AUCTIONING MECHANISMS FOR DARK ORDER BLOCK TRADING

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] The present application is a continuation-in-part of U.S. Patent Application No. 14/139,724, filed December 23, 2013, which claims the benefit of U.S. Provisional Patent Application No. 61/746,486, filed December 27, 2012, and U.S. Provisional Patent Application No. 61/784,222, filed March 14, 2013, the disclosures of which are all hereby incorporated by reference herein in their entirety.

TECHNICAL FIELD

[0002] Embodiments of the invention relate generally to financial trading systems and, more specifically, to auctioning mechanisms for dark order block trading.

BACKGROUND

[0003] In the finance field, dark liquidity is commonly understood to be trading volume created by orders not openly available to the public. A bulk of dark liquidity is represented by block orders facilitated away from central exchanges.

[0004] Dark order block trades allow access to a good source of liquidity, with a growing percentage of the total market volume trading via crossing networks and exchange hidden orders. A recognized advantage of dark order block trades is it can allow for buying and selling of large blocks of securities without the need to identify the side, price or size of trades or the identity of market participants engaging in such trades.

[0005] Primary concerns associated with dark order block trades are information leakage and gaming, both of which can have a significant impact on the market and result in degradation of liquidity quality. To maintain the integrity of dark order block trades and avoid significant market impact, controls must be in place to reduce the likelihood of information leakage and to minimize the potential for gaming.

[0006] Accordingly, there is a need for auctioning mechanisms adapted to improve the integrity of dark order block trading.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The present invention is illustrated by way of example, and not by way of limitation, and will become apparent upon consideration of the following detailed description, taken in conjunction with the accompanying drawings, in which like reference characters refer to like parts throughout, and in which:

[0008] **FIG. 1** is a block diagram illustrating an exemplary computer network in which embodiments of the present invention may operate.

[0009] **FIGS. 2A** and **2B** are flow diagrams illustrating an embodiment of a method for conducting an auction for block order trading.

[0010] **FIGS. 3A** and **3B** illustrate, respectively, an order book comprising orders received from market participants, excluding orders competing with an auction initiator, and a corresponding order book comprising the resulting transaction.

[0011] **FIG. 4** is a flow diagram illustrating an embodiment of a method for conducting a partial book auction corresponding to the order books illustrated in **FIGS. 3A** and **FIG. 3B**.

[0012] **FIGS. 5A-5C** illustrate, respectively, an order book comprising orders received from market participants, including orders competing with an auction initiator, a corresponding order book comprising the resulting transaction in favor a competing market participant, and a corresponding order book comprising the resulting transaction in favor of the auction initiator.

[0013] **FIG. 6** is a flow diagram illustrating an embodiment of a method for conducting a full book auction corresponding to the order books illustrated in **FIGS. 5A-5C**.

[0014] **FIGS. 7A-7C** are flow diagrams illustrating an embodiment of a method for conducting an auction at a pre-determined time, absent a market participant acting as an auction initiator, utilizing a reference price in a primary market.

[0015] **FIGS. 8A-8D** illustrate an order book comprising orders received from market participants and the corresponding distribution of shares in accordance with the method illustrated by the flow diagrams of **FIGS. 7A-7C**.

[0016] **FIG. 9** illustrates a diagrammatic representation of a machine in the exemplary form of a computer system.

DETAILED DESCRIPTION

[0017] Embodiments of the invention provide methods for conducting auctions suitable for dark order block trading.

[0018] In the following description, numerous details are set forth. It will be apparent, however, to one skilled in the art, that the present invention may be practiced without these specific details. In some instances, well-known structures and devices are shown in block diagram form, rather than in detail, in order to avoid obscuring the present invention.

[0019] Some portions of the detailed descriptions are presented in terms of algorithms and symbolic representations of operations on data bits within a computer memory. These algorithmic descriptions and representations are the means used by those skilled in the data processing arts to most effectively convey the substance of their work to others skilled in the art. An algorithm is here, and generally, conceived to be a self-consistent sequence of steps leading to a desired result. The steps are those requiring physical manipulations of physical quantities. Usually, though not necessarily, these quantities take the form of electrical or magnetic signals capable of being stored, transferred, combined, compared, and otherwise manipulated. It has proven convenient at times, principally for reasons of common usage, to refer to these signals as bits, values, elements, symbols, characters, terms, numbers, or the like.

[0020] It should be borne in mind, however, that all of these and similar terms are to be associated with the appropriate physical quantities and are merely convenient labels applied to these quantities. Unless specifically stated otherwise, as apparent from the above discussion, it is appreciated that throughout the description, discussions utilizing

terms such as "receiving", "determining", "generating", "transmitting", "building", "identifying", "selecting", "executing", "filling", "canceling", "processing", or the like, refer to the action and processes of a computer system, or similar electronic computing device, that manipulates and transforms data represented as physical (electronic) quantities within the computer system's registers and memories into other data similarly represented as physical quantities within the computer system memories or registers or other such information storage, transmission or display devices.

[0021] The present invention also relate to an apparatus for performing the operations herein. This apparatus may be specially constructed for the required purposes or it may comprise a general purpose computer selectively activated or reconfigured by a computer program stored in the computer. Such a computer program may be stored in a computer readable storage medium, such as, but not limited to, any type of disk including floppy disks, optical disks, CD-ROMs and magnetic-optical disks, read-only memories (ROMs), random access memories (RAMs), EPROMs, EEPROMs, magnetic or optical cards, flash memory devices including universal serial bus (USB) storage devices (e.g., USB key devices) or any type of media suitable for storing electronic instructions, each of which may be coupled to a computer system bus.

