

# Lesson 44: Capital Markets Technology

## Module 4: Traditional Digital Finance

Digital Finance Course

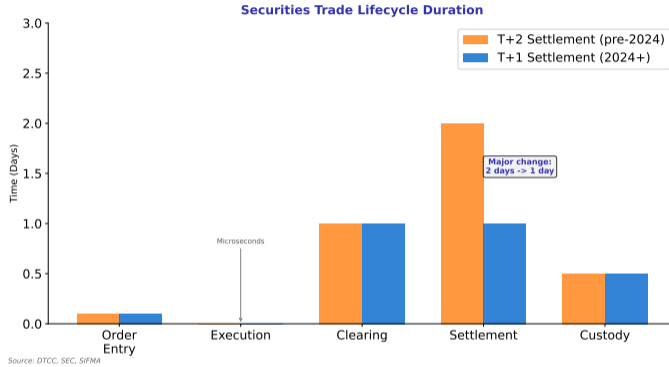
2025

## Learning Objectives

- Understand the trade lifecycle from order to settlement
- Analyze Order Management Systems (OMS), Execution Management Systems (EMS), and Portfolio Management Systems (PMS)
- Examine clearing and settlement infrastructure
- Evaluate post-trade processing and T+1 settlement
- Assess securities lending and repo technology

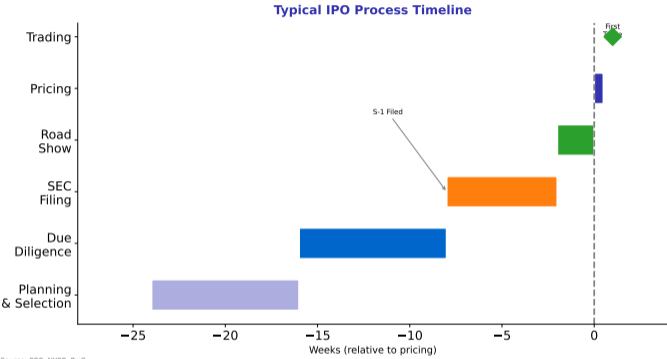
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Source: Financial industry data and regulatory publications

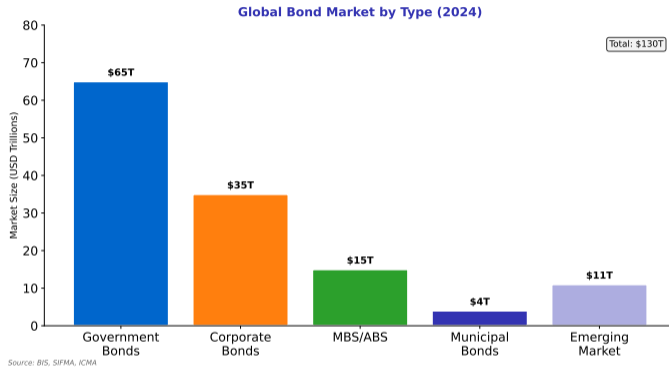


Capital markets involve complex workflows from origination to settlement.

# IPO Timeline and Process



**IPO process requires coordination across multiple parties over several months.**



**Bond markets offer diverse instruments across risk and maturity spectrum.**

# End-to-End Trade Lifecycle

## Pre-Trade Phase:

- 1 **Investment Decision:** Portfolio manager identifies opportunity
- 2 **Compliance Check:** Pre-trade compliance rules (limits, restrictions)
- 3 **Order Creation:** Order entered into OMS
- 4 **Order Routing:** EMS routes to broker/venue

## Trade Execution Phase:

- 5 **Market Access:** Order reaches exchange/OTC market
- 6 **Execution:** Order matched and filled
- 7 **Trade Capture:** Execution details recorded
- 8 **Trade Enrichment:** Add settlement instructions, SSIs

## Post-Trade Phase:

- 9 **Trade Confirmation:** Counterparty agreement (affirmation)
- 10 **Clearing:** Central counterparty (CCP) or bilateral
- 11 **Settlement:** Exchange of securities for cash
- 12 **Custody:** Asset safekeeping and servicing
- 13 **Reporting:** Regulatory and client reporting

## Typical Timeline (Equities):

- Execution: Milliseconds to seconds
- Confirmation: T+0 (same day)
- Settlement: T+1 (US, May 2024) or T+2 (Europe)

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Technology adoption follows predictable patterns—timing matters for investment decisions.

