



Autobahn Equity Americas US Routing Logic

Smarter Liquidity – Innovation with Integrity

October 2018

This document describes the routing logic used for orders sent to the Autobahn desk.

page 1/5

How Orders are Routed When Sent to Autobahn’s Algorithmic Strategies

The algorithms utilize the **Smart Order Router** and **SuperX+ Router** 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.

Smart Order Router (SOR)

SOR accesses displayed liquidity and DB’s ATS, SuperX. The router determines where to send orders based on the following principles:

1. Fulfill Reg. NMS obligations.
2. 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.
3. All else being equal, DB will attempt to minimize explicit transaction costs, subject to that not being in conflict with #1 and #2 above.

The logic employed to realize these principles varies by client trading strategy and instruction. By default, our algorithms utilize a router mode (“SOR Aggressive” with SuperX ATS ping) that will cross the spread when taking liquidity and prefer venues with lowest latency and highest fill probability. This feature is called the Taker Tactic. When posting, our algorithms use a router mode (“SOR Neutral” with no SuperX ATS Ping) where passive orders are posted on one or more venues to reduce expected time to fill. This feature is called the Supplier Tactic.

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

Taker Tactic	Supplier Tactic
<ul style="list-style-type: none"> – Sweeps SuperX-ATS with an aggressive limit – Sweeps top of book on all eligible venues – Prefers lowest latency venues – May allocate a multiple of display size 	<ul style="list-style-type: none"> – Posts with a passive limit – Shares allocated on expected time to fill – Display size of posted orders is equal to the average trade size

Please see [SOR Routing Modes](#) on page 3 for more information on the smart order router.

SuperX+ (Dark Router)

SuperX+ accesses non-displayed liquidity. The logic employed to realize execution objectives varies by client trading strategy and instruction. By default, our algorithms utilize an urgency ("SX+ 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	Supplier Tactic	Dark Tactic
<ul style="list-style-type: none"> – Used to sweep non-displayed liquidity resting within the NBBO – Periodically sweeps multiple venues – Shares allocated based on urgency, order size, and dark pool ranking 	<ul style="list-style-type: none"> – Used to post orders passively – Posts with a passive limit – Shares allocated based on urgency, order size, and dark pool ranking 	<ul style="list-style-type: none"> – 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

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 (IOC vs. Day) may also affect the number of pools selected.
- Non-actionable orders may rest in SuperX ATS until they become actionable. Please see [SuperX+ Routing Urgencies](#) on page 4 for more information.
- Odd lot orders may be handled separately for clean-up.

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

SOR Routing Modes

Execution price is the primary routing factor in the SOR. Where multiple venues quote at the same price, the SOR uses a number of “modes” to allow the user to balance explicit transaction costs and fill probability. The following table describes the behavior for each of the major SOR modes.

By default, the **Neutral** mode (with SuperX ATS Ping) is used when clients send marketable and non-marketable orders directly to the SOR. Any client may opt-in to another mode or combination of modes. For example, the **Cost-Neutral** mode uses **Neutral** logic on non-marketable orders and **Cost-Saver** logic on marketable orders.

For the non-marketable behavior of each mode, if client specifies a display quantity (MaxFloor), this display quantity is used on each venue submission.

By default, the SOR attempts to internalize the order by sending an Immediate Or Cancel (IOC) order to SuperX ATS before sending to external venues. This feature is called **SuperX ATS Ping**. This feature may be disabled on request.

SOR Modes	Intended <u>Marketable</u> Behavior	Intended <u>Non-Marketable</u> Behavior
Aggressive	<ul style="list-style-type: none"> Orders are sent to multiple venues, one price level at a time. Where there are multiple venues displaying the same price, fill probability/latency is used to select the venues. The order is sent to venues ordered by display size. 	<ul style="list-style-type: none"> Order is split among venues to reduce expected fill time. This calculation considers, among other factors, each venue’s expected fill rate and queue size. Display quantity is equal to 200% of average fill size, unless client specifies MaxFloor.
Neutral	<ul style="list-style-type: none"> Orders are sent to multiple venues, one price level at a time. Where there are multiple venues displaying the same price, both exchange fee and fill probability/latency are used to select the venues. Half of the order is sent to venues ordered by expected fill rate, half is sent to venues, ordered by exchange fee. 	<ul style="list-style-type: none"> Order is split among venues to reduce expected fill time. This calculation considers, among other factors, each venue’s expected fill rate and queue size. Display quantity is equal to 100% of average fill size, unless client specifies MaxFloor.
Cost-Saver	<ul style="list-style-type: none"> Orders are sent to multiple venues, one price level at a time. Where there are multiple venues displaying the same price, exchange fee is used to select the venues. The order is sent to venues ordered by exchange fee. 	<ul style="list-style-type: none"> A short-list of venues is created for each order. Only venues with an expected symbol-specific fill rate higher than the threshold are included in the short-list. Of those venues, the whole order is sent to the venue with the highest rebate. Display quantity is equal to 100% of average fill size, unless client specifies MaxFloor.

