Howti Gateway: A Closed-Loop Instant Payment System for In-Store Retail Transactions

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Abstract

Traditional in-store payment processing through card networks faces significant challenges including high interchange fees (2-4%), settlement delays of 1-2 days, complex integration processes, and security vulnerabilities. This paper presents Howti Gateway, a novel payment system architecture that combines a specialized point-of-sale terminal device with a mobile banking application to enable instant settlements within a closed-loop payment ecosystem. The system reduces interchange fees to 1.6-1.9%, eliminates settlement delays through real-time fund transfers between accounts maintained within the same banking partner, and implements enhanced security through two-factor authentication. We describe the system architecture, payment protocol, economic advantages, and discuss future extensions including integration with FedNow for open-loop instant payments. Our analysis demonstrates that closed-loop payment systems can significantly reduce transaction costs while improving settlement speed and security for retail merchants and consumers.

1 Introduction

The retail payment processing industry has evolved significantly over the past decades, yet fundamental inefficiencies persist in the current card-based payment infrastructure. When a consumer makes an in-store purchase using a credit or debit card, the transaction traverses a complex path involving the merchant's point-of-sale system, a payment terminal, the merchant's acquiring bank, card networks (such as Visa or Mastercard), and the card-issuing bank. This multi-party architecture, while ubiquitous, introduces several pain points that affect both merchants and consumers.

First, merchants face substantial costs in the form of interchange fees, typically ranging from 2-4% of each transaction value. For a $100 purchase, a merchant might retain only $96-$98 after fees, significantly impacting profit margins, particularly for small businesses operating on thin margins. Second, settlement times remain problematic, with funds taking 1-2 days to move from the consumer's account to the merchant's account, creating cash flow challenges for merchants. Third, integrating new payment methods or features into existing point-of-sale terminals requires coordination across multiple parties and can take years to implement. Finally, card-based payments remain vulnerable to fraud, as physical cards can be stolen and used by unauthorized parties.

Recent developments in payment infrastructure, such as the Federal Reserve's FedNow service launched in July 2023, promise instant inter-bank transfers. However, these systems face adoption challenges including limited network participation, higher latency than desired for point-of-sale transactions, and complexity in integration with existing retail payment workflows.

This paper presents Howti Gateway, an alternative payment system architecture designed to address these challenges through a closed-loop payment ecosystem. The system consists of three primary components: (1) a specialized payment terminal device that integrates with existing electronic cash register (ECR) systems, (2) a mobile banking application that consumers use to approve transactions, and (3) merchant and consumer bank accounts maintained within the same banking partner to enable instant settlements through ledger-based transfers.

The key contributions of this work include:

- A novel terminal device architecture that operates in parallel with existing payment infrastructure while capturing standard ECR signals
- An NFC-based transaction protocol with mobile app approval that provides two-factor authentication security
- A closed-loop settlement mechanism enabling instant fund transfers with reduced interchange fees (1.6-1.9%)
- A flexible rewards system integrated directly into the transaction settlement process
- An extensible platform architecture supporting future payment methods including cryptocurrency and buy-now-pay-later options

The remainder of this paper is organized as follows. Section II provides background on traditional payment processing and related work. Section III describes the system architecture. Section IV details the payment flow

protocol. Section V analyzes key innovations and economic advantages. Section VI discusses future extensions and open-loop integration. Section VII presents a critical discussion of adoption challenges and limitations. Section VIII concludes with future research directions.

2 Background and Related Work

2.1 Traditional Payment Processing

Contemporary in-store payment processing follows a well-established multi-party model. When a consumer presents a payment card at a merchant location, the transaction flow involves several steps. The merchant's ECR system communicates the purchase amount to a payment terminal (also called an Electronic Funds Transfer or EFT device). This terminal reads the card information and sends an authorization request through the merchant's acquiring bank to the appropriate card network (Visa, Mastercard, etc.). The card network routes the request to the card-issuing bank, which verifies the consumer's account balance and either approves or denies the transaction.

Upon approval, the transaction enters a "pending" state. Later in the day, typically during batch processing, the merchant "captures" the transaction, which initiates the settlement process. The card network then orchestrates the transfer of funds from the issuing bank to the acquiring bank, minus interchange fees. These fees are distributed among the card issuer, card network, and payment processors. The entire settlement process typically requires 1-2 business days to complete.

