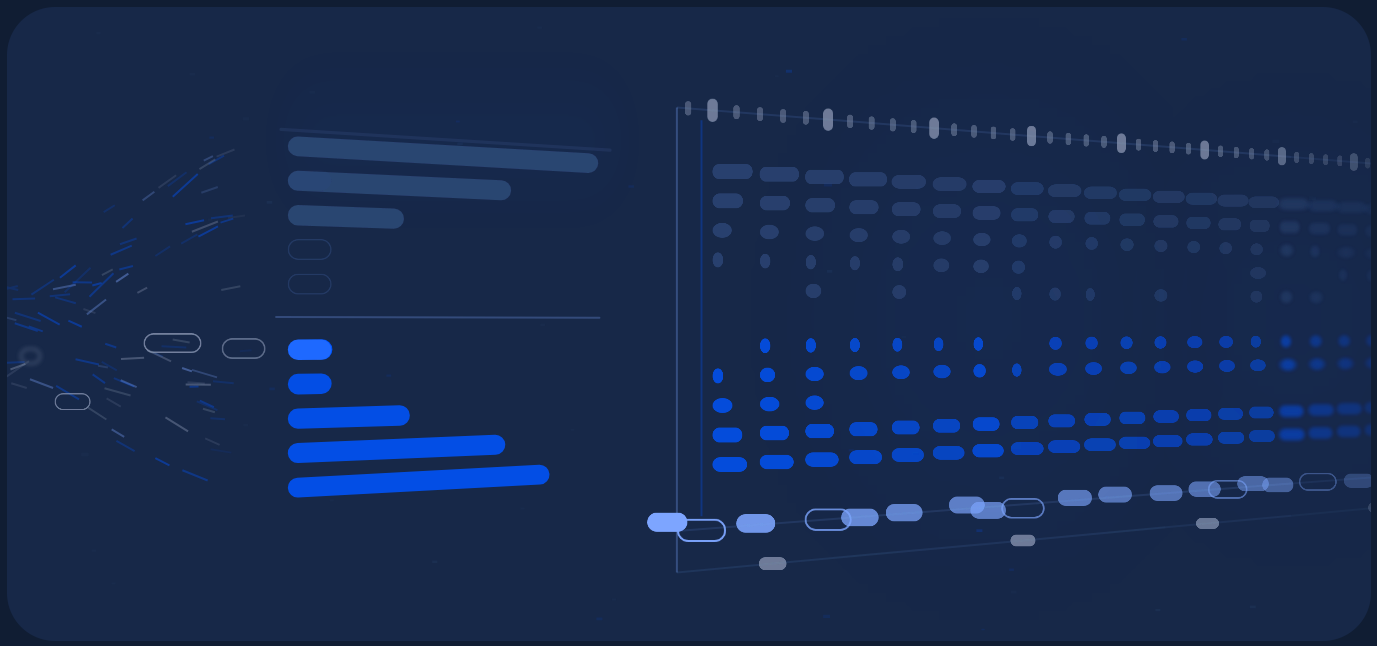
Rillor

EXPLAINER

Level 1, 2 and 3 market data explained

Level 2 vs level 3 market data: the size at each price, or every order. Venue specifications show what each level carries and which studies need it.



Rillor

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Summary

Level 1, level 2 and level 3 market data name three depths of an order book's record, the top of the book, the total size at each price and each order, and the specifications that define them use the labels in different ways [1, 2, 6, 7].