[0022] The algorithms and displays presented herein are not inherently related to any particular computer or other apparatus. Various general purpose systems may be used with programs in accordance with the teachings herein or it may prove convenient to construct more specialized apparatus to perform the required method steps. The required structure for a variety of these systems will be apparent from the description above. In addition, the present invention is not described with reference to any particular

programming language. It will be appreciated that a variety of programming languages may be used to implement the teachings of the invention as described herein.

[0023] The present invention may be provided as a computer program product, or software, that may include a machine-readable medium having stored thereon instructions, which may be used to program a computer system (or other electronic devices) to perform a process according to the present invention. A machine-readable medium includes any mechanism for storing or transmitting information in a form readable by a machine (e.g., a computer). For example, a machine-readable (e.g., computer-readable) medium includes a machine (e.g., a computer) readable storage medium (e.g., read only memory ("ROM"), random access memory ("RAM"), magnetic disk storage media, optical storage media, flash memory devices, etc.), a machine (e.g., computer) readable transmission medium (non-propagating electrical, optical, or acoustical signals), etc.

[0024] **FIG. 1** is a block diagram illustrating an exemplary computer network **100** in which embodiments of the present invention may operate. Referring to **FIG. 1**, computer network **100** may be comprised of at least one trading platform **110**, an initiating market participant **102** (also referred to herein as "auction initiator") and a plurality of market participants **122**, which may be collectively referred to herein as exchange members **120**. In one embodiment, initiating market participant **102** and each of market participants **122** may be represented by a computing device (not shown) communicatively coupled to and programmed to access trading platform **110** via a network **130**. Network **130** may be a private network (e.g., a local area network (LAN), wide area network (WAN), intranet, etc.) or a public network (e.g., the Internet).

[0025] Trading platform **110** may be comprised of one or more modules configured to process block orders (buy and sell) received from initiating market participant **102** and market participants **122**. For example, trading platform **110** may be comprised of an order management module **112** and an order matching module **114**.

[0026] In one embodiment, order management module **112** may be configured to manage all aspects of initiating and conducting an auction in response to receiving a firm limit order from initiating market participant **102**. Order management module **112** may, for example, be configured to generate a request for auction (RFA), determine the status of other pending auctions, execute various determinations to confirm whether predetermined criteria required for participating in an auction are satisfied, identify and communicate auction parameters to select market participants **122** and build an order book for conducting an auction.

[0027] In one embodiment, order matching module **114** may be configured to match orders provided in an order book built for conducting an auction initiated by order management module **112** in response to receiving a firm limit order from initiating market participant **102**. Order matching module **114** may, for example, be configured to select an auction price based on orders provided in an order book, determine parameters and/or restrictions associated with the orders provided in the order book, and fill qualifying orders in accordance with the same.

[0028] Those skilled in the art will appreciate that trading platform **110** may be configured with more or less modules to conduct the auctioning methods described herein with reference to **FIGS. 2A-2B, 4, 6** and **7A-7C**. As illustrated in **FIGS. 2A-2B, 4, 6** and **7A-7C**, each of corresponding methods **200, 400, 600** and **700** may be performed by

processing logic that may comprise hardware (e.g., circuitry, dedicated logic, programmable logic, microcode, etc.), software (such as instructions run on a processing device), or a combination thereof. In one embodiment, methods **200**, **400**, **600** and **700** may be performed by one or more processing components associated with modules **112** and **114** of trading platform **110**.

[0029] **FIGS. 2A** and **2B** are flow diagrams illustrating a method **200** for conducting an auction for block order trading, according to an embodiment of the invention. Referring to **FIGS. 2A** and **2B**, method **200** may be initiated upon receiving, at step **202**, a firm limit order from an auction initiator. The firm limit offer received may be processed, for example, by order management module **112** of trading platform **110**.

[0030] Upon receiving a firm limit order, an initial determination may be made, at step **204**, to ascertain whether another auction is already in progress. For example, a determination may be made to ascertain if an auction in progress is related to an equity for which the auction initiator has submitted a firm limit order. If a related auction is determined to be in progress, then the firm limit order received from the auction initiator may be rejected, at step **206**. A rejection notification may be generated and transmitted to the auction initiator, wherein the auction initiator may be notified of the rejected order and informed of the ongoing related auction. In providing the rejection notification, the auction initiator may be permitted to participate in the ongoing related auction. For example, the notification generated and transmitted to the auction initiator may be comprised of information communicated in an RFA associated with the ongoing related auction.

[0031] If a determination is made that a related auction is not already in progress, then the firm limit order received from the auction initiator may be subject to an additional determination, at step **208**, to ascertain if order parameters (e.g., order size, auction time, etc.) for initiating an auction are satisfied. For example, to initiate an auction on trading platform **110**, a minimum order size of 10,000,000 units may be required. If order parameters submitted in the firm limit order are not permitted, then the order may be rejected, at step **206**, and communicated to the auction initiator.

