Lesson 2: Digital Payments I – Fundamentals

Module 1: Fintech and Innovation

Digital Finance Course

December 7, 2025

Payment Fundamentals: Overview

What is a Payment?

- Transfer of monetary value from payer to payee
- Settlement of obligation or exchange
- Requires: Authorization, clearing, settlement
- Involves multiple intermediaries

Payment Ecosystem Participants:

- Payer (consumer/business)
- Payee (merchant/recipient)
- Issuing bank (payer's bank)
- Acquiring bank (merchant's bank)
- Payment network (Visa, Mastercard)
- Payment processors (Stripe, Adyen)

Key Payment Characteristics:

- Speed (real-time vs batch)
- Cost (fees and FX spread)
- Security (fraud prevention)
- Finality (irrevocable vs reversible)
- Reach (domestic vs cross-border)

Payment Types:

- Push: Payer initiates (credit transfer)
- Pull: Payee initiates (direct debit)
- Card: Network-based (Visa/MC)
- A2A: Account-to-account (open banking)

Payment Lifecycle: Four Stages

1. **Authorization:**
   - Merchant requests payment approval
   - Issuer checks funds/credit availability
   - Response: Approve or decline
   - Duration: 1-3 seconds
   - Holds funds on card (authorization hold)

2. **Authentication:**
   - Verify cardholder identity
   - 3D Secure (3DS): Password/OTP
   - Strong Customer Authentication (SCA, PSD2)
   - Biometrics (fingerprint, face ID)
   - Reduces fraud, increases approval rates

3. **Clearing:**
   - Batch processing of transactions
   - Exchange of transaction details
   - Calculation of net positions
   - Typically occurs daily (end-of-day)

4. **Settlement:**
   - Actual movement of funds
   - Issuer pays acquirer (via network)
   - Merchant receives funds (minus fees)
   - T+1 to T+3 for card payments
   - Instant for real-time payment rails

Card Payment Flow: Step-by-Step

Transaction Steps:

1. Customer presents card at merchant POS/online
2. Merchant sends authorization request to acquirer
3. Acquirer routes to card network (Visa/MC)
4. Network routes to issuing bank
5. Issuer checks account and responds (approve/decline)
6. Response travels back through chain
7. Merchant receives approval, completes sale
8. Clearing batch sent at end of day
9. Settlement occurs (funds transferred)
10. Merchant receives payment (T+1 to T+3)

Messaging Standards:

- ISO 8583: Card transaction messaging
- EMV: Chip card standards
- 3D Secure: Online authentication protocol
- PCI DSS: Security standards for card data

Approval Rate Factors:

- Sufficient funds/credit limit
- Card not blocked/expired
- Fraud screening passed
- Correct CVV and address
- Industry average: 85%-90%

Card Networks: Visa and Mastercard

Visa Inc:

- Founded: 1958 (BankAmericard)
- Market cap: $530B (2024)
- Cards in circulation: 4.2B globally
- Transaction volume: $14.8 trillion (2023)
- Revenue: $32.7B (FY2023)
- Net margin: 51%

Mastercard Inc:

- Founded: 1966 (Interbank Card)
- Market cap: $410B (2024)
- Cards in circulation: 3.1B globally
- Transaction volume: $9.0 trillion (2023)
- Revenue: $25.1B (FY2023)
- Net margin: 46%

Business Model:

- Four-party scheme (issuer, acquirer, network, cardholder)
- Do NOT issue cards or acquire merchants
- Revenue from transaction fees
- License brand to financial institutions
- Operate global payment networks

Revenue Streams:

- Service fees: 0.13%-0.15% per transaction
- Cross-border assessment fees: 1.0%-1.1%
- Volume-based rebates and incentives
- Value-added services (fraud, analytics)
- Licensing and certification

Interchange Fees: The Hidden Economy

What is Interchange?

