Lesson 1.3: Real-Time Payments and Cost Compression
Practice Exercises

Digital Finance

Exercise 1: RTGS Liquidity Buffer Calculation

A bank participates in an RTGS system and processes the following outgoing payments on a single day:

Time	Outgoing (€)	Incoming (€)	Net Position (€)
09:00	5,000,000	0	?
10:00	3,000,000	2,000,000	?
11:00	0	8,000,000	?
12:00	7,000,000	1,000,000	?
14:00	2,000,000	4,000,000	?
16:00	0	6,000,000	?

Calculate:

1. The cumulative net position after each time slot
2. The **maximum intraday liquidity need** (peak negative cumulative position)
3. If the bank uses a **deferred net settlement** (DNS) system instead, what single end-of-day net amount settles?
4. What is the liquidity saving of DNS vs. RTGS (maximum intraday buffer vs. DNS amount)?

Exercise 2: Instant Payment Cost Savings

An online retailer currently processes all payments via card networks.

Current state (card-only):

- Monthly transactions: 50,000
- Average transaction value: €65
- Blended card MDR: 1.85%

Proposed state (hybrid):

- 30% of transactions migrate to instant payment (A2A via open banking)
- Instant payment cost: €0.08 per transaction (flat fee)
- Card MDR remains 1.85% for remaining 70%
- Integration cost for open banking: €15,000 one-time

Calculate:

1. Monthly card fees under current state
2. Monthly fees under proposed hybrid state (cards + instant payments)
3. Monthly net savings
4. Payback period for the integration investment (in months)
5. At what migration percentage does the payback period drop below 3 months?

Exercise 3: BNPL Provider Unit Economics

A BNPL provider offers 4-installment, interest-free financing.

Given per-transaction data:

- Average order value (AOV): $180
- Merchant Discount Rate (MDR): 5.5%
- Cost of capital (annualized): 6% (provider borrows to fund advances)
- Average repayment period: 6 weeks
- Default rate: 3.2% of transaction value (total loss on defaulted portion)
- Operational cost per transaction: $1.20 (underwriting, servicing, collections)
- Late fee revenue: averages $0.80 per transaction (across all transactions)

Calculate:

1. MDR revenue per transaction
2. Cost of capital per transaction (hint: annualized rate $\times$ fraction of year)
3. Credit loss per transaction
4. Net contribution per transaction (revenue $-$ all costs $+$ late fee revenue)
5. Contribution margin (% of AOV)
6. If the default rate rises to 5%, what is the new contribution per transaction?

Exercise 4: Stablecoin Corridor vs. Correspondent Banking

Compare two routes for a $10,000 cross-border remittance from the US to the Philippines.

Route A: Correspondent Banking

- Sending bank fee: $25 flat
- Intermediary bank fee: $15 flat
- FX markup: 2.5% over mid-market rate
- Receiving bank fee: $10 flat
- Settlement time: 3–5 business days

Route B: Stablecoin Corridor

- On-ramp fee: 0.25% of value
- Blockchain network fee: $0.10
- Off-ramp fee: 0.40% of value
- FX markup at off-ramp: 0.8% over mid-market rate
- Settlement time: approximately 5 minutes

Calculate:

1. Total cost of Route A (in USD)
2. Total cost of Route B (in USD)
3. Percentage cost saving of Route B over Route A
4. If the sender sends $10,000 monthly for a year, what is the annual saving?

Exercise 5: Payment Orchestration ROI

A merchant evaluates adding a payment orchestration layer.

Current state (single acquirer):

- Monthly transactions: 200,000
- Average transaction value: $80
- Current authorization rate: 88%
- Current blended fee: 2.30%

Projected state (orchestrated, 3 acquirers):

- Authorization rate improves to 93% (smart routing + retry logic)
- Blended fee drops to 2.05% (least-cost routing)
- Orchestration platform fee: $0.03 per transaction
- Monthly platform subscription: $2,000

Calculate:

1. Current monthly revenue lost due to declines (failed auth $\times$ avg. txn value)
2. Revenue recovered by improving auth rate from 88% to 93%
3. Monthly fee savings from lower blended rate (on successful transactions only)
4. Total monthly cost of the orchestration platform
5. Net monthly benefit (recovered revenue + fee savings $-$ platform cost)
6. Annual ROI of the orchestration investment

Exercise 6: ISO 20022 Migration Impact

A bank's cross-border payment operations before and after ISO 20022 migration.

