The Architecture of Settlement

Stablecoins, CBDCs, Tokenization, and Programmable Financial Infrastructure

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Abstract

This paper examines the structural transformation of financial systems through the lens of settlement infrastructure. While the first wave of payments innovation focused on improving access, speed, and user experience, it left the underlying mechanisms of settlement largely unchanged. A new phase is now emerging — defined not by incremental optimization, but by a redesign of how value is transferred, recorded, and governed.

The central argument is that the outcome of this transition depends not on technological capability alone, but on the governance choices that determine how these systems are structured, integrated, and scaled across jurisdictions. Settlement is becoming a core layer of system design — one that shapes how liquidity moves, how risks are managed, and how financial relationships are structured.

The analysis identifies three converging developments shaping this transition: the rise of stablecoins as privately issued settlement assets, the development of central bank digital currencies (CBDCs) as public alternatives, and the expansion of tokenized financial assets that integrate payment and asset transfer. Together, these represent competing architectures for programmable financial infrastructure — each embedding different assumptions about control, interoperability, compliance, and the role of public versus private actors.

The implications extend to financial institutions, asset managers, and policymakers, requiring new approaches to infrastructure participation, regulatory design, and strategic positioning.

Keywords: programmable finance; settlement infrastructure; stablecoins; CBDCs; tokenization; financial architecture; digital assets; payment systems; financial infrastructure; regulatory design; real-world assets (RWA)

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1. Introduction: The Argument This Paper Makes

The evolution of payments systems has entered a new phase. The first wave of transformation was defined by the digitization of existing processes — improving access, speed, and user experience through mobile interfaces, real-time payment rails, and API-driven (application programming interfaces) integration. While these developments delivered meaningful gains in efficiency and convenience, they left the underlying structure of settlement largely unchanged (Sing, 2019).

The current phase is structurally different. The focus is no longer on how payments are initiated or processed, but on how value is ultimately settled, recorded, and governed. What is emerging is not simply a more efficient payments system, but a redesign of the settlement layer itself, the infrastructure where transactions become final — meaning financial obligations are settled, ownership is transferred, and economic activity is legally completed.

This shift is driven by the convergence of three developments. First, stablecoins have introduced a form of privately issued, digitally native settlement asset capable of operating across jurisdictions with minimal friction. Second, central banks are exploring and deploying CBDCs as a means of preserving monetary sovereignty and maintaining control over settlement infrastructure (BIS, 2025). Third, the tokenization of financial assets is collapsing the distinction between payment and asset transfer, enabling the possibility of unified, atomic — meaning simultaneous and indivisible — settlement across asset classes (WEF, 2025). Figure 1 illustrates how these components map onto the layered architecture of the emerging settlement system.

These developments represent distinct but interrelated approaches to the redesign of settlement infrastructure. Stablecoins and CBDCs address the same function — serving as the digital cash leg of a transaction — through different governance models: one market-driven, one state-controlled. Tokenization operates at a different layer, integrating the asset leg into the same digital infrastructure. While their roles differ, the three interact: the viability of tokenized asset settlement depends on the availability of a compatible settlement asset, whether stablecoin, CBDC, or tokenized deposit. Each embeds different assumptions about control, interoperability, compliance, and the role of public versus private actors. The outcome is not predetermined, nor is it purely technological. It is fundamentally a question of governance and design — how legal, regulatory, and institutional frameworks shape the structure of financial infrastructure (IMF, 2024).

This paper argues that the transition underway should be understood not as an extension of fintech innovation, but as an infrastructure redesign problem. The analytical focus therefore shifts from products and interfaces to system architecture: who controls the settlement layer, how it operates, and under what rules value is transferred and obligations are settled.

The implications extend beyond payments. Settlement infrastructure underpins financial markets, liquidity management, and regulatory enforcement. As programmable technologies are

introduced into this layer, financial interaction itself begins to evolve — from discrete transactions toward conditional, automated processes embedded within infrastructure.

