Topic 2.1: Digital Payments
How Money Actually Moves

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By the end of this topic, you will be able to:

1. **Explain** the four-layer payment stack and identify each layer's function
2. **Trace** a card payment from initiation to settlement using the four-party model
3. **Compare** payment methods by speed, cost, and consumer protection trade-offs
4. **Analyze** the conceptual economics of interchange and explain why payment fees exist
5. **Evaluate** how FinTech innovations challenge traditional payment infrastructure
6. **Apply** payment analysis techniques to transaction data (NB02)

Key Competency: Trace a digital payment from initiation to settlement and identify where value is captured at each layer.

Definition:
A **payment** is the transfer of value from one party (payer) to another (payee) in exchange for goods, services, or to fulfill an obligation.

Three Essential Components:

1. **Instruction**: The order to transfer funds
2. **Clearing**: Verification and reconciliation of the transaction between parties
3. **Settlement**: The final, irrevocable transfer of money

The Hidden Complexity

What seems simple is actually complex. When you tap your card at a coffee shop, what actually happens in the next few seconds — and the next few days?
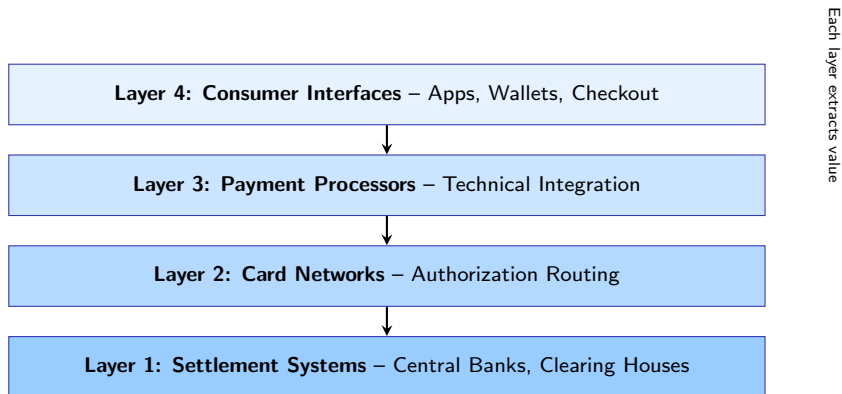
Key Terms

- **Payer**: Person or entity sending money
- **Payee**: Person or entity receiving money
- **Settlement**: When funds actually move
- **Float**: The gap between approval and settlement

The Insight

The gap between "approved" and "money moved" is where enormous value is created and captured.

The Problem

Why does a simple coffee purchase involve so many parties?

Layer 4: Consumer Interfaces – Apps, Wallets, Checkout

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Layer 3: Payment Processors – Technical Integration

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Layer 2: Card Networks – Authorization Routing

↓

Layer 1: Settlement Systems – Central Banks, Clearing Houses

Each layer extracts value

The Hidden Journey of a Payment (cont.)

The Insight

Each layer in the payment stack captures a portion of every transaction. Understanding the stack reveals who profits from your purchase — and where disruption is possible.

The Problem

How does money *actually* move between banks?

The Concept:

- **Settlement** = the final, irrevocable transfer of money between banks
- Operated by central banks or banking consortia
- The foundation on which all other payment layers are built
- Different systems exist for domestic vs. international transfers

Authorization vs. Settlement:

- **Authorization**: "Yes, this payment is approved" — happens in seconds (like making a reservation)
- **Settlement**: "Money has actually moved" — can take days (like completing the transaction)

The Float

You can spend money in seconds that takes days to actually move. This gap is called **float**[1]— and it creates both risk and opportunity.

During the float period:

- The merchant does not yet have the funds
- The payer's bank has reserved but not released the money
- Intermediaries may earn interest on funds in transit

Float — the time money is "in transit" between accounts, during which neither party can fully use it.

Layer 1: Settlement Systems (cont.)

The Insight

The delay between "approved" and "settled" is not a bug — it is where significant economic value is created.