Before migration (legacy MT messages):

- Monthly cross-border payments: 12,000
- Exception rate (requires manual repair): 8%
- Average cost per exception: €45 (staff time + delays)
- Average STP (Straight-Through Processing) rate: 92%

After migration (ISO 20022):

- Exception rate drops to 1.5%
- Average cost per exception: €30 (simpler to diagnose with structured data)
- STP rate improves to 98.5%
- Migration cost (one-time): €800,000
- Ongoing annual maintenance: €50,000

Calculate:

1. Monthly exception-handling cost before migration
2. Monthly exception-handling cost after migration
3. Monthly net savings from reduced exceptions
4. Payback period for the migration investment (months)
5. 3-year net present value (NPV) of savings at an 8% annual discount rate, net of migration and maintenance costs

Exercise 7: Open Banking A2A vs. Card Payment Comparison

A subscription service evaluates switching recurring payments from card pull to open banking A2A.

Current state (card recurring):

- Monthly subscribers: 25,000
- Subscription fee: €12.99/month
- Card MDR: 1.65% + €0.10 per transaction
- Card failure rate (expired cards, insufficient funds): 4.5%
- Recovery rate on failed card payments (retry + dunning): 60%

Proposed A2A (open banking direct debit via PISP):

- Cost: €0.05 per transaction
- Failure rate: 1.8% (bank account more stable than card-on-file)
- Recovery rate on failures: 80%
- Integration cost: €20,000 one-time

Calculate:

1. Monthly payment processing cost under card (on successful charges)
2. Monthly revenue lost to card failures net of recovery
3. Monthly payment cost and lost revenue under A2A
4. Monthly net savings of A2A over card
5. Payback period for the integration cost

Exercise 8: Multi-Rail Payment Strategy Design

Design a payment strategy for an EU marketplace with the following transaction profile:

Segment	Monthly Volume	Avg. Value	Customer Type
Low-value domestic	40,000	€22	EU consumer
Mid-value domestic	15,000	€85	EU consumer
High-value domestic	3,000	€350	EU consumer
Cross-border EU	8,000	€60	EU consumer
Cross-border non-EU	2,000	€95	Non-EU consumer

Available rails and costs:

- Card (Visa/MC): 1.8% + €0.12
- Open Banking A2A (PISP): €0.06 flat
- SEPA Instant: €0.04 flat
- BNPL (high-value only): 5.2% (increases conversion by 22% for orders >€200)

Tasks:

1. Assign the optimal rail to each segment (justify)
2. Calculate total monthly processing cost under your strategy
3. Calculate what the cost would be if all segments used cards only
4. What is the percentage saving of your multi-rail strategy vs. card-only?

Answer Key: Exercise 1

1. **Cumulative net positions:**

Time	Out	In	Cumulative Net
09:00	−5M	0	−5,000,000
10:00	−3M	+2M	−6,000,000
11:00	0	+8M	+2,000,000
12:00	−7M	+1M	−4,000,000
14:00	−2M	+4M	−2,000,000
16:00	0	+6M	+4,000,000

2. **Maximum intraday liquidity need:** €6,000,000 (at 10:00)
3. **DNS end-of-day net:** Total out = 17M, Total in = 21M → Net = +€4,000,000 (bank *receives*)
4. **Liquidity saving:** RTGS requires €6M buffer; DNS requires €0 (bank is net receiver). Saving = €6M. However, if the bank were a net payer, DNS would only require the net amount.

Answer Key: Exercise 2

1. **Monthly card fees (current):** $50{,}000 \times €65 \times 1.85\% = €60{,}125$
2. **Monthly fees (hybrid):**
   - Cards: $35{,}000 \times €65 \times 1.85\% = €42{,}087.50$
   - Instant: $15{,}000 \times €0.08 = €1{,}200$
   - Total: €43,287.50
3. **Monthly savings:** $€60{,}125 - €43{,}287.50 = €16{,}837.50$
4. **Payback period:** $€15{,}000/€16{,}837.50 = 0.89$ months $\approx$ **less than 1 month**
5. **Target migration %:** Let p = migration fraction. Savings $= 50{,}000 \times 65 \times 0.0185 \times p - 50{,}000 \times p \times 0.08 = p \times (60{,}125 - 4{,}000) = p \times 56{,}125$. Payback < 3 months: $p \times 56{,}125 > 15{,}000/3 = 5{,}000 \rightarrow p > 8.9\%$. Even $\sim$9% migration achieves 3-month payback.