# Key Systems in Trade Lifecycle

## Front Office Systems:

- **PMS (Portfolio Management):** Holdings, analytics, compliance
- **OMS (Order Management):** Order creation, routing, allocation
- **EMS (Execution Management):** Smart order routing, algos, broker connectivity
- **RMS (Risk Management):** Pre/post-trade risk checks

## Middle Office Systems:

- **Trade Matching:** Confirm execution details with counterparty
- **P&L and Attribution:** Explain portfolio performance
- **Collateral Management:** Margin calls, OTC derivatives
- **Corporate Actions:** Dividends, stock splits, tenders

## Back Office Systems:

- **Clearing:** CCP novation, netting
- **Settlement:** DVP (Delivery vs Payment) processing
- **Custody:** Safekeeping, asset servicing
- **Reconciliation:** Cash, positions, NAV
- **Reporting:** Regulatory (MiFID II, EMIR), client statements

## Data Management:

- **Reference Data:** Securities master, counterparty data
- **Market Data:** Prices, corporate actions
- **Master Data:** Accounts, legal entities (LEI)

*Leading platforms: Charles River (PMS/OMS/EMS), Bloomberg AIM, SimCorp Dimension, Aladdin (BlackRock)*

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Technology adoption follows predictable patterns—timing matters for investment decisions.

# Order Management Systems (OMS)

## Core OMS Functions:

- **Order Entry:** Support all order types (market, limit, algo)
- **Pre-Trade Compliance:** Rule-based checks (concentration limits, restricted lists)
- **Order Routing:** Send to EMS or broker for execution
- **Execution Management:** Track fill status and average price
- **Allocation:** Distribute fills across accounts (pro-rata, FIFO)
- **Audit Trail:** Immutable log of all order events (MiFID II requirement)

## Order Lifecycle in OMS:

- 1 Created (PM enters order)
- 2 Validated (compliance check)
- 3 Routed (sent to broker/EMS)
- 4 Partially Filled / Filled
- 5 Allocated (to client accounts)
- 6 Booked (to accounting system)

## OMS Vendors:

- **Charles River IMS:** Multi-asset, buy-side focused
- **Bloomberg AIM:** Integrated with market data and analytics
- **Eze OMS (SS&C):** Hedge funds and asset managers
- **SimCorp Dimension:** Front-to-back platform
- **Aladdin (BlackRock):** Enterprise investment management

## Integration Points:

- **Upstream:** PMS portfolio models, compliance system
- **Downstream:** EMS, brokers (FIX protocol)
- **Lateral:** Market data, reference data, risk analytics
- **Back Office:** Trade booking, settlement systems

*Industry trend: Cloud-native OMS (Enfusion, Talos) gaining traction vs legacy on-premise*

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Source: Financial industry data and regulatory publications

# Execution Management Systems (EMS)

## EMS Core Capabilities:

- **Smart Order Routing (SOR):** Best execution across venues
- **Algorithmic Trading:** VWAP, TWAP, implementation shortfall
- **Direct Market Access (DMA):** Low-latency connectivity
- **Broker Aggregation:** Consolidate execution across brokers
- **TCA (Transaction Cost Analysis):** Post-trade performance measurement
- **FIX Connectivity:** Industry-standard protocol for order routing

## Buy-Side vs Sell-Side EMS:

- **Buy-Side:** Broker-neutral, multi-broker connectivity, TCA focus
- **Sell-Side:** Broker-specific, liquidity sourcing, client order handling

## Leading EMS Providers:

- **FlexTrade:** Multi-asset, broker-neutral
- **Bloomberg EMSX:** Integrated with Terminal
- **Fidessa (ION):** Equities and derivatives
- **Portware (FactSet):** Algorithmic trading focus
- **TradingScreen:** FX and multi-asset

## Best Execution Framework:

- **Pre-Trade:** Venue analysis, liquidity assessment
- **Execution:** SOR optimizes routing decisions
- **Post-Trade:** TCA benchmarks (VWAP, arrival price, implementation shortfall)
- **Reporting:** RTS 27/28 (MiFID II), Rule 606 (US)

*Typical EMS connects to 20-50 brokers and 100+ execution venues globally*

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Source: Financial industry data and regulatory publications

# Portfolio Management Systems (PMS)

## PMS Core Functions:

- **Portfolio Modeling:** Target allocations, rebalancing
- **Performance Measurement:** Time-weighted, money-weighted returns
- **Attribution Analysis:** Decompose returns (allocation vs selection)
- **Risk Analytics:** VaR, tracking error, factor exposures
- **Compliance Monitoring:** Investment guidelines, restrictions
- **Client Reporting:** Customizable statements and factsheets

