Offline Digital Eurozone Train Tickets

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1 Introduction

With the European Commission's promotion of the Interrail pass through the DiscoverEU program, it is natural that an adequate service for train reservations should follow to support this program.

Currently, Interarail ticketing systems rely heavily on online connectivity and centralized platforms, which creates barriers for cross-border users, and regions with limited connectivity, notably with the Commission establishing the partnership with notional train network to areas outside the eurozone and European Union, like Turkey or the United Kingdom.

Currently, although Interrail ticketing systems have centralized ticket reservation on their website, end-reservation must still be performed on the train operator company's own website and thus relies heavily on online connectivity and centralized digital platforms, which also creates friction on train exchanges, notably when having to re-order a new ticket in case a customer has missed his train due to a delayed train.

Such reliance on connectivity and fragmented national platforms limits interoperability and undermines the DiscoverEU program's.

Therefore, this paper calls for the implementation of a new Central Bank Digital Currency (CBDC)–enabled system that would allow for secure offline transactions, to allow for seamless train ticket reservations. Furthermore, according to Kiff. (2024), 94% of central banks were exploring a CBDC in 2023, with 104 jurisdictions investigating retail CBDCs, with a currency union as one experiment.

Therefore, this paper proposes the establishment of a new rCBDC for the train transportation within the European Union area, with the ambition of a growing system to include a pan-european ticketing system to accompany the growth of the Interrail System.

2 Current Problems

Currently, the Interrail Pass relies on the coordination of multiple payment systems used by national railway operators. Information is therefore isolated on a singular website and not shared on a singular platform, creating cross-border frictions and network-challenged environments that are highly vulnerable to connectivity failures and interoperability issues, because one customer from a specific country might have connectivity issues in another one, unable to access his wallet. Furthermore, during train network disruptions, automatic ticket replacement fails, and validation may fail, with multiple operation platforms acting as information.

Existing solutions exacerbate these challenges. Mobile app–based ticketing typically requires a stable network connection, making it ineffective in areas with poor connectivity, or for customers with inadequate coverage plan. Furthermore, traditional card-based payment systems card providers can charge currency exchange fees, and transactions require terminals with continuous Wi-Fi or network access, further limiting their reliability .

Together, these limitations highlight a systemic need for a more resilient, low-dependency ticketing approach that can operate seamlessly regardless of network conditions. Therefore, a Central Bank Digital Currency (CBDC) enabled solution could directly address these challenges. By leveraging a widget or scanner installed on trains, or integrated into passenger mobile applications, travelers could pay with locally stored digital coins. These digital coins would have to be bought on a transnational Distributed ledger technology that in turn with ticket issuance would be instantaneous and independent of real-time connectivity.

To enable this, customers would redeem retail CBDC (rCBDC) against their national currency, allowing digital coins to be loaded onto their wallet or device. This ensures seamless, offline-capable transactions while maintaining full integration with existing monetary systems. Moreover, these digital tokens could be designed to automatically redeem or transfer value in cases where a passenger misses a train for a valid reason, such as delays or cancellations. The system could detect eligible scenarios and either reassign the ticket to a later service or convert the unused digital coin back into rCBDC.

The rCBDC would be handled by a transnational.

3 Stakeholders & Incentives

For this ticketing system to be viable, incentives must align with passengers, train operators, intermediaries, and public authorities.

For travellers, their main benefit is reliability and convenience. Payments in this case wouldn't depend on WiFi or ticket machines working. This lowers stress during rush hour, cross-border trips, or in areas that are rural. Also, instant settlement reduces the risk of payments failing or cards being temporarily blocked when you're travelling abroad. If you build refunds or rebooking processes around the original payment (without changing the currency itself), passengers also gain from faster resolution in cases of delays. Because rCBDC would be legal tender issued by the central bank, users would probably see it as a safer option that depends only on commercial card networks.

Train operators mainly benefit through lower costs and more efficient operations. We know card payments include interchange and scheme fees, and the risk of chargebacks. But a retail CBDC could diminish merchant service fees and get rid of chargebacks, thanks to the finality of instant settlement. Cash handling costs would also be decreasing. Being able to work offline can help collect more fares in areas with poor connectivity and ease queues during peak periods. Also, fewer technical payment failures mean easier boarding and fewer disputes with customers.

With the intermediated model, wallets would be distributed by regulated PSPs. This makes sure they stay involved with an active role. PSPs could gain from more wallet usage, higher transaction volumes, and opportunities to offer extra services like identity verification, fraud monitoring, and integration with transport apps. The model keeps their customer relationship while introducing a new settlement rail backed by the central bank.

Authorities benefit from improved payment reliability and less reliance on non-European card networks. Our ticketing system supports the EU's strategic autonomy objectives while reinforcing the DiscoverEU programme. It also boosts financial inclusion by making digital payments available even in places with weak infrastructure.

4 Business Model

Our proposed system should remain simple. Consumers wouldn't be charged fees for using rCBDC to buy tickets (same as the treatment of cash). Operators would pay a small transaction fee to PSPs, likely lower than traditional card merchant fees, since it avoids interchange and scheme charges.

PSPs can earn revenue through wallet services, partnerships with transport operators, and potentially premium features (like travel budgeting tools or identity-linked services). Costs in terms of infrastructure (e.g., upgrading mobile ticket validators) could be backed, at the start, by EU digital infrastructure or mobility funding programmes to encourage adoption.

Since rCBDC settlement is final and immediate, operators would find better cash flow management, and simpler reconciliation could help lower back-office costs.

5 Compliance & Consumer Protection

This system would adhere to AML/CFT and GDPR requirements through the intermediated model. PSPs would carry out customer checks to meet EU standards. A tiered wallet system could allow users to hold small amounts with a simpler sign-up process, while higher balances would need full KYC verification.

Offline payments would have strict limits to prevent double-spending and reduce fraud risks. Secure hardware in devices could hold value temporarily and sync it once connectivity is back.

As far as data protection, the central bank wouldn't directly access personal data in transactions. Instead, PSPs would handle customer data according to GDPR rules, ensuring it's transparent and kept to a minimum.

Strong consumer protection mechanisms (e.g., dispute resolution and the ability to trace transactions once reconnected) would help maintain trust in comparison with existing digital payment systems.

6 Rollout Strategy

Rolling it out in phases would make it less risky. A pilot could start with a limited group of national rail operators in the Eurozone, focusing on offline ticket validation. After evaluation, the system could extend to cross-border DiscoverEU routes.

We'd need partnerships between the ECB, national central banks, major PSPs, and selected rail operators. Clear communication with users would strengthen reliability. We're starting small with trains so people can see the rCBDC actually makes life easier. Once it works well in this environment, it can be used for other everyday services too.

Bibliography

[1]Kiff J. (2024), Kiffmeister Chronicles, 5 September,
https://kiffmeister.com/2024/09/05/jurisdictions-where-retail-cbdc-isbeing-explored-3/

Incentives

Being allowed to redeem your stale ticket for free

Passengers

Fewer queues, less stress during rush hour
Can buy ticket at any time
Works with little signal

Train operators

More fares paid for
Fewer staff/tech required
Fewer delays meaning fewer refunds
inspections easier

PSPs

Higher transaction volume from travellers
More wallet usage

Public authorities

More fares paid since more staff freed up for inspections
Better quality transport coverage in underserved regions
More digital infrastructure

Potential problems/issues

-Have to handle fare component, CBDCs are just for payments, something still has to
process/decide the fare amount based on journey?
-double spend problems and other exploits, probably should just be an a temporary
 alternative payment method during exceptionally busy times and have a very strict spend cap