

Lesson 44: Capital Markets Technology

Module 4: Traditional Digital Finance

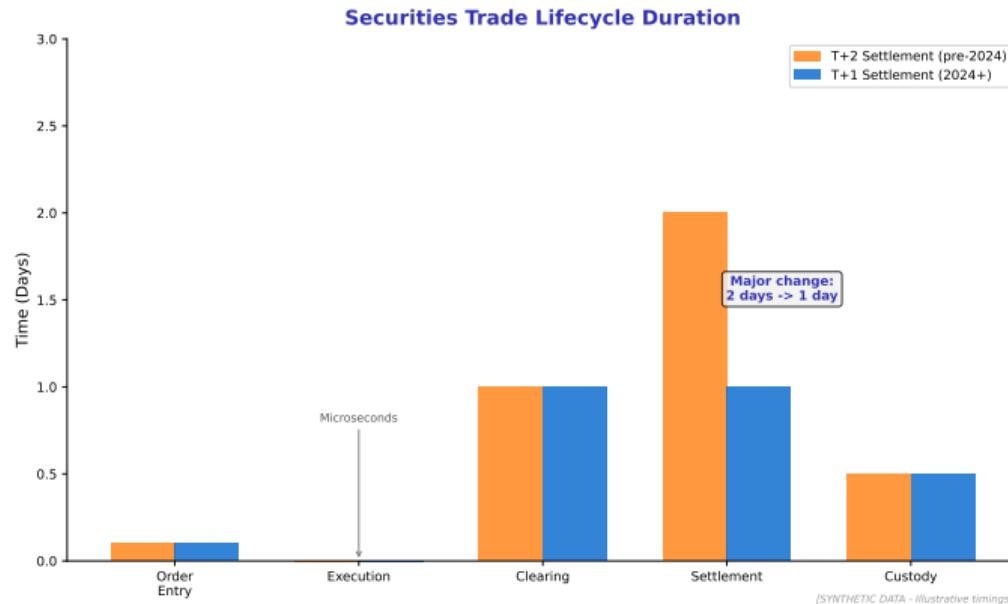
Digital Finance Course

2025

Learning Objectives

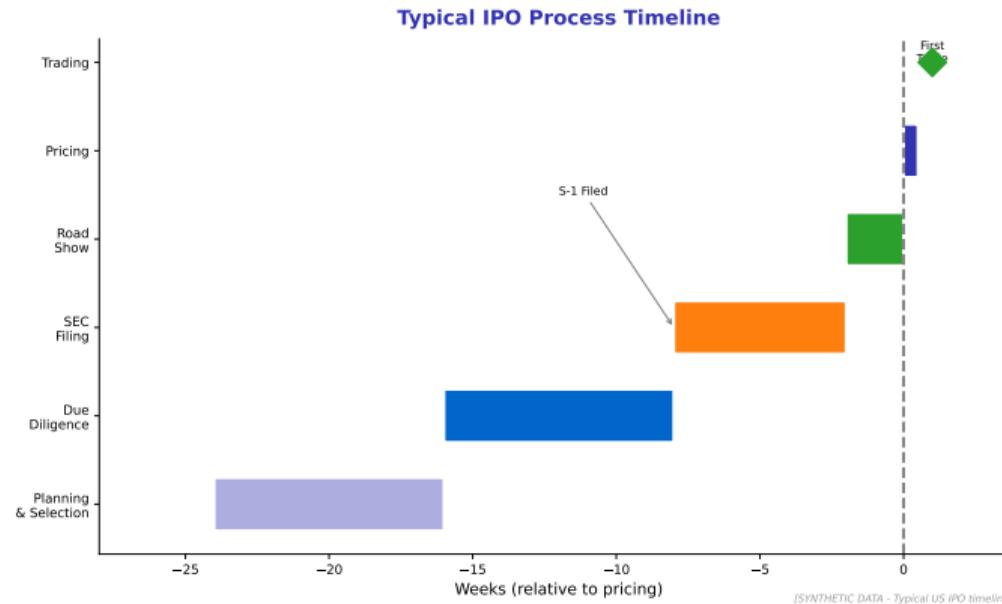
- Understand the trade lifecycle from order to settlement
- Analyze Order Management Systems (OMS), Execution Management Systems (EMS), and Portfolio Management Systems (PMS)
- Examine clearing and settlement infrastructure
- Evaluate post-trade processing and T+1 settlement
- Assess securities lending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