## Performance Attribution (Brinson Model):

$$R_p - R_b = \underbrace{\sum w_i(R_i - R_b)}_{\text{Allocation}} + \underbrace{\sum W_b(r_i - R_i)}_{\text{Selection}} + \underbrace{\sum (w_i - W_b)(r_i - R_i)}_{\text{Interaction}}$$

where  $w_i$  = portfolio weight,  $W_b$  = benchmark weight,  $r_i$  = sector return,  $R_i$  = benchmark sector return

## Leading PMS Platforms:

- **Aladdin (BlackRock):** Enterprise, institutional scale
- **SimCorp Dimension:** Front-to-back, asset managers
- **Charles River IMS:** Integrated OMS/PMS
- **FactSet:** Analytics and reporting focus
- **Refinitiv (LSEG) Eikon:** Multi-asset portfolio tools

## Data Sources:

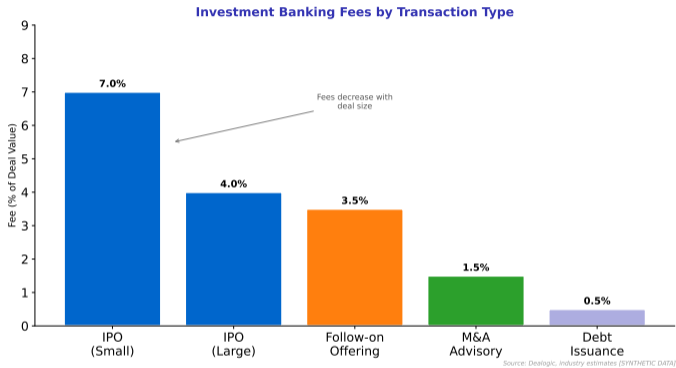
- **Positions:** From custodians, prime brokers
- **Prices:** Market data vendors (Bloomberg, Refinitiv)
- **Transactions:** OMS, trade confirmations
- **Benchmarks:** Index providers (MSCI, FTSE Russell)
- **Corporate Actions:** Data vendors, custodians

*Aladdin serves \$21+ trillion AUM across 13,000+ institutions (2024)*

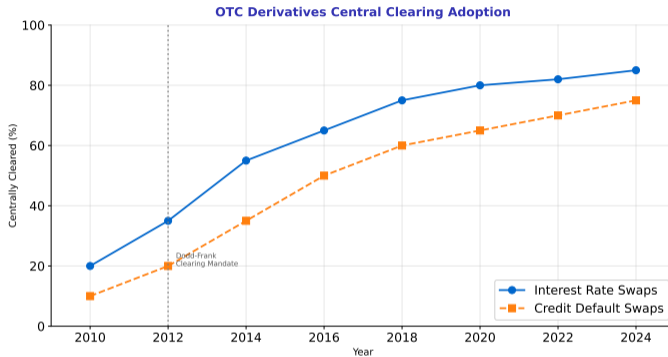
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Source: Financial industry data and regulatory publications

# Underwriting Fee Structures



Underwriting fees vary by deal size, complexity, and market conditions.



Clearing reduces counterparty risk through central counterparty novation.

## CCP Functions:

- Novation: Buyer to every seller
- Netting: Reduce settlement volume
- Margin: Initial + variation margin
- Default management: Waterfall

## Major CCPs:

- DTCC/NSCC (US equities)
- LCH SwapClear (\$500T+ IRS)
- CME, Eurex, ICE

## Margin Requirements:

- IM: Collateral at inception (VaR-based)
- VM: Daily mark-to-market

## Default Waterfall:

- 1 Defaulter's margin + fund
- 2 CCP skin-in-the-game
- 3 Mutualized default fund
- 4 Assessment powers

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CCPs reduce counterparty risk through novation and margin. [Source: BIS, LCH 2024]

# Settlement Infrastructure

## Delivery vs Payment (DVP):

- Simultaneous exchange; eliminates principal risk
- Model 1: Gross RTGS; Model 2: Gross sec/net cash
- Model 3: Net both (most common)

## Central Securities Depositories:

- DTC (US), Euroclear (Int'l), Clearstream (German)
- National CSDs: SIX SIS, Monte Titoli, etc.