2. The Structural Shift: From Rails to Settlement Layer

The first wave of innovation in payments was concentrated at the interface and access layers. Mobile wallets, peer-to-peer platforms, and real-time payment systems reduced friction in how payments are initiated and experienced. Application programming interfaces enabled integration across services, while improvements in authentication and user experience accelerated adoption.

Despite these advances, the underlying settlement processes remained largely unchanged. Many payment transactions — while appearing instantaneous to users — continue to rely on legacy clearing and settlement systems operating on delayed or batch-based processes. This distinction between perceived speed and actual settlement finality — the point at which a payment becomes irrevocable and the recipient's ownership of funds is legally assured — remains a defining feature of modern financial systems (BIS, 2025).

As a result, core inefficiencies persist. Cross-border payments remain costly and slow due to reliance on correspondent banking networks and fragmented jurisdictional frameworks (World Bank, 2022). Liquidity is often trapped within siloed systems, requiring pre-funding and increasing capital costs. Reconciliation processes continue to introduce operational complexity and risk, as institutions must align records across multiple systems.

These constraints have shifted the focus of innovation toward the settlement layer itself. Rather than optimizing how payments are initiated, new models seek to redefine how they are completed — rethinking how obligations are settled, how settlement timing is determined, and how payment and asset transfer are integrated.

A defining feature of this emerging layer is programmability. Settlement systems are beginning to incorporate logic that allows transactions to be executed conditionally, automatically, and in coordination with other financial events. This introduces the possibility of atomic settlement, where the transfer of assets and payment occurs simultaneously, eliminating counterparty risk associated with asynchronous processes (WEF, 2025).

In this context, the settlement layer becomes a source of strategic value. Control over settlement infrastructure determines access, participation rules, and the economics of value transfer. It shapes how liquidity moves through the system, how risks are managed, and how new financial products are structured.

Figure 1: Settlement Architecture Stack

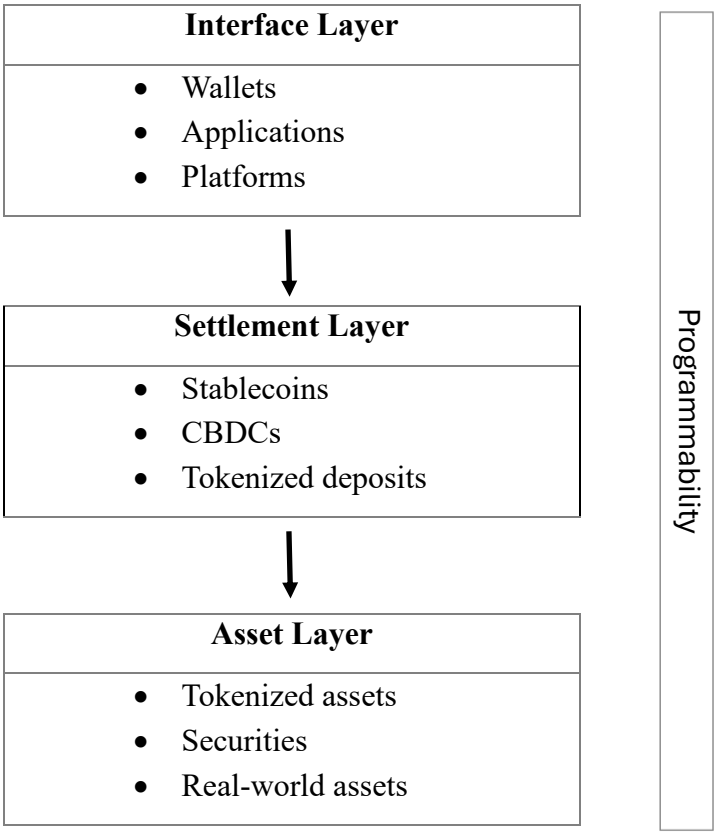

Figure 1: Settlement Architecture Stack. *The emerging financial system can be understood as a layered architecture consisting of interface, settlement, and asset layers. Stablecoins and CBDCs operate at the settlement layer, while tokenization expands the asset layer. Programmability spans across all layers, enabling conditional and automated financial processes.*

The shift from rails to settlement layer therefore represents a reordering of priorities. Where the previous phase emphasized user experience and accessibility, the current phase is defined by system architecture and control. The entities that shape this layer — whether private platforms, central banks, or financial institutions — are effectively defining the operating conditions of the next generation of financial infrastructure.

