PRE-MATCH RISK VALIDATION OF ORDERS

TECHNICAL FIELD

Embodiments of the present invention presented herein generally relate to pre-match risk validation of orders. More particularly, embodiments presented herein relate to a method and a pre-order validation device for the risk validation of orders submitted to an exchange system, prior to the orders being accepted by the exchange system for matching.

BACKGROUND

Electronic exchanges, or exchange systems, provide users with a fast and efficient way for trading financial instruments. Exchange systems have evolved greatly over the years and take into account a variety of factors when processing orders. In particular, the electronic exchanges are capable of pre-validating orders to determine if an order is too high a risk to match. That is, the electronic exchanges are capable of performing a pre-match risk validation of orders (i.e. before orders are accepted for matching) to determine if an order is too high a risk too match.

Margin calculations, sometimes referred to margin requirement calculations, (e.g., calculations related to the required collateral needed for a derivative portfolio) are made primarily on a portfolio basis. That is, the calculations take into account orders in a portfolio that have been completed (i.e., that have been matched and processed).

There is a general desire to evaluate risk of incoming orders and have the ability to automatically reject orders that will increase the margin requirements above a certain threshold (e.g., the currently pledged collateral value). For example, if a worst case margin requirement is higher than a threshold value for a particular order for an account, then the order should be rejected; otherwise, it should be accepted.

The Standard Portfolio Analysis of Risk (SPAN®) system presently calculates margin requirements for portfolios for a given account. The SPAN® was originally developed by the Chicago Mercantile Exchange in 1988 and is nowadays a widely used system to

calculate margin requirements. The SPAN® methodology comprises a series of calculations, including portfolio stress testing and commodity price correlations that can yield the worst possible performance loss a certain portfolio can suffer over a given time period. To do this, SPAN® generally leverages a set of parameters set by a clearinghouse, or clearinghouse system, reflecting the market conditions of traded financial instruments and allowing the clearinghouse to choose its desired degree of coverage.

SPAN® is generally based on the division of financial instruments in so-called combined commodities, i.e. groupings of instruments that share the same underlying asset. For example, a portfolio containing futures contracts and options on futures contracts are segmented into different bins (combined commodities), where each bin only contains contracts of one specific asset, such as steel or copper to name only two examples. SPAN® then performs a number of calculations, some on each combined commodity separately and some on all combined commodities in a portfolio.

SPAN® calculations yield as a final result an initial margin requirement, aka margin requirement. The margin requirement represents the loss of value of the portfolio in a worst-case risk scenario. The formula for the margin requirement may, e.g., be:

> *Initial Margin Requirement*=max(*Scanning Risk* + *Intermonth Spread Charge* + *Delivery Month Charge* – *Intercommodity Spread Credit, Short Option Minimum Charge)* – *Net Option Value*

Generally, each of the terms in the formula requires a separate calculation and is also performed in different ways on the portfolio.

In other words, in the SPAN® (Delta Hedge) margin model, the margin requirement is calculated by adding (or subtracting) a number of margin components, see hereinabove.

Usually, the dominant component is the scanning risk, as discussed further below, but other margin components are considered as well.

The scanning risk is determined by calculating the theoretical price of each position at multiple different scenario points (e.g., 16). A scenario point is represented by an underlying price and an implied volatility (stressed values compared to the current market price). Within an underlying (or combined commodity), a net calculation is performed where all positions are added in each scenario point, resulting in a profit or loss in that scenario point. A worst case loss at one of these scenario points can represent the scanning risk.

It should be appreciated that the stressed values can refer to the shifting of the underlying price and volatility where the stressed values result in the scenario points where the value of the portfolio is calculated. The term underlying can also refer to what an instrument (e.g., a derivative) will/can turn into upon expiration (when using physical delivery as opposed to cash settlement). As is understood from the above, the term combined commodity is a SPAN® term that can refer to one or more underlyings where an arrangement of combined commodities can be handled by a clearinghouse.

Another margin component is related to an intermonth spread charge. The intermonth spread charge is calculated for groups of orders with the same underlying asset (combined commodity). These orders are assigned to preconfigured tiers, where each tier corresponds to orders with maturities in a specified range. Tier spread charges are then assigned to spreads formed within and between all the tiers in the combined commodity. The magnitude of the spread charges and the order in which spreads are formed between tiers are preconfigured. The sum total of all spread charges in all combined commodities in the portfolio is the intermonth spread charge.

Yet another margin component is related to a delivery month charge. The delivery month charge relates to orders with maturity less than one month, and assigns risk based on the position deltas of these orders. Spreads are formed according to a priority list using the position deltas of the orders in the delivery month and higher maturities. Normally, the delivery month has the highest priority. The spreads are assigned a delivery month spread charge, and for position deltas in the delivery month that cannot

be used to form spreads, the remaining positions are assigned an outright charge (which is usually larger). The delivery month charge is the sum of the delivery month spread charges and the outright charges.

A drawback to the SPAN® model is that it only calculates margin requirements for accounts where transactions that have already been executed. That is, the SPAN® model does not take into account the portfolio and orders awaiting matching (i.e., non-matched, open orders) for a particular account. As a result, it is difficult to evaluate whether an open order will increase or decrease the margin requirement for the account. One solution could be to calculate a margin, or margin requirement, for all possible portfolios that can result from the orders in the orderbook for that account. However, this is problematic because it requires an exponentially high number of possible portfolios (i.e., 2^(# of orders)). Such an exponential amount requires an unreasonably large number of time consuming calculations in order to perform pre-order validation (i.e. pre-match risk validation of orders) in real-time, or in substantially real-time. Thus, it would be advantageous to have a system that provides more efficient pre-order validation calculations so that margin components can be calculated relatively accurately and in real-time, or in substantially real-time.

Another solution could be to also calculate a margin requirement for all possible portfolios that can result from all the orders associated with an account and prevent changes to the portfolio composition that will increase the margin requirements above a certain threshold (e.g., the currently pledged collateral value). However, this is also problematic because it likewise requires an exponentially high number of possible portfolios (i.e., 2^(# of orders)). Such an exponential amount requires an unreasonably large number of time consuming calculations in order to perform pre-order validation (i.e. pre-match risk validation of orders) in real-time, or in substantially real-time. Thus, it would be advantageous to have a system that provides more efficient pre-order validation calculations so that margin components can be calculated relatively accurately and in real-time, or in substantially real-time.