Dynamic SAS

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

- Order-acknowledgement latencies for each exchange are monitored in real-time throughout the day
- The SOR uses historical latencies for initialization and calculates a moving average of order-acknowledgement latency for each exchange
- 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
- The aim is to have all submissions arrive at all exchanges at the same time, after taking into account current network conditions

How Orders are Routed When Sent Directly to SuperX+

SuperX+ accesses non-displayed liquidity. The router is driven by historical and real-time pool performance information, and uses the following algorithmic models to achieve the varying execution objectives for clients.

1. 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.
2. Anti-Adverse Selection Model: briefly pauses trading when there are several simultaneous fills from multiple destinations.
3. 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.

SuperX+ Routing Urgencies

The following table describes the behavior for each of the major SuperX+ urgencies.

SuperX+ Urgencies	Intended Behavior
Aggressive	<ul style="list-style-type: none"> – Sends orders to all venues. – Dark venues: Peg to market where available, otherwise, peg to midpoint. – Hidden orders send to exchanges: Peg to midpoint. – No delays between fills and new submissions. – Sweeps multiple venues starting from highest ranked venues. – Unallocated remaining shares are sent to SuperX ATS.
Neutral	<ul style="list-style-type: none"> – Sends orders to the top 80% of eligible dark pools from ranking model. – Hidden orders send to exchanges and dark pools: Peg to midpoint. – Shorter delays between fills and new submissions. – Sweeps multiple venues starting from highest ranked venues. – Unallocated remaining shares are sent to SuperX ATS.
Passive	<ul style="list-style-type: none"> – Sends orders to the top 60% of eligible dark pools from ranking model. – Peg to midpoint. – Longer delays between fills and submissions. – Sweeps multiple venues starting from highest ranked venues. – Unallocated remaining shares are sent to SuperX ATS.
Custom-Venue	<ul style="list-style-type: none"> – Rests in a single venue – Please contact your Autobahn coverage for more information

If the order is considered non-actionable, the whole order may rest in the SuperX ATS. An order is considered non-actionable if the limit price of the order is very passive relative to the NBBO and considered to have a negligible chance of execution. Note that an order’s marketability can change over time depending on the movement of the current market bid and offer. SuperX+ will change its behavior accordingly.



Contacts:

European Execution Desk:

+44 (0)207 547 2022
autobahnequity.emea@list.db.com

Asia (Ex Japan) Execution Desk:

+852 2203 6028
autobahnequity.apac@list.db.com

Japan Execution Desk:

+813 5156 6642
autobahnequity.tokyo@list.db.com

Americas Execution Desk:

+1 212 250 3988
autobahnequity.us@list.db.com

Australia Execution Desk:

+61 2 8258 2862
autobahnequity.aus@list.db.com

Autobahn

Autobahn Equity is part of Deutsche Bank's electronic trading platform, providing you with access to execution solutions in all major equities markets. Autobahn trading is available in both lit and alternative venues via our flexible suite of algorithms or direct market access (DMA) and both are supported by robust risk controls. Detailed market knowledge and algorithmic trading expertise are provided by our dedicated coverage team.

Further information:

Support:

Europe: +44 207 545 3448

US: +1 212 250 5001

Website:

www.autobahn.db.com

Asia (ex Japan): +852 2203 7700

Japan: +813 5156 6642

These materials are generic in nature and may not apply in particular circumstances. Quantitative models, processes and parameters are subject to amendment, modification, adjustment and correction at Deutsche Bank's discretion, and may incorporate Deutsche Bank's qualitative judgment. Deutsche Bank may from time-to-time run or update such models at its discretion.

Categorization of counterparties in SuperX is for analysis purposes and DB is not responsible for updating the included data if client categorizations change at a later date.

Deutsche Bank may from time to time modify the methods, processes and parameters used in the analyses and/or as described in this material. Any descriptions of such models, processes, or parameters, or the analyses resulting from them, are only represented to be accurate as of the date of this material. There may be regional differences in the processes, parameters and models in Deutsche Bank's products.

This document does not constitute an offer, an invitation or a recommendation to enter into any transaction. We have sent you this document in our capacity as a potential counterparty acting at arm's length. We are not acting as your financial adviser or in a fiduciary capacity in respect of this proposed transaction or any other transaction with you unless otherwise expressly agreed by us in writing. Prospective investors should understand and discuss with their professional tax, legal, accounting and other advisors the effect of a transaction they may enter into.

