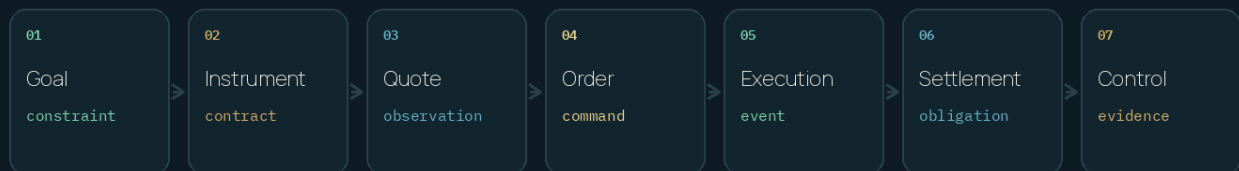


Markets as a System

From first principles to a safe paper-trading platform

ONE TRANSACTION

Intent becomes market fact, obligation, durable record, and evidence.



SURROUNDING CONTROLS

identity + permissions + risk + provenance + audit

16 designed chapters | 8 real system views | 5 mastery levels

Educational material. This handbook explains mechanisms and engineering judgment. It is not investment, legal, accounting, or compliance advice. System screenshots and workflows are simulated unless explicitly marked as dated reference data.

How to use this handbook

Use the marked 90-minute path for the mental model, a focused weekend for operational fluency, and the two-week builder path for implementation. The repeated rhythm is deliberate: explain, see, calculate, translate, challenge, and test.

90 MIN	Follow chapters marked as the fast path. Learn the lifecycle and twelve deeper questions.
WEEKEND	Complete every worked example, system view, misconception check, and primary reading.
2 WEEKS	Repeat read, inspect, calculate, explain, build, break, and recover. Finish the capstone trace.

Contents

00	See one transaction before learning the pieces	FAST
01	What markets are for and who does what	FAST
02	Money, time, return, and purchasing power	FAST
03	Instruments are contracts, not ticker symbols	FAST
04	Quotes are numbers plus provenance	FAST
05	Liquidity lives in a changing queue	FULL
06	An order is intent; a fill is a fact	FAST
07	Positions, valuation, and profit and loss	FULL
08	Leverage magnifies paths, not just outcomes	FAST
09	After the click: clearing, settlement, and custody	FAST
10	Reconciliation proves scoped agreement, not universal truth	FULL
11	Eligibility, suitability, surveillance, and human accountability	FULL
12	Model the domain before choosing the services	FAST
13	Build the data and order paths for ambiguity	FULL
14	Ledgers, evidence, observability, and failure recovery	FULL
15	From replay to a safe paper-trading capstone	FAST

Twelve questions that make market talk precise

Weak market language usually hides a missing unit, source, side, time, scope, or state. Use these questions until they become reflexive.

- 01 Which exact instrument and legal contract?
- 02 In which currency, units, scale, and direction?
- 03 What is the source and as-of time?
- 04 Is the price reference, indicative, firm, or executable?
- 05 Which venue or counterparty and for what size?
- 06 Which order constraints and time-in-force rules apply?
- 07 How much was accepted, filled, canceled, rejected, and left?
- 08 Which spread, fees, impact, financing, tax, and FX costs apply?
- 09 What is the trade date, value date, and settlement state?
- 10 Which risk measure, scope, assumptions, and threshold?
- 11 Which record is authoritative for this exact fact?
- 12 What evidence, owner, and correction path resolve an exception?

See one transaction before learning the pieces

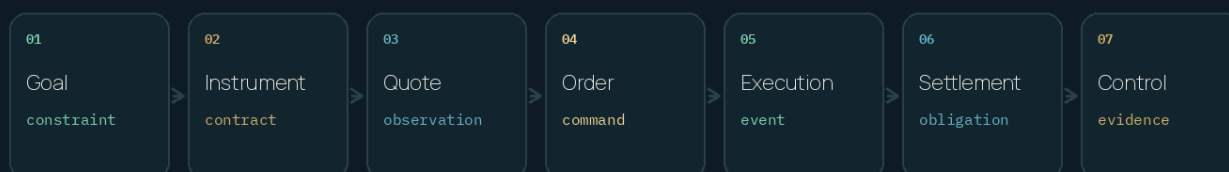
The full lifecycle is the map that stops finance from becoming a pile of disconnected terms.

IN 30 SECONDS

A trading platform converts a human goal into controlled records. The useful sequence is goal, instrument, quote, order, execution, trade, settlement, custody, and reconciliation. Identity, permissions, risk, provenance, and audit surround every step.

ONE TRANSACTION

Intent becomes market fact, obligation, durable record, and evidence.



SURROUNDING CONTROLS

identity + permissions + risk + provenance + audit

Understand the mechanics

Intent A goal and an order describe what someone wants. Intent can be valid, rejected, amended, canceled, or left unfilled.	Observation A quote or chart is observed market information with a source, scope, timestamp, and freshness state.
Event An execution is a fact reported by a venue or counterparty. It records what quantity matched at what price.	Obligation A trade creates duties to deliver cash and an asset. Those duties can remain pending or fail.
Durable record Settlement and custody update controlled books. Reconciliation compares those books with independent records.	Evidence Audit history explains who acted, what inputs and policy were used, and which result followed.

Worked example: Classify the records

- 01 A customer submits a limit order: intent.
- 02 A venue reports a fill: event and matched fact.
- 03 Operations creates cash and security delivery instructions: obligations.
- 04 The custodian confirms settled holdings: durable external evidence.
- 05 A reconciliation difference is assigned to an operator: controlled exception.

Builder lens

- 01 Give every stage its own identifier and status. Do not mutate one order row until it pretends to be the entire lifecycle.
- 02 Carry correlation and causation IDs so a reader can trace customer intent through risk, execution, settlement, and evidence.
- 03 Design unknown outcomes explicitly. A timeout says the system does not yet know, not that the venue rejected the order.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
I think of a trade as a distributed lifecycle: requested is not accepted, accepted is not filled, filled is not settled, and settled is not automatically reconciled.	A database transaction can make one service's writes atomic. It cannot make an external venue, bank, custodian, and clearing system one ACID transaction.

Ask one level deeper

- 01 Which record is intent and which is fact?
- 02 Where is the current obligation?
- 03 Which external record proves or challenges our view?

Misconceptions to reject

- 01 A green filled badge means the whole transaction is complete.
- 02 The order table is the financial ledger.
- 03 One timestamp proves the exact causal sequence across systems.

PREDICT BEFORE REVEAL

A venue accepts an order but no quantity trades. What exists?

An accepted instruction exists. There is no execution, trade, settlement obligation, or new position yet.

Primary sources

[FIX Trading Community: Order State Changes](#) | 20 min

The real complexity of partial fills, cancels, replaces, and corrections.

[BIS and CPMI-IOSCO: Principles for Financial Market Infrastructures](#) | 20 min

International principles for clearing, settlement, custody, and operational resilience.

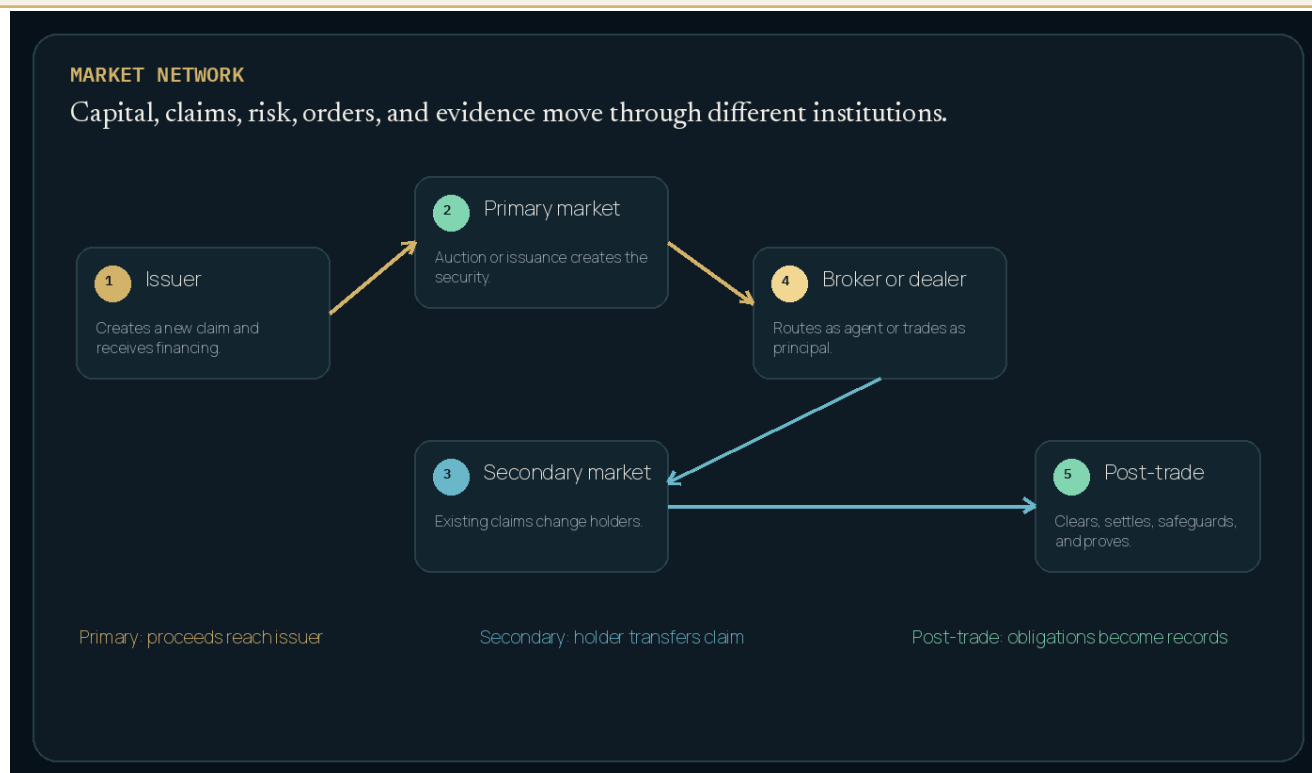
01 FINANCIAL FOUNDATIONS | 90-MINUTE PATH

What markets are for and who does what

Markets are networks of specialized institutions, not a single app or database.

IN 30 SECONDS

Markets connect people who need capital or risk transfer with people willing to supply it. Primary markets create new claims and direct proceeds to issuers. Secondary markets transfer existing claims between holders and support liquidity and price discovery.



Understand the mechanics

Issuer Creates a security to raise financing. Governments issue bills and bonds; companies can issue debt or equity.	Investor Supplies capital and accepts the contract's return and risk profile.
Broker Acts as agent to handle customer orders, routing, and account services.	Dealer or market maker Trades as principal and may quote prices from its own inventory and risk capacity.
Venue Provides rules and mechanisms for matching or negotiating trading interest. Exchanges and OTC markets organize this differently.	Post-trade infrastructure Clearing houses, central counterparties, depositories, custodians, and banks manage obligations and records after execution.

Worked example: Primary versus secondary

- 01 The Central Bank of The Gambia auctions a new Treasury bill. Investor cash finances the government: primary market.
- 02 A holder later sells that bill to another participant. Cash goes to the seller, not the original issuer: secondary market.
- 03 The second transaction can still affect observed yield and price, even though it raises no new issuer capital.

Builder lens

- 01 Model legal role and capacity. An agency order and a principal trade can create different economics, disclosures, and controls.
- 02 Treat venue and counterparty as first-class data. A symbol without market scope is ambiguous.
- 03 Expect several independently controlled systems. Use explicit messages, acknowledgements, reconciliation, and recovery.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
The primary market creates the claim and funds the issuer; the secondary market transfers the existing claim and supports liquidity and price discovery.	A microservice map can resemble the participant network, but a company cannot retry or roll back another legal entity's system at will.

Ask one level deeper

- 01 Is this primary issuance or secondary trading?
- 02 Who acts as agent and who takes principal risk?
- 03 Which venue, custodian, and settlement infrastructure are involved?

Misconceptions to reject

- 01 The broker, exchange, clearing house, and custodian are the same function.
- 02 Every trade on an exchange finances the issuer.
- 03 OTC means unregulated or informal.

PREDICT BEFORE REVEAL

When you buy an existing share from another investor, who receives your cash?

The selling holder receives the proceeds through the market and post-trade chain. The issuer generally does not receive those secondary-market proceeds.

Primary sources

[Investor.gov: Investment Products](#) | 8 min

Authoritative starting point for common product types.

[Central Bank of The Gambia: Open Market Operations](#) | 8 min

Regional government-securities and primary-dealer context.

[Ghana Stock Exchange: Overview](#) | 7 min

A regional view of exchange, fixed-income, depository, and settlement infrastructure.

Money, time, return, and purchasing power

A return number is incomplete until you know the time, cash flows, costs, currency, and inflation context.

IN 30 SECONDS

Return measures how value changed relative to capital committed. Compounding lets earlier gains earn later gains. Real return asks whether purchasing power grew after inflation. Liquidity and time horizon determine whether the reader can wait for a risky or illiquid outcome.