Layer 2: Card Networks

The Problem

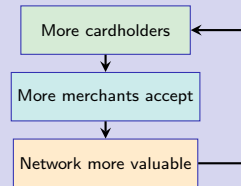How does your card work at a store on the other side of the world?

The Concept:

- Card networks connect **issuing banks**[1] to **acquiring banks**[2]
- They route authorization requests across borders
- They set rules, standards, and manage fraud liability
- The largest networks operate globally, accepted nearly everywhere

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[a]Issuing bank — your bank that issued your card.

[b]Acquiring bank — the merchant's bank that receives payments on their behalf.

Network Effects Create Dominance

Merchants accept what consumers carry. Consumers carry what merchants accept.

The Insight

Network effects create a self-reinforcing cycle — once a card network reaches critical mass, it becomes extremely difficult to displace.

Layer 3: Payment Processors

The Problem

Why can't merchants just connect directly to card networks?

The Concept:

- Connecting directly to networks requires complex technical integration and regulatory compliance
- **Payment processors** handle this complexity on behalf of merchants
- They provide fraud detection, developer tools (APIs), and multi-network routing
- They charge a small markup on each transaction for this service

Before vs. After Processors

Without processors:

- Custom bank integration
- Months of development
- Complex compliance requirements
- Network-by-network negotiation

With processors:

- Simple API integration
- Fast setup
- Bundled compliance and fraud protection
- Multi-network routing in one package

Layer 3: Payment Processors (cont.)

The Insight

By simplifying integration, processors unlocked payment innovation for millions of businesses that could never have connected to networks on their own.

The Problem

Why is every tech company building a wallet or payment app?

The Concept:

- The interface layer is the user-facing payment experience
- It stores payment credentials securely
- Types include: mobile wallets, peer-to-peer apps, e-commerce checkout, point-of-sale terminals, bank apps

Why Everyone Wants This Layer:

- Owns the **customer relationship**
- Captures **spending data**
- Enables **cross-selling** other products
- Builds **brand loyalty**

Where Competition Happens

Most FinTech innovation targets this layer because it is closest to the customer.

The underlying rails (networks, settlement) remain largely unchanged — the battle is over who controls the experience on top.
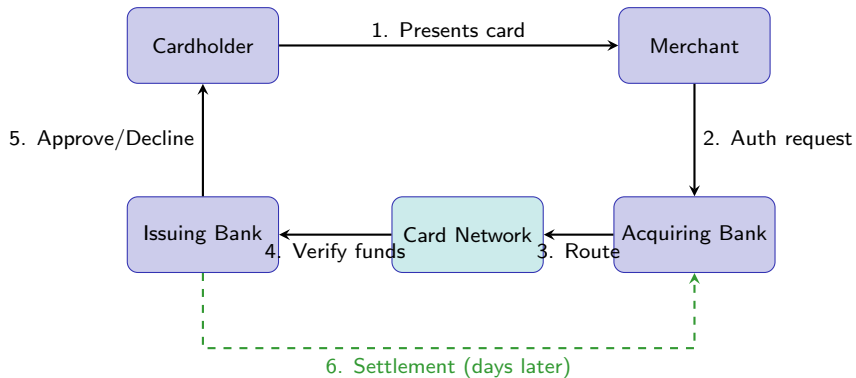
Think About It

How many different payment apps are on your phone right now? Each one is competing for this layer.

Layer 4: Consumer Interfaces (cont.)

The Insight

The real battle in payments is not moving money — it is **owning the customer relationship**.

The Problem

When you swipe your card, who is involved and what happens?

Cardholder →(1. Presents card)→ Merchant

Merchant →(2. Auth request)→ Acquiring Bank

Acquiring Bank →(3. Route)→ Card Network

Card Network →(4. Verify funds)→ Issuing Bank

Issuing Bank →(5. Approve/Decline)→ Cardholder

6. Settlement (days later)

The Insight

Authorization happens in seconds; settlement takes days. The merchant sees "approved" almost instantly, but the actual money moves much later in batch processing.