This architecture, while proven and widely adopted, introduces several inefficiencies. The involvement of multiple intermediaries increases costs, with interchange fees typically consuming 2-4% of transaction value. Settlement delays create working capital challenges for merchants. The distributed nature of the system makes it difficult to implement new features or payment methods, as changes require coordination and agreement among multiple parties with competing interests.

2.2 Instant Payment Systems

Recognition of these limitations has spurred development of instant payment systems. The Federal Reserve's FedNow service, launched in July 2023, enables participating financial institutions to provide instant payment services to their customers. Similarly, The Clearing House's Real-Time Payments (RTP) network offers comparable functionality. These systems allow individuals and businesses to send and receive payments in real-time, with funds available to the recipient within seconds.

However, these instant payment networks face several challenges in the retail point-of-sale context. First, network latency, while measured in seconds rather than days, remains higher than ideal for in-store transactions where customers expect near-instantaneous confirmation. Second, adoption has been gradual, with many financial institutions not yet participating in these networks. Third, integration with existing point-of-sale systems and workflows requires significant merchant-side development.

2.3 Mobile Payment Solutions

Mobile payment systems such as Apple Pay, Google Pay, and various bank-specific applications have gained traction by offering convenience and enhanced security through tokenization. These systems typically work by storing payment card credentials on the mobile device and using NFC technology to communicate with payment terminals. However, they still rely on the traditional card network infrastructure for transaction processing and settlement, inheriting the associated fees and delays.

Some closed-loop mobile payment systems exist, most notably in markets like China with Alipay and WeChat Pay, which operate their own payment ecosystems. These demonstrate the viability of closed-loop approaches but have achieved success primarily in markets with different regulatory environments and consumer behaviors than Western markets.

2.4 Research Gap

While existing research and commercial systems address various aspects of payment processing challenges, a gap remains for a solution that combines instant settlement, reduced fees, enhanced security, and seamless integration with existing retail infrastructure. Closed-loop systems have demonstrated success in specific markets but lack adoption in traditional retail environments. Instant payment networks offer speed but face integration challenges and still involve bank-to-bank transfers. The Howti Gateway system, described in the following sections, aims to address this gap through a hybrid approach that works alongside existing infrastructure while enabling instant, low-cost settlements within a closed-loop ecosystem.

3 System Architecture

The Howti Gateway system comprises three interconnected components that work together to enable instant payment processing in retail environments. This section describes each component and their integration.

3.1 Howti Terminal Device

The Howti terminal device is a specialized hardware unit designed to integrate with existing point-of-sale infrastructure while providing new payment capabilities. The device specifications include:

- **NFC Reader/Writer:** A dynamic near-field communication module enables communication with con-

Figure 1: Traditional payment processing flow showing the multi-party architecture involving payment terminals, acquiring banks, card networks, and issuing banks.

sumer mobile devices for transaction initiation and approval

- **Display:** An integrated screen displays transaction amounts and status information to both cashier and consumer
- **ECR Communication Ports:** Standardized interfaces enable the device to receive signals from existing ECR systems following protocols used by major payment processors including Verifone and Ingenico
- **Network Connectivity:** Ethernet port provides internet connection for communication with Howti financial services APIs
- **Software Platform:** Remotely upgradeable software enables feature additions and protocol updates without hardware replacement
- **Optional EMV Chip Reader:** Future versions may include chip card reading capability for hybrid payment scenarios

A critical design decision is that the Howti terminal operates in parallel with existing payment terminals rather than replacing them. This parallel architecture reduces deployment risk and provides flexibility for consumers to choose their preferred payment method.

The device captures standard ECR interface signals, following specifications such as the Ingenico ZVT ECR interface protocol and Verifone's implementation guides. This standardization ensures compatibility with diverse point-of-sale systems without requiring merchant-side software modifications.

3.2 Howti Mobile Banking Application

The consumer-facing mobile application serves multiple functions within the ecosystem:

- **High-Yield Bank Account:** Users maintain a bank account offering competitive interest rates, from which daily spending transactions are funded
- **Transaction Approval:** When a consumer taps their phone on a Howti terminal, the app presents transaction details and requests biometric or facial recognition approval
- **Backup Debit Card:** A physical debit card linked to the Howti account enables payments at locations without Howti terminals, processing through traditional card networks
- **Rewards Management:** The app displays earned rewards from merchants and provides visibility into reward program terms
- **Financial Management Tools:** Additional features may include virtual cards, spending analytics, and budget tracking

Security is enhanced through two-factor authentication: physical possession of the mobile device (first factor) and biometric authentication to approve transactions (second factor). This approach eliminates risks associated with stolen physical cards.

