Testing the New Approach to Wholesale Central Bank Settlement

Use Case of Connecting Axiology DLT Trading and Settlement System with Real-Time Gross Settlement System to Facilitate Government Bond Transactions

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Axiology

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Glossary

CBM – Central Bank Money

DLT – Distributed Ledger Technology

ECB – European Central Bank

EU – European Union

FMI – Financial Markets Infrastructure

TARGET – Trans-European Automated Real-time Gross Settlement Express Transfer system

TIPS – Target Instant Payment Settlement

TSS – Trading and Settlement Systems

UTEST – User Testing

WCBDC - Wholesale Central Bank Digital Currency

Executive Summary

The Eurosystem has recently conducted an experiment to explore the use of distributed ledger technology (DLT) for wholesale financial transactions, including wholesale central bank digital currency (wCBDC). This initiative evaluated DLT's potential to enhance efficiency, reduce costs, and drive innovation in financial markets through tokenisation and programmable assets.

The urgency of this initiative is high because most market stakeholders surveyed by the Eurosystem expect a significant uptake of DLT for wholesale payments and securities settlement in the coming years.

Against this backdrop, facilitating the settlement of wholesale financial transactions in central bank money may soon require either having a form of money that could be used as an on-chain settlement asset (wCBDC) or bridging solutions. One such approach, the Deutsche Bundesbank's Trigger Solution, was tested to enable interoperability by linking TARGET2 with eligible market DLT platforms, exploring a potential approach for a gradual transition to DLT-based infrastructure.

Axiology, a Lithuanian capital markets infrastructure provider, successfully participated in the experiment. The company tested its blockchain-based trading and settlement system for the primary distribution, coupon payments, and redemption of bonds, with simulated government debt securities as the primary focus. The testing was conducted using the ISO 20022 format in T2 UTEST, the testing environment of the Eurosystem's TARGET payment system, where simulated cash settlements were processed. A high-level framework of the test is presented in Picture 1.

Picture 1. Scheme of Axiology's participation in the Eurosystem wholesale DLT experimentation

Key findings from Axiology's test:

- Transaction success rates of up to 100% across all 138 processed transactions, divided into three use cases (primary distribution, coupon payment, and maturity redemption).
- Parallel processing significantly improved efficiency, reducing execution time by 2–3 times compared to sequential processing.
- Cash settlement was the primary source of latency, accounting for 60–70% of total processing time, with delays ranging from 40 to 250 seconds.
- Interoperability with TARGET2 via the Trigger Solution was successfully demonstrated, confirming the feasibility of bridging DLT-based and traditional financial infrastructure.

1. Introduction and Background

The ECB has explored the potential use of DLT to settle wholesale financial transactions within the Eurosystem. Specifically, it aimed to explore new technologies for wholesale central bank money (CBM) settlement, which include potential future usage of wCBDC.

By conducting the work on DLT settlement solutions, the Eurosystem pursued several objectives:

- To consolidate and further develop ongoing work of Eurosystem central banks in DLT settlement solutions.
- To gain insights into how different solutions could facilitate interaction between TARGET Services and DLT platforms.
- To meet market demand for central bank money solutions for the entities operating under the DLT Pilot Regime, which entered into application in March 2023. (Learn more about the topic on the ECB website)

Axiology was one of only two entities operating under the EU's DLT Pilot Regime Regulation, which were selected to participate in the Eurosystem's experimentation. Within the experiment, the focus was on Axiology's blockchain-based trading and settlement system (Axiology DLT TSS), which was used for the simulated settlement of primary distribution, coupon payments, and maturity redeption of bonds.

Axiology used Deutsche Bundesbank's Trigger Solution to simulate the cash settlement of the transactions. The central bank of Lithuania, Lietuvos bankas (Bank of Lithuania), also played a role by providing the test accounts on the T2 UTEST (the test environment of the Eurosystem's payment system TARGET) for the Axiology experiment.

2. Emergence of DLT Arrangements as a Novel Type of Financial Market Infrastructure

Traditional financial market infrastructures (FMI) serve three primary economic functions: reducing information and transaction costs, promoting risk-sharing, and improving resource allocation and economic welfare. However, a significant challenge facing current FMIs is their friction, often caused by a lack of interoperability, fragmented processes, and differing legal and technical frameworks, particularly in cross-border contexts.

