

Implementation Models for Banks in the Context of the Digital Euro

Research Focus

This thesis investigates the technical architecture and system integration challenges required to connect commercial bank back-ends to the Eurosystem's Digital Euro Service Platform (DESP). It specifically examines the critical integration pathways, including API selection (REST vs. gRPC), data model mapping (linking internal customer IDs to pseudonymous Digital Euro Account Numbers/DEANs), and the automation of Dedicated Cash Account (DCA) liquidity management.

Furthermore, the research analyzes the processing of advanced functionalities such as conditional payments and the complex synchronization required for offline transactions. It evaluates architectural patterns—specifically microservices versus monolithic integration—to determine their impact on system latency, security, and maintainability. The ultimate goal is to provide technical blueprints and strategic recommendations for High, Mid, and Low-tier banks to implement the Digital Euro in a cost-efficient, scalable, and compliant manner, leveraging In-house, Vendor, or Hybrid models.

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1. Introduction

1.1. Background & Motivation:

- 1.1.1. The evolution of the Digital Euro project from investigation to the preparation phase.
- 1.1.2. The role of the Intermediary (PSP) is the bridge between the end-user and the Eurosystem's settlement infrastructure.
- 1.1.3. The technical imperative: Banks must integrate with the DESP while maintaining high resilience and low latency.

1.2. Problem Statement:

- 1.2.1. Banks face a "trilemma" of ensuring compliance with the Single Rulebook, managing massive investment costs (estimated at up to €18bn for the sector), and selecting a technical architecture that is future-proof.
- 1.2.2. There is a lack of clarity on how to map legacy core banking systems to the new DESP requirements.

1.3. Research Objectives & Questions:

1.3.1. Primary Question:

- 1.3.1.1. How can banks architect their back-end systems to integrate with the DESP effectively while balancing cost, performance, and strategic control?

1.3.1.2. Sub-Questions:

- 1.3.1.2.1. What are the comparative technical advantages of REST vs. gRPC interfaces for high-volume Digital Euro transaction processing?
- 1.3.1.2.2. How should Dedicated Cash Accounts (DCA) and Waterfall/Reverse Waterfall mechanisms be automated within the bank's treasury and ledger systems to ensure 24/7 liquidity?
- 1.3.1.2.3. What are the specific architectural challenges of synchronizing offline transactions (secure elements) with the online ledger?
- 1.3.1.2.4. How do Bank Tiers (Size) influence the choice between In-house, Outsourced, or Hybrid implementation models?
- 1.3.1.2.5. To what extent can market synergies and shared infrastructure reduce the implementation burden for Mid and Low-tier banks?

2. Theoretical Framework & The Digital Euro Ecosystem

2.1. The DESP Architecture:

- 2.1.1. Analysis of the High-Level Functional Architecture.
- 2.1.2. The separation of the User Domain (Bank responsibility) and the Eurosystem Domain (DESP responsibility).

2.2. The Single Rulebook Technical Standards:

- 2.2.1. Overview of the Rulebook's functional and non-functional requirements.
- 2.2.2. Standards for Access Management, Liquidity Management, and Transaction Management.

3. Bank Categorization (Tiers) & Differentiation Parameters

3.1. Parameters for Differentiation:

- 3.1.1. Total Assets: Used as the primary proxy for IT budget and complexity capabilities.
- 3.1.2. IT Landscape: Legacy monolithic systems vs. modern agile stacks.
- 3.1.3. Transaction Volume: High-frequency processing needs.
 - 3.1.3.1. What are the other parameters?

3.2. Definition of Bank Tiers (Based on ECB/PwC Analysis):

- 3.2.1. High Size (Tier 1): Banks with >€100 Billion in total assets. These banks typically have complex legacy IT, high internal development capacity, and a strategic need for proprietary UX differentiation.
- 3.2.2. Mid-Size (Tier 2): Banks with €30 Billion – €100 Billion in total assets. These often rely on standard software packages (e.g., Temenos, Avaloq) or partial outsourcing.