SUMMARY

It is in view of the above considerations and others that the various embodiments of the present invention have been made. Technology is presented that more efficiently calculates a worst case margin requirement for a particular order. The calculated worst case margin requirement may then be compared to pledged collateral for a particular order to determine if the margin, or margin requirement, is above the pledged collateral amount. The calculated worst case margin requirement may also be compared to pledged collateral associated with an account to determine if the margin, or margin requirement, is above the pledged collateral amount associated with the account. If the calculated worst case margin requirement exceeds the pledged collateral, then the order may not be processed (i.e., matched). In determining the worst case margin requirement, several factors may be taken into account including, but not limited to, a scanning risk, an intermonth spread charge, and a delivery month spread charge.

According to a first aspect, there is provided a method performed by a pre-order validation device for pre-match risk validation of orders. The method comprises: receiving from a client system, by a receiver, an electronic data message comprising an order and identification information identifying an account pertaining to said client system; receiving from a clearinghouse system, by the receiver, an electronic data message comprising information associated with a portfolio associated with said account; receiving from an exchange system, by the receiver, an electronic data message comprising information about orders associated with said account; performing, by a processing logic, a risk analysis for said portfolio associated with said account to determine whether the received order will be accepted so that the exchange system is allowed to attempt to match the order; performing, by the processing logic, a risk analysis for said orders associated with said account to determine whether the received order will be accepted so that the exchange system is allowed to attempt to match the order; determining, by the processing logic, a margin requirement value for said account based on the risk analysis performed for said portfolio and for said orders; determining, by the processing logic, if said margin requirement value is higher than a pre-defined threshold value for said account; and determining, by the processing logic, that the

received order is accepted for subsequent matching by the exchange system when the margin requirement value for the account is below or equal to the threshold value for the account.

The method may additionally comprise determining, by the processing logic, that that the received order is rejected for subsequent matching by the exchange system when the margin requirement value for the account is higher than the threshold value for the account.

The method may also comprise transmitting, by a transmitter, the received order to the exchange system for subsequent matching by the exchange system when the margin requirement value for the account is below or equal to the threshold value for the account.

Furthermore, the method may comprise: transmitting, by a transmitter, an electronic data message to the clearing house system, said electronic data message comprising the identification information associated with said account as well as a request to return information associated with a portfolio associated with said account.

Yet further, the method may comprise: transmitting, by a transmitter, an electronic data message to the exchange system, said electronic data message comprising the identification information associated with said account as well as a request to return information about orders associated with said account.

In some embodiments, parameters of the margin requirement value may be determined, by the processing logic, based at least on a scanning risk. The method may further comprise: establishing, by the processing logic, one or several scenario points for said account, each scenario point being based on an underlying price and an underlying volatility; establishing, by the processing logic, for each of the one or several scenario points, a profit or loss; determining, by the processing logic, a worst case scenario point representing a highest loss; setting, by the processing logic, the highest loss in the worst case scenario point as the scanning risk; and modifying, by the processing logic, the

margin requirement value on the basis of the highest loss in the scanning risk. Additionally, the method may optionally comprise: modifying the margin requirement value by adding one or both of the following parameters: an intermonth spread charge and a delivery month charge.

In some embodiments, when establishing a profit or loss for each of the one or several scenario points, the method further comprises: identifying each order that contribute with a loss in each scenario point; and calculating a profit or loss value for each of the scenario points, wherein the calculation is based on a profit or loss value of the portfolio and a loss value associated with the identified orders in each scenario point.

The method may advantageously be performed before an attempt is made, by a matching device (or matching engine) of the exchange system, to match the received order with orders previously stored in an order book of the exchange system.

According to another aspect, there is provided a pre-order validation device for pre-match risk validation of orders before an attempt is made to match a received order with orders previously stored in an order book of an exchange system. The pre-order validation device according to one embodiment comprises a receiver and processing logic. The receiver is configured to receive, from a client system, an electronic data message comprising an order and identification information identifying an account pertaining to said client system; to receive, from a clearinghouse system, an electronic data message comprising information associated with a portfolio associated with said account; and to receive from the exchange system, an electronic data message comprising information about orders associated with said account. Also, the processing logic is configured to perform a risk analysis for said portfolio associated with said account to determine whether the received order will be accepted so that the exchange system is allowed to attempt to match the order; to perform a risk analysis for said orders associated with said account to determine whether the received order will be accepted so that the exchange system is allowed to attempt to match the order; to determine a margin requirement value for said account based on the risk analysis performed for said portfolio and for said orders; to determine if said margin requirement

value is higher than a pre-defined threshold value for said account; and to determine that the received order is accepted for subsequent matching by the exchange system when the margin requirement value for the account is below or equal to the threshold value for the account.

The processing logic may be further configured to determine that that the received order is rejected for subsequent matching by the exchange system when the margin requirement value for the account is higher than the threshold value for the account.

The pre-order validation device may also comprise a transmitter configured to transmit the received order to the exchange system for subsequent matching by the exchange system when the margin requirement value for the account is below or equal to the threshold value for the account.

Also, the pre-order validation device may comprise a transmitter configured to transmit an electronic data message to the clearing house system, said electronic data message comprising the identification information associated with said account as well as a request to return information associated with a portfolio associated with said account.
Yet further, the pre-order validation device may comprise a transmitter configured to an electronic data message to the exchange system, said electronic data message comprising the identification information associated with said account as well as a request to return information about orders included in the order book that is associated with said account.

According to some embodiments, parameters of the margin requirement value are determined, by the processing logic, based at least on a scanning risk. The processing logic may be configured to establish one or several scenario points for said account, each scenario point being based on an underlying price and an underlying volatility; to establish for each of the one or several scenario points, a profit or loss; to determine a worst case scenario point representing a highest loss; to set the highest loss in the worst case scenario point as the scanning risk; and to modify by the processing logic, the margin requirement value on the basis of the highest loss in the scanning risk. The

processing logic may optionally also be further configured to modify the margin requirement value by adding one or both of the following parameters: an intermonth spread charge and a delivery month charge.

In some embodiments, the processing logic of the pre-order validation device is further configured to, when establishing a profit or loss for each of the one or several scenario points, identify each order that contribute with a loss in each scenario point; and calculate a profit or loss value for each of the scenario points, wherein the calculation is based on a profit or loss value of the portfolio and a loss value associated with the identified orders in each scenario point.