3.3 Howti Merchant Accounts

Merchants participating in the Howti ecosystem maintain bank accounts with the same banking partner that provides consumer accounts. This common banking infrastructure is essential for the closed-loop architecture. Merchants access a web-based portal for:

- Account management and transaction monitoring
- Configuration of customized reward programs
- Integration of Howti terminals with their ECR systems
- Real-time reporting and reconciliation

The closed-loop design enables instant settlement because funds transfer between accounts maintained within the same banking partner's ledger system, eliminating inter-bank settlement delays.

3.4 Integration Architecture

Figure 1 illustrates the overall system architecture and how components interact. The Howti terminal integrates with the merchant's existing ECR system while maintaining parallel operation with traditional payment terminals. When a transaction is initiated, the ECR sends signals to both the traditional payment terminal and the Howti device. The consumer chooses which device to use

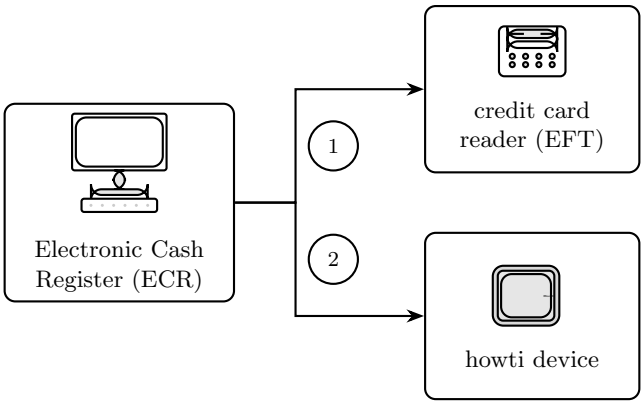

Figure 2: Parallel deployment architecture showing the Howti terminal operating alongside traditional payment infrastructure. The ECR sends signals to both the traditional EFT terminal (path 1) and the Howti device (path 2), allowing consumers to choose their preferred payment method.

for payment. If selecting Howti, the terminal communicates via NFC with the consumer's mobile app, which in turn communicates with Howti financial services APIs for transaction authorization and settlement.

4 Payment Flow and Protocol

This section describes the detailed transaction sequence when a consumer makes a purchase using the Howti Gateway system.

4.1 Transaction Initialization

The payment flow begins when a cashier enters items into the ECR system:

1. The consumer presents items for purchase totaling a specific amount (e.g., $100)
2. The cashier scans items and enters the order into the ECR system
3. The ECR system generates a payment request signal containing the transaction amount and merchant identifier
4. This signal is transmitted simultaneously to both the traditional payment terminal and the Howti terminal device
5. The Howti terminal receives and parses the standard ECR protocol message
6. The transaction amount displays on the Howti terminal screen

At this point, the consumer chooses whether to pay using a traditional payment card with the existing terminal or to use the Howti system.

4.2 NFC-Based Transaction Approval

When the consumer selects the Howti payment method:

1. The consumer taps their mobile device on the Howti terminal's NFC reader
2. The terminal transmits transaction details to the mobile device via NFC, including amount, merchant name, and transaction identifier
3. The Howti mobile application launches automatically and displays transaction details
4. The app requests biometric authentication (fingerprint or facial recognition) from the consumer
5. Upon successful authentication, the consumer reviews transaction details and taps an approval button
6. The mobile app transmits the approval to Howti financial services APIs via encrypted connection

This approval process typically completes within 2-3 seconds, comparable to the time required for chip card transactions in traditional terminals.

4.3 Backend Settlement Processing

Once the consumer approves the transaction through the mobile app:

1. Howti financial services APIs verify the approval signature and transaction details
2. The system checks the consumer's account balance
3. If sufficient funds exist, the system calculates the final settlement amounts:
    - Interchange fee (1.6-1.9% of transaction amount)