Capital Markets Workflow



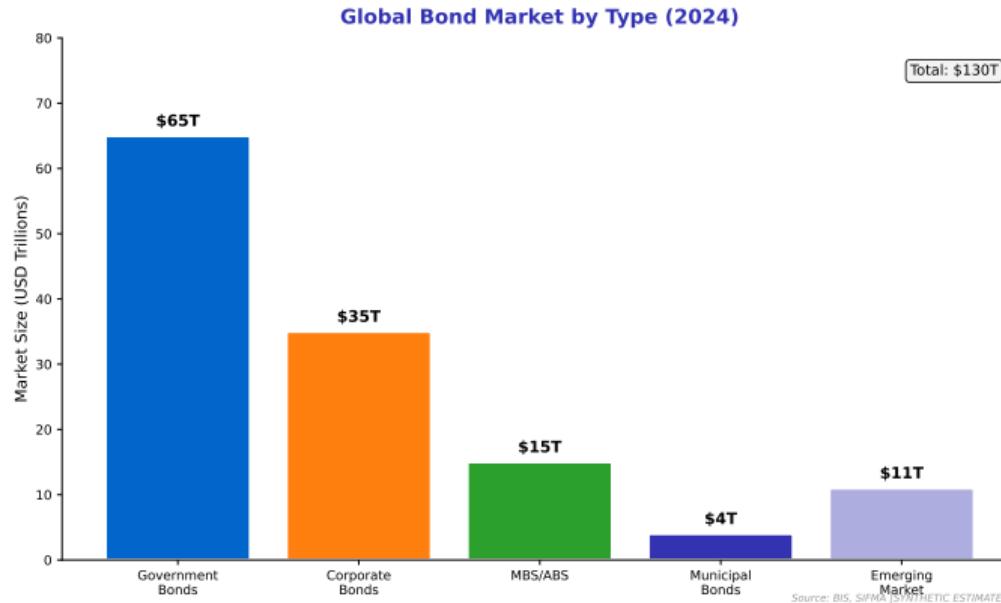
Capital markets involve complex workflows from origination to settlement.

IPO Timeline and Process



IPO process requires coordination across multiple parties over several months.

Bond Market Instruments



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)

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)

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

Key concepts from this slide inform practical applications in finance.

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

Key concepts from this slide inform practical applications in finance.

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

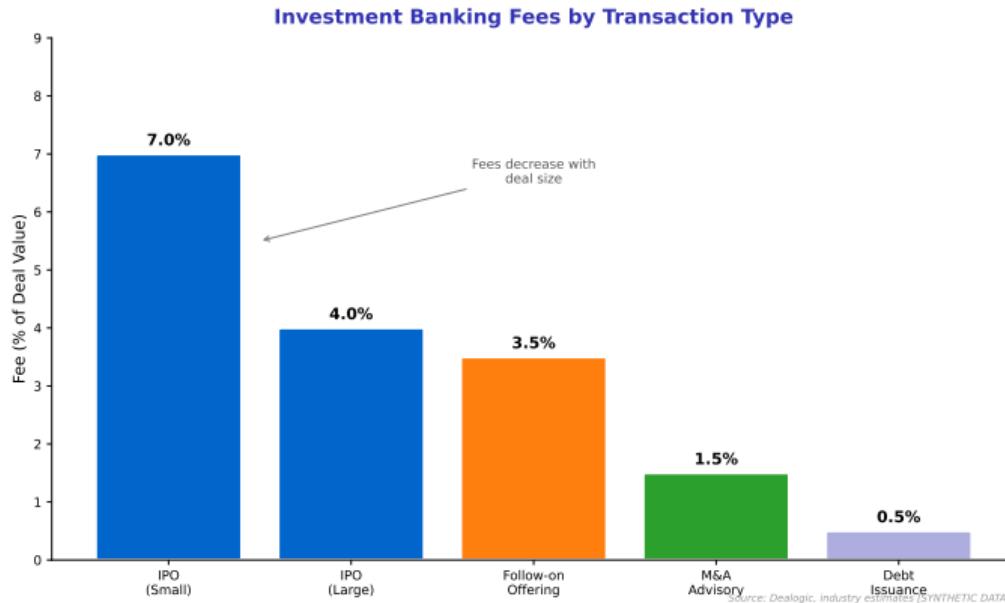
Data Sources:

- **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)