In some embodiments, the pre-order validation device is comprised in the exchange system. In other embodiments, the pre-order validation device does not form part of the exchange system, but is rather a separate entity.

BRIEF DESCRIPTION OF DRAWINGS

These and other aspects, features and advantages of the invention will be apparent and elucidated from the following description of embodiments of the present invention, reference being made to the accompanying drawings, in which:

Fig. 1 shows a function block diagram of an example embodiment of an exchange system 300;

Fig. 2 shows an example block diagram of an exchange system 300 performing pre-order validation, or pre-match risk validation, on an order;

Fig. 3 shows an example application flowchart of a method for calculating a scanning risk during preorder validation;

Fig. 4 shows an example application flowchart of a method for calculating an approximate upper bound on an intermonth spread charge during preorder validation;

Fig. 5 shows an example application flowchart of a method for calculating an approximate upper bound on a delivery month charge during preorder validation;

Fig. 6 shows a sample illustration of various scenario points;

Fig. 7 is an illustration showing how a tier structure can be collapsed into one level;

Fig. 8 illustrates that preconfigured intermonth spread charges can be collapsed into one level;

Fig. 9 illustrates two "scenario" portfolios; and

Fig. 10 illustrates an example embodiment of a pre-order validation device in an example environment of pre-match risk validation of orders.

DETAILED DESCRIPTION

In the following description, for purposes of explanation and non-limitation, specific details are set forth, such as particular nodes, functional entities, techniques, protocols, etc. in order to provide an understanding of the described technology. It will be apparent to one skilled in the art that other embodiments may be practiced apart from the specific details described below. In other instances, detailed descriptions of well-known methods, devices, techniques, etc. are omitted so as not to obscure the description with unnecessary detail. Individual function blocks are shown in the figures. Those skilled in the art will appreciate that the functions of those blocks may be implemented using individual hardware circuits, using software programs and data in conjunction with a suitably programmed microprocessor or general purpose computer, using applications specific integrated circuitry (ASIC), and/or using one or more digital signal processors (DSPs). The software program instructions and data may be stored on non-transitory computer-readable storage medium and when the instructions are executed by a computer or other suitable processor control, the computer or processor performs the functions. Although databases may be depicted as tables below, other formats (including relational databases, object-based models and/or distributed databases) may be used to store and manipulate data.

Although process steps, algorithms or the like may be described or claimed in a particular sequential order, such processes may be configured to work in different orders. In other words, any sequence or order of steps that may be explicitly described or claimed does not necessarily indicate a requirement that the steps be performed in that order. The steps of processes described herein may be performed in any order possible. Further, some steps may be performed simultaneously despite being described or implied as occurring non-simultaneously (e.g., because one step is described after the other step). Moreover, the illustration of a process by its depiction in a drawing does not imply that the illustrated process is exclusive of other variations and modifications thereto, does not imply that the illustrated process or any of its steps are necessary to the invention(s), and does not imply that the illustrated process is preferred. A description of a process is a description of an apparatus for performing the process. The apparatus that performs the process may include, e.g., a processor and those input devices and output devices that are appropriate to perform the process.

Various forms of computer readable media may be involved in carrying data (e.g., sequences of instructions) to a processor. For example, data may be (i) delivered from RAM to a processor; (ii) carried over any type of transmission medium (e.g., wire, wireless, optical, etc.); (iii) formatted and/or transmitted according to numerous formats, standards or protocols, such as Ethernet (or IEEE 802.3), SAP, ATP, Bluetooth, and TCP/IP, TDMA, CDMA, 3G, etc.; and/or (iv) encrypted to ensure privacy or prevent fraud in any of a variety of ways well known in the art.

Fig. 1 shows a function block diagram of an example embodiment of an exchange system 300 coupled via a network 200 to a client system 100 configured to create and place orders with the exchange 300 (also referred to as exchange system). The client system 100 can be implemented with and/or used via a personal computer, a PDA (personal digital assistant) device, a cell phone (aka mobile phone), a server computer, or any other system/device for conducting the electronic exchange 300 described herein. It should also be appreciated that the client system 100 can be any individual and/or business conducting electronic trading with the exchange 300. It should also be

appreciated that the exchange system 300 may communicate with a plurality of client systems 100 to match orders.

The client system 100 includes a central processing unit (CPU) 101, a memory 102, and a data transmission device 103. The data transmission device (DTD) 103 can be, for example, a network interface device that can connect the client system 100 to the network 200. The connection can be wired, optical, or wireless and can connect over a Wi-Fi network, the Internet, or a cellular data service, for example. The data transmission device 103 can also be an input/output device that allows the broker system 100 to place the data on a computer-readable storage medium. It should be appreciated that the data transmission device 103 is capable of sending and receiving data (i.e. a transceiver). Data may be received and/or transmitted by way of data packages, i.e. electronic data messages.

The client system 100 can be used for conducting exchange with the exchange system 300. For example, the client system 100 can be used for creating electronic data messages relating to the placement of orders for purchasing or selling of securities and transmitting said electronic data messages to the exchange system 300. The client system 100 can take an order from a user for a derivative instrument, for example, and the exchange system 300 can attempt to match the order.

The exchange system 300 includes a CPU 301, a memory 302, and a data transmission device 303. In an example embodiment, the exchange system 300 may include multiple processors and/or memories and may be designed for fail-safe redundancy. The data transmission device (DTD) 303 can be, for example, a network interface device that can connect the exchange 300 to the network 200. It should be appreciated that the data transmission device 303 is capable of sending and receiving data (i.e. a transceiver).

The exchange system 300 also has a matching engine 304, which can be implemented using one or more processors, for matching orders, an order book memory 305 for storing orders, and a pre-order validation engine 306. It should be appreciated that the order book 305 can exist in the memory 302 of the exchange system 300. Also, it should

be appreciated that the exchange system 300 may comprise several order books (collectively denoted 305 in fig. 3), where each order book may include several orders.

As discussed above, the exchange system 300 can receive an order placed from the client system 100 via, for example, the network 200. Upon receiving an order, the matching engine 304 attempts to match an order with a corresponding order in the order book 305. Prior to matching the order, the pre-order validation engine 306 can perform preorder validation using the methods described herein. In an example embodiment, if the order does not successfully match, the exchange 300 can store the order in the order book 305. It should also be appreciated that the exchange system 300 can also partially match orders in the order book 305.