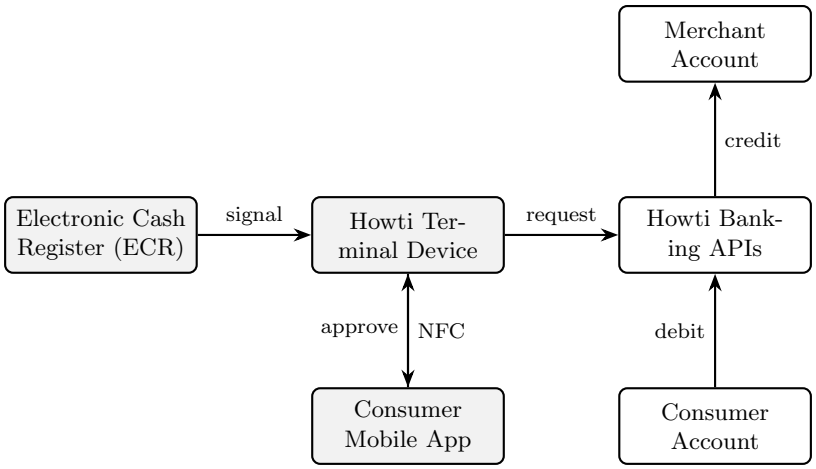

Figure 3: Howti Gateway system architecture showing integration between ECR, terminal device, mobile app, and banking services.

- Any applicable merchant-configured rewards
- Net amount to transfer to merchant account

4. The system executes a ledger-based transfer, debiting the consumer's account and crediting the merchant's account
5. A transaction completion message is sent to both the mobile app and the terminal device

For a $100 purchase with 1.7% interchange and 3% merchant reward:

$$\begin{aligned}
\text{Consumer charged} &= \$100.00 \\
\text{Interchange fee} &= \$100.00 \times 0.017 = \$1.70 \\
\text{Merchant reward} &= \$100.00 \times 0.03 = \$3.00 \\
\text{Merchant receives} &= \$100.00 - \$1.70 - \$3.00 = \$95.30 \\
\text{Consumer reward} &= \$3.00
\end{aligned}$$

The entire backend settlement completes in under one second, as it involves only database operations within a single banking system rather than inter-bank transfers.

4.4 Transaction Completion

After successful settlement:

1. The Howti terminal device displays a success message
2. The terminal sends a completion signal back to the ECR system using the same protocol standard that traditional terminals employ
3. The ECR system receives the completion signal and marks the order as paid
4. A receipt is generated for the consumer
5. The mobile app displays the transaction confirmation, updated balance, and any earned rewards

The ECR system cannot distinguish between a payment processed through a traditional terminal versus the Howti terminal, ensuring seamless integration with existing retail workflows.

4.5 Refunds and Disputes

The system handles post-transaction scenarios through standard protocols:

Refunds: When a merchant initiates a refund through their ECR system, the ECR sends a refund signal containing the original transaction identifier. The Howti terminal recognizes this signal and processes the refund by reversing the original ledger transaction, returning funds to the consumer's account instantly.

Disputes: Unlike traditional card networks where disputes go through formal chargeback processes involving multiple parties, Howti disputes are handled directly between merchant and consumer, with the Howti platform providing mediation tools and transaction records.

4.6 Security Considerations

The payment protocol incorporates multiple security layers:

- **Device Authentication:** The mobile device must be registered with the consumer's Howti account
- **Biometric Verification:** Each transaction requires biometric approval, preventing unauthorized use even if the device is stolen
- **Encrypted Communication:** All data transmitted between terminal, mobile app, and backend services uses end-to-end encryption
- **Transaction Limits:** The system can enforce per-transaction and daily spending limits