- Level 1 market data is the top of the book, the best bid and offer with their sizes, plus trades. The SEC's December 2020 account of U.S. consolidated data lists the last sale, each exchange's best quote and the national best bid and offer (NBBO) [14].
- Level 2 market data, which CME calls market by price, adds the total size resting at each price. Its depth differs by venue: 3, 5 or 10 levels per instrument at CME, 10 to 1,000 at Kraken and the full book at Coinbase [2, 20, 22].
- Level 3 market data, which CME calls market by order, sends each order under its own ID. It shows each order's place in the queue and lets fills be matched to resting orders, which Kraken says level 2 data cannot do [1, 24].
- The labels conflict. Nasdaq's own Level 2 product carries the best bid and ask of each market participant [6], and in 1994 Level 3 was a Nasdaq quote entry service that every Nasdaq market maker needed from 1 August [7].
- Even order-level feeds leave out hidden size. Nasdaq reports executions of non-displayed orders only as trade messages with an order reference of zero, and Kraken's level 3 feed excludes the hidden quantity of iceberg orders [5, 23].
- Hyperliquid, an on-chain perpetual futures venue, names what the exchange feeds studied here keep anonymous: its trade messages carry the buyer and seller addresses. Its public book feed counts the orders at each price level and can group prices into buckets [26, 27].
- In December 2020 the SEC defined depth of book in U.S. consolidated data as five price levels beyond the NBBO. In September 2024 it wrote that the rules would add that depth once implemented, and recalled that the data of the securities information processors (SIPs), which publish U.S. consolidated data, held only top-of-book quotes [14, 15].

Background

What an order book records

Gould and coauthors define a limit order book at time t as "the set of all active orders in a market at time t", which "can then be considered as a set of queues, each of which consists of active buy or sell orders at a specified price" [31]. The bid is the highest price among active buy orders, the ask the lowest among active sell orders, and the spread the difference between them [31]. Under price-time priority, "among all resting orders awaiting trade at a given price, earlier orders are prioritized for matching with contra-side liquidity takers" [33].

A feed is a stream of changes to that set, and what it sends decides what a user can rebuild. Moallemi and Yuan contrast "market-by-level data, which displays orders accumulated on price" with market-by-order data, which "makes it possible to reconstruct the limit order book at any given time" [33]. Even a complete feed shows only part of the book. "Many exchanges display only active orders that lie within a certain range of relative prices", and many accept iceberg orders, whose hidden quantity each exchange treats by its own rules [31].

Why the labels need a source

Nasdaq named two of its own services "Level 2" and "Level 3" [6, 7]. Coinbase and Kraken use level 1 to level 3 for the depths of their APIs [20, 21, 22, 23]. CME says market by price and market by order [1, 2], NYSE describes price level and order-by-order feeds [8, 10], and Eurex names its interfaces netted, un-netted and order by order, with no level 1 to level 3 product labels [17, 18]. This report defines each level by what the feed carries and cites the specification for each claim. It is written for quant researchers and data buyers comparing feed tiers before they buy, and for traders checking what a level means.

Method

What was examined. For each level: what one message carries, how many price levels a feed sends, whether every change is sent or changes are sampled, which venues a feed covers and from what date its history runs.

Sources. Exchange and SIP specifications and data pages from CME, Nasdaq, NYSE, the CQ Plan and Eurex, in versions dated July 2022 to October 2026 [1, 2, 3, 4, 5, 6, 8, 9, 10, 11, 12, 13, 17, 18]. API documentation from four crypto venues, one of them an on-chain perpetual futures venue [19, 20, 21, 22, 23, 24, 25, 26, 27, 28]. Four SEC releases from 2020, 2024 and 2026 and a 1994 notice to NASD members [7, 14, 15, 16, 36]. One vendor's schema page, cited only for its labels [29]. Five research papers [30, 31, 32, 33, 34] and Rillor's service page [35].

How. Quotes are exact. Specifications are cited by version and date, and undated pages as viewed on 8 November 2026. Counts of levels, intervals and dates are as each source states them, and inferences drawn from a source are marked. No feed was captured or tested for this report, and no fee or licensing term was examined.

Findings

1. Level 1: the top of the book and trades

U.S. consolidated data. The SEC's December 2020 market data release says the equity data plans "provide for the dissemination of top-of-book ("TOB") data and transaction information" [14]. The plans generally define core data as the price, size and exchange of the last sale, each exchange's current highest bid and lowest offer with the shares available at those prices, and the NBBO, "the highest bid and lowest offer currently available on any exchange" [14]. In September 2024 the SEC recalled that the market data infrastructure (MDI) adopting release explained "that SIP data currently only includes top-of-book quotes" [15].