The ECB has been exploring ways to modernise the Eurosystem infrastructure, including experimentation with tokenised assets on programmable platforms. This platform type shows potential value in supporting multiple asset types and integrating key financial functions, such as payments, securities settlement, and collateral management. For now, the Eurosystem's work remains exploratory, focusing on assessing feasibility, efficiency, and interoperability with existing systems.

DLT FMIs have the potential to offer:

- **Enhanced efficiency.** Programmability enables the automated execution of agreements, reducing the need for intermediaries and offering a shared, decentralised ledger as a single source of truth.
- **Reduced costs.** Shorter value chains, less third-party involvement, and fewer reconciliations contribute to lower costs, while automation reduces administrative and error-resolution expenses.
- **New market opportunities.** Tokenisation is better for handling fractional ownership and enhancing liquidity, while programmable finance can expand the universe of possible contracting outcomes, e.g. through the use of programmable money.

Despite all the potential benefits DLT FMIs can bring, they currently face compatibility issues with traditional settlement assets (both central bank money and commercial bank money). Stablecoins are attempting to fill this gap by bridging traditional infrastructure with DLT FMIs and acting as a new type of settlement asset. Tokenised commercial bank money and wCBDC are also intended to act as links, smoothing the transition between the mentioned infrastructures, and the experiment Axiology participated in is one of the instruments used to make this possible.

3. Axiology - Trigger Solution set up During the Eurosystem's Experimentation

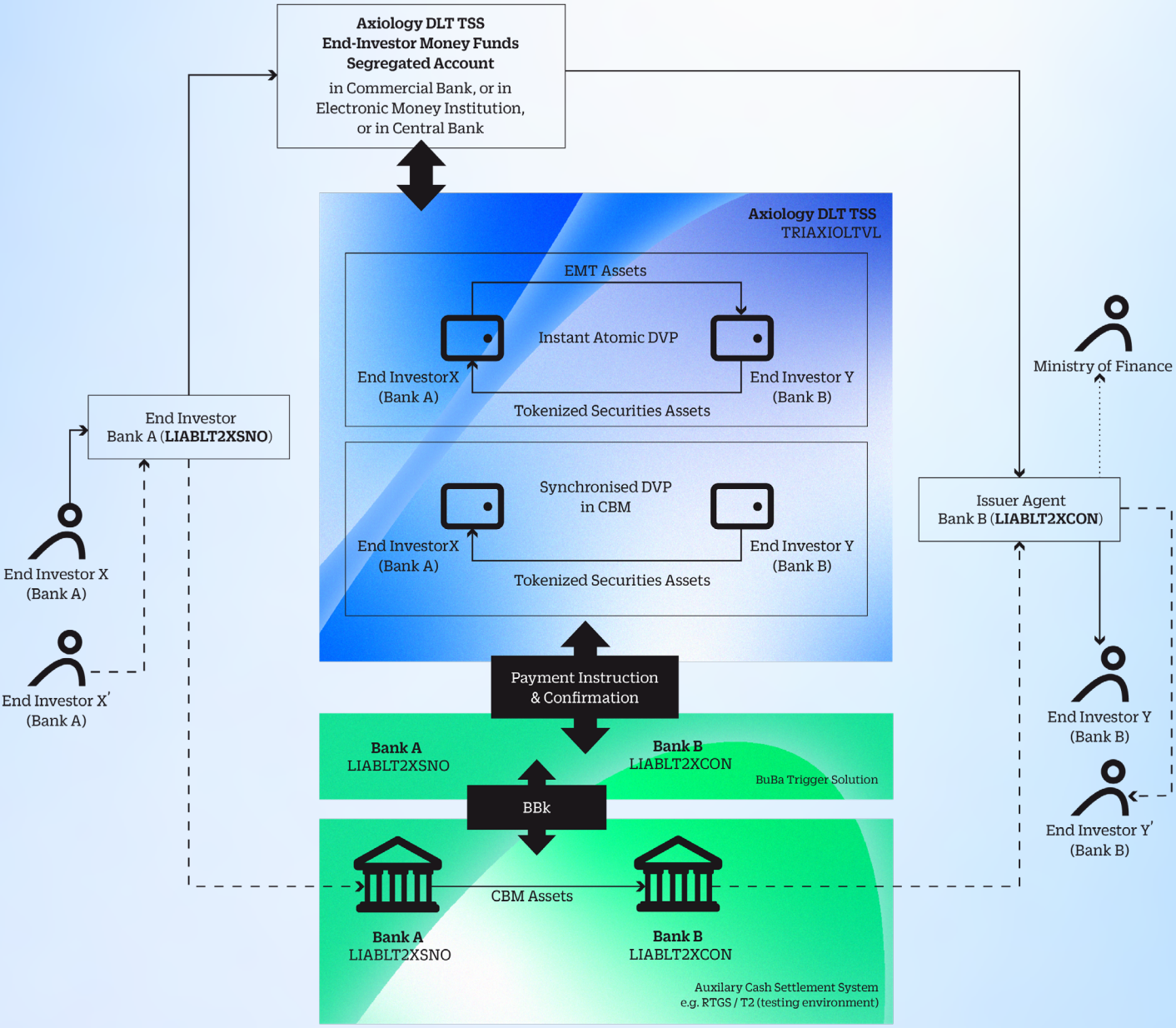
During the wholesale central bank money settlement experimentation, the Eurosystem provided three interoperability-type solutions: full DLT operability solution, TIPS Hash-Link, and Trigger Solution. Axiology's test on the settlement of bonds was a part of the Deutsche Bundesbank's Trigger Solution.