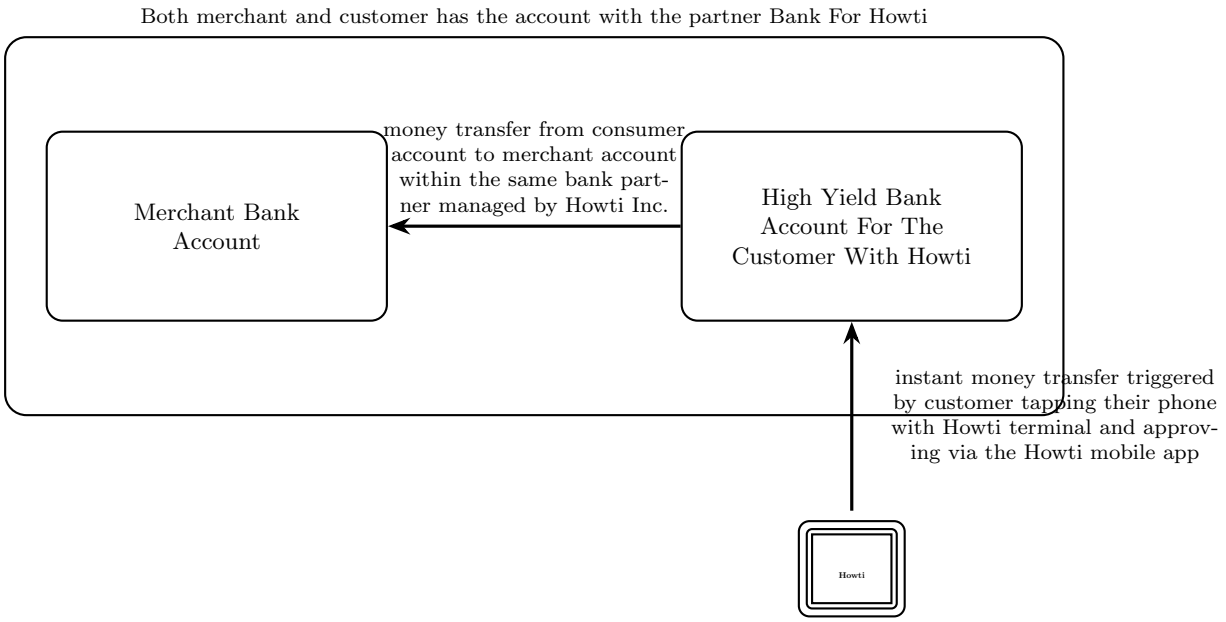

Figure 4: Howti instant payment flow of funds showing the closed-loop settlement mechanism. Both merchant and consumer maintain accounts within the same banking partner, enabling instant ledger-based transfers managed by Howti Inc.

- **Real-time Monitoring:** Fraud detection algorithms analyze transaction patterns for anomalies

This multi-layered approach provides security exceeding that of traditional card-based payments, where physical card theft enables unauthorized transactions.

5 Key Innovations and Economic Analysis

5.1 Instant Settlement Mechanism

The primary innovation of the Howti Gateway system is the instant settlement capability enabled by its closed-loop architecture. Traditional payment systems require 1-2 days for settlement because funds must move between different financial institutions, each with their own processing schedules and risk management requirements. In contrast, the Howti system maintains both merchant and consumer accounts within the same banking partner's infrastructure.

This architectural choice transforms settlement from an inter-bank transfer requiring batch processing and network coordination into a simple ledger update within a single database system. When a transaction is approved, the system immediately debits the consumer's account ledger entry and credits the merchant's account ledger entry. From the merchant's perspective, funds are available instantly for use or withdrawal.

The instant settlement capability provides merchants with improved cash flow management and eliminates the uncertainty associated with pending transactions. For consumers, it provides immediate visibility into spending and account balances.

5.2 Reduced Interchange Fees

Traditional card transaction interchange fees range from 2-4%, distributed among card issuers, card networks, acquiring banks, and payment processors. The Howti system reduces these fees to approximately 1.6-1.9% by eliminating several intermediaries:

- **No card network fees:** Transactions do not route through Visa, Mastercard, or similar networks
- **No acquiring bank fees:** While Howti maintains partnerships with banking institutions, the closed-loop architecture eliminates traditional acquiring services
- **Simplified risk management:** Two-factor authentication and instant settlement reduce fraud risk and associated costs

For a merchant processing $1 million annually in sales, the interchange reduction from 3% to 1.7% saves $13,000 per year. These savings can be retained by the merchant, shared with consumers through enhanced rewards, or used to reduce prices.

5.3 Programmable Rewards Systems

Traditional rewards programs typically operate separately from the payment processing infrastructure, re-

quiring third-party providers to track purchases, calculate rewards, and manage redemption. The Howti system integrates rewards directly into the transaction settlement process.

When configuring their merchant portal, merchants can define reward rules such as:

- Flat percentage cashback on all purchases
- Tiered rewards based on purchase frequency (e.g., 2% back after second purchase in a month)
- Time-based promotions (e.g., 5% back on weekend purchases)
- Category-based rewards (e.g., higher rewards on specific product categories)

During transaction settlement, the system automatically calculates applicable rewards and credits them to the consumer's account or applies them to the current transaction. This integration eliminates the complexity and cost of external rewards program providers.

The savings from reduced interchange fees enable merchants to offer competitive rewards while maintaining profitability. For example, with a 1.7% interchange versus the traditional 3%, a merchant saves 1.3%. They might choose to offer 1% to consumers as rewards while retaining 0.3% in additional profit.