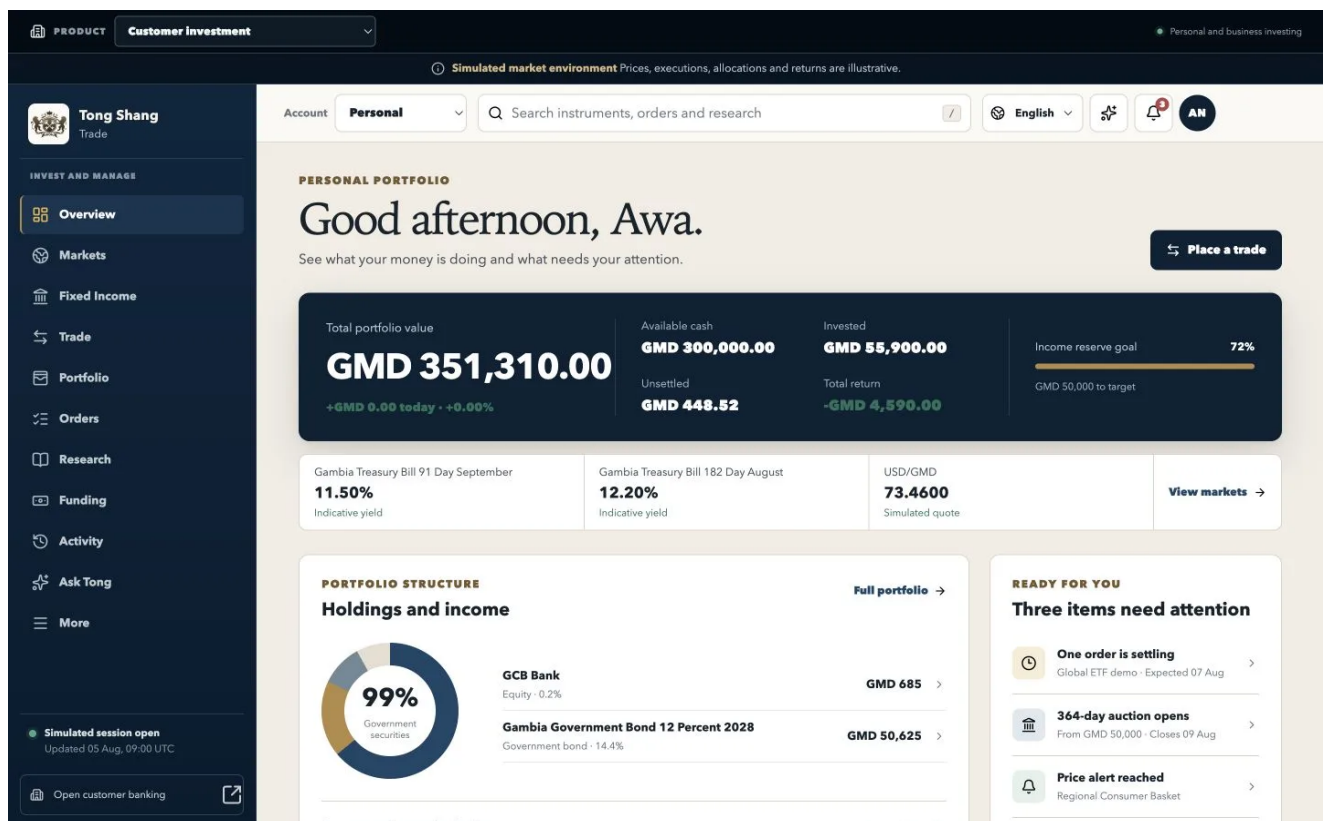
Understand the mechanics

Principal The capital initially committed to an investment or loan.	Cash flow Money paid in or out over time, such as contributions, dividends, coupons, fees, and withdrawals.
Simple return For one period with no intermediate cash flows: (ending value - starting value) / starting value.	Compounding A recursive process in which gains remain invested and can produce additional gains.
Nominal versus real Nominal return describes money units. Real return adjusts for inflation and better reflects purchasing power.	Liquidity need A near deadline can make a volatile or hard-to-sell asset unsuitable even when its expected long-term return is attractive.

Worked example: GMD 100,000 after one year

- 01 Ending value is GMD 108,000, so the nominal gain is GMD 8,000 and the simple return is 8 percent.
- 02 If fees total GMD 1,000, the after-fee ending value is GMD 107,000 and the after-fee return is 7 percent.
- 03 If inflation is 5 percent, a useful exact real-return calculation is $1.07 / 1.05 - 1$, or about 1.90 percent.
- 04 The example is arithmetic, not an expected investment outcome. Taxes and timing can change the result further.

See it in the Tong Shang system



System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01 Store monetary amount, currency, and scale together. Never accept a naked number named amount.
- 02 Represent available, reserved, unsettled, and invested value separately. They have different permissions and timing.

- 03 Use decimal or fixed-point arithmetic and version the rounding policy. Binary floating point is not authoritative money math.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
I would not discuss return without the measurement period, cash flows, fees, currency, and whether the number is nominal or real.	A recursive function is a useful compounding analogy, but markets do not return a deterministic constant rate and losses compound too.

Ask one level deeper

- 01 What period and cash-flow assumptions does this return use?
- 02 Is this before or after fees and inflation?
- 03 Which part of the value is actually available now?

Misconceptions to reject

- 01 All cash shown on an account is spendable.
- 02 An annualized rate is the realized return.
- 03 A positive nominal return always increases purchasing power.

PREDICT BEFORE REVEAL	An account grows 7 percent after fees while inflation is 5 percent. Is the exact real return 2 percent? Not exactly. The precise one-period result is $1.07 / 1.05 - 1$, about 1.90 percent. Subtracting is a close approximation for small rates.
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Primary sources

Investor.gov: [Introduction to Investing](#) | 10 min
Goals, compounding, asset allocation, and risk.

03 FINANCIAL FOUNDATIONS | 90-MINUTE PATH

Instruments are contracts, not ticker symbols

Start with rights, obligations, cash flows, currency, dates, and failure modes. The chart comes later.

IN 30 SECONDS

An instrument defines an economic and often legal relationship. Equity is residual ownership. A bond is a debt promise. FX exchanges currency units. A fund is a wrapper around underlying assets. Derivatives define future or conditional payments whose value depends on another variable.

INSTRUMENT CONTRACT ANATOMY

Ask the same five questions before comparing any financial product.

01

CASH

- who owes what?
- currency + units?
- cash-flow dates?
- conditions?
- failure modes?

Currency claim
Access + inflation

02

DEBT

- who owes what?
- currency + units?
- cash-flow dates?
- conditions?
- failure modes?

Issuer repayment
Credit + rates

03

EQUITY

- who owes what?
- currency + units?
- cash-flow dates?
- conditions?
- failure modes?

Residual ownership
Business + market

04

FUND

- who owes what?
- currency + units?
- cash-flow dates?
- conditions?
- failure modes?

Pooled wrapper
Holdings + fees

05

FX

- who owes what?
- currency + units?
- cash-flow dates?
- conditions?
- failure modes?

Currency exchange
Direction + spread

Understand the mechanics

Cash and deposits

A claim denominated in one currency. Key risks include inflation, institution credit, access, and currency loss.

Treasury bill or bond

A government debt contract with maturity and repayment terms. Price, discount, coupon, and yield describe different things.

Equity

A residual claim on a company. Returns can come from distributions and price changes, with no promised maturity payment.

Fund or ETF

A pooled vehicle. The wrapper affects pricing and trading, while the underlying holdings determine much of the economic exposure.

Foreign exchange

A directional conversion between two currency units. The pair, side, settlement date, and rate source matter.

Derivative

A future, option, forward, or swap creates conditional or future obligations. These require deeper treatment than a cash instrument.

Worked example: A discounted Treasury bill

- 01
- Suppose GMD 96,500 is paid today for a maturity payment of GMD 100,000.
- 02
- The cash gain at maturity is GMD 3,500 if the issuer pays as promised and the bill is held to maturity.
- 03
- The holding-period return is $3,500 / 96,500$, or about 3.63 percent.
- 04
- An annualized yield depends on tenor, day count, price basis, and market convention. It is not automatically the customer's realized return.

See it in the Tong Shang system

PRODUCT

Customer investment

Personal and business investing

Simulated market environment Prices, executions, allocations and returns are illustrative.

Tong Shang Trade

INVEST AND MANAGE

Overview

Markets

Fixed Income

Trade

Portfolio

Orders

Research

Funding

Activity

Ask Tong

More

Simulated session open
Updated 05 Aug, 09:00 UTC

Open customer banking

Account

Personal

Search instruments, orders and research

English

AM

GOVERNMENT SECURITIES

Put cash to work with a known maturity.

Compare tenor, expected proceeds and liquidity before preparing a simulated auction subscription.

90-day

Indicative yield

11.10%

2026-08-06, 11:00 GMT

111-day

Indicative yield

11.50%

2026-08-13, 11:00 GMT

180-day

Indicative yield

12.20%

2026-08-07, 11:00 GMT

SELECTED INSTRUMENT

Gambia Treasury Bill 91 Day August

Auction upcoming

Issuer

Government of The Gambia

Discount rate

11.10%

Indicative yield

11.10%

Days to maturity

90

Settlement

2026-08-06

Maturity

2026-11-04

Minimum

GMD 50,000

Liquidity

Held to maturity in this simulation

Risk context

Sovereign exposure, illustrative. Returns, allocation and settlement are simulated and not guaranteed.

TREASURY CALCULATOR

Estimate the maturity outcome

Investment amount

GMD 25000

Minimum GMD 50,000

GMD 10,000 GMD 25,000 GMD 50,000

Investment cost

GMD 25,000.00

Estimated face value

GMD 25,703.50

Estimated return

+GMD 703.50

Approximate annual yield

11.41%

Maturity value

GMD 25,703.50

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01
- Use a stable internal instrument ID. Symbols can be reused, venue-specific, or changed by corporate actions.

-
- 02 Version identifiers, tick size, lot size, price scale, multiplier, calendar, settlement convention, and status.
-
- 03 Model cash-flow rules and product-specific validation instead of forcing every instrument through an equity-shaped schema.
-

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
Before discussing an instrument, I want to know who owes what, in which currency, on what dates, under which conditions, and what can fail.	A programming type is a strong analogy for an instrument contract, but legal rights cannot be inferred from fields alone. Jurisdiction and governing documents matter.

Ask one level deeper

-
- 01 Is this ownership, debt, pooled ownership, currency, or a derivative claim?
-
- 02 What are the cash flows and maturity rules?
-
- 03 Which issuer, currency, seniority, and liquidity risks apply?
-

Misconceptions to reject

-
- 01 A ticker uniquely identifies an instrument forever.
-
- 02 Yield is a promised return.
-
- 03 An ETF is automatically diversified or low risk.
-

PREDICT BEFORE REVEAL	Why can two bonds with the same issuer still behave differently? They can differ by currency, maturity, coupon, seniority, security, liquidity, call terms, issue size, and settlement or tax treatment.
------------------------------	---

Primary sources

[Investor.gov: Stocks](#) | 8 min

Ownership rights, returns, and risks.

[Investor.gov: Bonds](#) | 10 min

Debt-contract language, maturity, and credit risk.

[Investor.gov: Mutual Funds](#) | 10 min

Pooled ownership, NAV, fees, and diversification.

[Central Bank of The Gambia: Auction Results](#) | 5 min

Current dated auction results for local context.

04 PRICE AND EXECUTION | 90-MINUTE PATH

Quotes are numbers plus provenance

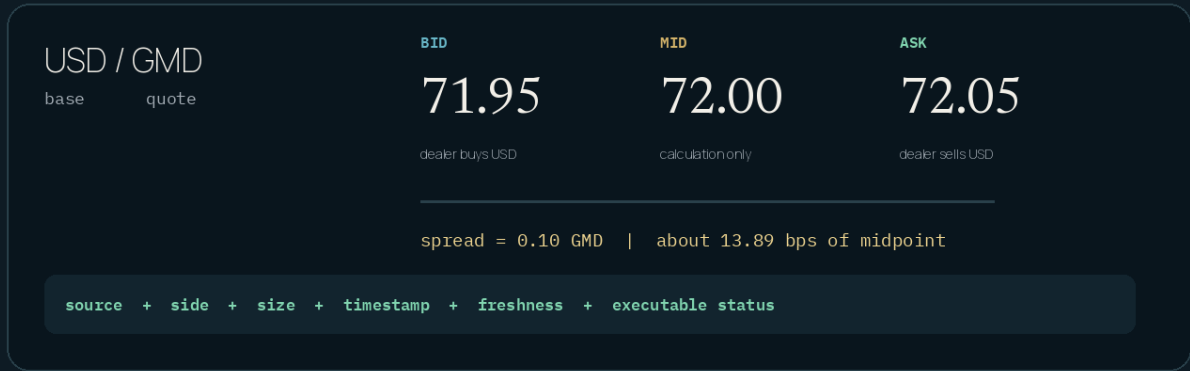
A market number is not meaningful until direction, source, time, size, and executability are known.

IN 30 SECONDS

The bid is the highest displayed price at which a buyer is currently willing to buy a stated quantity. The ask is the lowest displayed selling price. Their difference is the spread. The midpoint is a calculation. The last trade is history. None is a universal current price without context.

QUOTE ANATOMY

One number is not a usable market statement.