3.2.3. Low Size (Tier 3): Banks with <€30 Billion in total assets. These banks heavily rely on full-stack banking vendors or cooperative central providers due to limited IT staff.

4. Analysis of Implementation Models

4.1. Model A: In-House Integration (Proprietary):

4.1.1. Definition: The bank builds its own Digital Euro Gateway directly connecting to the DESP.

4.1.2. Pros: Full control over data, custom UX, no vendor lock-in, direct DCA management.

4.1.3. Cons: High CAPEX/OPEX, responsibility for all certification/compliance.

4.1.4. Target Audience: Primarily large-sized banks.

4.2. Model B: Vendor/Outsourcing (D€aaS - Digital Euro as a Service):

4.2.1. Definition: The bank connects to a Payment Processor (e.g., Worldline, Nexi), which acts as the "Instructing Party" to the DESP.

4.2.2. Pros: Speed to market, shared compliance burden, lower upfront cost (OpEx model).

4.2.3. Cons: Loss of control over the "last mile" UX, dependency on vendor roadmaps.

4.2.4. Target Audience: Primarily small-sized banks.

4.3. Model C: Hybrid Collaborative Model:

4.3.1. Definition: Banks (e.g., Savings Banks, Cooperatives) share a central IT provider (e.g., Atruvia, Federcasse) for the "commodity" connection layers but retain some control over the frontend app.

4.3.2. Pros: High synergies (up to 90-98% cost savings for the group), robust infrastructure.

4.3.3. Target Audience: Mid-size banks and Cooperative networks.

5. Technical Architecture & Back-End Integration

5.1. Connectivity & Interface Design:

5.1.1. REST API: Analysis of current standards (v1/v2/v3) for onboarding and basic flows.

5.1.2. gRPC: Evaluating gRPC for high-performance, low-latency settlement instruction, and its advantages over REST.

5.2. Data Model & Identity Management:

5.2.1. Pseudonymization: Architecture for mapping internal Customer IDs to Digital Euro Account Numbers (DEANs) and Aliases.

5.2.2. Privacy Layer: Designing the "Privacy Proxy" to ensure no PII reaches the DESP.

5.3. Liquidity Management Architecture:

- 5.3.1. Automated Liquidity Bridge: Designing the logic to trigger Reverse Waterfall (auto-funding from commercial accounts) in milliseconds to prevent transaction failures.
- 5.3.2. DCA Monitoring: Systems for 24/7 monitoring of the Dedicated Cash Account at the central bank.

5.4. Advanced Functionality Implementation:

- 5.4.1. Conditional Payments: Implementing the state machine for "Reservation of Funds" (creation -> trigger -> execution).
- 5.4.2. Offline Synchronization: The architectural challenge of reconciling local "Secure Element" balances with the central ledger upon reconnection.

6. Methodology

6.1. Research Design:

- 6.1.1. Qualitative approach using Expert Interviews (Banks, Vendors, ECB tech teams) and Document Analysis (API specs, Rulebooks).

6.2. Data Sources:

- 6.2.1. ECB Technical documentation (API specs, Progress Reports).
- 6.2.2. PwC and other industry cost studies

7. Discussion & Strategic Recommendations

7.1. The "Make or Buy" Decision Matrix:

7.1.1. Correlating Bank Tiers to Implementation Models based on cost-benefit analysis.

7.2. Achieving Cost-Efficiency:

7.2.1. How market synergies (outsourcing) can reduce the sector's investment from €18bn down to ~€6bn.

7.3. Architecture for Scalability:

7.3.1. Why Microservices (e.g., a dedicated "Digital Euro Gateway Service") are superior to Monolithic integration for maintaining 24/7 uptime independent of legacy core banking maintenance windows.

8. Conclusion

8.1. Summary of blueprints.

8.2. Final recommendations for banks to prepare their IT stacks for the 2026-2028 timeline.