## Settlement Cycles (2024):

- US Equities: T+1 (May 2024); Treasuries: T+1
- EU: T+2 (T+1 in 2027); UK: T+2; FX: T+2 (CLS)

## T+1 Benefits:

- Lower counterparty risk and margin requirements
- Improved capital efficiency, faster settlement

## T+1 Challenges:

- Compressed affirmation timeline, FX timing
- Securities lending recall, legacy system upgrades

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**US moved to T+1 in May 2024; EU follows in 2027—reducing counterparty risk.**

# Settlement Fails and Penalties

## Causes of Settlement Failures:

- **Operational:** Incorrect settlement instructions (SSI mismatch)
- **Liquidity:** Insufficient cash or securities
- **Corporate Actions:** Ex-date timing issues
- **Fails Chains:** Cascading failures (A fails to B, B fails to C)
- **Short Selling:** Failure to deliver borrowed securities

## Fail Rates:

- US equities: 1-3% of trades (value basis)
- European equities: 3-8% (varies by market)
- Fixed income: Higher in corporate bonds (5-10%)

## CSDR Settlement Discipline (EU):

### Mandatory Buy-Ins:

- Liquidity-critical securities: 4 business days after intended settlement date (ISD)
- Other securities: 7 business days after ISD
- Failing party bears costs of buy-in

### Cash Penalties:

- Daily penalty for each day of fail
- Rate based on security type and liquidity
- Liquid shares: 1 bp/day, Illiquid: 0.5 bp/day
- Bonds: 0.25-0.5 bp/day depending on liquidity

### Implementation:

- Effective February 2022 (penalties)
- Mandatory buy-ins delayed to 2025
- Goal: Reduce systemic settlement risk

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AI and ML are transforming financial services through automation and prediction. [Source: McKinsey, Gartner 2024]

# Securities Lending Technology

## Securities Lending Overview:

### Participants:

- **Lenders:** Long-term investors (pension funds, mutual funds)
- **Borrowers:** Hedge funds (short selling), market makers (hedging)
- **Agent Lenders:** BNY Mellon, State Street, JPMorgan
- **Principal Lenders:** Goldman Sachs, Morgan Stanley

### Lending Mechanics:

- **Collateral:** 102-105% of security value (cash or non-cash)
- **Rebate Rate:** Interest paid on cash collateral
- **Lending Fee:** Borrower pays (bps per annum)
- **Term:** Open (callable) or fixed-term

### Fee Structure:

$$\text{Lender Revenue} = \text{Rebate Spread} + \text{Lending Fee}$$

Typical: 20-80 bps for general collateral, up to 1000+ bps for hard-to-borrow (specials)

## Technology Platforms:

### Agent Lender Systems:

- **EquiLend:** Trading, post-trade, analytics
- **FIS Securities Finance:** End-to-end platform
- **Pirum:** Post-trade automation and reconciliation
- **CloudMargin:** Collateral management

### Electronic Trading:

- **AQS (EquiLend):** Central limit order book
- **SL-x (IHS Markit):** Automated lending platform
- **Bloomberg SECL:** Integrated with Terminal

### Automation Benefits:

- Real-time inventory matching
- Automated recalls and returns
- Collateral optimization (cheapest-to-deliver)
- Regulatory reporting (SFTR in EU)

*Global securities lending market: **\$2.5 trillion on loan (2024)***

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**Source: Financial industry data and regulatory publications**

## Repo Structure:

- Sell securities + repurchase agreement = borrow cash
- Types: Bilateral, Tri-Party (BNY/Euroclear), GCF (FICC cleared)
- Haircut: 2% typical → \$100M bonds collateralizes \$98M cash

## Market and Technology:

- Size: US \$4-5T, EU EUR 9-10T outstanding (2024)
- Platforms: DTCC/FICC, BNY Mellon, Euroclear, MTS Repo
- Regulation: SFTR reporting, proposed CCP mandate

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Repo markets are critical for short-term funding and liquidity management. [Source: ICMA 2024]

# Trade Matching and Affirmation

## Matching Process:

- **Pre-Matching:** Allocate block to accounts; T+0 deadline
- **Central Matching:** US (DTCC/Omgeo), EU (Euroclear/CSDs)
- Match on: security, quantity, price, settlement date, SSI

## Affirmation:

- Both parties confirm via DTCC ID or CTM (Omgeo)
- Must affirm by T+0 to settle T+1 (US)

