Lesson 6.2: Core Banking and Legacy Systems

Module 6: The Infrastructure Problem

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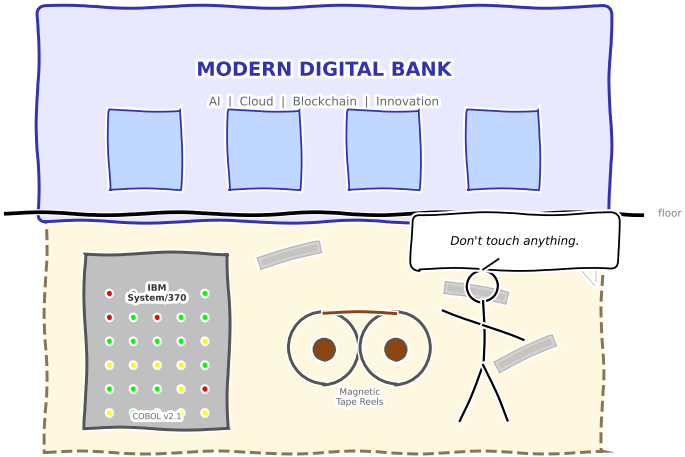
Bank Modernization: Expectations vs. Reality



"We put a chatbot on top of COBOL and called it digital transformation."

Learning Objectives

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

1. Describe the components of a core banking system and explain the role of the general ledger
2. Identify the causes and consequences of technical debt in financial institutions
3. Compare migration strategies (big bang, strangler fig, parallel run) and evaluate their risk profiles
4. Explain the strangler fig pattern and why it dominates modern bank modernization
5. Evaluate cloud migration trade-offs specific to financial services (latency, regulation, cost)
6. Contrast monolithic and microservice architectures in the context of banking
7. Distinguish data warehouse, data lake, and data mesh approaches for financial data
8. Describe event-driven architecture and its advantages for real-time banking

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These eight objectives cover the full modernization journey: from understanding legacy systems to designing their replacements.

Bridge: From Payment Rails to Bank Internals

Where we have been (Lesson 6.1):

- We traced the payment rails that connect institutions
- SWIFT, SEPA, real-time payment networks
- ISO 20022 messaging standards
- Settlement and clearing infrastructure

Where we are going:

- We see the payment rails. Now: **what is inside the banks that connect to them?**
- Core banking systems: the "engine room" of every financial institution
- Why modernizing these systems is a $300+ billion global effort

Lesson 6.1 explored the roads. Lesson 6.2 opens the hood of the vehicles that drive on them.

Every payment, every account balance, every interest calculation flows through a core banking system. Understanding these systems is essential to understanding modern banking.

What Is a Core Banking System?

Definition:

- The central software that processes a bank's daily transactions and posts updates to accounts and financial records
- "Core" = **C**entralized **O**nline **R**eal-time **E**xchange
- Every account balance, interest calculation, and transaction flows through this system

Core functions:

- Account management (open, close, modify)
- Transaction processing (debits, credits, transfers)
- Interest and fee calculation
- Regulatory reporting and compliance

Who builds core banking systems?

- **Legacy vendors:** FIS (Systematics), Fiserv (Signature), Temenos (T24), Finastra
- **Cloud-native challengers:** Thought Machine (Vault), Mambu, 10x Banking, Finxact
- **In-house:** JP Morgan, Goldman Sachs build proprietary systems

Scale:

- FIS serves 50+ of the world's top 100 banks
- Temenos: 3,000+ institutions, 1.2 billion end users
- Global core banking market: $18B (2024), growing 10%+ annually