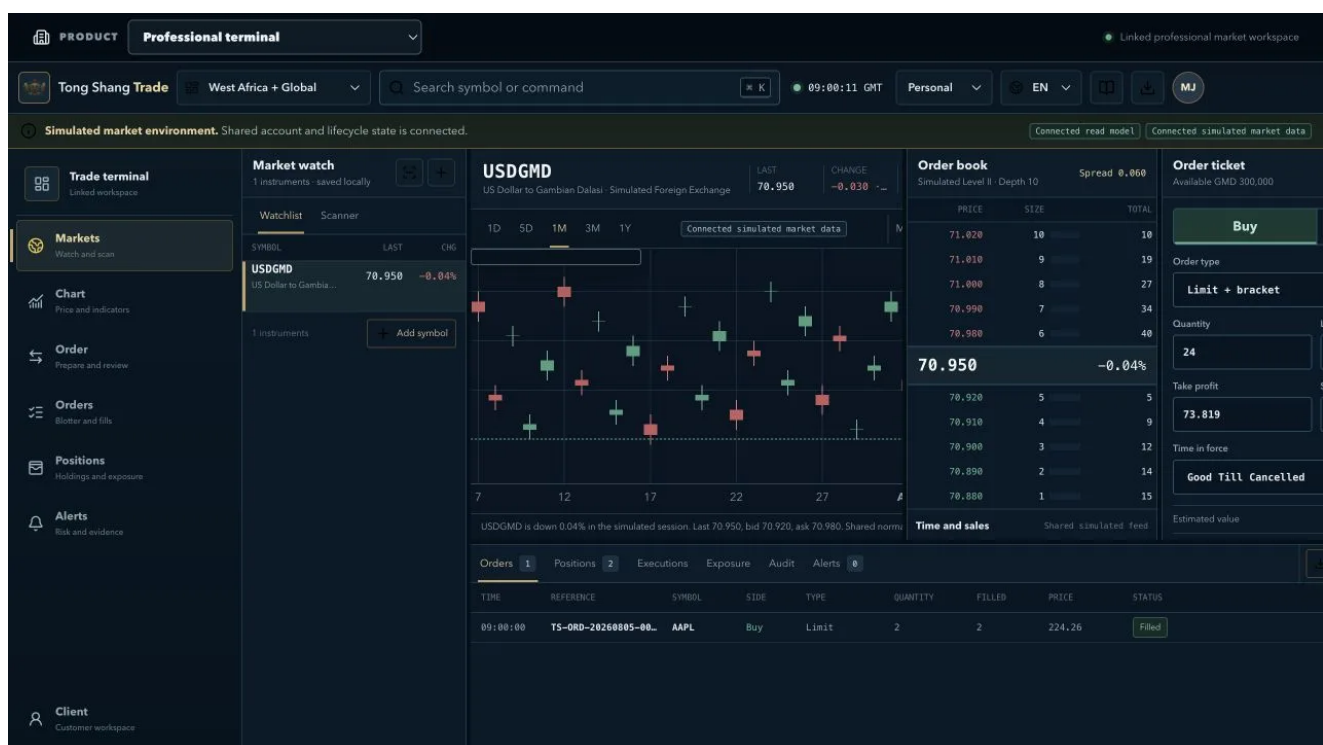
Understand the mechanics

Base and quote USD/GMD states GMD per one USD. USD is the base currency and GMD is the quote currency.	Bid and ask A simplified dealer convention shows the price at which the dealer buys the base currency and the price at which it sells it.
Mid and spread Mid = (bid + ask) / 2. Spread = ask - bid. Spread in basis points divides the spread by the midpoint and multiplies by 10,000.	Reference versus executable A central-bank or benchmark rate may support valuation or explanation. It does not prove a counterparty will transact at that number.
Last trade and candle A last trade is a completed event. A candle summarizes open, high, low, and close over an interval. Neither predicts the next execution.	Scope and freshness Venue, side, size, timestamp, expiry, delayed status, trading condition, and source determine what a quote can support.

Worked example: USD/GMD at 71.95 / 72.05

- 01 The midpoint is 72.00 GMD per USD and the displayed spread is 0.10 GMD.
- 02 The spread is about 13.89 basis points: $0.10 / 72.00 \times 10,000$.
- 03 In a simplified two-way dealer quote, a customer buying USD faces the ask, while a customer selling USD faces the bid.
- 04 Fees, customer tier, size, market movement, and settlement terms can add costs beyond the displayed spread.

See it in the Tong Shang system



Builder lens

- 01 A normalized quote needs instrument, venue, bid, ask, sizes, source-event time, receive time, sequence, condition, and provenance.
- 02 Never label delayed, cached, fallback, or reference data as live executable market data.
- 03 Store FX direction explicitly. An unlabeled fx_rate invites inverse-rate errors and broken P&L.

TALK LIKE YOU UNDERSTAND IT

WHERE THE ANALOGY BREAKS

The displayed USD/GMD number is only useful after I know the direction, side, source, timestamp, size, and whether it is reference, indicative, firm, or executable.

A quote resembles an observation in a telemetry stream, but the observation can itself change behavior as participants react and liquidity moves.

Ask one level deeper

- 01 Which way is the pair quoted?
- 02 Is that bid, ask, mid, last, reference, or executable?
- 03 For which size, venue, source, and as-of time?

Misconceptions to reject

- 01 The midpoint is a price I can trade.
- 02 The last trade is the next available price.
- 03 A reference FX rate is a dealer commitment.

PREDICT BEFORE REVEAL

At USD/GMD 72.00, do you multiply or divide to convert USD 100 to GMD?

Multiply: $\text{USD } 100 \times 72 \text{ GMD per USD} = \text{GMD } 7,200$. Converting GMD back to USD uses division, subject to the applicable side and costs.

Primary sources

[Investor.gov: Bid Price and Ask Price](#) | 3 min

The official plain-language definition of bid, ask, and spread.

[Investor.gov: Executing an Order](#) | 8 min

Routing, execution, and why a screen is not the whole market.

[Central Bank of The Gambia: Open Market Operations](#) | 8 min

Regional government-securities and primary-dealer context.

05 PRICE AND EXECUTION

Liquidity lives in a changing queue

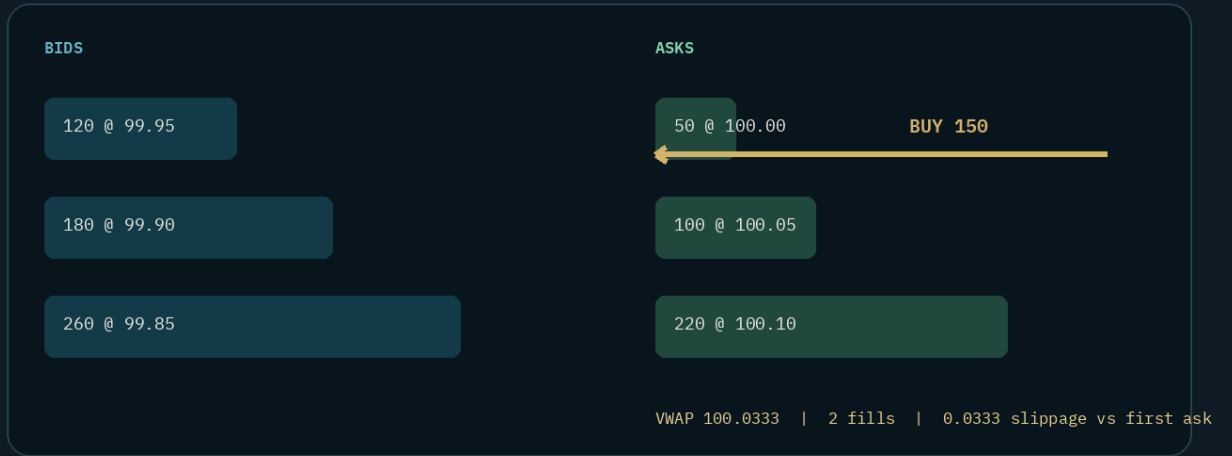
The top quote is only the first available layer. Size, depth, queue position, and recovery determine what can actually trade.

IN 30 SECONDS

An order book arranges buying and selling interest by price and often time priority. A marketable order consumes displayed liquidity. If its quantity exceeds the best level, it walks the book and receives several fills. Liquidity therefore includes spread, depth, immediacy, and resiliency, not volume alone.

ORDER-BOOK DEPTH

A 150-unit market buy walks two offer levels.



Understand the mechanics

Level One price and its displayed aggregate quantity. Some feeds expose individual orders; others expose price levels.	Priority Many venues use price-time priority, but allocation models vary. Reaching a limit price does not guarantee a fill if earlier quantity remains.
Depth Quantity available across prices before the expected execution price changes materially.	Immediacy How quickly a desired quantity can be completed under current market conditions.
Resiliency How quickly liquidity returns after a large order or shock removes it.	Slippage and impact The average execution can differ from the arrival quote because the order consumes levels and the market changes.

Worked example: Buying 150 units through two offers

- 01

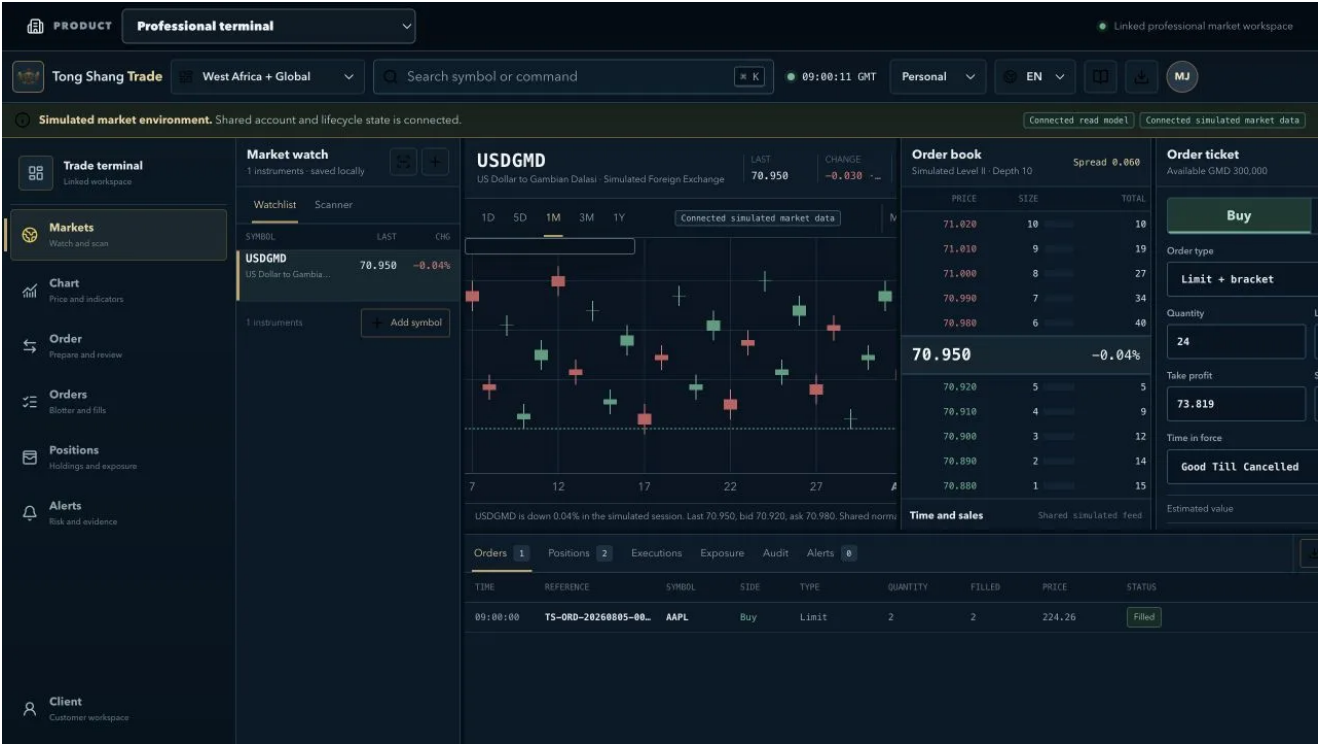
The book offers 50 units at 100.00 and 100 units at 100.05.
- 02

A market buy of 150 receives two fills: 50 x 100.00 and 100 x 100.05.
- 03

The volume-weighted average price is $(5,000 + 10,005) / 150 = 100.0333$.
- 04

Buyer slippage versus the first ask is 0.0333 per unit before fees. The first ask was true but incomplete for this size.

See it in the Tong Shang system



System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01

A feed handler must detect sequence gaps, mark books stale, obtain a recovery snapshot, and replay only valid later incrementals.
- 02

Store fixed-point price and quantity scales from the instrument or feed specification.
- 03

A simulation should model at least partial fills, changing depth, queue assumptions, rejects, halts, fees, and deterministic replay.

TALK LIKE YOU UNDERSTAND IT

WHERE THE ANALOGY BREAKS

Volume tells me activity; liquidity asks what size can trade, how quickly, at what total cost, and how the market recovers afterward.

A queue data structure is useful, but real priority can include hidden liquidity, special order types, auctions, venue rules, and participant access differences.

Ask one level deeper

01 How much size is displayed at and beyond the best price?

02 What priority and hidden-liquidity rules apply?

03 What was the arrival price and volume-weighted fill price?

Misconceptions to reject

01 High daily volume guarantees easy execution now.

02 Touching my limit price guarantees my order fills.

03 The best ask is enough to price any buy quantity.

PREDICT BEFORE REVEAL

Why can a 100.00 limit buy remain unfilled after trades print at 100.00?

Earlier orders may have priority, printed trades may occur on another venue or under different conditions, and the displayed quantity at that price may be insufficient.

Primary sources

[Investor.gov: Bid Price and Ask Price](#) | 3 min

The official plain-language definition of bid, ask, and spread.

[Nasdaq: TotalView ITCH 5.0](#) | 30 min

Concrete feed messages, sequence, scales, and instrument-location semantics.

06 PRICE AND EXECUTION | 90-MINUTE PATH

An order is intent; a fill is a fact

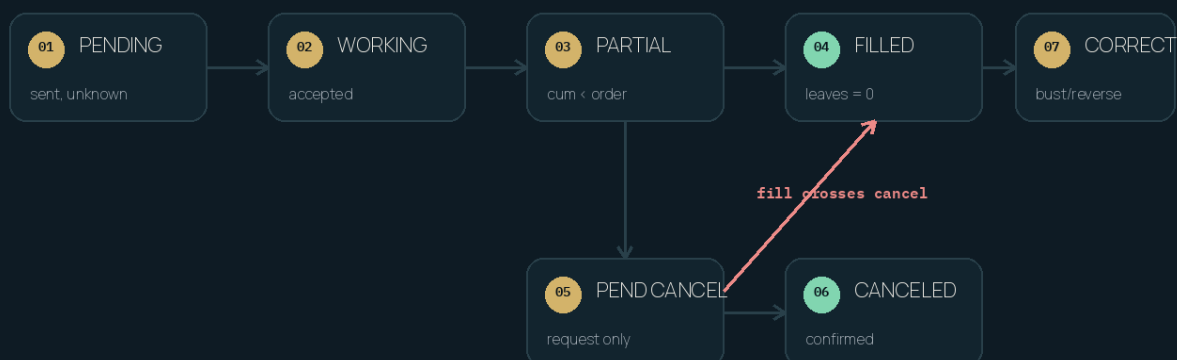
Order types choose which uncertainty you accept: price, completion, or time.

IN 30 SECONDS

A market order prioritizes prompt execution but not price. A limit order sets a worst acceptable price but can remain unfilled. A stop can activate another order after a trigger, but the trigger price is not a guaranteed fill. Time in force controls duration and partial-fill behavior.

ORDER STATE IS NOT ONE STRAIGHT LINE

Partial fills and cancel races are normal, not edge-case trivia.