- Fee paid by acquirer to issuer
- Compensation for fraud risk, funding, processing
- Set by card networks (Visa, Mastercard)
- Largest component of merchant fees
- Controversial and heavily regulated

Interchange Rate Factors:

- Card type (debit vs credit, premium)
- Merchant category code (MCC)
- Transaction type (card-present vs online)
- Region (EU capped, US market-driven)
- Card acceptance method (chip vs swipe)

Typical Interchange Rates (EU):

- Consumer debit: 0.2% (capped by regulation)
- Consumer credit: 0.3% (capped by regulation)
- Commercial cards: Uncapped (1.5%-2.5%)
- Cross-border: Additional 0.4%-0.8%

Typical Rates (USA, unregulated):

- Debit card: 1.0%-1.5%
- Credit card: 1.5%-3.0%
- Premium rewards cards: 2.5%-3.5%
- Example: \$100 purchase = \$2-\$3 interchange

Merchant Discount Rate (MDR): Total Cost

MDR Components:

- Interchange fee (70%-80% of MDR)
- Card network fee (0.13%-0.15%)
- Acquirer markup (0.10%-0.50%)
- Payment processor fee (if applicable)

Total MDR Examples (EU):

- Debit card: 0.5%-1.0%
- Credit card: 0.8%-1.5%
- American Express: 2.0%-3.5% (three-party)
- Large merchants: Negotiate lower rates
- Small merchants: Pay higher rates

Merchant Cost Analysis:

- 100 credit card purchase (EU)
- Interchange: 0.30 (0.3% cap)
- Network fee: 0.14 (0.14%)
- Acquirer margin: 0.25 (0.25%)
- Total MDR: 0.69 (0.69%)
- Merchant receives: 99.31

Impact on Business:

- Low-margin sectors (supermarkets: 2%-3%)
- Payment fees = significant cost
- Incentive for cash or A2A payments
- Volume discounts for large merchants

Interchange Fee Regulation

European Union (IFR 2015):

- Consumer debit cap: 0.2%
- Consumer credit cap: 0.3%
- Commercial cards: Exempt
- Cross-border treated as domestic
- Saved merchants 1.2B annually

United Kingdom (Post-Brexit):

- Maintained EU caps for domestic
- Cross-border EEA: Caps removed (2021)
- Interchange tripled on EU cards (1.5%)
- PSR reviewing commercial card fees

United States:

- Durbin Amendment (2010): Debit cap \$0.21 + 0.05%
- Applies only to large banks (\$10B+ assets)
- Credit cards: Unregulated
- Ongoing litigation (merchant class actions)

Australia:

- RBA regulation since 2003
- Weighted average caps
- Credit: 0.5%, Debit: 0.2% (2017)
- Allowed surcharging (pass cost to consumer)

ACH: Automated Clearing House

What is ACH?

- Electronic batch payment system (US)
- Operated by Nacha (formerly NACHA)
- Bank-to-bank transfers
- Low cost, high volume, batch processing
- 31B transactions, $76 trillion (2023)

ACH Transaction Types:

- Direct deposit (payroll, benefits)
- Direct debit (bill payments, subscriptions)
- B2B payments (vendor payments)
- P2P transfers (Venmo, Cash App backend)
- Tax payments and refunds

ACH Processing:

- Batch processing (4 times daily)
- Standard: T+1 settlement
- Same-Day ACH: Settlement same day (since 2016)
- Cost: $0.20-$1.50 per transaction
- Pull (debit) or Push (credit)

ACH vs Wire Transfer:

- ACH: Batch, low cost, T+1, reversible
- Wire: Real-time, high cost ($15-$30), irrevocable
- ACH volume: 100x higher than wire
- Wires for large/urgent payments

SEPA: Single Euro Payments Area

What is SEPA?

- Harmonized euro payment system
- Covers 36 countries (EU + EEA + others)
- Launched: 2008 (credit transfer), 2009 (direct debit)
- Treats cross-border like domestic
- 500M+ citizens, 20M+ businesses

SEPA Instruments:

- SEPA Credit Transfer (SCT): Push payments
- SEPA Instant Credit Transfer (SCT Inst): Real-time
- SEPA Direct Debit (SDD): Pull payments
- SEPA Card Framework (less successful)

SEPA Credit Transfer (SCT):

- Settlement: T+1 (next business day)
- No amount limit
- IBAN and BIC required
- ISO 20022 XML messaging
- Cost: Same as domestic

SEPA Instant (SCT Inst):

- Launched: November 2017
- Settlement: 10 seconds maximum
- Limit: 100,000 per transaction (raised from 15k in 2024)
- Available 24/7/365
- Adoption: 70%+ of EU banks (2024)
- Mandatory for banks by 2025 (EU regulation)

SEPA Direct Debit

SDD Core Scheme:

- Consumer pull payments
- Requires signed mandate
- Pre-notification required (14 days default)
- Refund rights: 8 weeks (authorized), 13 months (unauthorized)
- Settlement: T+1 or T+2

SDD B2B Scheme:

- Business-to-business only
- No refund right (authorized mandate)
- Bank verification of mandate
- Lower fraud risk
- Separate scheme identifier