3. Stablecoins: Private Settlement Infrastructure

Stablecoins have emerged as a critical component of the evolving settlement layer, not because of their tokenized form, but because of the function they perform. At their core, stablecoins represent a digitally native settlement asset — denominated in fiat currency, transferable across networks, and capable of operating outside traditional banking rails. Their growth reflects a

demand for settlement mechanisms that are faster, more flexible, and more globally interoperable than existing systems (IMF, 2024).

Initially associated with cryptocurrency trading, stablecoins have expanded into a broader range of use cases, including decentralized finance, cross-border payments, and increasingly, institutional treasury and collateral management. This evolution reflects a shift in their role — from transactional convenience to infrastructure for value transfer. Stablecoins are functioning, in effect, as privately operated settlement systems.

Their significance lies in their ability to provide near-instant, always-available settlement across jurisdictions without reliance on correspondent banking networks. In traditional systems, cross-border payments involve multiple intermediaries, time zone constraints, and liquidity frictions. Stablecoins enable direct transfer of value between participants on a shared ledger, reducing settlement time and operational complexity (BIS, 2025).

However, the rise of stablecoins introduces structural tensions that extend beyond efficiency. As privately issued instruments that function as money-like assets, stablecoins challenge existing regulatory classifications and raise questions related to monetary sovereignty, financial stability, and systemic risk (FSB, 2023). The distinction between a payment instrument, a deposit, and a security becomes less clear as stablecoins are increasingly used for both settlement and store-of-value purposes.

From an architectural perspective, stablecoins embed a model of settlement that prioritizes flexibility, global accessibility, and programmability, but that operates with varying degrees of regulatory oversight. This creates a fundamental trade-off between innovation and control. While stablecoins enable new forms of financial activity by reducing friction, they also introduce dependencies on private issuers whose incentives may not fully align with broader policy objectives.

Regulatory responses have increasingly focused on formalizing oversight frameworks, including requirements related to reserve backing, redemption rights, and operational resilience. Approaches differ across jurisdictions, however, leading to fragmentation in how stablecoins are issued, regulated, and integrated into financial systems — with direct consequences for where stablecoin activity concentrates and how cross-border settlement networks evolve.

For financial institutions, stablecoins introduce a strategic question: whether to integrate with emerging private settlement infrastructure, compete with it, or develop institutionally controlled alternatives. These decisions involve not only technological considerations, but also regulatory positioning, balance sheet implications, and long-term control over transaction flows and client relationships.

Stablecoins are not simply an extension of digital payments. They represent a parallel settlement system — one that operates alongside, and increasingly in competition with, traditional financial infrastructure. Their continued development will play a significant role in shaping how value is transferred and how financial systems are structured going forward.

4. CBDCs and Public Settlement Infrastructure

Central bank digital currencies represent the public sector's response to the emergence of privately issued digital settlement assets. While stablecoins introduce a model of market-driven settlement, CBDCs are designed to preserve monetary sovereignty, maintain control over the settlement layer, and ensure that public money remains central to the functioning of financial systems (BIS, 2022).

CBDCs are best understood not as a single product, but as a design space. Central banks must make a series of interdependent decisions regarding structure, distribution, and system integration. These include whether the CBDC is retail or wholesale, account-based or token-based, and whether it is issued directly by the central bank or intermediated through financial institutions. Each choice carries implications for adoption, financial stability, and the role of existing intermediaries (IMF, 2024).