How the NBBO is set. The CQS output specification, version 2.11b of 29 January 2026, states that CQS receives transactions from the participating U.S. stock exchanges and the FINRA Alternative Display Facility, and calculates the NBBO and the best odd lot order (BOLO) [13]. It ranks quotes by price, then size, then earliest time, and "Appendages are not added if it is determined that the current quote does not affect the National BBO" [13].

One exchange's top of book. NYSE's Pillar BBO feed, specification 2.5d of 28 March 2025, "provides top of book quote data for all traded securities on the respective NYSE exchanges" for clients who need "a direct, unconsolidated feed" [9]. Its best bid and offer is one exchange's, beside the SIP's national one.

Crypto venues. Kraken's ticker "streams level 1 market data, i.e. top of the book (best bid/offer) and recent trade data" [21]. Coinbase's REST book at level 1 returns "The best bid, ask and auction info", with the size at a price summed over its orders and a count of those orders [20]. Table 1 sets these beside the other level 1 feeds.

Feed	What it covers	When it updates	Source
CQS NBBO appendage	National best bid and offer across exchanges	When a quote changes the NBBO	[13]
NYSE Pillar BBO	One NYSE exchange's best quote	In real time, with matching-engine timestamps	[9]
Kraken ticker	Best bid and offer, recent trades	On every trade by default, or on a BBO change if requested	[21]
Coinbase ticker	Best bid and ask with sizes, last match	Every match, batched in cascades	[19]
Binance book ticker	Best bid and ask with quantities	Any change, in real time	[25]

Feed	What it covers	When it updates	Source
Hyperliquid bbo	Best bid and ask levels	When the BBO changes on a block	[26]

Table 1. Level 1 feeds, from each venue's documentation.

Why the choice matters for research. Holden and Jacobsen write that "Researchers examining recent years (2009 and thereafter) must use National Best Bid and Offer (NBBO) quotes" [34]. For 100 randomly selected firms from April to June 2008, with 34 million trades and 351 million quotes, the second-stamped Monthly TAQ gave a percent effective spread 54% larger than a millisecond database with the NBBO, and trades outside the NBBO happened "eight times more often" [34]. A level 1 study depends on which top of book a file holds and on the clock that stamps it.

2. Level 2: market by price

CME. CME's client systems "build and update the Market by Price (MBP) aggregate central limit order book, with a predetermined number of price levels", in which "order quantity is the total quantity available at each price level" [2]. Depth is 3, 5 or 10 levels, read per instrument from tag 264-MarketDepth, so on one channel "Instrument x can have a 5-deep order book, while Instrument y has a 10-deep order book" [2]. CME also sends a top of book and a 2-deep book for implied futures [2]. The book "reports summarized order quantities and order counts at a given price level", and when a new price level arrives, client systems shift the others down and delete "any price levels past the defined depth" [3]. Trades arrive separately, and "The trade data block itself is not used to update the order book" [3].

NYSE. OpenBook Ultra, specification 2.1k of 25 July 2024, "is a price level depth of book feed which includes all displayed limit orders, trading floor interest and DMM interest", with "aggregated limit-order volume and number of orders" at each price point [10]. Pillar Depth, version 1.7 of 30 July 2026, gives "a consolidated view of the ten best bid and ten best offer price points" across NYSE, NYSE American, NYSE Arca, NYSE Texas and NYSE National [12]. The specification calls it "a frequency-based market data product", and the assumptions of its worked scenarios describe a "1 second output feed" that publishes "only delta updates which occurred during the last second" [12].

Eurex. The T7 Release 14.1 market data manual of 6 March 2026 sets two price-level interfaces side by side. EMDI "provides un-netted market data", with updates for "all order book changes up to a given level" and every on-exchange trade reported individually. MDI "provides netted market data", sent "at regular intervals", and does not report on-exchange trades individually [18].

Crypto venues. Kraken's book channel "streams level 2 (L2) order book" with "aggregated order quantities at each level", 10 to 1,000 levels deep [22]. Coinbase's level2 channel "guarantees delivery of all updates" and sends "the updated size at the price level, not a delta" [19]. Coinbase's REST level 2 gives one size per price "as if there was only a single order for that size at the level" [20]. Binance's partial depth streams send the top 5, 10 or 20 levels every 1,000 or 100 milliseconds [25].