Understand the mechanics

Market Useful when immediacy dominates, but exposed to depth, gaps, halts, and fast price movement.	Limit A buy limit caps price and a sell limit sets a floor. Execution probability becomes uncertain.
Stop and stop-limit A trigger controls activation. A triggered market order can slip; a triggered limit order can fail to fill.	Time in force Day, good-till-canceled, immediate-or-cancel, and fill-or-kill answer how long and how partially the order may work.
Partial fill One order can produce many executions. Cumulative quantity and remaining quantity must be updated exactly once.	Cancel and replace race A request to cancel or amend can cross a fill already in flight. Pending cancel is not canceled.

Worked example: One order, three executions, one late cancel

- 01 Buy 1,000 units. First fill: 300, so cumulative quantity is 300 and leaves quantity is 700.
- 02 Second fill: 500, so cumulative quantity is 800 and leaves quantity is 200.
- 03 A cancel request is sent. Before the venue accepts it, the final 200 fills.
- 04 The order is filled. A later cancel rejection is an expected race outcome, not permission to reverse the executions.

See it in the Tong Shang system

The screenshot displays the Tong Shang system interface. The top navigation bar includes 'PRODUCT' (Customer Investment), 'Simulated market environment' (Prices, executions, allocations and returns are illustrative.), and user settings (Personal, English, etc.). The left sidebar lists navigation options: Overview, Markets, Fixed Income, Trade, Portfolio, Orders (selected), Research, Funding, Activity, Ask Tong, and More.

The main content area is titled 'ORDERS AND ACTIVITY' and features the headline 'Know what is drafted, filled and still moving.' Below this, a summary bar shows: All (1), Open (0), Filled (1), and Settlement (0). A table lists the order details:

Reference	Instrument	Side / type	Quantity	Value	Status
TS-ORD-20260805-000001 2026-08-05 09:00:00 GMT	AAPL	Buy · Limit	2 / 2	GMD 449	Filled

Below the table, the 'SELECTED LIFECYCLE' for order TS-ORD-20260805-000001 is shown:

- Draft validated**: Customer eligibility, buying power and tick size checked.
- Submitted and acknowledged**: 05 Aug, 14:28 GMT · Audit event AUD-260805-172.
- Partially filled**: 20 of 40 units · Average 1,262.00.
- Complete remaining fill**: Awaiting explicit simulation action.
- Settle and post custody**: Expected T+2 after execution.

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01 Persist order intent, venue messages, normalized events, and current projections separately.
- 02 Use client order IDs, venue order IDs, execution IDs, sequence, and idempotency keys. Each solves a different identity problem.
- 03 Corrections and broken trades require compensating events and financial reversals, not silent edits.

A market order accepts price uncertainty for immediacy, while a limit order accepts execution uncertainty for a price boundary.

A command/event analogy is strong, but venue protocols include negotiated semantics and state precedence that a generic event bus does not define.

Ask one level deeper

- 01 Which failure is worse here: a worse price or no fill?
- 02 How much is filled and how much remains?
- 03 Is cancel confirmed, merely requested, or already too late?

Misconceptions to reject

- 01 Market means guaranteed execution.
- 02 Limit means guaranteed good outcome.
- 03 Sending cancel means the order is canceled.

PREDICT BEFORE REVEAL

A 1,000-unit order is 800 filled when cancellation is requested, then 200 fills. What is the final state?

Filled. The last execution completed the order before cancellation became effective. The cancel response may reject the request as too late.

Primary sources

FINRA: Order Types | 8 min

Market, limit, stop, and stop-limit tradeoffs.

FIX Trading Community: Order State Changes | 20 min

The real complexity of partial fills, cancels, replaces, and corrections.

FIX Trading Community: ExecutionReport | 10 min

Why an event reason and current order state are separate fields.

Nasdaq: OUCH 5.0 Order Entry | 30 min

Concrete order-entry, execution, cancel, and broken-trade messages.

07 RISK AND POST-TRADE

Positions, valuation, and profit and loss

Quantity, cash, cost, value, and P&L are related projections, not one balance.

IN 30 SECONDS

A position records economic quantity in an instrument. Valuation applies a sourced price. Unrealized P&L measures change on still-open quantity, while realized P&L records results on closed quantity under an explicit cost-basis policy. Fees, financing, corporate actions, and FX translation also matter.



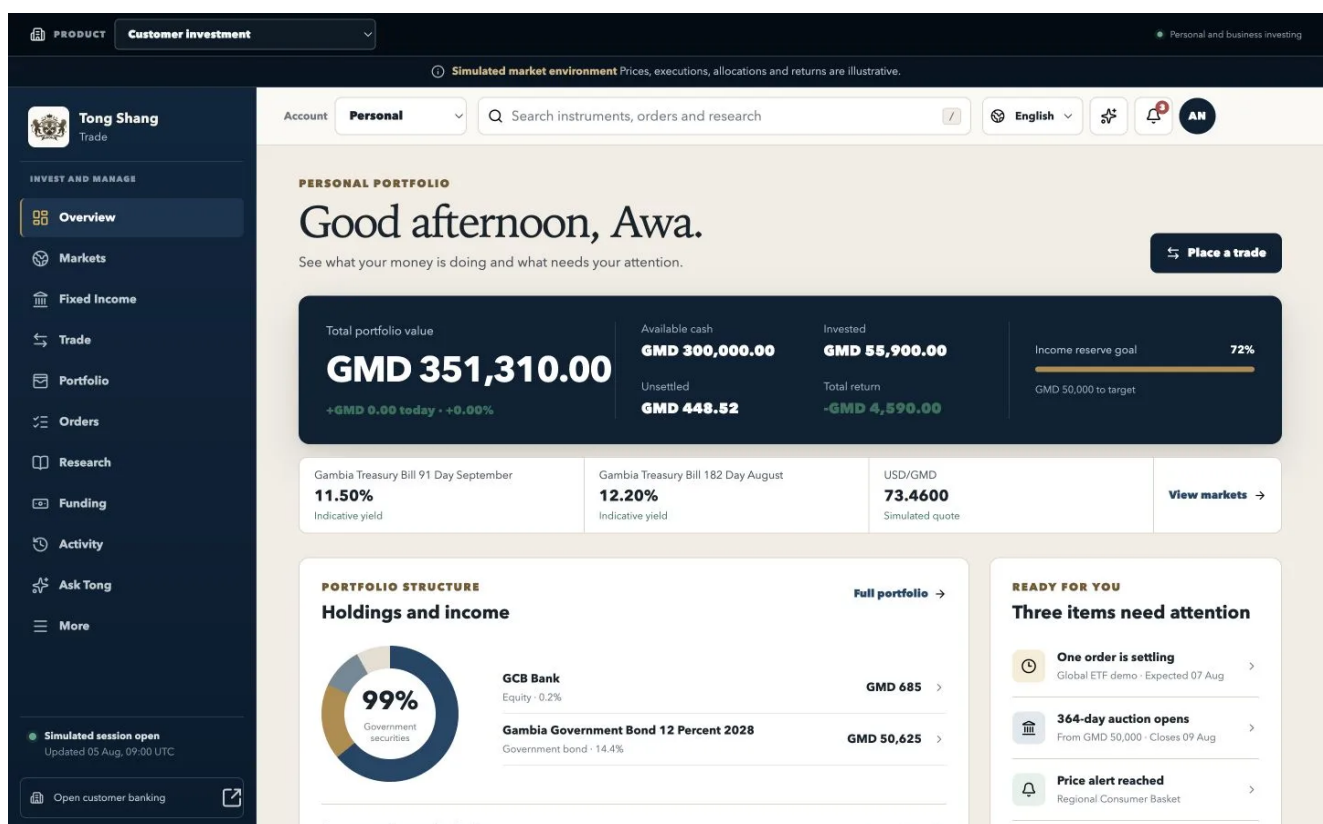
Understand the mechanics

Long, flat, short Positive quantity is long, zero is flat, and negative quantity is short under the chosen sign convention.	Average cost and lots Cost basis can use average cost, FIFO, specific lots, or jurisdiction-specific rules. The policy must be explicit.
Mark to market A valuation source and timestamp convert quantity into a current estimate. Stale or indicative marks need a visible status.	Realized P&L The result associated with quantity that has been closed, after the selected cost-basis policy and included costs.
Unrealized P&L The modeled gain or loss on quantity still open. It can change before the position is sold.	Gross and net exposure Gross sums absolute exposures; net offsets signed exposures. Netting can hide large opposing positions and funding needs.

Worked example: Buy 100, sell 40

- 01 Buy 100 shares at 10.00 plus a 5.00 fee. A simplified total cost is 1,005.00.
- 02 Sell 40 at 12.00 with a 2.00 fee. Under simplified pro-rata average cost, released cost is 402.00.
- 03 Net proceeds are 478.00, so realized P&L is 76.00 on the closed 40 shares.
- 04 The remaining 60 shares still have unrealized P&L that depends on the current sourced mark. Settlement status and taxes are separate questions.

See it in the Tong Shang system



System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01 Treat positions and balances as rebuildable projections from immutable accepted economic events.
- 02 Keep trade-date and settlement-date views separate. A filled trade can create pending quantity and payable cash before final settlement.
- 03 Store valuation price, source, timestamp, currency, FX source, and policy alongside each P&L snapshot.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
A position is quantity and state; value requires a sourced mark, and P&L requires cost-basis, fee, currency, timing, and settlement assumptions.	A materialized view is a useful analogy for positions, but accounting and legal books can have controlled posting and correction requirements beyond a technical projection.

Ask one level deeper

- 01 Is this trade-date or settlement-date position?
- 02 Which mark and FX source produced the value?
- 03 Which costs and cost-basis policy are in P&L?

Misconceptions to reject

- 01 A position is the same as cash balance.
- 02 Unrealized profit is guaranteed cash.
- 03 Net exposure alone describes risk.

PREDICT BEFORE REVEAL	Can two systems show the same position quantity but different P&L without either being broken? Yes. They may use different marks, as-of times, FX rates, fee treatment, corporate-action state, or cost-basis policy. Reconciliation must define the compared field and policy.
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Primary sources

[Investor.gov: Stocks](#) | 8 min

Ownership rights, returns, and risks.

[PostgreSQL: Transaction Isolation](#) | 15 min

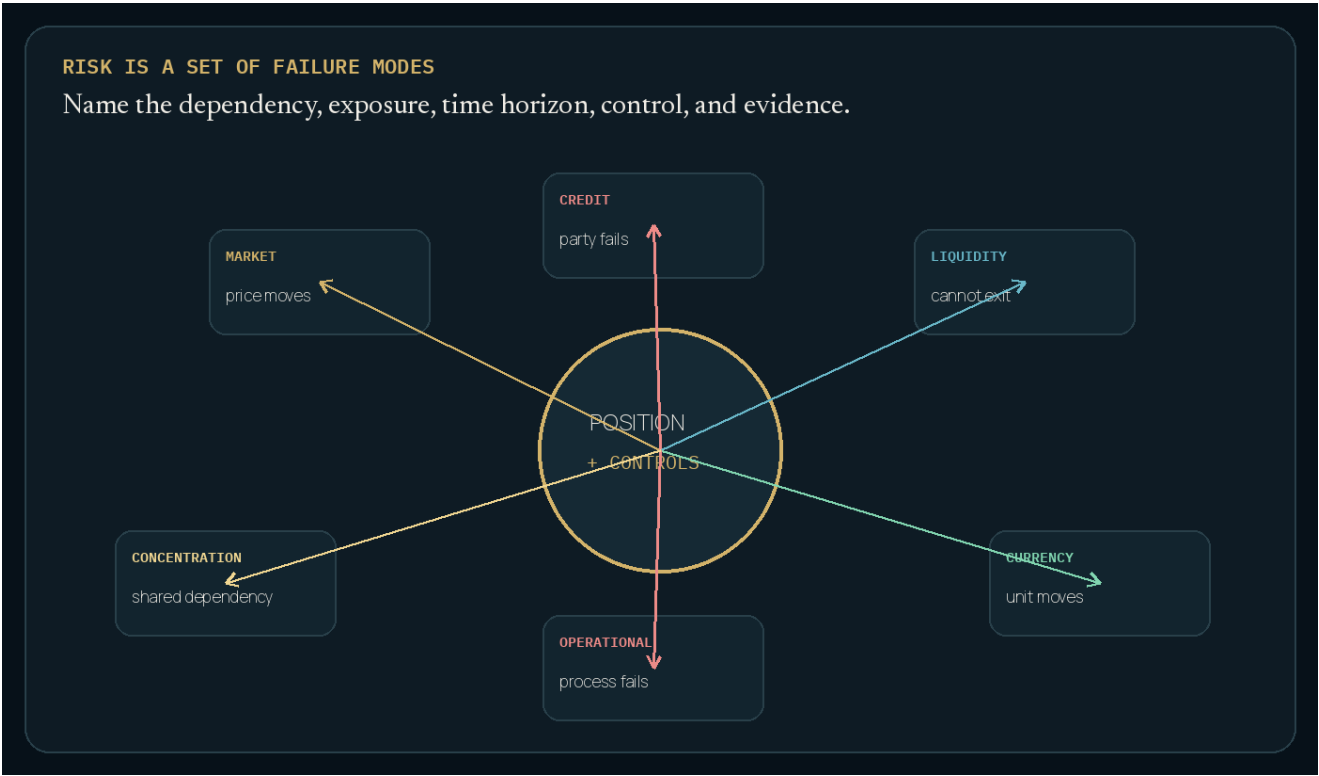
Concurrency behavior and why transactions do not replace domain invariants.

Leverage magnifies paths, not just outcomes

Risk is a collection of failure modes and dependencies. Leverage makes less room for delay and error.

IN 30 SECONDS

Leverage creates economic exposure larger than account equity. It magnifies gains and losses, accelerates maintenance breaches, and can cause forced liquidation. Risk must also be separated into market, credit, liquidity, concentration, currency, settlement, operational, model, legal, and conduct dimensions.