5.4 Enhanced Security Model

The Howti system's security model provides multiple advantages over card-based payments:

No Physical Card Vulnerability: Traditional payment cards can be stolen, skimmed, or cloned. The Howti system requires physical possession of the registered mobile device plus biometric authentication, significantly raising the bar for fraudulent transactions.

Two-Factor Authentication: Every transaction requires something the consumer has (their phone) and something they are (their biometric signature). This represents true two-factor authentication, whereas traditional chip cards only verify possession of the physical card.

Real-time Consumer Approval: Unlike card transactions that can occur without the cardholder's immediate knowledge, Howti transactions require explicit approval through the mobile app. Consumers receive instant notification of transaction attempts and can deny unauthorized attempts in real-time.

Granular Control: The mobile app enables consumers to set transaction limits, restrict merchant categories, or temporarily disable payment capability. These controls provide a level of security customization not available with physical cards.

5.5 Platform Extensibility

The Howti terminal device's software-upgradeable architecture enables rapid deployment of new payment capabilities. Unlike traditional payment terminals that require hardware replacement or complex certification processes for new features, Howti terminals can receive software updates remotely.

Potential future capabilities include:

- **Cryptocurrency payments:** Software updates could enable the terminal to accept cryptocurrency payments, converting them to fiat currency for merchant settlement
- **Buy-Now-Pay-Later (BNPL) integration:** Partnership with BNPL providers could offer point-of-sale financing options
- **Dynamic currency conversion:** For international travelers, automatic currency conversion at competitive rates
- **Loyalty program integration:** Direct integration with merchant loyalty programs for point accrual and redemption

This extensibility addresses one of the key limitations of traditional payment infrastructure, where new payment methods can take years to achieve widespread point-of-sale acceptance.

6 Future Extensions

6.1 Open-Loop Payments via FedNow

The closed-loop architecture provides optimal performance and cost characteristics but requires both merchants and consumers to maintain accounts within the Howti ecosystem. To expand merchant coverage and provide consumers with universal payment capability, future versions will integrate with instant payment networks such as FedNow and RTP.

FedNow, launched by the Federal Reserve in July 2023, enables participating financial institutions to offer instant payment services. When integrated with the Howti system, a consumer with a Howti account could make instant payments to merchants banking with any FedNow-participating institution.

However, this open-loop approach faces several challenges:

Increased Latency: FedNow transactions, while measured in seconds rather than days, introduce network latency. Initial implementations show average processing times of 5-10 seconds, compared to under 1 second for closed-loop Howti transfers. This additional time at the point-of-sale may impact customer experience.

Network Coverage: As of early 2024, FedNow adoption remains limited. If a merchant's bank does not participate in the FedNow network, instant payment cannot occur through this channel.

Cost Structure: While FedNow fees are significantly lower than card network interchange, they exceed the cost of closed-loop ledger transfers. The fee structure must be carefully considered in the system's economics.

Despite these challenges, FedNow integration provides strategic value by enabling the Howti system to serve merchants outside the closed-loop ecosystem while maintaining the instant settlement capability that differentiates the platform.

6.2 Direct Issuer Routing

An intermediate approach between fully closed-loop and open-loop instant payments involves direct communication with card issuers. When a consumer presents a Howti debit card at a Howti terminal (in locations where the terminal is installed but the merchant does not have a Howti account), the terminal can identify the card's Bank Identification Number (BIN) and route the transaction directly to Howti's issuing services, bypassing the card network.

This approach offers several advantages:

- Faster processing than traditional card network routing
- Reduced interchange fees compared to full card network involvement
- Simplified dispute resolution through direct issuer-consumer communication
- Potential for instant or near-instant settlement depending on the merchant's banking arrangements

The same direct routing approach could extend to non-Howti issued cards through partnerships with other card issuers. If multiple issuers agreed to direct routing protocols, the Howti terminal could become a universal instant payment gateway, selecting the optimal routing path based on card BIN identification.

6.3 Backup Payment Options

Consumer adoption of new payment systems depends partially on ensuring universal payment capability. The Howti system addresses this through multiple backup mechanisms:

Howti Debit Card: Consumers receive a physical debit card linked to their Howti account. This card operates on traditional card networks (Visa, Mastercard) and can be used at any merchant accepting those networks, including locations without Howti terminals. While these transactions process through traditional card networks with standard interchange fees and settlement times, they ensure consumers can access their Howti account funds anywhere.

EMV Chip Reader Option: Future Howti terminal versions may include EMV chip card readers. When a Howti debit card is inserted into this reader, the terminal recognizes the card's BIN and routes the transaction through direct issuer communication rather than the card network, maintaining the instant settlement and reduced fee benefits even when using the physical card.