The Trigger Solution is a technical solution developed by Deutsche Bundesbank together with Deutsche Börse Group and Germany's Finance Agency to enable the settlement of transactions using CBM. It is a technical bridge between TARGET2 (T2) and eligible market DLT platforms. The arrangement was created in response to the increasing demand for central bank money to be used in settlement for transactions initiated on the market DLT platforms, aiming to reduce certain risks related to such transactions. It supports the gradual adoption of DLT without requiring an immediate overhaul of central banking infrastructure.

The Trigger Solution creates a technical interface where funds for the cash leg are "locked" in the central bank payment system (e.g., TARGET2 or TIPS) until specific conditions, verified by the DLT system, are met. Once the conditions are satisfied, the locked funds are released to complete the payment. The solution allows participants to connect through APIs or by hosting their nodes, facilitating integration with DLT-based and traditional financial systems.

A more detailed representation of the process, as experienced by Axiology during Eurosystem's experimentation, is shown in Picture 2. It illustrates two ways in which money from the end investor's bank (Bank A) can reach the issuer agent's bank (Bank B). If the process does not involve central bank money (CBM), the funds are routed through Axiology DLT TSS without any interference from TARGET2 or the Trigger Solution.

However, if the transfer involves CBM, Axiology initiates the process by reserving assets in the investor's wallet and sending a signal to the Trigger Solution. This triggers a verification process between the Trigger Solution and TARGET2. Intermediaries are required because CBM assets are stored in investors' representative banks, which are part of TARGET2. The confirmation process concludes when the Trigger Solution sends Axiology a signal to either release the reserved funds or return them.



Picture 2. The setup used by Axiology during its participation in the Eurosystem's exploratory work on settlement in central bank money using new technologies.

4. Government Bond Use Cases Tested by Axiology

During the Eurosystem's experiment conducted by Axiology, 138 simulated transactions were proposed. Of these, 92 were Delivery versus Payment (DvP) transactions involving synchronized settlement on securities settlement and payment platforms (Trigger Solution – T2 UTEST), and 46 were payment transfers related to assets accounted for on Axiology DLT TSS platform (coupon payments).

The transactions covered three use cases: primary bond distribution, coupon payment, and maturity redemption. Each contained four separate transaction batches, all with their ISINs. The batches differed in the number of transactions (from 9 to 14) and how they were processed (parallel and sequential processing modes).

On the test platform of Axiology DLT TSS, 15 wallets of simulated end investors were created in connection with two mock participants of Axiology DLT TSS. One of the mock-up participants acted as an issuer agent (and managed the issuer wallet), and the second participant represented 14 end investors.

The Bank of Lithuania has linked these Axiology DLT TSS mock-up participants to the Bank of Lithuania's two pilot accounts in the T2 UTEST (the test environment of the Eurosystem's payment system TARGET). As a third party, Axiology DLT TSS simulated the primary distribution, coupon payment, and final redemption operations between the mentioned parties.