[0032] If the determinations, at steps **204** and **208**, are satisfied in favor of the firm limit order received from the auction initiator, then a corresponding RFA may be generated, at step **210**. Depending on desired configuration parameters, the RFA may be generated with a limited number of order parameters. For example, in one embodiment, order management module **112** of trading platform **110** may generate a RFA comprising only the order size and time of the auction, and omit pricing information desired by the auction initiator. In another embodiment, order management module **112** of trading platform **110** may generate a RFA with no order parameters at all - e.g., in orders where a reference price is used (described in further detail herein).

[0033] After the RFA is generated, it may be transmitted, at step **212**, to select market participants. Various criteria may be used to determine which market participants may receive the RFA. In one embodiment, market participants **122** already showing liquidity in a particular order book may be selected to receive the RFA. In another embodiment, market participants **122** prepared to bring liquidity may be selected to receive the RFA. In yet another embodiment, a combination of those market participants **122**

already showing liquidity in a particular order book and those market participants **122** prepared to bring liquidity may be selected to receive the RFA.

[0034] It should be noted that any market participants **122** classified in exchange members **120** may send a dark block order during a pre-auction phase, even if the market participant was not a direct recipient of the RFA transmitted by order management module **112** of trading platform **110**. Objective access criteria, as may be defined by order management module **112** and subject to local regulations, may be used in determining which market participants receive the RFA or are permitted to engage in the pre-auction phase.

[0035] Block orders from market participants are received, at step **214**, and a corresponding order book comprising the block orders may be built for use in the auction. Similar to the firm limit order received from an auction initiator, block orders received from market participants, whether in direct or indirect response to the RFA, may be subject to one or more determinations to ascertain whether or not they are qualified to participate in the auction.

[0036] A first determination may be made, at step **216**, to ascertain whether block orders received from market participants wishing to participate in the auction satisfy a predetermined minimum order size. If a minimum order size is not satisfied, the block order received from a market participant is rejected, at step **218**. If the minimum order size is satisfied, then the block order received from a market participant may undergo a second determination, at step **220**, to ascertain whether or not the block order was timely submitted for participation in the auction. If the time for auction has not yet been reached

(also referred to as the "pre-auction phase"), block orders may continue to be received from market participants and entered into the corresponding order book.

[0037] In one embodiment, the time for auction may be a user-defined time period provided by the auction initiator when a firm limit order is submitted and received at order management module **112** of trading platform **110**. In another embodiment, to preventing gaming by market participants, a random timer may be employed. The random timer may randomly adjust a user-defined time period provided by the auction initiator. More specifically, the user-defined time period provided by the auction initiator may be used as input in any one of a plurality of functions of the random timer. For instance, one function of the random timer may be configured to add or subtract a period of time (e.g., +/- 15 seconds) from the user-defined time period provided by the auction initiator. For example, the auction initiator may provide for a time period of two (2) minutes. Using the aforementioned function of the random timer, which is configured to adjust by plus (+) or minus (-) fifteen (15) seconds, the actual time for auction used may be two (2) minutes and fifteen (15) seconds or one (1) minute and forty-five (45) seconds.

[0038] Upon determining, at step **220**, that the auction time has been reached, block orders from market participants are rejected, at step **218**, and an auction price may be determined, at step **222**, based on prices associated with the orders received from market participants, as provided in the order book. In another embodiment, prices for orders received from market participants may not be needed for ascertaining the auction price. Rather, if available, a reference price may be used. A reference price may be an external price that may be determined based on market data retrieved from one or more markets. Additionally, minimum and maximum pricing thresholds may be set around the reference

price to prevent gaming influencing the reference price in the main market place. The minimum and maximum pricing thresholds may be user-defined values provided by the auction initiator or may be defined automatically by the system based on the reference price observed at the time the auction initiator submits the RFA.

[0039] Once the auction price is determined, qualifying orders in the order book may be filled, at step **224**, and any remaining unexecuted orders in the order book may be canceled, at step **226**. Determination of the auction price and filling qualifying orders are discussed in further detail with reference to the process flows illustrated in **FIGS. 4** and **6**.

[0040] **FIG. 3A** illustrates an order book associated with an RFA initiated by a buy order received from an auction initiator, the order book comprising only corresponding sell orders received from market participants. **FIG. 3B** illustrates an order book comprising the resulting transaction at the time of auction based on qualifying sell orders received from the market participants, as provided in the order book illustrated in **FIG. 3A**.

[0041] Referring to the order book illustrated in **FIG. 3A**, an auction initiator ("Buy Side A") may submit an order to buy 10,000,000 units of a security (e.g., bond) at a price of $101.00 per unit. Upon receiving the order from the auction initiator, an RFA is generated and orders may be received from market participants ("Dealer B", "Dealer C" and "Dealer D") in response to the RFA. For example, as provided in the order book illustrated in **FIG. 3A**, a sell order of 7,000,000 units of the security is received from market participant "Dealer B" at a price of 100.55 per unit, a sell order of 5,000,000 units of the security is received from market participant "Dealer C" at a price of 100.75 per unit, and a sell order of 15,000,000 units of the security is received from market participant "Dealer D" at a price of 101.20 per unit. Orders received the market participants in

response to the RFA may be sorted by order price, order size, order time or a combination thereof. As illustrated in **FIG. 3A**, orders received from the market participants are sorted in the order book by at least the order price.

