

## Lesson 44: Capital Markets Technology

### Module 4: Traditional Digital Finance

Digital Finance Course

2025

- 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

# 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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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*

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# 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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# 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)*

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# 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

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# 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.

# 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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# 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)

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# 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

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# 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)*

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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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# 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)