A central challenge in CBDC development is balancing innovation with institutional constraints. Central banks operate under mandates that prioritize financial stability, consumer protection, and systemic resilience. As a result, CBDC designs often incorporate safeguards to limit disintermediation of the banking system, prevent rapid deposit shifts, and ensure compliance with existing regulatory frameworks. These constraints can limit functional flexibility relative to privately issued alternatives.

Interoperability remains one of the most significant unresolved issues. While domestic CBDC systems may function efficiently within individual jurisdictions, cross-border integration is more complex. Differences in regulatory regimes, currency controls, and settlement conventions create barriers to interoperability. Multilateral initiatives — such as cross-border CBDC pilots — have begun to explore shared platforms and standards, but a scalable, globally interoperable framework has yet to emerge (BIS, 2022).

The strategic importance of CBDCs lies not only in their functionality, but in their role as instruments of policy. CBDCs allow central banks to shape the architecture of digital money, define access and participation rules, and embed regulatory requirements directly into settlement infrastructure. In this sense, CBDCs represent both a technological innovation and a governance mechanism.

Adoption will depend on whether CBDCs offer a compelling value proposition relative to existing alternatives. If perceived as less flexible or less interoperable than stablecoins or other digital settlement mechanisms, their use may remain limited to specific institutional or policy contexts. Conversely, well-designed CBDCs could provide a trusted and standardized foundation for digital settlement that integrates with both public and private financial systems.

For financial institutions, CBDCs introduce new considerations around liquidity management, infrastructure integration, and regulatory compliance. Institutions must assess how CBDCs interact with existing systems and how evolving policy frameworks will influence competitive dynamics across jurisdictions.

CBDCs highlight a core tension in the evolution of settlement infrastructure: the balance between public control and private innovation. Stablecoins demonstrate what is possible under market-driven models while CBDCs reflect the priorities and constraints of public institutions. The interaction between these approaches — whether competitive or complementary — will play a defining role in shaping the future architecture of financial systems.

5. Tokenization: Settlement Meets the Asset Layer

The development of tokenized financial assets introduces a structural shift that extends beyond payments and into the architecture of financial markets. While stablecoins and CBDCs address the settlement asset — the "cash leg" of a transaction — tokenization transforms the "asset leg," enabling financial instruments to be represented, transferred, and settled on digital infrastructure. The convergence of these layers collapses a long-standing separation within financial systems: the distinction between payment and asset settlement.

In traditional financial markets, the transfer of assets and the transfer of payment occur as coordinated but separate processes. Clearing and settlement systems manage these steps with time delays, intermediaries, and reconciliation mechanisms designed to mitigate counterparty risk. Tokenization introduces the possibility of atomic settlement, in which the exchange of assets and payment occurs simultaneously within a single system. This reduces settlement risk, shortens settlement cycles, and removes the need for many of the processes designed to manage asynchronous execution (WEF, 2025).

The implications extend beyond operational efficiency. By integrating asset and payment settlement into a unified process, tokenization changes how liquidity is managed within financial systems. Capital that would otherwise be locked in collateral or pre-funded accounts can be deployed more dynamically as settlement timing becomes more certain. This has the potential to reduce capital requirements, improve market efficiency, and enable new forms of financial activity that are not feasible under existing settlement constraints (BIS, 2025).

From an allocator's perspective, tokenization also alters how capital formation and distribution are structured. It introduces the possibility of more direct and flexible access to assets that have historically been constrained by operational complexity and limited distribution channels — with implications for how investment opportunities are originated, accessed, and scaled across different investor classes.

Tokenization further expands the scope of assets that can participate in digital settlement systems. While early applications have focused on bonds, funds, and other traditional financial instruments, the same infrastructure can be applied to a broader range of assets, including private markets, real estate, and other real-world assets. Institutional adoption has followed a predictable sequence: fund-based structures — particularly tokenized money market funds and government bond vehicles — have attracted early institutional participation because they inherit established

legal frameworks, governance arrangements, and fiduciary relationships (Sing, 2025). Project-level and bespoke real assets face structurally greater resistance (Sing, 2023; Sing, 2024).

