medical devices and logistics tracking.

With the increase in data velocity, veracity, volume, and variety, it is infeasible for any one supplier to curate, store, and provision all relevant data to complex transactions. However, it is possible to supply infrastructure that allows this data to live up to its potential in a decentralized economy. In private markets, the Four V's are particularly challenging. This is due to the sheer number of discrete assets, a general lack of standards, and fewer contemporary and scalable technology solutions. Inveniam's focus on digitized private market assets provides a deep understanding of solutions required to meet the challenges of the Four V's. In the sub-sections below, we discuss how Inveniam's solutions address velocity, veracity, volume, and variety in a decentralized economy.

INCREASING TRANSACTION VELOCITY THROUGH TOKENIZATION AND "KYA"

Digital dematerialization or tokenization refers to the creation of digital representations of assets and rights on distributed ledgers. These digital tokens can represent assets, rights, goods, and even services. Tokenization brings several advantages. First, illiquid assets, such as real estate, private equity, or art, can be represented by tokens and traded on a secondary market. Investors can own and trade fractions of these assets via token. As a result, tokenization increases liquidity and facilitates fractionalization of assets. Second, tokenization renders non-tradable assets tradable. For instance, students could tokenize

future earnings and sell to investors to finance their studies. Third, tokenization increases efficiency by enabling faster and cheaper transactions and settlement. This is made possible by automation of certain steps in the exchange process eliminating the need for certain intermediaries.

Tokenizing private market assets produces immediate benefits in the form of data portability and integrity. Real-time data feeds pertaining to asset performance and peer assets are either anchored or embedded into a cryptographically secured ledger connected to the token via an event series that can contain unlimited data. Such anchored data may include legal, operational, and financial data that exists in a federation of data storage systems accessed through a maintained, permissioned directory. This data drives consistent, frequent, and transparent pricing for private market assets. In turn, these assets can become more transparent and liquid. The resulting digital financial instrument represents not only proportionate asset ownership but also an auditable source of performance data. In this way, we go beyond KYC by establishing a platform for "KYA" – know your assets. This KYA and KYC data can be embedded within the digital representation of the asset itself, thereby greatly reducing the time it takes to execute a transaction.

With smart contracts, decentralized business logic can be used to automatically trigger transaction settlement and exchange. Consequently, the speed of execution increases, and transaction costs decrease because counterparty risk is reduced substantially. Private equity funds and fund administrators are plagued by an overabundance of manual processes, resulting in errors, wasted time, and money. Automation and better use of data in a controlled, private manner leads to more accurate asset valuations and greater liquidity. DLT facilitates automated transaction processing by means of smart contracts, enabling private markets to transact with greater velocity.

The Inveniam.io platform automates complex waterfall provisions and variations through its investor calculations functionality. This includes automated capital calls, distributions, expense allocations and management fees as well as clawbacks and catch-ups. The platform supports provisions on a regional basis increasing geographical asset management flexibility. In addition to automating any number of rule combinations and levels, the platform manages and tracks amendments to rules. This functionality further increases the platform's flexibility. Inveniam investor calculations provide automated, end-to-end waterfall calculations for investor allocations and sub-ledger recording. However, the benefits of smart contract automation can only be realized if both payments and digitized trust are part of automated settlement.

ESTABLISHING VERACITY WITH THE INVENIAM EVENT SERIES AND "VaaS"

The establishment of a mechanism for validated transparent and actionable data inputs is key to the success of any innovative payment system. This is particularly true for decentralized private market transactions. Money moves when it is trusted, yet decentralization removes the intermediaries that

traditionally served as mechanisms of trust. To establish veracity in a decentralized economy, Inveniam has developed the concept of the "event series" — an auditable record that shows how a tokenized asset's reference data has evolved over time. With the Inveniam platform, any event can be documented and notarized on the blockchain. For example, after a lease has been signed, it can be scanned and uploaded to Inveniam.io, where it will receive a digital signature before its metadata is stored on a blockchain. Inveniam's process for verifying data includes trusted, credentialed actors who provide supporting documentation before the information is stored immutably on the blockchain.

The Inveniam event series thereby serves as a mechanism of commuting trust for digitized, data-rich assets. This credentialed data restores integrity to decentralized transactions, which means that smart contracts can be triggered in a trusted manner. With Inveniam's tools, programmable money can know that the lease has been signed. Or that the certificate of occupancy has been issued. Or that the coupon payment has been made for the bond. With data completeness and correctness playing such a central role in the concept of digitized trust, Inveniam's ability to provide an auditable record of data integrity is key.

Another key feature of the Inveniam.io platform is the "valuation-as-a-service," or VaaS offering. Through Inveniam's VaaS offering, the platform can generate observable inputs that feed third-party expert valuation models. These real-time data inputs are secure, actionable, and credentialed. As a result, the platform generates monthly asset valuations that can lead to better accounting treatment. Data collection is facilitated with rudimentary robotic processing automation (RPA) embedded into configurable workflows. Tasks such as data extraction utilizing a host of tools are performed automatically. The data is fielded and indexed so that unstructured data sources, like PDFs, can be used in these sophisticated valuation models. Consistent and transparent pricing can then be generated based on the fair market value ascertained by the models administered by subject matter experts. This ensures underlying assets are always "ready for sale" and greatly reduces time required for pre-sale due diligence. Moreover, asset performance can be compared against peers locally and globally.