The Problem

Who actually pays for the "free" card in your wallet?

Party	Role	How They Earn
Cardholder	Initiates payment	(Consumer — pays indirectly through prices)
Merchant	Accepts payment	Sells goods/services
Issuing Bank	Issues card, bears risk	Receives the largest share of fees
Acquiring Bank	Processes for merchant	Keeps a small portion of fees
Card Network	Routes transactions	Charges assessment fees

The Fee Flow: Merchant pays → Acquirer passes on → Network routes → Issuer receives most

The Insight

The **issuing bank** receives the largest share because it bears the credit and fraud risk. The merchant passes these costs into prices — so consumers ultimately pay, even if their card is "free."

The Cost of Convenience

The Problem

Why do card payments cost merchants more than a simple bank transfer?

What Interchange Fees Pay For:

- **Fraud protection**: The issuing bank covers fraudulent transactions
- **Rewards funding**: Points, cashback, and miles are funded by merchant fees
- **Network maintenance**: Infrastructure for global real-time authorization
- **Consumer credit risk**: The bank lends money to cardholders and may not get it back

This is called **cross-subsidization**[2]*— one group's fees fund another group's benefits.*

Cross-subsidization — when one product's profits pay for another's losses (e.g., card rewards funded by merchant fees).

Regional Variation

Different regions regulate these fees very differently:

- Some regions **cap interchange fees** by law, resulting in much lower costs for merchants
- Other regions allow the market to set fees, resulting in significantly higher rates
- This creates vastly different payment landscapes around the world

Think About It

If interchange fees were capped everywhere, what would happen to credit card rewards programs?

The Insight

Interchange is not just a fee — it is a cross-subsidy that funds the entire card ecosystem. Change the fee structure and you reshape the industry.

The Problem

With so many ways to pay, how do you choose the right one?

Method	Speed	Cost	Consumer Protection
Wire Transfer	Slow to moderate	High (flat fee)	Very limited
Bank Transfer	Slow	Low	Limited
Card Payment	Fast auth, slow settle	Moderate (percentage)	Strong (chargebacks)
Digital Wallet	Fast	Moderate to high	Varies
Real-Time Rails	Instant	Very low	Final (no reversal)
Cryptocurrency	Variable	Variable	Final (no reversal)

The Fundamental Tradeoff:

Fast + Cheap ↔ Less consumer protection

Slow + Expensive ↔ More certainty and recourse

The Insight

Every payment method is a tradeoff — there is no single "best" option. The right choice depends on the specific context: speed, cost, and how much protection you need.

The Problem

What if payments could be instant *and* nearly free?

The Concept:

- Governments around the world are building **real-time payment infrastructure**
- These are public systems — instant, low-cost, available to all banks
- Examples exist across many countries: Brazil, India, the UK, the EU, and the US have all launched or are rolling out such systems
- They settle in seconds, not days

How They Differ from Cards:

- Government-operated (public good)
- Near-zero transaction cost
- Bank-to-bank (no intermediary network)
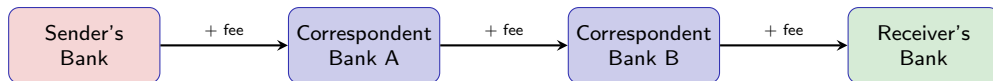- Irrevocable (no chargebacks)

Impact on the Payment Landscape

- **Commoditizes payment rails**: Basic money movement becomes free
- **Threatens card networks**: Why pay a percentage fee when instant transfer is free?
- **Enables new business models**: Micropayments, real-time payroll, instant refunds
- **Shifts competition**: Value moves from moving money to services built on top

The Insight

When the government builds free instant payment infrastructure, it changes the entire competitive landscape for private payment companies. The value shifts from *moving* money to *services around* money.