Fig. 2 shows an example block diagram of an exchange, or exchange system, interacting with a clearinghouse. As can be seen in Fig. 2, an incoming order (e.g., an electronic data message relating to the placement of an order) may have various attributes, such as an indication whether to buy/sell an instrument, a limit price/market price on the order, a quantity, and/or an indication of an account, can undergo pre-order validation. The pre-order validation can use information about positions, as discussed further below, from the clearinghouse and information about orders from the exchange, for each account.

If an order is accepted (after pre-order validation), a matching engine will attempt to match the incoming order with one or more orders in orderbook 1-N. A matched order will result in a trade where an unmatched order can simply be placed in the order book. If the order matches, the trades will be added to the respective account, and the "positions" will be updated based on the matched order. At the clearinghouse, the matched order can be added to a portfolio for a given account where each portfolio can have one or more instruments comprising positions and trades. A position can be a number of long and short contracts in the instrument. The clearinghouse can also handle expirations, option exercises, and perform margin calculations as is known among persons skilled in the art. In the example shown in Fig. 2, the orders can be handled by the exchange system whereas the portfolios can be handled by the

clearinghouse. The pre-order validation according to some of the embodiments described herein is thus advantageous because it can prevent orders from being matched where an account may not have put up enough pledged collateral to cover the order thereby preventing the clearinghouse from potentially losing money from the transaction.

As explained above, one drawback to the SPAN® system is that only the portfolio is evaluated and there is no efficient way for determining a margin requirement that also takes into account live, unmatched orders that are stored in an order book. In non-limiting, example implementations, when an incoming order is received at an exchange, the existing portfolio for that account plus all orders in the orderbook for that account can be evaluated. The evaluation can take into account several SPAN® parameters.

One parameter in particular in the SPAN® calculation is the scanning risk. The system is capable of evaluating scenario points when an incoming order is received. In each scenario point, the profit/loss for all existing positions will be included in the calculation (e.g. scanning risk calculation) and the profit/loss for each order will be calculated. If there is a loss at the scenario point, the order will be included in the calculation (e.g. scanning risk calculation). That is, the worst case in that scenario point is that the order is executed and added to the portfolio. It should be appreciated that an order is an instruction to buy/sell that may or may not be executed. If executed (either wholly or partially), it will result in one trade (or multiple trades if partially executed more than once). The trades can update positions for an account and that instrument. The position for an account and instrument is the number of long and short contracts respectively (accumulated). All positions for an account (i.e., for all instruments) represent a portfolio. Thus, a portfolio will only have trades and not orders. A sample illustration of various scenario points is provided in Fig. 5.

It should be appreciated that a determined profit/loss for a position or an order can be extended with the market value as well as the option premium for orders (not positions) related to the option series. These values can also affect the final margin requirement, and thus it is important to also take these values into account when selecting orders to

be included in the worst case. The evaluation can be calculated by determining orders with a loss plus a paid premium value minus a received premium and minus a market value. In this case, if there is a loss, the order is included and the market value is also included in the same way for positions because it also affects the final margin requirement.

The loss at the worst case resulting scenario point represents the worst case margin requirement for the portfolio plus the worst case collection of the orders being executed. For this worst case calculation of the scanning risk, the number of calculations is proportional to the number of orders instead of the number of calculations being proportional to an exponentially high number of possible portfolios. This allows an exchange, or exchange system, to perform pre-order validation (i.e. in real-time and automatically performs validation on incoming orders instead of having to wait for the orders to be already executed by the exchange. As explained above, the worst case calculation for the scanning risk can be used to determine if the pledged collateral for an account/order is higher than the worst case calculated risk.

In another non-limiting, example implementation, an upper bound approximation on the intermonth spread charge can be calculated and used as the margin requirement or added to the margin requirement. The effect on an intermonth charge of an incoming order is dependent on the existing configuration of orders and tiers already associated with the portfolio. Traditionally, it is difficult to exactly evaluate the marginal intermonth spread charge of a single order without trying all permutations of orders being matched (or not being matched). However, an upper bound approximation of the intermonth spread charge can be determined.

The approximated upper bound of the intermonth spread charge can be calculated by first reducing the tier structure of a combined commodity to a single tier comprising all orders. This tier is then assigned a tier spread charge corresponding to the largest preconfigured tier spread charge. The upper bound approximation reaches its maximum value when all orders under consideration are included in the portfolio, as the single tier intermonth spread charge grows with the number of spreads formed. The maximum

intermonth spread charge is determined by assuming that all orders are matched and put into the portfolio.

An illustration showing how the tier structure is collapsed into one level is provided in Fig. 7.

The preconfigured intermonth spread charges can also be collapsed into one level, as illustrated in Fig. 8.

The upper bound approximation of the intermonth spread charge can be combined with (e.g., by adding) the worst case scanning risk calculation, discussed above, to modify the worst case margin requirement. As it is an upper bound of the intermonth spread charge, the component cannot add more to the margin requirement than determined above and this solution once again helps make it possible for an exchange system to perform pre-order validation in real-time while automatically performing validation on incoming orders instead of having to wait for the orders to execute.

In another non-limiting, example implementation, an upper bound approximation of the delivery month charge can also be calculated. It should be appreciated that a delivery month charge normally only applies for a particular delivery month and any other orders or positions can only transform outrights into spreads. As an example, an underlying might have 8 future instruments (e.g., expiring each quarter for two years to come). Those represent 8 different maturities. For each maturity, there could be several option instruments (call and put of many different strike prices). The future closest to expire as well as all the option instruments for that maturity are said to be for the delivery month. A position (or aggregated deltas for all delivery month instruments in a combined commodity) could have 10 long (positive deltas) and 7 short (negative deltas), with 7 spreads and 3 outrights (on the positive side). As a further example, for other maturities of the same combined commodity, there can be 5 outrights (also on the positive side) and some spreads. An incoming order for a non-delivery month with 2 negative deltas will execute resulting in having 9 spreads in the delivery month. That is, 2 outrights will have been "transformed" into spreads.