Mandate Requirements:

- Unique Mandate Reference (UMR)
- Creditor Identifier (CI)
- Debtor IBAN
- Debtor signature (physical or electronic)
- Electronic mandates: PSD2 SCA required

Use Cases:

- Recurring bills (utilities, telecom)
- Subscriptions (streaming, gym)
- Loan repayments
- Insurance premiums
- Variable amount collections

Payment Processing Value Chain

Frontend Processors:

- Gateway providers (Stripe, Adyen, Checkout.com)
- Authorization routing
- Fraud screening
- 3D Secure authentication
- Merchant dashboard and APIs
- Revenue: Payment processing fees

Backend Processors:

- Clearing and settlement
- Reconciliation services
- Chargeback handling
- FIS, Fiserv, TSYS (now Fiserv)

Acquirer vs Gateway:

- Acquirer: Licensed bank, holds funds, settles
- Gateway: Technology layer, routes transactions
- Full-stack processors: Combine both (Adyen, Stripe)
- Traditional: Separate acquirer + gateway

Modern Payment Stack:

- Merchant integration: API/SDK
- Payment orchestration: Routing logic
- Multiple acquirers: Redundancy, optimization
- Network tokens: Enhanced security
- Real-time reporting: Analytics

Payment Service Providers (PSPs)

Leading PSPs:

- Stripe: $1 trillion TPV (2023), 100+ countries
- Adyen: 786B TPV (2023), unified platform
- PayPal/Braintree: $1.5 trillion TPV (2023)
- Worldpay (FIS): $2.2 trillion TPV
- Square/Block: $211B TPV (2023)

PSP Value Proposition:

- Single API for multiple payment methods
- Global reach with local acquiring
- Fraud prevention tools
- PCI compliance management
- Fast onboarding (hours vs months)

Pricing Models:

- Blended rate: e.g., 2.9% + $0.30 per transaction
- Interchange plus: IC + 0.5% + $0.10
- Custom enterprise pricing (volume discounts)
- Monthly subscription fees (optional)

Feature Comparison:

- Stripe: Developer-first, excellent APIs
- Adyen: Enterprise focus, single platform
- PayPal: Consumer brand, checkout conversion
- Square: SMB focus, integrated POS
- Checkout.com: High customization, flexible

Payment Security: PCI DSS

PCI DSS Overview:

- Payment Card Industry Data Security Standard
- Managed by PCI Security Standards Council
- Mandatory for all card payment entities
- Current version: PCI DSS 4.0 (March 2022)
- Compliance deadline: March 2025

12 Requirements (6 Goals):

1. Build and maintain secure network
2. Protect cardholder data
3. Maintain vulnerability management
4. Implement strong access controls
5. Monitor and test networks
6. Maintain information security policy

Compliance Levels (Visa):

- Level 1: 6M+ transactions/year (annual audit)
- Level 2: 1M-6M transactions (annual SAQ)
- Level 3: 20k-1M e-commerce (annual SAQ)
- Level 4: ¡20k e-commerce (annual SAQ)

Key Technical Controls:

- Encryption of cardholder data
- Tokenization (replace PAN with token)
- Firewall and network segmentation
- Vulnerability scanning
- Penetration testing
- Log monitoring and SIEM

Payment Fraud: Types and Prevention

Fraud Types:

- Card-not-present (CNP): Online fraud
- Card-present: Counterfeit, stolen cards
- Account takeover (ATO): Credential theft
- Friendly fraud: Chargeback abuse
- Refund fraud: Return scams

Fraud Statistics (Global):

- Total card fraud: $32B annually (2023)
- CNP fraud: 75% of total fraud
- Fraud rate: 0.15%-0.20% of volume
- Chargebacks: 0.6%-1.0% of transactions
- Cost to merchants: 3.6x transaction value

Prevention Technologies:

- 3D Secure 2.0: Frictionless authentication
- Machine learning fraud scoring
- Device fingerprinting
- Behavioral biometrics
- Address Verification System (AVS)
- CVV/CVC verification

Liability Shift:

- EMV chip: Shift to non-compliant party
- 3DS: Shift to issuer (if authenticated)
- Merchants incentivized to adopt
- Reduces fraud and chargebacks

Chargebacks: Process and Impact

Chargeback Reasons:

- Fraud: Card used without authorization
- Processing error: Duplicate charge, wrong amount
- Consumer dispute: Product not received/as described
- Authorization issue: Expired authorization

Chargeback Process:

1. Cardholder disputes with issuer (120 days)
2. Issuer initiates chargeback
3. Merchant notified via acquirer
4. Merchant provides evidence (10-45 days)
5. Issuer reviews and decides
6. Pre-arbitration or arbitration (if disputed)
7. Final decision (issuer or network)

Merchant Impact:

- Chargeback fee: $20-$100 per case
- Lost revenue from sale
- Lost merchandise (if shipped)
- Administrative time
- High ratios: Monitoring programs

Excessive Chargeback Programs:

- Visa: ¿0.9% ratio or 100/month
- Mastercard: ¿1.5% ratio or 100/month
- Penalties: Fines, higher MDR, termination
- Prevention: Fraud tools, clear policies

Real-Time Payments: Global Overview

Key Characteristics:

- Settlement in seconds (¡10 seconds)
- 24/7/365 availability
- Immediate funds availability
- Irrevocable payment
- ISO 20022 messaging standard

Global RTP Systems:

- UK: Faster Payments Service (2008)
- India: UPI (2016, 12B txns/month)
- Brazil: PIX (2020, 3.6B txns/month)
- USA: FedNow (2023), RTP Network (2017)
- EU: SEPA Instant (2017)
- China: Alipay/WeChat (proprietary)

UPI Success (India):

- Volume: 12.8B transactions/month (Oct 2024)
- Value: $240B/month
- Zero transaction fees (government subsidy)
- QR code-based payments
- 500M+ active users

Benefits:

- Improved cash flow
- Reduced fraud (account verified)
- Lower cost than cards
- Enhanced customer experience
- Financial inclusion (no card needed)

FedNow: US Real-Time Payments

FedNow Service:

- Launched: July 2023
- Operated by Federal Reserve
- Competing with RTP Network (Clearing House)
- Instant settlement (seconds)
- No transaction amount limit (initially $500k)
- Available to all US depository institutions

Adoption Challenges:

- Requires bank system upgrades
- Competition from existing RTP
- Zelle dominance in P2P
- Limited initial use cases
- 700+ financial institutions signed up (2024)

RTP Network (Clearing House):

- Launched: 2017
- Private sector alternative
- Owned by 22 major banks
- 400+ participants
- Similar functionality to FedNow

Use Cases:

- Emergency disbursements (disaster relief)
- Instant refunds and rebates
- Just-in-time payroll
- Gig economy payments
- Bill pay with immediate credit
- Business liquidity management

Payment Method Comparison

Cards:

- Speed: 2-4 seconds authorization, T+1-3 settlement
- Cost: 1%-3% MDR
- Reach: Global
- Security: Strong (EMV, 3DS)
- Consumer protection: Chargebacks
- Best for: E-commerce, POS

ACH/SEPA:

- Speed: T+1 (standard), same-day available
- Cost: $0.20-$1.50 or 0.2%-0.5%
- Reach: Domestic/regional
- Security: Bank-level
- Best for: Recurring, B2B, large amounts

Real-Time Payments:

- Speed: ¡10 seconds
- Cost: Low (often free to consumer)
- Reach: Domestic
- Security: Bank-verified accounts
- Irrevocable: Limited consumer protection
- Best for: P2P, urgent payments

Wire Transfer:

- Speed: Same-day
- Cost: $15-$50 per transaction
- Reach: Global (SWIFT)
- Security: High, irrevocable
- Best for: Large, urgent, cross-border

Summary and Key Takeaways

Payment Lifecycle:

- Authorization → Authentication → Clearing → Settlement
- Multiple intermediaries (issuer, acquirer, network)
- Card payments: 2-3 days for merchant settlement
- Real-time rails: Seconds

Card Networks:

- Visa and Mastercard dominate globally
- Four-party model (efficient network effects)
- Interchange = largest merchant cost component
- EU regulation caps interchange (0.2%-0.3%)

Payment Systems:

- ACH: US batch system, low cost, T+1
- SEPA: EU harmonized system, instant available
- Real-time: Growing globally, instant settlement
- Trade-offs: Speed vs cost vs security

Emerging Trends:

- Real-time payment adoption accelerating
- Account-to-account (A2A) challenging cards
- ISO 20022 standardization
- Open banking enabling payment initiation

Lesson 3: Digital Payments II – Mobile Wallets

We will explore:

- NFC technology and contactless payments
- Tokenization and security
- Apple Pay, Google Pay architecture
- M-Pesa and mobile money in emerging markets
- Alipay, WeChat Pay, and super-app models