The Problem

Why is sending money abroad still slow and expensive?

| Sender's Bank | + fee → | Correspondent Bank A | + fee → | Correspondent Bank B | + fee → | Receiver's Bank |

Each hop adds time and cost

Why It Is Broken:

- Money must "hop" through several **correspondent banks**[3]— each one charges a fee and adds delay
- Currency conversion happens at each hop, often at unfavorable rates
- Compliance checks (anti-money laundering) at every intermediary slow the process further
- The sender often does not know the total cost until the money arrives

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[3]Correspondent banking — a system where banks maintain accounts at other banks in foreign countries to facilitate international transfers.

The Insight

Cross-border payments are the most expensive, slowest part of the payment system — making them a prime target for FinTech disruption.

FinTech Solutions for Cross-Border Payments

The Problem

How are companies trying to fix international payments?

Approach 1: Local Rail Matching

- Match senders and receivers in different countries
- Use *local* payment rails on each end
- Money never actually crosses borders
- Faster and cheaper than correspondent banking

Approach 2: Blockchain Settlement

- Use a shared digital ledger to transfer value
- No correspondent banks needed
- Settlement in minutes, not days
- Requires adoption by both sides

Approach 3: Stablecoin Transfers

- Send digital tokens pegged to a currency
- Available around the clock
- Recipient converts to local currency
- Regulatory status still evolving

The Insight

Each approach trades off different dimensions: speed, cost, regulatory clarity, and adoption requirements. No single solution dominates yet — the race to fix cross-border payments is still open.

The Problem

What happens when a payment is declined — and why does it matter more than you think?

Common Reasons Payments Fail:

- **Insufficient funds**: The most common cause
- **Fraud blocks**: Automated systems flag suspicious activity
- **Expired or invalid card**: Outdated payment credentials
- **Network timeouts**: Technical failures between intermediaries
- **Authentication abandonment**: Customer drops out during security checks

A **chargeback**[4] *is when a consumer disputes a transaction and the payment is reversed — typically the merchant bears the cost.*

Chargeback — a consumer's right to dispute and reverse a card transaction within a defined window.

The Hidden Cost of "False Positives"

A **false positive** occurs when a legitimate transaction is incorrectly blocked as fraud.

Why this matters:

- The customer may abandon the purchase entirely
- The merchant loses revenue permanently
- Customer trust and loyalty suffer
- Blocking good transactions often costs **more** than the fraud it prevents

Think About It

Has a legitimate purchase of yours ever been declined? How did it affect your experience?

The Insight

Payment optimization is not just about preventing fraud — it is about finding the right balance between security and a smooth customer experience.

The Problem

Why would a merchant pay *higher* fees for installment payments?

How BNPL Works:

1. Consumer selects BNPL at checkout
2. BNPL provider pays the merchant (minus a fee)
3. Consumer repays in several installments
4. Typically no interest if payments are on time

Why Merchants Accept Higher Fees:

- Increases average order value
- Attracts customers who might not buy otherwise
- Converts browsers into buyers
- Shifts credit risk to the BNPL provider

BNPL Revenue Sources

- **Merchant fees**: Higher than standard card fees — the provider's main revenue
- **Late payment fees**: Charged when consumers miss installments
- **Interest**: On longer-term loan products

Business Model Tensions

- Credit losses without traditional underwriting[5]
- Growing regulatory scrutiny globally
- Consumer debt accumulation concerns
- Sustainability questions when growth slows

The Insight

BNPL shifts credit risk from consumers to providers, creating new business model tensions between growth and sustainability.

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[5]Underwriting — the process of assessing whether a borrower is likely to repay.

Hands-On: NB02 Payment Transaction Analysis

The Problem

How do we analyze payment data to make better business decisions?

Notebook Overview

Analyze simulated payment transaction data to understand:

- How different payment methods compare in practice
- How fee structures affect merchant profitability
- How settlement times vary and why it matters for cash flow
- How network analysis can reveal transaction patterns

What You Will Do:

- Work with a realistic simulated payment dataset
- Compare multiple payment methods across key dimensions
- Visualize cost and settlement trade-offs
- Build and analyze a payment network graph

No Programming Prerequisites

The notebook is self-guided with code provided. Your job is to **interpret the results** and draw business conclusions — not to write code from scratch.