However, the integration of tokenized assets introduces persistent challenges in legal recognition, custody, and regulatory treatment. Questions remain regarding the enforceability of ownership rights, the role of custodians, and the cross-border treatment of tokenized instruments. These are not transitional frictions — they are structural requirements that tokenization must satisfy before institutional capital can participate at scale. Regulatory frameworks are evolving, but remain uneven across jurisdictions and asset classes (FSB, 2023).

From an architectural perspective, tokenization reinforces the importance of interoperability across the financial stack. For tokenized assets to scale, they must integrate seamlessly with settlement assets — whether stablecoins, CBDCs, or tokenized deposits — and with systems governing identity, compliance, and market access. Fragmentation at any layer limits adoption and constrains the efficiency gains that tokenization promises.

Tokenization represents not merely a technological innovation, but a reconfiguration of financial system architecture. By integrating assets and settlement into a unified system, it extends the logic of programmable infrastructure beyond payments and into the core of capital markets.

6. Smart Contracts and Programmability

The defining feature that distinguishes emerging settlement infrastructure from legacy systems is programmability. While stablecoins, CBDCs, and tokenized assets introduce new forms of digital value, it is the ability to embed logic directly into financial transactions that transforms how these systems operate. Smart contracts provide the mechanism through which settlement becomes conditional, automated, and integrated into broader financial processes.

In traditional systems, payments are discrete actions that require initiation, verification, execution, and reconciliation across multiple parties. These steps are governed by institutional processes and often involve manual intervention or batch-based coordination. Programmability alters this structure by enabling the terms of a transaction to be encoded directly into the infrastructure. Payments can be executed automatically when predefined conditions are met, without external orchestration.

Table 1: Comparison of Settlement Components

Dimension	Stablecoins	CBDCs	Tokenized Assets
Issuer	Private	Public	Varies
Primary Function	Settlement	Settlement	Asset transfer
Control	Market-driven	State-controlled	Hybrid
Use Case	Payments / liquidity	Infrastructure	Capital markets
Key Constraint	Regulation	Adoption	Legal framework

Table 1: Comparison of Settlement Components. *Stablecoins, CBDCs, and tokenized assets represent distinct but interrelated components of emerging financial infrastructure, each with different roles, control structures, and constraints.*

This enables a shift from transactions as isolated events to transactions as components of broader financial contracts. Payments can be linked to the delivery of goods, completion of services, or fulfillment of contractual milestones. Escrow arrangements, conditional disbursements, and multi-party workflows can be implemented as embedded logic rather than managed processes. Financial execution becomes more integrated, responsive, and directly tied to outcomes.

Programmability also changes the nature of settlement. In systems that support smart contracts, settlement can occur automatically as part of transaction execution, eliminating the need for subsequent reconciliation. There is no divergence between transaction intent and recorded outcome. The concept of atomic settlement — introduced in the context of tokenization — becomes operational at scale (WEF, 2025).

The role of intermediaries is correspondingly reshaped. Functions such as verification, processing, and coordination — historically performed by centralized actors — can be partially embedded within infrastructure. This does not eliminate intermediation, but shifts its form. Intermediaries increasingly move from executing transactions to defining, auditing, and governing the logic through which transactions occur.

One of the most significant implications of programmability is its impact on compliance. In traditional systems, compliance is applied externally through monitoring and reporting. Programmable infrastructure enables compliance requirements to be embedded directly into transaction execution. Rules related to identity verification, transaction limits, and regulatory reporting can be enforced automatically, increasing transparency and reducing reliance on post-hoc enforcement (FATF, 2021).