ATM Functionality: Howti terminals could be extended to provide ATM-style cash withdrawal capabilities, allowing consumers to access cash from their accounts at merchant locations. This feature leverages the existing terminal hardware and merchant relationships to provide additional consumer value.

6.4 Cross-Border Payments

International payment processing introduces additional complexity through currency conversion, higher fees, and regulatory requirements. The Howti platform architecture could extend to cross-border scenarios through several approaches:

- Partnership with international banking partners to create a global closed-loop network
- Integration with real-time gross settlement systems in multiple countries
- Dynamic currency conversion at competitive exchange rates for international travelers
- Support for multi-currency accounts within the Howti mobile app

These extensions would position Howti as a global payment solution rather than a domestic-only system.

7 Discussion

7.1 Adoption Challenges

Despite its technical and economic advantages, the Howti Gateway system faces significant adoption challenges characteristic of two-sided network markets:

Merchant Adoption: Merchants must invest in Howti terminal hardware, establish Howti bank accounts, and train staff on the new system. While the hardware operates in parallel with existing terminals to minimize disruption, merchants may be reluctant to adopt a new payment system without proven consumer demand. The reduced interchange fees provide economic incentive, but merchants must weigh potential savings against implementation costs and operational complexity.

Consumer Adoption: Consumers must download the Howti mobile app, transfer funds to their Howti account, and learn the new payment workflow. Consumer

payment behavior tends toward conservatism, with many consumers satisfied with existing payment methods. The system must provide compelling value propositions such as rewards, enhanced security, or unique features to motivate adoption.

Network Effects: The system's value to both merchants and consumers increases with adoption on both sides. A consumer gains little value from a Howti account if few merchants accept Howti payments. Similarly, merchants gain little value from Howti terminals if few consumers use Howti accounts. Breaking this circular dependency requires carefully sequenced rollout strategies, potentially focusing initially on specific geographic regions or merchant categories to achieve critical mass.

Trust and Brand Recognition: Payment systems require high levels of consumer trust, as they involve financial accounts and sensitive transactions. Established card networks benefit from decades of brand building and consumer familiarity. New entrants must invest significantly in security, consumer education, and brand development to achieve comparable trust levels.

7.2 Regulatory Considerations

Payment systems operate within complex regulatory frameworks that vary by jurisdiction:

Banking Regulations: The Howti system involves maintaining consumer and merchant deposit accounts, requiring partnerships with licensed banking institutions and compliance with banking regulations including capital requirements, deposit insurance, and anti-money-laundering (AML) rules.

Payment Processing Regulations: Depending on the jurisdiction and specific system architecture, Howti may need to register as a payment processor, money transmitter, or similar regulated entity. Each designation carries specific compliance requirements and operational restrictions.

Consumer Protection: Payment systems must comply with consumer protection regulations including dispute resolution requirements, liability limits for unauthorized transactions, and clear disclosure of terms and fees.

Data Privacy: The system collects and processes sensitive consumer financial data, requiring compliance with data protection regulations such as GDPR in Europe, CCPA in California, and similar regulations in other jurisdictions.

Competition Law: If the system achieves significant market share, it may face scrutiny under competition laws, particularly regarding merchant agreements and exclusive arrangements.

These regulatory requirements add complexity and cost to system operation but are essential for consumer protection and market integrity.

7.3 Scalability Considerations

The closed-loop architecture provides significant advantages in cost and speed but raises questions about long-term scalability:

Banking Partner Capacity: The system depends on the underlying banking partner's infrastructure to maintain accounts and process transactions. As transaction volume grows, the banking partner must scale their systems accordingly. The instant settlement capability requires high-performance database systems capable of processing thousands of transactions per second with strong consistency guarantees.

Geographic Expansion: Expanding to new geographic markets may require establishing relationships with additional banking partners if a single partner cannot provide nationwide or international coverage. This could complicate the closed-loop architecture or require hybrid approaches combining closed-loop and open-loop settlements.

Merchant Diversity: Different merchant categories have different transaction patterns. High-volume retailers with many small transactions have different requirements than low-volume merchants with large transactions. The system must scale to accommodate this diversity.

Mobile App Performance: As the consumer base grows, the mobile app infrastructure must scale to handle concurrent transaction approvals, real-time balance updates, and other interactive features. The 2-3 second transaction approval time requirement places strict performance constraints on the app and backend services.