The Insight

Data analysis reveals patterns invisible in individual transactions — what seems random at the single-payment level becomes predictable at scale.

Part 1: Data Exploration

- Load and examine the transaction dataset
- Analyze how transaction amounts are distributed
- Explore temporal patterns (e.g., business hours vs. weekends)
- Calculate summary statistics by payment method

Part 2: Fee Analysis

- Compare fee structures across payment methods
- Calculate effective fee rates at different transaction sizes
- Determine which method is cheapest for different scenarios
- Visualize cost curves to see where methods cross over

Part 3: Settlement Analysis

- Examine how long different methods take to settle
- Understand why the "typical" time can be misleading
- Consider how settlement speed affects merchant cash flow

Part 4: Network Analysis

- Build a payment network graph from transaction data
- Identify which parties are most connected (hubs)
- Find critical bridges in the payment network
- Analyze the direction of money flows

Key Skills Practiced

Data exploration, visualization, comparative analysis, network thinking

Discussion: Choosing Payment Methods

Scenario Analysis

For each scenario, which payment method would you recommend and why? Think about the trade-offs.

Scenario A: Monthly Rent Payment

- Recurring, predictable amount
- Speed is not critical
- Minimizing cost matters most

What method minimizes fees here?

Scenario B: Small In-Store Purchase

- Convenience and speed matter
- High volume, low value per transaction
- Customer experience is the priority

What method optimizes for experience?

Scenario C: High-Value Property Transaction

- Certainty of payment is essential
- Large transfer amount
- Legal requirements may apply

What method provides maximum certainty?

Scenario D: International Supplier Payment

- Cross-border transfer needed
- Currency conversion required
- Balance of speed and cost

Which newer approaches could help here?

There are no single right answers — the best method depends on the specific context and priorities.

Discussion: Where Will Disruption Happen?

Most Vulnerable to Disruption:

- **Cross-border payments**: High friction, many intermediaries, strong incentive for alternatives
- **Business-to-business payments**: Still heavily reliant on manual processes in many industries
- **Interchange economics**: Regulatory pressure growing globally
- **Settlement speed**: Real-time government infrastructure eroding the value of slow private rails

Most Protected from Disruption:

- **Card networks**: Powerful network effects and deep merchant integration
- **Settlement systems**: Government-operated, regulatory barriers to entry
- **Consumer habits**: Trust, convenience, and inertia are powerful protectors
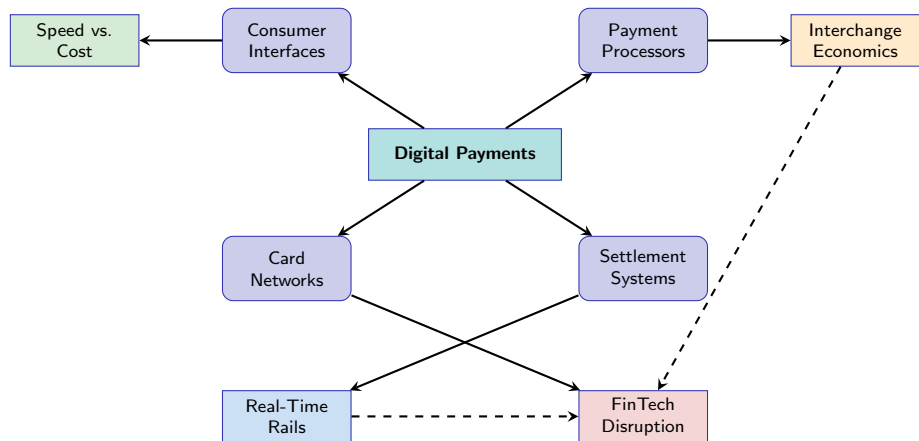
Discussion Questions

1. If instant government payment rails are free, what happens to card networks?
2. Why haven't cryptocurrencies replaced traditional payments for everyday use?
3. What would it take to displace a dominant card network?