Feed	Price levels	How changes are sent	Source
CME MBP	3, 5 or 10, set per instrument	Add, change and delete blocks, with order counts	[2, 3]
NYSE OpenBook Ultra	Every displayed price	In real time as events occur, with order counts	[10]
NYSE Pillar Depth	10	The changes of each second, once a second	[12]
Eurex EMDI	Up to a given level	Every book change, un-netted	[18]
Eurex MDI	Up to a given level	Netted, at regular intervals	[18]
Coinbase level2	The full book	All updates, or 50 ms batches	[19]
Binance partial depth	5, 10 or 20	Every 1,000 or 100 ms	[25]

Table 2. Level 2 feeds, from each venue's documentation. Pillar Depth's one-second interval is from its specification's scenario assumptions [12].

What a price-level book leaves out. Read from the book alone, a smaller size at a level could be a fill or a cancellation, since CME sends the trade separately and does not use it to update the book (an inference from [3]). Kraken's guide states that matching fills to book entries by order ID "is not possible with L2 data" [24]. A level 2 book also shows no queue. It gives how much rests at a price and, where the feed counts orders, how many, without their order of arrival [2, 3, 10].

Research at level 2. Xu, Gould and Howison's multi-level order flow imbalance (MLOFI) "measures the net flow of buy and sell orders at different price levels" [32]. For "6 liquid stocks on Nasdaq" in 2016, from the LOBSTER database's event-by-event Nasdaq records, "the out-of-sample goodness-of-fit of the relationship improves with each additional price level that we include in the MLOFI vector" [32]. The measure is per price level, built from event-by-event data that records all order-flow activity [32].

3. Level 3: market by order

CME. CME's Market by Order Full Depth (MBOFD) "disseminates individual orders and quotes at every price level for the given instrument" while "preserving market participant anonymity" [1]. Orders at one price are ranked by tag 37707-MDOrderPriority, where "a lower value is a higher priority" [1]. "For MBOFD, there is no maximum number of orders or depth allowed on the book", and "Implied order book information is not sent in MBOFD format" [1]. CME's DataMine MBO files "provide all market data messages required to recreate the book", "time stamped to the millisecond" [4]. Their rollout "was staged over the first half of 2017": NYMEX and COMEX from 7 January, CBOT from 1 April and CME from 13 May 2017 [4].

Nasdaq. TotalView-ITCH 5.0, last revised 28 April 2023, gives Nasdaq's "full order depth" and "uses a series of messages to track the life of a customer order", stamped in nanoseconds since midnight [5]. It carries order-level data for Nasdaq-listed securities and for NYSE, NYSE American, NYSE Arca and BATS listed securities [5]. An Add Order message comes with or without the market participant identifier (MPID) of the firm that entered it [5]. "By combining the executions from both types of Order Executed Messages and the Trade Message, it is possible to build a complete view of all non-cross executions that happen on Nasdaq" [5].

NYSE. The Pillar Integrated Feed, version 2.5h of 30 July 2026, gives "a unified view of events, in sequence, as they appear on the Pillar matching engines", with Add, Modify, Delete and Replace order messages under an Order ID that "is good for current day only" [11]. NYSE's history comes in the same tiers. "TAQ NYSE Integrated Feed provides a comprehensive order-by-order view of events in the NYSE equities market", TAQ NYSE OpenBook "enables users to recreate the limit order book for any given time", and the TAQ NYSE BBO file holds NYSE best quotes [8].

Eurex. T7 EOBI "provides the entire visible order book, by publishing information on each individual order and quote side", with each one's side, price, priority timestamp and quantity, and "Order book information disseminated without any depth limitation" [17]. Price levels "can be derived from individual orders" [17].

