Project Simbolon

under the Memorandum of Understanding
between the Deutsche Bundesbank
and Monetary Authority of Singapore

Cross-Border FX Settlement Connectivity Across Independent Digital Infrastructures











Insights from the Deutsche Bundesbank–Monetary Authority of Singapore collaboration

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As financial markets become increasingly digital, interconnected and operate across longer shared time windows, interoperability between settlement infrastructures across borders and currencies will be critical to supporting safe and efficient transactions across products, markets and networks. For cross-border settlement, this is not simply about greater speed, but greater certainty in settlement, effective risk management and more precise use of liquidity. Enhanced connectivity between trusted, independently governed settlement infrastructures can support cross-border settlement arrangements without requiring reliance on a single platform or jurisdiction.

This Insights Note presents key takeaways from a proof-of-concept conducted by the Deutsche Bundesbank and the Monetary Authority of Singapore, together with Deutsche Bank and DBS as participating commercial banks and Partior as their technology provider. The project explored how zero-knowledge (ZK) proofs could support atomic EUR/SGD payment-versus-payment (PvP) settlement using wholesale central bank digital currencies (CBDCs) across independent distributed ledger technology (DLT)-based settlement environments.

This collaboration lays the groundwork for stronger settlement connectivity between the euro area and Singapore, supporting cross-border funding and investment while preserving independent governance of participating infrastructures. The EUR/SGD corridor could also serve as a blueprint for wider connectivity between European and Asia-Pacific markets.

Connecting independent digital settlement environments

The future financial system is unlikely to run on a single platform or technology. Central bank and private-sector settlement infrastructures will continue to evolve across different technologies, forms of money and institutional arrangements. Advancing interoperability across these infrastructures can support transactions across markets and networks.

The proof-of-concept tested whether ZK proof technology could support atomic EUR/SGD PvP settlement using wholesale CBDCs across the two central bank DLT-based test environments. Following the matching of settlement instructions, the PvP settlement process began by locking the tokens in escrow on both ledgers. Once both locks had been verified, a single settlement decision was recorded and proven to each ledger, enabling the release of the locked assets on both. Instead of relying on the attestation of a trusted intermediary or a shared ledger, the project used an interoperability mechanism based on ZK proofs to verify that each lock had been recorded and finalised on its ledger.

This ZK proof-based approach enabled both currency legs to be coordinated to a single settlement outcome while remaining on their respective central bank test environments. The proof-of-concept demonstrated a potential route to cross-border PvP settlement without a shared ledger or direct bilateral link between the two central bank ledgers. Each central bank retained control over its own ledger and settlement requirements.



Supporting cross-border funding and liquidity needs

Project Simbolon considered two illustrative use cases to examine how the settlement approach tested could support cross-border funding and liquidity needs of financial institutions operating across different markets and time zones.

Liquidity conditions and settlement windows in FX markets vary throughout the operating day. The timing of settlement can therefore affect when financial institutions need to source, position and commit liquidity. The two use cases consider how this settlement approach could support more effective liquidity management while mitigating principal risk through PvP settlement.

- **Funding securities transactions across time zones under shorter settlement cycles.** Investors purchasing securities in another market must obtain and position the required settlement currency within the applicable settlement timeframe. As settlement cycles shorten, the time available to execute and settle the associated FX transaction becomes increasingly compressed. PvP settlement across extended operating hours could allow the required currency to be committed closer to the point of securities settlement, reducing the need to secure liquidity in advance through credit facilities or pre-positioned funds.

- **Managing temporary intraday liquidity needs.** A financial institution may require additional liquidity in a currency for part of the operating day before returning to a surplus position. An intraday FX swap could provide the required currency and then reverse the transaction later that day, aligning the period for which liquidity is obtained more closely with the duration of the underlying need. This could support more efficient balance sheet and liquidity management by limiting overfunding, shortening the period for which funds are committed and reducing the associated earnings drag.

Key takeaways from the proof-of-concept

- **Atomic PvP settlement across independent DLT-based test environments.** The experiment demonstrated that two wholesale CBDC settlement legs could reach a common settlement outcome across separate central bank test environments while each currency remained on its respective ledger.

- **Proof generation was the main contributor to settlement time.** In the test environment, the generation of ZK proofs accounted for most of the end-to-end settlement time. Optimising proof generation could materially reduce settlement time in future implementations.

- **Finality is not solely determined by the technical design of the ledger.** The basis for determining finality on each ledger also depends on the requirements of each central bank. Any future implementation would need to establish how the settlement outcome is recognised as final under the applicable legal frameworks.

- **The ZK proof-based approach retains key operational dependencies.** Relayers and provers remain necessary to generate and transmit proofs, while proof generation depends on access to relevant ledger data. Any future implementation would require appropriate governance and operating arrangements for these functions and the necessary data access.



Looking ahead

The proof-of-concept has demonstrated technical feasibility in a controlled environment. Building on this bilateral collaboration, future work could examine the potential for broader settlement connectivity between Europe and the Asia-Pacific region.

Wider application of the settlement approach tested will require further assessment on how effectively it can address the funding and liquidity needs illustrated in this Note, together with the legal, regulatory, operational and governance requirements identified through the experiment. Future work could also examine the conditions under which this settlement approach could be extended to additional infrastructures and currencies.

A detailed report, to be published on Wednesday, 18 November 2026, will provide the detailed analysis underpinning these insights, including the business use cases, technical solution, testing undertaken and key findings. It will also set out areas for further exploration as the collaboration progresses.