BEFORE ENTERING INTO ANY TRANSACTION YOU SHOULD TAKE STEPS TO ENSURE THAT YOU UNDERSTAND AND HAVE MADE AN INDEPENDENT ASSESSMENT OF THE APPROPRIATENESS OF THE TRANSACTION IN LIGHT OF YOUR OWN OBJECTIVES AND CIRCUMSTANCES, INCLUDING THE POSSIBLE RISKS AND BENEFITS OF ENTERING INTO SUCH TRANSACTION. YOU SHOULD ALSO CONSIDER MAKING SUCH INDEPENDENT INVESTIGATIONS AS YOU CONSIDER NECESSARY OR APPROPRIATE FOR SUCH PURPOSE.

Although the information herein has been obtained from sources believed to be reliable, we do not guarantee its accuracy completeness or fairness. Opinions and estimates may be changed without notice and involve a number of assumptions which may not prove valid. The past performance of securities, indexes or other instruments referred to herein does not guarantee or predict future performance. If applicable, the principal protection feature applies only if the securities or instruments are held to maturity. Please note: market values may be affected a number of factors including index values, interest rates, volatility, time to maturity, dividend yields and issuer credit ratings. These factors are interrelated in complex ways, and as a result, the effect of any one factor may be offset or magnified by the effect of another factor.

Calculations of returns on instruments referred to herein may be linked to a referenced index or interest rate. In such cases, the investments may not be suitable for persons unfamiliar with such index or interest rate, or unwilling or unable to bear the risks associated with the transaction. Products denominated in a currency, other than the investor's home currency, will be subject to changes in exchange rates, which may have an adverse effect on the value, price or income return of the products. These products may not be readily realizable investments and are not traded on any regulated market. The securities referred to herein involve risk, which may include interest rate, index, currency, credit, political, liquidity, time value, commodity and market risk and is not suitable for all investors.

These instruments are not insured by the Federal Deposit Insurance Corporation (FDIC) or any other U.S. governmental agency. These instruments are not insured by any statutory scheme or governmental agency of the United Kingdom. The distribution of this document and availability of these products and services in certain jurisdictions may be restricted by law. These securities have not been registered under the United States Securities Act of 1933 and trading in the securities has not been approved by the United States Commodity Exchange Act, as amended. We or our affiliates or persons associated with us or such affiliates may: maintain a long or short position in securities referred to herein, or in related futures or options, purchase or sell, make a market in, or engage in any other transaction involving such securities, and earn brokerage or other compensation.

Deutsche Bank AG and/or its affiliated entities, as the context requires, does not provide accounting, tax or legal advice. Notwithstanding any other express or implied agreement, arrangement or understanding to the contrary, we hereby authorize you (and any of your employees, representatives or agents), subject to applicable U.S. federal and state securities laws, to disclose to any and all persons the structure and tax aspects of this potential transaction, and all materials of any kind (including opinions or other tax analyses) that are provided to you related to such structure and tax aspects, without Deutsche Bank imposing any limitation of any kind. This authorization is effective without limitation of any kind from the commencement of our discussions.

Deutsche Bank Private Wealth Management refers to Deutsche Bank's wealth management activities for high-net-worth clients around the world. Deutsche Bank Alex. Brown is a division of Deutsche Bank Securities Inc. Deutsche Bank AG, including its subsidiaries and affiliates, does not provide legal, tax or accounting advice. This communication was prepared solely in connection with the promotion or marketing, to the extent permitted by applicable law, of the transaction or matter addressed herein, and was not intended or written to be used, and cannot be used or relied upon, by any taxpayer for purposes of avoiding any U.S. federal income tax penalties. The recipient of this communication should seek advice from an independent tax advisor regarding any tax matters addressed herein based on its particular circumstances.

Derivative transactions involve numerous risks including among others, market, counterparty default and liquidity risk. The appropriateness or otherwise of these products for use by investors is dependent on the investors' own circumstances including their tax position, their regulatory environment and the nature of their other assets and liabilities and as such investors should take expert legal and financial advice before entering into any transaction similar to or inspired by the contents of this publication. Trading in options involves risk and is not suitable for all investors. Prior to buying or selling an option investors must review the Characteristics and Risks of Standardized Options (<http://onn.theocc.com/publications/risks/riskstoc.pdf>). If you are unable to access the website please contact Deutsche Bank AG at +1 (212) 250-8182 for a copy of this important document. Please note that multi-leg options strategies will incur multiple commissions. The products described in this document are not eligible for sale in all countries and in any event may only be sold to qualified investors. Securities shown in this document shall not be offered or sold to any persons prohibited by the law in their country of origin or in any other relevant country.

IMPORTANT: This presentation has been prepared by members of our Global Markets department. Statements and opinions regarding the Company's investment case, positioning and valuation are not, and should not be construed as, an indication that Deutsche Bank will provide favourable research coverage of the Company or publish research containing any particular rating or price target for the Company's common stock. This presentation speaks only as of the date it is given, and the views expressed are subject to change based upon a number of factors, including market conditions and the Company's business and prospects.