Understand the mechanics

Market risk Prices or risk factors move against the position.	Credit and counterparty An issuer or trading counterparty fails to meet an obligation.
Liquidity and funding A position cannot be exited or funded promptly near the expected cost.	Concentration Too much depends on one issuer, sector, currency, maturity, venue, model, or counterparty.
Operational and technology People, data, processes, software, infrastructure, or external services fail.	Model and legal Assumptions are wrong or misused, or the contract and process do not have the expected legal effect.

Worked example: Three times gross leverage

- 01 Account equity is 100. Gross exposure is 300, so gross leverage is 3.0x.
- 02 A 5 percent adverse move on the exposure creates a 15 loss before financing and fees, or 15 percent of initial equity.
- 03 A 5 percent favorable move similarly creates a 15 gain before costs. Leverage does not improve the underlying prediction.
- 04 Maintenance rules, price gaps, liquidity, collateral haircuts, and broker house requirements can force action before a planned exit.

See it in the Tong Shang system

The screenshot shows the Tong Shang Risk and Intelligence system interface. The sidebar on the left contains navigation options: Overview, Client suitability, Exposure (highlighted), Trade surveillance, Cases, Management intelligence, Audit trail, and Simulated market environment. The main content area displays 'EXPOSURE' with a title 'Cash, currency, concentration, and maturity context are reviewable.' Below the title, it states 'Connected market context is used where available, with a deterministic fallback and visible provenance.' There are buttons for 'Export' and 'Refresh'. A section titled 'Shared read models connected (4/4)' shows 'As of 05 Aug, 09:00 UTC. Shared and simulated sources are labelled per record.' Below this, there are four cards: 'Records in view' (6), 'Needs attention' (2), 'Shared records' (6), and 'As of' (05 Aug, 09:00). A table of records is shown with filters and sorting options. The table has columns: REFERENCE, CUSTOMER OR OWNER, TYPE, VALUE, STATUS, and SOURCE. The table shows 6 records in view, with 2 needing attention. The interface also displays a 'Market connector: Frankfurter v2'.

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01 Pre-trade controls should evaluate entitlement, instrument state, tick and lot size, stale data, price collars, notional, exposure, cash or margin, restrictions, and kill switches.
- 02 Persist each risk decision with inputs, policy version, result, reason codes, scope, approver, and expiration for any override.

- 03 Risk controls must work across venues and strategies. Per-order checks alone miss aggregated exposure and message-rate failure.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
Risk is not one score. I want to name the failure mode, exposure, time horizon, assumptions, limit, and action if the limit is breached.	A circuit breaker is a good analogy for stopping propagation, but financial controls also need legal ownership, approved policy, human escalation, and evidence.

Ask one level deeper

- 01 What exact exposure can produce loss?
- 02 Which dependency or concentration dominates?
- 03 What control prevents, detects, contains, and evidences the failure?

Misconceptions to reject

- 01 Leverage only increases purchasing power.
- 02 Volatility is the complete definition of risk.
- 03 Diversification eliminates loss.

PREDICT BEFORE REVEAL	If a hedged portfolio has near-zero net exposure, can its gross risk still be large? Yes. Large offsetting positions can create basis, liquidity, funding, counterparty, and timing risks even when a simple net measure is close to zero.
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Primary sources

SEC: [Margin and Its Risks](#) | 8 min

Why leverage can create forced sales and losses beyond initial cash.

SEC: [Market Access Risk Controls](#) | 12 min

Pre-trade limits, erroneous-order controls, restrictions, and authorized access.

FINRA: [Algorithmic Trading](#) | 12 min

Testing, supervision, monitoring, governance, and change control.

Federal Reserve: [SR 26-2 Model Risk Management](#) | 20 min

Current purpose, materiality, validation, challenge, and monitoring principles.

After the click: clearing, settlement, and custody

Execution creates obligations. Ownership and finality require a different chain of systems and controls.

IN 30 SECONDS

Trade capture records the matched economics. Clearing calculates and may net obligations, and a central counterparty can become buyer to every seller and seller to every buyer under its rules. Settlement transfers assets and funds with legal finality. Custody safeguards and administers the resulting holdings.



Understand the mechanics

Allocation and confirmation Institutional trades may need quantities assigned to accounts and details matched or affirmed before settlement.	Clearing and netting Many trades can be transformed into fewer net obligations. Netting reduces flows but creates dependency on rules and infrastructure.
Central counterparty A CCP can substitute its counterparty exposure for bilateral exposure and manage collateral and default resources. Risk is transformed, not erased.	Delivery versus payment DvP links the securities leg to the cash leg so one should not become final without the corresponding payment under the model.

Custody
Safekeeping and record administration continue after settlement, including entitlements, restrictions, maturity, and corporate actions.

Settlement convention
T+1, T+2, same day, and other cycles are product, market, jurisdiction, holiday, and contract specific.

Worked example: A two-leg delivery

- 01
- A buy execution creates a cash payable and a security receivable. Neither is the final settled position yet.
- 02
- Settlement instructions specify accounts, parties, asset, quantity, cash amount, currency, value date, and market infrastructure.
- 03
- DvP coordinates the two obligations. If the conditions are satisfied, cash and securities become final according to the relevant rules.
- 04
- Custody records the settled holding. Reconciliation then compares internal records with the custodian, depository, clearing source, and bank as applicable.

See it in the Tong Shang system

PRODUCT

Markets operations

Tong Shang

Markets Operations

LIFECYCLE POSTURE

3 decisions due

Overview

Control room

Customer

Accounts and evidence

Orders

Live blotter

Primary auctions

Bids and allocation

Settlement

Due obligations

Custody

Safekeeping

Reconciliation

Break resolution

Market configuration

Rules and sessions

Communications

Customer notices

Simulated market environment

Session healthy · local

MARKETS OPERATIONS

Wednesday, 5 August 2026

Q Search

Language English

Market lifecycle control workspace

Due obligations and posting status are explicit.

Trades and auction allocations remain traceable through cash, securities, fees, and custody posting.

Shared read models connected (4/4)

As of 05 Aug, 09:00 UTC. Shared and simulated sources are labelled per record.

Market connector: Frankfurter v2

Records in view

1

Current module

Needs attention

1

Human review required

Shared records

1

Authoritative read model

As of

05 Aug, 09:00

Connected simulation clock

Filter

All records

Sort

Priority first

1 of 1 records

Settlement control

Trades and auction allocations remain traceable through cash, securities, fees, and custody posting.

REFERENCE	CUSTOMER OR OWNER	TYPE	VALUE	STATUS	SOURCE
SET-000001 2026-08-27	Awa Njie	AAPL delivery versus payment	USD 448.52	Pending	SHARED READ MODEL

AAPL delivery versus payment

SET-000001

SHARED READ MODEL

The settlement obligation links the trade, cash leg, securities leg, and final posting.

TradeTRD-000001

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01
- Generate settlement obligations from immutable trades, not from the latest mutable order status.

-
- 02 Use calendars and product conventions as versioned reference data. Never hardcode one universal settlement day.
-
- 03 Model pending, instructed, matched, partially settled, settled, failed, canceled, and corrected states with owned exception paths.
-

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
A fill creates the trade; clearing transforms obligations; settlement moves value with finality; custody administers the resulting holding.	A two-phase commit resembles DvP, but legal finality, central-bank money, depository rules, cutoffs, and insolvency law cannot be reduced to one database protocol.

Ask one level deeper

-
- 01 Which obligations exist and in which units?
-
- 02 What settlement model and value date apply?
-
- 03 Which bank, custodian, depository, or CCP record proves the result?
-

Misconceptions to reject

-
- 01 Filled means owned and spendable.
-
- 02 All securities settle on the same cycle.
-
- 03 A CCP removes counterparty and operational risk.
-

PREDICT BEFORE REVEAL	A trade is filled on Tuesday under a market-specific T+1 convention. When is the intended settlement date? Normally the next business day, subject to the product, market calendar, holidays, and transaction rules. T+1 is an example, not a universal constant.
------------------------------	---

Primary sources

FINRA: [Understanding Settlement Cycles](#) | 7 min

Trade date versus settlement date and the US T+1 example.

DTCC: [Accelerated Settlement](#) | 10 min

Operational context for matching, affirmation, and settlement.

BIS and CPMI-IOSCO: [Principles for Financial Market Infrastructures](#) | 20 min

International principles for clearing, settlement, custody, and operational resilience.

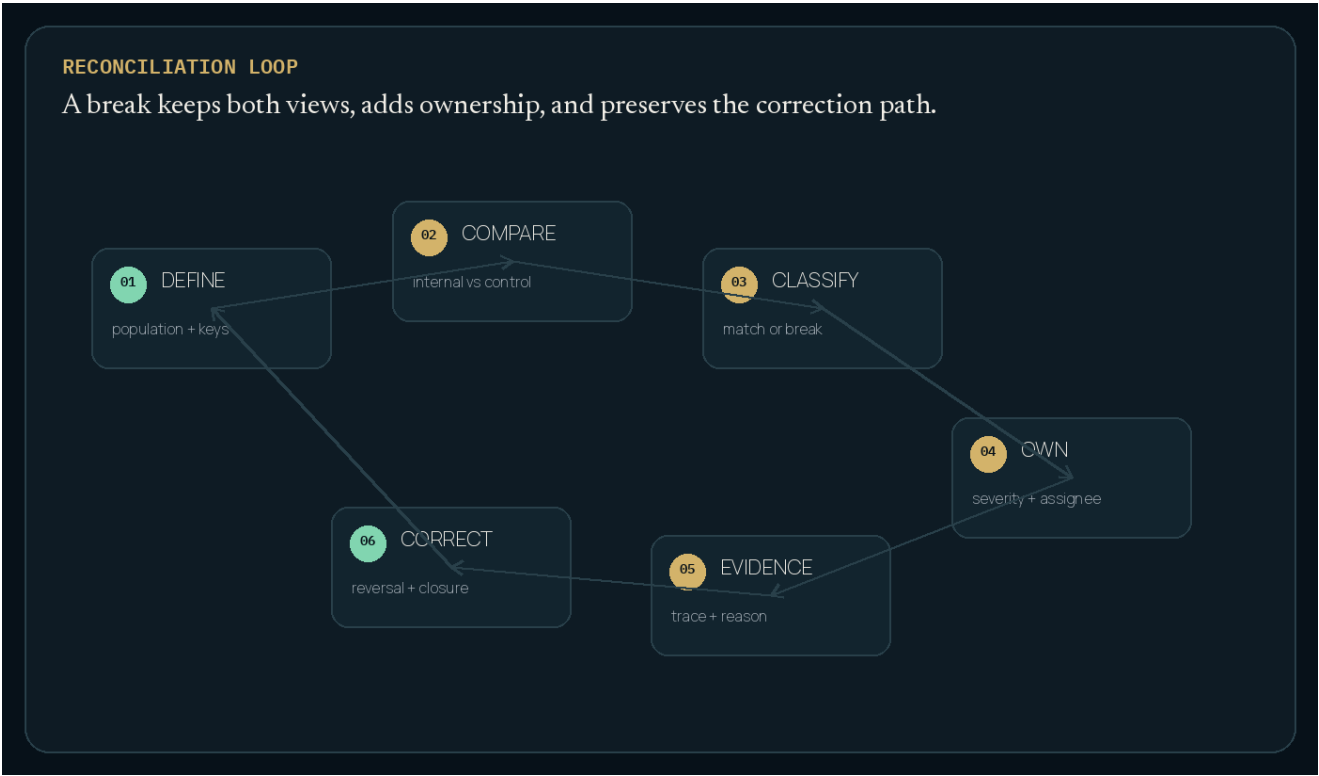
10 RISK AND POST-TRADE

Reconciliation proves scoped agreement, not universal truth

A match is useful evidence. A break is a controlled investigation, not an embarrassing row to hide.

IN 30 SECONDS

Reconciliation compares a defined internal population with an independent or controlled record under explicit keys, dates, tolerances, and policies. A match means those fields agree within scope. It does not prove correct valuation, profitability, legal ownership, or the absence of missing records outside the population.



Understand the mechanics

Population Define which accounts, instruments, dates, currencies, statuses, and sources are in the comparison.	Match key Identifiers and economic fields determine which records should correspond. Weak keys create false matches or false breaks.
Tolerance Some comparisons permit explained timing or rounding differences. Tolerance must be policy, not an ad hoc excuse.	Break A difference needs type, amount or quantity, severity, age, owner, evidence, and resolution state.

Correction

Fixing economic history normally requires a compensating or reversing record that preserves the original evidence.

Control ownership

The team that produces a record should not be the only team or process that certifies it.

Worked example: Internal 1,000 versus custodian 950

- 01
- The internal custody projection shows 1,000 units; the custodian statement shows 950 for the same account and instrument.
- 02
- The 50-unit break may be timing, failed settlement, incorrect account mapping, duplicate posting, missing corporate action, or an external error.
- 03
- The correct response is not to force either value. Freeze the scope, preserve both inputs, assign an owner, inspect linked trade and settlement evidence, and post a controlled correction if justified.
- 04
- After resolution, retain the before state, decision, evidence, approver, and resulting posting.

See it in the Tong Shang system

PRODUCT

Markets operations

Tong Shang

Markets Operations

LIFECYCLE POSTURE

3 decisions due

Customer

Accounts and evidence

Orders

Live blaster

Primary auctions

Bids and allocation

Settlement

Due obligations

Custody

Safekeeping

Reconciliation

Break resolution

Market configuration

Rules and sessions

Communications

Customer notices

Audit trail

Lifecycle history

Simulated market environment

Session healthy · local

MARKETS OPERATIONS

Wednesday, 5 August 2026

Q Search

Language English

Market lifecycle control workspace

Market connector: Frankfurter v2

Records in view

3

Current module

Needs attention

1

Human review required

Shared records

0

Authoritative read model

As of

05 Aug, 09:00

Connected simulation clock

Filter

All records

Sort

Priority first

3 of 3 records

Reconciliation

• BANK CONTEXT SIMULATION

This bank-operating view is a labelled simulation until a reconciliation service is connected.