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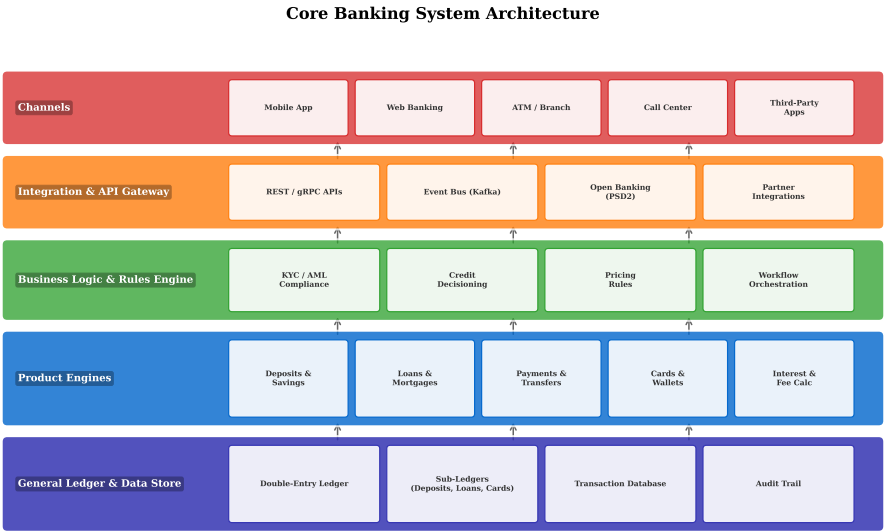
A core banking system is to a bank what an operating system is to a computer: invisible to customers, but nothing works without it.

Core Banking Architecture



The General Ledger: Foundation of All Banking

What is a general ledger?

- The authoritative record of every financial transaction
- Double-entry bookkeeping: every debit has a matching credit
- **Assets = Liabilities + Equity** must hold at all times
- If the general ledger is wrong, the bank is wrong

Why it matters for technology:

- Sub-ledgers (deposits, loans, trading) feed into the GL
- End-of-day vs. real-time posting is a key architectural choice
- Reconciliation between sub-ledgers and GL is a daily operational risk

Double-entry example (customer deposit):

Account	Debit	Credit
Cash (Asset)	$1,000	
Customer Deposit (Liability)		$1,000

Modern GL challenges:

- Real-time balances vs. batch posting
- Multi-currency, multi-entity consolidation
- Regulatory reporting (IFRS 9, Basel III)
- Audit trail and immutability requirements

The general ledger is the single source of truth for a bank's financial position. Every modernization project must answer: "How do we migrate the GL without losing a single cent?"

COBOL, Mainframes, and the Legacy Burden

The COBOL reality:

- COBOL (1959): still processes 95% of ATM transactions and 80% of in-person transactions globally
- 220 billion lines of COBOL in production today
- IBM mainframes run the core systems of most top-50 banks
- Average age of a bank's core system: 25–35 years

Why banks still run COBOL:

- Extremely reliable: mainframes achieve 99.999% uptime
- Highly optimized for batch transaction processing
- Regulatory-compliant and audited for decades
- "If it ain't broke, don't fix it" mentality

The demographic time bomb:

- Average COBOL programmer age: 55–60 years
- Universities stopped teaching COBOL decades ago
- Knowledge locked in undocumented code and retiring experts
- During COVID-19 (2020), US states scrambled to find COBOL programmers to fix unemployment systems

Mainframe economics:

- MIPS (Million Instructions Per Second) pricing
- License costs: $1–3M per year for large banks
- Hardware refresh cycles: 5–7 years
- Vendor lock-in: switching costs enormous

COBOL is not dead—it processes $3 trillion in daily commerce. The problem is not the language; it is the shrinking pool of people who understand it.

Technical Debt: The Hidden Cost of "Good Enough"

Definition:

- The implied cost of rework caused by choosing a quick, easy solution now instead of a better approach that would take longer
- Like financial debt: you pay "interest" in the form of slower development, more bugs, and higher maintenance costs

Sources in banking:

- Decades of patches on top of patches
- Mergers: bolting together incompatible systems
- Regulatory changes requiring quick fixes
- Point-to-point integrations (spaghetti architecture)
- Undocumented business logic in code

Measurable impact:

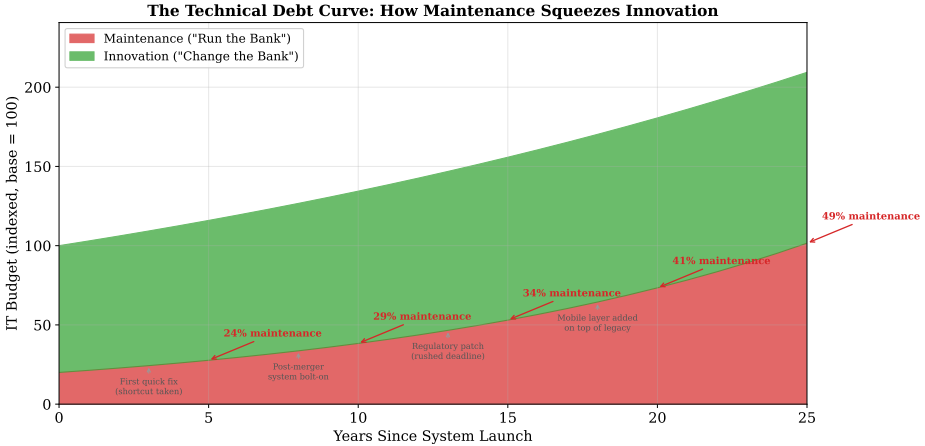
- Banks spend 70–80% of IT budgets on maintenance ("run the bank") vs. innovation ("change the bank")
- Average time to launch a new product: 12–18 months (legacy) vs. 2–4 weeks (cloud-native)
- Integration costs: $50–200M for a typical merger

The "paving over" pattern:

- Layer 1: COBOL batch system (1980s)
- Layer 2: Java middleware (2000s)
- Layer 3: REST APIs over middleware (2010s)
- Layer 4: Mobile app calling APIs (2020s)
- Result: 4 layers of abstraction, one fragile stack

Ward Cunningham coined "technical debt" in 1992. In banking, the compound interest on this debt has reached crisis levels—some institutions spend $1B+ annually just to keep legacy systems running.

The Technical Debt Curve



As technical debt accumulates, the cost of change rises exponentially. Eventually, maintenance consumes nearly the entire IT budget, leaving nothing for innovation.

Core Banking Migration: Three Approaches

1. Big Bang

- Replace entire system at once
- Single cutover weekend
- All-or-nothing

Pro: Clean break, no dual maintenance
Con: Catastrophic failure risk, no rollback

Example: TSB Bank (2018)—botched migration left 1.9M customers locked out for weeks

2. Strangler Fig

- Gradually replace components
- Old and new coexist
- Route traffic incrementally

Pro: Low risk, reversible, incremental value
Con: Dual-system complexity, slower

Example: Commonwealth Bank of Australia—5-year program, 15M accounts migrated

3. Parallel Run

- Both systems process simultaneously
- Compare results daily
- Switch when confidence is high

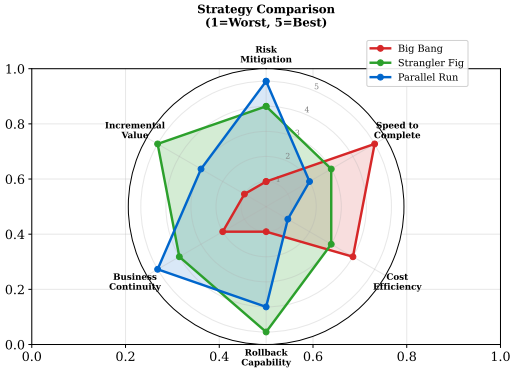
Pro: Maximum safety, full verification
Con: Double the cost, data sync challenges

Example: Common in regulatory-critical systems (trading, settlement)

There is no risk-free migration strategy. The choice depends on the bank's risk appetite, budget, and regulatory constraints.