7.4 Limitations of Closed-Loop Approach

While the closed-loop architecture enables instant settlement and reduced fees, it introduces limitations:

Account Prefunding: Consumers must proactively transfer funds to their Howti accounts before making purchases. This differs from credit cards, which provide payment first with settlement later, or debit cards linked to primary checking accounts where consumers naturally maintain balances. The prefunding requirement creates friction in consumer adoption.

Limited Merchant Coverage: Consumers can only use Howti instant payments at merchants who have adopted the Howti system. While the backup debit card provides universal payment capability, it sacrifices the instant settlement and fee advantages that make the system attractive. Achieving sufficient merchant coverage for consumers to view Howti as a primary payment method requires substantial market development effort.

Liquidity Management: Merchants must decide whether to maintain working capital in their Howti accounts or regularly transfer funds to their primary business bank accounts. If funds are frequently transferred out, the merchant loses the benefit of the high-yield ac-

count feature. If funds remain in the Howti account, the merchant may face liquidity constraints in other business operations.

Integration Complexity: While the Howti terminal is designed to integrate with standard ECR protocols, retail technology environments vary widely. Some merchants may use legacy systems with non-standard interfaces, requiring custom integration work. The parallel deployment model (operating alongside existing terminals) reduces risk but increases hardware costs and checkout counter space requirements.

7.5 Competitive Landscape

The Howti system enters a competitive market with established players and emerging challengers:

Traditional Card Networks: Visa, Mastercard, and other card networks possess enormous scale, established merchant relationships, and universal consumer acceptance. While Howti offers lower fees and instant settlement, card networks are also investing in faster settlement technologies and may reduce interchange fees in response to competitive pressure.

Digital Wallets: Mobile payment systems such as Apple Pay and Google Pay provide convenience and security through tokenization but still rely on underlying card networks. If these systems achieve dominant market position, consumers may have little incentive to adopt alternative payment apps.

Cryptocurrency Payment Systems: Various cryptocurrency-based payment systems promise low fees and fast settlement. However, these systems face regulatory uncertainty, price volatility concerns, and limited merchant adoption.

Bank-Operated Instant Payment Systems: Large banks may develop their own instant payment systems leveraging FedNow or RTP, potentially offering similar benefits to Howti while building on existing customer relationships and trust.

Howti's competitive advantage lies in its integrated approach combining hardware, software, and banking services into a cohesive system optimized for in-store retail. However, maintaining this advantage requires continuous innovation and strong execution.

8 Conclusion

This paper has presented Howti Gateway, a novel payment system architecture that addresses key inefficiencies in traditional retail payment processing. Through a closed-loop ecosystem combining a specialized terminal device, mobile banking application, and common banking infrastructure for merchants and consumers, the system enables instant payment settlement with reduced interchange fees and enhanced security.

The key technical innovations include an NFC-based transaction protocol with mobile app approval providing two-factor authentication, a parallel deployment model integrating with existing ECR systems through standard protocols, instant settlement via ledger-based transfers within a single banking partner's infrastructure, and a software-upgradeable terminal platform supporting future payment methods and features.

Economic analysis demonstrates significant advantages over traditional card processing, with interchange fees reduced from 2-4% to 1.6-1.9% and settlement time reduced from 1-2 days to under one second. These improvements benefit both merchants through lower costs and improved cash flow, and consumers through enhanced security and integrated rewards programs.

Future extensions including FedNow integration for open-loop instant payments, direct issuer routing for hybrid transaction processing, and backup payment options through traditional card networks address scalability and adoption challenges while maintaining core system advantages.

However, the system faces significant adoption challenges characteristic of two-sided markets, requiring coordinated value propositions for both merchants and consumers. Regulatory compliance, scalability constraints, and competition from established payment networks present additional hurdles.

Future research directions include empirical evaluation of consumer and merchant adoption patterns in pilot deployments, optimization of transaction protocols to minimize latency while maintaining security, analysis of optimal reward program structures to maximize consumer engagement while preserving merchant profitability, and investigation of hybrid architectures combining closed-loop and open-loop settlement mechanisms for different transaction types or merchant categories.

The Howti Gateway system demonstrates that significant improvements in payment processing speed, cost, and security remain achievable through architectural innovation. As instant payment infrastructure like FedNow matures and consumer comfort with mobile-based financial services increases, systems combining the benefits of closed-loop efficiency with open-loop universality may reshape the retail payment landscape.

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