REFERENCE	CUSTOMER OR OWNER	TYPE	VALUE	STATUS	SOURCE
REC-260805-014 2026-08-05 14:32:00 GMT	Custody operations	Fractional unit allocation	0.500 unit	Open break	• BANK CONTEXT SIMULATION
REC-260805-008 2026-08-05 14:32:00 GMT	Cash operations	GMD settlement cash	GMD 1,240,000	Matched	• BANK CONTEXT SIMULATION
REC-260805-006	Auction operations	Auction face	GMD 120,000	Matched	• BANK CONTEXT SIMULATION

Fractional unit allocation

Open break

REC-260805-014

• BANK CONTEXT SIMULATION

This reconciliation work item is simulated bank operating context. Record the evidence and reason before resolving it.

Internal position

20.500 units

Custodian position

20.000 units

Difference

0.500 unit

Owner

Custody operations

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

01

Reconcile orders to venue acknowledgements, fills to drop copy, trades to clearing, cash to bank, positions to custodian, and subledgers to the general ledger.

PAGE 35

-
- 02 Design reruns and late data deliberately. The same batch should not create duplicate breaks or erase prior ownership history.
-
- 03 Track break counts by cause, severity, and age. A low break count can still hide a critical high-value difference.
-

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
Reconciliation tells me whether defined records agree under defined rules. It does not by itself prove that the records are economically or legally correct.	A checksum analogy communicates comparison, but financial reconciliation includes semantic scope, timing, tolerance, legal records, and human investigation.

Ask one level deeper

- 01 What population and as-of time are compared?
-
- 02 Which fields and tolerances define a match?
-
- 03 Who owns the break and what evidence will close it?
-

Misconceptions to reject

- 01 Two matching systems prove truth.
-
- 02 Every difference is a system defect.
-
- 03 Correcting a break means editing the old row.
-

PREDICT BEFORE REVEAL	Internal and external records match exactly. Can valuation still be wrong? Yes. Both systems can use the same stale price, wrong instrument mapping, or incorrect quantity. The match proves scoped agreement, not universal correctness.
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Primary sources

BIS and CPMI-IOSCO: Principles for Financial Market Infrastructures | 20 min
 International principles for clearing, settlement, custody, and operational resilience.
 OWASP: Logging Cheat Sheet | 15 min
 Useful evidence without leaking secrets or sensitive data.

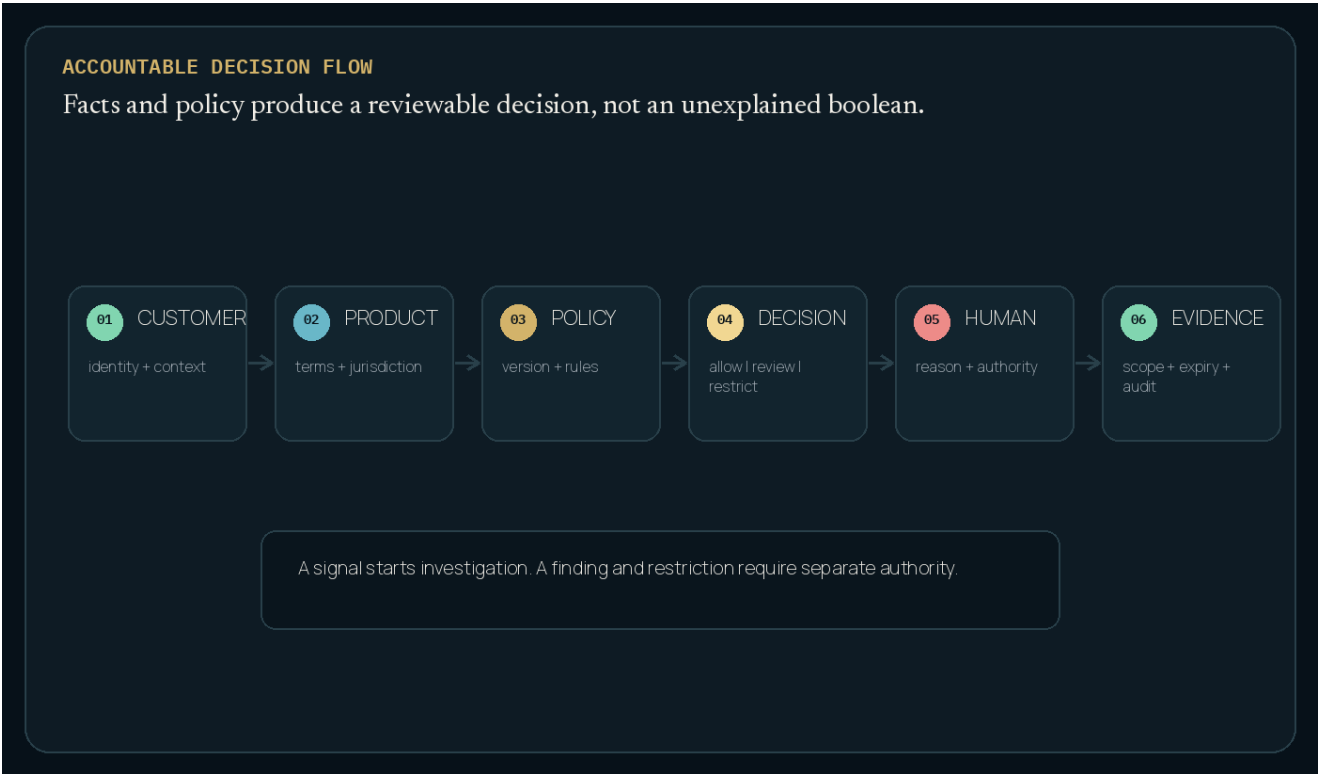
11 RISK AND POST-TRADE

Eligibility, suitability, surveillance, and human accountability

Availability is not appropriateness, a signal is not a verdict, and an override is not a missing control.

IN 30 SECONDS

Trading systems combine identity, account authority, product eligibility, permissions, restrictions, suitability or appropriateness processes, surveillance, and accountable human review. Exact obligations depend on jurisdiction, firm role, product, customer, and activity, so universal thresholds are dangerous.



Understand the mechanics

Identity and authority Know which customer and actor are involved, which account they may use, and which actions their role permits.	Product eligibility A product can be unavailable because of account type, jurisdiction, agreement, knowledge, risk classification, or restriction.
Suitability and appropriateness Different regimes use different tests. The system must store inputs, policy, outcome, limitations, and responsible decision.	Surveillance Rules and models generate signals about patterns such as manipulation or misuse. A signal starts investigation; it is not a finding.

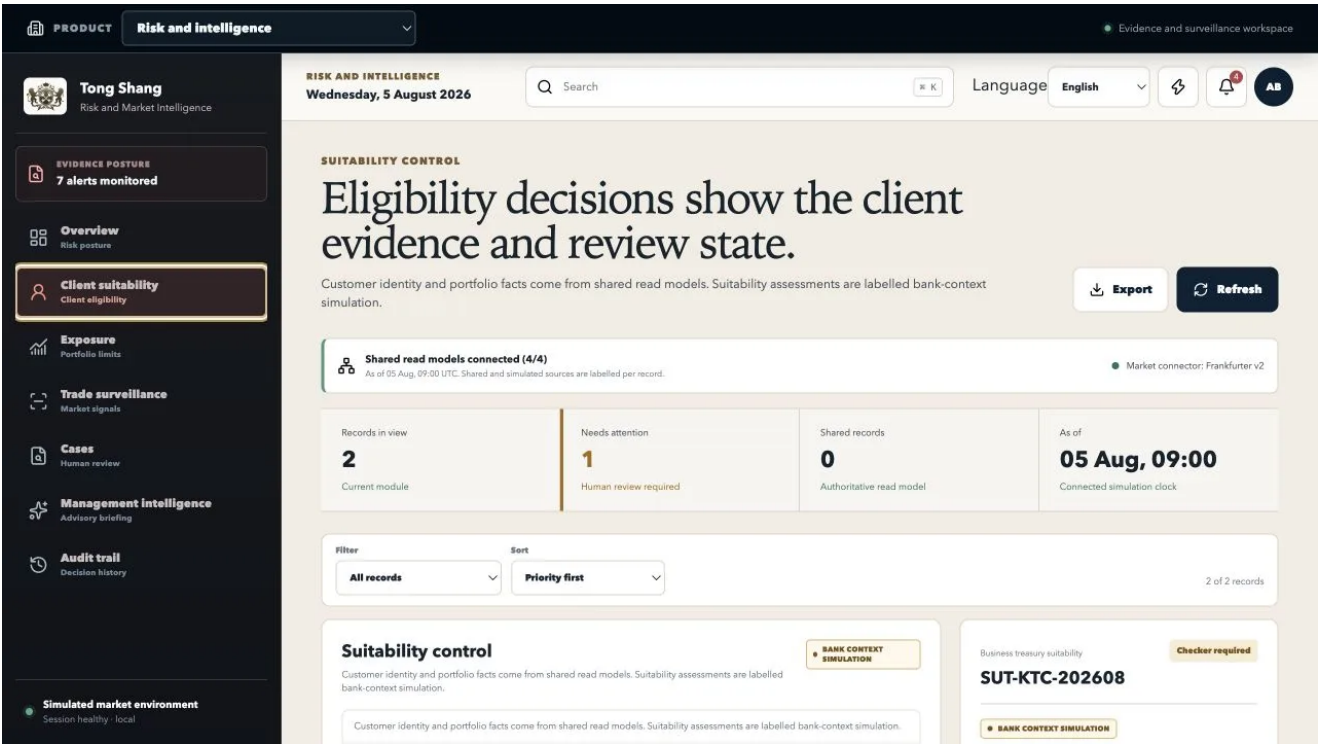
Case and decision
Human review needs evidence, reason, policy version, scope, timestamp, approver, and follow-up action.

Entitlement
Permissions must be enforced server-side and scoped to function, account, product, environment, and time.

Worked example: Signal to restriction

- 01
- A surveillance rule detects repeated order entry and cancellation near the best price.
- 02
- The system creates a signal with source events, rule version, threshold, and confidence context.
- 03
- An analyst reviews intent, market context, related accounts, fills, and alternative explanations. The signal may be closed, escalated to a case, or linked to other evidence.
- 04
- Any restriction is a separate accountable decision with explicit scope and reason. The raw signal remains unchanged.

See it in the Tong Shang system



System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01
- Represent policy decisions as durable records, not booleans sprinkled through UI code.
- 02
- Separate alert, investigation, finding, restriction, and override states. Each has different authority and evidence.

- 03 Use least privilege, dual control for sensitive actions, versioned policy, expiring overrides, and regular access review.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
A product can be technically available yet unsuitable or restricted. I would ask which customer facts, policy version, jurisdiction, evidence, and human authority produced the decision.	Authorization resembles access-control middleware, but customer protection also depends on facts, product documents, human judgment, changing law, and accountable governance.

Ask one level deeper

- 01 Is this an eligibility check, a suitability assessment, or a trading restriction?
- 02 Which policy and customer facts were used?
- 03 Is this a signal, a finding, or a final decision?

Misconceptions to reject

- 01 If the UI shows the product, the customer may trade it.
- 02 A surveillance signal proves misconduct.
- 03 An admin role should bypass controls without additional evidence.

PREDICT BEFORE REVEAL	Why should an override have an expiry and scope? Because a permanent broad bypass silently replaces policy. Scope, reason, approver, evidence, and expiration make exceptional authority reviewable and contain its risk.
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Primary sources

SEC: Market Access Risk Controls | 12 min
Pre-trade limits, erroneous-order controls, restrictions, and authorized access.

FINRA: Algorithmic Trading | 12 min
Testing, supervision, monitoring, governance, and change control.

NIST: Secure Software Development Framework | 20 min
Prepare, protect, produce, and respond as a secure build discipline.

Model the domain before choosing the services

The safest first build is often a modular monolith with clear records, not a fleet of premature microservices.

IN 30 SECONDS

The domain model must keep customer, account, instrument, quote, order, execution, trade, cash movement, position, settlement obligation, custody record, reconciliation result, risk decision, case, and audit event distinct. These records answer different questions and change under different authority.



Understand the mechanics

Command A request to perform an action, such as submit, cancel, allocate, settle, or approve.	Business event An accepted fact such as order accepted, execution received, cash reserved, or settlement failed.
Projection A query-friendly current view derived from controlled events, such as open orders or available cash.	System of record The authoritative record for a defined fact. Authority can differ for venue execution, internal ledger, bank cash, and custodian position.

Correlation A stable thread across customer request, risk decision, venue messages, executions, trade, settlement, and audit.	Boundary One module owns each invariant. Cross-module effects use explicit contracts and recovery instead of shared mutable tables.
---	---

Worked example: One trade, several truths

- 01 The order stores the customer's instruction and lifecycle. The venue execution stores matched price and quantity.
- 02 The trade record stores the economic agreement and parties. The ledger stores monetary effects under accounting policy.
- 03 Settlement stores delivery obligations and finality. Custody stores the resulting controlled holding.
- 04 Reconciliation stores comparison evidence. Audit stores attributable action and reason. None should silently impersonate the others.

Builder lens

- 01 Begin with modules for identity/accounts, instrument data, market data, OMS, risk, execution adapter, ledger/positions, post-trade, reconciliation, and audit.
- 02 Use database constraints for identity and referential integrity, plus domain invariants and transactional outbox for atomic local effects.
- 03 Split services only when ownership, scaling, resilience, security, or deployment needs justify the operational cost.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
I would separate intent, market events, financial postings, settlement obligations, and evidence, then define which module and external source owns each fact.	A domain entity resembles a software object, but records may be governed by external law, accounting policy, venue rules, and evidentiary retention requirements.

Ask one level deeper

- 01 Which entity owns this invariant?
- 02 Is this immutable evidence or a rebuildable projection?
- 03 Which identifier traces the record across boundaries?

Misconceptions to reject

- 01 Microservices make a trading system safer by default.
- 02 One mutable order row can represent every stage.
- 03 The most recent database value is always the authoritative truth.

PREDICT BEFORE REVEAL

Should the current position be stored or calculated?

It can be stored as a controlled projection for performance, but it should be reproducible from authoritative economic events and checked against independent records.