[0042] **FIG. 4** is a flow diagram illustrating a method **400** for conducting a partial book auction corresponding to the order book illustrated in **FIG. 3A**. A partial book auction may only take into consideration orders received from the market participants in response to an RFA, excluding competing orders – i.e., a market participant submitting an order that competes with the firm limit order submitted by the auction initiator.

[0043] Referring to **FIG. 4**, method **400** may be initiated upon receiving, at step **402**, a firm limit order from an auction initiator. In one embodiment, the firm limit order received from an auction initiator may be "dark" – i.e., not visible to a broader market. For example, market participants may only receive information regarding the order size and auction time identified in the firm limit order submitted by the auction initiator. Advantages of this approach may be to encourage market participants to make more aggressive orders, while at the same time minimizing occurrences of price manipulations. In another embodiment, the auction initiator may choose to allow more information associated with the firm limit order to be revealed so as to solicit the interest of more, or a particular group of, market participants.

[0044] Once the firm limit order is received, and made subject to qualifying determinations (as previously described in conjunction with **FIGS. 2A-2B**), an RFA may be generated, at step **404**, to be transmitted, at step **406**, to select market participants. As illustrated in **FIG. 3A**, an order book comprising the auction initiator's firm limit order and orders received from market participants in response to the RFA may be built, at step **408**,

and may continue to receive, at step **412**, orders from market participants (excluding competing orders) until a determination is made, at step **410**, that the auction time has been reached.

[0045] Upon reaching the auction time, as may be designated by the auction initiator at the time of submitting the firm limit order, an auction price for conducting the auction may be determined. Determining the auction price may take into consideration the orders received from market participants, excluding orders competing against the auction initiator, as sorted in the order book of **FIG. 3A**. The auction price selected, at step **414**, may be determined based on the least aggressive price permitting maximum volume execution.

[0046] For example, referring to the order book in **FIG. 3A**, sell orders are received from market participant "Dealer B" for 7,000,000 units at $100.55 per unit, from market participant "Dealer C" for 5,000,000 units at $100.75 per unit, and from market participant "Dealer D" for 15,000,000 units at $101.20 per unit. The following table reflects the resulting buy-side volume and sell-side volume for each of the sell order prices received from market participants "Dealer B", "Dealer C" and "Dealer D".

BUY-SIDE VOLUME	PRICE	SELL-SIDE VOLUME
- 0 -	$101.20	27M
10M	$100.75	12M
10M	$100.55	7M

[0047] The sell price of $101.20 associated with the sell order price submitted by market participant "Dealer D" exceeds the permissible buy price that the auction initiator ("Buy Side A") is willing to pay and, therefore, the sell order submitted by market

participant "Dealer D" is deemed as a non-qualifying order and is not considered in determining the auction price. In view of the foregoing comparison of the buy-side and sell-side volume yielded for the sell orders remaining, the least aggressive price permitting maximum volume execution is $100.75.

[0048] After the auction price of $100.75 is selected, qualifying orders are filled, at step **416**, and any remaining unfilled orders are canceled. Using qualifying sell orders from market participants sorted in the order book, as illustrated in **FIG. 3A**, the resulting transaction order book, as illustrated in **FIG. 3B**, shows sell orders associated with market participant "Dealer B" and market participant "Dealer C" filled at the selected auction price of $100.75.

[0049] **FIG. 5A** illustrates an order book associated with an RFA initiated by a buy order received from an auction initiator, the order book comprising competing buy orders and corresponding sell orders received from market participants. **FIG. 5B** illustrates an order book comprising the resulting transaction at the time of auction based on qualifying buy and sell orders received from the market participants, as provided in the order book illustrated in **FIG. 5A**, favoring the highest competing order received from a market participant. **FIG. 5C** illustrates an order book comprising the resulting transaction at the time of auction based on qualifying buy and sell orders received from the market participants, as provided in the order book illustrated in **FIG. 5A**, favoring the auction initiator.

[0050] Referring to the order book illustrated in **FIG. 5A**, an auction initiator ("Buy Side A") may submit an order to buy 10,000,000 units of a security (e.g., bond) at a price of $101.00 per unit. Upon receiving the order from the auction initiator, an RFA is

generated and orders may be received from market participants ("Dealer B", "Dealer C" and "Dealer D") in response to the RFA. For example, as provided in the order book illustrated in **FIG. 5A,** a sell order of 7,000,000 units of the security is received from market participant "Dealer B" at a price of $100.55 per unit, a sell order of 5,000,000 units of the security is received from market participant "Dealer C" at a price of $100.75 per unit, and a sell order of 15,000,000 units of the security is received from market participant "Dealer D" at a price of $101.20 per unit.

[0051] In addition to the sell orders received from market participants, competing buy orders received after generation of the RFA, but prior to the designated auction time, may be considered and entered into the order book. For example, as provided in the order book illustrated in **FIG. 5A,** market participant "Buy Side B" may submit a competing buy order of 12,000,000 units of the security at a price of $101.20 per unit, market participant "Dealer B" may submit a competing buy order of 7,000,000 units of the security at a price of $100.35 per unit, and market participant "Dealer C" may submit a competing buy order of 5,000,000 units of the security at a price of $100.30 per unit.

[0052] **FIG. 6** is a flow diagram illustrating a method **600** for conducting a full book auction corresponding to the order book illustrated in **FIG. 5A.** A full book auction may take into consideration all orders received from the market participants in response to an RFA, including competing orders – i.e., a market participant submitting an order that competes with the firm limit order submitted by the auction initiator.