Using the assumption that the outright charges are larger than the spread charges, we can ignore these calculations since this would reduce the margin requirement (thereby not providing an upper bound approximation). In analyzing the portfolio(s) for an account, two portfolios are selected with one comprising only orders in the order book with long positions included and one portfolio with only orders with short positions included. The portfolios can be two "scenario" portfolios that both, e.g. together, comprise all the positions in the actual portfolio. The orders are divided based on whether they would contribute with positive or negative deltas. For example, the orders may be divided based on whether they, if executed, would contribute with positive or negative deltas The portfolio with the largest number of outrights is selected as the worst-case portfolio. Two example cases are provided in Fig. 9.

The upper bound approximation of the delivery month charge can be combined with the worst case scanning risk calculation (and the upper bound of the intermonth spread charge approximation), discussed above, to modify the worst case margin requirement. As it is an upper bound of the delivery month charge, the component cannot add more to the margin requirement than determined above and this solution once again helps make it possible for an exchange to perform pre-order validation in real-time while automatically performing validation on incoming orders instead of having to wait for the orders to execute.

Although the above methods can be implemented for any type of orders, the methods are particularly useful for performing preorder validation for derivatives risks. By performing preorder validation with the methods described above on derivatives, a more refined preorder validation scheme is provided that allows for more accurate margin calculations and possibly allowing more incoming orders to be matched.

Fig. 3 shows an example application flowchart of a method for calculating a scanning risk during preorder validation by the matching engine 304. The process begins by receiving an order (S301) from a client system 100, for example. The portfolio of the account placing the order is then analyzed (S302). In a non-limiting, example

implementation the portfolio will consist of multiple positions and each position will be analyzed for each scenario point when determining the scanning risk (S304).

After analyzing the portfolio, the process will then analyze orders in the order book for the particular account placing the order (S303). Similar to the analysis for the positions in the portfolio, the order book, in an example implementation, will contain multiple orders for an account in addition to the incoming order. For each scenario point in the scanning risk calculation, each order in the order book will be analyzed, e.g. for each scenario point (S304).

Upon evaluating the risk with respect to each scenario point (S304), the process proceeds to determine the worst case scenario point in the scanning risk evaluation (S305). The scenario point with the worst case margin is then used to modify the margin requirement (S306). This can be accomplished by simply setting the margin requirement to the worst case scenario point or by adding the value found for the worst case scenario point to the total margin requirement. For example, the margin requirement may also take into account other calculations for various SPAN® parameters (e.g., intermonth spread charge, delivery month charge).

The modified margin requirement (i.e., the margin requirement taking into account the calculated scanning risk) can then be compared to the threshold value for an account to allow an order to execute (S307). In an example implementation, the threshold value will correlate to the pledged collateral required to cover the highest resulting margin requirement for a worst case execution of the order. If the modified margin requirement is higher than the pledged collateral, the system may then reject the order (S308) and likewise if the modified margin requirement is lower than the pledged collateral, the system may accept/execute the order (S309).

A non-limiting, example pseudo-code representation of the example method shown in Fig. 3 is as follows:

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Portfolio consisting of positions P1, P2, ... Pn
Orders O1, O2, ... Om are residing in the orderbook
Order O is incoming
Worst = 0
Loop: Scenario points
        Acc = 0
        Loop: Positions in portfolio
            P&L = - Theoretical price change for Pi - market_value
            Acc = Acc + P&L
        Endloop positions
        Loop: Orders in the orderbook as well as incoming order
            P&L = -Theoretical price change for Oi + premium_paid
                - premium_received - market_value
            If loss (i.e. P&L > 0)
                Acc = Acc + P&L
        Endloop orders
If Acc worse than Worst (i.e. Acc > Worst)
        Worst = Acc
Endloop scenario points
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By calculating the scanning risk in this manner, the required computation resources are significantly more reasonable even when the number of orders in the orderbook for a particular account is growing. This also makes it possible for accurate real-time preorder validation of incoming orders that employ traditional SPAN® methods while also taking into account existing, unmatched orders for a particular account.

With reference to Fig. 3, a non-limiting example embodiment of a pre-validation device 306 as illustrated in Fig. 10 will now be described in more detail. The pre-validation device 306 may be configured to execute the method described with reference to Fig. 3.

To this end, a method performed by the pre-order validation device 306 for pre-match risk validation of orders comprises receiving (S301), from a client system 100, an

electronic data message 1001 comprising an order and identification information identifying an account pertaining to said client system 100. Also, the method comprises receiving (S302) from a clearinghouse system 600, an electronic data message 1002 comprising information associated with a portfolio associated with said account. Yet further, the method comprises receiving (S303), from an exchange system 300, an electronic data message 1003 comprising information about orders associated with said account. A risk analysis for said portfolio associated with said account is performed (S303, S304) to determine whether the received order will be accepted so that the exchange system 300 is allowed to attempt to match the order, e.g. by means of a matching engine 304 of the exchange system 300. Also, a risk analysis is performed (S303, S304) for said orders associated with said account to determine whether the received order will be accepted so that the exchange system 300 is allowed to attempt to match the order. Subsequently, the method continues by determining (S305) a margin requirement value for said account based on the risk analysis performed for said portfolio and for said orders. It is also determined (S307) if said margin requirement value is higher than a pre-defined threshold value for said account. The received order is accepted for subsequent matching by the exchange system 300 when the margin requirement value for the account is determined (S309) to be below or equal to the threshold value for the account. The received order is rejected for subsequent matching by the exchange system 300 when the margin requirement value for the account is determined (S308) to be higher than the threshold value for the account. The method may also comprise transmitting the received order to the exchange system 300 for subsequent matching by the exchange system 300 when the margin requirement value for the account is below or equal to the threshold value for the account.

The method may additionally comprise transmitting (S302) an electronic data message to a clearing house system 600, wherein said electronic data message comprises identification information associated with said account as well as a request to return information associated with a portfolio associated with said account.

Also, the method may additionally comprise transmitting (S302) an electronic data message to the exchange system 300, wherein said electronic data message comprises

the identification information associated with said account as well as a request to return information about orders associated with said account.

Yet further, the method may comprise establishing (S306) one or several scenario points for said account, each scenario point being based on an underlying price and an underlying volatility; establishing (S306) for each of the one or several scenario points, a profit or loss; determining (S306) a worst case scenario point representing a highest loss, setting (S306) the highest loss in the worst case scenario point as the scanning risk; and modifying (S306) the margin requirement value on the basis of the highest loss in the scanning risk.