Executive Summary: Key Takeaways

1. **Payments are multi-layered**: Consumer interfaces → processors → networks → settlement systems. Each layer extracts value from every transaction.
2. **Speed vs. protection is the fundamental tradeoff**: Faster, cheaper payments are typically less reversible. Every payment method trades off these dimensions differently.
3. **Interchange funds the card ecosystem**: The issuing bank receives the largest share of fees because it bears credit and fraud risk. Merchants pass these costs to consumers through prices.
4. **Real-time government rails are reshaping competition**: When instant payments become free public infrastructure, the value shifts from moving money to the services built on top.
5. **Most FinTechs are layers, not replacements**: The majority of payment innovators build on top of existing rails rather than replacing them — true disruption of the underlying infrastructure is rare.

One Sentence Summary

Digital payments flow through a four-layer stack where each layer captures fees, and understanding this architecture reveals both where value is extracted and where FinTech disruption is possible.

Reading the map: Each arrow shows a conceptual relationship. Dashed arrows indicate that real-time rails and interchange economics both drive FinTech disruption.

Settlement
: The final, irrevocable transfer of funds from payer to payee. Distinct from authorization.

Interchange
: The fee paid by the acquiring bank to the issuing bank for each card transaction. The issuing bank receives the largest share because it bears credit and fraud risk.

Four-Party Model
: Card payment structure involving cardholder, merchant, issuing bank, and acquiring bank, connected by the card network.

Float
: The time money is "in transit" between authorization and settlement, during which intermediaries may earn value on funds that have not yet moved.

Chargeback
: A consumer's right to dispute and reverse a card transaction within a defined window. The merchant typically bears the cost.

BNPL
: Buy Now Pay Later — a payment method allowing consumers to split purchases into installments, typically with no interest if paid on time.

Correspondent Banking
: A system where banks maintain accounts at other banks in foreign countries to facilitate international transfers — each intermediary adds time and cost.

Common Misconceptions

Myth 1: "Card payments are instant"
Reality: Authorization is instant, but settlement takes days. The merchant sees "approved" immediately, but does not receive the funds until later.

Myth 2: "Wire transfers are always best for large amounts"
Reality: Wire transfers provide certainty, not cost efficiency. A simple bank transfer is often much cheaper — wire transfers are chosen when guaranteed finality matters more than cost.

Myth 3: "FinTechs have replaced traditional payment rails"
Reality: Most payment FinTechs are layers *on top of* existing infrastructure, not replacements. The underlying settlement systems remain largely the same.

Myth 4: "Lower fees always mean a better payment method"
Reality: Speed, reversibility, and consumer protection all matter. The cheapest option may offer no recourse if something goes wrong — sometimes paying more buys valuable protection.

Self-Assessment

Question 1: The Payment Stack

A new FinTech company builds a mobile payment app. Which layer of the payment stack are they primarily competing in, and why does this layer attract so much innovation?

Question 2: Speed vs. Protection

A consumer makes an instant, irrevocable payment and later discovers the product is defective. Why is this situation fundamentally different from a credit card purchase? What is the tradeoff?

Question 3: Cross-Border Disruption

Explain why cross-border payments are more expensive than domestic payments, and describe one FinTech approach that attempts to solve this problem.

If you can answer these three questions conceptually, you have mastered the key ideas of this topic.

What's Next: Topic 2.2 — The API Economy

Preview of T2.2:

- How APIs enable non-banks to offer financial services
- Open Banking: regulators requiring banks to share data
- Banking-as-a-Service: renting banking infrastructure
- Embedded finance: financial products inside non-financial apps

Connection to Payments:
APIs are how payment processors make integration simple for merchants — the technology bridge between Layer 3 and the businesses that use it.

Key Question for T2.2

How can a tech company offer you a bank account without being a bank?

Hands-On: NB03
Open Banking API Simulation — make API calls to retrieve accounts, transactions, and initiate payments.

Action Item

Complete **NB02 — Payment Transaction Analysis** before starting Topic 2.2.

Questions?

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