With the Inveniam.io platform, data veracity is further ensured though cryptographically secured hashes anchored to an asset owner's data systems, with matching hashes synced to public or private distributed ledgers or on a single node. Since the hashed data is embedded in the token and deployed to an immutable distributed ledger, data provenance is both auditable and commutable. Private data is credentialed in a distributed data ecosystem with permissioned roles-based access, while maintaining a historical time-stamped audit of all changes to the data. This complete and permanent audit trail can prove essential for many private asset use cases as well as ESG performance and compliance reporting on an asset basis. Inveniam.io provides "just in time" permissioned private data that is evergreen and seasons over time with new data, so it never goes stale.

MANAGING VOLUME WITH A FEDERATED DATA ROOM

Another key component of the Inveniam platform is the Federated Data Room (FDR). In principle, the FDR allows source data to remain in situ, rather than necessitating a copy to a central oracle. This is akin to a virtual database that spans multiple domains. The FDR is agnostic as to the underlying repository or location of data whether it exists in a file system, application, database, or IoT device.

In a world where the volume of data is growing exponentially, the FDR pipes in data from any source into a single user interface and re-permissioning structure so it can be gathered, "Verified by Inveniam," and passed along to third-party verifiers and transaction participants. The FDR is mostly a virtual "rearranging" of UIs, directories, and permissions of data from its original and true place of rest. This will allow data to remain in place within its origin repository, a necessary capability when the volume of data makes it infeasible to rely on a single data supplier. In addition to allowing for data to remain stored at its place of origin, the FDR allows for Inveniam to store data when necessary. There are likely to be needs for Inveniam to store data. For example, when the data owner has no natural place for the data to be stored.

The FDR records underlying metadata and allows a "read" operation to generate a cryptographically secure hash of the data, thereby notarizing it and establishing authenticity and a certain level of veracity. This hash and associated metadata are subsequently stored on a blockchain to ensure immutability, further enabling the data to be linked to an associated asset token. This technology with RPA and simple AI will trigger an alert or exception report should there be an out-of-band or unauthorized change to the underlying data. As such, the FDR can provide permissioned data access to a specified, yet decentralized, audience while also enabling the data to be stored in a location of the data owner's choosing.

TAPPING INTO A VARIETY OF PROTOCOLS AND DATA SOURCES

In the second quarter of 2021, Inveniam will be deploying a blockchain "hub," enabling single sign-on and canonical access to a variety of public and private chains, and associated wallets, via a common interface. With a proliferation of chains and lack of underlying protocol interoperability, such a framework is required. In financial markets, the hub is analogous to a FIX hub. Much as Mosaic and Netscape simplified Internet access for the average user, we believe the hub will simplify blockchain access and solve for the upkeep of multiple wallets, credentials, and cryptographic keys.

Inveniam is integrating with multiple natural language processing (NLP) engines that will enable the Inveniam user to process unstructured data. Unstructured data comes in various formats since it is not governed by any underlying data model. These NLP engines will allow more granular field-level data and contextual rules to be extracted from unstructured data for downstream validation and ingestion by other workflows and systems. The output of the NLP engines is similarly captured on chain as part of the event

series. NLP engines can be utilized for any document-centric transaction. We believe this is a critical piece in the end-to-end value chain of digitized assets. *In contrast to the Bundesbank characterization of the decentralized economy as lacking in "standards and interoperability" due to "stand-alone solutions that offer little added value," the Inveniam platform provides interoperable solutions that can account for a variety of data sources and formats.* As a result, complex data can move from blockchain to blockchain in a secured manner at a client's discretion.

CONCLUSION

Although the Bundesbank paper draws interesting conclusions, many of the concepts are not new. Programmable money is a reality that exists today. The Bundesbank must balance its role as an agent of monetary stability with its desire to enter the digital asset world.

Central banks share a common plight when faced with this new, programmable money paradigm. In fact, a paper published by the Bank of International Settlements (BIS) acknowledges that "new currencies will emerge as the central lynchpins of large, systemically important social and economic platforms that transcend national borders, redefining the ways in which payments and users' data interact." The paper concludes that "the advent of these new monies could reshape the nature of currency competition, the architecture of the international monetary system, and the role of government-issued public money." However, economic incumbents need not fear the potential of programmable money. There is a mechanism for establishing trust among digital counterparties participating in open transactions. The establishment of this trust hinges on verified data and the rule of law.

In 2018, Inveniam published a white paper entitled "Introducing the Tokenization of the Global Debt Markets," in which we wrote that "the underlying financial instrument is and always will be the legal agreement, not the code that encapsulates a subset of the legal understanding about the financial instrument." With this statement, we highlighted the importance of data over code when conducting digitized asset transactions. Transactions on the blockchain are not rooted in computer code but in law. That law is formalized via legally binding documents that can be become digitized data. This data can be managed and provisioned via smart contracts that are stored on or near distributed ledgers, utilizing their unique capabilities in a trustless environment.

The ability to ascertain asset value by credentialing data on the blockchain will unleash trillions of dollars in private market assets. The Inveniam platform gives institutional market actors like fund administrators, endowments, pensions, and private equity firms the tools to credential the value of digitized private assets and trade them at the most efficient price. By credentialing the value of such assets, these entities can breathe life into their balance sheets. The economic importance of digital asset transactions grows larger every day. As a result, the need for digitized trust grows in parallel. The Inveniam platform was built with this purpose in mind, providing chain-agnostic tokenization and credentialing capabilities that can move private markets into the digital age.

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