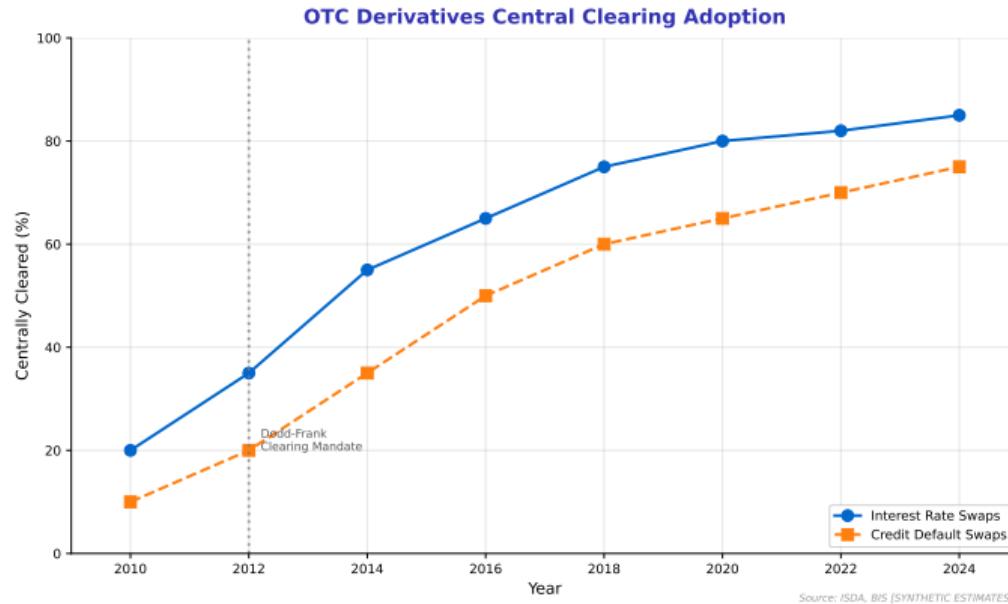
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Underwriting Fee Structures



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

Clearing Process Overview



Clearing reduces counterparty risk through central counterparty novation.

Central Counterparty (CCP) Clearing

CCP Role:

- **Novation:** CCP becomes buyer to every seller, seller to every buyer
- **Netting:** Reduce number of settlements (multilateral netting)
- **Risk Management:** Margin collection (initial and variation)
- **Default Management:** Mutualized loss-sharing (default fund)

Benefits:

- Reduce counterparty credit risk
- Increase operational efficiency (netting)
- Enhance market transparency
- Facilitate anonymous trading

Major CCPs:

- **DTCC (US):** Equities, corporate bonds (NSCC)
- **CME Clearing:** Futures, swaps
- **LCH (LSEG):** SwapClear (rates), RepoClear, EquityClear
- **Eurex Clearing:** Derivatives, repo
- **ICE Clear:** CDS, energy

Margin Requirements:

Initial Margin (IM):

- Collateral posted at trade inception
- Covers potential loss during liquidation period
- Calculated via SPAN, VaR, or Expected Shortfall
- Typical holding period: 2-10 days

Variation Margin (VM):

- Daily mark-to-market settlements
- Cash transfer to reflect P&L
- Mandatory for OTC derivatives (UMR, EMIR)

Default Waterfall:

- ➊ Defaulter's margin
- ➋ Defaulter's default fund contribution
- ➌ CCP skin-in-the-game
- ➍ Mutualized default fund (survivors)
- ➎ Assessment powers (additional contributions)

LCH SwapClear: \$500+ trillion notional cleared (2024)

Key concepts from this slide inform practical applications in finance.

Settlement Infrastructure

Securities Settlement Systems:

Delivery vs Payment (DVP):

- Simultaneous exchange of securities and cash
- Eliminates principal risk
- **DVP Model 1:** Gross trade-by-trade settlement (RTGS)
- **DVP Model 2:** Gross securities, net cash
- **DVP Model 3:** Net securities, net cash (most common)

Central Securities Depositories (CSDs):

- **DTC (US):** Equities, corporate bonds
- **Euroclear:** International securities (Belgium-based)
- **Clearstream:** International and German securities
- **National CSDs:** Country-specific (e.g., SIX SIS, Monte Titoli)

Settlement Cycles:

Current (2024):

- **US Equities:** T+1 (May 28, 2024)
- **EU Equities:** T+2 (moving to T+1 in 2027)
- **UK Equities:** T+2 (T+1 under consideration)
- **US Treasuries:** T+1 (same-day for some)
- **FX Spot:** T+2 (CLS for major currencies)

T+1 Benefits:

- Reduce counterparty credit exposure
- Lower margin requirements (shorter exposure)
- Improved capital efficiency
- Align with faster trading technology

T+1 Challenges:

- Compressed affirmation and allocation timeline
- FX conversion timing (international trades)
- Securities lending recall (1 day notice)
- Legacy system upgrades

Key concepts from this slide inform practical applications in finance.