Migration Strategy Comparison

Core Banking Migration: Strategy Comparison



Strategy Summary

Dimension	Big Bang	Strangler Fig	Parallel Run
Best for	Small banks, simple systems	Large banks, complex systems	Regulated, mission-critical
Duration	3-6 months	3-7 years	2-4 years
Risk Level	Very High	Low-Medium	Low
Cost	Lowest upfront	Medium	Highest (2x ops)
Industry Preference	Rare (neobanks)	Most common	Trading/settlement

The strangler fig pattern dominates modern migrations because it balances risk reduction with continuous delivery of business value.

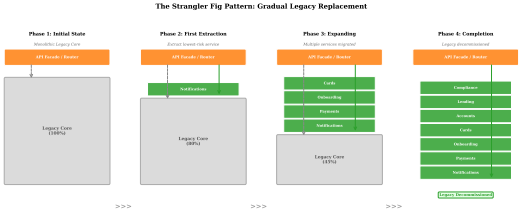
The Strangler Fig Pattern

Named after the strangler fig tree:

- A fig vine grows around a host tree
- Gradually replaces the host's structure
- Eventually the host dies, leaving only the fig
- Martin Fowler popularized this for software (2004)

How it works in banking:

1. Identify a bounded context (e.g., savings accounts)
2. Build the new service alongside the old system
3. Route new traffic to the new service (facade pattern)
4. Migrate existing data gradually
5. Decommission the old component when fully replaced
6. Repeat for the next bounded context



The strangler fig pattern is the de facto standard for bank modernization. It allows continuous delivery of value while managing risk incrementally.

Case Study: TSB Bank Migration Failure (2018)

What happened:

- TSB migrated from Lloyds Banking Group's legacy platform to Sabadell's Proteo4UK
- "Big bang" cutover over a single weekend (April 2018)
- 1.9 million customers locked out of online banking
- Some customers could see other people's accounts
- Fraud losses spiked as criminals exploited the chaos

Root causes:

- Insufficient testing under production load
- Data migration errors (account mapping)
- No phased rollout or canary deployment
- Compressed timeline driven by commercial pressure

Consequences:

- CEO resigned
- £330M in costs (remediation, compensation, fines)
- 80,000 customers left the bank
- FCA regulatory investigation
- IBM report cited 586 failures across 117 categories

Lessons learned:

- Big bang migrations are high risk for retail banking
- Test at production scale, not just functional correctness
- Phased rollout with rollback capability is essential
- Board and executive ownership of IT risk
- Independent assurance before go-live

TSB is the cautionary tale every bank CTO references. The total cost exceeded 10 times the original migration budget. "Move fast and break things" does not apply to banking.

Cloud Migration in Financial Services

Why banks are moving to cloud:

- **Elasticity:** Scale compute for end-of-month, year-end, Black Friday
- **Speed:** Provision new environments in minutes, not months
- **Cost:** OpEx vs. CapEx; pay-per-use instead of owning hardware
- **Innovation:** Access to AI/ML, analytics, managed databases
- **Resilience:** Multi-region redundancy out of the box

Cloud models:

- **IaaS:** Lift-and-shift VMs (least value, easiest)
- **PaaS:** Managed databases, containers
- **SaaS:** Core banking as a service (Thought Machine, Mambu)

Banking-specific cloud challenges:

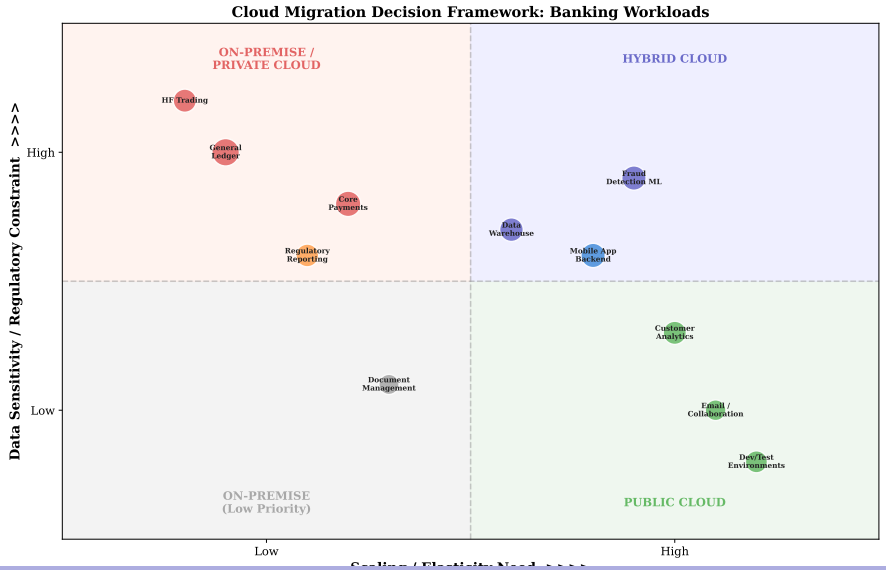
- **Data sovereignty:** Customer data must stay in-jurisdiction (EU GDPR, Swiss FINMA)
- **Concentration risk:** Regulators worry about dependence on AWS/Azure/GCP
- **Latency:** Trading systems need sub-millisecond latency
- **Auditability:** Full audit trail of who accessed what data
- **Exit strategy:** What if you need to leave the cloud provider?

Industry reality (2024):

- Only $\sim$15% of banking workloads are in public cloud
- Hybrid cloud dominates: sensitive data on-premise, analytics in cloud
- Regulators now accept cloud if controls are demonstrated

Cloud is not a destination; it is an operating model. The question is not "should we go to cloud?" but "which workloads benefit from cloud, and under what controls?"

Cloud Migration Decision Framework



Monolithic vs. Microservice Architecture

Monolithic architecture:

- Single deployable unit containing all functionality
- Shared database, shared codebase
- Change one module $\rightarrow$ redeploy everything
- Tight coupling: one bug can bring down the entire system

Advantages:

- Simpler to develop initially
- Easier debugging (single process)
- No network latency between components
- Well-understood by existing teams

Microservice architecture:

- Independent services communicating via APIs
- Each service owns its own data store
- Deploy, scale, and update independently
- Team autonomy: each team owns a service

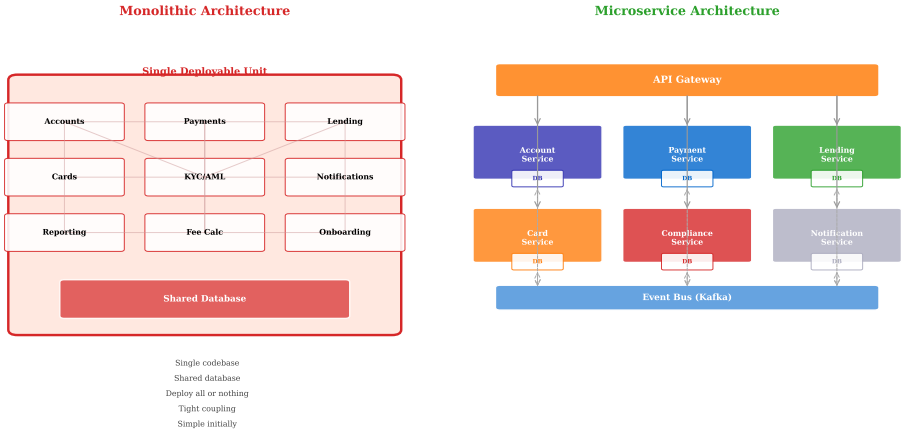
Advantages:

- Independent deployment and scaling
- Technology diversity (polyglot)
- Fault isolation (one service fails, others continue)
- Better alignment with agile/DevOps teams

Microservices are not universally better. They trade monolithic complexity for distributed-system complexity. The right choice depends on team size, system maturity, and operational capability.

Architecture Comparison

Monolithic vs. Microservice: Architecture Comparison



Microservices excel when teams are large, deployments are frequent, and components scale at different rates. Monoliths are appropriate for smaller teams and simpler domains.

API-First Architecture: The Integration Layer

What is API-first?