[0053] Initial steps of method **600** are similar to those described in conjunction with the partial book auction in method **400** of **FIG. 4.** Referring to **FIG. 6,** method **600** may be initiated upon receiving, at step **602,** a firm limit order from an auction initiator.

Once the firm limit order is received, and made subject to qualifying determinations (as previously described in conjunction with **FIGS. 2A-2B**), an RFA may be generated, at step **604**, to be transmitted, at step **606**, to select market participants. As illustrated in **FIG. 5A**, an order book comprising the auction initiator's firm limit order and orders received from market participants in response to the RFA may be built, at step **608**, and may continue to receive, at step **612**, orders from market participants (including competing orders) until a determination is made, at step **610**, that the auction time has been reached.

[0054] Upon reaching the auction time, an auction price for conducting the auction may be determined. Unlike the partial book auction of method **400**, the full book auction of method **600** employs a different process for determining the auction price. Determining the auction price in the full book auction may take into consideration all orders (i.e., sell orders in response to the RFA and competing buy orders) received from market participants, as sorted in the order book of **FIG. 5A**. The auction price selected, at step **614**, may be determined based on the price permitting maximum volume execution.

[0055] For example, referring to the order book in **FIG. 5A**, sell orders are received from market participant "Dealer B" for 7,000,000 units at $100.55 per unit, from market participant "Dealer C" for 5,000,000 units at $100.75 per unit, and from market participant "Dealer D" for 15,000,000 units at $101.20 per unit. Additionally, buy orders are received from competing market participant "Buy side B" for 12,000,000 units at $101.20, competing market participant "Dealer B" for 7,000,000 units at a price of $100.35 per unit, and competing market participant "Dealer C" for 5,000,000 units at a price of $100.30 per unit. The following table reflects the resulting buy-side volume and sell-side volume for each of the sell order and buy order prices received from all market participants

"Dealer B", "Dealer C", "Dealer D", "Buy side A" and "Buy side B", irrespective of whether or not a market participant is competing with the auction initiator.

BUY-SIDE VOLUME	PRICE	SELL-SIDE VOLUME
12M	$101.20	27M
22M	$101.00	12M
22M	$100.75	12M
22M	$100.55	7M
29M	$100.35	- 0 -
34M	$100.30	- 0 -

[0056] The buy prices of $100.35 and $100.30 associated with, respectively, the competing buy orders submitted by market participant "Dealer B" and market participant "Dealer C" result in zero sell-side volume and, therefore, these buy orders are deemed as non-qualifying orders and are not considered in determining the auction price. In view of the foregoing comparison of the buy-side volume and sell-side volume yielded for the orders remaining, the price permitting maximum volume execution is $101.00. When more than one price yields the same maximum volume, the highest price may be selected.

[0057] After the auction price of $101.00 is selected, a determination is made, at step **616**, as to whether configuration parameters employed by order matching module **114** of trading platform **110** are set to give the auction initiator preference in filling orders. If no preference is given to the auction initiator, then qualifying orders may be filled, at step **618a**, in favor of a competing market participant. Using qualifying orders from market participants sorted in the order book, as illustrated in **FIG. 5A**, the resulting transaction order book, as illustrated in **FIG. 5B**, shows sell orders associated with market participant "Dealer B" and market participant "Dealer C" filled at the selected auction price of $101.00

in favor of competing market participant "Buy side B", wherein competing market participant "Buy side B" is favored due to their buy order size being larger than the buy order size of auction initiator "Buy side A".

[0058] In another embodiment, where no preference is given to the auction initiator, competing market participant "Buy side B" may be favored due to their buy order price being more aggressive (i.e., higher price) than the buy order price of auction initiator "Buy side A". In yet another embodiment, where a reference price is used, rather than prices associated with orders received from market participants, the size and time (instead of the price and time) of orders received may be used to determine priority in filling orders, wherein orders may be filled in favor of a market participant having the largest order and, in those cases where order size is the same between two or more market participants, in favor of the market participant first in time.

[0059] If preference is given to the auction initiator, then qualifying orders may be filled, at step **618b**, in favor of the auction initiator first. Using qualifying orders from market participants sorted in the order book, as illustrated in **FIG. 5A**, the resulting transaction order book, as illustrated in **FIG. 5C**, shows sell orders associated with market participant "Dealer B" and market participant "Dealer C" filled at the selected auction price of $101.00 first to auction initiator "Buy side A" and then with remaining units to competing market participant "Buy side B". In this embodiment, since preference is given to auction initiator "Buy side A", competing market participant "Buy Side B" only receives a partial execution on the competing buy order even though the buy order received from competing market participant "Buy Side B" is larger than the buy order received from auction initiator "Buy side A".

[0060] In another embodiment, an auction may not be initiated by a firm limit order received from an auction initiator, but rather may be initiated automatically by trading platform **110** at a pre-determined time (e.g., where a desired level of liquidity is detected to be available in the market) and conducted based on a reference price dictated in the primary market. Allowing an auction to be organized in this manner may provide yet an even higher degree of protection against information leakage – information about the auction other than the time for participating, which may be randomized (as previously discussed), is not necessarily available to market participants. **FIGS. 7A-7C** are flow diagrams illustrating an embodiment of a method **700** for conducting an auction at a pre-determined time, absent a market participant acting as an auction initiator, utilizing a reference price in a primary market. The auction conducted at the pre-determined time may only take into consideration the reference price, which may be calculated as the midpoint bid/ask price in the primary market.