With continued reference to Fig. 10, an example environment comprises a client system 100, a pre-order validation device 306, an exchange system 300 and a clearinghouse system 600. The client system 100 is used for issuing electronic data messages 1001 including orders. As described earlier, the client system 100 can be implemented with and/or used via a personal computer, a PDA device, a cell phone, a server computer, or any other system/device for conducting electronic exchange described herein. The client system 100 may be operated by any individual and/or business entity (e.g. a broker, dealer, trader or market maker) conducting electronic trading. The client system 100 is exemplified by a single entity in fig. 10, but it should be appreciated that there may exist several client systems 100.

The exchange system 300 is communicatively connectable to the client system 100 via the pre-order validation device 306. Also, the clearing house system 600 is communicatively connectable to the exchange system 300. The pre-order validation device 306 is configured to perform pre-match risk validation of incoming orders as described herein. The pre-order validation device 306 comprises a communication interface (i/f) 306a. The communication interface 306a comprises a receiver (Rx). Also, the communication interface 306a may comprise s transmitter (Tx). Alternatively, transmission and reception functionality may be embodied in a transceiver (Tx/Rx). Moreover, the pre-order validation device 306 comprises processing logic 306b, or processing circuitry. The pre-order comprise a memory 306c. For example, the memory

306c may store computer program, which when run by the processing logic 306b, causes the pre-order validation device 306 to execute one or more of the methods described herein.

As mentioned above, the pre-order validation device 306 is configured for pre-match risk of orders before an attempt is made to match a received order with orders previously stored in an order book 305 of exchange system 300. For example, a receiver (Rx) 306a may configured to receive, from client system 100, an electronic data message 1001. The electronic data message 1001 may comprise an order as well as identification (ID) information identifying an account pertaining to the client system 100 from which the electronic data message (order) was sent.

The receiver (Rx) 306b may also be configured to receive, from the clearinghouse system 600, an electronic data message 1002 comprising information associated with a portfolio associated with said account. In some embodiments, the pre-order validation device 306 may be configured to use its transmitter (Tx) 306a to transmit an electronic data message to the clearing house system 600 for requesting this information. More specifically, the transmitter (Tx) 306a may be configured to transmit an electronic data message to the clearing house system 600, wherein the electronic data message comprises information about the above-mentioned account associated with the client system 100 from which the order was sent as well as a request for returning information of orders associated with said account.

Additionally, the receiver (Rx) 306a may be configured to receive, from the exchange system 300, an electronic data message 1003 comprising information about orders associated with said account. The orders may be stored in one or several order books 305 of the exchange system, as is well-known in the art. In some embodiments the pre-order validation device 306 may be configured to use its transmitter (Tx) 306a to transmit an electronic data message to the exchange system 300 for requesting this information. More specifically, the transmitter (Tx) 306a may be configured to transmit an electronic data message to the exchange system 300, wherein the electronic data message comprises information about the above-mentioned account associated with the client

system 100 from which the order was sent as well as a request for returning information of orders associated with said account.

The processing logic 306b may be configured to perform a risk analysis for said portfolio associated with said account to determine whether the received order 1001 will be accepted so that the exchange system 300 is allowed to attempt to match the order. The processing logic 306b may also be configured to perform a risk analysis for said orders associated with said account to determine whether the received order 1001 will be accepted so that the exchange system 300 is allowed to attempt to match the order. Furthermore, the processing logic 306b may be configured to determine a margin requirement value for said account based on the risk analysis performed for said portfolio as well as for said orders. In other words, the risk analysis can be performed for both the portfolio and the orders. Yet further, the processing logic 306b may be configured to determine if said margin requirement value is higher than a pre-defined threshold value for said account. Still further, the processing logic 306b may be configured to determine that the received order is accepted for subsequent matching by the exchange system 300 when the margin requirement value for the account is below or equal to the threshold value for the account. The processing logic 306b may additionally be configured to determine that the received order is rejected for subsequent matching by the exchange system 300 when the margin requirement value for the account is higher than the threshold value for the account.

Also, the transmitter (Tx) 306a may be configured to transmit, i.e. forward, the electronic data message (order) 1001 to the exchange system 300 for subsequent matching by, for example, a matching engine 304 of the exchange system 300 when the margin requirement value for the account has been determined to be below or equal to the threshold value for the account.

According to one example embodiment, parameters of the margin requirement value may be determined, by the processing logic 306b, based at least on a scanning risk. For instance, the processing logic 306b may be configured to establish one or several scenario points for said account, each scenario point being based on an underlying price

and an underlying volatility; to establish for each of the one or several scenario points, a profit or loss; to determine a worst case scenario point representing a highest loss; to set the highest loss in the worst case scenario point as the scanning risk; and to modify by the processing logic, the margin requirement value on the basis of the highest loss in the scanning risk. Still further, the processing logic 306b may be further configured to modify the margin requirement value by adding one or both of the following parameters: an intermonth spread charge and a delivery month charge (which will be described in more detail hereinafter).

As can be seen in fig. 10, it may be advantageous to provide the pre-order validation device 306 separate from the exchange system to perform the pre-match risk validation of orders. This way, incoming orders can be filtered efficiently before matching attempts are made by, for example, a matching engine 304 of the exchange system 300. However, in alternative embodiments, the pre-order validation device 306 may be embodied as an integral part of the exchange system (see e.g. Fig. 1).

Fig. 4 shows an example application flowchart of a method for calculating an approximate upper bound on an intermonth spread charge during preorder validation by the pre-order validation engine 306. The process begins when the exchange 300 receives an order (S401). Upon receiving the order, the portfolio for the account placing the order is analyzed (S402) as well as the orders in the order book for the particular account (S403).

A preconfigured intermonth tier spread charge is then established (S404) and the overall tier spread charge is set as the max of the preset tier of spread charges. The process can then assume that all orders in the order book are matched and placed in the portfolio (S405) where the process will then determine an approximated upper bound for the intermonth spread charge (S406). In determining the approximate upper bound, the process can loop through all positions in the portfolio plus all orders (orders in the order book plus the incoming order). A number of spreads will be determined based on the total number of long positions determined in the analysis and the total number of short positions determined in the analysis. The spread can then be multiplied by the max tier

spread charge to determine the approximated upper bound on the intermonth spread charge.

It should be appreciated that each instrument can have an associated delta which can range from -1 to +1 (for options it is theoretically calculated based on e.g., strike price, underlying price, and volatility). A position delta is (long - short) * instrument delta. For an order, (buy quantity - sell quantity) * instrument delta can be used. For example, a put option with a delta of -0.5 and a short position of 5 will result in a position delta of 2.5 (positive). For a combined commodity (or for a tier within a combined commodity), the positive deltas and negative deltas can be summarized from different instruments.