- Design the API contract *before* building the implementation
- APIs are the product, not an afterthought
- OpenAPI/Swagger specifications define the contract
- Enables parallel development: frontend and backend teams work independently

API gateway pattern:

- Single entry point for all external requests
- Handles authentication, rate limiting, routing
- Decouples internal service topology from external consumers
- Examples: Kong, Apigee, AWS API Gateway

Why API-first matters for banking:

- Open Banking (PSD2) mandates APIs for third-party access
- Partners, fintechs, and regulators need structured data access
- Internal microservices communicate via APIs
- API versioning prevents breaking changes

API governance in banking:

- **Authentication:** OAuth 2.0, mutual TLS
- **Authorization:** Scope-based access (read-only, transactional)
- **Rate limiting:** Protect core systems from overload
- **Audit logging:** Every API call recorded
- **Versioning:** Semantic versioning (v1, v2) with deprecation policy

API-first is not just a technology pattern—it is a business strategy. Banks that master APIs can become platforms, offering Banking-as-a-Service (BaaS) to third parties.

Event-Driven Architecture for Real-Time Banking

What is event-driven architecture (EDA)?

- Systems communicate by producing and consuming events
- An event = "something happened" (e.g., "account credited $500")
- Producers do not know who consumes their events
- Loose coupling: add new consumers without changing producers

Key technologies:

- **Apache Kafka:** Distributed event streaming platform
- **Event sourcing:** Store events as the primary data model (not current state)
- **CQRS:** Command Query Responsibility Segregation—separate read and write models

Banking use cases:

- Real-time fraud detection (process events as they occur)
- Instant balance updates across channels
- Regulatory event reporting (MiFID II transaction reporting)
- Customer notifications (push alerts on transactions)

EDA vs. batch processing:

	Batch	**Event**
Latency	Hours	Milliseconds
Coupling	Tight	Loose
Scaling	Vertical	Horizontal
Replay	Difficult	Built-in

Event-driven architecture is the foundation of real-time banking. Kafka processes trillions of events daily across the financial industry, enabling instant payments, fraud detection, and compliance.

Data Architecture Evolution: Warehouse, Lake, Mesh

Data Warehouse

- Structured, schema-on-write
- Star/snowflake schemas
- SQL-based querying
- **Use:** Regulatory reporting, BI dashboards

Pro: Clean, governed, performant
Con: Rigid schema, slow to adapt

Data Lake

- Raw data, schema-on-read
- Stores structured + unstructured
- Cheap storage (S3, ADLS)
- **Use:** ML training, exploration, archiving

Pro: Flexible, cost-effective
Con: Can become "data swamp" without governance

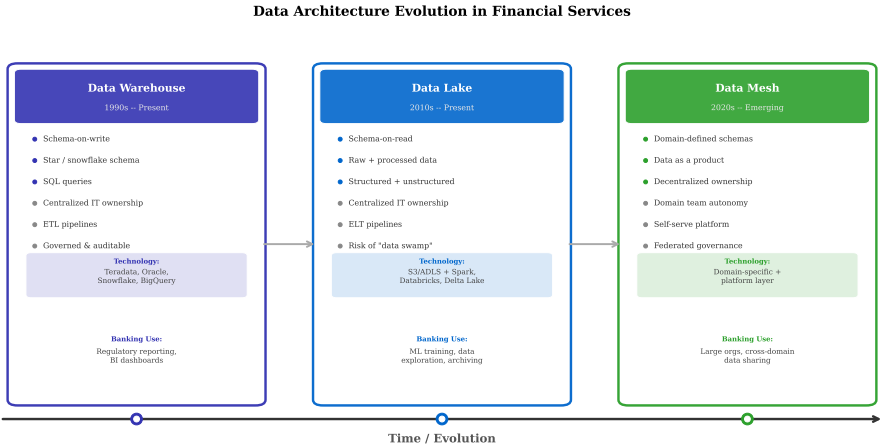
Data Mesh

- Decentralized ownership
- Domain teams own their data products
- Self-serve data platform
- **Use:** Large, complex organizations

Pro: Scalable governance, domain expertise
Con: Organizational change required, coordination overhead

Most modern banks use a hybrid: a governed data warehouse for regulatory reporting, a data lake for analytics and ML, and increasingly data mesh principles for cross-domain data sharing.

