

How orders are routed when sent to Cortex Equities' algorithmic strategies

The algorithms utilize the Smart Order Router ("SOR") to access displayed and non-displayed liquidity, respectively. The interaction between algorithms and routers varies as a function of client objective and the intended behavior of the strategy.

Displayed Routing

SOR accesses displayed liquidity and Cortex ATS*. The router determines where to send orders based on the following principles:

- Fulfill Reg. NMS obligations.
- Achieve execution objectives for clients, which vary as a function of client strategy. Clients may seek to maximize liquidity, minimize implicit transaction costs (i.e., payment of spread), or minimize explicit transaction costs if they are cost-sensitive. The SOR has various modes that work to achieve these execution objectives and are configurable by client and algorithmic strategy.
- All else being equal, BNP Paribas will attempt to minimize explicit transaction costs, subject to that not being in conflict with the previous bullets.

The logic employed to realize these principles varies by client trading strategy and instruction. By default, our algorithms utilize a router mode that will cross the spread when taking liquidity targeting the highest fill probability. When posting, our algorithms use a router mode where passive orders are posted on one or more venues to reduce expected time to fill and optimize the total costs.

Steps when taking liquidity or posting orders in lit exchanges for algorithmic strategies:

* Cortex ATS is slated for launch Q3 2021. The behaviors described reflect the routing strategy behavior post launch.

Taker Tactic

- May oversize based on our hidden liquidity estimates
- Utilizes the direct 'Marketable Behavior'

Supplier Tactic

- Determines an appropriate limit price
- Display size of posted orders is equal to the trade size
- Utilizes the direct 'Non-Marketable Behavior'

Non-Displayed Routing

SOR will also access non-displayed liquidity when appropriate. The logic employed to realize execution objectives varies by client trading strategy and instruction. By default, our algorithms utilize an urgency ("Neutral") with dynamic order parameters to interact with non-displayed liquidity.

Based on the order's execution progress and the signals generated within the algorithm, one or more of the following tactics may be used:

Pounce Tactic

- Used to sweep non-displayed liquidity resting within the national best bid offer ("NBBO")
- Periodically sweeps multiple venues
- Shares allocated based on urgency, order size, and dark pool ranking

Supplier Tactic

- Used to post orders passively
- Posts with a passive limit
- Shares allocated based on urgency, order size, and dark pool ranking

Dark Tactic

- Used to post orders within the NBBO with a dynamic minimum quantity
- Posts within the NBBO with a dynamic minimum quantity
- Shares allocated based on urgency, order size, and dark pool ranking



How Orders are Routed When Sent Directly to the Smart Order Router

Routing Modes

SOR Modes	Marketable Behavior	Non-Marketable Behavior
Displayed	<ul style="list-style-type: none"> Orders are sent to multiple venues, one price level at a time The order is sent to venues based on fill probability of both displayed and estimated reserve volume. Sweeps top of book on all eligible venues including Cortex ATS* using an aggressive limit 	<ul style="list-style-type: none"> Real time predictions for passive order fill probability and opportunity cost drive venue selection Machine learning models which leverage approximately 50 input features, produce more accurate predictions compared to previous systems Display quantity is a function of average display size
Non-Displayed	<ul style="list-style-type: none"> See Non-Displayed Routing Urgencies below Conditional orders can be utilized to send to multiple external venues at the same time 	

Displayed Routing Urgencies

Limit price is the primary routing factor in the SOR. The previous table described the behavior for different limit marketability.

For non-marketable orders, if the client specifies a display quantity (MaxFloor), this display quantity is prorated across all venue submissions. Otherwise, a function of average display size is used.

For marketable orders, the SOR attempts to simultaneously send IOC orders to external venues and Cortex ATS when there is available liquidity. SOR is aware of such available liquidity on Cortex ATS via an aggregated anonymized feed. Sending to Cortex ATS can be disabled upon request.

Submission Arrival Synchronization (“SAS”)

For all Marketable Modes: When sending to multiple venues, orders are sent simultaneously with the aim of minimizing quote fade. All SOR instances use a feature called SAS, described below.

- Order-acknowledgement latencies for each exchange are based on a historical average of recent trading days
- When the SOR receives a marketable order that takes liquidity from multiple venues, the venue submissions are staggered by the real-time, expected latency offset adjusted for the difference in theoretical speed of light minimum time to each venue
- The aim is to have all submissions arrive at all exchanges at the same time

How Orders are Routed When Sent Directly to Non-Displayed Liquidity

The router may leverage historical, and/or real-time pool performance information, and may make use of the following algorithmic models depending on the varying execution objectives for clients.

- Fair Price Model: determines when to trade based on the real-time return relative to an ETF and the historical volatility of the stock. This is combined with order parameters to establish a theoretical “fair price” to trade. Note that the “fair price” is dynamic and will change over time with the change in relative return.
- Anti-Adverse Selection Model: briefly pauses trading when there are several simultaneous fills from multiple destinations.
- Dark Pool Ranking Model: measures historical liquidity quality and quantity based on reversion metrics and fill rates to establish a rank by value. This is combined with order parameters to select the appropriate number of dark pools to which the order will initially be sent. Clients have the ability to exclude any venue or venues.

Non-Displayed Routing Urgencies

The following table describes the behavior for each of the primary urgencies:

Urgencies	Behavior
Aggressive	<ul style="list-style-type: none">▪ Sends orders to all venues based on legacy dark pool ranking model▪ Dark venues: Peg to market where available, otherwise, peg to midpoint▪ Hidden orders sent to exchanges: Peg to midpoint▪ No delays between fills and new submissions.▪ Sweeps multiple venues starting from highest ranked venues.▪ Pouncing feature enabled which allows for follow up allocations to a destination when liquidity is detected
Neutral	<ul style="list-style-type: none">▪ Sends orders to eligible dark pools based on dynamic ranking model▪ Orders are pegged to midpoint▪ Child slices will be allocated amongst the venues, favoring those categorized as preferred while allocating a smaller portion to those categorized as explore. Venues categorized as less preferred based on intraday observations of fill rate and adverse selection may receive an allocation as a last resort▪ Longer delays between fills and new submissions
Passive	<ul style="list-style-type: none">▪ Sends orders to eligible dark pools on the dynamic ranking model—▪ Orders are pegged to primary▪ Child slices will be allocated amongst the venues, favoring those categorized as preferred while allocating a smaller portion to those categorized as explore. Venues categorized as less preferred based on intraday observations of fill rate and adverse selection may receive an allocation as a last resort▪ Longer delays between fills and new submissions

A number of factors may affect the pools to which an order is allocated:

- A lower urgency may result in allocation to fewer dark pools and more passive placement (at midpoint), whereas higher urgencies will result in more aggressive order placement and allocation to a broader number of pools.
- Minimum acceptable quantity (MAQ) thresholds are designed to specify the smallest individual order with which the strategy will interact. Depending on the size of the MAQ, the number of pools selected for allocation may change.
- Order type (Immediate Or Cancel ("IOC") vs. Day) may also affect the number of pools selected.
- Non-actionable orders may rest in Cortex ATS until they become actionable. Odd lot orders may be handled separately for clean-up.

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