Answer Key: Exercise 3

1. **MDR revenue:** $\$180 \times 5.5\% = \$9.90$
2. **Cost of capital:** $\$180 \times 6\% \times (6/52) = \$180 \times 0.00692 = \$1.25$ (6 weeks out of 52)
3. **Credit loss:** $\$180 \times 3.2\% = \$5.76$
4. **Net contribution:** $\$9.90 - \$1.25 - \$5.76 - \$1.20 + \$0.80 = \$2.49$
5. **Contribution margin:** $\$2.49 / \$180 = 1.38\%$
6. **At 5% default rate:** Credit loss $= \$180 \times 5\% = \$9.00$. Net contribution $= \$9.90 - \$1.25 - \$9.00 - \$1.20 + \$0.80 = -\$0.75$ (net loss per transaction).

Answer Key: Exercise 4

1. **Route A (Correspondent):**
   - Fees: $\$25 + \$15 + \$10 = \$50$
   - FX markup: $\$10{,}000 \times 2.5\% = \$250$
   - Total: $\$300$
2. **Route B (Stablecoin):**
   - On-ramp: $\$10{,}000 \times 0.25\% = \$25$
   - Network: $\$0.10$
   - Off-ramp: $\$10{,}000 \times 0.40\% = \$40$
   - FX at off-ramp: $\$10{,}000 \times 0.8\% = \$80$
   - Total: $\$145.10$
3. **Cost saving:** $(\$300 - \$145.10)/\$300 = 51.6\%$
4. **Annual saving:** $(\$300 - \$145.10) \times 12 = \$154.90 \times 12 = \$1{,}858.80$

Answer Key: Exercise 5

1. **Revenue lost to declines:** $200{,}000 \times (1 - 0.88) \times \$80 = 24{,}000 \times \$80 = \$1{,}920{,}000$
2. **Revenue recovered (auth 88% $\rightarrow$ 93%):**
   - New declines: $200{,}000 \times (1 - 0.93) = 14{,}000$
   - Recovered txns: $24{,}000 - 14{,}000 = 10{,}000$
   - Recovered revenue: $10{,}000 \times \$80 = \$800{,}000$
3. **Fee savings:**
   - Current fees: $200{,}000 \times 0.88 \times \$80 \times 2.30\% = 176{,}000 \times \$80 \times 0.023 = \$323{,}840$
   - New fees: $200{,}000 \times 0.93 \times \$80 \times 2.05\% = 186{,}000 \times \$80 \times 0.0205 = \$305{,}040$
   - Fee saving: $\$323{,}840 - \$305{,}040 = \$18{,}800$
4. **Platform cost:** $200{,}000 \times \$0.03 + \$2{,}000 = \$8{,}000$
5. **Net monthly benefit:** $\$800{,}000 + \$18{,}800 - \$8{,}000 = \$810{,}800$
6. **Annual ROI:** Annual benefit $= \$810{,}800 \times 12 = \$9{,}729{,}600$. Annual cost $= \$8{,}000 \times 12 = \$96{,}000$. ROI $= \$9{,}729{,}600 / \$96{,}000 = 10{,}135\%$.

Note: The massive ROI reflects that authorization-rate improvement recovers *revenue*, not just reduces *fees*—demonstrating why auth rate is the most impactful metric.

Answer Key: Exercise 6

1. **Monthly exception cost (before):** $12{,}000 \times 8\% \times €45 = 960 \times €45 = €43{,}200$
2. **Monthly exception cost (after):** $12{,}000 \times 1.5\% \times €30 = 180 \times €30 = €5{,}400$
3. **Monthly savings:** $€43{,}200 - €5{,}400 = €37{,}800$
4. **Payback period:** $€800{,}000 / €37{,}800 = 21.2$ months $\approx$ **1.8 years**
5. **3-year NPV:** Annual savings $= €37{,}800 \times 12 = €453{,}600$. At $r = 8\%$:

$$\text{NPV} = -800{,}000 + \frac{453{,}600 - 50{,}000}{1.08} + \frac{403{,}600}{1.08^2} + \frac{403{,}600}{1.08^3}$$

$$= -800{,}000 + 373{,}704 + 346{,}022 + 320{,}391 = €240{,}117$$

The migration has a positive NPV of approximately €240,000 over 3 years.