Upon determining the approximated upper bound on the intermonth spread charge, the margin requirement can be modified based on the upper bound approximation (S407). Similar to modifying the margin requirement based on the calculated worst case scenario point, the margin requirement can add the calculated upper bound value on the intermonth spread charge.

The modified margin requirement (i.e., the margin requirement taking into account the calculated upper bound on the intermonth spread charge) can then be compared to the threshold value for an account to allow an order to execute (S408). In an example implementation, the threshold value will correlate to the pledged collateral required to cover the highest resulting margin requirement for a worst case execution of the order. If the modified margin requirement is higher than the pledged collateral, the system may then reject the order (S409) and likewise if the modified margin requirement is lower than the pledged collateral, the system may accept/execute the order (S410).

A non-limiting, example pseudo-code representation of the example method shown in Fig. 4 is as follows:
Portfolio consisting of positions P1, P2, ... Pn
Orders O1, O2, ... Om are residing in the orderbook
Order O is incoming

```
Tier spread charge = max of preset tier spread charges
longTot = 0
shortTot = 0
        Loop: Positions in portfolio + orderbook + incoming order
                PosD = Position delta of the position or order
                if(PosD > 0)
                        longTot = longTot + PosD
                else
                        shortTot = shortTot - PosD
                        ## shortTot will be a positive number of negative deltas
        Endlooop
spreads = min (longTot, shortTot)
intermonth spread charge = tier spread charge*spreads
```

Fig. 5 shows an example application flowchart of a method for calculating an approximate upper bound on a delivery month charge during preorder validation by the pre-order validation engine 306. The process begins when the exchange 300 receives an order (S501). Upon receiving the order, the portfolio for the account placing the order is analyzed (S502) as well as the orders in the order book for the particular account (S503).

The orders executing for a determined delivery month can next be determined (S504). In an example implementation, these orders could be for instruments that are near expiration. For example, the delivery month could be the nearest non-expired month within a term of an instrument contract (e.g., an order expiring July 31 with a July delivery month).

Upon determining the orders for a specified delivery month, two portfolios are selected, or constructed. The first portfolio relates to one with only orders in the order book with long positions included (S505) and the second portfolio relates to one with only orders with short positions included (S506). The portfolio with the largest number of outrights is selected (S507) as the worst case portfolio with which to approximate the upper bound

calculation of the delivery month charge. It should be appreciated that spreads represent the number of positive deltas that are balanced by an equal number of negative deltas, and outrights can be deltas on the bid side that cannot be balanced by any remaining deltas on the other side (after the spreads have formed).

The margin requirement can then be modified based on the approximate upper bound calculation of the delivery month charge (S508). Similar to the scanning risk and intermonth spread charge, the delivery month charge can be added to the total margin requirement.

The modified margin requirement (i.e., the margin requirement taking into account the calculated upper bound on the delivery month charge) can then be compared to the threshold value for an account to allow an order to execute (S509). In an example implementation, the threshold value will correlate to the pledged collateral required to cover the highest resulting margin requirement for a worst case execution of the order. If the modified margin requirement is higher than the pledged collateral, the system may then reject the order (S510) and likewise if the modified margin requirement is lower than the pledged collateral, the system may accept/execute the order (S511).

A non-limiting, example pseudo-code representation of the example method shown in Fig. 5 is as follows:
Portfolio consisting of positions P1, P2, ... Pn
Orders O1, O2, ... Om are residing in the orderbook
Order O is incoming

o_charge = preconfigured charge for outright positions in delivery month
s_charge = preconfigured charge for spread positions in delivery month
spr = number of spread deltas in the portfolio for the delivery month
outr = number of outright deltas in the portfolio for the delivery month
side = 1 if outrights are on the long side, otherwise -1
longTot = 0
shortTot = 0

```
        Loop: Orders in the orderbook as well as the incoming order O
                if order is not for delivery month
                        continue with the next iteration of the loop
                delta = Delta of order Oi
                if(delta > 0)
                        longTot = longTot + delta
                else
                        shortTot = shortTot - delta
                        ## shortTot will be a positive number of negative deltas
        Endloop
        if (side > 0)
                new_outr = max (longTot+outr, shortTot-outr)
        else
                new_outr = max (longTot - outr, shortTot+outr)
delivery_month_charge = spr*s_charge + new_outr*o_charge
```

It should be appreciated that the processes described above in Figs. 3-5 can be performed as separate pre-order validations or as one whole pre-order validation. For example, when determining the margin requirement with respect to the scanning risk as shown in Fig. 3, if the order is rejected no further analysis will be carried out where if the order is accepted, the process can then determine the margin requirement with respect to the intermonth spread charge as shown in Fig. 4. Likewise, if an order is accepted after the analysis with respect to the intermonth spread charge, further analysis can be conducted with respect to the delivery month charge as shown in Fig. 5. That is, it is only when the sum of all margin components have been determined to be less than the threshold value that the order will be accepted where acceptance means that the order is sent to the matching engine where other validations can take place.

It should also be appreciated that SPAN® calculations presently take place for accounts (i.e., portfolios) and are carried out by a clearinghouse. The pre-order validation described above can take place before the order reaches the matching engine (and subsequently before it is matched and added to a portfolio in the clearinghouse). In

some embodiments, the calculations can be done on behalf of the clearinghouse which can be the means for the clearinghouse to avoid the risk that a counterparty (e.g.., investor) rapidly sends in orders that if/when are traded result in a portfolio for which it cannot pledge the necessary collateral in the traditional manner (i.e., a situation where the buffer capital in the form of pledged collateral will not be sufficient for the clearinghouse in case the counterparty goes into default at this time). While the technology has been described in connection with non-limiting, example embodiments, it is to be understood that the technology is not to be limited to the disclosed embodiments, but on the contrary, covers various modifications and equivalent arrangements. Thus, the technology is limited only by the accompanying claims and other embodiments than the specific above are equally possible within the scope of the appended claims. As used herein, the terms "comprise/comprises" or "include/includes" do not exclude the presence of other elements or steps. Furthermore, although individual features may be included in different claims, these may possibly advantageously be combined, and the inclusion of different claims does not imply that a combination of features is not feasible and/or advantageous. In addition, singular references do not exclude a plurality. Finally, reference signs in the claims are provided merely as a clarifying example and should not be construed as limiting the scope of the claims in any way.