Crypto venues. Kraken's level3 channel "provides visibility of individual orders in the book" [23]. It excludes in-flight orders, unmatched market orders, untriggered stop-loss and take-profit orders and the "Hidden quantity of iceberg orders", and it needs an API token [23]. Kraken's guide says level 3 enables "determination of queue priorities, resting times, fill probabilities", and that its FIX and WebSocket level 3 feeds "both carry OrderID, so fills in ExecutionReports can be deterministically matched against book entries" [24]. Coinbase's full channel sends updates that "can be applied to a level3 order book snapshot" [19], and Coinbase warns that polling its REST level 3 book can get access "limited or blocked" [20].

Research at level 3. Moallemi and Yuan's study of queue position value uses Nasdaq ITCH because market-by-order data "can be used to view queue position and size of individual orders at a price while remaining anonymous" [33]. Their example is Bank of America, with "an average daily volume of 88 million shares in August 2013" and a spread "almost always equal to one tick" [33]. They "consider only the NASDAQ order book", and they note that in a pro-rata market "queue position is not relevant to order value" [33].

4. How venues label their feeds

Label	Who uses it	What it carries	Source
Level 1	Kraken ticker	Top of book and recent trades	[21]
Level 1	Coinbase REST	Best bid and ask, with summed size and order count	[20]
level 1	NYSE Bonds	Bond trades	[8]

Label	Who uses it	What it carries	Source
Level 2	Nasdaq Level 2 product	The best bid and ask of each market participant	[6]
Level 2	Kraken book	10 to 1,000 aggregated price levels	[22]
Level 2	Coinbase REST	The full book, aggregated by price	[20]
level 2	NYSE Bonds	The full depth of book	[8]
Market by price	CME	An aggregate book of 3, 5 or 10 levels per instrument	[2, 3]
Price level aggregated	Eurex EMDI and MDI	Aggregated depth up to a given level, un-netted or netted	[18]
Level 3	Nasdaq, 1994	A quote entry service for market makers	[7]
Level 3	Kraken, Coinbase	Individual orders	[20, 23]
Market by order	CME	Individual orders, no depth limit, with priority	[1]
Order by order	NYSE Integrated Feed	Depth of book order data	[8, 11]
No level named	Eurex EOBI	Each individual order and quote side	[17]

Table 3. Feed labels and what each feed carries, from the sources cited.

Nasdaq's Level 2. Nasdaq's specification, version 2.0 of 14 July 2022, says Level 2 carries "only the best bid and ask position for each Nasdaq market participant registered in an issue", with unattributed orders shown only as the top buy and sell prices under the MPID "NSDQ" [6]. For more depth it points readers to Nasdaq's TotalView products [6]. Nasdaq's Level 2 is one best quote per market participant, which is neither a price-level book nor an order book (an inference from [6]).

Nasdaq's Level 3. A notice to NASD members of 1 September 1994 described the "Level 3 Nasdaq Workstation Service (Level 3 Service)", whose subscribers could insert quotes for other market makers [7]. From 1 August 1994, "only Level 3 Service subscribers may function as Nasdaq market makers" [7]. In 1994, Level 3 named a service for entering quotes [7].

Other names. NYSE lists a "level 2 Bonds Orderbook" and "level 1 Bonds Trades" for its bond market [8]. Moallemi and Yuan say "market-by-level" where CME says market by price [2, 33]. One vendor maps market by order and auction imbalance data to L3, its ten-level market by price to L2, and its top-level book and trade schemas to L1 [29]. Under that mapping, a file labelled L3 can hold auction data.

5. On-chain feeds: aggregated levels, order counts and trade addresses

Public book feed. Hyperliquid's l2Book subscription returns "5 levels if fast, 20 levels if slow", each with a price, a size and the "number of orders" [26]. The book snapshot from its info endpoint "Returns at most 20 levels per side" and can aggregate levels to 2, 3, 4 or 5 significant figures, or keep "full precision" [27]. A Hyperliquid level can therefore be a bucket of prices. The documentation describes a snapshot feed pushed on each block "that is at least 0.5 since last push", with no unit stated [26].

Trades. Each Hyperliquid trade message carries the users as a pair, buyer then seller, and a trade ID that "is 50-bit hash of (buyer_oid, seller_oid)" [26].

Node output. The raw book diffs a Hyperliquid node writes to hourly files carry the user's address, the order ID, the coin, the side and the price, and record a new order, a size update or a removal [28].