[0061] Referring to **FIGS. 7A-7C**, method **700** may be initiated upon execution of an action or instruction by trading platform **110** to create, at step **702**, an auction at a pre-determined time. A minimum order entry size and minimum fill size for the auction may be pre-defined, wherein orders failing to meet the minimum order entry size are deemed ineligible and are not permitted to participate in the auction. By way of example and for purposes of illustrating the calculations and corresponding share distributions that follow, the minimum order entry size may be 50,000 and the minimum fill size (MFS) may be 20,000.

[0062] A notification may be transmitted, at step **704**, announcing creation of the auction to market participants. As firm limit orders are received, at step **706**, from market

participants, an order book for the auction is built, at step **708**. Until a determination is made, at step **710**, that an auction time has been reached, orders from market participants continue to be received, at step **706**, and entered, at step **708**, into the order book. When the auction time is reached, the reference price may be calculated, at step **712**, and ineligible orders may be removed, at step **714**, from the order book. An order may be deemed ineligible, for example, if the limit price associated with a sell order is higher than a reference price or if the limit price associated with a buy order is lower than a reference price.

[0063] **FIG. 8A** illustrates an order book that may be built from buy and sell orders received from market participants for the auction. Referring to the order book illustrated in **FIG. 8A**, buy orders are received from market participants "ABC", "DEF", "GHI" and "JKL" and sell orders are received from market participants "MLN", "OPQ", "RST", "UVW" and "XYZ", wherein a corresponding order size (designated by the label "Quantity"), an order time (designated by the label "order n°") and an order price (designated by the labels "Bid" or "Ask") are identified for orders received from each of the foregoing market participants. Although an order price is provided for in the order book, as illustrated in **FIG. 8A**, it may only be used as a parameter for purposes of determining which orders are to be excluded from the auction when compared to the reference price. For example, if the reference price is identified as $100.10 at the time of auction, the limit order price of $100.00 associated with the buy order received from market participant "JKL" is identified as ineligible and removed from the order book.

[0064] After ineligible orders are removed from the order book, the remaining orders in the order book may be sorted, at step **716**. **FIG. 8B** illustrates the order book of

FIG. 8A, wherein the ineligible buy order from market participant "JKL" has been removed from the order book and remaining orders from market participants "ABC", "DEF" and "GHI" on the buy-side and market participants "MLN", "OPQ", "RST", "UVW" and "XYZ" on the sell-side are sorted by their size and time. In one embodiment, orders may be sorted first by their size and then secondarily by their time.

[0065] Once orders are sorted in the order book, method **700** may then proceed to determine the minimum size that all eligible participants in the auction will receive. In order to do so, first the total number of shares available on the buy-side and the total number of shares available on the sell-side are calculated, at step **718**, to identify which side has the lowest and which side has the highest total number of shares to be bought or sold. The side with the lowest total number of shares to be bought or sold is defined, at step **720**, to be the "light-side" and the side with the highest total number of shares to be bought or sold is defined, at step **722**, to be the "heavy-side". Referring to the order book illustrated in **FIG. 8B**, the total number of shares on the buy-side is 370,000 and the total number of shares on the sell-side is 700,000. Accordingly, the buy-side is defined as the "light-side" and the sell-side is defined as the "heavy-side" in the present example.

[0066] Orders received from market participants associated with the light-side will be completely filled. While the number of orders that will be filled on the heavy-side, along with the number of shares that will be distributed for each order qualified for a fill, must be calculated. The total number of shares on the light-side may be used to calculate, at step **724**, the number of orders out of the total number of orders on the heavy-side that are eligible to receive a fill. The calculation, at step **724**, comprises dividing the total number of shares on the light-side by the predefined MFS, wherein the value yielded by

this computation is compared to the actual number of orders on the heavy-side. Thereafter, a determination is made, at step **726**, whether the value yielded by the foregoing computation is greater than or equal to the actual number of orders on the heavy-side. In this particular example, the value yielded by the foregoing computation (i.e., 370,000/20,000 = 18.5) is greater than the actual number of orders on the heavy-side (i.e., 5). Accordingly, all 5 orders identified on the heavy-side, as represented in the order book illustrated in **FIG. 8B**, will receive a fill.

[0067] After the number of orders qualified for a fill on the heavy-side is determined, the maximum execution size (MES) to be distributed per order on the heavy-side may be calculated. In doing so, method **700** may first identify, at step **728**, the order on the heavy-side with the smallest order size. Referring to the order book illustrated in **FIG. 8B**, the order associated with market participant UVW has the smallest order size (i.e., 50,000) on the heavy-side. Thereafter, the MES may be calculated, at step **730**, by dividing the total number of shares on the light-side by the number of orders on the heavy-side qualified to receive a fill, wherein the value yielded by this computation (i.e., 370,000/5 = 74,000) is compared to the smallest order size on the heavy-side (i.e., 50,000), as identified at step **728**. The minimum of these two values, in this particular example 50,000, is selected as the MES and is distributed, at step **732**, to each order on the heavy-side, as reflected in the order book illustrated in **FIG. 8C**.