Data Architecture Evolution



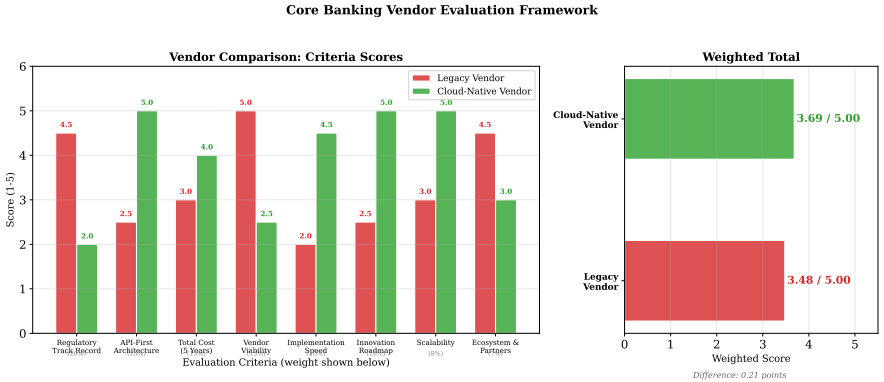
Each generation addressed limitations of the previous one. Data mesh is the newest paradigm, treating data as a product owned by domain teams rather than a centralized IT function.

Core Banking Vendor Landscape

Vendor	Product	Architecture	Cloud	Notable Client
Thought Machine	Vault	Cloud-native, microservices	Yes (GCP)	Lloyds, SEB, Standard Chartered
Temenos	Transact	Modular, API-first	Hybrid	3,000+ banks globally
FIS	Modern Banking Platform	Modular	Hybrid	50+ top-100 banks
Mambu	SaaS Core	Cloud-native, composable	Yes (AWS)	N26, ABN AMRO
10x Banking	SuperCore	Cloud-native	Yes (AWS/GCP)	JPMorgan Chase (UK)
Finxact	Core-as-a-Service	API-first	Yes (AWS)	Acquired by Fiserv

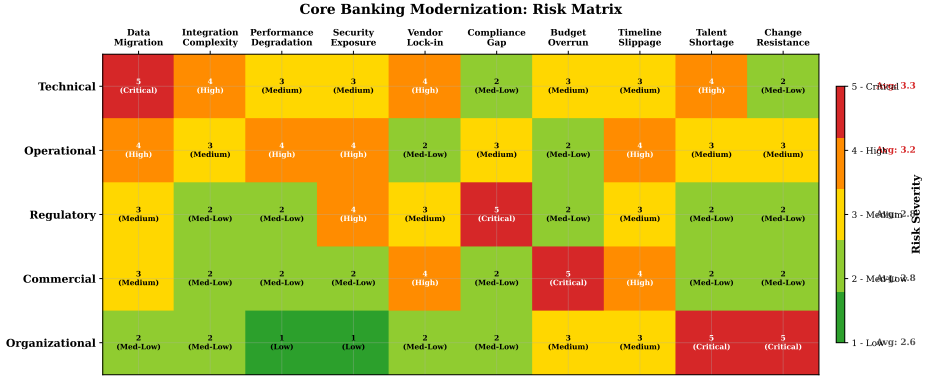
The vendor choice is one of the most consequential technology decisions a bank makes. It determines architecture, operational model, and innovation capacity for 10–20 years.

Vendor Evaluation Framework



A rigorous evaluation framework considers technology, commercial terms, regulatory fit, vendor viability, and implementation track record. No single vendor excels on all dimensions.

Modernization Risk Matrix



Core banking modernization carries risks across multiple dimensions: technical, operational, regulatory, commercial, and organizational. A risk matrix helps prioritize mitigation efforts.