Against exchange feeds. CME's order-level feed preserves "market participant anonymity" [1], and Nasdaq's names a market participant only on orders entered with MPID attribution [5]. On Hyperliquid, the public book is a price-level book with order counts, trades name both addresses, and the order-level record with owners comes from a node's output [26, 28].

6. Depth of book in U.S. core data

The 2020 definition. Rule 600(b)(26), adopted on 9 December 2020, reads as printed: "Depth of book data means all quotation sizes at each national securities exchange and on a facility of a national securities association at each of the next five prices at which there is a bid that is lower than the national best bid and offer that is higher than the national best offer" [14]. The size at each of these five prices "shall be attributed to such exchange or association" [14]. The Commission wrote that depth of book on each exchange "helps market participants decide where to place orders and provides information about order book imbalances and potential future price moves", and that "the five price levels included in the definition of depth of book data are measured from the NBBO" [14]. The release states that "The final rules are effective June 8, 2021" [14].

The 2024 status. In September 2024 the Commission recalled that SIP data included only top-of-book quotes when the MDI rules were adopted, and wrote that the rules would add depth of book to consolidated market data "Once implemented" [15]. The implementation schedule "includes a 180-day development period, during which competing consolidators can register with the Commission, and ends with the cessation of the operations of the exclusive SIPs" [15]. The participants' plan amendments of 5 November 2021 were disapproved, so new proposed amendments must be filed under Rule 608 [15].

Odd lots. The September 2024 release set the first business day of May 2026 as the compliance date for odd-lot information [16]. On 15 January 2026 the Commission granted relief from Rule 600(b)(69)(ii), which covers odd lots at or between the national best bid and offer "aggregated at each price level at each national securities exchange and national securities association", "until the first business day of May 2028" [16]. The request letter it cites stated that the exclusive SIPs would begin disseminating the BOLO in May 2026 [16], and a June 2026 SEC proposal says they disseminate it, with top-of-book odd-lot quotations implemented on 27 April 2026 [36]. The CQS specification of 29 January 2026 lists round-lot and odd-lot quote messages with NBBO and BOLO appendages, and no depth-of-book message [13].

Date	Step	Source
9 Dec 2020	Rule adopted, depth of book defined as five price levels from the NBBO	[14]
8 Jun 2021	Rule effective	[14]
18 Sep 2024	Release recalls SIP data as top of book only, with depth of book added "Once implemented"	[15]
15 Jan 2026	Relief from the odd-lot price level part until the first business day of May 2028	[16]
29 Jan 2026	CQS specification lists odd-lot quote messages and BOLO appendages	[13]

Table 4. U.S. core data steps, as dated in the sources.

7. Which research needs which level

Research question	Level used in the sources	Sources
Quoted and effective spreads	Level 1 with the NBBO	[34]
Order flow imbalance at the best prices	Level 1	[30]
Imbalance across several price levels	Level 2 measure, computed from event-by-event data	[32]
Queue position and fill probability	Level 3	[24, 33]
Matching fills to resting orders	Level 3	[5, 24]

Table 5. Research questions and the level each source used.

Spreads. Level 1 serves when the file holds the NBBO on a fine enough clock, as Holden and Jacobsen's comparison shows [34].

Order flow imbalance. Cont, Kukanov and Stoikov used "the NYSE TAQ data for 50 U.S. stocks" and found that "over short time intervals, price changes are mainly driven by the order flow imbalance", the imbalance between supply and demand at the best bid and ask, with a slope "inversely proportional to the market depth" [30]. Xu, Gould and Howison note that because TAQ "does not contain order-flow information", those authors estimated it from changes in volume at the best prices at regularly spaced times, while event-by-event data lets net order flow be calculated exactly [32]. The multi-level measure improved its fit with each added level [32].

Queue position and fills. Market-by-order data shows each order's place and size at a price [33], CME ranks orders by a priority field [1], ITCH executions carry the order reference number [5], and Kraken's order IDs match fills to book entries [24]. In a pro-rata market, queue position does not affect an order's value [33].