CLAIMS:

1. A method, comprising:

at an exchange system that includes a memory, a network interface device, and at least one processor:

storing, in the memory, an order book, the order book comprising orders for financial instruments that have been cleared by the exchange system for matching;

receiving, via the network interface device, an electronic data message including an order, the order comprising information associated with an account;

performing, by the least one processor, a risk analysis based on:

portfolios associated with the account ;

the received order; and

orders associated with the account and stored in the order book;

calculating, by the at least one processor, a margin requirement value for the account based on the risk analysis;

determining, by the at least one processor, if the margin requirement value for the account is higher than a threshold value for the account;

clearing, by the at least one processor, the order for matching when the margin requirement value for the account is equal to or lower than the threshold value for the account; and

upon clearing the order for matching, the at least one processor matching the order against one or more orders in the order book or storing the order in the order book.

2. The method of claim 1, wherein components of the margin requirement value calculations are determined based on at least one of a scanning risk, an intermonth spread charge, or a delivery month charge.

3. The method of claim 2, further comprising:

establishing one or more scenario points for the account, each scenario point based on an underlying price and a volatility;

determining, for each of the one or more scenario points, a profit or a loss value;

determining a worst case scenario point representing a highest loss and setting the profit or loss value in the worst case scenario point as the scanning risk; and

modifying the margin requirement value based on the highest loss in the scanning risk.

4. The method of claim 3, further comprising:

identifying, by the at least one processor, each order that contributes with a loss in each scenario point, and wherein determining the profit or loss value for each of the one or more scenario points comprises:

calculating, by the at least one processor, a profit or loss value wherein the calculation is based on a profit or loss value of the portfolios and a loss value associated with the identified orders in each scenario point.

5. The method of claim 3, further comprising:

setting the intermonth spread charge to a predetermined value;

reducing a tier structure having a plurality of tiers to a single tier containing all orders;

assigning a tier spread charge corresponding to a largest preconfigured tier spread charge;

determining an upper bound value of the intermonth spread charge based on the tier spread charge and an assumption that all orders in the order book have been matched; and

modifying the margin requirement value based on the upper bound value.

6. The method of claim 3, further comprising:

determining a delivery month based on a current calendar month;

determining one or more orders in the order book for an account that could match for the delivery month;

calculating one or more portfolios based on the one or more orders in the order book that could match for the delivery month;

selecting a first portfolio having a highest number of long positions;

selecting a second portfolio having a highest number of short positions;

determining whether the first portfolio or the second portfolio has a highest number of outright positions;

selecting either the first portfolio or the second portfolio when the portfolio is determined to have the highest number of outright positions;

determining an upper bound value of the delivery month charge based on the selected first or second portfolio; and

modifying the margin requirement value based on the upper bound value of the delivery month charge.

7. The method of claim 3, wherein the margin requirement value may be modified by adding together one or more of the scanning risk, the intermonth spread charge, and the delivery month charge.

8. A non-transitory computer-readable storage medium having computer readable code embodied therein which, when executed by a computer having a memory, a data transmission device, and one or more processors, causes the computer to perform functionality comprising:

storing, in the memory, an order book, the order book comprising orders for financial instruments that have been cleared for matching;

receiving, via the data transmission device, an electronic data message including an order, the order comprising information associated with an account;

performing, by the one or more processors, a risk analysis based on:

portfolios associated with the account;

the received order; and

orders associated with the account and stored in the order book;

calculating, by the one or more processors, a margin requirement value for the account based on the risk analysis;

determining, by the one or more processors, that the margin requirement value for the account is higher than a threshold value for the account;

clearing, by the one or more processors, the order for matching; and

matching, by the one or more processors, the order against one or more orders in the order book.

9. An apparatus, comprising:

a memory configured to store an order book, the order book comprising orders for financial instruments;

a network interface device configured to receive an electronic data message including an order, the order comprising information associated with an account; and

at least one processor, coupled to the memory and the network interface device, configured to perform functionality including:

performing a risk analysis based on:

one or more portfolios associated with the account;

the received order; and

orders associated with the account and stored in the order book;

calculating a margin requirement value for the account based on the risk analysis;

determining, based on the margin requirement value, whether to clear the order for matching; and

clearing the order for matching.

10. The apparatus of claim 9, wherein components of the margin requirement value calculations are determined based on at least one of a scanning risk, an intermonth spread charge, or a delivery month charge.

11. The apparatus of claim 10, wherein the at least one processor is further configured to perform functionality comprising:

establishing one or more scenario points for the account, each scenario point based on an underlying price and a volatility;

determining, for each of the one or more scenario points, a profit or a loss value;

determining a worst case scenario point representing a highest loss and setting the profit or loss value in the worst case scenario point as the scanning risk; and

modifying the margin requirement value based on the highest loss in the scanning risk.

12. The apparatus of claim 11, wherein the at least one processor is further configured to perform functionality comprising:

identifying, by the at least one processor, each order that contributes with a loss in each scenario point, and wherein determining the profit or loss value for each of the one or more scenario points comprises:

calculating, by the at least one processor, a profit or loss value wherein the calculation is based on a profit or loss value of the portfolios and a loss value associated with the identified orders in each scenario point.

13. The apparatus of claim 11, wherein the at least one processor is further configured to perform functionality comprising:

setting the intermonth spread charge to a predetermined value;

reducing a tier structure having a plurality of tiers to a single tier containing all orders;

assigning a tier spread charge corresponding to a largest preconfigured tier spread charge;

determining an upper bound value of the intermonth spread charge based on the tier spread charge and an assumption that all orders in the order book have been matched; and

modifying the margin requirement based on the upper bound value.

14. A system, comprising:

a memory configured to store data that includes an order book, the order book including orders for financial instruments;

a data transceiver device configured to receive information that includes an order for a financial instrument, the order associated with an account; and

a processor, coupled to the memory and the data transceiver, and configured to perform functionality comprising:

performing a risk analysis based on:

one or more portfolios associated with the account; and

the received order;

calculating a margin requirement value for the account based on the risk analysis;

determining that the margin requirement value for the account is higher than a threshold value for the account; and

matching the order against one or more orders in the order book or storing the order in the order book.