Primary sources

[PostgreSQL: Constraints](#) | 12 min

Unique identity, referential integrity, and defensive data rules.

[PostgreSQL: Transaction Isolation](#) | 15 min

Concurrency behavior and why transactions do not replace domain invariants.

[FIX Trading Community: Order State Changes](#) | 20 min

The real complexity of partial fills, cancels, replaces, and corrections.

13 BUILDING THE SYSTEM

Build the data and order paths for ambiguity

Sequence gaps, stale quotes, duplicate submits, timeouts, and cancel-fill races are ordinary design cases.

IN 30 SECONDS

Market-data and order paths are coupled but not identical. The data path must normalize, sequence, timestamp, recover, and expose provenance. The order path must validate, authorize, apply risk controls, reserve resources, route, consume reports, and preserve unknown outcomes without duplicating economic effects.



Understand the mechanics

Three clocks Store source-event, receive, and processing or commit times. Use monotonic clocks for duration and synchronized wall clocks for evidence.	Sequence recovery A gap makes the affected book suspect. Recovery joins a snapshot boundary with queued later updates before returning to live.
Idempotent submit The same key and same payload returns the existing result. Reusing the key with a different payload is rejected.	Unknown outcome A timeout after send is neither acceptance nor rejection. Recover session state, query, use execution reports or drop copy, and reconcile.

Reservation

Cash or inventory reservation prevents simultaneous accepted orders from spending the same capacity.

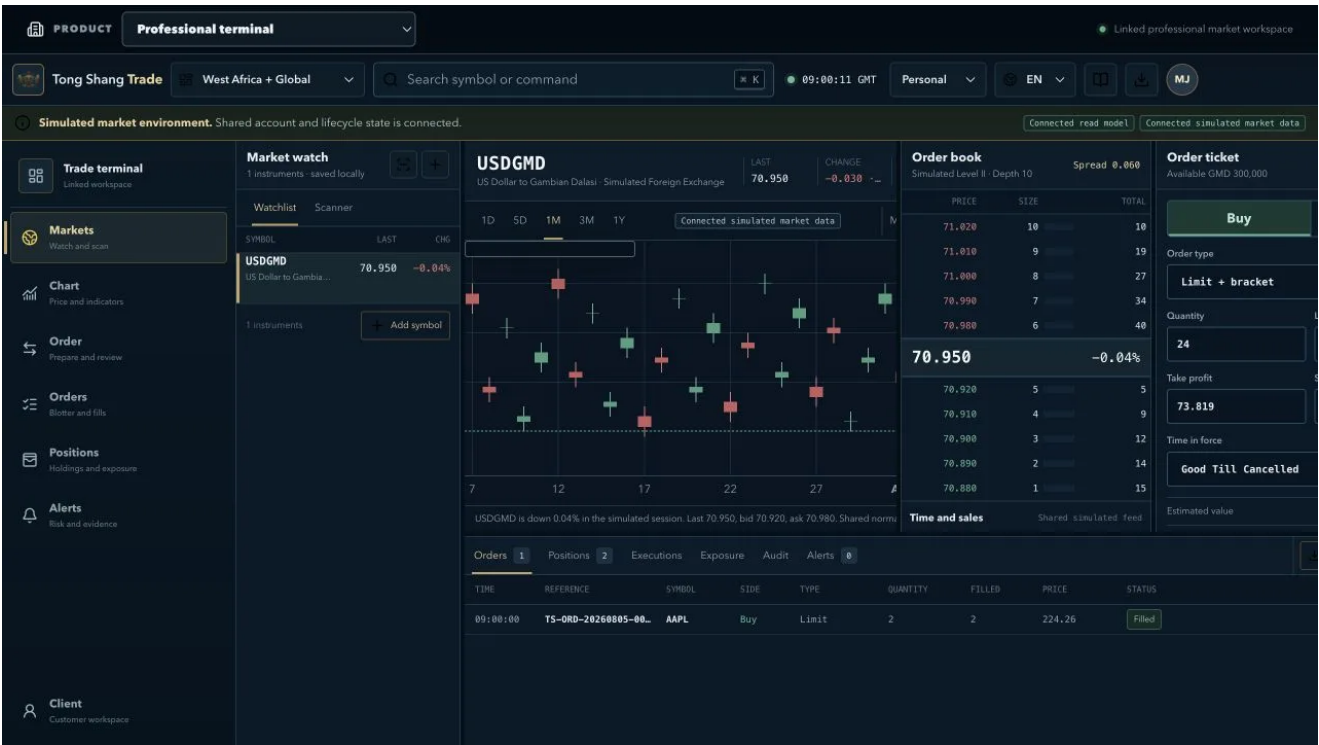
OMS versus EMS

OMS manages intent, controls, accounts, and lifecycle. EMS focuses on routing, child orders, venue connectivity, and execution behavior.

Worked example: The duplicate-submit trap

- 01
- Client POSTs an order with idempotency key K. The server commits the order but the response times out.
- 02
- The client retries K with the same body. A unique key and request hash return the original order rather than creating another one.
- 03
- If the second body differs, the server rejects it. Reusing identity for new intent is unsafe.
- 04
- Order, audit record, reservation, and outbox event commit in one local transaction. Consumers also deduplicate immutable event IDs.

See it in the Tong Shang system



System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01
- Normalize money as fixed-point or decimal with explicit scale; retain the raw protocol message for investigation.

-
- 02 Persist risk inputs and decision before routing. Fail closed when a mandatory control or authoritative input is unavailable.
-
- 03 Fence active gateways and test disconnect semantics so two leaders cannot send the same order.
-

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
A timeout creates an unknown outcome. I would recover and reconcile the original identity before deciding whether any new order is safe.	Exactly-once is a useful product requirement but a misleading transport promise. Effective-once behavior comes from durable identity, atomic local writes, deduplication, and reconciliation.

Ask one level deeper

-
- 01 What sequence or freshness state supports this book?
-
- 02 What business identity makes retry safe?
-
- 03 What happens if a fill crosses a pending cancel or the gateway disconnects?
-

Misconceptions to reject

-
- 01 A timeout is a rejection.
-
- 02 Transport sequencing prevents duplicate business effects.
-
- 03 A FIX version guarantees identical counterparty behavior.
-

PREDICT BEFORE REVEAL	Why is a new client order ID dangerous after a submission timeout? The original order may already exist at the venue. A new identity can create a second valid order. First recover the original outcome using its durable identifiers.
------------------------------	--

Primary sources

Nasdaq: TotalView ITCH 5.0 | 30 min

Concrete feed messages, sequence, scales, and instrument-location semantics.

Nasdaq: OUCH 5.0 Order Entry | 30 min

Concrete order-entry, execution, cancel, and broken-trade messages.

FIX Trading Community: Order State Changes | 20 min

The real complexity of partial fills, cancels, replaces, and corrections.

IETF HTTPAPI: Idempotency-Key Draft | 12 min

Recognizing safe retries of non-idempotent requests.

SEC: Market Access Risk Controls | 12 min

Pre-trade limits, erroneous-order controls, restrictions, and authorized access.

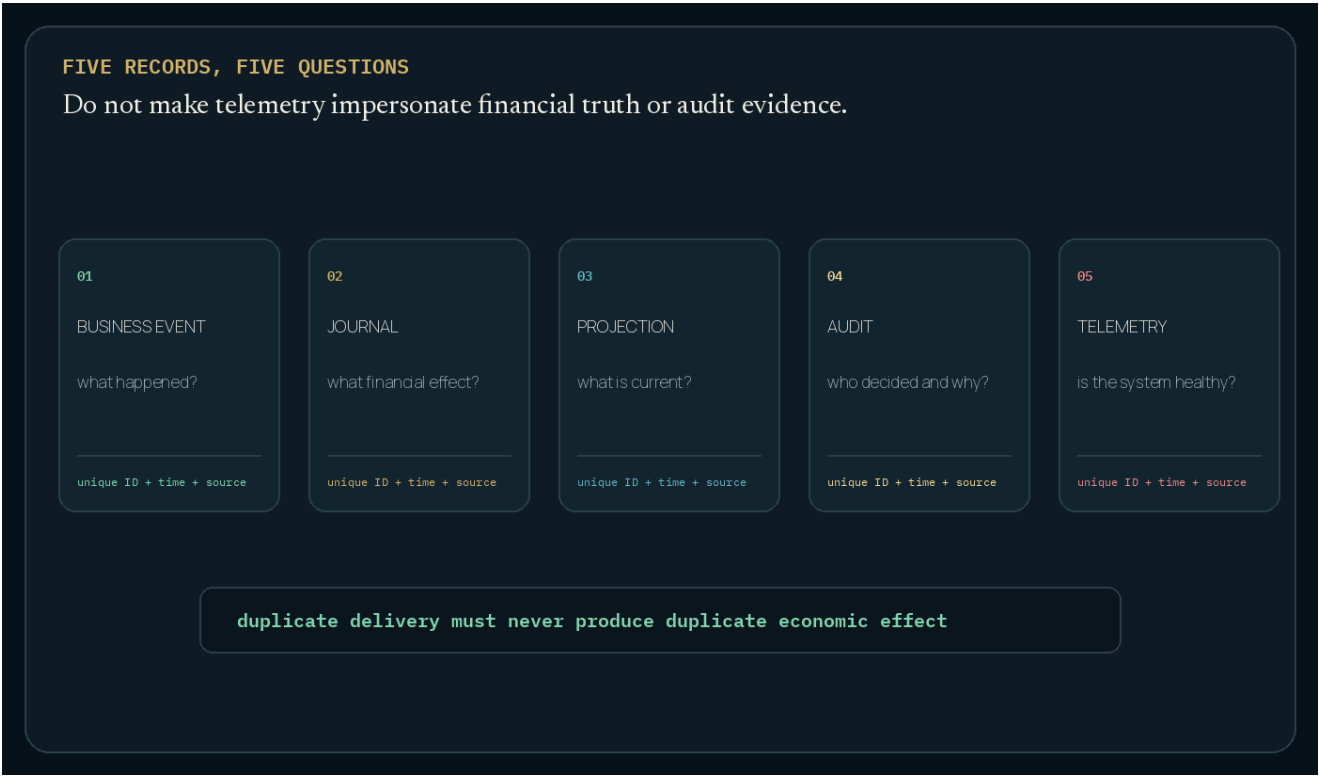
14 BUILDING THE SYSTEM

Ledgers, evidence, observability, and failure recovery

Correctness must survive retry, reordering, correction, restart, stale data, and operator error.

IN 30 SECONDS

An append-only journal records accepted financial effects. Balanced entries, explicit units, unique business-event IDs, and reversals make corrections reconstructable. Business audit history preserves attributable actions. Operational telemetry explains system health. Backups, replay, reconciliation, and tested recovery make the design operable.



Understand the mechanics

Journal and entry One business event produces a journal with linked debit and credit entries under a documented accounting policy.	Reservation versus posting Available, reserved, pending, and settled cash or assets are different states. Rejection and cancellation must release unused reservation.
Reversal A correction references and offsets an earlier journal. It preserves history instead of rewriting it.	Business audit Actor, action, reason, policy, correlation, prior state, new state, and timestamps support reconstruction.

Telemetry

Metrics reveal rates and saturation, traces connect distributed work, and logs explain events. None replaces business identity or accounting records.

Recovery

Define RTO and RPO, test restore and replay, fence leaders, bound retries, apply backpressure, and keep reconciliation available during order-entry shutdown.

Worked example: Reserve, fill, settle, reverse

- 01
- A buy order reserves GMD 10,000. Available cash falls while total cash ownership has not yet changed.
- 02
- A partial fill consumes GMD 6,000 of reservation and creates pending asset and cash obligations. The remaining GMD 4,000 stays reserved while the order works.
- 03
- Cancellation releases unused reservation. Settlement moves pending balances into settled cash and custody under policy.
- 04
- A busted execution creates linked reversals. Replaying accepted events must reproduce the same controlled projections without duplicate effects.

See it in the Tong Shang system

PRODUCT

Markets operations

Tong Shang

Markets Operations

LIFECYCLE POSTURE

3 decisions due

Customer

Accounts and evidence

Orders

Live blaster

Primary auctions

Bids and allocation

Settlement

Due obligations

Custody

Safekeeping

Reconciliation

Break resolution

Market configuration

Rules and sessions

Communications

Customer notices

Audit trail

Lifecycle history

Simulated market environment

Session healthy · local

MARKETS OPERATIONS

Wednesday, 5 August 2026

Q Search

Language English

Market lifecycle control workspace

Market connector: Frankfurter v2

Shared read models connected (4/4)

As of 05 Aug, 09:00 UTC. Shared and simulated sources are labelled per record.

Records in view

3

Current module

Needs attention

1

Human review required

Shared records

0

Authoritative read model

As of

05 Aug, 09:00

Connected simulation clock

Filter

All records

Sort

Priority first

3 of 3 records

Reconciliation

BANK CONTEXT SIMULATION

This bank-operating view is a labelled simulation until a reconciliation service is connected.

This bank-operating view is a labelled simulation until a reconciliation service is connected.

REFERENCE	CUSTOMER OR OWNER	TYPE	VALUE	STATUS	SOURCE
REC-260805-014	Custody operations	Fractional unit allocation	0.500 unit	Open break	BANK CONTEXT SIMULATION
2026-08-05 14:32:00 GMT					
REC-260805-008	Cash operations	GMD settlement cash	GMD 1,240,000	Matched	BANK CONTEXT SIMULATION
2026-08-05 14:32:00 GMT					
REC-260805-006	Auction operations	Auction face	GMD 100,000	Matched	BANK CONTEXT SIMULATION

Fractional unit allocation

Open break

REC-260805-014

This reconciliation work item is simulated bank operating context. Record the evidence and reason before resolving it.

Internal position

20.500 units

Custodian position

20.000 units

Difference

0.500 unit

Owner

Custody operations

System values and workflows are simulated unless the screen explicitly identifies dated reference data.

Builder lens

- 01
- Enforce unique external execution IDs and balanced journal invariants in the database and application layer.