However, embedding compliance into infrastructure introduces new governance challenges. Decisions about which rules are encoded, how they are updated, and who has authority over them become central questions. Unlike traditional systems — where policies can be modified through institutional processes — changes to programmable systems may require coordination

across technical, legal, and regulatory domains — the first governing property rights and contractual enforceability through statute and courts, the second governing supervisory standards through agency rules and guidance. The question of who governs the logic embedded in settlement infrastructure is distinct from, and in many ways more consequential than the question of who regulates the institutions that use it. This is because infrastructure governance shapes outcomes at the system level, whereas institutional regulation shapes the behavior of individual actors within it.

Programmability represents the layer at which the components of emerging settlement infrastructure converge. Stablecoins provide the means of transferring value, CBDCs define the role of public money, and tokenization integrates assets into the system. Programmability binds these elements together, enabling them to operate as a cohesive and automated financial architecture.

The significance of smart contracts lies not in their technical novelty, but in their ability to redefine how financial systems function. By embedding logic into infrastructure, programmability transforms settlement from a process into a system — one in which the transfer of value, execution of agreements, and enforcement of rules are integrated within a single operational framework.

7. Implications for Institutions and Policymakers

The emergence of programmable settlement infrastructure redefines not only how financial transactions are executed, but how institutions and policymakers must position themselves within the financial system. The shift from payments as a service to settlement as infrastructure introduces a set of strategic considerations centered on control, participation, and governance of the underlying architecture.

7.1 Positioning within the infrastructure stack

A central strategic question is where to position within the evolving financial stack — the three-layer architecture illustrated in Figure 1. Control of the interface layer enables ownership of the customer relationship and data. Control of the settlement layer defines access, participation rules, and the economics of value transfer. The asset layer, increasingly shaped by tokenization, determines how financial products are structured and distributed.

Historically, many institutions operated across multiple layers. Increasing specialization and technological complexity are forcing more explicit positioning decisions. Institutions must determine whether to compete for control of one or more layers or to participate through partnerships and ecosystem integration — choices that carry direct implications for capital allocation, regulatory exposure, and long-term strategic relevance.

7.2 Rethinking build, buy, and partner strategies

Traditional strategy frameworks — build, buy, or partner — remain relevant but must be reinterpreted in the context of infrastructure. The relevant question is no longer whether to develop a product or acquire a capability, but whether to participate in the construction of foundational systems.

Building internal infrastructure capabilities provides greater control but requires sustained investment and technical expertise. Partnering or investing in external platforms accelerates access but may introduce dependencies on third-party infrastructure and limit strategic flexibility. Institutions are increasingly adopting hybrid approaches — combining internal development with selective partnerships and targeted investments in emerging infrastructure platforms. The effectiveness of these strategies depends on a clear prior determination of which layers of the stack are strategically non-negotiable and which can be shared or outsourced.

7.3 Compliance as a design variable

Programmable infrastructure transforms compliance from an external constraint into an internal design variable. Institutions that engage early in infrastructure design can influence how compliance is implemented — potentially reducing operational burden while improving consistency and auditability. Regulators themselves have become participants in system design, shaping the rules encoded into infrastructure rather than just supervising outcomes after the fact (FATF, 2021).

The boundary between technology design and regulatory policy becomes increasingly difficult to maintain. Effective positioning requires not only technical capability, but the ability to engage with regulators and contribute meaningfully to the development of standards and frameworks before those frameworks are set.

7.4 Jurisdictional competition and infrastructure strategy

The development of programmable settlement infrastructure is shaped by jurisdictional policy choices. Regulatory clarity, licensing frameworks, and institutional support for innovation all shape where infrastructure is developed and where activity concentrates.

Jurisdictions that move early to establish clear and workable frameworks for stablecoins, CBDCs, and tokenized assets are better positioned to attract capital, talent, and institutional participation. Those with fragmented or uncertain regulatory approaches risk ceding influence over infrastructure design to others (IMF, 2024). This dynamic creates competition not only for financial activity, but for control over the standards and architectures that underpin it — with long-term implications for financial centers and cross-border capital flows.