The processing of each transaction involved six steps, which were executed sequentially in Axiology DLT TSS and Payment Platforms (Trigger Solution - T2 UTEST), namely:

1. **Trade is agreed** (Auction results processing initiation, Redemption initiation, Coupon payment initiation) / (DLT TSS)
2. **The asset is locked** (Sec. is locked in Escrow account) / (DLT TSS)

3. **The payment instruction is prepared** / (Payment Platform)
4. **Payment instructions are approved and submitted** / (Payment Platform)
5. **Payment status changes to “Completed”/”Failed”** / (Payment Platform)
6. **The asset is released in the market DLT platform / Burning** / (DLT TSS)

5. Axiology Experiment Results

The results of the experiment conducted by Axiology demonstrated a success, with 100% of all 138 processed transactions successfully completed. These transactions were divided into three distinct use cases: primary distribution, coupon payment, and maturity redemption. This high success rate reflects the robustness and efficiency of the process, providing valuable insights into the feasibility of using new technologies for wholesale central bank money settlement.

It is important to consider the detailed latency metrics that highlight individual and average transaction timings to provide a clearer understanding of transaction performance. All detailed quantitative data related to the individual latency of each transaction, as well as the average latency of the executed transactions, are presented in the Annex.

In the experiment, all transactions adhered to the DvP and atomicity principles. Although the process is technically instantaneous, it operates below current market standards for instant paymen. The average processing time for a single transaction, spanning steps 1 to 6, exceeds 10 seconds, regardless of whether the method is parallel or sequential. The total time required for the cash settlement leg (steps 3, 4, and 5) ranges from 40 to 250 seconds, with step 5—”Payment status changes to Completed/Failed”—taking the longest, at 30 to 120 seconds. Processing on Axiology DLT TSS platform (steps 1, 2, and 6) also shows room for improvement, with durations ranging from 22 to 100 seconds.

A consistent finding is that the cash leg takes longer than the securities settlement leg, accounting for approximately 60-70% of the total processing time. While pinpointing the exact cause of this delay is challenging, several communication stages—Axiology Trigger Solution, Trigger Solution-T2, T2-Trigger Solution, and Trigger Solution-Axiology—may contribute to the extended duration.

These results highlight key system inefficiencies, which Axiology is actively addressing. By allocating appropriate technical resources to the securities asset accounting side,

we expect to significantly improve processing times on Axiology DLT TSS platform. Additionally, we aim to explore opportunities to enhance the reliability of communication channels with the payment system and to potentially reduce dependence on public internet infrastructure.

Based on the results, parallel processing is two to three times faster for overall transaction batch execution than sequential processing. However, for individual transactions, sequential processing remains up to three times more efficient.

6. Conclusions and the Road Ahead

The Eurosystem's experimentation with DLT for wholesale financial transactions has highlighted the transformative potential of this technology for financial market infrastructures. Axiology, as an eligible market DLT platform, participated successfully in the initiative. From this valuable experience, several key insights have emerged:

1. **DLT as a Viable Financial Infrastructure:**
   The testing validated that DLT-based systems, like Axiology DLT TSS, can manage the entire lifecycle of bonds. This includes primary distribution, coupon payments, and maturity redemption.
2. **Interoperability with Traditional Systems:**
   The Trigger Solution effectively bridged market DLT platforms with TARGET2, proving that gradual integration of DLT into traditional FMIs is feasible without requiring an immediate overhaul of central banking infrastructure.
3. **Challenges and Adaptability:**
   Initial issues, including VPN bandwidth limitations and blockchain instability, highlighted the technical hurdles associated with DLT implementation. However, these challenges were resolved through system upgrades, demonstrating the potential for adaptability of DLT infrastructure.
4. **Insights for Future Development:**
   Axiology will use the experience gained to inform the further development of Axiology DLT TSS. Soon, Axiology plans to use euro-denominated e-money tokens as a settlement asset and to transition to settlement using central bank money once it becomes available for DLT market operators in non-experimental settings.

Annex

Batch #	Processing mode	Number of Operations	Latency of the full process, ms	Average latency of a single transaction, ms
Primary Distribution				
1st	Parallel	9	218 242	191 261
2nd	Sequential	9	691 201	76 800
3rd	Parallel	14	372 701	313 001
4th	Sequential	14	1 027 646	73 403
Coupon Payment				
1st	Parallel	9	241 744	229 701
2nd	Sequential	9	440 124	48 903
3rd	Parallel	14	393 884	381 537
4th	Sequential	14	670 727	47 909
Maturity Redemption				
1st	Parallel	9	205 331	169 162
2nd	Sequential	9	628 178	69 798
3rd	Parallel	14	318 239	255 096
4th	Sequential	14	962 707	68 765