Hidden liquidity. ITCH sends executions of non-displayed orders only as Trade messages, "Since no Add Order Message is generated when a non-displayed order is initially received" [5]. Since 6 December 2010 those messages carry an order reference number of zero, and since 14 July 2014 a buy or sell indicator of "B" whatever the resting side [5]. Kraken's level 3 excludes the hidden quantity of iceberg orders [23], and the rules for that hidden quantity "vary greatly from one exchange to another" [31].

One venue or the market. NYSE Pillar Depth covers the five NYSE Group exchanges [12], ITCH carries Nasdaq's own orders [5], and Moallemi and Yuan used Nasdaq's book alone [33]. One venue's book is part of a market whose national best prices CQS computes from every participating exchange's quotes (an inference from [12], [13] and [33]).

8. Questions to ask a data supplier

1. Which label do you use, and does the file hold a best quote per venue, a consolidated NBBO, aggregated price levels or individual orders [6, 13, 20, 29]?
2. How many levels, and is the depth fixed or set per instrument [2, 12, 22, 25, 26]?
3. Is every update kept, or are changes sampled or netted, as in one-second, 100 millisecond, 50 millisecond or per-block output [12, 18, 19, 25, 26]?
4. Is each level a single price or a bucket of prices [27]?
5. Does each level carry an order count [3, 10, 20, 26]?
6. Are implied prices included, given that CME's market by order leaves them out [1, 2]?
7. How are hidden and non-displayed executions recorded [5, 23]?
8. Does the file cover one venue or several, and which consolidation sets the best prices [12, 13]?
9. From which date is history held at this level, given that CME's order-level files start in 2017 [4]?

0. What timestamps does each record carry, and at what precision, from nanoseconds in ITCH to milliseconds in CME's MBO files [4, 5]?

Implications

For quant researchers. Pick the level from the question. Spreads were studied on level 1 data with the NBBO [34] and top-of-book order flow imbalance on TAQ data [30], multi-level imbalance needs price levels [32], and queue position and fill matching need order IDs [24, 33]. A data section that names the feed, its depth, its update rule and its clock lets a reader judge what the data can show [3, 12, 34].

For data buyers. A product called level 2 can be a best quote per market participant, ten aggregated levels or the full aggregated book [6, 29, 20]. One called L3 can include auction imbalance data [29]. The ten questions in Finding 8 turn a label into a description of the file.

For teams working with on-chain data. Hyperliquid's public book carries order counts and price buckets, its trades name both addresses, and its order-level changes with owners come from a node's output [26, 27, 28]. CME's and Nasdaq's order-level feeds keep participants anonymous [1, 5].

For U.S. equity work. The SEC's 2020 rule defined five-level depth of book for consolidated data, and its September 2024 release said the rules would add it to consolidated data "Once implemented" [14, 15]. In the sources read, depth beyond the top of book comes from each exchange's own feeds, such as NYSE OpenBook Ultra, Pillar Depth and the Integrated Feed and Nasdaq TotalView-ITCH [5, 10, 11, 12].

Rillor's market data holds order books from on-chain perpetual futures venues, rebuilt from snapshots and book diffs at every price level on both sides, and trade and quote history for U.S. stocks and futures, all on one UTC clock [35].

Limits of this analysis

- Specifications describe feeds as their venues publish them. No feed was captured or tested for this report.
- Each specification is cited in the version named, and venues revise them.
- No source read states whether depth-of-book data is part of U.S. consolidated data in November 2026. The latest SEC text read, the June 2026 proposal, says depth of book information is "available only to investors who subscribe to the proprietary data feeds of all exchanges" [36].
- No fee, price or licensing term for any feed level was examined.
- No broker or retail platform documentation was read, so this report says nothing about what a given screen labelled level 2 shows.
- Hyperliquid's documentation gives its book push interval without a unit [26].
- Other on-chain venues' documentation was not read for this report.
- One vendor's labels are cited as one example of a mapping [29].
- The research uses rest on four empirical papers whose samples run from 2008 to 2016 and one survey [30, 31, 32, 33, 34].
- This report gives no investment or trading advice.

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