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

AI and ML are transforming financial services through automation and prediction.

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)

Key concepts from this slide inform practical applications in finance.

Repo Markets and Technology

Repo (Repurchase Agreement):

Structure:

- **Seller:** Sells securities, agrees to repurchase (borrows cash)
- **Buyer:** Buys securities, agrees to resell (lends cash)
- **Repo Rate:** Interest rate on cash loan
- **Haircut:** Collateral value > cash (risk mitigation)

Repo Types:

- **Bilateral:** OTC between two parties
- **Tri-Party:** Custodian (BNY Mellon, Euroclear) manages collateral
- **GCF (General Collateral Finance):** Cleared via FICC (DTCC)
- **Term:** Overnight, term (weeks/months), open

Haircut Example:

- \$100M Treasury bonds as collateral
- 2% haircut → lend \$98M cash
- Protects lender from collateral price drop

Repo Market Size:

- US Treasury repo: \$4-5 trillion outstanding (2024)
- European repo: EUR 9-10 trillion (ICMA survey)
- Critical for money markets and liquidity

Technology Platforms:

- **DTCC/FICC:** GCF Repo, DVP Repo clearing
- **BNY Mellon:** Tri-party repo platform (US)
- **Euroclear:** Tri-party repo (Europe)
- **Clearstream:** Tri-party and triparty GC pooling
- **BondIT, MTS Repo:** Electronic trading

Regulatory Developments:

- **SFTR (EU):** Securities Financing Transactions Regulation
- **Transparency:** Trade reporting to regulators
- **Central Clearing:** CCP mandate for standardized repo (proposed)
- **Margin:** Initial margin for non-cleared (BCBS-IOSCO)

Key concepts from this slide inform practical applications in finance.

Trade Matching and Affirmation

Matching Process:

Pre-Matching (Allocation):

- Buy-side allocates block order to client accounts
- Send allocation instructions to broker/custodian
- Deadline: T+0 by 9pm ET (US), EOD (Europe)

Central Matching:

- **US:** DTCC Trade Information Warehouse (TIW), Omgeo OASYS
- **EU:** Euroclear, Clearstream, local CSDs
- Compare buy-side allocation vs sell-side confirmation
- Match on: security, quantity, price, settlement date, SSI

Affirmation:

- Both parties confirm trade details
- **DTC ID:** Affirm via DTCC's ID system
- **CTM (Central Trade Manager):** Omgeo platform
- Must affirm by T+0 to settle T+1 (US)

Matching Rates:

- US institutional: 90-95% affirmed by T+0
- Europe: 70-85% (more fragmented, T+2)
- Unmatched trades escalate to manual resolution

Common Mismatch Reasons:

- Settlement instructions (SSI) discrepancies
- Quantity/price differences (partial fills)
- Settlement date disagreements
- Missing or incorrect counterparty details

Technology Solutions:

- **Omgeo (DTCC):** CTM (trade matching), Alert (standing instructions)
- **SWIFT:** FIX/SWIFT messaging for confirmations
- **Automation:** Straight-through processing (STP) for matched trades
- **Exception Management:** Manual workflow for breaks

Key concepts from this slide inform practical applications in finance.

Reconciliation and Exceptions

Types of Reconciliation:

1. Trade Reconciliation:

- Front office (trading system) vs back office (settlement system)
- Identify missing or duplicate trades
- Frequency: Real-time or EOD

2. Position Reconciliation:

- Internal books vs custodian statements
- Detect settlement fails, corporate actions
- Frequency: Daily (T+1)

3. Cash Reconciliation:

- Expected cash movements vs bank statements
- Dividends, interest, fees, trade settlements
- Frequency: Daily

4. NAV Reconciliation:

- Fund accounting vs administrator
- Critical for mutual funds (daily NAV publication)

Exception Management:

Common Exceptions:

- Settlement fails (securities or cash)
- Pricing differences (stale or incorrect prices)
- Corporate actions not processed
- FX conversion errors (multicurrency portfolios)
- Custody fees/charges not captured

Technology Solutions:

- **SmartStream TLM:** Transaction lifecycle management
- **Broadridge:** Reconciliation and exception management
- **Gresham (Sandbox):** Multi-asset reconciliation
- **AutoRek:** Automated reconciliation platform

Automation Impact:

- Manual reconciliation: 70-90% of breaks require human intervention
- Automated platforms: 30-50% auto-resolved
- Machine learning: Pattern recognition for recurring exceptions

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Corporate Actions Processing

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)

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

Key concepts from this slide inform practical applications in finance.

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)