-
- 02 Track market-data age, sequence gaps, order acknowledgement latency, rejects, unknown outcomes, duplicate events, settlement failures, break age, and ledger imbalance count.
-
- 03 Exclude passwords, tokens, keys, and unnecessary sensitive data from logs. Separate PII and use least privilege and tamper-resistant retention.
-

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
I separate business events, financial journals, current projections, audit evidence, and operational telemetry because each answers a different question.	An event log can rebuild projections, but it is not automatically an accounting policy, compliant recordkeeping system, backup, or independent reconciliation source.

Ask one level deeper

-
- 01 Which invariant makes duplicate processing harmless?
-
- 02 How is a correction reversed and evidenced?
-
- 03 Can operators restore, replay, reconcile, and disable trading without guessing?
-

Misconceptions to reject

-
- 01 Append-only means correct and compliant.
-
- 02 Logs are an audit trail even if they leak secrets or can be altered.
-
- 03 A successful backup job proves recovery.
-

PREDICT BEFORE REVEAL	What should happen if the same fill event is delivered twice? The second delivery should be recognized by immutable identity and produce no second economic posting. The duplicate can be measured and evidenced without changing the position or ledger twice.
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Primary sources

PostgreSQL: Transaction Isolation | 15 min

Concurrency behavior and why transactions do not replace domain invariants.

PostgreSQL: Constraints | 12 min

Unique identity, referential integrity, and defensive data rules.

OpenTelemetry: Observability Primer | 10 min

Traces, metrics, logs, and questions about unknown failures.

OWASP: Logging Cheat Sheet | 15 min

Useful evidence without leaking secrets or sensitive data.

NIST: Secure Software Development Framework | 20 min

Prepare, protect, produce, and respond as a secure build discipline.

15 BUILD AND PRACTICE | 90-MINUTE PATH

From replay to a safe paper-trading capstone

The goal is not to predict markets. It is to prove that the system remains controlled when its assumptions and dependencies fail.

IN 30 SECONDS

Build one asset class, venue model, account model, and currency first. Progress through deterministic replay, a simulated venue, protocol certification, shadow comparison, paper trading, and only then a separately authorized tiny pilot. Each stage needs explicit risk limits, observation, approval, and rollback.

BUILD MATURITY STAIRCASE

Advance only when the previous environment proves its stated risks and recovery.

`read -> inspect -> calculate -> explain -> build -> break -> recover`

01

REPLAY

deterministic inputs

02

SIMULATOR

partial + failure

03

CERTIFY

protocol behavior

04

SHADOW

compare, no orders

05

PAPER

workflow rehearsal

06

TINY PILOT

separate authority

Understand the mechanics

Unit and property tests

Prove arithmetic, scale, state transitions, and invariants over many generated cases.

Golden protocol tests

Parse and serialize known venue messages exactly, including rejects, partial fills, gaps, and corrections.

Replay

The same captured inputs and configuration should reproduce the same normalized book, orders, executions, and projections.

Fault injection

Inject duplicates, reorderings, timeouts, disconnects, stale data, leader overlap, database contention, disk pressure, and failed settlement.

Paper-trading gap Paper fills omit some queue position, market impact, real latency, rejects, fees, borrow, halts, corporate actions, and operational failures.	Model risk Backtests require lineage, out-of-sample design, fees, slippage, capacity, bias controls, validation, monitoring, challenge, and a disable path.
--	--

Worked example: The capstone trace

01	Load a versioned instrument and a sourced timestamped quote. Make the quote stale and show the order control reacting by policy.
02	Accept one idempotent limit order, reserve resources, and simulate two partial fills plus a cancel-fill race.
03	Post balanced pending effects exactly once, generate cash and asset settlement obligations, and deliberately fail one leg.
04	Create a reconciliation break, assign it, resolve it with evidence and a correcting journal, then replay the whole trace deterministically.

Builder lens

01	Deliver an architecture diagram, domain model, API schema, event catalog, state machines, invariant suite, end-to-end trace, failure report, and teach-back presentation.
02	Keep a global kill path, but also support account, strategy, instrument, and venue scopes. Test every switch.
03	Do not connect live funds without qualified legal, compliance, accounting, security, venue, operational, and financial review.

TALK LIKE YOU UNDERSTAND IT	WHERE THE ANALOGY BREAKS
A credible trading-system demo is not the one that always fills. It is the one that explains, contains, and recovers from stale, duplicate, delayed, rejected, partial, and failed outcomes.	A test pyramid conveys layers, but market systems also need protocol certification, deterministic replay, reconciliation, operational drills, and ongoing control validation.

Ask one level deeper

01	Which invariant would catch the worst silent error?
02	What real behavior does the simulator omit?
03	What evidence is required before advancing to the next environment?

Misconceptions to reject

- 01 Paper profitability proves live profitability.
- 02 Passing unit tests makes venue behavior safe.
- 03 Low latency is more important than correctness and control.

PREDICT BEFORE REVEAL

What is the most important first build boundary?

Define what the system will and will not do: user, jurisdiction, asset class, venue, simulated/live boundary, data rights, custody assumptions, failure limits, and who can authorize change.

Primary sources

[FINRA: Algorithmic Trading](#) | 12 min

Testing, supervision, monitoring, governance, and change control.

[Federal Reserve: SR 26-2 Model Risk Management](#) | 20 min

Current purpose, materiality, validation, challenge, and monitoring principles.

[NIST: Secure Software Development Framework](#) | 20 min

Prepare, protect, produce, and respond as a secure build discipline.

[OpenTelemetry: Observability Primer](#) | 10 min

Traces, metrics, logs, and questions about unknown failures.

Connected glossary

Search for relationships among these terms in the HTML edition. In print, use the definitions to explain each term without circular language.

Agency	Acting on behalf of a customer rather than trading for the firm's own account.
Ask	The lowest displayed price at which a seller currently offers a stated quantity.
Basis point	One hundredth of one percent, or 0.0001 in decimal form.
Bid	The highest displayed price a buyer currently offers for a stated quantity.
Broker	A firm or person that handles transactions for customers, subject to its legal role and jurisdiction.
Central counterparty	An infrastructure that interposes itself between counterparties under defined clearing and risk rules.
Clearing	The process of matching, calculating, netting, and managing obligations before settlement.
Custody	Safekeeping and administration of assets and ownership records after settlement.
Depth	Displayed or available quantity across price levels before expected execution cost changes materially.
Execution	A matched fact recording quantity and price that traded.
Exposure	The amount and direction through which a risk factor can affect value or obligations.
Fill	One execution against an order. One order can have zero, one, or many fills.
FIX	A family of financial messaging standards. Connection behavior still depends on negotiated profiles and rules.
Gross leverage	Total absolute economic exposure divided by account equity under a defined policy.
Idempotency	The property that safe retries do not create duplicate business effects.
Instrument	A specific financial contract with identifiers, terms, cash flows, units, and rules.
Limit order	An order with a worst acceptable execution price, but no guarantee of execution.

Liquidity	The ability to transact a desired size promptly near the expected total cost, plus the market's capacity to recover.
Market order	An order that prioritizes prompt execution while accepting price uncertainty.
Mark to market	Valuing a position using a specified current price source and as-of time.
Midpoint	The arithmetic average of bid and ask. It is a reference calculation, not normally an executable price.
Notional	A contract or exposure amount used for sizing and risk. Its calculation is product specific.
Order	A typed instruction containing instrument, side, quantity, price controls, duration, and account context.
Position	Economic quantity held or owed in an instrument, with availability and settlement state.
Primary market	The market in which newly issued claims are sold and proceeds reach the issuer.
Reconciliation	A controlled comparison of defined records under explicit keys, scope, time, and tolerance.
Reference rate	A sourced rate intended for valuation or information, not necessarily a transaction commitment.
Secondary market	Trading of existing claims among holders after issuance.
Settlement	The final exchange and posting of cash and asset obligations under the applicable rules.
Slippage	The difference between a benchmark such as arrival price and the actual average execution price under a defined sign convention.
Spread	Ask minus bid for the same scoped quote.
Stop order	An order that activates after a trigger. The trigger price is not a guaranteed execution price.
Trade	The economic agreement created by one or more executions, before post-trade completion.
Unrealized P&L	Modeled gain or loss on quantity that remains open under stated valuation and cost assumptions.
Yield	An annualized comparison measure based on defined price, cash flow, tenor, and market conventions.

Primary source library

Rules, conventions, venue behavior, and data change. Revisit the primary source before relying on a dated statement.

Investor.gov: Introduction to Investing | 10 min

Goals, compounding, asset allocation, and risk.

<https://www.investor.gov/introduction-investing>

Investor.gov: Investment Products | 8 min

Authoritative starting point for common product types.

<https://www.investor.gov/introduction-investing/investing-basics/investment-products>

Investor.gov: Stocks | 8 min

Ownership rights, returns, and risks.

<https://www.investor.gov/introduction-investing/investing-basics/investment-products/stocks>

Investor.gov: Bonds | 10 min

Debt-contract language, maturity, and credit risk.

<https://www.investor.gov/introduction-investing/investing-basics/investment-products/bonds-or-fixed-income-products/bonds>

Investor.gov: Mutual Funds | 10 min

Pooled ownership, NAV, fees, and diversification.

<https://www.investor.gov/introduction-investing/investing-basics/investment-products/mutual-funds-and-exchange-traded-funds-etfs/mutual-funds>

Investor.gov: Bid Price and Ask Price | 3 min

The official plain-language definition of bid, ask, and spread.

<https://www.investor.gov/introduction-investing/investing-basics/glossary/ask-price>

FINRA: Order Types | 8 min

Market, limit, stop, and stop-limit tradeoffs.

<https://www.finra.org/investors/investing/investment-products/stocks/order-types>

Investor.gov: Executing an Order | 8 min

Routing, execution, and why a screen is not the whole market.

<https://www.investor.gov/introduction-investing/investing-basics/how-stock-markets-work/executing-order>

SEC: Disclosure of Order Execution and Routing Practices | 12 min

Execution quality includes price, likelihood, speed, and reliability.

<https://www.sec.gov/rules-regulations/2001/03/disclosure-order-execution-routing-practices>

SEC: Margin and Its Risks | 8 min

Why leverage can create forced sales and losses beyond initial cash.

<https://www.sec.gov/about/reports-publications/investorpubsmargin.htm>

SEC: Regulation SHO Overview | 10 min

Borrowing, delivery, and short-sale mechanics.

<https://www.sec.gov/investor/pubs/regsho.htm>

FINRA: Understanding Settlement Cycles | 7 min

Trade date versus settlement date and the US T+1 example.

<https://www.finra.org/investors/insights/understanding-settlement-cycles>

DTCC: Accelerated Settlement | 10 min

Operational context for matching, affirmation, and settlement.

<https://www.dtcc.com/accelerated-settlement>

BIS and CPMI-IOSCO: Principles for Financial Market Infrastructures | 20 min

International principles for clearing, settlement, custody, and operational resilience.

https://www.bis.org/cpmi/info_pfmi.htm

[FIX Trading Community: Order State Changes](#) | 20 min

The real complexity of partial fills, cancels, replaces, and corrections.

<https://www.fixtrading.org/online-specification/order-state-changes/>

[FIX Trading Community: ExecutionReport](#) | 10 min

Why an event reason and current order state are separate fields.

https://fiximate.fixtrading.org/legacy/en/FIX.5.0SP2/body_5756.html

[SEC: Market Access Risk Controls](#) | 12 min

Pre-trade limits, erroneous-order controls, restrictions, and authorized access.

<https://www.sec.gov/rules-regulations/2011/06/risk-management-controls-brokers-or-dealers-market-access>

[FINRA: Algorithmic Trading](#) | 12 min

Testing, supervision, monitoring, governance, and change control.

<https://www.finra.org/rules-guidance/key-topics/algorithmic-trading>

[Central Bank of The Gambia: Open Market Operations](#) | 8 min

Regional government-securities and primary-dealer context.

<https://www.cbg.gm/open-market-operations>

[Central Bank of The Gambia: Auction Results](#) | 5 min

Current dated auction results for local context.

<https://www.cbg.gm/auction-results>

[Ghana Stock Exchange: Overview](#) | 7 min

A regional view of exchange, fixed-income, depository, and settlement infrastructure.

<https://gse.com.gh/overview/>

[Nasdaq: TotalView ITCH 5.0](#) | 30 min

Concrete feed messages, sequence, scales, and instrument-location semantics.

<https://nasdaqtrader.com/content/technicalsupport/specifications/dataproducts/NQTVITCHSpecification.pdf>

[Nasdaq: OUCH 5.0 Order Entry](#) | 30 min

Concrete order-entry, execution, cancel, and broken-trade messages.

<https://nasdaqtrader.com/content/technicalsupport/specifications/TradingProducts/Ouch5.0.pdf>

[PostgreSQL: Transaction Isolation](#) | 15 min

Concurrency behavior and why transactions do not replace domain invariants.

<https://www.postgresql.org/docs/current/transaction-iso.html>

[PostgreSQL: Constraints](#) | 12 min

Unique identity, referential integrity, and defensive data rules.

<https://www.postgresql.org/docs/current/ddl-constraints.html>

[IETF HTTPAPI: Idempotency-Key Draft](#) | 12 min

Recognizing safe retries of non-idempotent requests.

<https://datatracker.ietf.org/doc/html/draft-ietf-httpapi-idempotency-key-header>

[OpenTelemetry: Observability Primer](#) | 10 min

Traces, metrics, logs, and questions about unknown failures.

<https://opentelemetry.io/docs/concepts/observability-primer/>

[OWASP: Logging Cheat Sheet](#) | 15 min

Useful evidence without leaking secrets or sensitive data.

https://cheatsheetseries.owasp.org/cheatsheets/Logging_Cheat_Sheet.html

[NIST: Secure Software Development Framework](#) | 20 min

Prepare, protect, produce, and respond as a secure build discipline.

<https://csrc.nist.gov/projects/ssdf>

[Federal Reserve: SR 26-2 Model Risk Management](#) | 20 min

Current purpose, materiality, validation, challenge, and monitoring principles.

<https://www.federalreserve.gov/supervisionreg/srletters/SR2602.htm>