Critical Success Factors for Core Banking Modernization

Technology:

- API-first design from day one
- Comprehensive automated testing (10,000+ test cases)
- Data migration rehearsals (minimum 3 full runs)
- Canary deployments and feature flags
- Performance testing at 2× production load

Organization:

- Executive sponsorship at board level
- Dedicated migration team (not shared with BAU)
- Early and continuous regulator engagement
- Change management for branch and operations staff

Process:

- Incremental delivery (strangler fig, not big bang)
- Business-outcome-driven milestones, not just technical milestones
- Independent assurance / third-party review
- Clearly defined rollback criteria and procedures

What the data shows:

- 70% of core banking migrations exceed their original timeline
- 50% exceed their original budget
- Average duration: 3–7 years for a large bank
- Success rate is higher with phased approaches
- Banks that involve regulators early face fewer delays

Core banking migration is as much an organizational transformation as a technology project. The banks that succeed treat it as a multi-year strategic program, not a one-off IT project.

Key Takeaways

1. **Core banking systems** are the central nervous system of a bank—processing every transaction, maintaining every balance, and feeding every report
2. **The general ledger** enforces double-entry bookkeeping and is the authoritative record; migrating it is the hardest part of any modernization
3. **Technical debt** compounds like financial debt—banks spending 70–80% of IT budgets on maintenance is the symptom
4. **COBOL is not the problem**; the shrinking talent pool and undocumented business logic embedded in legacy code are
5. **The strangler fig pattern** is the industry standard for migration: gradual, reversible, incremental value delivery
6. **Cloud migration** in banking is a regulatory and architectural decision, not just a hosting decision
7. **Microservices and event-driven architecture** enable the agility banks need but introduce distributed-system complexity
8. **Data architecture** is evolving from centralized warehouses to hybrid approaches including data mesh for domain ownership

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Modernizing core banking is the defining technology challenge of the 2020s for financial institutions. Getting it right determines competitive survival.

Summary: Lesson 6.2

Concepts Covered:

- Core banking system components and the general ledger
- COBOL, mainframes, and the legacy burden
- Technical debt: sources, measurement, and consequences
- Migration strategies: big bang, strangler fig, parallel run
- TSB Bank case study (migration failure)
- Cloud migration: drivers, models, and banking-specific challenges
- Monolithic vs. microservice architecture
- API-first design and API governance
- Event-driven architecture (Kafka, event sourcing, CQRS)
- Data warehouse, data lake, and data mesh
- Vendor landscape and evaluation framework

What comes next:

- Lesson 6.3: Identity, authentication, and cybersecurity infrastructure
- Lesson 6.4: Operational resilience and disaster recovery

Key numbers to remember:

- 95% of ATM transactions run on COBOL
- 70–80% of bank IT budgets go to maintenance
- 70% of core migrations exceed their timeline
- £330M: cost of TSB's failed migration
- $18B: global core banking software market (2024)

Core banking modernization is the foundation on which all other digital finance innovations are built. Without it, real-time payments, open banking, and embedded finance remain aspirations.

Discussion Questions

1. A mid-size European bank (2M customers, €50B assets) is running a 30-year-old COBOL core. The board asks: "Should we modernize?" What questions would you ask before recommending a strategy?

2. Why did TSB choose a big bang migration, and what organizational pressures might have overridden the technical risks? Could the same failure happen today?

3. A neobank built cloud-native from day one argues it has "zero technical debt." Do you agree? What new forms of technical debt might cloud-native systems accumulate?

4. Compare the data architecture needs of a retail bank (millions of small transactions) vs. an investment bank (fewer but larger, more complex transactions). Would they choose the same approach?

5. If COBOL processes $3 trillion daily and achieves 99.999% uptime, is the push to modernize driven by genuine need or by technology fashion? Argue both sides.

These questions have no single right answer. They require balancing technical, commercial, regulatory, and organizational considerations—exactly like real decisions in banking.