[0068] Therefore, each of the 5 orders on the heavy-side eligible to receive a fill receives 50,000 shares, thereby resulting in 250,000 shares initially being distributed. The remaining balance of shares (i.e., 370,000 - 250,000 = 120,000) may then be distributed proportionally, at step **734**, to orders on the heavy-side that have not yet been completely

filled, as reflected in the order book illustrated in **FIG. 8D**. For clarity, **FIGS. 8C** and **8D** are order books illustrating, respectively, an initial and final distribution of shares in accordance with method **700**.

[0069] In the alternative, if the determination made, at step **726**, confirms that the value yielded by the computation, at step **724**, is less than the actual number of orders on the heavy-side, one or more orders on the heavy-side may be eliminated to match the number of orders permitted to receive a fill. The difference between the value yielded by the computation and the number of orders on the heavy-side may be identified, at step **727**, so that the appropriate number of orders on the heavy-side is eliminated, at step **729**. For example, if the value yielded by the computation was 4, rather than 5 as in the previous example, then one order on the heavy-side would have to be eliminated. The order selected for elimination may be based on a size/time priority principal, wherein the order represented by the smallest order size and submitted later in time is eliminated first.

[0070] After the appropriate number of orders on the heavy-side is eliminated, at step **729**, the predefined MFS (i.e., 20,000) is distributed, at step **731**, to each of the remaining orders on the heavy-side. Therefore, each of the 4 orders remaining on the heavy-side eligible to receive a fill receives 20,000 shares, thereby resulting in 80,000 shares initially being distributed. The remaining balance of shares (i.e., 370,000 - 80,000 = 290,000) may then be distributed proportionally, at step **733**, to orders on the heavy-side that have not yet been completely filled.

[0071] It should be noted that the sequence of operations described in conjunction with methods **200**, **400**, **600** and **700** may be different from that illustrated, respectively, in corresponding **FIGS. 2A-2B**, **4**, **6** and **7A-7C**. For example, the operations at step **208**

illustrated in method **200** of **FIGS. 2A-2B** may be executed before the operation of step **204**. Similarly, the operations at step **412** illustrated in method **400** of **FIG. 4** may be executed before the operation of step **408**.

[0072] **FIG. 9** illustrates a diagrammatic representation of a machine in the exemplary form of a computer system **900** within which a set of instructions, for causing the machine to perform any one or more of the methodologies discussed herein, may be executed. In alternative embodiments, the machine may be connected (e.g., networked) to other machines in a local area network (LAN), an intranet, an extranet, or the Internet. The machine may operate in the capacity of a server or a client machine in a client-server network environment, or as a peer machine in a peer-to-peer (or distributed) network environment. The machine may be a personal computer (PC), a tablet PC, a set-top box (STB), a personal digital assistant (PDA), a cellular telephone, a web appliance, a server, a network router, switch or bridge, or any machine capable of executing a set of instructions (sequential or otherwise) that specify actions to be taken by that machine. Further, while only a single machine is illustrated, the term "machine" shall also be taken to include any collection of machines that individually or jointly execute a set (or multiple sets) of instructions to perform any one or more of the methodologies discussed herein.

[0073] The exemplary computer system **900** may be comprised of a processing device **902**, a main memory **904** (e.g., read-only memory (ROM), flash memory, dynamic random access memory (DRAM) (such as synchronous DRAM (SDRAM) or Rambus DRAM (RDRAM), etc.), a static memory **906** (e.g., flash memory, static random access memory (SRAM), etc.), and a data storage device **918**, which communicate with each other via a bus **930**.

[0074] Processing device **902** represents one or more general-purpose processing devices such as a microprocessor, central processing unit, or the like. More particularly, the processing device may be complex instruction set computing (CISC) microprocessor, reduced instruction set computer (RISC) microprocessor, very long instruction word (VLIW) microprocessor, or processor implementing other instruction sets, or processors implementing a combination of instruction sets. Processing device **902** may also be one or more special-purpose processing devices such as an application specific integrated circuit (ASIC), a field programmable gate array (FPGA), a digital signal processor (DSP), network processor, or the like. Processing device **902** is configured to execute processing logic **926** for performing the operations and steps discussed herein.

[0075] Computer system **900** may further include a network interface device **908**. Computer system **900** also may include a video display unit **910** (e.g., a liquid crystal display (LCD) or a cathode ray tube (CRT)), an alphanumeric input device **912** (e.g., a keyboard), a cursor control device **914** (e.g., a mouse), and a signal generation device **916** (e.g., a speaker).

[0076] Data storage device **918** may include a machine-readable storage medium (or more specifically a computer-readable storage medium) **928** having one or more sets of instructions (e.g., software **922**) embodying any one or more of the methodologies of functions described herein. For example, software **922** may store instructions to conduct an auction for block order trading. Software **922** may also reside, completely or at least partially, within main memory **904** and/or within processing device **902** during execution thereof by computer system **900**; main memory **904** and processing device **902** also

constituting machine-readable storage media. Software **922** may further be transmitted or received over a network **920** via network interface device **908**.