Answer Key: Exercise 7

1. **Monthly card processing cost:**
   - Successful charges: $25{,}000 \times (1 - 0.045) \times (€12.99 \times 1.65\% + €0.10)$
   - $= 23{,}875 \times (€0.2143 + €0.10) = 23{,}875 \times €0.3143 = €7{,}504$
2. **Revenue lost to card failures:**
   - Failed: $25{,}000 \times 4.5\% = 1{,}125$; Unrecovered: $1{,}125 \times 40\% = 450$
   - Lost revenue: $450 \times €12.99 = €5{,}846$
3. **A2A costs:**
   - Processing: $25{,}000 \times (1 - 0.018) \times €0.05 = 24{,}550 \times €0.05 = €1{,}228$
   - Failed: $25{,}000 \times 1.8\% = 450$; Unrecovered: $450 \times 20\% = 90$
   - Lost revenue: $90 \times €12.99 = €1{,}169$
4. **Monthly savings:**
   - Card total: $€7{,}504 + €5{,}846 = €13{,}350$
   - A2A total: $€1{,}228 + €1{,}169 = €2{,}397$
   - Savings: $€13{,}350 - €2{,}397 = €10{,}953$
5. **Payback:** $€20{,}000 / €10{,}953 = 1.83$ months $\approx$ **under 2 months**

Answer Key: Exercise 8 (Part 1)

1. **Optimal rail assignment:**
   - **Low-value domestic** (40k × €22): SEPA Instant (€0.04) – cheapest flat fee; percentage-based rails too expensive at low values
   - **Mid-value domestic** (15k × €85): Open Banking A2A (€0.06) – flat fee, reliable for mid-value
   - **High-value domestic** (3k × €350): BNPL (5.2%) – conversion uplift of 22% on high-value items justifies MDR premium
   - **Cross-border EU** (8k × €60): SEPA Instant (€0.04) – works across EU, flat fee
   - **Cross-border non-EU** (2k × €95): Card (1.8% + €0.12) – only rail with non-EU coverage
2. **Multi-rail monthly cost:**
   - Low-value: $40{,}000 \times €0.04 = €1{,}600$
   - Mid-value: $15{,}000 \times €0.06 = €900$
   - High-value: $3{,}000 \times €350 \times 5.2\% = €54{,}600$ (but generates 22% uplift $= 3{,}000 \times 0.22 \times 350 = €231{,}000$ incremental revenue)
   - XB-EU: $8{,}000 \times €0.04 = €320$
   - XB-non-EU: $2{,}000 \times (€95 \times 1.8\% + €0.12) = 2{,}000 \times €1.83 = €3{,}660$
   - **Total: €61,080**

Answer Key: Exercise 8 (Part 2)

3. Card-only monthly cost:

- Low-value: $40{,}000 \times (€22 \times 1.8\% + €0.12) = 40{,}000 \times €0.516 = €20{,}640$
- Mid-value: $15{,}000 \times (€85 \times 1.8\% + €0.12) = 15{,}000 \times €1.65 = €24{,}750$
- High-value: $3{,}000 \times (€350 \times 1.8\% + €0.12) = 3{,}000 \times €6.42 = €19{,}260$
- XB-EU: $8{,}000 \times (€60 \times 1.8\% + €0.12) = 8{,}000 \times €1.20 = €9{,}600$
- XB-non-EU: $2{,}000 \times €1.83 = €3{,}660$
- **Total: €77,910**

4. Percentage saving vs. card-only:
Comparing directly: $(€77{,}910 - €61{,}080)/€77{,}910 = 21.6\%$
However, the BNPL segment actually costs *more* per transaction than cards (€54,600 vs. €19,260). The multi-rail strategy is justified because:

- BNPL generates €231,000 in incremental revenue (far exceeding the €35,340 extra cost)
- The non-BNPL segments save $€77{,}910 - €19{,}260 - €3{,}660 = €54{,}990$ on card fees, replaced by $€1{,}600 + €900 + €320 = €2{,}820$
- **Net processing savings on non-BNPL:** $€54{,}990 - €2{,}820 - €3{,}660 = €48{,}510$ (88% reduction)