## Matching Rates:

- US: 90-95% affirmed T+0; EU: 70-85% (T+2)
- Mismatches: SSI errors, quantity/price, counterparty data

## Technology Solutions:

- Omgeo CTM/Alert, FIX/SWIFT messaging
- STP for matched trades; manual exception workflow

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**T+1 settlement requires 90%+ same-day affirmation—automation is critical.**

# Reconciliation and Exceptions

## Reconciliation Types:

- **Trade:** Front vs back office (real-time/EOD)
- **Position:** Internal books vs custodian (T+1)
- **Cash:** Expected vs bank statements (daily)
- **NAV:** Fund vs administrator (mutual fund critical)

## Exceptions and Automation:

- **Common:** Settlement fails, pricing, corporate actions, FX errors
- **Platforms:** SmartStream TLM, Broadridge, AutoRek
- **Impact:** Manual 70-90% human; automated 30-50% auto-resolved

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ML enables pattern recognition for recurring reconciliation exceptions. [Source: Industry 2024]

## Corporate Action Types:

### Mandatory Events:

- **Dividends:** Cash or stock distributions
- **Stock Splits:** Share count increase (e.g., 2-for-1)
- **Mergers:** Cash or share exchange
- **Spinoffs:** New entity distribution
- **Maturities:** Bond redemptions

### Voluntary Events:

- **Tender Offers:** Buyback at premium
- **Rights Issues:** Purchase additional shares at discount
- **Bond Calls:** Optional early redemption

### Mandatory with Options:

- **Dividend Reinvestment:** Cash or shares
- **Elective Stock Dividend:** Cash or stock choice

## Processing Workflow:

### 1. Announcement:

- Issuer announces via exchange, newswire
- Data vendors (Bloomberg, Refinitiv) publish
- Custodian notifies clients

### 2. Entitlement Calculation:

- Record date: Shareholder of record eligibility
- Ex-date: Trading without entitlement
- Payment date: Cash/securities distributed

### 3. Client Election (if voluntary):

- Deadline typically 2-5 days before record date
- Default option if no election (protect basis)

### 4. Settlement:

- Custodian processes entitlements
- Update positions and cash balances

*Automation rate: 70-80% for mandatory, 30-50% for voluntary (require client input)*

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**Understanding the process flow is key to identifying optimization opportunities.**

# Distributed Ledger Technology in Post-Trade

## DLT/Blockchain Use Cases:

### 1. Instant Settlement (T+0):

- Atomic swap of securities and cash
- Eliminate settlement risk entirely
- Reduced capital requirements (no exposure period)

### 2. Tokenized Securities:

- Digital native issuance on blockchain
- Programmable compliance and corporate actions
- 24/7 trading and settlement

### 3. Collateral Management:

- Real-time margining and collateral mobility
- Shared ledger across CCPs and custodians
- Reduced operational friction

## Pilot Projects:

### ASX CHESS Replacement:

- DLT-based post-trade platform (VMware Blockchain)
- Originally scheduled 2023, delayed to 2025+
- Challenges: Scope creep, technology complexity

### Project Ion (DTCC):

- Explore DLT for US equity settlement
- Proof-of-concept with AWS and Digital Asset
- Findings: Feasible but requires industry coordination

### HQLAX (Eurex):

- DLT platform for securities lending collateral
- Live since 2020 with multiple banks
- R3 Corda-based

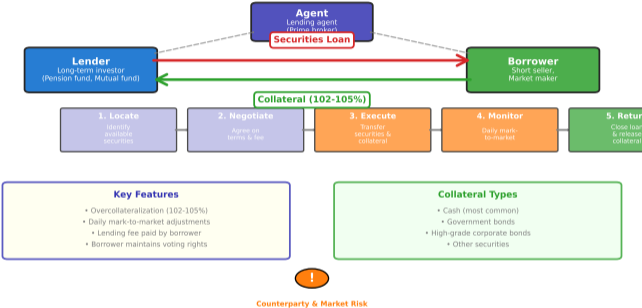
*Consensus: DLT will take 5-10+ years for full adoption in public markets due to legacy infrastructure*

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Source: Financial industry data and regulatory publications

# Securities Lending Flow

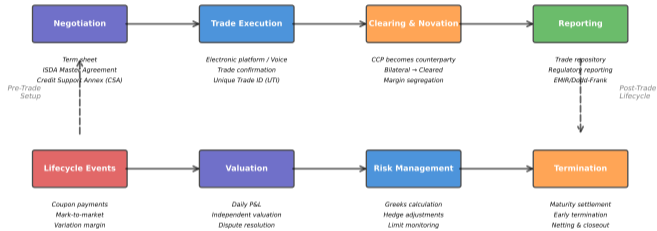
## Securities Lending Flow with Collateral Management



Source: ISLA, SEC, RMA Securities Lending Standards

Securities lending enables short-selling and generates incremental returns for long-term holders.