[0077] Machine-readable storage medium **928** may also be used to store instructions to conduct an auction for block order trading. While machine-readable storage medium **928** is shown in an exemplary embodiment to be a single medium, the term "machine-readable storage medium" should be taken to include a single medium or multiple media (e.g., a centralized or distributed database, and/or associated caches and servers) that store the one or more sets of instructions. The term "machine-readable storage medium" shall also be taken to include any medium that is capable of storing or encoding a set of instruction for execution by the machine and that causes the machine to perform any one or more of the methodologies of the present invention. The term "machine-readable storage medium" shall accordingly be taken to include, but not be limited to, solid-state memories, and optical and magnetic media.

[0078] Whereas many alterations and modifications of the present invention will no doubt become apparent to a person of ordinary skill in the art after having read the foregoing description, it is to be understood that any particular embodiment described and shown by way of illustration is in no way intended to be considered limiting. Therefore, references to details of various embodiments are not intended to limit the scope of the claims, which in themselves recite only those features regarded as the invention.

What is claimed is:

1. A computer-implemented method of conducting an auction, said method comprising:

creating an auction, by a programmed computer, having a minimum fill size, wherein the auction is automatically created based on monitored activity in a market;

transmitting, by the programed computer, a notification of the auction to a plurality of market participants;

building, by the programmed computer, an order book for the auction based on firm limit orders received from the plurality of market participants;

identifying, by the programmed computer, a reference price for conducting the auction, the reference price calculated as a midpoint of bid and ask prices in the market; and

filling, by the programmed computer, qualifying orders received from the plurality of market participants based on the reference price.

2. The method of claim 1, wherein a firm limit order received from a market participant is a dark order, the dark order not being visible to a broader market.

3. The method of claim 1, wherein the plurality of market participants receive limited or no information in the notification as to an auction time.

4. The method of claim 3, wherein an actual auction time is randomized and unknown to the plurality of market participants.

5. The method of claim 1, wherein a firm limit sell order is identified as an ineligible order and removed from the order book when its price is higher than the reference price.

6. The method of claim 1, wherein a firm limit buy order is identified as an ineligible order and removed from the order book when its price is lower than the reference price.

7. The method of claim 1, further comprising designating a buy-side or a sell-side as a light-side or a heavy-side in the auction, wherein the buy-side or the sell-side with the lowest total number of shares is defined as the light-side, and wherein the buy-side or the sell-side with the highest total number of shares is defined as the heavy-side.

8. The method of claim 7, further comprising calculating a maximum execution size, the maximum execution size representative of a number of shares to be distributed to each order on the heavy-side.

9. The method of claim 8, wherein the calculation comprises comparing two values, a first value representative of the smallest order size on the heavy-side and a second value representative of a computational value yielded by dividing the total number of shares on

the light-side by the number of orders on the heavy-side, the maximum execution size being a minimum of the first value and the second value.

10. The method of claim 8, wherein a first distribution of shares is distributed to each order on the heavy-side, each order on the heavy-side receiving the first distribution of shares equal to the maximum execution size calculated.

11. The method of claim 10, wherein a second distribution of shares is distributed to each order on the heavy-side that has not been completely filled, the second distribution representative of a remaining balance of shares on the light-side after the first distribution of shares to each order on the heavy-side, the remaining balance of shares being distributed proportionally to each order on the heavy-side that has not been completely filled by the first distribution of shares.

12. The method of claim 7, further comprising calculating a number of orders eligible to receive a fill on the heavy-side.

13. The method of claim 12, wherein the calculation comprises comparing two values, a first value representative of a number of orders on the heavy-side and a second value representative of a computational value yielded by dividing the total number of shares on the light-side by the minimum fill size, the number of orders eligible to receive a fill on the heavy-side being a minimum of the first value and the second value.

14. The method of claim 13, wherein one or more orders on the heavy-side is eliminated when the minimum of the first value and the second value is less than the number of orders on the heavy-side.

15. The method of claim 14, wherein a first distribution of shares is distributed to each order remaining on the heavy-side after the one or more orders on the heavy-side is eliminated, each order remaining on the heavy-side receiving the first distribution of shares equal to the minimum fill size.

16. The method of claim 15, wherein a second distribution of shares is distributed to each order remaining on the heavy-side that has not been completely filled, the second distribution representative of a remaining balance of shares on the light-side after the first distribution of shares to each order remaining on the heavy-side, the remaining balance of shares being distributed proportionally to each order remaining on the heavy-side that has not been completely filled by the first distribution of shares.

17. A computer system for conducting an auction, comprising:

a memory component;

a processing component coupled to said memory component, wherein the processing component is configured to:

create an auction having a minimum fill size, wherein the auction is automatically created based on monitored activity in a market;

transmit a notification of the auction to a plurality of market participants;

build an order book for the auction based on firm limit orders received from the plurality of market participants;

identify a reference price for conducting the auction, the reference price calculated as a midpoint of bid and ask prices in the market; and

fill qualifying orders received from the plurality of market participants based on the reference price.

18. A non-transitory computer-readable storage medium programmed to include instructions that, when executed by a processing device, cause the processing device to perform a method of conducting an auction, said method comprising:

creating an auction having a minimum fill size, wherein the auction is automatically created based on monitored activity in a market;

transmitting a notification of the auction to a plurality of market participants;

building an order book for the auction based on firm limit orders received from the plurality of market participants;

identifying a reference price for conducting the auction, the reference price calculated as a midpoint of bid and ask prices in the market; and

filling qualifying orders received from the plurality of market participants based on the reference price.