7.5 Strategic implications for financial institutions and asset managers

For financial institutions and asset managers, programmable settlement and tokenization introduce both opportunities and structural risks. More efficient settlement mechanisms can

reduce costs, improve liquidity management, and enable new forms of product design. At the same time, changes to market infrastructure may disrupt existing roles — particularly in clearing, custody, and distribution.

The distinction between financial institutions, infrastructure providers, and technology platforms is becoming less clear. Institutions that have historically operated as intermediaries may increasingly participate in infrastructure design, while technology platforms increasingly assume functions traditionally associated with financial institutions — originating credit, holding deposits, and distributing financial products — often operating under lighter regulatory frameworks than incumbent banks. Alibaba and Tencent in China, and Apple, Google, and Amazon in the United States, illustrate this convergence most visibly. This convergence is not unique to payments — it is the same structural dynamic observed across tokenized asset markets, where the boundaries between asset management, market infrastructure, and settlement are already being redrawn (Sing, 2023). BlackRock's BUIDL fund, which settles subscriptions and redemptions in USDC on-chain, and Franklin Templeton's FOBXX, which records share ownership on a public blockchain, illustrate how asset managers are embedding settlement infrastructure into product design — a function previously delegated entirely to custodians and clearinghouses.

Institutions must evaluate how these developments affect their core business models: how assets are issued and distributed, how liquidity is sourced and managed, and how client relationships are maintained when infrastructure plays a more central role than product. This requires a broader view of competitive positioning — one that accounts for participation in the governance of the underlying system, not only for the products and services built on top of it.

7.6 The strategic imperative

A defining characteristic of infrastructure transitions is that early design decisions have long-lasting effects. Once standards are established and systems achieve scale, they become difficult to change. Institutions that engage early — through pilot programs, partnerships, and infrastructure investment — are more likely to shape outcomes in ways aligned with their strategic interests. Those that delay participation will risk reduced influence over the system design at precisely the moment when the foundational choices are being made.

For policymakers, the challenge is to balance innovation with system stability — not only setting regulatory frameworks, but engaging with market participants to understand emerging models and to design systems that support both efficiency and resilience. The governance of programmable infrastructure is not a downstream regulatory question. It is a design question that must be addressed before systems achieve the scale where governance becomes difficult to change.

8. Conclusion: The Architecture of Settlement

The transformation of financial systems has moved beyond the digitization of payments and into the redesign of settlement infrastructure. What began as improvements in access and user experience has evolved into a structural shift in how value is transferred, recorded, and governed.

Stablecoins, CBDCs, and tokenized assets represent distinct but interrelated approaches to this transformation. Stablecoins demonstrate the viability of privately issued, digitally native settlement assets. CBDCs reflect the public sector's effort to maintain control over monetary infrastructure. Tokenization extends these developments into financial markets, integrating assets into programmable settlement systems. Programmability binds these elements together, enabling conditional, automated, and integrated financial processes.

These developments are best understood not as isolated innovations, but as components of a broader transition toward programmable financial infrastructure. In this model, settlement becomes a core layer of system design — shaping how liquidity moves, how risks are managed, and how financial relationships are structured.

The outcome of this transition will depend less on technological capability than on the governance choices that shape how these systems are designed, integrated, and adopted. Decisions regarding regulatory frameworks, interoperability standards, and infrastructure design will determine which models achieve scale and how financial systems evolve across jurisdictions. Technology determines what is possible. Governance determines what endures.

For institutions, strategy must extend beyond products and services to include participation in infrastructure development. For policymakers, the challenge is to design systems that balance innovation with stability — enabling new forms of financial activity while preserving trust and resilience.

As digital assets, tokenized instruments, and programmable systems continue to converge, the boundaries between payments, markets, and infrastructure will become increasingly blurred. The architecture of settlement will define not only how transactions occur, but how financial systems function — and who shapes the rules they operate by.

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