## OTC Derivatives Lifecycle

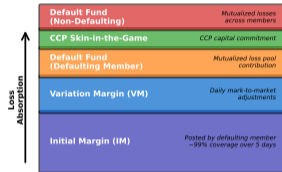


Source: ISDA, DTCC, BIS Derivatives Standards

OTC derivatives involve bilateral negotiation, documentation, and ongoing lifecycle management.

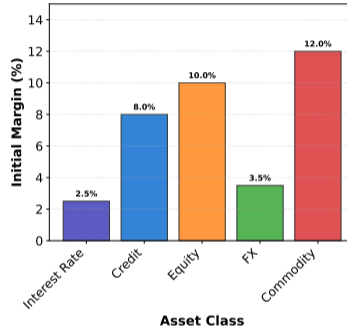
# Central Counterparty Margin Framework

**CCP Margin Waterfall  
(Resources Used in Default Event)**



Source: EMIR, CFTC, BIS/CPMI-IOSCO

**Margin Requirements  
by Asset Class**



CCPs require initial and variation margin to mitigate counterparty risk.

# Summary and Key Takeaways

## Trade Lifecycle:

- Pre-trade (OMS, compliance) → Execution (EMS, SOR) → Post-trade (clearing, settlement)
- Key systems: PMS (analytics), OMS (orders), EMS (routing), clearing, settlement
- Settlement: T+1 (US equities May 2024), T+2 (Europe, moving to T+1 by 2027)

## Clearing and Settlement:

- CCP novation reduces counterparty risk
- DVP eliminates principal risk
- Major CSDs: DTC (US), Euroclear, Clearstream
- CSDR penalties: 1 bp/day for fails (EU)

## Securities Lending and Repo:

- \$2.5T securities on loan globally
- Repo: \$4-5T US Treasuries, EUR 9-10T Europe
- Tri-party platforms: BNY Mellon, Euroclear
- SFTR reporting (EU), potential CCP mandate

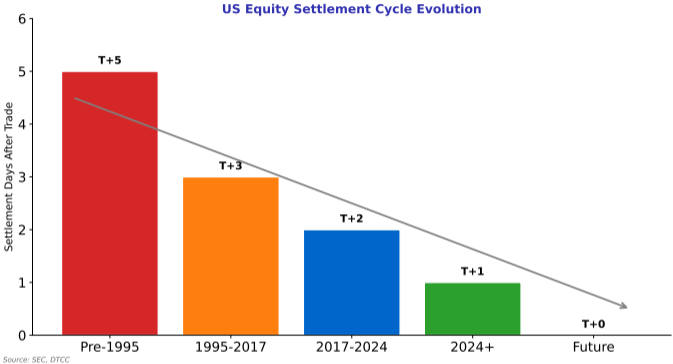
## Post-Trade Processing:

- Affirmation by T+0 critical for T+1 settlement
- Reconciliation: Trade, position, cash, NAV
- Corporate actions: 70-80% automation (mandatory)
- DLT pilots: ASX CHESS, DTCC Ion, HQLAX (live)

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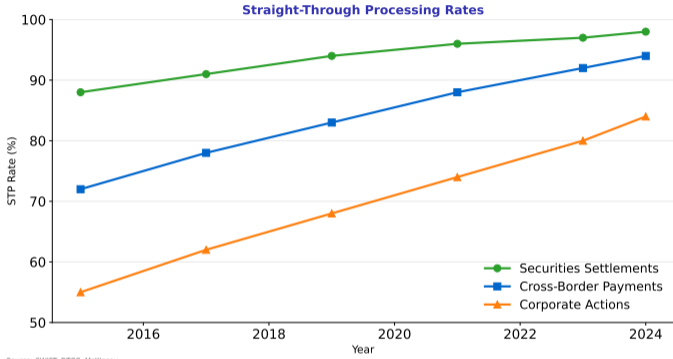
Data sources: Federal Reserve, ECB 2024

# Settlement Cycle Evolution



**T+1 becoming the new global standard.**

# STP Rate Improvement



Automation drives STP toward 100%.